Friends of the Earth

Rethinking No-Till:

The toxic impact of conventional no-till agriculture on soil, biodiversity, and human health

EXECUTIVE SUMMARY
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Acknowledgments

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EXECUTIVE SUMMARY

The concept of regenerative agriculture has gained momentum over the past few years, bringing increased interest and funding, from multimillion dollar investments by companies such as Nestle, Mars, and PepsiCo to state and federal funding.[1] With billions of dollars — and the future of our food system — at stake, we must ensure that the practice of regenerative agriculture is robust and is guarded against greenwashing.

This report compiles the latest scientific research and USDA data on no-till agriculture with a focus on the leading no-till crops in the U.S. by acreage — corn and soy. No-till and reduced tillage is the practice most often included in definitions and descriptions of regenerative agriculture given by nonprofit organizations, extension agencies, and farmers.[2] No-till has been incentivized through the USDA's climate-smart commodities investment,[3] and major companies such as Tyson Foods, ADM, Cargill, and Bayer are promoting or funding no-till as a regenerative practice.[4,5,6, 7]

No-till and minimum-till corn and soy account for approximately 28% of the nation's total cropland, or about 107 million acres.[8,9,10,a] The majority of this corn and soy is not produced as food for human consumption, but for livestock feed and biofuels.[b]

We find that **the vast majority (93%) of U.S. corn and soy acreage grown in no-till and minimum-till management systems relies on toxic pesticides that harm soil health and threaten human health.** That represents an area approximately the size of California.

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[a] For corn and soy, the USDA reports data on "no-till or minimum-till" acreage combined in their Chemical Use Survey Highlights. We used this data as the basis of our analysis. We refer to these acres as "no-till" throughout this report for simplicity and to follow the term of art that has shaped the public conversation and billions worth of public and private spending. It is also worthwhile to note that "no-till" is largely misnomer: USDA data show that at least 80% of "no-till" corn, soybean, wheat, and cotton acres were tilled at some point over a four-year period. (Claassen, R., Bowman, M., McFadden, J., Smith, D., Wallander, S. 2018. Tillage Intensi and Conservation Cropping in the United States. U.S. Department of Agriculture: Washington, D.C. September, https://mssoy.org/sites/default/files/documents/tillage-study-ers-sep-2018-six.pdf.

[b] More than 80% of U.S. corn goes to the production of feed and ethanol fuel. USDA Economic Research Service. Feed Grains Sector at a Glance. U.S. Department of Agriculture: Washington, D.C. Webpage. Accessed January 7, 2025.https://www.ers.usda.gov/topics/crops/corn-and-other-feed-grains/feed-grains-sector-at-a-glance/. More than 90% of U.S. soy that is not exported is crushed, creating soybean meal – used in livestock feed – and soybean oil, approximately half of which goes to biofuel production. Vaiknoras, K., Hubbs, T. 2023. Characteristics and Trends of U.S. Soybean Production Practices, Costs, and Returns Since 2002. USDA Economic Research Service: Washington, D.C. June. https://www.ers.usda.gov/webdocs/publications/106621/err-316.pdf?v=2345.2

A staggering one-third of the U.S.'s total annual pesticide use can be attributed solely to corn and soy grown in no- and minimum-till systems, based on our novel analysis of USDA data (pesticides is a term that encompasses herbicides, insecticides, and fungicides). We estimate that 61% of this use is pesticides classified as highly hazardous to human health and/or the environment. Glyphosate (aka Roundup) is by far the most widely used pesticide in no-till corn and soy production.

What's more, no-till is associated with increased use of herbicides in conventional farming systems since no-till farmers rely on herbicides rather than physical cultivation to manage weeds and/or terminate cover crops. Based on our conservative estimates, **at least 26 million pounds of additional herbicides are used in the U.S. each year due to conventional no-till corn and soy.**

We also show that at least **90% of no-till corn and soy acres (91% of soy and 88% of corn) rely on genetically engineered seeds**, driving a cycle of increased pesticide use, and that **potentially all no-till corn seeds are coated with neonicotinoids**, a class of insecticides harmful to soil life, pollinators and other beneficial organisms, as well as to human health.

