Journal of Agriculture, Food Systems, and Community Development
ISSN: 2152-0801 online
https://foodsystemsjournal.org

Cover crops, chemicals, and emissions in Pottawatomie County, Kansas, USA

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Submitted December 13, 2024 / Revised April 15, June 22, September 9, and October 7, 2025 / Accepted October 8, 2025 / Published online February 4, 2026

Citation: Miller-Klugesherz, J. A. (2026). Cover crops, chemicals, and emissions in Pottawatomie County, Kansas, USA. *Journal of Agriculture, Food Systems, and Community Development*, *15*(2), 53–79. https://doi.org/10.5304/jafscd.2026.152.002

Abstract

Cover crops have numerous benefits, including enhanced erosion control, forage biomass, nitrogen fixation, nutrient recycling, weed suppression, water management, temperature moderation, and carbon sequestration. Still, the adoption of cover crops by farmers is significantly influenced by their individual goals and preferences, their specific agroecological contexts, and larger agro-industrial structures and systems. Farmers in Pottawatomie County, Kansas, planted cover crops on 8.2% of the county's cropland in 2022 (nearly twice the national average). This study sought to understand what these farmers were looking for in cover crops by specifically choosing to interview them. Utilizing information gleaned from interviews with 22 farmers and/or cover crop experts, I was able to thematically analyze the resulting data. Coding revealed that many interviewees were on the "chemical herbicide treadmill" for cover crop suppression and/or termination. I used this information as a theoretical framework to inform descriptive analyses of farm characteristics, crop types, farmland use, and emissions. After comparing trends and themes, I found that interviewees looked for cover crops to be affordable if not profitable, suitable for use as a supplement forage bio-

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Author Note

This article is based on a chapter in the author's doctoral dissertation (expected publication in May 2026; Miller-Klugesherz, in press).

Funding Disclosure

This research was funded by the Agriculture and Food Research Initiative Competitive Grant No. 2021-68012-35923 from the U.S. Department of Agriculture, National Institute for Food and Agriculture. Any expressed opinions, findings, conclusions, or recommendations are those of the author and do not necessarily reflect the view of the U.S. Department of Agriculture.

Conflict of Interest Disclosure

The author has lived in Pottawatomie County for two-thirds of his life, and the author's spouse is a JAFSCD Editorial Board member.

mass/nutrition for cattle, and ideally subsidized by cost-share programs (~US$50/acre). Weather and labor availability and labor cost were also key influences. When grazing or crimping cover crops was not an option for their suppression or termination, interviewees preferred using herbicides over minimum tillage. This preference was reflected in the 1997–2022 county-level trends of increased herbicide application rates and expenses, notable changes in the primary cropland type from hay(lage) to corn and soybeans, and accelerated leaching emissions. Finally, I discussed implications for adopting soil health principles that trended more organic than regenerative, and offered resources for cover crop education, outreach, and cost share.

Keywords
chemical herbicide treadmill, climate change, conservation agriculture, cover crop suppression and termination, herbicides, Pottawatomie County, Kansas, soil health principles

Introduction

Communities in the U.S. must adapt to the triple planetary crises of climate change, pollution, and biodiversity loss (Hellweg et al., 2023). Adaptation includes favoring policies that better align with United Nations sustainable development goals (Guterres, 2021; Ibrahim & Ahmed, 2022) and the Intergovernmental Panel on Climate Change's (IPCC, 2021) land degradation targets. In the U.S., the Biden Administration's Partnerships for Climate-Smart Commodities allocated US$3.1 billion to hundreds of agriculture organizations, corporations, universities, and nonprofits for "climate-smart" projects (Graddy, 2023; U.S. Department of Agriculture, Natural Resources Conservation Service [USDA NRCS], 2023). The intention of this funding was to "pass most of the money on to tens of thousands of farmers, ranchers, and forest owners" (Popkin, 2023, p. 1). Continuous government funding for these projects, however, is unreliable, and adoption of climate-smart projects is ultimately up to farmers and communities themselves and the demands of their places (Lloyd & Chalabi, 2021; van der Ploeg, 1994, 2022). To better understand how these practices are implemented on the ground, it was crucial to investigate how farmers in one community utilized, perceived, and valued one specific climate-smart agricultural practice: cover crops (CCs).

Although CCs are "no silver bullet" (Environmental Defense Fund [EDF], 2022, p. 28; Lamichhane & Alletto, 2022), there are several reasons to plant CCs before, after, or in companion with corn and soybeans (USDA NRCS, 2019a, 2019b). These include enhanced erosion control, soil organic matter, forage biomass, nitrogen fixation, nutrient recycling, weed suppression, water management, temperature moderation, and carbon sequestration (Green Cover, 2024; Kranz, n.d.; USDA NIFA SARE, 2024). Among other options, farmers can seed CCs with shorter season genetics into commodity crop systems, or no-till a cash crop into a living, green cover (Correira et al., 2023; Practical Farmers of Iowa [PFI], 2023a). In the past 15 years, CC implementation in the U.S. has surged (Plastina et al., 2024). This trend has been true in my lifelong community of Pottawatomie County, Kansas (PT), which features highly erodible, native Flint Hills prairie.

From 2012 to 2022, the number of PT cropland acres planted to a CC—excluding Conservation Reserve Program (CRP) acres—surged from 3,894 to 13,660 acres (1,576 to 5,528 ha), and, among farms with CCs, their average CC acreage nearly doubled, from 105 in 2017 to 201 in 2022 (USDA National Agricultural Statistics Service [NASS], 2019, p. 713; USDA NASS, 2024, p. 684).[1] In 2017, 4.3% of total PT cropland acres (excluding CRP) were planted to CCs; by 2022, 8.2% were, which exceeded the contiguous U.S. CC average of 4.7% in 2022 (Bowman & Morales, 2024). Therefore, in this study I explored the following three-pronged question: Why did such a rapid increase in CC adoption occur in PT, what were the primary individual and structural factors driving enhanced adoption, and what were PT farmers looking for in CCs?

[1] The NASS Agriculture Census's wording on the CC question means that a CC could be planted after a crop is harvested or be the only use of land during the census year (Zulauf et al., 2024).

The answers and findings made novel additions to the robust CC management and adoption literature for larger-than-average operations ($\bar{x}$ = 1,183 acres or 479 hectares) and offered implications on how the chemical herbicide treadmill influenced PT farmers' uses of and beliefs in CC suppression/termination.

Review of Extant Literature

Since antiquity, farmers in ancient China, Greece, and Rome have used CCs, otherwise known as "green manure" (Magdoff & Van Es, 2021). A proven ecological management practice (USDA NRCS, n.d.-c), CCs have several beneficial agri-ecological functions for the ecosphere's four spheres (Figure 1).

CCs can enhance soil cover, increase plant and animal biodiversity, and improve the presence of living roots, which altogether total more than half of the generally agreed-upon soil health principles (Brown, 2018; Groundswell Agriculture, 2019; USDA NRCS, n.d.-a). CCs have also been shown to decrease a soil's susceptibility to compaction, temperature, and erosion (Adetunji et al., 2020; Huang et al., 2025), while simultaneously increasing soil aggregate stability, nitrogen (*N*) concentration, and soil water content (Blanco-Canqui et al., 2011, 2012).

Despite the multiple benefits of CCs, the adoption rate of U.S. acreage for CCs has remained in the low single digits (Zhou et al., 2022), indicating that CCs can present more challenges than benefits for most farmers. CCs can be complex to manage and may require new knowledge and specialized equipment (Acharya et al., 2019; Koehler-Cole et al., 2023; Kreitzman et al., 2022). The advantages of CC benefits can take years to accrue. In the meantime, farmers can incur extra costs and reduced yields (Deines et al., 2023), which is one reason why farmers have called for greater CC economic incentives and more diverse crop and livestock markets (Bergtold et al., 2017; Roesch-McNally et al., 2018).

Understanding the holistic impact of CCs requires examining farmers' considerations and perceptions of CCs while also considering their personal and agronomic goals, as well as commodity and CC types (Basche et al., 2014; Mwangi et al., 2015; Van Eerd et al., 2023). Therefore, the purposes of this research were to (1) analyze PT farmers' treatment, management, and implementation of CCs, and (2) consider agroecological, climatological, and socio-cultural influences on PT farmers' CC adoption.

Figure 1. Cover Crop Benefits for the Ecosphere's Spheres

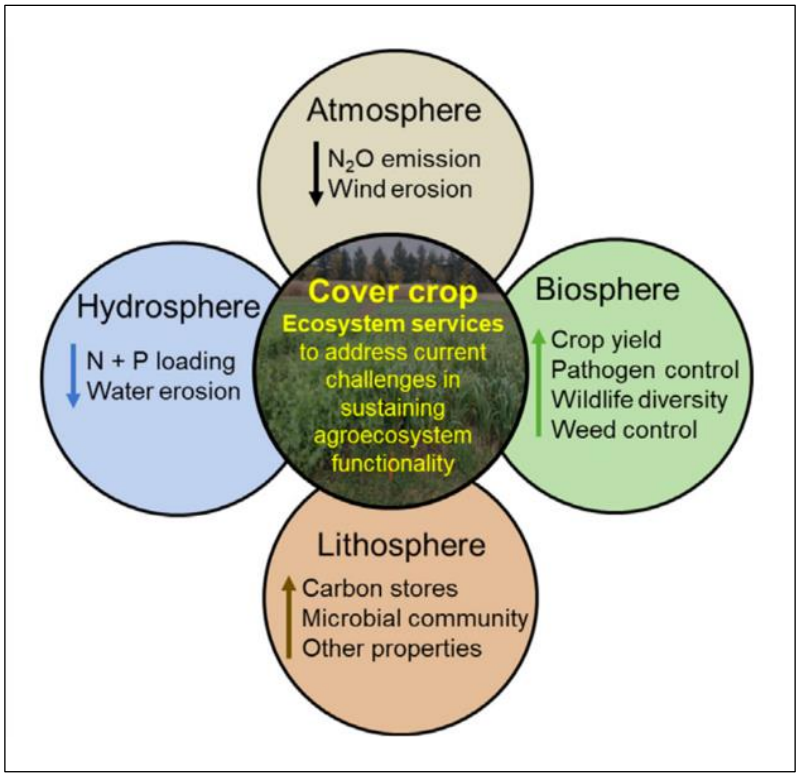


Image source: Van Eerd et al., 2023, p. 1; shared under CC-BY-4.0 license.

