Reducing climatic and disease risks through minimum tillage systems for vegetables

2011 Annual Report

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Summary

Reduced and modified tillage (RT) systems (e.g. no-, zone-, strip) represent strategies to reduce soil degradation and erosion and protect water quality. We have shown that zone and deep zone tillage systems can provide the environmental and economic benefits of an RT system for many vegetable crops without the harvest delays or losses observed in straight no-till. Each season, more vegetable growers express interest or try RT on their farms. To insure continued success, we will now evaluate the ability of RT systems to ameliorate large fluctuations in water supply which may result from climate change. RT systems may reduce crop losses to flooding, drought and vegetable diseases like Phytophthora capsici. We will use on-farm and on-station research, workshops, and field trials to evaluate and then promote RT systems to improve water management and soil quality while reducing disease spread and fuel and labor costs. Our team includes soil and crop scientists, plant pathologists, and vegetable growers from MA and NY. Our case studies will continue to capture grower experiences and innovation. Surveys and grower on-farm research networks will help monitor progress towards our milestones and performance target. Over 500 growers will attend training events or field days on RT systems and 150 will demonstrate new knowledge on how these systems can improve soil and disease management.

Objectives/Performance Targets

As a result of this project's trainings and on-farm trials on reduced tillage systems, 40 growers new to RT will apply these systems on at least 20% of their land (2000 acres total), and report increased management flexibility and timeliness and improved profitability. These production cost savings will average $25 per acre, including fuel (2 gallons per acre or $8/acre) and labor ($10/acre) and income will increase from

Phytophthora capsici susceptible crops by 20% or range from $700 to $4,000 per acre, depending on the crop and market.

Accomplishments/Milestones

Milestone 1

Our field days this summer and fall were well attended by vegetable growers, with almost 200 collective participants at our meetings. Many of the attendees at the UMass Center for Agriculture Field Day reported positive changes in knowledge and the likelihood that they would adopt DZT practices in the future. The Summer Twilight Field Day was promoted by NOFA-NY and attended by both conventional and organic vegetable growers. Five growers from that field day have stated that they would like to try deep zone tillage on their plots. We did not hold a summer field day for reduced tillage on Long Island in 2011, but the organic research plots at LIHREC were part of the Vegetable Tour during the Organic Field Day on August 23, 2011 and the Plant Science Day on September 8, 2011 UMass Center for Agriculture Field Day – Summer 2011 Our work with deep zone tillage was highlighted in two tours during the UMass Center for Agriculture field day. Pits were dug through demonstration plots of field corn and a soil scientist was on hand to show and explain the differences that were visible between the deep zone tillage plots, conventional plots, and no-till plots. We also showcased our on-station trials and distributed literature about general deep zone tillage practices and this project in particular, including information on how [growers] could become involved and request an equipment demonstration on their own farm. We had zone tillage equipment on hand and provided live demonstrations. Attendance at both tours was roughly 60 participants. Comments from the exit surveys were positive. Approximately 50% of the attendees who responded to an exit survey reported an increase in both knowledge of DZT systems and the likelihood that they would adopt a DZT system on their own farm. All of the one hundred eleven attendees were provided with an informational packet that detailed our work with deep zone tillage and contained information on how to contact us if they were interested in using UMass equipment or to request a consultation. NYS Grower Reduced Tillage Videoconference – February 11, 2011 A videoconference titled, “Making Reduced Tillage Work on Your Farm,” was held on February 11, 2011 from 9am to 2:30pm. Sixteen growers attended the Videoconference, which also included cooperative extension and educators from New York State and Massachusetts. Topics included grower evaluations of Deep Zone Tillage equipment, weed and cover crop management challenges and grower experiences with fertility management. Local discussions and evaluations were then conducted for specific sites. Twilight Organic Field Day - August 4, 2011 The Twilight Organic Field Day this year was held at the Organic Research plots of Cornell University’s Homer C. Thompson Research Farm (see figure 1). The event was well attended, with roughly 60 growers, gardeners and those with an agricultural interest in attendance. Approximately three quarters of the participants in the Organic Field Day attended the reduced tillage presentation. Of those that attended the presentation, five growers demonstrated an explicit interest in conducting on farm deep zone tillage trials and in borrowing deep zone tillage equipment. The growers who confirmed their interest were small farm owners and managers, representing Tompkins, Delaware and Niagara Counties. Due to their limitations of tractor size and the small area of their plots, they expressed interest in borrowing our Yeoman’s zone builder, which has been specially built for tractors with lower horsepower. Forty of the growers at the Field Day were given our ‘Guidelines for Deep Zone Tillage in Vegetable Production’ publication. The pamphlet highlights key equipment, field preparation, fertility management and planter setup issues that should be considered when starting a successful deep zone tillage program for vegetables. As part of a future field day we would include a general overview of cover crop techniques to give growers a greater comparison of strip planted

cover crops with the variety of cover cropping practices. Many of the growers we interacted with had only a limited knowledge of cover cropping techniques while others had experience with monocultures and had not used mixes before. LIHREC Vegetable Tour – August 23, 2011 A summer field day on reduced tillage was not held on LI in 2011. A field day was held in November 2010. The reduced tillage research fields at LIHREC were part of the Vegetable Tour during the Organic Field Day on 23 August and Plant Science Day on 8 September. Hadley Twilight Meeting – August 24, 2011 We held our first on-farm Deep Zone Tillage twilight meeting on August 24. The meeting was hosted by two of our cooperating DZT growers. The meeting was attended by at least two dozen growers and other interested parties. Two different zone building implements were demonstrated by cooperating growers, who also shared their experiences using DZT in numerous crop families and under differing soil conditions. All of the attendees who filled out an exit survey indicated a positive change in knowledge, and two of the attendees signed up to experiment with DZT in 2012 using UMass equipment. New England Vegetable and Fruit Conference and Trade Show, December 13-15, 2011 We spoke as part of a 5-part session on reduced tillage at the NEVF Conference and Trade Show. Attendance numbered approximately 110 people. The session included two other talks from a NY and MA grower, who spoke as advocates for the DZT system. NEVBGA Annual Meeting – January 29, 2012 We will be participating in a half-day session on reduced tillage at the New England Vegetable Growers Association meeting in Waltham, MA on January 29 2012. Expected attendance is 70 growers. Miscellaneous Outreach 2011 The UMass Vegetable Program website receives ~165,000 hits annually. The site is currently undergoing a complete overhaul. The new site will include a section dedicated to reduced tillage. If we receive sufficient interest, we will include a grower forum in this section. In addition, this project will be showcased on the UMass Extension IPM Facebook page, launching this winter. Both the Facebook page and the project section of the website will offer clear instructions on how interested growers can contact us for consultation, and will be updated regularly with project activities. Articles on Deep Zone Tillage and an invitation to the project were published in the Vegetable Notes newsletter on April 15 and September 16 (subscription base 1,023). Information about our ongoing Deep Zone Tillage Trials and our financial and logistical support for growers looking to adopt reduced tillage to their vegetable production systems will be published in the January 2012 edition of the Veg Edge Newsletter, a publication distributed by the Cornell Vegetable Program and the Capital District Vegetable & Small Fruit Program.

