Advancing Reduced Tillage for Organic Vegetable Production: Lessons Learned from a Living Lab

By Sarah Larsen

The Motivation

The motivation behind Ken Laing's Living Lab–Ontario project came from seeing the results of a soil health benchmark study he conducted in cooperation with EFAO in 2019. "It was shocking to see how much more organic matter we have in our undisturbed fence rows compared to our land in production. We've grown organically, with cover crops, for years, and the benchmark results showed me we have to do more if we want to build soil organic matter."

Longtime EFAO member Ken Laing has been farming with his family in St Thomas for over 40 years. As he transitioned into retirement, Ken became determined to figure out how to reduce tillage and increase cover in organic vegetable production systems for mid- to large-scale growers, Ken took on the extensive role managing EFAO's "Horticulture Division," as he calls it.

"Developing a horticultural system for vegetables with no tillage is very challenging because we often use tillage to terminate one crop and get another established, and then we come in again with tillage to control weeds."

For his trials, Ken established the following principles: 1) reduce tillage as much as possible; 2) avoid the use of agricultural plastics; 3) use a 60" bed system; 4) mechanized, tractor-scale system similar to a mid-scale market garden; 5) no hand or mechanical weeding throughout the season.

The Method

With these principles in place, he used an iterative approach: he started with a screening trial to identify promising systems, which he then compared in side-by-side demonstration plots the following year, followed by randomized, replicated trials of the most successful crop-cover combinations in the third season.

In 2020, Ken performed a broad survey of many strategies and crops to narrow down promising combinations. He tried plantings of spinach, peas, beans, sweet corn, tomatoes, sunflowers, squash and garlic in different treatments: winter-killed cover crops, deep compost mulch, and mown and /or roller/crimped cover crops.

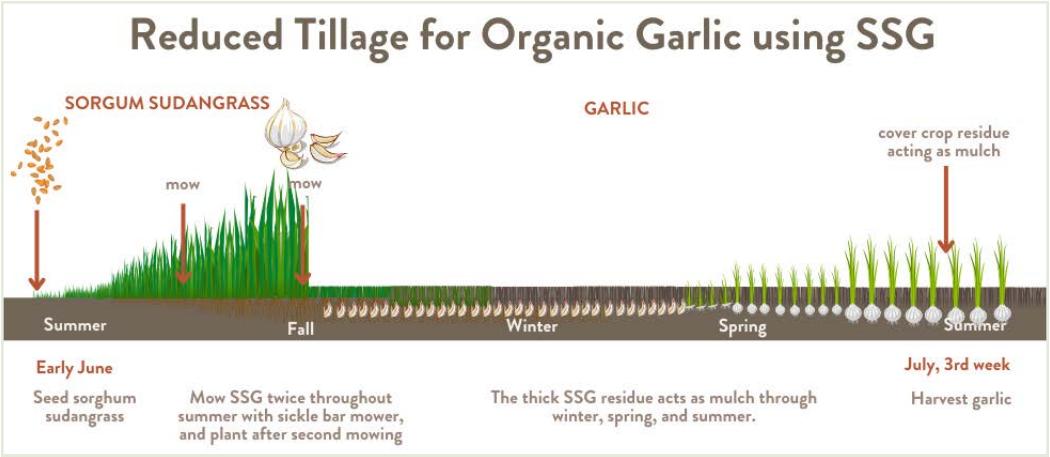
Ken's observations from 2020, included:

- Crops that were transplanted into cover crops were more successful than those seeded directly.
- It is very important to adjust the fertility before the cover crop is planted.

- Winter-killed cover crops have limited weed control. For example: daikon radish leaves very little residue to control weeds the following season and sorghum sudangrass residue breaks down enough for the weed control to start failing by mid-July. Even very early planting of oats/peas to roll before late planted crops makes for very late planting and poor yields.

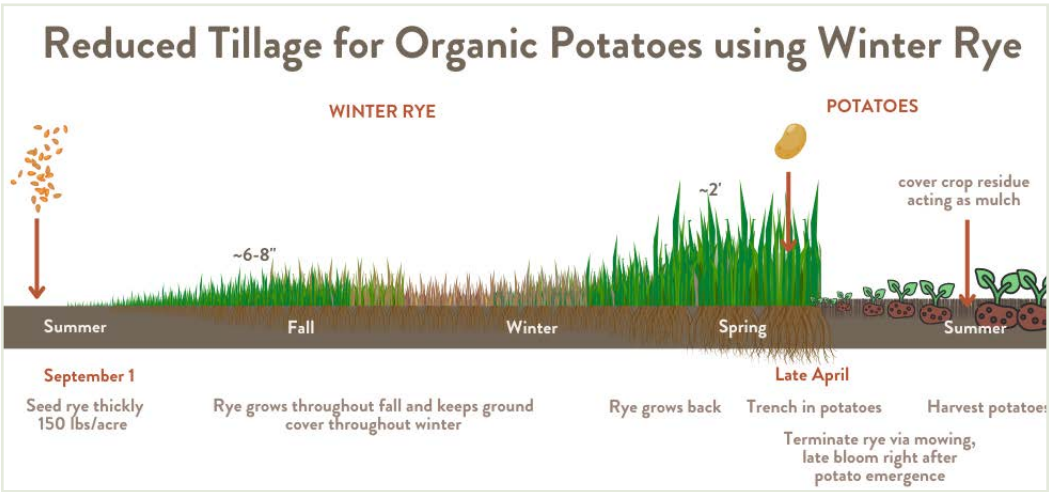
- Having equipment that could cut through lots of residue to allow for planting *and* get the planting trench closed required Ken to modify equipment that was designed for conventional no-till, which does not require so much residue for weed control.