The toxic pesticides widely used in conventional no-till are fundamentally at odds with regenerative agriculture. A strong body of science shows that synthetic pesticides disrupt the soil microbiome and harm soil organisms that are central to the goals of regenerative agriculture: building healthy soil, sequestering carbon, protecting biodiversity, conserving water, and improving farmers' climate resilience.[11,12] They also harm biodiversity aboveground, including birds, fish, and pollinators. And they are associated with devastating harm to human health. **In short, the most prominent form of no-till agriculture in the U.S. is not regenerative.**

Classifying conventional, chemical-intensive no-till as regenerative invites extensive greenwashing from food, agribusiness, and pesticide companies. Pesticide companies like Bayer and Syngenta have capitalized on the growing interest in soil health by promoting conventional no-till — which relies heavily on their pesticides, genetically engineered seeds, and digital agriculture platforms — as regenerative.[13,14,15] In fact, the pesticide industry is deeply intertwined with the ascendance of no-till over the past few decades, as discussed in this report.

What is regenerative agriculture?

The definition of regenerative agriculture is open to debate. Like the term sustainable, some definitions are robust while others are weak or even meaningless. Regenerative agriculture has been broadly described as a holistic farming approach that challenges the status quo of conventional agriculture and its degenerative impacts on the environment and human health. Robust approaches prioritize protection of soil health and biodiversity to achieve resilience, water conservation, and carbon sequestration. Meaningful approaches include reduction or elimination of synthetic pesticides and fertilizers as a central tenet and result in improved ecological, social, economic, and human health outcomes, including long-term food security.

No-till is a misnomer

It is important to understand that "no-till" is largely a misnomer. U.S. Department of Agriculture (USDA) data show that at least 80% of "no-till" corn, soybean, wheat, and cotton acres were tilled at some point over a four-year period. However, we use "no-till" throughout this report to follow the term of art that has shaped the public conversation and billions worth of public and private spending. Our findings are based on USDA reporting on "no till or minimum till" acreage.

We also summarize **current scientific data that show no clear relationship between no-till and soil carbon sequestration.** This belies the widely held assumption that no-till is definitively linked to increased soil carbon sequestration. We place particular emphasis on this point, as both public and private initiatives to promote regenerative agriculture are currently operating on this faulty assumption.

We determine that c**onventional no-till corn and soy has a significant carbon footprint**. The CO_2-equivalent emissions associated with pesticides and synthetic fertilizers used in no- and minimum-till corn and soy are comparable to the total cars on the road each year in the top 9 no-till states: Kansas, Nebraska, South Dakota, North Dakota, Montana, Iowa, Illinois, and Indiana (11.4 million cars).

Finally, we summarize data showing **that tillage can be a part of regenerative farming systems.** This is important given that tillage is often called out as universally detrimental to soil health. Research shows that the impact of tillage on the soil depends greatly on the depth, spatial coverage, and frequency of tillage and the implement used, as well as other practices in the farming system. What's more, multiple studies suggest that the routine use of pesticides has greater and more disruptive effects on soil bacterial and fungal communities than routine tillage does.[16,17] **A narrow focus on tillage is insufficient and misleading when trying to determine whether or not a farm or system is regenerative.**

To be clear, no-till in and of itself does not have inherently negative impacts. When incorporated into a holistic, ecological approach to farm management, no-till can lead to positive outcomes, including reduced erosion. It is when no-till is implemented as a standalone practice in large-scale, chemical-intensive systems that it not only falls short of regeneration but also results in negative externalities.

Large-scale, chemical-intensive agriculture currently predominates in the U.S., not through the fault of farmers, but because that is what public policies and markets support. The adoption of no-till by conventional growers who once practiced standard tillage is indicative of the fact that many farmers are interested in conservation and are willing to adapt and implement new practices. We must now restructure our policies and markets to support these and other farmers to achieve truly regenerative agriculture.

