LIVING LABORATORIES INITIATIVE
Advancing Reduced Tillage for Organic Field Crop Systems

ECOLOGICAL FARMERS ASSOCIATION OF ONTARIO

FARMER-RESEARCHER
Brett Israel, 3Gen Organics

FUNDING
Agriculture and Agri-Food Canada as part of the Living Lab–Ontario project

IN A NUTSHELL

To make reduced tillage more scalable for organic field crop production systems in southern Ontario, Brett Israel tested strategies to diversify his rotations by double cropping soybeans with small grains and forages and adding N-fixing forages to his corn rotation. Over two years of trials, the most promising systems that emerged from his investigations included:

- Overwintered cereal rye harvested for forage before planting soybeans
- Winter barley planted ahead of short season soybeans
- Spring-planted alfalfa harvested for forage and then incorporated as the sole nitrogen source for the following corn crop

MOTIVATION

The motivation behind Brett's Living Lab–Ontario project came from seeing his family (all three generations!) successfully use small grains in organic crop rotations to reduce tillage, improve soil health, and grow great quality field crops and forage. He saw that, when planted early and at high seeding rates, small grains can outcompete weeds and perform well with minimal tillage.

This success motivated Brett to take "the principles of best management practices for small grains, and utilize the same philosophy to have greater success growing row crops like corn and soybeans", he says.

Brett Israel of 3Gen Organics near Wallenstein. For more information on the Living Lab–Ontario project, please see below.

DOUBLE CROPPED SOYBEANS

DOUBLE CROPPED SOYBEANS WITH CEREAL RYE

In 2019-2021, Brett and Jake Munroe from the Ontario Ministry of Agriculture, Food and Rural Affairs (OMAFRA) experimented with soybeans and cereal rye, which is known for its weed-suppressing effects, as part of a study led by the Ontario Soil and Crop Improvement Association (OSCIA; Tier 2 project) and funded by OMAFRA and the Canadian Agricultural Partnerships (**1**).

Brett established cereal rye in the fall, let it overwinter, roller-crimped the rye in spring, and then planted soybeans. This technique achieved good weed suppression but the yield and profitability of the soybeans were unimpressive compared to his standard 30-inch beans. Despite the poor results, Brett saw some potential advantages of using cereal rye ahead of soybeans and chose to tweak his original system for the Living Lab–Ontario trials.

The main tweak to the system was to harvest the rye as forage for his hogs, as shown in **Figure 1**. While not directly tested here, Brett thinks this tweak allowed the rye to ramp up its allelopathic effect after cutting, resulting in good weed control in the soybeans, as shown in **Figure 2**. Even more, "we were able to maximize solar interception by having the beans solid-seeded. In a dry year that's important because we're not getting enough precipitation to have more vegetative growth", says Brett.