Milestone 2

The growers who have participated in on-farm Summer field days and conferences, as well as those who have contacted us after learning of deep zone tillage through external sources have been added to the mailing lists offered by our reduced tillage team. The mailing list offers these growers updates on equipment availability, educational meetings or field days, additional information resources and up-to-date contacts. Each grower who has provided contact information and displayed an active interest in conducting deep zone tillage on their farm will be contacted via telephone call and asked to schedule an interview. Depending on the grower’s proximity to our location they will be given the option of borrowing our zone tillage equipment, with the research farm being able to provide transportation of equipment to the cooperating farm. In the case of those farms that are not regionally located, we have made contacts with a number of rental sources of deep zone tillage equipment that we can direct a grower to and help subsidize the cost of loaning and transportation. Six new farmers from New York who have attended our Summer Twilight Field Day and expressed interest in borrowing equipment and conducting deep zone tillage on their farms. These farmers will be contacted in the winter of 2012 and asked to schedule an interview for an

assessment of their farm's needs and disease profile. During this call, a loan period will be determined for which the equipment will be made available for them to use, arranging transportation when necessary. The grower will then receive a consultation over the phone or in-person demonstrating the possible adjustments to the equipment so they might manipulate the zone tillers to fit their planting rows, soil type and cover crop residue. We will work with the grower to develop a management plan that suits the specific nutrient needs of their farm while also accounting for weed and disease pressure and their tractor's rating level. We will subsequently advise the grower on the immediate versus long term shifts in yield and soil health that they are likely to encounter. The grower will also receive instructions regarding cleaning the equipment to prevent soil disease transfer before transportation back to the research farms or other cooperating growers. All growers are encouraged to contact us with questions about deep zone and reduced tillage methods as well as equipment procurement. Most of the interest in deep zone tillage reflects the advantages introduced and discussed in our outreach, as a means of improving drainage, soil organic matter, fuel costs, alleviating timing issues and allowing crops a greater adaptability in the occurrence of an extreme weather event, such as a drought or heavy rain. Many of the growers have moderate issues with standing water and Phytophthora capsici on their farms. Of the growers that attended the Twilight Field Day, only those with lower tractor ratings demonstrated an interest in borrowing our zone tillage equipment, thus favoring the Yeoman's plow which was used in a series of demonstrations and constructed with the tractor capacity of small-farm growers in mind. In Massachusetts, we used our mailing list extensively to provide information to growers. The mailing list consists of newsletter articles and updates about meetings and events. Growers who have expressed interest in deep zone tillage (DZT) by attending a meeting or responding to one of our project announcements are given the opportunity to subscribe to the list. Growers who are interested in experimenting with the system are offered support in the way of farm visits and phone consultation, as well as the use of our equipment, access to reference materials, and probably most importantly, access to our expanding network of grower-collaborators. We are currently scheduling conference calls with growers who have expressed interest in experimenting on their own farms in the 2012 season. Of the seven growers who have expressed interest in using DZT on their farms for the first time in 2011, four have firmly committed and will be using equipment provided by UMass. In return, these growers will allow us to document and evaluate their experiences with the system and participate in educational outreach to other interested growers. In addition, we are in contact with one of the major equipment dealers in our state (Padula Bros., Inc.) to ensure that customers interested in purchasing DZT equipment know that there is technical support available through UMass Extension. We are expanding this relationship to other equipment dealers. Due to time constraints, we were unable to bring our equipment to all the growers that were interested in experimenting with DZT in the 2011 season. These growers are at the top of our list for 2012. We will be in contact with them in late winter 2012 to work out a detailed plan in advance of the planting season. We also have had growers referred to us by NRCS, and are exploring options for working more closely with that organization, as DZT is one of the erosion control practices that farmers can receive EQIP payments for. In addition, we will be posting a call to our email list, website, and Facebook group prior to the 2012 planting season to solicit inquiries from growers interested in learning more about DZT and inviting them to participate in the ongoing discussion. We plan on holding 1-2 formal discussion groups or information sessions in early 2012, as well as covering the topic during our 2012 series of Twilight Meetings. Interest in DZT in the Massachusetts area has ranged from improving drainage, improving soil health, reducing disease impacts, and reducing time and labor costs. The weight individual growers place on each factor depends on the particular constraints and challenges on their farm – for instance, Grower 1 is primarily interested in the time saving aspect as labor costs and his time is the primary constraints to the profitability of his farm. Grower 2, another interested grower, is primarily concerned with improving the

drainage on her farm, as that is a major issue for her. Our growing experience and network of experienced growers allows us to address most grower's interests in the system as well as the challenges they face when using Deep Zone Tillage on their farm for the first time. Currently, the flow of information is mediated by project staff through site visits, email, and phone conversations. Ideally, a critical mass of experience will develop within the community of growers through the efforts of this project and the exchange of information and experience on this topic will rely less on Extension intermediaries and more on direct grower-to-grower communication, albeit often at Extension-sponsored meetings and events. In regards to our ongoing follow-ups and recruitment, we currently have seven farmers in MA outside of our initial 3 cooperating growers who have started using DZT on their farm or are interested in experimenting with DZT in the coming season. We will be working with these growers to provide them with support and information generated by this project and to use their experience to inform our work and ease the path for growers who are considering making the transition to DZT. Seven growers in Long Island expressed their Interest in reduced tillage in the Spring of 2011. These growers are all new to deep zone tillage with their current production of crops being managed through conventional tillage methods. They have cited improving soil health as the main reason for this interest in reduced tillage. Grower 3 purchased a 2-row Unverferth zone builder after attending the video conference conducted in February. He used it for sweet corn in 2011. Growers 4 and 5 borrowed our Unverferth zone builder that is maintained at LIHREC. They used it to prepare ground for planting pumpkins and snap beans, respectively. The remaining four growers were not ready to implement reduced tillage on their farms in 2011, feeling they wanted to first see more results from other farms and research fields. During the 2011/2012 winter season these growers will be contacted individually to learn more about their experiences in 2011 and to discuss their plans for reduced tillage production in 2012. They will also be invited to join the Long Island RT Discussion Group in 2012.