Given the urgency of the public health, biodiversity, and climate crises we face, the growing interest in regenerative agriculture must be harnessed in service of robust approaches that truly increase soil health and carbon sequestration, improve air and water quality, bolster farmers' resilience, and protect biodiversity and human well-being. **Truly regenerative agriculture cannot be boiled down to single practices, such as no-till — it requires holistic, systems-based approaches.** Truly regenerative agriculture must be a force to reduce the use of harmful pesticides and synthetic fertilizers.

Companies, policymakers, and regenerative advocates should promote, uplift, and incentivize approaches that are rooted in shifting away from a toxic, industrial model of agriculture and towards diversified and ecological farming systems. In particular, they should provide increased financial, technical, and other forms of support to conventional growers to adopt practices and systems that build fertility and manage pests with significantly fewer, if any, synthetic chemical inputs. Reducing inputs in conventional systems is possible, and it comes with a host of benefits for the climate, biodiversity, and human health. And along with regenerating soils and ecosystems, it can lower costs and improve farm profitability.

Equally, companies, policymakers, and advocates must do a better job investing

in and supporting growers who are already practicing diversified organic and other leading forms of regenerative agriculture. As we discuss below, decades of scientific data show that on average, diversified organic growing systems sequester more carbon, build healthier soils, increase biodiversity, and improve resilience — thereby protecting farmers' yield during droughts and floods — compared to conventional growing systems. Investing in low-input, systems-based approaches like organic agriculture is a no-regrets solution for achieving the goals of regenerative agriculture.

Summary of key recommendations:

- Any regenerative agriculture definitions promulgated by federal, state, or local governments, private or public regenerative certifications, or other regenerative initiatives must explicitly center and prioritize agrochemical reduction if they are going to meet their stated goals.
- USDA should increase incentives for farm operations that deeply reduce or eliminate the use of synthetic pesticides and fertilizers and increase technical assistance to spur the adoption of practices that reduce agrochemical inputs.
- USDA should pursue research that evaluates the contexts in which promoting and incentivizing the adoption of no-till as a standalone practice may lead to increased reliance on agrochemicals and assess possible methods for preventing further expansion of chemical-intensive no-till.
- Congress should create a new training program for NRCS Technical Service Providers focused on soil health and input reduction. Additionally, Congress should adopt new regenerative agriculture programs that help farmers transition to perennial, agroforestry, and other diversified cropping systems, such as those outlined in the bipartisan Innovative Practices for Soil Health Act.
- Congress should increase funding for the National Organic Program and other key organic programs, recognizing that diversified organic is a leading form of regenerative agriculture.
- Federal, state, and local governments should fund and direct resources towards researching and spurring the adoption of techniques (such as roller-crimping, flame weeding, occultation, and animal grazing) that can replace herbicides to effectively suppress weeds in no-till and minimal-till systems, accelerating the ability of farmers to reap the benefits of reduced tillage without needing to rely on degenerative chemical inputs.
- Food manufacturers and retailers should set time-bound, measurable goals to phase out toxic pesticides and synthetic fertilizers and transition towards ecological, least-toxic approaches along their entire food and beverage supply chains.
- Companies should not fund or incentivize no-till as a standalone practice, as this is unlikely to achieve the stated goals of regenerative agriculture and may incentivize degenerative practices. Instead, companies should provide financial and technical assistance to suppliers to support a broad transition to ecological, low-input growing systems, including organic agriculture — which may or may not use tillage depending on context.
- Members of the regenerative community are encouraged to promote a nuanced understanding of tillage: tillage is not universally detrimental to soil health and can be part of truly regenerative growing systems, depending on context. Conversely, be aware that uplifting strict no-till without equally prioritizing input reduction can inadvertently incentivize chemical-dependent growing systems that are at odds with regenerative goals.
- We also encourage members of the regenerative community to understand diversified organic agriculture as a leading type of growing system that falls under the broad umbrella of regenerative. We encourage members of the regenerative community to recognize that supporting the National Organic Program, as well as organic researchers, farmers, and advocates, is a way to advance the goals of the regenerative movement and speed the transition to a more sustainable, equitable, and healthy food system.