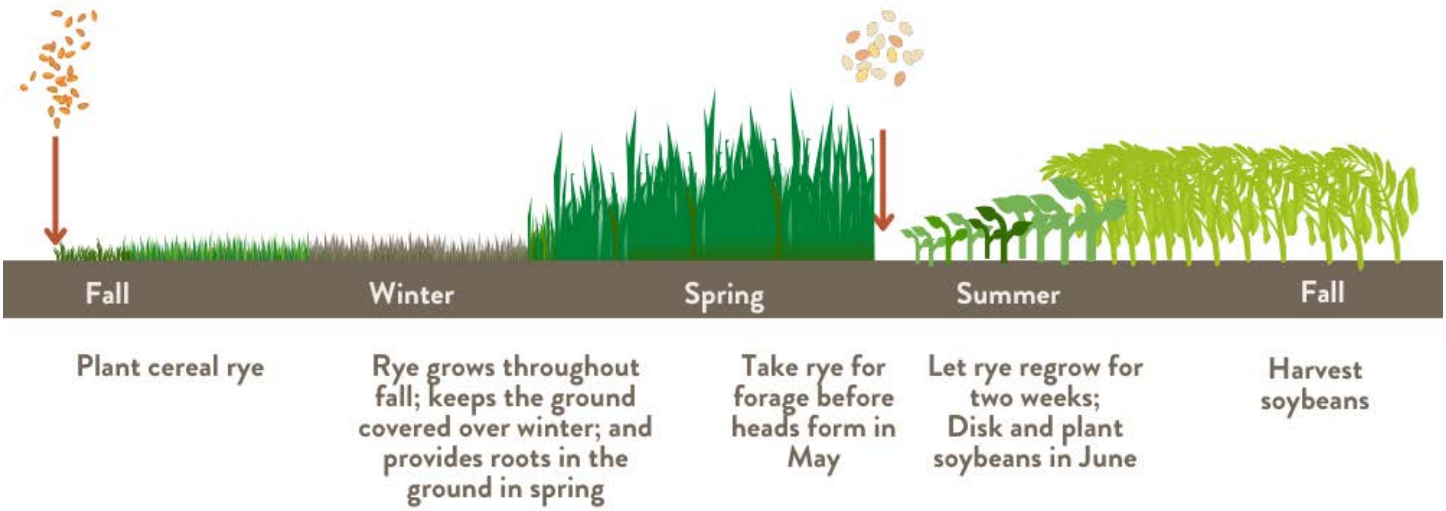


Figure 1. Reduced tillage double cropped soybeans with overwintered cereal rye. While Brett also tried roller crimping the rye, depicted here he chose to cut it for hog forage before heads formed in May; then let the rye regrow for two weeks, and ran a high speed disc over the rye planting soybeans in June. The result was a thick crop of healthy soybeans and almost no weeds. Brett planted Sevita "Panorama" soybeans at a rate of 240,000 seeds per acre for the tilled soybean comparison and 350,000 seeds per acre for the double cropped soybeans. From the rye that was used for forage, Brett harvested 5 4x5 silage bales per acre equivalent to around 4000 lbs/acre of forage.

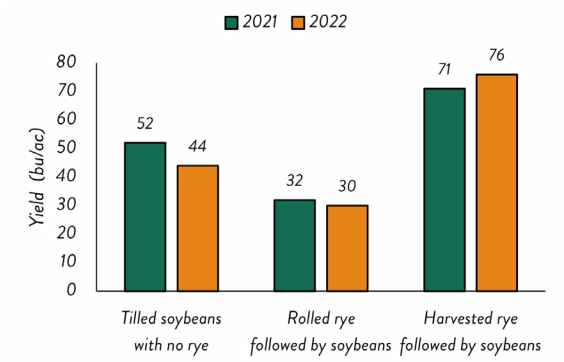
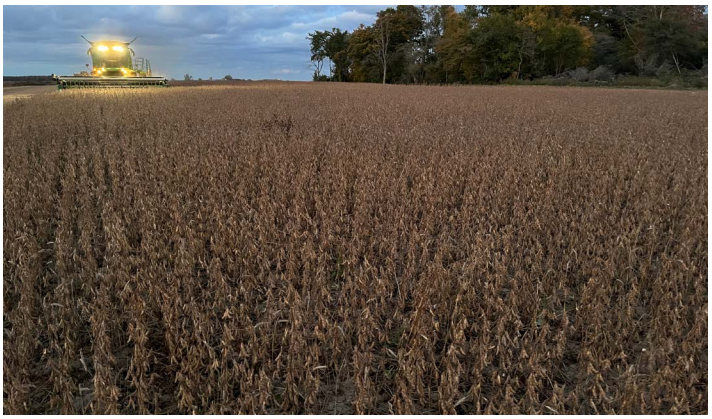


Figure 2. Yield comparison of Brett's standard tilled organic soybeans and double cropped soybeans planted after roller crimped cereal rye and rye that was harvested for forage. For details on the system, see Figure 1.

A record-breaking stand of organic soybeans at 3Gen Organics in 2021.

Cereal rye after cutting it for forage in the spring.

3Gen Organics organically-raised hogs enjoying rye forage, which mixes up their ration and provides them with diverse nutrients.



Harvesting double cropped soybeans in fall 2021, after planting them following cereal rye that was cut for forage.