Milestone 3

A videoconference, that included representatives and growers from Massachusetts and New York, was held on February 11, 2011. The videoconference was geared towards farmers new to DZT and those that had previous experience with the system. The structure of the discussion was laid out beforehand and sent as an agenda in order to direct conversation in an efficient manner. It began with growers, who had previously adopted DZT to portions of their farms, providing an evaluation of the various DZT equipment and attachments. A presentation and ensuing discussion on weed and cover crop management challenges was conducted by educators from Cornell and the University of Massachusetts. Growers discussed fertility management in relation to their own experiences, and for the second half of the videoconference, growers and educators were divided into locally specific discussions that included trial sites. We haven't formalized a 'discussion group' for the Massachusetts region aside from the video conference on February 11, 2011 in which we had 16 people, including both growers and extension, participate; we've had numerous independent discussion groups at meetings, a video conference, and one-on-one conversations with growers via email, phone, and site visits. There have been ongoing discussions between extension and growers, as well as extension-mediated discussion between growers, but the extent of these meeting structures have been informal and varying to meet grower's schedules. Most of the discussion that we've facilitated has been a part of the twilight meetings listed above, or through individual and group mediation. One form of mediation that we plan on carrying out is represented by the RT trials of Grower 6 and Grower 7, two farmers who have had success with DZT in pumpkins. We will contact these growers and arrange times to discuss their management techniques for weed control. We will then relay that information to farmers like Grower 8 who have had a difficult time managing weed pressure in their DZT pumpkin plots.

We believe that, given the relatively low number of growers with experience in DZT, a formal discussion group between growers is less likely to be informative without the direct input and heavy mediation by extension agents to support growth and supplement gaps in knowledge. A discussion group will not be able to form an effective and ongoing forum unless the number of growers with direct experience reaches a critical mass. Once more growers become accustomed to DZT, the expectations related to it, and have conducted it for a number of seasons there will be enough experience and shared knowledge to create a sustainable discussion that can accommodate growers new to DZT, as well as those who are attempting to manage their existing systems more efficiently. Currently, we are planning on having a presence at a soil health farmer-to-farmer discussion at Manchester to recruit growers to conduct trials. This winter, we would also like to set up a group farmer/extension discussion, either via telephone or in-person. A discussion group will be started on Long Island this winter with a meeting early in 2012. The meeting will include growers who implemented reduced tillage in 2011 and those who are interested in reduced tillage. The focus of this first discussion session will be growers presenting the observations they made in the 2011 growing season. Feedback from New-to-RT Growers: Grower 9. Grower 9's conventional tillage method consists of moldboard plowing followed by two cultivations. He has 250 acres (150 additional acres in rotation with a rye or clover cover crop) on which 80 acres are strip tilled sweet corn and around 2 to 3 acres of cucurbits and peppers. He currently undergoes a tillage cycle that begins with moldboard plowing in the spring —it is hard to put down plastic if the soil is not loose, due to the presence of sod, rye or clover— followed by DZT in the fall, to break up the plow pan formed in the spring and before planting a rye cover crop. Grower 9 aspires to conduct DZT in the fall on rye and then make beds in the Spring, without any other tillage. He wants to reduce tillage to improve organic matter in his soil and reduce his reliance of fertilizer. Grower 9 has stated he wants to conduct trials again in 2012. He said that one of the main reasons he signed on to do the Yeoman's and Unververth trial was because he was allowed enough time to adjust the machines at his leisure and was able to wait until the ideal day to conduct DZT. He stated that both the Yeoman's and the Unververth have potential for RT and laying plastic on his farm, with the Unververth capable of tilling multiple rows with more efficiency. This spring, grower 9 is planning on growing peppers, squash, tomatoes and maybe cucumbers. Instead of moldboard plowing and two passes of disking, grower 9 is thinking of taking his deep ripper and tilling all his ground with one pass, leaving the between row areas bare. He noted that growing a cover crop in the bare ground between rows was foolish, considering the area was driven over 6 times, killing any cover crop that was there and compacting the soil. He wants to break up that compaction later in the season with deep ripping shanks. Grower 9 also wants to reduce the number of passes by combining multiple rows on a single unit. Grower 19. Grower 19 started with DZT last year on sweet corn and reported that the crop fared better than the conventional plots. He conducted a zone tillage trial this year on sweet corn, cabbage, brussel sprouts, other assorted cole crops, pumpkins and winter squash. The cabbage and brussel sprouts were only zone tilled, so there was no side-by-side comparison. However, he said that the crops were comparable to the years he had tilled the soil conventionally. Grower 19's typical tillage practices consist of one pass for plowing, disking twice and possibly pulling drags over the soil after disking. With DZT he made two passes, unless the ground was especially silty. He said that he saw reductions in fuel usage as it didn't require as much energy to pull the zone tiller through the soil. He said that DZT with fewer passes helped him with timing issues, as he didn't have the help or timing needed for plowing when the weather allowed for ideal conditions. Grower 19 wants to continue using DZT to improve drainage for the years with heavy rainfall as his soil has a lot of clay and sod. Grower 19 has Phytophthora capsici present on his farm, though he could not tell if it would have presented much of an issue this year as he lost many plots to the high winds and flooding from the hurricane.

