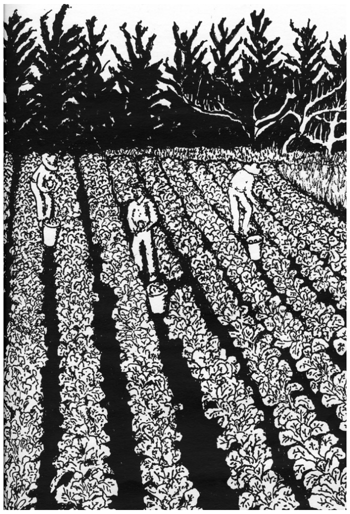

Forrest Cook

News & Notes of the UCSC Farm & Garden

Issue 160, Spring 2019

No-Till Study Underway at the UC Santa Cruz Farm

This spring a patchwork quilt of research plots will emerge at the UCSC Farm, as research lands manager Darryl Wong launches a 3-year field trial to study the effect of no-till and reduced tillage farming practices on organic crop production and soil carbon levels. More specifically, he's interested in finding out whether no-till organic vegetable systems can produce comparable yields to tilled systems while at the same time improving soil health and sequestering carbon in the soil.

Tillage defined

"Tillage" is a general term for turning the soil to prepare planting beds using tractor-draw implements, resulting in the familiar sight of fields striped with rows of crops, alternating with rows of bare soil. No-till, sometimes used under the umbrella term "conservation tillage," eliminates the mechanical tillage process. Instead, no-till systems leave a layer of vegetation — usually a "knocked down" or "winter killed" cover crop — on the soil surface, which acts as a thick mulch. A specialized "no-till" planter is then used to cut a narrow strip through the mulch, dropping seeds or transplants in the soil furrow, but otherwise leaving the soil undisturbed.

Why no till?

No-till systems address a number of issues facing agriculture. By turning the soil and incorporating crop or cover crop residues, typical tillage systems improve short- term productivity by introducing oxygen, which increases soil microbial activity, improves fertility, raises soil temperatures, and reduces weed competition. The drawback to intensive tillage is that organic matter in the soil breaks down more quickly, releasing carbon dioxide into the atmosphere. Tillage can also increase erosion and negatively impact soil fungal populations and earthworm habitat. Tillage also disrupts the soil "clumps," or aggregates, that create good soil structure.

Undisturbed by tillage, decomposing cover crops and roots can boost organic matter levels in the soil. In no-till systems the soil's microbial communities and earthworm populations can flourish, soil structure is preserved, water infiltrates more readily, and soils better retain moisture. In addition, carbon stays in the soil, sequestered in soil organic matter—although research shows carbon levels may only be higher in the top few inches of soil in no-till systems.

No-till can also decrease the cost of inputs, including fuel, fertilizers, and equipment. Instead of running tractors across a field 15 or more times to prepare beds and manage weeds, no-till may only require 2 or 3 tractor passes in a season, as well as less energy to pump irrigation water. Less fuel and energy use translates to lower costs and fewer carbon emissions.

No-till's challenges

No-till agriculture has been adapted on a large scale by many conventional growers, particularly on the Midwest and Northeast's corn, soybean, and grain farms, as well as in similar cropping systems in Brazil, Argentina, and Canada. So if no-till has so many advantages, why aren't more organic farmers using it?

Part of the answer lies with weeds and seeds: most no-till systems rely on synthetic chemical herbicides, often Roundup, to kill cover crops prior to planting and control weeds once the crop is growing. Farmers pair herbicides with genetically modified (GMO) corn and soybean seeds designed to withstand chemical sprays, so that the crops aren't damaged by the weed killers. Without these tools in their toolbox, organic growers face more hurdles in successfully adapting no-till methods.

