

Strategic Tillage Has Its Place in No-Till Agriculture

| By Megan Sever

Strategic tillage in on a Brazil farm. Photo courtesy of Bruno Montoani Silva and Devison Souza Peixoto.



No-till farming is great—until it's not. When problems like resistant weeds or compaction arise, a well-chosen one-off till job, often called strategic tillage, could be just what the doctor—or CCA—ordered. Earn 0.5 CEUs in Soil & Water Management by reading the article and taking the quiz at <https://bit.ly/3pII4TG>. View all CEUs online at <https://web.sciencesocieties.org/Learning-Center/Courses>.

No-till farming has gained momentum over the past few decades as a key part of conservation agriculture. By 2015–2016, more than 444 million acres of farmland globally were under no-till—that's 12.5% of total farmland. And no-till agriculture has been increasing by nearly 26 million acres per year globally. Some 25–30% of cropland in Nebraska is in continuous no-till agriculture.

No-till provides myriad benefits, from decreased soil erosion and decreased costs and energy use to better conservation of water. When compared with conventional tillage, no-till can significantly increase crop yields as well, especially in semiarid

regions. But problems can arise with no-till systems, such as buildup of herbicide-resistant weeds, soil compaction, runoff of dissolved nutrients and herbicides, and soil nutrient stratification. Some of these challenges can be solved by introducing cover crops, diversifying cropping systems, and other management practices. But for more persistent challenges, a well-chosen one-off till job, often called strategic tillage, can be just what the doctor—or CCA—ordered.

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What Is Strategic Tillage?

No-till agriculture is just that: No mechanical soil disturbance of any type occurs. Strategic tillage—also called occasional tillage, one-time tillage, targeted tillage, or single-inversion tillage—involves tilling on an occasional basis, like once every 5 or even 10 years, or it might mean tilling once and not again. It differs from conventional tillage and short-term tillage in frequency (every year and every couple of years, respectively). It's not to be confused with reduced tillage, which generally refers to some regular shallow tillage with little soil inversion. Strategic tillage can be done with any method—moldboard plows, chisels, disks, or anything else—at any depth.

Many no-till farmers are adamant that any tillage would ruin years of soil regeneration gained by not tilling, so the very idea of introducing strategic tillage has caused a bit of an uproar, says Charles Wortmann, a soil management specialist and agronomist with the University of Nebraska–Lincoln (UNL). In 2020, Wortmann, along with UNL colleague Humberto Blanco, an applied soil physicist, published a review paper on strategic tillage's effects on no-till fields in *Soil & Tillage Research*. The research does not bear out the notion that strategic tillage will ruin the benefits of no-till, Wortmann says. Research around the world “has shown that, yes, [strategic tillage] can be done without significant harmful effects,” he says. And in fact, he adds, “you’re more likely to have a yield increase than decrease.”

Another 2020 study looked at the effects of tilling once in a long-term no-till system and found “that a single tillage does not

negatively affect crop productivity compared to a continuous no-till system,” wrote Kansas State University’s Alan Schlegel and his team in *Agronomy Journal* (<https://doi.org/10.1002/agj2.20284>).

That’s ostensibly good news, Wortmann says. “But the big question is, do you have a sufficient reason to [do strategic tillage]?”

Why Use Strategic Tillage?

Strategic tillage can help with many challenges, such as increasing soil carbon at depth, reducing crop residue accumulation, and reducing nutrient stratification. But the two most likely reasons for introducing strategic tillage in a no-till system are herbicide-resistant weeds and soil compaction problems.

In one meta-analysis of 68 articles, published in *Science of the Total Environment* in 2020, Bruno Montoani Silva and colleagues at the Federal University of Lavras in Brazil reported that strategic tillage was carried out to improve soil physical conditions (especially compaction) in 66% of the cases they examined. Weed control accounted for 17% of cases, nutrient stratification for 12%, and improving soil fertility by applying limestone or other fertilizers at depth for 5%. Soil compaction may be the biggest reason to use strategic tillage globally, but Blanco notes that in the U.S., it’s resistant weeds.

Resistant Weeds

“If you have a difficult-to-control weed such as a perennial that is resistant to herbicides . . . with the right type of tillage, you can knock it out,” Wortmann says. Worldwide, more than 40 weed species have developed resistance to glyphosate, including foxtail barley, downy brome, amaranth, pigweed, and common waterhemp. Other weeds like bunchgrasses or tree species like Siberian elm can also wind up in fields and can be difficult to eliminate, Wortmann notes. Dozens of weeds have developed resistance to other herbicides. A study presented at the Agricultural and Applied Economics Association’s 2018 annual meeting noted that due to resistant weeds in no-till agriculture, there was a 9.2% decrease in no-till across the U.S. So resistant weeds are having an effect.

The right kind of tillage, including the right depth and timing, is important, Wortmann says. The right tillage



Kochia and pigweed dominating winter wheat in western Kansas. A recent study noted that due to resistant weeds in no-till agriculture, there was a 9.2% decrease in no-till across the U.S. Photo by Anju Giri.

would disrupt weed germination and growth, thus decreasing weed populations. The effects seem to last five years or more, Blanco and Wortmann reported. Silva and his team found that in no-till managed areas, strategic tillage decreased the number of weeds by 70%.