Methods

Methods proceeded in three steps. First, I thematically analyzed participant interview transcripts and a 23-item survey of their CC beliefs (Appendix, Table A1). Second, while coding certain themes, the "chemical herbicide treadmill" emerged as a guiding theoretical framework. Finally, I reported descriptive variable trends—

measuring farm characteristics, crop types, farmland use, and emissions—to contextualize the thematic analysis.

Table 1. Descriptives of Interviewed Farmers

Item	*n* responses	Mean
Total acres operated	16	1,183 acres / 479 hectares
Substantial off-farm income[a]	17	53%
Use cover crops?	16	81%
Integrate livestock?	16	94%

[a] Defined as "being able to make it financially without farming."

Thematic Analysis

Following institutional IRB procedures, I conducted semi-structured interviews with 22 participants from December 20, 2023, to May 19, 2024, using both purposeful (Campbell et al., 2020; Palinkas et al., 2015) and snowball (Noy, 2008) sampling techniques. I primarily interviewed farmers, but also included CC experts in extension, federal conservation, agronomy, input sales, and crop insurance. At the end of the interviews, I asked for recommendations of other potential interviewees. Five of the participating interviewees were individuals I had previously known, which introduced minimal purposeful sampling bias and constituted a limitation.

There were 18 farmers and four non-farmers, with 10 of the 18 farmers holding leadership positions in agricultural and/or community organizations. We conversed in vehicle cabs, barns, pastures, and during chore time. On average, interviews lasted nearly two hours. Participants were 100% non-Hispanic white and 72.3% male, with an average age of 55 (range = 26–71). With an average of 1,183 operated acres (479 ha) (Table 1), the sample more than doubled PT's 2022 average farm size of 493 acres (200 ha) (USDA NASS, 2024, p. 245). To ensure anonymity, I assigned pseudonyms to respondents.

As detailed below, I followed the six steps of reflexive thematic analysis (Braun & Clarke, 2006; Byrne, 2022; Knott et al., 2022; Naeem et al., 2023; Vanover et al., 2021).

1. **Become familiar with the data**. I initially used Otter.ai to transcribe the interviews, then checked its transcriptions against the recordings for accuracy and edited the former as needed. While doing so, I became more familiar with the data.

2. **Generate initial codes.** Going through the transcripts a second time, I used inductive coding to search for key words and phrases and generated initial codes (Bingham, 2023) while simultaneously searching for complete sentences or thoughts and entire paragraphs (meta codes). This ensured thorough, inclusive, and comprehensive coding (Braun & Clarke, 2006). I also used Atlas.ti's AI code suggestion feature to generate a separate list of codes.

3. **Search for emergent themes.** While searching for emergent themes, I compared my initial codes against those generated by Atlas.ti's AI code suggestion feature and the paragraph-level 'meta' codes. I revised, combined, and eliminated codes, checking them against one each other as well as the original data; in this way, themes iteratively evolved.

4. **Review themes.** I reviewed themes to ensure they were internally coherent, consistent, and distinctive. I compared data points and codes, and then condensed these codes into categories, categories into themes, and themes into findings (Charmaz, 2024).

5. **Define themes.** Defining entailed assigning a code name label, arriving at a full definition based on inclusion and exclusion criteria, and highlighting exemplary quotations (DeCuir-Gunby et al., 2011).

6. **Name themes.** For the last step, I named the finalized codes. To ensure that naming codes did not stem from my prejudices and prior experiences, I explicitly recognized my presuppositions, set them aside, and incorporated rival positions (Bailey, 2008).

During steps four and five of thematic analysis, I struggled to explain why many participants chose herbicide applications for CC suppression or termination by default, with no unprompted explanation of why that was their go-to method. CC and herbicide rates increased over 25 years (1997-2022), even though CCs were supposed to reduce the extent to which farmers applied herbicides to manage weeds (Giuliano et al., 2021). To make sense of the simultaneous increase in CCs and herbicides, one theoretical explanation emerged as most salient: the "chemical herbicide treadmill."

Theoretical Framework: Chemical Herbicide Treadmill

Chemical herbicide treadmill is a combinatory concept that is derived from several sources (e.g., Aronov, 2020; Haggblade et al., 2017; Howard, 2016; Merrill, 1976; Mortensen et al., 2024; J. I. Rodale, 1954). Although chemical herbicides can reduce labor and tillage costs, their widespread and repeated use exerts strong selection pressure on weed populations, and resistance evolves and spreads (Bharadia, 2025). To "fix" this problem, farmers add new herbicides, adjust formulations, utilize higher rates, and/or switch to crops that are tolerant to multiple herbicides, which can once again accelerate selection for multi-resistant weeds and increase costs and continue this cycle or "treadmill" (Peterson et al., 2025).

Powerful agro-industrial actors sell chemicals meant to be used with crops genetically geared to their use, forcing farmers onto the chemical herbicide treadmill. By continuously marketing and selling these new-and-improved "fixes" to farmers, consolidated and concentrated agro-industries handsomely profit (Carolan, 2022). There are other socio-cultural forces shaping herbicide hegemony and adding a faster "spin" to the chemical herbicide treadmill.

For instance, public dollars—which are allocated via direct payments to farmers (disproportionally to farmers of larger operations who sell commodity crops)—indirectly subsidize farmers' herbicide expenses. Also, land-grant extension agents offer farmers technical assistance including long lists of pre- and post-herbicide blends considered optimal for CC species suppression/termination (Grint et al., 2022; Hill & Sprague, 2024; Palhano et al., 2018). However, the primary purpose of these herbicide formulations is to minimize CC competition with cash crops to maximize yield per acre, which remains the culturally-touted metric of a "good" productivist farmer (Burton, 2004).

The chemical herbicide treadmill is a byproduct of the agricultural treadmill of production (Cochrane, 1993, 2003; Curran, 2017; Levins & Cochrane, 1996; Lynch, 2017; Sanderson & Hughes, 2019). Technological advances, production scales, and government subsidies encourage farmers to continually expand production and capital investment to maintain the pace or else leave, which in turn depresses commodity prices and creates additional scaling pressures. For example, farmers' widespread adoption of herbicide-tolerant crops can contribute to reduced labor, enabled larger fields and simplified rotations, exacerbated farm consolidations, and reinforced production incentives. Meanwhile, the intensive and repetitive use of herbicides selected for resistant weeds has forced farmers to consider additional herbicide options and new genetically modified traits that are tolerant to other herbicides. This example explains the mechanistic similarities between the treadmill of production (scale, subsidies) and chemical herbicide treadmill (herbicide overuse, weed resistance).

Descriptive Analysis

After performing a thematic analysis and establishing a theoretical framework, I compared interviewee data to county-level descriptive data measuring farm characteristics, crop types, farmland use, and emissions (Bingham, 2023). I then analyzed these data points in a comparative, integrated, and systematic approach (National Institute of Health Office of Behavioral and Social Sciences, 2018). County-level descriptive analyses also served as important validity and reliability checks on interviewee data (Guest et al., 2012).

I sourced most variables from USDA NASS (2004, 2009, 2012, 2019, 2024) and Conservation Technology Information Center (CTIC), Regrow Ag, Inc., et al. (2023). The latter developed a remote-sensing algorithm using earth-observing satellite data to document the adoption of soil health practices and greenhouse gas emissions at

high spatial-temporal resolutions (Hagen et al., 2020). These are available through the Operation Tillage Information System (OpTIS) 2.0 database (TNC et al., 2023). Regrow Ag, Inc., then utilized the Denitrification–Decomposition 11.0 model to estimate greenhouse gas emissions for nitrous oxide (N_2O), nitrate (NO_3^-), and soil organic carbon (SOC) (Gilhespy et al., 2014). I reported OpTIS and Denitrification Decomposition (DNDC) descriptive statistics to compare 2005–2019 trends in residue cover and leaching of soil organic *C* and *N*-based gases with 2002–2022 trends in harvested cropland types.

Findings and Discussion

The primary findings were grouped in three sections: (1) interviewees' CC beliefs, practices, and peer information networks; (2) county-level changes in leading crop types (less perennials, more corn and soybeans) and emissions over time; and (3) interviewees' preferences for "spray over spade" to control CCs; that is, automatically deferring to herbicide applications rather than minimum tillage to suppress and/or terminate CCs.

Beliefs, Practices, and Peer Information Networks

At first glance, using the chemical herbicide treadmill as a theoretical framework may not seem appropriate to analyze farmers' CC beliefs and practices. However, the chemical herbicide treadmill's socio-cultural hegemony shapes farmers' beliefs and practices regarding CCs. The treadmill fuels lock-ins and path dependence, fails to support the internalization of supposed 'externalities,' and creates arms-race dynamics that demand stronger chemicals, making it difficult to adopt alternatives (such as front-mount roller crimping, which requires neither spraying nor spading certain CCs, like rye) (Green, 2018; Green & Owen, 2011).