Milestone 4

Massachusetts Grower 17. Grower 17 began using DZT in 2010 after hearing about it at the NEVBGA meeting in Manchester, NH. He was impressed by what he heard from other growers and from Extension presenters. He used the system on over 30 Acres of sweet corn in 2011, as well as smaller acreage of carrots. In 2012 he plans to increase the acreage and expand the system to cucurbit crops. Many of his fields have a history of Phytophthora blight and he hopes that this system may mitigate losses to this disease. He feels that his crops in DZT fared better than the conventionally planted crops during the dry conditions that persisted for much of the 2011 growing season. He found that weed management and the timing around killing the cover crop were once again challenging in the DZT system, but that the benefits of the system in terms of decreased labor time and possible improved drought tolerance far outweigh these issues. We are supporting grower 17 by sharing the information from this project (both directly and through presentations at grower meetings) and bringing him into a discussion group with other DZT growers. Grower 8. Grower 8's Berry Farm is a 150 Acre farm in MA. Grower 8 grows a mix of vegetables, small fruit, tree fruit, and bedding plants. Grower 8 trialed DZT this year in pumpkins and sweet corn. The sweet corn worked well, but he had serious issues with weed control in his pumpkins that led to drastically increased herbicide use (4 applications compared with 0 in the conventional field) and reduced yield due to weed competition. He currently uses a no-till system for sweet corn, but is interesting in converting it to DZT if he can work it out for other crops. A pumpkin-sweet corn rotation would be particularly useful for him. He will be trialing DZT again in 2012, and adding beans and/or brassica trials. Two additional growers have begun to adopt DZT to their vegetable production systems. We will conduct further interviews and assessments of their observations in the winter. Long Island One grower borrowed the Unverferth zone builder for this project to grow snap beans. Another grower started in 2010 to grow sunflowers for cut flowers at his farm stand using reduced tillage. He has observed no obvious difference in growth compared to sunflowers produced with conventional tillage. Six growers produced sweet corn with reduced tillage in 2011, four of these growers own their own equipment purchased within the past few years (one before the 2011 season and two for the 2010 season). This was the second season using the Unverferth zone builder for this project to prepare ground for planting sweet corn for the fifth grower who has also been using it for reduced-till pumpkin production. Some comments were obtained from growers during summer farm visits. They will be contacted early in 2012 for more feedback and details about their production. Growers have been satisfied with sweet corn crops grown with reduced tillage. Central New York Grower 18. Grower 18 borrowed our Yeoman's plow, which is best suited for his ~68 horsepower, 4-wheel drive tractor, and left the setup as it was with two straight leg shanks for deep ripping. Typically, grower 18 would chisel plow then disk and use a raised bedder before planting into the raised bed. The zone tillage didn't work this year for grower 18 as he was attempting plow into a rye cover crop that had been chopped when it was tall resulting in a heavy residue. The rollers on the Yeoman's kept binding up on the flailed rye. Grower 18 wants to try the DZT system again in the 2012 season on small plots of fall Brassicas, Broccoli and Cabbage, and hopes to mow the cover crop when it is smaller. Grower 18 has Phytopthora present, with more incidence after the heavy rains this season. He feels that Botrytis is a larger problem on his farm and he doesn't have drainage issues. Grower 18 hopes to implement DZT to reduce labor and fuel costs and improve overall soil health. Grower 19. Grower 19 borrowed our Unververth Zone Tillage Unit, using it with 2 straight leg shanks for deep ripping on his ~100 horsepower tractor. He began his DZT trial last year on sweet corn to gain experience and reported that the crop fared better than the conventional areas. He conducted a zone tillage trial this year on sweet corn, cabbage, brussel sprouts, other cole crops, pumpkins

and winter squash. He conducted deep zone tillage on half of his pumpkin and winter squash acreage (~3 acres); the other half was conventionally plowed. He sprayed roundup to manage weeds and oats stubble. He found that he had issues with weed management, but that it was equally distributed across the conventional and deep zone tilled plots. His farm was hit by Hurricane Irene before he was able to harvest, but he said that the the DZT plots produced a good crop and could see no difference between it and the conventional plots. He noted that all crops with DZT produced similar if not the same yields as the conventional. He would like to purchase a 4 row zone tilling unit but is unsure whether it would be financially viable at this time. He has looked into outfitting an older unit. Grower 20. Grower 20 was supposed to receive our Unververth Unit from another grower but did not due to a miscommunication. We have remained in contact with grower 20 who is still interested conducting a DZT trial in the spring 2012.

Milestone 5

New York Grower 9. He planted tomatoes, squash and peppers using the Yeoman's plow and Unververth. We were unable to use the data from the tomatoes and squash as the trial was designed without a side-by-side comparison. The peppers were the only crop with a uniform comparison and were sampled. The peppers were the most uniform stand with no pests and animals and a paired comparison of the same variety planted in conventional and DZT tillage treatments. In the pepper plots, 2 rows were tilled with the Yeoman's and 1 row with the Unververth. A cover crop was grown in the alleyways though after the amount of driving over the same area the cover crop was killed and the soil compacted heavily. Grower 9 also saw an increase in grass pressure in the DZT areas, though it did not become a problem until the fourth harvest, 2 months after planting. Grower 9 observed that the soil under the DZT plastic was lumpy and uneven as compared with the conventional, which had more uniform soil. The plastic and drip tape laid well in both treatments. He reported that DZT cost him 1/3 the amount of labor and approximately ½ the fuel usage. Grower 9 has Phytophthora capsici present in all of his soil but finds that it is only really a problem late in the season (due to careful management) when zucchini and squash are picked from the end of the vines (no longer resting on the plastic). He observed no differences in disease pressure between Phytophthora susceptible plants in DZT and conventional. There were also no observed drainage differences between DZT and Conventional plots. Grower 9 has stated he wants to conduct trials again in 2012. He said that one of the main reasons he signed on to do a Yeoman's and Unververth trial was because he was allowed enough time to adjust the machines at his leisure and was able to wait until the ideal day to conduct DZT. He states that both the Yeoman's and the Unververth have potential for RT and laying plastic, with the Unververth capable of tilling multiple rows with more efficiency. This spring, grower 9 is planning on growing peppers, squash, tomatoes and maybe cucumbers. Instead of moldboard plowing and two passes of disking, grower 9 is thinking of taking his deep ripper and tilling all ground but with one pass leaving the between rows bare, stating that growing a cover crop in the bare ground between rows was foolish considering the area was driven over 6 times, killing an cover crop that was there and compacting the soil. He wants to break up that compaction later with deep ripping shanks. He also wants to build three beds at once, saving fuel and improving carbonization because the ground is only stirred once. Grower 10. This was grower 10's second year conducting DZT using his own Blu-jet 16 row deep zone tiller with a 250-300 horsepower range tractor. He deep zone tilled 600 acres of some sweet corn, soy beans, sunflowers, vine crops and field corn his first year and increased the number to 1000 acres the second year. He conducted DZT on sweet corn but felt like this was a different kind of year with the weather being very hot and dry for much of the season. He observed that the strip tilled plots were much more variable than the conventional plots and did not yield as well. He added that the crops that were mature on time