One answer has been an implement called a "roller crimper" that organic farmers in some parts of the country have used successfully to "knock down" and chop up cover crops. A seeder drawn behind the tractor then parts the mat of cover crops and drops in seeds.

continued on page 2

For a number of reasons, the roller crimper hasn't worked for California farming systems. In part, it's economics: California's farmers pay the highest land prices in the country. High costs mean that growers are under pressure to produce two, three, or more high-value crops a year. Crops such as corn and soybeans that perform well in no-till systems don't generate enough income compared to specialty vegetable and fruit crops. And because California land values are so high, it's often not practical to delay planting while waiting for a cover crop to mature to the point that a roller crimper system can be used.

Pest populations can also build up in fields mulched with cover crops, creating challenges that organic growers have a harder time controlling. And cover crops left to develop into the spring draw precious moisture from the soil, leaving less in reserve for the crop that follows. This can increase the need for irrigation once the crop is planted, which can be a problem in a state subject to periodic drought.

Soil temperature also comes into play. The heavy mulch of no-till systems cools the soil, which slows the release of soil nutrients from organic inputs such as compost or other fertility sources, thus slowing crop development. And because many of the crops produced here—including carrots, lettuce, beets, kale, and brassicas—grow from small seeds, the seedlings may have trouble pushing through a thick mulch of cover crops left on the soil surface.

Study compares three tillage approaches

All of these challenges factor into the field trial that Darryl Wong is starting this year on a quarter-acre plot at the UCSC Farm. The research is part of Wong's graduate work in Environmental Studies, supported by a grant from the Gordon Family Foundation.

His approach to the study is based in part on what other farmers in the area have done in trying to incorporate no-till systems into their practices. "There have been a lot of attempts by growers in the region to make no-till work," says Wong. "This study provides a chance to experiment with different approaches, and try to learn how best to adapt and modify the technique for conditions on the Central Coast."

To address the issue of weed control, he's planted a winter cover crop of mustard. As it grows and decomposes, mustard releases plant chemicals that suppress weed growth through a process known as allelopathy. Mustard also flowers in late winter and can be "mow killed" in early spring, using a flail mower to chop up the mustard and leave it on the soil surface. This timing works well with the vegetable cropping systems used at the UCSC Farm.

After mowing the mustard this month, Wong will open a narrow strip in the resulting mulch and plant Romaine lettuce. Following the Romaine crop, he'll plant a summer cover crop of buckwheat, which grows quickly and suppresses weeds. He'll then mow-kill the buckwheat and plant a crop of broccoli into the decomposing surface mulch. After the broccoli harvest, the plots will again be planted with mustard in late fall, starting the cycle again.

CASFS Farm & Garden Apprenticeship grad Mike Nolan using a roller-crimper on his organic farm in Colorado, where he is conducting a no-till study funded by the Western Sustainable Agriculture Research and Education program. Read more at – mountainrootsproduce.com/farmblog/2018/12/10/western-sare-project-crimping-and-strip-tilling

Regional growers are also interested in whether a "reduced tillage" system might produce some of the same soil health and potential carbon-capturing benefits of no till, but with better weed control. Wong will use a "shallow tillage" technique on some of the study plots to test this theory, tilling to just 3–6" deep prior to planting and, once the crops are established, to manage weeds.

Crop yield and soil carbon levels in the no-till and reduced-tillage systems will be compared to those of the "standard" tillage system used at the farm. This sytem includes a deeper tillage pass (6–12") with a spader to incorporate the cover crop prior to planting, followed by additional passes with a cultivator to prepare beds and control weeds. In addition, he'll evaluate the amount of labor and fuel used by each system, to see whether no-till and reduced tillage saves time and resources.

In assessing changes in soil carbon levels, Wong measured carbon at three different depths prior to planting this winter's cover crops to establish a baseline, and will measure it again at the end of the trial period. He will also measure how much carbon is contributed by the cover crop's roots and other inputs, such as compost.

You can see this new research project in action next time you visit the UCSC Farm, and read more about it on the Center for Agroecology & Sustainable Food Systems website, casfs.ucsc.edu (click on the Research heading), where we'll post periodic updates.

– Martha Brown