Interviewees believed in the union of no-till and CCs. In 2022, 49.5% of PT farmland was no-till. An extension agent and farmer named Tammy remarked, "With cover crops, you don't have to have all the different tillage equipment." There are other mutualistic reasons for the union of no-till and CCs. Farmer Tom said, "no-till and cover crops go together," commenting on their ability to improve moisture retention and regenerate "poorer ground":

> I did not see any yield drag at all except one field on one farm. Instead, the yields increased, especially on poorer ground. You're going to see more of an increase in yield with no-till and cover crops with your poor ground. Your poor ground is going to be a little wetter ground, you're going to have problems getting into it in the spring. … Have the patience to wait to have that ground dried out, and your cover crop will help get that moisture down deeper, just like money in the bank. … The soil is not going to have as much compaction, so when your seeds sprout, the roots of the new seed are not fighting all that hard against wet, tight, and compacted ground. … Walk into that field, and it's good ground. Good corn has a lot of trash [corn stover or crop residue].

Although Tom did not experience overall yield drag from CC, that can be the case. For instance, the first large-scale, field-level analysis of observed yield impacts from cover cropping implemented across the U.S. Corn Belt found there was an average corn yield loss of 5.5% (Deines et al., 2023). For soybeans, there was an additional 3.5% yield loss on fields where CCs were used for three or more years, compared to fields that did not adopt CCs (Deines et al., 2023).

To address Tom's other points, integrating CCs into no-till acreage can improve the soil's physical properties and decrease its compaction and temperature (Blanco-Canqui et al., 2011, 2012). Western corn belt producers have previously perceived diverse cropping rotations as an adaptive strategy to cope with marginal lands (Wang et al., 2021), and among U.S. soybean farmers, CC adoption has been positively correlated with crop diversification and no-till adoption (Lee & McCann, 2019). Interviewed farmers believed that CCs enhanced crucial agri-ecological services. Based on a 23-item survey of their CC beliefs, they most strongly agreed that CCs decrease natural resource degradation and soil erosion (see Appendix, Table A1). For instance, Tom regularly plants CCs after harvest to stymie soil erosion:

> One year I got the crops off way too late to plant any covers. So, I thought, "Well, I've been doing this for six years, I can skip a year." And I skipped that year, but it was amazing how many ditches I had out there. I mean, it was something you could just visually see, you didn't need to bring somebody in to point it out. And so, [ever since] I've been continuous cover cropping no matter what. I'm right behind the combine with the drill.

Despite CC's benefits, there can be drawbacks. For instance, Camden, a federal conservationist and farmer, cautioned farmers not to be complacent with initial CC success:

> Cover crops make weeds manageable, but they are not a cure-all. There's no one thing that works every year [because] every year is different. That is probably the biggest thing I would tell you—if you think you got it figured out, you better not pat yourself on the back too hard because next year's going to be different.

CCs can be sunk costs if a farmer chooses expensive mixes. Camden remarked:

> You got to have these very specific mixes, and they get expensive, especially if people don't have the capability to graze them because they don't have fence, water, etc. Even if the government pays me US$45 an acre, it still may not pencil out because I got to buy this crazy expensive seed just to terminate it.

Tammy also addressed concerns about CC seed costs, stating that cost share programs can sometimes require multispecies CC seed blends, which are more expensive to plant:

> Sometimes those cost share program rules say that you must use species from each different class, you must have brassicas, grasses, and legumes. Very commonly, one or two species out of a mix is going to dominate.

In 2019, Myers et al. identified some specific situations that can accelerate farmers' CC profitability. Their study contextualized responses from interviewed farmers who wanted CCs to be affordable, if not profitable. By utilizing CCs to increase their soil organic matter ratio to help improve future yields (Jacobs et al., 2022), the opportunity to potentially sell CCs on a secondary market can be considered. Increases in CC adoption have previously shown a high correlation with funding from federal and state conservation programs (Zhou et al., 2022), and farmers are eager to receive federal risk protections and incentives (Sawadgo et al., 2021; Wallander et al., 2021). For example, in the Southern Great Plains, producers expressed moderate willingness to accept CCs if they were paid US$26.38/acre (Johnson et al., 2024). In our study, a farmer interviewee named Hank confirmed that he would plant more CCs if the government subsidized seed costs to the tune of US$50/acre:

> The problem with cover crops is they may not always be the way. Right now, the seed is expensive. I mean, it costs you quite a bit per acre to put cover crops on…I'd rather do it for 50 bucks. But if the cost of the seed was regulated or somehow moderated or supplied by the government that would kind of make a difference too. Think back when the government did the soil belt programs, they supplied clover seed.

While much smaller than USDA Environmental Quality Incentive Program (EQUIP) CC payments of US$40–50 per acre (Myers & Wilson, 2023, p. 6), the 2022 USDA Risk Management Agency's (RMA's) (2022) Pandemic Cover Crop Program offered a US$5/acre premium discount to producers who planted qualifying CCs and were enrolled in eligible crop insurance policies.[2] Curtis, a farmer and crop insurance agent, remarked,

[2] H.R.8527 (2023) would have extended this program by providing a US$5/acre crop insurance discount (Casten, 2023), but it died in subcommittee.

> They're good for me, they're throwing me an extra five bucks an acre, and that makes a little bit of a difference. It might not pay for a chemical application throughout the spring or pay for seed costs, but it will make a little bit of a dent. … The option to graze them has become popular, because until just two years ago, [RMA] wouldn't allow you to graze or hay your cover crops. … Opening that up … really helped because farmers don't have to let acres sit idle for that long, and they can bring additional value back into their operations.

In Curtis' last point, he was referring to USDA RMA's (2021) decision that producers with crop insurance could hay, graze, or chop CCs for silage, haylage, or baleage at any time and still receive 100% of the prevented planting payment. Previously, farmers could only hay, graze, or chop CCs after November 1; otherwise, their prevented planting payment was reduced by 65%. Crop insurance also benefits from the USDA RMA's decision. Won et al. (2023), for instance, found that counties with higher CC adoption rates had lower levels of crop insurance losses caused by prevented planting.

When livestock graze CCs, they recycle manure back into the agroecosystem (Groff, 2015; USDA NIFA SARE, 2024). CC systems integrating livestock can be more profitable than those livestock systems without, because the value of CC forage is greater than its costs (Bowman et al., 2024). One interviewee, Martin—a farmer and employee working in the animal health industry—used wheat as a CC for soybeans, with one option for his end use goal of the wheat being cattle feed:

> We'll use wheat as a buffer between soy rotations. We will plant corn this year on everything down there, then turn around after corn harvest is done and plant wheat to help with erosion and to keep that ground covered until we plant soybeans in the spring. We will do one of three things—either spray the wheat, harvest it and take it to market, or cut and bale it up for cattle feed.

Tom preferred to graze his livestock on CCs for the quality protein it provided them:

> As a normal practice, I'll plant covers right after silage and I'll get a foot to eighteen inches of grazing off it. It's top nutrition, high [quality] protein. The cows will just get fatter than fat off it and do really well. … Because I run livestock, this here was chopped for corn silage and put in the silo, then I went in and planted turnip, radishes, and triticale. … As soon as it warms up, they will take off. That's what I like to see.

Edwin would plant late-summer cover mixes into wheat stubble, and then sell the silage to his neighbor to feed cattle:

> I've got a window of time in late summer after I harvest wheat to plant cover crops. I drill them into the wheat stubble. I've got a neighbor who we sell our cows to, and they want to buy chuck silage and put it in the silo for feed for their calves in the winter. We've worked with them where we can take that planter corn and bean—we have a rotation—and we can take that silage off, usually in early August, and that allows me to go in there and drill cover crops and turnips all in the same blend.

There's more to CCs than simply harvesting or grazing them. CCs require practice, patience, adaptation, long-term planning, and the ability to learn new management practices. To assist with the adoption of CCs, there are several resources available that consider species type and plant characteristics that best align with each farmer's goals (e.g., Community Alliance with Family Farmers [CAFF] & The Freshwater Trust, 2023; Hamilton et al., 2017; USDA NRCS, n.d.-b). Integrating CCs means learning new management skills. Luckily, there are several CC education and outreach resources in PT and the surrounding region: Pottawatomie County Conservation District (KACD, n.d.) (in Westmoreland); Kansas State University Research and Extension's (n.d.) Northeast Regional Office and Department of Agronomy (n.d.) (in Manhattan); the Kansas Soil Health Alliance (n.d.) (in Esbon); Kansas Farmers Union

(n.d.) (in McPherson); Kansas' USDA NRCS (n.d.) office (in Salina); Rodale Institute Regional Resource Center at Kansas Wesleyan University (in Salina); and the Kansas Alliance for Wetlands & Streams (n.d.) (in Newton). Finally, Kientzy et al. (2023) provided a summary of CC seeding machinery, equipment costs, coverage rates, seeding quality, seed size, and consistency.

Interviewees also emphasized that growing a successful CC stand "is more of a timing thing" (farmer Earl). "Timing" meant different things to different farmers. It meant receiving timely moisture after seeding CCs to ensure successful germination (farmer Michael), planting CCs before a freeze (farmer Zach), or terminating CCs before they "go to seed" (farmer Tammy). Farmer Sam lamented that lack of time and affordable labor prevented him from consistently planting CCs:

> I don't always get cover crops planted everywhere. I'd like to, but I don't always have time. The last several years I planted cover crops, and they didn't come up until the spring because it was too dry, so that didn't really help much. In fact, [planting] covers was more problematic than helpful. And so, this year, it was just too dry, and so I just didn't plant them. … I don't really see anything wrong with that.

Nick commented on the trade-offs of not tilling (but increasing his herbicide application rates for CC suppression/termination), and the time-intensive nature of CC management. He said,

> We use less fuel than we used to because we're not out there ripping the guts out of a tractor tilling. But we're also doing our own spraying, and so that kind of offsets that benefit. … Since I've gotten more into the cover crops, I have one guy who now works full-time for us on them.

Farmer peer information networks also influenced interviewees' CC decision-making. Geraldine noted,

> Cover crops are big talk at the coffee shop because people want to try it. They want to know their neighbor is doing them and when they can see the results, then they're going to try to plant them.