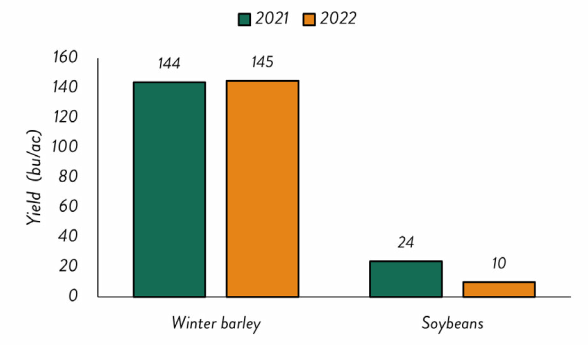


Figure 4. Yield of Brett's double cropped winter barley and soybeans. For comparison, average yields of tilled soybeans were 52 bu/ac in 2021 and 44 bu/ac in 2022, as shown in Figure 2. For details on the system, see Figure 3.

DOUBLE CROPPED SOYBEANS WITH WINTER BARLEY

For his second double cropping experiment, Brett planted winter barley in the fall, harvested it the first week in July, then planted short season hybrid soybeans, as shown in **Figure 3**. 3Gen Organics invested in grain-drying technology that allows them to harvest barley relatively early at a higher moisture level.

Some advantages of this system include that the application timing of manure fits the 4Rs of nutrient stewardship; the clipping action of the combine during barley harvest acts as good weed control before soybeans, and the seeding date for soybeans means they are past the emergence of many broadleaf weeds and weeds were minimal. If needed, Brett used a tine weeder or rotary hoe to weed the soybeans.

Barley yields were good at 144-145 bu/ac but soybeans yield were below 25 bu/acre, as shown in **Figure 4**. Even with the disappointing soybean yield, high commodity prices in the organic space meant Brett's break-even yield on the double cropped beans was 6 bu/acre—making the low yields financially profitable for the farm. In addition, as a legume, the soybeans are helping to fix nitrogen in the soil.

Brett dancing in his fields of barley in 2021.

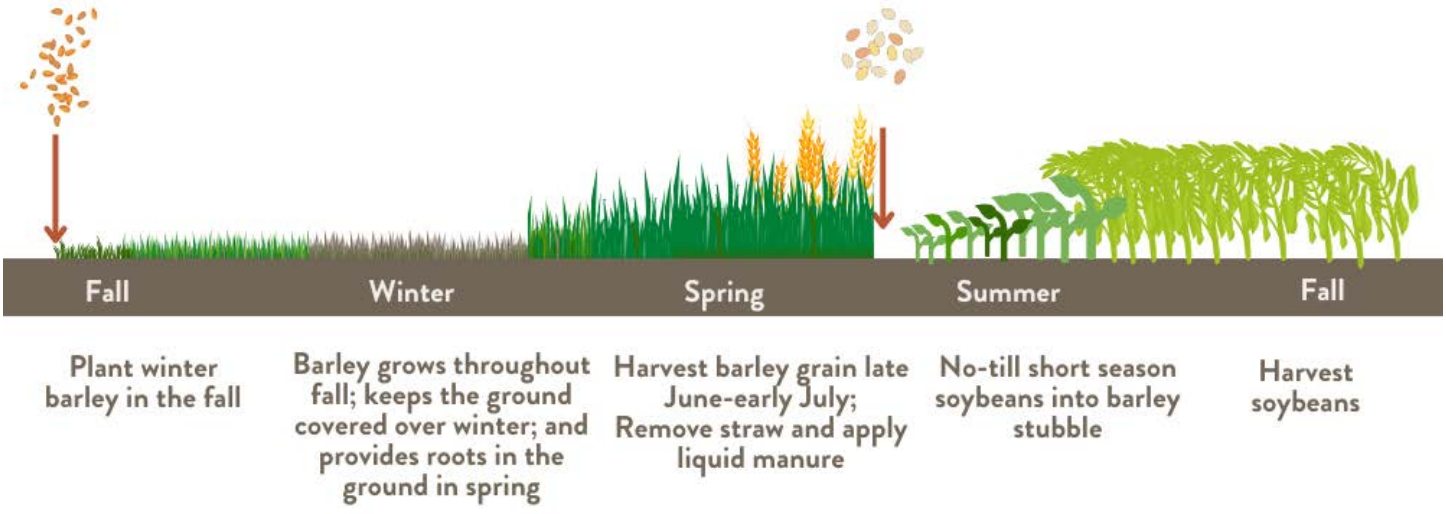


Figure 3. For the double crop of winter barley and soybeans, Brett planted winter barley AC Calypso at 1.6 million seeds/acre in the fall, harvested it for grain in late June/early July; then removed the straw and applied liquid hog manure. After managing the barley crop, he no-till planted short season hybrid soybeans (Meteor, from Manitoba) into the barley stubble at 350,000 seeds/acre.