weren’t desirable because of a lack of uniformity. They would only harvest once, with maybe half of the heads being marketable. The conventionally tilled plots were substantially better. The spots that had a side by side comparison were accidentally plowed, but grower 10 reported that there was definitely a smaller percentage yield (~10% lower). No cover crops were grown for any of the plots. Grower 10 farm soil is a silt loam and his tillage practices consist of plowing everything (DZT and Conventional) in the fall and then disking twice in the Spring before planting. He would also disk once or twice before strip tilling in order to be able to plant in the soil. Grower 10 has no real problems with Phytophthora capsici as they employ rotation schedules and grow mostly corn. He also noted that they had less rain this year than last year. In terms of weed pressure, grower 10 reported no observable differences as he was able to use the same herbicide program on both conventional and DZT and disk before strip tilling. Grower 10 reported that DZT limits his options for planting. He has to often make changes to plots and move crops around once the time to plant arrives. He will not participating in a trial in 2012. Massachusetts Grower 6. Grower 6 has been experimenting with zone tillage on his own since 2009. In 2010 he put three of his fields onto our split-field trials, all of which have some history of Phytopthora blight. Two of the fields were planted to butternut squash and one to sugar pumpkins. Soil health in all fields was ranked 'low' or 'very low' by the Cornell soil health tests with low organic matter, active carbon, aggregate stability, and extractable phosphorus as well as high subsurface hardness being the common constraining factors. Grower 6 is very interested in seeing how deep zone tillage may affect changes in these metrics in comparison to conventional tillage, as well as any potential effects on losses to Phytophthora blight. Grower 6 lost a long term lease this year which put his year 1 experiments out of commission. On one of his three fields he still has control over the DZT half, and the other half will still be conventional so we can compare long term tillage effects but not crop effects, different crops will be planted in each treatment. Grower 6 is still using DZT in many of his crops, and we will continue to work with him, but most of his paired fields are a loss in year two. Infiltrometer readings, bulk density, and Cornell soil health tests will be taken in the last year of the project in his one remaining split field to assess how treatments differ from the baseline information collected in 2010. Grower 11. Grower 11 began experimenting with deep zone tillage in 2010 after seeing a demonstration of the equipment at the 2009 UMass Extension field day cemented his growing interest in the system. This was his first year using the system. He hopes that DZT will reduce the time it takes to prepare fields, improve the timing of planting, and help to rehabilitate some problem fields. Grower 11 has two fields in the study, both are in an area with a long history of phytophthora blight. In both fields soil health was ranked 'low' or 'very low' by the Cornell soil health tests with low organic matter, active carbon, aggregate stability, and extractable phosphorus as well as high subsurface hardness being the constraining common factors. Grower 11 lost one of his year one fields as well. His second field from year one is still working as a split field trial. Infiltrometer readings, bulk density, and Cornell soil health tests will be taken in the last year of the project in his one remaining split field to assess how treatments differ from the baseline information collected in 2010. Grower 12. Grower 12 plowed his DZT fields because he needed some place to plant peppers instead. Growers 6, 11 and 12 have committed 1-3 fields to a three year trial (A total of six fields, in which each field is split between DZT and conventional tillage; the fields are otherwise treated identically in terms on fertility, pest management, and other production practices. Before tillage treatments were applied, we ran a battery of tests including infiltrometer and penetrometer readings and Cornell soil health tests. These serve as our baseline. After the treatements were established and the crops planted, we repeated the infiltrometer readings in each treatment area, as well as sampling above-ground crop biomass and crop emergence. New Growers to DZT: Growers 13 and 14. Their operation is a 150 acre vegetable farm located at the points where Seekonk,Ma; Swansea, Ma; Barrington, RI; and East Providence, RI all come together. Their family has been producing food on the farm since roughly 1900. Growers 13 and 14

now represent the fourth and fifth generations to work the land. They have agreed to put in a long-term split field trial on land that has a history of Phytophthora capsici. This year the split field trial was in sweet corn. We saw equal stand and yield in both trials. They are planning on growing a Phytophthora susceptible crop in 2012. Grower 15. The Farmer's Garden is a 200 acre vegetable farm in Rehoboth, MA. The farm is managed by Grower 15, who recently took over management of the land from his father and expanded into CSA and retail markets as well as wholesale. Grower 15 agreed to establish a long term split field trial on land with a history of Phytophthora capsici and drainage problems. Shortly after planting his father harrowed the whole thing in and re-planted it. Later in the season, grower 15 said that when he was picking he felt that the yield was much better in the part that had been DZT'd despite the harrowing and he's excited to do more. Due to the harrowing we were unable to get crop response data, but do have the baseline Cornell and infiltrometer tests, and are set up well for next year and possible adoption (see figure 2). Growers 1. Founded in 1800, growers 1, a husband and wife team, own a 75-acre farm. They have committed one field to a split-field trial, and are also experimenting with it in other crops. The field where the long term trial is located has heavy soil, with poor drainage. He hasn't had P. capsici in this field yet, but does have it in another field and will likely use DZT as part of his management program there. He had 2.5A in DZT in 2011, and would like to increase that to 15 in 2012. His long term trials (sweet corn) had poor stand in the DZT compared to the conventional, but he feels that with some more time and experience in adjusting the equipment he can easily overcome that hurdle. Yield was roughly equal but hard to estimate as the crop in both treatment areas was largely destroyed by wind and rain – it was laid down flat and partially under water. He also has problems with nutsedge in both the conventional and DZT treatments. We are working with him to develop a cultivation/herbicide regime that will improve his weed management (particularly nutsedge) in both the DZT and conventional areas of the field. Grower 16. Founded in 1908, grower 16's Market Garden is an 80 acre farm in Massachusetts that he manages himself. He implemented a long term split-field trial this year in a field with a history of P. capsici. He planted a crop of butternut this year. Stand was roughly equal between treatments but the crop was destroyed by flooding before harvest data was taken. Growers 18 and 19 in New York attempted to conduct DZT this year but were unable to produce any plots available for sampling due to issues with equipment and flooding. Long Island Six growers on Long Island produced pumpkins using reduced tillage in 2011. Five of these growers have had Phytophthora blight occur in pumpkins on their farms. Two of these growers have a few years of experience with reduced tillage and now only grow pumpkins under this system; it was not possible to conduct a comparison of pumpkins produced with deep zone and conventional tillage on their farms. Blight was not observed in pumpkin fields of the grower with the longest history of producing pumpkins no-till and more recently with reduced tillage. Blight did develop in pumpkin crops at the other farms. Conditions during the 2011 growing season were very favorable for blight. Thus it was not surprising that blight occurred widely. One grower tried reduced tillage by rototilling strips for planting in his rye cover crop. The strips were rototilled twice. The section of his field with reduced tillage included a low spot. Blight developed first in this spot where water pooled. Penetrometer measurements revealed greater resistance in the planted rows that were rototilled than in the rows that were conventionally tilled, documenting the importance of the deep shank component of reduced tillage and the negative impact that rototilling can have on soil. It was not possible to prevent blight from developing throughout the field by disking up affected plants and applying fungicides regularly at least partly due to highly favorable conditions. Effectively managing weeds with herbicides continues to be a major constraint to producing pumpkins with reduced tillage, and often with conventionally-produced pumpkins as well. The main herbicide, Strategy, needs water to be activated. Many growers rely on rainfall because they are not set up to irrigate entire fields at one time. More water is needed with reduced tillage in order to be able to move the herbicide