KEY FINDINGS

We found that:

Conventional no-till has a toxic footprint

- At least 93% of no-till and minimum-till corn and soy acreage in the U.S. uses synthetic herbicides. That represents an area the size of California — approximately 100 million acres of U.S. cropland.
- Herbicide use in no-till corn and soy can be associated with a whopping 33% of total annual pesticide use in the U.S. — 285 million out of 851 million pounds of pesticides (a term that encompasses herbicides, insecticides, and fungicides). These chemicals are associated with significant harm to human health, biodiversity, and soil health, including the soil invertebrates and microorganisms that are the basis of truly regenerative agriculture.
- We estimate that the majority of use (61%) is herbicides classified as highly hazardous to human health and/or the environment — 173 million out of 285 million pounds of herbicides used annually in no-till corn and soy.
    - Glyphosate (aka Roundup), dicamba, 2,4-D, atrazine, acetochlor, and S-metolachlor[c] account for the majority of herbicide use in corn and soy. Of these, glyphosate, 2,4-D, and acetochlor are classified as highly hazardous.
    - Glyphosate alone accounts for an estimated 40% of the total use of herbicides in no-till corn and soy. The glyphosate used in no-till corn and soy account for approximately 13% of the total use of pesticides in U.S. agriculture annually.
    - The use of the highly hazardous herbicide paraquat has also increased dramatically in soy production in the past decade.
- Conventional no-till is associated with increased herbicide use over standard tillage. This is due to greater reliance on chemical forms of weed management compared to conventional systems with tillage. Based on our conservative estimates, at least 26 million pounds of additional herbicides are used annually due to conventional no-till management in corn and soy.
- At least 89% of conventional no-till corn and soy acres (91% of soy and 88% of corn) rely on seeds genetically engineered (GE) to be herbicide tolerant. These GE seeds are associated with a dramatic increase in use of glyphosate and growing use of antiquated, hazardous herbicides dicamba and 2,4-D.
- Neonicotinoid seed coatings are used on up to 100% of conventional no-till corn acreage. This represents up to 2.47 million pounds of toxic insecticide used annually. Neonicotinoids are associated with significant harm to soil life, pollinators, and human health.

Conventional no-till has a significant carbon footprint

- The herbicides and synthetic fertilizers used in conventional no-till have a significant carbon footprint. The energy-intensive production of herbicides associated with no-till corn and soy results in upwards of 3.4 million metric tons of CO_2-equivalent emissions annually based on available estimates. The production, transportation, and application of nitrogen

[c] We have aggregated use of S-metolachlor and metolachlor for our findings because they are functionally very similar chemicals. See Appendices 1 and 2 for the breakdown between S-metolachlor and metolachlor use in corn and soy. For more information about the two chemicals, see: Benbrook, C. M. 2001. Factors Shaping Trends in Corn Herbicide Use: An Update and Technical Report. Northwest Science and Environmental Policy Center: Sandpoint, Idaho. July

fertilizer used on no-till corn acres likely accounts for between 18.4 million to 49.3 million metric tons of CO_2-equivalent emissions. At the high end, these emissions are equivalent to 11.4 million cars on the road for a year — approximately the number of cars in the top 9 no-till states: Kansas, Nebraska, South Dakota, North Dakota, Montana, Iowa, Illinois, Missouri and Indiana.

Conventional no-till does not increase soil carbon sequestration

- The latest science shows that, on average, conventional no-till production does not increase soil carbon and in some cases has been found to reduce it.