ALFALFA-FUELED CORN

Brett was also interested in exploring how growing forages could reduce the need for tillage in organic corn systems. 3Gen uses livestock manure for fertility, but they don't want to overload the soil with phosphorus and potash, which can contribute to runoff and encourage annual broadleaf weeds. Instead, they tried using alfalfa to manage weeds and fix nitrogen for a subsequent corn crop.

In 2021, their first attempts to kill alfalfa failed because the alfalfa stand grew back too thick after they had planted corn. To try to salvage some of the corn crop, Brett used a rotavator in some parts of the field in the first week of June. The rotovator did a great job of terminating the alfalfa, and they planted an 80-day corn hybrid into the rotovated sections in June. With no additional tillage or nitrogen, the corn yielded an average of 244 bu/acre, as shown in **Figure 6.**

Learning from this experience, Brett replicated the system across 50 acres in 2022, testing two techniques to control alfalfa: letting it overwinter and using a bigger, improved rotavator in the spring; or moldboard ploughing in the fall.

"We've all been told the moldboard plough is a bad thing, that it shouldn't be used," says Brett. "What was fascinating was that across all of our corn acres, the ploughed down alfalfa was the best corn we had in 2022. Even in peak drought conditions it never showed drought stress." Brett will continue playing with his alfalfa-fueld corn systems, including evaluating longer-term impacts of the systems on soil ecology.

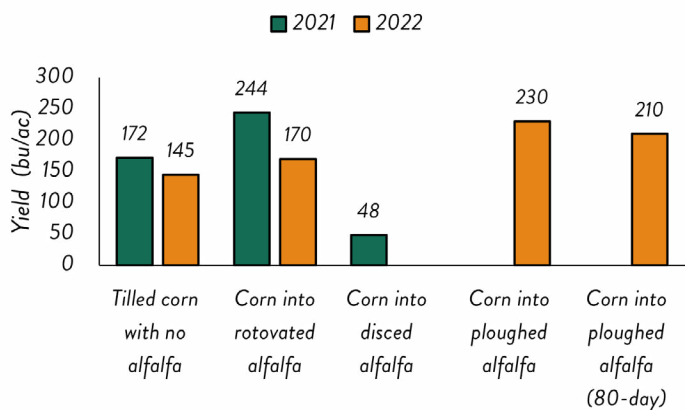


Figure 6. Yield comparison of Brett's alfalfa-fueled corn compared to the average organic corn yield on the farm. Unless noted, the corn was a 90-day hydrid. Along with the exciting success of Brett's alfalfa-fueled corn system, there also risks, challenges, and learning opportunities. Case in point: in the disced field where the alfalfa was not controlled, corn yields were very low. For details on the system, see Figure 5.

Brett and his family grew record yields of organic field corn using alfalfa as the sole source of fertilizer.