Farmers who use CCs are more likely to bond with other farmers who use CCs (PFI, 2023b), primarily for knowledge exchange. As Curtis explained,

> The guys that have done covers in the past are the first ones to tell you what has worked, what blend that they've used, or stuff that may not have worked as good for their operation.

Virtual mediums (online forums and Facebook groups), in-person events (e.g., No-Till on the Plains conferences), and everyday interactions with neighbors and community members spur knowledge exchange and bonding (Riley & Robertson, 2022). Trust and reciprocity norms emerge from regular and repeated interactions within a community (Bridger & Alter, 2006). Camden noted that the "farmer see, farmer do" mentality has even helped sway CC-skeptical farmers:

> I've heard conversations at many of the talks I've been to, like "just see what crazy Jim is doing, he's putting cover crops down!" They might talk about each another behind their backs a little bit but [then say], "he's been doing it for five years now, so he must be doing it for a reason."

Fewer Perennials, More Corn and Soybeans, and Accelerated Emissions

To better understand why CCs increased, it is necessary to examine an overview of county-level changes in leading crop types. From 2002 to 2012, PT farmers harvested more acres of hay(lage) than corn and soybeans. By 2017, the combined harvested acreage of soybeans and corn for grain or silage overtook hay(lage) acreage, and by 2022, soybean acres were the most prevalent crop (Figure 2).

Camden questioned the economic rationale of farmers who converted hilly hay fields to cropland:

> You get guys who will try and farm the top [ground], and it makes me shake my head. What are you gonna get? You got to plow it up and lose that grass. Prairie soils are highly erodible, so you have to put structural conservation on the ground—terraces, waterways—and then by the time you do that, now you have marginal farmland. How you gonna make that pencil out?

From 2005 through 2019, the PT cover crop rate increased, as well as crop residue rates of 51–100%. Meanwhile, conventional tillage and reduced tillage, low-residue cover crop rates decreased (Appendix, Table A2). Over that same timeframe, all leaching emissions increased (Table 2 and Figure 3).

In sum, CC rates increased in the county, but so did all emission types. This was especially sur-

Figure 2. Pottawatomie County, Kansas (PT), Harvested Cropland Acres by Select Crop Types, 2002–2022

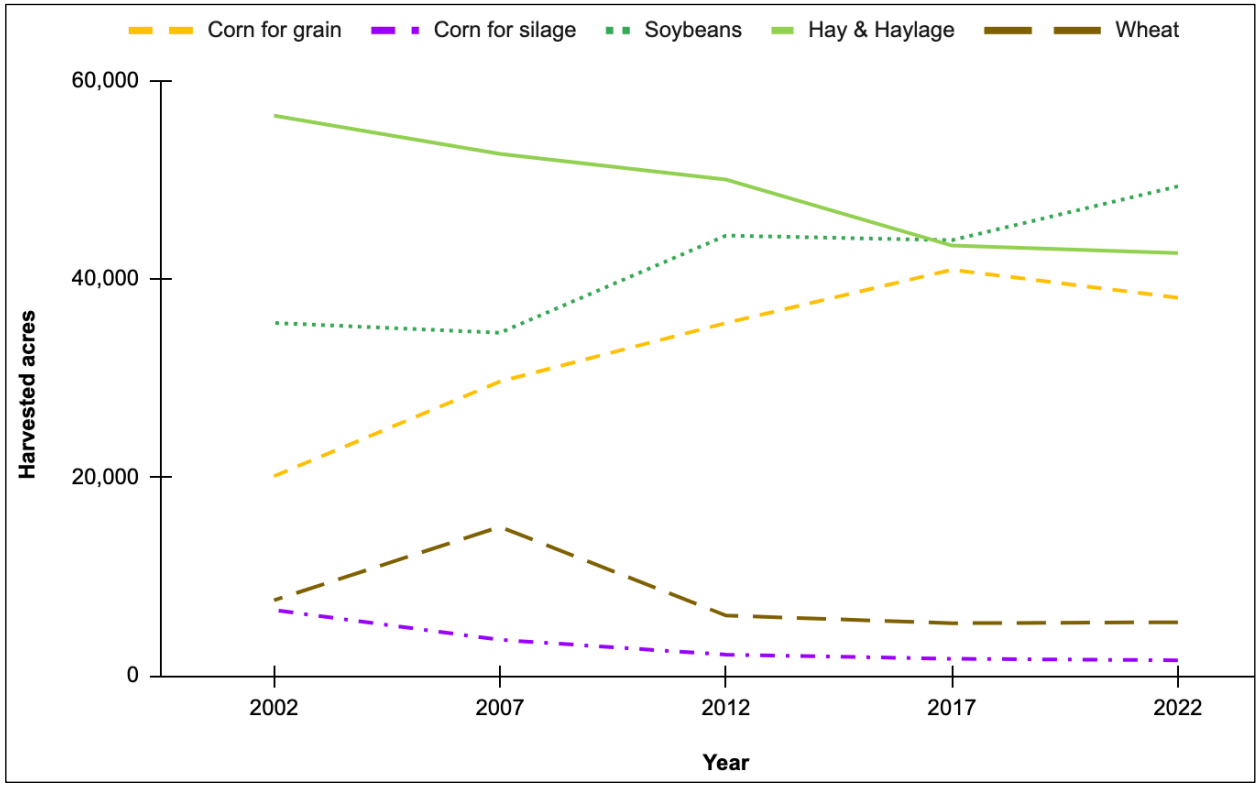


Figure by Jacob Miller-Klugesherz, © 2026; shareable under a CC-BY 4.0 license.
Data sources: USDA NASS 2004 (pp. 212, 226); 2009 (pp. 259, 268); 2014 (pp. 237, 251); 2019 (pp. 244, 271); 2024 (pp. 538, 554, 577).

Table 2. Denitrification Decomposition (DNDC) Emission Trends for Farmland Acres in Pottawatomie County, Kansas

Annual leaching emissions	% Δ (2005 to 2019)	Linear r^2	Min. (yr.)–Max. (yr.)	CSB 2019 Rank %
Nitrous oxide (kgN_2O/ha-yr)	53.19	0.432	0.778 ('08)–1.649 ('18)	73.73
Nitrate ($kgNO_3^-$/ha-yr)	93.41	0.524	22.69 ('06)–60.32 ('19)	64.1
Daily soil organic carbon global warming potential (kgC/ha/yr)	103.3	0.383	–0.306 ('16)–0.01 ('19)	70.01
Daily global warming potential, total atmospheric emissions ($kgCO_2$-eq/ha/yr)	370.8	0.523	–0.113 ('05)–0.306 ('19)	75.52

Data source: The Nature Conservancy [TNC] et al., 2023.

prising for nitrate emissions because Nouri et al.'s (2022) global meta-analysis found that, across different soil types and agronomic systems, cover crops reduced nitrate leaching by 69% compared with fallow. There was a sizeable discrepancy, in directionality and magnitude, between the emissions data I expected and those I observed.

One possible explanation for this discrepancy was that the acreage ratio of perennials, alfalfa, and woodlands all decreased, while corn and soybean acreage and productive intensification increased over the same time. The percentage of acres planted to herbaceous perennials was >11% in 2005–2007, but in 2009, it dropped to 4.41% and remained <5% through 2019 (Hagen et al., 2020). Acres of harvested alfalfa declined since 1997 (10,163 acres), reaching its lowest point in 2022 at 6,077 acres (USDA NASS, 2019, 2024). This could have collectively skewed C-N ratios below the ideal 24:1 thresholds (e.g., alfalfa fields exhibit a 25:1 C-N ratio) (Gullickson, 2015). Moreover, although CCs can supplement inorganic fertilizers by fixing more N_2 (Blanco-Canqui et al., 2012), in certain conditions—especially in drier fields fertilized with inorganic N—decomposing, leguminous CC residues can consume soil O_2 and lead to N_2O emissions via respiration-induced anoxia (Lussich et al., 2024). As Basche et al. (2014, p. 471) concluded, "cover crops do not always reduce direct N_2O emissions from the soil surface in the short term."

Organic farmer Vanessa explained why increased CC attention can distract from understanding the broader impacts of farmland use patterns:

> I've seen some pretty bad examples of no-till. How is there still a lot of sediment in the ditches and in the reservoirs if we're doing such a good job with [no-till]? So now they implement more cover crops and chemicals in

Figure 3. Annual Average Daily Global Warming Potential of Total Atmospheric Emissions on Pottawatomie County, Kansas (PT), Cropland Acres by Year, 2005–2019
Negative values equal net sequestration and positive values represent net emissions.