through straw residue to the soil. High residue cultivator would be a valuable tool for these growers. On-Station Experiments: UMass: In the on-station trials we maintained the long-term plots that were used in the 2010 experiments. This consisted of 4 matched sets of treatments plots. Each set contained one 100x24' DZT plot and one 100x24' conventional (plowed and disked) plot. All plots had winter rye as a cover crop planted during the week of 9/13/2010. The rye in the DZT plots was killed with roundup prior to transplanting winter squash. Squash was transplanted on June 20 2011. Moisture sensors were installed in 3 sets of paired plots, in the row, at depths of six and nine inches. Sensors recorded soil tension at depths of 6 inches and 9 inches every 30 minutes until October 4, allowing us to closely track the soil water dynamics in the two systems. Plants were sidedressed with 19-19-19 during the week of July 11. Harvest samples were taken on September 19. We saw a significant reduction in yield in the DZT plots, both in total number of fruit harvested per plot and the percent of the fruit that were marketable (Figures 3 and 4). Due to unusually dry weather, none of our experimental fields showed signs of Phytophthora blight. Cornell, Homer C. Thompson Research Farm: This past growing season we established a research trial funded by TSF focused on strip planting of cover crops prior to zone tillage, with the goal of improving crop growth and weed management in organic RT systems. We transplanted broccoli in an organic, deep zone tilled system with strip planted, overwintering and winter killed, cover crops. Cover crops were established in fall 2010. Winter-killed, over-wintering or bareground treatments strips were planted, to create areas that would have low levels of residue at the time of zone building. The results of the trial demonstrated that the bare ground control and oat pea in and between rows produced the higher yields than when rye vetch was grown both in and between plots, or when rye vetch was just between plots. Weed control strategies, even with the reduced amount of cover crop residue, remained a challenge. In 2012, we seek to replicate this experiment (for publication) and test alternative mechanical cultivation strategies for high residue ground. A paired broccoli trial was conducted simultaneously with the organic broccoli trial. This trial also had a deep zone tilled system with strip planted, overwintering and winter killed, cover crops with the difference being conventional management through the use of herbicides, pesticides and fertilizer. Our long-term deep zone tillage plot, at the Cornell Homer C. Thompson Research Farm, has had reduced tillage systems in place for the production of large seeded vegetables since 2004 (figure 5), hosting such crops as sweet corn, winter squash and dry beans before this year's trial. A conventional reduced tillage system was established at the Freeville Farm this past year for growing short and long season cabbage. This trial included a randomized complete block design with each replication divided between conventional tillage –with zone tillage conducted afterwards-- and deep zone tillage. Within those tillage treatments were sub-treatments categorizing the form of fertilizer application, the fertilizer rate (0, 120, 180 N/A) and the cultivar variety (long vs. short season). The fertilizer was applied over the plots at varying rates with two subcategories: those plots that had a liquid fertilizer applied during the zone tillage procedure and those that did not. Certain plots received a side dressing of ammonium nitrate. Two varieties of cabbage were grown: a long season variety and a short season variety. The cabbage were grown in the greenhouse and then moved to cold frames to become hardier just before transplanting. At planting, all plots were given starter fertilizer applied to the zone tilled trench underneath the transplants. Even with herbicide applications, weed pressure remained a persistent issue. A thorough in-row and between-row hand weeding was conducted before harvest time. There was an incidence of white mold (Figure 9) near the end of the season after a short period of heavy rain. The mold affected a significant percentage of the cabbage plants with the impact on the short season variety being much greater (over half) than the long season variety (less than 25%). The DZT treatments proved to result in similar yields to the conventional treatments (figure 6). In addition, an analysis of our soil moisture probes at a 6 inch depth showed that the DZT plots had higher soil moisture levels that were significantly different from the conventional plots (figure 8, table 1). The 9 inch

depth probes displayed that the DZT plots had lower moisture levels but greater stability than the conventional (figure 7). Cornell University Agricultural Experiment Station in Geneva: In the fall of 2010 a designated portion of a field at the Phytophthora blight farm at the Geneva Experiment Station was zone tilled and subsequently inoculated with cull-fruits that were infected with Phytophthora capsici. The soil type in the trial was an Odessa silt loam, which is a poorly drained soil formed in clay lacustrine deposits. In late spring, the conventional section of the field was plowed and disked. The trial was arranged in a block design with four replications. In the reduced tillage section the zones were previously ripped 30” apart and for the conventional tillage the rows were spaced 30” apart. Red Knight pepper transplants where acquired from a commercial greenhouse on 23 June. Soil samples, penetrometer and infiltrometer readings were done on 5 July. Peppers were transplanted into the field 13 July. During the transplant process liquid fertilizer (22-0-0) at 40 lbs/A was applied. Transplants in both sections were spaced 12”apart. The trial was inoculated on 1 August using a media mix of V8 juice and vermiculite inoculated with Phytophthora capsici (65 mL/ft2) which was evenly applied on the soil surface around the base of the plants. Monthly rainfall was 0.72 and 6.84 in. for July and August respectively. Due to the dry conditions in July and to promote transplant growth overhead irrigation was applied on 15, 18, 21 and 25 July. Disease severity of Phytophthora blight was rated on 17 August and 2 September. Disease incidence was recorded for leaf and stem lesions and fruit (if fruiting) in 10 consecutive plants for each tillage methodology in each replication (See table 2). EVALUATION OF REDUCED TILLAGE PRODUCTION SYSTEM FOR PUMPKIN Investigators: M. McGrath, S. Menasha, and L. Hunsberger Location: Long Island Horticultural Research and Extension Center The primary goals of this multi-year project are to investigate changes in soil health and compare crop growth over successive years of implementing reduced tillage practices. A replicated experiment was conducted in 2011 to compare pumpkin grown under a reduced tillage system with pumpkin grown using conventional tillage in a research field that has only been used to study reduced tillage since 2004. The cover crop in this field was fall-seeded rye. Two timings for killing the cover crop were examined in 2011. In the reduced-till plots the cover crop was rolled with a coulter packer then sprayed with the herbicide Round-up. This was done on May 3 in replications 1 and 2 when rye was about 24 in tall and on May 28 in replications 3 and 4 when rye was full grown (about 48 in tall) and shedding pollen. A 2-row Unverferth zone builder was used to establish the rows in all replications on June 16. The conventional-till plots were established by mowing the cover crop on May 25, removing extra straw by baling it, then roto-tilling and disking to prepare the soil for planting. On June 28 pumpkin (cv Field Trip) was direct-seeded into all conventional and reduced-till rows with 625 lb/A 19-10-9 controlled release fertilizer applied by the seeder in 2 bands about 2 inches from the seed on both sides. Weed control in the pumpkins was accomplished by applying herbicide at planting and using a hand-operated roto-tiller in the conventional-till plots and a hand-operated sickle-bar mower in the reduced-till plots in late July. Strategy (3 pt/A) plus Sandea (0.5 oz/A) were applied immediately after seeding. The field was irrigated the day after applying herbicide. Plots were three approximately 300-ft-long rows at 68-in spacing. Biomass measurements were taken during the season, and yield was measured at maturity. Soil health measurements including infiltration and penetration were taken. Plant growth was visibly better in the reduced-till plots than the conventional-till plots. Rye was visibly taller in the spring. There was more weed growth in the reduced-till plots where the rye cover crop was killed early than at full growth. Estimated total weight of fruit was numerically greater for both sets of reduced-till plots compared to the conventional-till plots (Table 3). There were few significant differences in yield. Late in the season, slug and grub pests impacted fruit quality due to feeding damage on the ground-side of fruit, which affected their ability to remain marketable through the fall. The reduced tillage plots had on average 20% insect-damaged fruit, while there were 36% damaged fruit in the conventional till plots. These pest populations may have