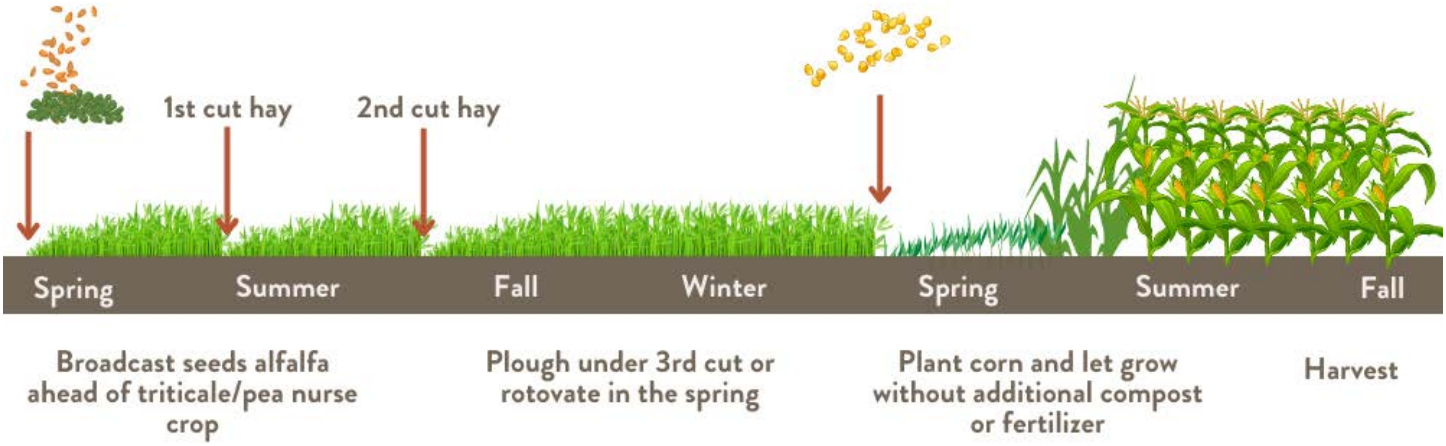


Figure 5. Brett broadcast seeded alfalfa (Performer) at 15 lbs/acre in early spring, and then drilled a triticale and pea nurse crop at 1.1 million seeds/acre. The first cut of forage off the nurse crop was fed to dry sows. Feed tests on top growth found crude protein over 35 per cent, estimated to provide 180 lbs/acre available nitrogen to the next crop. Over two years, Brett tried three methods for terminating the alfalfa: moldboard ploughing in the fall, rotovating in the spring, and high-speed discing in the spring. The moldboard plough and rotovator were the better tools, and their use depends on the specific conditions. From the two years, it looks like spring rotavating produces better yields when moisture is adequate, and fall ploughing may result in better yields in dry years. Brett used the 80-day hybrid Pioneer 8034 and the 90-day hybrid Pioneer 9188, both at 36,000 seeds/acre.

A view from the combine of alfalfa-fueled at harvest in 2021. This corn grew with rotovated alfalfa as its sole source of fertilizer.

LOOKING FORWARD

Brett is also keen to evaluate interseeding cover crops in corn; taking a first cut off of alfalfa in the second year; and perfecting the timing of planting and harvesting double cropped soybeans.

After seeing the results of this project, Brett and his family are curious whether cereal rye can be established after a high-moisture shorter-day corn in late September, and not just after a small grain. Then, it may be possible for the rotation to go from alfalfa-fuelled corn to rye-based soybean, and then to winter wheat.

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 included five farmers; Ecological Farmers Association of Ontario, Innovative Farmers Association of Ontario, Ontario Soil Network; scientists and researchers from Agriculture and Agri-Food Canada and Environment and Climate Change Canada; and Essex Region Conservation Authority, Lower Thames Valley Conservation Authority, and Upper Thames River 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 including Brett's looking at field crops and another site looking at vegetable production managed by Ken Laing at Orchard Hill Farm near St. Thomas.

For more information about EFAO's involvement with the Living Lab–Ontario project please visit efao.ca/living-lab.

SHARING WITH OTHER FARMERS

Over the course of the project, Brett hosted two field days and one rain-check meet-up on the farm, eight presentations at agricultural conferences in Ontario, and three presentations in the US.

REFERENCES

1. https://farmtario.com/crops/no-till-organic-soybean-trials-fall-short-on-yield/

ACKNOWLEDGEMENTS

We thank the Living Lab–Ontario project team, including Tracey Ryan, Pam Joosse, Eric Page, Natalie Feisthauer, Andy Van Niekerk, and all of the other team members across organizations.

TAKE HOME MESSAGE

As an outcome to the Living Lab–Ontario project, Brett says he aimed "to make reduced tillage and diverse rotations more scalable for organic production".

The systems that were most promising in this way included overwintered cereal rye followed by soybeans, which are planted two weeks after the rye is harvested for forage; and alfalfa that is used as forage in its first year and then incorporated as the sole nitrogen source for the following corn crop.

Brett sees these systems having the potential to create more opportunities for larger-scale field croppers to transition to organic without relying on extensive tillage, and for smaller organic farms to scale-up production—a win-win for ecological farmers across the province, and for our soils.