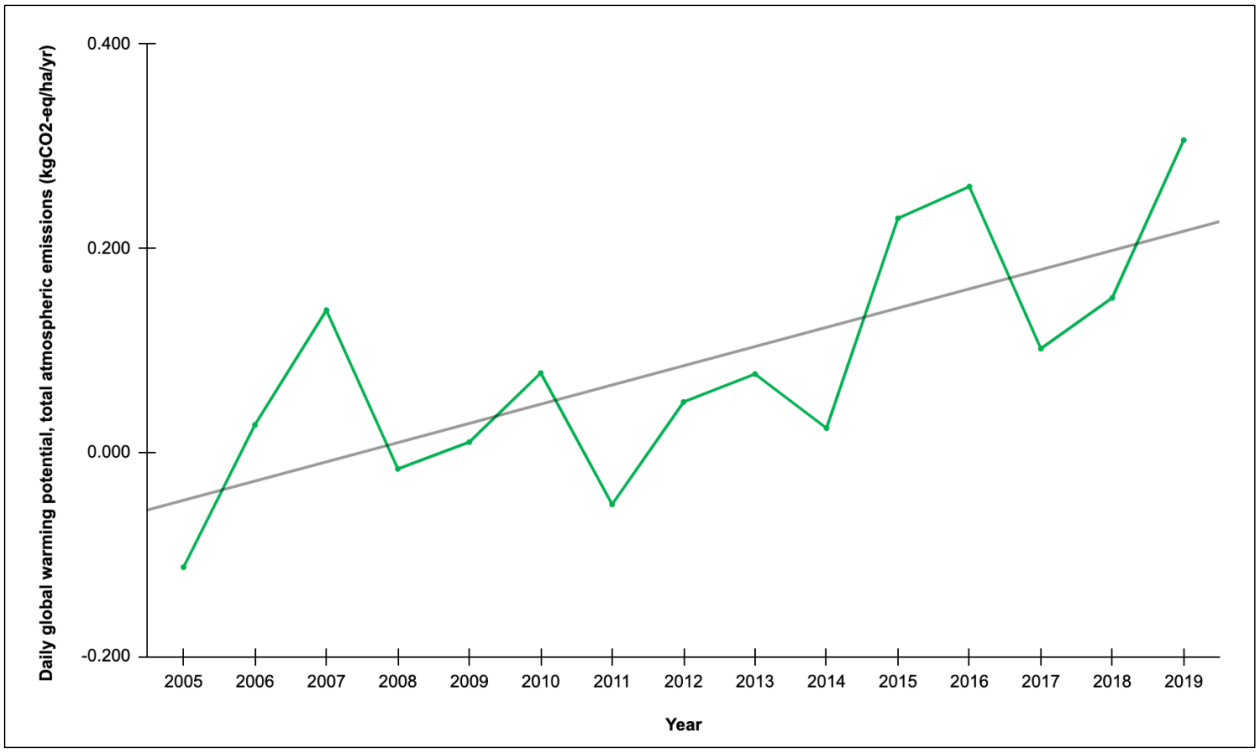


Figure by Jacob Miller-Klugesherz, © 2026; shareable under a CC-BY 4.0 license.
Data source: Hagen et al., 2020, p. 16.

> corn and soybean rotations. But that's not enough diversity. We are not going to solve the problems of water quality and soil health until we recognize and solve the problem of size and scale. I see the bulldozing going on, and they're constantly pushing the borders of the fields. They're filling in the little low places and farming the riparian and brushy areas. They're taking all that out so to do monocultured corn and soybeans. And then they say, "Oh, I'm environmental because I've thrown in some rye cover crop or a mix. And you know, I graze our cattle out there, so those are good things." But for the big picture, we're not going to solve the bigger problems this way.

Vanessa's perspective was holistic. Similarly, Nathan recognized the importance of public dollar investment in CC payments, but experienced a situation when a government program incentivized farmers to convert native prairie to CC-planted cropland:

> [I was on a] project where farmers tore out a whole bunch of native prairie to put it in cropland. They had a proposal that would pay them to implement cover crops on this land they had taken out of native grass. I was adamantly opposed and said, "we are just rewarding bad behavior. We should not be supporting it." But man, there were people on that committee who said, "but it will do good going forward." It passed and … it's still paying them for something that they should not have done.

There was another potential explanation for increased emissions: excessive herbicide application can result in NO_2 and NO_3^- leaching, which occurs when an herbicide is dissolved in water, moves down through the soil profile, and is carried away from crop and weed germination zones (Giuliano et al., 2021; Nogueira Bandeira et al., 2022). From 1997 through 2017, the percent of total PT cropland acres applied with herbicides more than doubled (USDA NASS, 2004, p. 563; 2014, p. 610; 2024, p. 670), and from 1997 through 2022, chemical expenses per operation (in June 2024 inflation-adjusted US$) more than tripled (USDA NASS, 2004, p. 268; 2014, p. 293; 2024, p. 309).

"Spray or Spade": The Rigid Dualism Dictating Cover Crop Suppression/Termination

Choosing the correct CC suppression or termination method depends on farmers' goals, equipment availability, cost, and management preferences. These options include mowing, disking, roller crimping, grazing, and herbicides (Adetunji et al., 2020; Anderson, 2023; Hill & Sprague, 2024). Ideally, cover crops' weed suppression should reduce the herbicide costs farmers pay for weed suppression. Tammy explained:

> Weed suppression is becoming more of a cover crop benefit that producers are focused on. They like the idea that they could use less expensive herbicide options, because the days of glyphosate working perfectly and never having to apply anything else are long gone. …They can help farmers use less costly herbicides, and potentially they might be able to use Roundup only for their burn-down.

The evidence that CCs can reduce herbicide costs is mixed. CTIC et al. (2025) have conducted nationwide surveys of CC users. In their 2023 survey, 55% of respondents saw no change in herbicide costs in corn following CCs, while 42% noted that they saved money on corn herbicides after CCs (CTIC, USDA SARE et al., 2023, p. 74).

Eight PT interviewees (36.36%) said that every year they must make the choice between minimum tillage or herbicides for cover suppression/termination. For their operational contexts, crimping or grazing were not options. They perceived "spray versus spade" to be a necessary choice for ensuring a harvestable and marketable cash crop. Earl argued,

> Either you spray, or you use a spade. I don't know how you could do it otherwise. … Cover crops can eliminate one trip across spraying for weeds, and that helps. And a lot of the chemical stuff has gotten high enough that this year, I think you could run over ground a couple

> times with a disk and a field cultivator for way less than the burndown cost. … I hired my chemical application done because I don't really want to be around the stuff. And they [coop] have better spray equipment with better filters on the cabs. If I were to go organic, that would make a pretty big change.

Curtis echoed Earl's rigid belief about the necessity of spray or spade:

> From an on-farm perspective, there are two ways to control weeds: with iron, whether that be a disc, moldboard, plow … or with a chemical application, [especially] when the weeds become so bad. … If you go through with a cultivator, you're only killing what's in between the rows. I think that's why some guys have gone back to a more of a minimum till instead of a no-till, because of the mis-management of the chemical that they had to begin with.

Some farmers were not concerned about the negative impacts of chemical herbicides, partly due to the implied trust that considers salespersons as the experts. As Pete explained,

> I don't see any other way to do it. … My grandfather came here from Germany in the late 1920s, and they farmed with a hoe. Back then you could round up a few kids to help weed. Now you can't do that or find anybody who would even consider doing that kind of work. … I go to farm meetings all the time, and with those farmers I talk to, all of us have used Roundup since it was initially invented. It's a very useful herbicide.

Hank, a noncertified organic farmer, said neighboring farmers used herbicides to terminate both annual CCs and emerging weeds around the planted-green cash crop:

> A lot of the no-tillers now are going in and are no-till planting the cash crop into that cover crop and then trying to come in later and spray it to kill the cover crop. So, they're kind of doing two things at once: they're killing the cover crop plus killing the new weeds coming in around the cash crop.

However, herbicides used to control weeds in a cash crop stand can affect CC planting schedules. This effect is called residual "carryover" (Corteva, 2022; Maia et al., 2024; Paris et al., 2024). Tammy explained the carryover:

> One of the other challenges to cover crop adoption is going to be the herbicides used on the cash crop. Some [herbicides] are going to kill some of the cash crops because of their perennial natures and the time between planting and harvest. When trying to get that cover crop established, not all of them are going to survive. And so sometimes the choices that you make in the cash crop will dictate what you can do with covers, or if you can grow anything after. A lot of our most effective weed control herbicides have some residuals, and there hasn't been testing done on every single cover crop known to man, and so you just try to find something close or look at the longest one. A lot of times, the longest [residuals] may be 15 months, but you don't have 15 months between the application and the need to plant a cover crop. So, there are some substantial limitations in terms of herbicide technologies and some testing that probably should be done on particular cover crop species and whether they can be established after using those herbicides.

Unless they did custom spraying themselves, most interviewed farmers distanced themselves from spraying and depersonalized its effects. They acknowledged certain risks but downplayed them to emphasize the necessity of spraying. For instance, Michael said,

> These airplanes, you gotta be careful. … Herbicides will kill people's gardens, flowers, and trees. … There aren't very many neighbors who don't get along, but that'd sure be a way to piss off your neighbor and have them not

talk to you—scorch their gardens.

"Kill." "Piss off." "Scorch." Such terms of death can reflect farmers' attitudes toward themselves, others, and their operations (Brown, 2020). Herbicides can be lethal for humans, as Hank attested:

> I quit using chemicals. … I can't make myself spray anymore. Dad came down with Alzheimer's [disease] when he was 60, and he just loved to spray. He'd come in soaking wet with chemicals. I think maybe that's what ended up doing him in. It got so bad he put a raincoat on me when I sprayed with a tractor, because it gets sprayed up. That was Agent Orange, you know?

Five PT interviewees displayed cognitive dissonance about using more herbicides for weed and CC suppression/termination. However, they all ultimately justified their intensified use of herbicides as being necessary to "feed the world," which is a powerful cultural and social "script," or a "commonly used line of argument that is widely invoked in response to a particular issue or situation" (Vanclay & Enticott, 2011, p. 256). Marvin followed this script thusly:

> There's always a balance. You either take the risk of death by cancer or death by starvation. The main goal that farmers are trying to tackle is just feeding the world. It's why you see the need for improved technologies. Bigger populations require more people to be fed. It's an interesting social dilemma.

Barbara admitted that her farming practices were heavily dependent upon herbicides and that they have negative impacts on human health (see Ahuja et al., 2024). However, Barabara justified her use of them:

> We are afraid of people starving, that we won't be able to produce enough to feed the world. We've already got people in the world starving.

Tammy believed there was no viable way to "feed the world" with organic production:

> The Certified Organic Program is perfectly acceptable if honesty is shared about what that actually means, which sometimes it's not. … But the reality is that if every producer adopted only those practices and went through that [organic certification], we would have trouble feeding the world for sure.