developed to damaging levels because through the field there are five permanent driveways with grass and clover, which provides favorable habitat. A very few fruit with Phytophthora fruit rot were observed at the low end of the field in both reduced-till and conventional-till plots. EVALUATION OF REDUCED TILLAGE PRODUCTION SYSTEM FOR BUTTERNUT SQUASH Investigators: M. McGrath, S. Menasha, and L. Hunsberger Location: Long Island Horticultural Research and Extension Center The primary goals of this multi-year experiment are to investigate changes in soil health and compare crop growth during the first years of implementing reduced tillage practices. Before 2010 the field was plowed and conventionally tilled every year. Spring cover crops of oats or annual ryegrass were seeded in mid April after disking in 10-10-10 fertilizer at 500 lb/A. The amount of cover crop growth obtained was moderate with the oats and less with the ryegrass compared to what can be obtain with a standard rye winter cover crop. The cover crops were rolled June 21. The conventional-till plots were roto-tilled and disked to prepare the soil for planting. A 2-row Unverferth zone builder was used to prepare the rows in the reduced-till plots. On July 6 butternut squash (cv Quantum) was direct-seeded into all rows with 625 lb/A 19-10-9 controlled release fertilizer applied in 2 band by the seeder. Weeds were controlled by applying Strategy (3 pt/A) plus Sandea (0.5 oz/A) immediately after seeding. The field was irrigated after applying herbicide. Each replication was 3 rows wide (5.5’ apart) with the field divided in half with cover crop (spring oats or ryegrass) randomly assigned to each half. Soil health measurements including infiltration and penetration were taken. Soil moisture was monitored at 4, 8 and 12 inch depths. Fruit was harvested October 10 in a grid of 3 rows by 25’. There were no differences between tillage treatments or spring cover (Table 4). Though not statistically significant, the oat cover crop, combined with the reduced tillage, produced both more marketable fruit and more total fruit. REDUCED TILLAGE LONG ISLAND ON-FARM RESEARCH 2011 Investigators: M. McGrath, S. Menasha, K. Sanwald, P. Priolo and L. Hunsberger Location: Various Farms on Eastern Long Island Five growers produced sweet corn using reduced tillage. Only one grower did not have a comparison area planted with conventional tillage. An area was located with appropriate plant stands and a 50’ area was measured. Five random plants were chosen and were cut at ground level, chopped into smaller pieces, placed into labeled paper bags and pre-dried in a hot, dry greenhouse. Drying was continued in a drying oven and dry weights were recorded. Soil health measurements including infiltration and penetration were taken. Yield was measured at crop maturity. Corn plant biomass in mid-season was often greater in the reduced-till than the conventional-till sections of the grower fields (Table 5). Pumpkin crops were grown with reduced tillage at six farms on Long Island in 2011. Weed control was a challenge in some fields. Phytophthora fruit rot was widespread in 2011 on Long Island. It did not occur in two farms, one farm does not have a history of this disease. At another farm, Phytophthora fruit rot was only observed in the reduced-till section, where weed control was unacceptable. At another farm, Phytophthora fruit rot started in a low spot in the reduced-till section. However, this grower did not use deep zone tillage but rather used a small roto-tiller to prepare strips for planting. Evaluation of Reduced Tillage Production System

Milestone 6

The level of grower interest in these systems is high and still growing. We will continue providing research-based information and facilitating the farmer-to-farmer exchange of practical information and skills. We have had numerous requests for the use of UMass and Cornell DZT equipment for the 2012 growing season. Growers have, overall, been satisfied with their sweet corn crops produced with reduced tillage, thus this acreage is most likely to be increased. However, these growers will always have some conventionally-tilled corn because the earliest crops need tillage and plastic to promote crop growth to

achieve early yield. Despite challenges producing pumpkins successfully with reduced tillage, most growers who have tried this production system are committed to continuing to use it. They have found that the DZT process opens up a larger soil profile for the plants and aids in the drainage of water which is good for pumpkins when managing Phytophthora. For a successful Pumpkin stand, DZT is also typically conducted alongside varying cover cropping techniques aimed at creating a mulch layer that will keep the pumpkins clean for direct marketing or wholesale. Grower 17 plans to increase the acreage and expand the system to cucurbit crops in 2012. Grower 9 is planning on growing peppers, squash, tomatoes and maybe cucumbers, increasing the acreage for trials he conducted in 2011. Grower 18 is going complete DZT on a trial area in 2012, which he was not able to complete in 2011 due to heavy cover crop residue.