Compaction

Compaction can occur for many reasons, especially in glacial till and other clayey soils, but one of the biggest reasons is traffic—driving over it. In such a case, Wortmann says, tillage is probably the best bet, and farmers would probably only need to till once to solve the problem. Farmers must be careful in when and how they till, though, he cautions. The soil needs to be pretty dry, so it can fracture in a shattering pattern. If the soil is wet, the shattering effect does not occur, and the tillage may actually increase compaction.

Compaction also occurs over time in soils that haven't been tilled in decades, such as in Brazil, where most of the millions of hectares of grain production has been in no-till systems for 40-plus years, Silva says. In addition, he says, other methods of controlling compaction, like crop rotation and letting a field fallow, aren't being used regularly, due to climatic or market effects (such as the price of one of the rotational crops plummeting). In severe cases of compaction, “we do recommend use of the [strategic tilling] technology,” Silva says. But before tilling, there needs to be “an adequate diagnosis of compaction.” The diagnosis needs to include the depth and thickness of the compacted layer. Without such a diagnosis that reveals a real need, he adds, “the use of mechanical intervention in the soil is discouraged.”

Other Benefits

Although strategic tillage can be effective for weed control and compaction, Blanco, Wortmann, and Silva agree that farmers should not use the technology *just* for one reason, regardless of the reason. If a farmer has a compaction or weed problem, combined with another problem for which strategic tillage can be helpful, then it can be a good option, Blanco says.

Strategic tillage has been shown to increase soil carbon at depth. In no-till systems, organic carbon can build up in the upper few centimeters of the soil surface but be depleted below. The same thing happens with phosphorus and other nutrients and

herbicides. In no-till systems, immobile nutrients can sit on the surface or seep a little way into the soil profile, leaving soil below virtually void of the nutrients. One deep-inversion tillage can mix that soil and eliminate the stratification. (Shallow or noninversion tillage are not likely to have much effect.) Research shows that phosphorus uptake by crops increases after just one till. Mixing in herbicides also helps decrease pollutant runoff. One deep-inversion tillage can also be used to incorporate a soil amendment like limestone or manure at depth as well as to reduce crop residue accumulation at the surface. And a well-designed till can help with water infiltration and porosity.

How to Use Strategic Tillage

Although Blanco, Wortmann, and Silva all caution against using strategic tillage inappropriately, they all recommend it as part of the “portfolio of options, or the various tools in the toolbox,” as Blanco puts it. The available research data say using occasional tillage can help.

That said, Blanco says, “Strategic tillage should maybe be the last tool in the toolbox—the last resort.” That’s because the research indicates that yield benefits are minimal, except in cases where herbicide-resistant weeds, compaction, or other problems have reduced yields; they are unlikely to make up for the costs. There are also some risks, including erosion and somewhat decreased microbial activity though not to an agronomically detrimental level, Wortmann says.



Farmers must be careful in when and how they till. If the soil is wet, the soil will not fracture in a shattering pattern, and the tillage may actually increase compaction. Photo by JJ Gouin/Alamy Stock Photo.

Certified Crop Advisers counseling farmers should first ask the farmer what other remedies they have tried for their specific problem. Did they try forage crops instead of row crops, for example? How about cover crops? How about decreasing traffic on the field, especially when the soil is wet? If a farmer has exhausted all other options and can solve multiple problems in a field by tilling, then go for it, Wortmann says. But make sure the problems are well diagnosed and that the best timing, tillage method, and tillage depth are observed. And apply manure or lime or another nutrient during the tillage or find another way to further help the soil. Basically, he says, use strategic tillage when you can get multiple benefits from it.

More Research Needed

Even though research so far indicates that strategic tillage doesn't usually negatively affect fields, more studies are needed, Blanco and Wortmann noted in their paper. Researchers need to look more carefully at how strategic tillage affects specific soils or fields, Blanco says. Different climates, soil types, depth and method of tillage, soil moisture conditions, and more could all affect results.

DIG DEEPER

Interested in this topic? View the open access *Agronomy Journal* article, "A Single Tillage in a Long-Term No-Till System on Dryland Crop Performance," at <https://doi.org/10.1002/agj2.20284>.

It would also be helpful to do more economic analyses, he says: "If strategic tillage isn't significantly increasing yield, then why are we doing it?" We need to see additional benefits, he says. One might be carbon sequestration. Early research suggests that tilling organic-carbon-rich topsoil deeper can bury carbon to deeper depths and may allow the newly tilled soil to take up more carbon dioxide from the atmosphere, he notes. That would have dual benefits: increasing the carbon throughout the soil profile and sequestering it from the atmosphere.

"This is something that needs to look at more in depth," Blanco says.

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- What percentage of global total farmland is under no-till agriculture?
 - 5.5%.
 - 25%.
 - 12.5%.
 - 52.2%.
- Strategic tillage involves the frequent, repeated use of tillage to solve challenges with nutrient stratification, cover crops, and other management practices.
 - True.
 - False.
- _____ and _____ are the two most likely reasons for introducing strategic tillage in a no-till system.
 - Increasing soil carbon at depth, reducing residue
 - Soil compaction, increasing soil carbon at depth
 - Herbicide-resistant weeds, reducing residue
 - Soil compaction, herbicide-resistant weeds
- Researchers found that with the right tillage depth and timing, the effects of tillage on weed germination and growth seems to last five years or more.
 - True.
 - False.
- Which of the following is NOT a benefit farmers may reap from using a single, well-designed round of strategic tillage?
 - Increasing water infiltration or porosity.
 - Increasing chances of runoff.
 - Incorporating amendments like manure or limestone.
 - Eliminating phosphorus and nutrient stratification.