Stewardship and business are two social roles that often represent competing moral imperatives (Bell, 2018, 2004). To reduce the tension between them, Iowa farmers portrayed themselves as a "hero feeding the world," a third social role with more positive moral overtones (Comito et al., 2013, p. 283). The "feed the world" justification for herbicide (over)use has been refuted (Stone, 2022). Scaled organic production can feed the world just as viably as conventional production (Badgley et al., 2007). As Lappé (2010) argued, creating a food system that encourages "low-input local production, with organic practices where viable, will not only help address the climate crisis but also help redress one of the most painful facts of the modern world: hunger amid plenty" (p. 172). Nevertheless, these interviewed farmers followed the "feed the world" script to justify their chemical herbicide suppression/termination of CCs.

From an agroecological perspective, the ideal management type is regenerative organic (Rodale Institute, n.d.),[3] which has been codified by the Regenerative Organic Alliance's (n.d.) Regenerative Organic Certified™ program. This certification indicates that both no spray *and* no spade is achievable, although PT interviewees perceived it as impractical. Given that many of these PT farmers will not stop using herbicides any time soon, a practical way that farmers can reduce usage rates is to consult and consider the best on-farm management practices (Prokopy et al., 2008, 2019). One option to consider is the 4R method, which

[3] The "original regenerative principles" (pluralism, protection, purity, permanence, peace, potential, and progress) did not specifically omit herbicides or tillage (Rodale Institute, 2019), although their exclusion was implied.

involves applying the right source at the right rate, time, and place (Rogers, 2019; TNC, n.d.). Jones (2009, p. 5) argued that if one had to pick between herbicides and minimum tillage, the latter would be best, because in most situations, herbicides cause greater loss of soil aggregation and structure than tillage. To minimize erosion and leaching, Jones continued, one should consider planting CCs immediately following a tillage event to incorporate some kind of living root back into the turned soil.

Conclusion

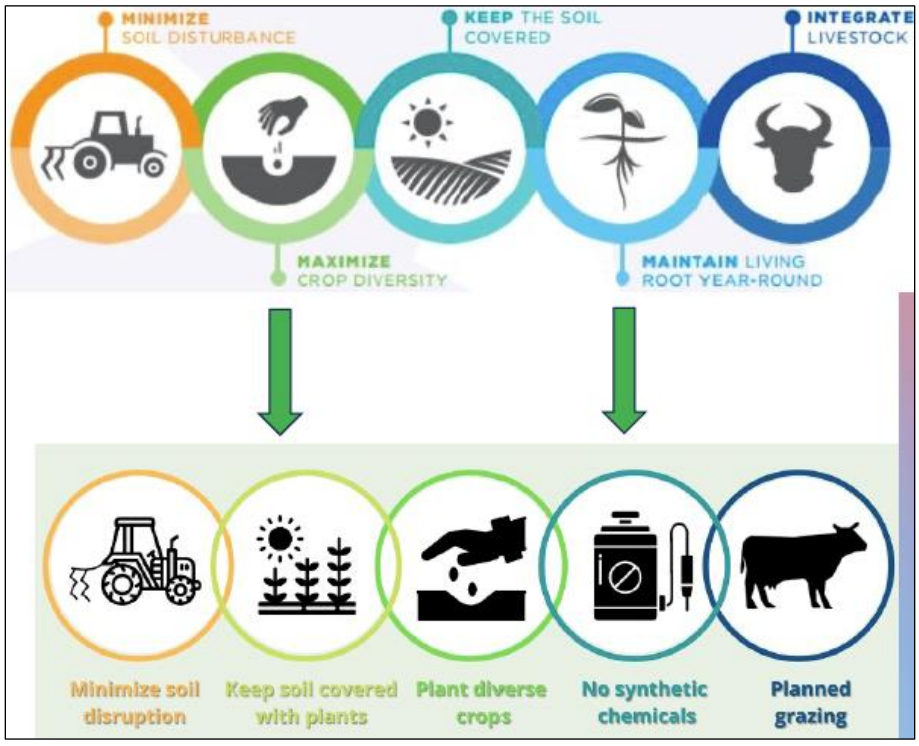
This study analyzed the CC beliefs and practices of Pottawatomie County (KS) farmers and CC experts on large corn and soybean operations ($\bar{x}$ = 1,183 acres or 479 ha), as well as structural factors influencing their CC perceptions, decision-making, and adoption. Interviewees foremost looked for CCs to be affordable, if not profitable, and subsidized by public dollars via cost-shares. PT farmers planted CCs to supplement forage biomass for cattle, and grazed cattle on CC residues, mostly corn stover. They learned about CCs from their neighbors and emphasized the importance of timing related to weather and available labor. They treated CCs as another tool in the conservation toolbox, not a silver bullet. One explanation for the increased adoption of CCs was that farmers converted more cropland acres from perennial crops to corn and soybeans from 1997 to 2022. During that same 25-year timespan, other concerning trends increased: acres applied with herbicides, total chemical expenses, and leaching emissions. These trends were associated, related, and likely correlative, although I did not empirically demonstrate correlation in this study.

When CC suppression and/or termination by crimping or grazing was not an option for farmers, they more frequently deferred to herbicides (spray) instead of minimum tillage (spade). While generalizations were limited to the study context, this finding raises implications for the tradeoff between herbicides versus minimum tillage under certain agricultural conditions and contexts (Dentzman, 2018).

Moving forward, PT farmers and agriculture-adjacent people could consider soil health principles that trend more organic than regenerative (Figure 4).

Starting from the five principles used by Jay Fuhrer (Groundswell Agriculture, 2019) and Gabe Brown (2018), replace the "maintain living roots year-round" principle with the "no synthetic chemicals" principle. The "maintaining living roots year-round" principle can be

Figure 4. Pottawatomie County, Kansas, Farmers' Potential Shift in Soil Health Principles: From Reducing Synthetic Agrochemicals (above) to Eliminating Them (below)



Sources of images: LandscapeDNA (n.d.) (above) and Health Care Without Harm (2025) (below); shared under CC-BY 4.0 licenses.

considered implicit to the "keep the soil covered" principle, and omitting the former allows for shallow, minimum tillage practices when and where appropriate. Front-mount roller crimping does not use herbicides or disrupt soil aggregate formation through tillage (Gailans & Bakehouse, 2022; USDA SARE & Clark, 2007, p. 115) and could therefore be considered as a suitable suppression/termination tool (Alonso-Ayuso et al., 2020). Of course, "regenerative" and/or "organic" labels are most useful when contextualized with ongoing, on-ground farm management practices, farmer experiences, and certification requirements (Staton et al., 2024).

Adopting healthier agricultural practices is at once difficult and necessary, yet ultimately dependent upon farmers' preferences, beliefs, and contexts. CCs are not a one-size-fits-all solution. When implemented and managed correctly, however, CCs can help root and spread the soil health revolution (Montgomery, 2018). They are a small but essential part of helping communities adapt to the triple planetary crises of climate change, pollution, and biodiversity loss.

Acknowledgment
I sincerely appreciate the late Dr. Cornelia B. Flora for her advisement.

References

Acharya, R. N., Ghimire, R., GC, A., & Blayney, D. (2019). Effect of cover crop on farm profitability and risk in the southern High Plains. *Sustainability*, *11*(24), Article 7119. https://doi.org/10.3390/su11247119

Adetunji, A. T., Ncube, B., Mulidzi, R., & Lewu, F. B. (2020). Management impact and benefit of cover crops on soil quality: A review. *Soil and Tillage Research*, *204*, Article 104717. https://doi.org/10.1016/j.still.2020.104717

Ahuja, M., Kumar, L., Kumar, K., Shingatgeri, V. M., & Kumar, S. (2024). Glyphosate: A review on its widespread prevalence and occurrence across various systems. *Environmental Science: Advances*, *3*(7), 1030–1038. https://doi.org/10.1039/D4VA00085D

Alonso-Ayuso, M., Gabriel, J. L., Hontoria, C., Ibáñez, M. Á., & Quemada, M. (2020). The cover crop termination choice to designing sustainable cropping systems. *European Journal of Agronomy*, *114*, Article 126000. https://doi.org/10.1016/j.eja.2020.126000

Anderson, M. (2023, April 3). *Cover crop termination review for 2023* [Blog post]. Iowa State University Extension and Outreach, Integrated Crop Management. https://crops.extension.iastate.edu/post/cover-crop-termination-review-2023

Aronov, S. (2020, September 16). How to break free from the 'pesticide treadmill.' *Forbes*. https://www.forbes.com/councils/forbestechcouncil/2020/09/16/how-to-break-free-from-the-pesticide-treadmill/

Badgley, C., Moghtader, J., Quintero, E., Zakem, E., Chappell, M. J., Avilés-Vázquez, K., Samulon, A., & Perfecto, I. (2007). Organic agriculture and the global food supply. *Renewable Agriculture and Food Systems*, *22*(2), 86–108. https://doi.org/10.1017/S1742170507001640

Bailey, J. (2008). First steps in qualitative data analysis: Transcribing. *Family Practice*, *25*(2), 127–131. https://doi.org/10.1093/fampra/cmn003

Basche, A. D., Miguez, F. E., Kaspar, T. C., & Castellano, M. J. (2014). Do cover crops increase or decrease nitrous oxide emissions? A meta-analysis. *Journal of Soil and Water Conservation*, *69*(6), 471–482. https://doi.org/10.2489/jswc.69.6.471

Bell, M. M. (2018). *City of the good: Nature, religion, and the ancient search for what is right*. Princeton University Press.

Bell, M. M.. (2004). *Farming for us all: Practical agriculture and the cultivation of sustainability* (1st ed.). The Pennsylvania State University Press.