Impacts and Contributions/Outcomes

Interest amongst our target audience (professional growers) remains high, but the most interesting piece that has emerged from this that is not detailed in the section above is the interest the project has generated in our non-target audiences. The soil scientists attached to the project have found the preliminary data generated by the on-station trials and demonstration pits compelling enough that they are developing a grant proposal to look more closely at the effects of the DZT system on soil microbial communities and the subsequent effects on soil health and crop response. In addition, the fact that DZT is supported under the NRCS EQIP program in Massachusetts opens up possibilities for collaboration and synergy. This project has also generated a renewed interest and concern for soil health among the Extension staff involved with it. While soil health has always been a major concern and topic of our educational programs, the information provided by this project in the form of soil health tests, infiltration rates, and other direct measures has brought home just how damaged many of our agricultural soils are. Even soils that we have considered prime farmland are suffering from badly depleted organic matter, low aggregate stability, high sub-surface compaction, and other serious constraints. In a time when environmental challenges seem to be increasing – extreme rainfall, drought, etc – building a healthy soil is a key component in increasing the resiliency of our farms. This project has renewed our commitment to working with growers on this critical piece of farm management. The 2011 growing season was a challenging year to implement and test reduced tillage. Rainy weather in June affected planting and herbicide treatments. Conditions in July were very dry which led to soil crusting that affected emergence and soil drainage. Several unusually intense rain events beginning in mid-August provided ideal conditions for development of Phytophthora blight, resulting in the worst outbreak of this disease on Long Island. In addition, the heavy rains brought on by Hurricane Irene did a great deal of damage to some areas of Central New York, with others remaining relatively untouched. Grower 10 had to plow one field because of the adverse soil conditions after the rain. Grower 19 lost a significant portion of his crop due to flooding. Grower 21 did not participate in the project this year; the heavy precipitation this spring put him behind schedule for planting his crops, making it difficult to focus on any projects. The level of Phytophthora capsici on his farm appears to be unmanageable. The majority of farms participating in our on-farm trials are either expanding their DZT this coming year or keeping it the same as last year with the exception of one. Grower 10 will no longer be conducting DZT as he believes it will limit his ability to be flexible with changing plantings and low risk management. He observed that the strip tilled plots were much more variable than the conventional plots and did not yield as well. He added that the crops that were mature on time weren't desirable because of a lack of uniformity. Grower 19 said that all the crops with DZT produced similar if not the same yields as the conventional. He started with DZT last year on sweet corn and reported that the crop fared better than the conventional areas. He hopes to conduct DZT on more cucurbit crops this coming year. His farm was hit by Hurricane Irene before he was able to harvest, but he said that the DZT plots produced a good crop and could see no difference between

it and the conventional plots. He would like to purchase a 4 row zone tilling unit but is unsure whether it would be financially viable at this time. He has looked into retrofitting an older unit. Grower 18 said that the zone tillage didn't work this year as he was attempting to plow into a rye cover crop that had been chopped when it was tall resulting in a heavy residue. He plans on managing his cover crop earlier next year in order to implement DZT effectively.

Grower Verification Forms

Attached are the grower verification forms.

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Attachments:

Figure 2: Infiltrometer tests at Grower 15's farm.: http://mysare.sare.org/mySARE/assocfiles/943585Figure 2.docx
Figure 4: Conventional vs DZT, percent of marketable heads produced.: http://mysare.sare.org/mySARE/assocfiles/943585Figure 4.docx
Figure 6: Analysis of Cabbage yield between conventional and DZT treatments. The analysis shows that some of the DZT treatments produced similar yields to the Conventional treatments (not significantly different –circled in red).: http://mysare.sare.org/mySARE/assocfiles/943585Figure 6.docx
Figure 8: Soil Moisture sensors at 6 inch and 9 inch depths for conventional and DZT plots. The lower kPa (closer to 0 on Y-axis) represents higher moisture levels. : http://mysare.sare.org/mySARE/assocfiles/943585Figure 8.docx
Table 1: DZT plots are significantly different from conventional plots at 6 inch depth. DZT plots have higher moisture levels (lower kPa levels) than conventional at 6 inch depth. These moisture levels are maintained longer than conventional. The DZT treatment at 9 inch depth shows greater stability in moisture levels than conventional.: http://mysare.sare.org/mySARE/assocfiles/943585Table 1.docx
Figure 9: Example of white mold on cabbage head.: http://mysare.sare.org/mySARE/assocfiles/943585Figure 9.docx
Table 2: Qualitative assessment of disease incidence by leaf and stem lesions.: http://mysare.sare.org/mySARE/assocfiles/943585Table 2.docx
Table 4. Plant growth and yield of butternut squash produced under conventional and reduced tillage. Yield was assessed for a 25-ft section of the three rows in each plot.: http://mysare.sare.org/mySARE/assocfiles/943585Table 4.docx
Figure 1: Conventional and Organic Growers collect at the main tent after a demonstration at the Twilight Organic Field Day (Aug. 4, 2011).: http://mysare.sare.org/mySARE/assocfiles/943578Figure 1.docx
Mike Candella Verification Form: http://mysare.sare.org/mySARE/assocfiles/943630NESARE Verification Sheet- mike candella 12_31_11.docx

Pete Reading Verification Form: http://mysare.sare.org/mySARE/assocfiles/943630Pete Reading Verification Sheet 12-30-11.docx
Table 3. Plant growth and yield of pumpkin produced under conventional and reduced tillage. Yield was assessed for a 25-ft section of the three rows in each plot.: http://mysare.sare.org/mySARE/assocfiles/943585Table 3.docx
Figure 3: Yield Counts – Conventional vs DZT, by Average Number of Total Fruit (marketable and unmarketable), Average Numbers of Marketable and Unmarketable Fruit : http://mysare.sare.org/mySARE/assocfiles/943585Figure 3.docx
Figure 5: Long-term deep zone tillage plot of cabbage. : http://mysare.sare.org/mySARE/assocfiles/943585Figure 5.docx
Table 5. Comparison of conventional and reduced till grown corn on Long Island, 2011. : http://mysare.sare.org/mySARE/assocfiles/943585Table 5.docx
Paul Martin Verification Form: http://mysare.sare.org/mySARE/assocfiles/943630NESARE Verification Sheet-paul martin 12-30-11.docx
Figure 7: Soil moisture readings at 6” and 9” depth for DZT and Conventional plots. The smaller amplitudes on the 9” depth DZT (light blue line), as compared with the 9” conventional (green line), shows less fluctuation in water (more stable). The DZT plots (light and dark blue) retain higher moisture levels as compared to the conventional. : http://mysare.sare.org/mySARE/assocfiles/943585Figure 7.docx
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