Ken mineral amended a large number of plots in 2020 to prepare for the 2021 trials. In 2021, he planted cover crops of rye/hairy vetch, hairy vetch, crimson clover, pearl millet, pearl millet/cowpeas, sorghum-sudan, sorghum sudan/sunn hemp. He also established plots of deep compost mulch on tilled or rolled covers. The crops grown included garlic, spinach, late broccoli, tomatoes, zucchini, winter squash, potatoes, peas, green beans, sweet corn, and sunflowers. Of these combinations, garlic, potatoes, and winter squash were most successful. Ken measured yields of these crops and also followed up with randomized, replicated trials for garlic and potatoes in 2022.



Garlic

For the reduced-tillage garlic system, Ken seeded sorghum sudangrass (SSG) the summer before garlic harvest (early to mid-July) at 40 lbs/acre, mowed it twice with a sickle bar mower when it reached 3-4 feet to increase biomass, and planted garlic into the mown cover crop in early October with a slightly modified RJ Equipment no-till carousel plug planter. The cover crop then winter kills and leaves a thick residue to control weeds while garlic grows the following summer. Throughout the season, there was no hand or mechanical wedding, and all garlic was harvested by hand with a fork. Yields ranged from 8.358 lbs/ac with 52.6 grams/bulb to 11,223 lbs/ac and 72.5 grams/bulb.



Potatoes

For the reduced tillage potato system, Ken no-till planted potatoes into a winter rye cover crop that he seeded September 1st the year before at 120 lbs/acre. Ken planted the potatoes "green"—into the standing cover crop— in late April or early May and terminated the rye via flail mowing at first potato emergence. Ken notes you could roll the cover crop but mowing gets better termination. Ken did not hill or weed the potatoes (hand nor mechanical) throughout the season. His reduced tillage system resulted in a 58% reduction in field passes associated with tillage, cultivation, weeding, mowing, irrigation, spraying organic pesticide (Entrust), and harvesting. Yields ranged from 25,289 lbs/acre with greening of 9,206 lbs/acre to 37,301 lbs/acre with no significant greening. The five year average for potato yields in Ontario is 21,700 lbs/acre.

Winter squash

For winter squash, Ken set-up demonstration plots of squash no-till planted into rye/hairy vetch, hairy vetch alone, and 2" of deep compost mulch on top of rolled hairy vetch. Overall, he found weed control and yield were very acceptable for organic production in Ontario.

- Squash transplanted into rolled rye had a hard struggle (average yield 13,684 lbs/ac), but when transplanted into the hairy vetch, the results were promising (29,950 lbs/ac)
- Squash transplanted into deep compost mulch was very productive (49,616 lbs/ac), but this method may be less profitable due to the cost of quality deep compost mulch (2" of compost requires 100 tons/ac)

General Findings

After many years of working with cover crops on his farm, and three years of doing so in cooperation with the Living Lab-Ontario project, Ken notes these important considerations when using cover crops for organic vegetable production:

- It is critical to make adjustments in soil fertility the year before the cover crops are planted because the opportunities to amend during the cash crop year are very limited;
- Any persistent and/or perennial weed problems need to be controlled before the cover crop is planted;
- Waiting for cover crops to reach the best termination date can delay planting and harvest dates, so that must be taken into consideration;
- Special equipment is required to deal with the residue and opening and closing a trench in soil fully occupied by roots of the cover crop;
- Flail mowing as a termination strategy for cover crops is more forgiving than rolling, especially when dealing with cover crop combinations.

> ***"A lot of farmers could benefit from having a leg up in using these strategies or knowing where to start."***
>
> **– Ken Laing**

About Living Lab—Ontario

The Living Laboratories Initiative is an integrated approach to agricultural innovation that brings farmers, scientists, and other partners together to co-develop, test, and monitor new practices and technologies in a real-life context.

Funded by Agriculture and Agri-Food Canada (AAFC), the 2020-2023 Living Lab—Ontario project was led by the Ontario Soil and Crop Improvement Association (OSCIA), Living Lab – Ontario project collaborators for the 2020-2023 project also included five farmers; EFAO, Innovative Farmers Association of Ontario, Ontario Soil Network; scientists and researchers from AAFC and Environment and Climate Change Canada; and Essex Region Conservation Authority, Lower Thames Valley Conservation Authority, and Upper Thames River Conservation Authority Conservation Authority. Together, our research focused on reducing the soil and nutrient runoff from agricultural land into Lake Erie, improving water quality, conserving soil health, and increasing biodiversity on agricultural lands in Ontario.

EFAO joined the Living Lab—Ontario project to support on-farm research and innovations to reduce tillage in organic vegetable and field crop production systems. This work focused on two farm sites: one site looking at reduced tillage for organic vegetable production, which was managed by Ken Laing at Orchard Hill Farm near St. Thomas; and a second farm site looking at reduced tillage for organic field crop systems, which was managed by Brett Israel at 3Gen Organics near Wallenstein.

More information about EFAO's involvement with the Ontario Living-Lab initiative, including ongoing updates and results of Ken's trials is available on the EFAO website at efao.ca/living-lab.

Read the final report, which includes additional observations, data, and photos, on Ken's Living Lab – Ontario trial at efao.ca/ken-laing-LLO. ■

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