No-till vegetable production: soil health, weed control, and crop yields
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Building healthy soils, integrating cover crops, and managing weeds are key elements of vegetable farms. The use of no-till and cover crops provide a wealth of soil benefits thereby improving the productivity of the farming systems. However, due to limited agricultural land, farmers often have increasing pressure to keep greater portions of their land in cash crops. Cover-crop based no-till practices allow farms to gain the benefits of cover crop rotations while still earning a financial return from the land.

No-tillage cropping systems are known to provide many benefits to soils that can improve crop productivity. Those benefits include better soil aggregate size and strength which means better soil structure, better infiltration, lower bulk density, better water holding capacity, decrease in erosion, and improved water quality. Other benefits include higher cation exchange capacity, which results in higher soil nutrient holding capacity and greater potential mineralizable nitrogen (increased soil nitrogen bank). Additionally, no-till contribute to increased organic matter (carbon) which serves as a food source for soil microbes. Soil microbes are responsible for the decay of organic matter and cycling of both macro-and micro-nutrients back into forms that plants can use.

Though no-till systems offer a multitude of soil building as well as weed control benefits, implementation is limited, particularly in cooler climates like New England with shorter growing seasons. Correct management of cover crops used in no-till practices is critical because mismanagement can lead to undesired consequences, including serious weed issues rather than effective weed control.

No-till and cover crop acres were increased significantly in Connecticut from 2012 to 2017. No-till acres was 18,153 acres (487 farms) according to 2017 Census of Agriculture, which was 54% increase from 2012. The cover crops acre was ~22,000 acres in 2017, which was 7.6% greater than 2012 (Soil Health Institute, 2019).

In this article, I present farmers’ experience and some research evidence that show the use of no-till and cover cropping can provide a wealth of soil benefits thereby improving the farm profitability.

Bryan O’Hara and Anita Johnson have been growing vegetables for a livelihood since 1990 at Tobacco Road Farm in Lebanon, Connecticut. Over the last twenty plus years of intensive vegetable growing at the farm, they constantly sought ways to improve the health and vitality of crops and soils.

“We slowly moved into no-till over the course of many years with experimentation. So, I do like to caution people to make sure it works for you before you put your whole farm into a new system because there are a lot of details.” Bryan says “We switched into no-till because we saw very strong improvement in crop health, less disease pressure, quite stunning results in plant disease and insect resistances, and very reduced need for weed control. We also saw the improvement in soil structure that resulted in much less irrigation needs. All of which resulted into greater profitability because crops were more vigorous, easier to harvest, stored better, and needed less labor.”
An experiment in Blacksburg, VA, tested the effects of three cultivation techniques (conventional-till, strip-till, and no-till) on ‘Gladiator’ pumpkin production, weed pressure, soil moisture, and soil erosion in 2014 and 2015 (O’Rourke and Petersen, 2016). Overall yields were higher in 2015, averaging 20 tons/acre, compared with 17 tons/acre in 2014. In 2014, pumpkin yields were similar across tillage treatments. In 2015, the average fruit weight of no-till pumpkins was significantly greater than strip-till (13%) and conventional-till (22%) pumpkins. Weed control was variable between years, especially in the strip-till treatment. Soil moisture was consistently highest in the no-till treatment in both years of study. Conventional-till pumpkin plots lost ~9 times more soil than the two conservation tilled treatments during simulated storm events. The 2015 yield advantage of no-till pumpkins seems related to both high soil moisture retention and weed control. Research results suggest that no-till and strip-till pumpkin production systems yield at least as well as conventional-till systems with the advantage of reducing soil erosion during extreme rains.

Jamie Jones of Jones Family Farm in Shelton, CT practices no-till pumpkin production. Figure 2 taken in mid-April shows winter rye with an herbicide strip where the pumpkins will be planted in June. “We will roll the rye with a roller crimper when the rye starts shedding pollen, averaging sometime late in May”. Jamie says “We planted this winter rye late September or early October in the last fall. It followed a cover crop of sorghum sudangrass that was planted after the strawberry field was turned under in early July”.
Another research was conducted at University of Massachusetts Amherst to evaluate the nutrient cycling and weed suppressive benefits of forage radish (*Raphanus sativus* L.* longipinnatus*) cover crop mixtures to develop an integrated system for no-till sweet corn production (Fine, 2018). Treatments included forage radish (FR); oats (*Avena sativa* L.) and forage radish (OFR); a mixture of peas (*Pisum sativum* subsp *arvense* L.), oats and forage radish (POFR); and no cover crop control (NCC). Fall-planted forage radish cover crops showed successful weed suppression and recycling of fall-captured nutrients. Results indicated that POFR and OFR provided improved N cycling and sweet corn yield compared with FR and NCC. Early season N from decomposing cover crop residue was sufficient to eliminate the need for N fertilizer at sweet corn planting, thereby reducing input costs and risks of environmental pollution.

Steve Munno, the Farm Manager at Massaro Community Farm in Woodbridge, CT, also uses cover crops and no-till to improve the soil health for organic vegetable production. “The combination of peas, vetch and oats works great in the no-till system”. Steve Munno says “With a single sowing of this cover crop mix in late summer we see significant accumulation of biomass throughout the fall from the peas and oats, an excellent winter cover protecting the soil, vigorous spring growth of vetch which produces more biomass and provides flowers for pollinators, plus nitrogen fixation (peas and vetch) and organic matter build up for the following crop”.

Lounsbury et al. (2018) tested whether reusable plastic tarps, an increasingly popular tool for small-scale vegetable farmers, could be used to augment organic no-till cover crop termination and weed suppression in New Hampshire. The authors no-till transplanted cabbage into a winter rye (*Secale cereale* L.)-hairy vetch (*Vicia villosa* Roth) cover crop mulch that was terminated with either a roller-crimper alone or a roller-crimper plus black or clear tarps. Tarps were applied for durations of 2, 4 and 5 weeks. Across tarp durations, black tarps increased the mean cabbage head weight by 58% compared with the no tarp treatment. This was likely due to a combination of improved weed suppression and nutrient availability. Plastic tarps effectively killed the vetch cover crop, whereas it readily regrew in the crimped but uncovered plots. However, emergence of large and smooth crabgrass (*Digitaria* spp.) appeared to be
enhanced in the clear tarp treatment. Although this experiment was limited to a single site-year in New Hampshire, it showed that use of black tarps can overcome some of the obstacles to implementing cover crop-based no-till vegetable productions in northern climates.

Bryan also shares his experience using tarps “Black and clear tarps are often superior to tillage events as some weeds can survive the tillage events, but tarps are really effective at giving us weed free surface to begin planting or seeding into”.

References
Soil Health Institute. 2019. Progress report: Adoption of soil health systems based on data from 2017 U.S. Census of Agriculture. Soil Health Institute, Morrisville, NC.