Bergtold, J. S., Ramsey, S., Maddy, L., & Williams, J. R. (2017). A review of economic considerations for cover crops as a conservation practice. *Renewable Agriculture and Food Systems*, *34*(1), 62–76. https://doi.org/10.1017/S1742170517000278

Bharadia, P. (2025, January 10). UK's first glyphosate-resistant weed found on Kent farm. *The Guardian*. https://www.theguardian.com/environment/2025/jan/10/uk-first-glyphosate-resistant-weed-found-kent-farm

Bingham, A. J. (2023). From data management to actionable findings: A five-phase process of qualitative data analysis. *International Journal of Qualitative Methods*, *22*, 1–11. https://doi.org/10.1177/16094069231183620

Blanco-Canqui, H., Claassen, M. M., & Presley, D. R. (2012). Summer cover crops fix nitrogen, increase crop yield, and improve soil–crop relationships. *Agronomy Journal*, *104*(1), 137–147. https://doi.org/10.2134/agronj2011.0240

Blanco-Canqui, H., Mikha, M. M., Presley, D. R., & Claassen, M. M. (2011). Addition of cover crops enhances no-till potential for improving soil physical properties. *Soil Science Society of America Journal*, *75*(4), 1471–1482. https://doi.org/10.2136/sssaj2010.0430

Bowman, M., Afi, M., Beenken, A., Boline, A., Drewnoski, M., Krupek, F. S., Parsons, J., Redfearn, D., Wallander, S., & Whitt, C. (2024). *Cover crops on livestock operations: Potential for expansion in the United States* (Administrative Publication No. AP-120). U.S. Department of Agriculture Economic Research Service. http://www.ers.usda.gov/publications/pub-details/?pubid=109082

Bowman, M., & Morales, M. (2024, April 16). *2022 Census of Agriculture: Cover crop use continues to be most common in eastern United States.* U.S. Department of Agriculture, Economic Research Service. http://www.ers.usda.gov/data-products/chart-gallery/gallery/chart-detail/?chartId=108950&cpid=email

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology*, *3*(2), 77–101. https://doi.org/10.1191/1478088706qp063oa

Bridger, J. C., & Alter, T. R. (2006). Place, community development, and social capital. *Community Development*, *37*(1), 5–18. https://doi.org/10.1080/15575330609490151

Brown, G. (2018). *Dirt to soil: One family's journey into regenerative agriculture*. Chelsea Green Publishing.

Brown, G. (2020). Working with life rather than death. In J. Kempf (Ed.), *Quality agriculture: Conversations about regenerative agronomy with innovative scientists and growers* (pp. 83–104). Regenerative Agriculture Publishing.

Burton, R. J. F. (2004). Seeing through the "good farmer's" eyes: Towards developing an understanding of the social symbolic value of "productivist" behaviour. *Sociologia Ruralis*, *44*(2), 195–215. https://doi.org/10.1111/j.1467-9523.2004.00270.x

Byrne, D. (2022). A worked example of Braun and Clarke's approach to reflexive thematic analysis. *Quality & Quantity*, *56*, 1391–1412. https://doi.org/10.1007/s11135-021-01182-y

Campbell, S., Greenwood, M., Prior, S., Shearer, T., Walkem, K., Young, S., Bywaters, D., & Walker, K. (2020). Purposive sampling: Complex or simple? Research case examples. *Journal of Research in Nursing*, *25*(8), 652–661. https://doi.org/10.1177/1744987120927206

Carolan, M. (2022). *The sociology of food and agriculture* (3rd ed.). Routledge.

Casten, S. (2023, May 18). *Casten introduces bipartisan COVER Act to boost soil health and align crop insurance with risk mitigation practices* [Press release]. https://casten.house.gov/media/press-releases/casten-introduces-bipartisan-cover-act-to-boost-soil-health-and-align-crop-insurance-with-risk-mitigation-practices

Charmaz, K. (2024). *Constructing grounded theory* (3rd ed.). SAGE. https://collegepublishing.sagepub.com/products/constructing-grounded-theory-3-255601

Cochrane, W. W. (1993). *The development of American agriculture: A historical analysis* (New, 2nd ed.). University of Minnesota Press. https://www.jstor.org/stable/10.5749/j.ctttsjt9 Original work published in 1979.

Cochrane, W. W. (2003). *The curse of American agricultural abundance: A sustainable solution*. University of Nebraska Press.

Comito, J., Wolseth, J., & Morton, L. W. (2013). Stewards, businessmen, and heroes?: Role conflict and contradiction among row-crop farmers in an age of environmental uncertainty. *Human Organization, 72*(4), 283–292. Retrieved from JSTOR: http://www.jstor.org/stable/44148723

Community Alliance with Family Farmers [CAFF] & The Freshwater Trust. (2023). *Cover crop decision guide for perennial cropping systems.* https://actionnetwork.org/user_files/user_files/000/049/274/original/CAFF_Cover_Crop_Guide_for_Perennial_Systems.pdf

Conservation Opportunity and Voluntary Environment Resilience Program Act of 2023, 3478, U.S. House of Representatives 118th, H.R. (2023). https://www.congress.gov/bill/118th-congress/house-bill/3478/all-actions

Conservation Technology Information Center [CTIC], Regrow Ag., Inc., & The Nature Conservancy [TNC]. (2023, September 27). *Operational Tillage Information System (OpTIS) 4.0: Using remote sensing data to map conservation ag practices*. Conservation Technology Information Center. https://www.ctic.org/OpTIS

CTIC, U.S. Department of Agriculture, Sustainable Agriculture Research and Education [USDA SARE], & American Seed Trade Association [ASTA]. (2023). *National cover crop survey report 2022-2023*. https://www.sare.org/wp-content/uploads/2022-2023-National-Cover-Crop-Survey-Report.pdf

CTIC, USDA SARE, & ASTA. (2025). *National cover crop survey report: Agricultural advisors March 2025*. https://www.sare.org/wp-content/uploads/CTIC_Cover_Crop_Report_2025.pdf

Correira, A., Otchere, V., Tomlinson, P. J., & Presley, D. R. (2023, October 29–November 1). *Planting green: Potential benefits and disadvantages of planting corn into a living cereal rye cover crop in northeastern Kansas* [Paper presentation]. 2023 ASA, CSSA, SSSA International Annual Meeting, St. Louis, Missouri. https://scisoc.confex.com/scisoc/2023am/meetingapp.cgi/Paper/150717

Corteva. (2022, July 25). *Herbicide carryover and cover crops don't always mix*. https://www.corteva.us/Resources/crop-protection/corn/herbicide-carryover-cover-crops.html

Curran, D. (2017). The treadmill of production and the positional economy of consumption. *Canadian Review of Sociology/Revue canadienne de sociologie*, *54*(1), 28–47. https://doi.org/10.1111/cars.12137

DeCuir-Gunby, J. T., Marshall, P. L., & McCulloch, A. W. (2011). Developing and using a codebook for the analysis of interview data: An example from a professional development research project. *Field Methods*, *23*(2), 136–155. https://doi.org/10.1177/1525822X10388468

Deines, J. M., Guan, K., Lopez, B., Zhou, Q., White, C. S., Wang, S., & Lobell, D. B. (2023). Recent cover crop adoption is associated with small maize and soybean yield losses in the United States. *Global Change Biology*, *29*(3), 794–807. https://doi.org/10.1111/gcb.16489

Dentzman, K. (2018). "I would say that might be all it is, is hope": The framing of herbicide resistance and how farmers explain their faith in herbicides. *Journal of Rural Studies*, *57*, 118–127. https://doi.org/10.1016/j.jrurstud.2017.12.010

Environmental Defense Fund [EDF]. (2024, January 3). *How climate change will impact U.S. corn, soybean and wheat yields: A county-level analysis of climate burdens and adaptation needs in the Midwest*. https://www.edf.org/sites/default/files/2022-10/climate-impacts-midwest-crop-yields.pdf

Gailans, S., & Bakehouse, J. (2022). *Timing of roll-crimping rye cover crop and planting soybeans* (PFI Cooperators' Program). Practical Farmers of Iowa. https://practicalfarmers.b-cdn.net/wp-content/uploads/2023/02/22.FC_.CC-Timing-of-Roll-Crimping-Rye-Cover-Crop-and-Planting-Soybeans.pdf

Gilhespy, S. L., Anthony, S., Cardenas, L., Chadwick, D., del Prado, A., Li, C., Misselbrook, T., Rees, R. M., Salas, W., Sanz-Cobena, A., Smith, P., Tilston, E. L., Topp, C. F. E., Vetter, S., & Yeluripati, J. B. (2014). First 20 years of DNDC (DeNitrification DeComposition): Model evolution. *Ecological Modelling*, *292*, 51–62. https://doi.org/10.1016/j.ecolmodel.2014.09.004

Giuliano, S., Alletto, L., Deswarte, C., Perdrieux, F., Daydé, J., & Debaeke, P. (2021). Reducing herbicide use and leaching in agronomically performant maize-based cropping systems: An 8-year study. *Science of The Total Environment*, *788*, Article 147695. https://doi.org/10.1016/j.scitotenv.2021.147695

Graddy, S. (2023, June 8). *Funding for climate-smart agriculture critical to tackling the climate emergency*. Environmental Working Group. https://www.ewg.org/news-insights/news/2023/06/funding-climate-smart-agriculture-critical-tackling-climate-emergency

Green, J. M. (2018). The rise and future of glyphosate and glyphosate-resistant crops. *Pest Management Science*, *74*(5), 1035–1039. https://doi.org/10.1002/ps.4462

Green, J. M., & Owen, M. D. K. (2011). Herbicide-resistant crops: Utilities and limitations for herbicide-resistant weed management. *Journal of Agricultural and Food Chemistry*, *59*(11), 5819–5829. https://doi.org/10.1021/jf101286h

Green Cover. (2024). *Soil health resource guide* (10th ed.). https://greencover.com/freeguides/?_kx=ApcNnL2bIJgrsUPcyD1D9CFqE1-NZGk0W7Sbq6oql2c.VJ7Zq7

Grint, K. R., Arneson, N. J., Arriaga, F., DeWerff, R., Oliveira, M., Smith, D. H., Stoltenberg, D. E., & Werle, R. (2022). Cover crops and preemergence herbicides: An integrated approach for weed management in corn-soybean systems in the US Midwest. *Frontiers in Agronomy*, *4*, Article 888349. https://doi.org/10.3389/fagro.2022.888349

Groff, S. (2015). The past, present, and future of the cover crop industry. *Journal of Soil and Water Conservation*, *70*(6), 130A–133A. https://doi.org/10.2489/jswc.70.6.130A

Groundswell Agriculture (Producer). (2019, July 6). *Jay Fuhrer—The Five Principles of Soil Health—Interview at Groundswell 2019* [Video]. YouTube. https://www.youtube.com/watch?v=mX1zUiuxkf0

Guest, G., MacQueen, K. M., & Namey, E. E. (2012). *Applied thematic analysis*. SAGE.