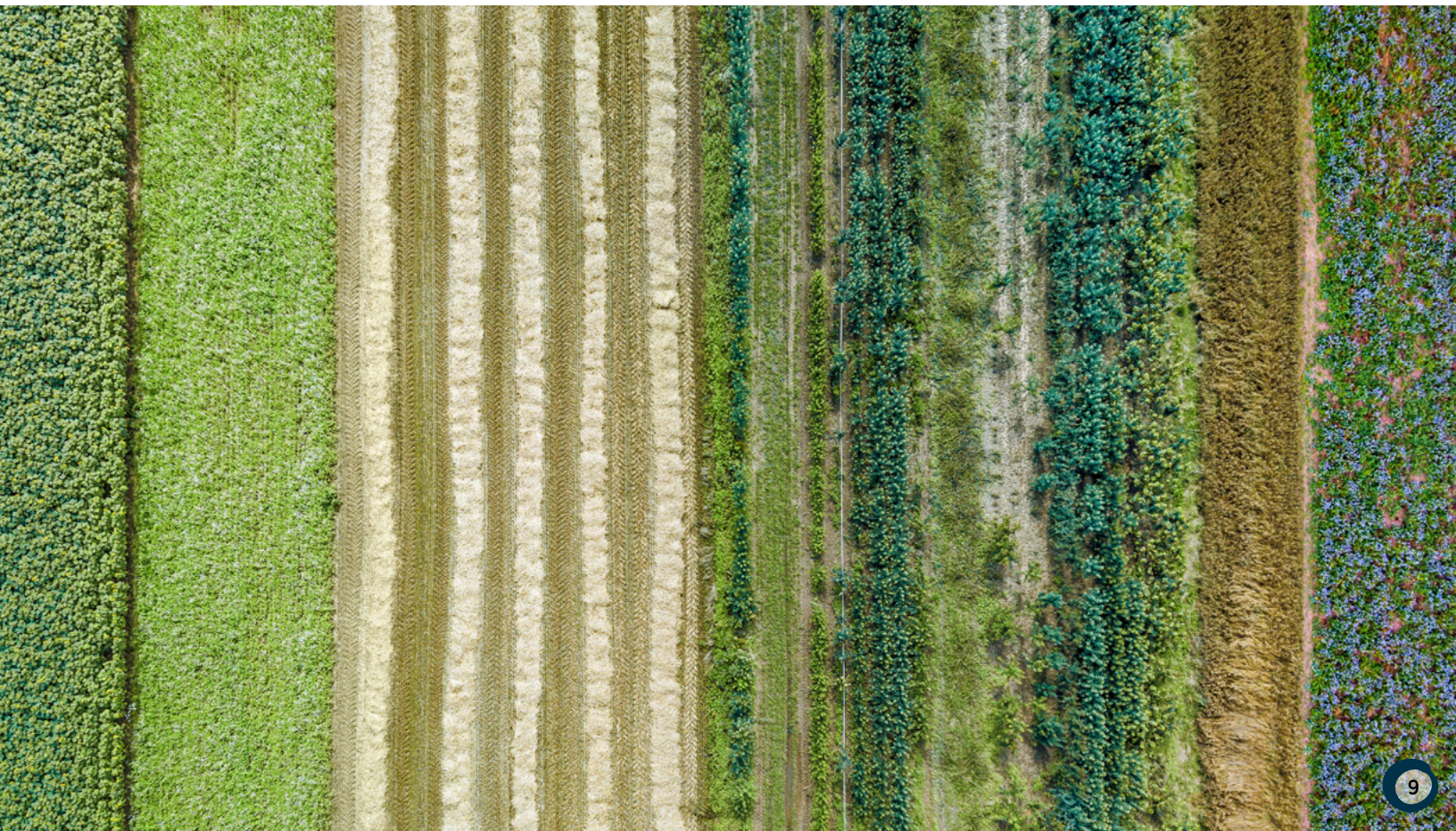
Tillage can be part of regenerative farming systems

- Tillage is not universally detrimental to soil health. Research shows that the impact of tillage on the soil depends greatly on the depth, spatial coverage, and frequency of tillage and the implement used, as well as other practices in the farming system.

A narrow focus on tillage is insufficient and misleading when trying to determine whether or not a farm or system is regenerative.

Truly regenerative agriculture is systems-based

- Truly regenerative agriculture cannot be boiled down to single practices, such as no-till — it requires holistic, systems-based approaches.
- Reducing synthetic pesticide and fertilizer use in conventional agriculture, by using systems-based approaches to build fertility and manage weeds and pests, has clear benefits for the climate, soil, and biodiversity – and can be achieved without harming yield or profitability.
- Agroecological farming, including diversified organic production, is a no-regrets solution for achieving soil health, promoting biodiversity, and mitigating and adapting to climate change. Research also shows that it can produce abundant food for a growing world population.[18]



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