Gullickson, G. (2015, March 18). *Here's why the carbon-nitrogen ratio matters*. Successful Farming. https://web.archive.org/web/20150325220327/https://www.agriculture.com/crops/cover-crops/heres-why-carbonnitrogen-ratio-matters_568-ar48014

Guterres, A. (2021). *Progress towards the Sustainable Development Goals: Report of the Secretary-General* (E/2021/58). United Nations Economic and Social Council. https://undocs.org/en/E/2021/58

Hagen, S. C., Delgado, G., Ingraham, P., Cooke, I., Emery, R., P. Fisk, J., Melendy, L., Olson, T., Patti, S., Rubin, N., Ziniti, B., Chen, H., Salas, W., Elias, P., & Gustafson, D. (2020). Mapping conservation management practices and outcomes in the Corn Belt Using the Operational Tillage Information System (OpTIS) and the Denitrification–Decomposition (DNDC) model. *Land*, *9*(11), Article 408. https://doi.org/10.3390/land9110408

Haggblade, S., Minten, B., Pray, C., Reardon, T., & Zilberman, D. (2017). The herbicide revolution in developing countries: Patterns, causes, and implications. *The European Journal of Development Research*, *29*, 533–559. https://doi.org/10.1057/s41287-017-0090-7

Hamilton, A. V., Mortensen, D. A., & Allen, M. K. (2017). The state of the cover crop nation and how to set realistic future goals for the popular conservation practice. *Journal of Soil and Water Conservation*, *72*(5), 111A-115A. https://doi.org/10.2489/jswc.72.5.111A

Health Care Without Harm. (2025, October 1). The dirt on climate change: Regenerative agriculture and health care. *Health Care Without Harm*. https://us.noharm.org/news/dirt-climate-change-regenerative-agriculture-and-health-care

Hellweg, S., Benetto, E., Huijbregts, M. A. J., Verones, F., & Wood, R. (2023). Life-cycle assessment to guide solutions for the triple planetary crisis. *Nature Reviews Earth & Environment*, *4*, 471–486. https://doi.org/10.1038/s43017-023-00449-2

Hill, E., & Sprague, C. (2024). *Cover crop termination* (MSUE CC-01). Michigan State University Extension. https://www.canr.msu.edu/resources/cover-crop-termination

Howard, P. H. (2016). *Concentration and power in the food system: Who controls what we eat?* Bloomsbury Academic.

Huang, W., Jiang, L., Zhou, J., Kim, H.-S., Xiao, J., & Luo, Y. (2025). Reduced erosion augments soil carbon storage under cover crops. *Global Change Biology*, *31*(3), Article e70133. https://doi.org/10.1111/gcb.70133

Ibrahim, I., & Ahmed, N. (2022). Investigating regenerative ideation within Sustainable Development Goals. *Sustainability*, *14*(16), Article 10137. https://doi.org/10.3390/su141610137

Intergovernmental Panel on Climate Change [IPCC]. (2021). Summary for policymakers. In V. Masson-Delmotte, P. Zhai, A. Pirani, S. L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M. I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J. B. R. Matthews, T. K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, & B. Zhou (Eds.), *Climate Change 2021: The physical science basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change* (pp. 3−32). Cambridge University Press. https://doi.org/10.1017/9781009157896.001

Jacobs, A. A., Evans, R. S., Allison, J. K., Garner, E. R., Kingery, W. L., & McCulley, R. L. (2022). Cover crops and no-tillage reduce crop production costs and soil loss, compensating for lack of short-term soil quality improvement in a maize and soybean production system. *Soil and Tillage Research*, *218*, Article 105310. https://doi.org/10.1016/j.still.2021.105310

Johnson, T. D., Mitchell-McCallister, D., deVilleneuve, S., & Berthold, T. A. (2024). Producer willingness to accept incentive levels for cover crop adoption in the southern Great Plains. *Journal of Agricultural and Applied Economics*, *56*(4), 635–649. https://doi.org/10.1017/aae.2024.30

Jones, C. (2009, September). Mycorrhizal fungi—Powerhouse of the soil. *Evergreen Farming*. https://www.amazingcarbon.com/PDF/JONES-MycorrhizalFungiEVERGREEN(Sept09).pdf

Kansas Alliance for Wetlands & Streams. (n.d.). *Home*. Retrieved April 15, 2025, from https://kaws.org/

Kansas Association of Conservation Districts [KACD]. (n.d.). *Pottawatomie County Conservation District*. Retrieved April 15, 2025, from https://www.kacd.net/businesses/Pottawatomie-Co-Conservation-District

Kansas Farmers Union. (n.d.). *Welcome to Kansas Farmers Union*. Retrieved April 15, 2025, from https://www.kansasfarmersunion.org/about-6

Kansas Soil Health Alliance. (n.d.). *Soil health practices*. Retrieved April 15, 2025, from https://kssoilhealth.org/soil-health-practices/

Kansas State University Department of Agronomy. (n.d.). *Cover crops*. Retrieved April 15, 2025, from https://www.agronomy.k-state.edu/extension/soil-management/cover-crops.html

Kansas State University Research and Extension. (n.d.). *Northeast Research-Extension Center: Overview*. Retrieved April 15, 2025, from https://www.northeast.k-state.edu/

Kientzy, D., Ellis, C., & Massey, R. (2023). *Selecting cover crop seeding machinery* (Publication No. G1209). University of Missouri Extension. https://extension.missouri.edu/publications/g1209

Knott, E., Rao, A. H., Summers, K., & Teeger, C. (2022). Interviews in the social sciences. *Nature Reviews Methods Primers*, *2*, Article 73. https://doi.org/10.1038/s43586-022-00150-6

Koehler-Cole, K., Basche, A., Thompson, L., & Rees, J. (2023). Comparing cover crop research in farmer-led and researcher-led experiments in the Western Corn Belt. *Frontiers in Sustainable Food Systems*, *7*, Article 1064251. https://doi.org/10.3389/fsufs.2023.1064251

Kranz, J. J. (n.d.). *Guide to cover crops*. Kiss the Ground. Retrieved March 26, 2025, from https://kisstheground.com/education/resources/cover-crops/

Kreitzman, M., Chapman, M., Keeley, K. O., & Chan, K. M. A. (2022). Local knowledge and relational values of Midwestern woody perennial polyculture farmers can inform tree-crop policies. *People and Nature*, *4*(1), 180–200. https://doi.org/10.1002/pan3.10275

Lamichhane, J. R., & Alletto, L. (2022). Ecosystem services of cover crops: A research roadmap. *Trends in Plant Science*, *27*(8), 758–768. https://doi.org/10.1016/j.tplants.2022.03.014

LandscapeDNA. (n.d.). *Regenerative farming*. Retrieved January 13, 2026, from https://landscapedna.org/actions/prevention/regenerative-farming/

Lappé, A. (2010). *Diet for a hot planet: The climate crisis at the end of your fork and what you can do about it*. Bloomsbury Publishing.

Lee, S., & McCann, L. (2019). Adoption of cover crops by U.S. soybean producers. *Journal of Agricultural and Applied Economics*, *51*(4), 527–544. https://doi.org/10.1017/aae.2019.20

Levins, R. A., & Cochrane, W. W. (1996). The treadmill revisited. *Land Economics*, *72*(4), 550–553. https://doi.org/10.2307/3146915

Lloyd, S. J., & Chalabi, Z. (2021). Climate change, hunger and rural health through the lens of farming styles: An agent-based model to assess the potential role of peasant farming. *PLoS ONE*, *16*(2), Article e0246788. https://doi.org/10.1371/journal.pone.0246788

Lussich, F., Dhaliwal, J. K., Faiia, A. M., Jagadamma, S., Schaeffer, S. M., & Saha, D. (2024). Cover crop residue decomposition triggered soil oxygen depletion and promoted nitrous oxide emissions. *Nature Scientific Reports*, *14*, Article 8437. https://doi.org/10.1038/s41598-024-58942-7

Lynch, P. (2017). On care for our common discourse: Pope Francis's nonmodern epideictic. *Rhetoric Society Quarterly*, *47*(5), 463–482. https://doi.org/10.1080/02773945.2017.1347953

Magdoff, F., & Van Es, H. (2021). *Building soils for better crops: Ecological management for healthy soils* (4th ed.). USDA NIFA SARE.

Maia, L. O. R., Piveta, L. B., & Johnson, W. G. (2024). Residual herbicide in cover cropping systems. *Agriculture*, *14*(11), Article 2089. https://doi.org/10.3390/agriculture14112089

Merrill, R. (Ed.). (1976). *Radical agriculture*. Harper & Row.

Miller-Klugesherz, J. A. (in press). *Heal soil, heal soul: Enhancing regenerative agriculture, cover cropping, and farmer and community wellbeing in four Kansas counties* [Unpublished doctoral dissertation]. Kansas State University.

Miller-Klugesherz, J. A. (2025, February 24). *Ethnographic case study of Pottawatomie County (KS) community capital stocks, cover crops, & conservation agriculture* [PowerPoint show]. Zenodo. https://doi.org/10.5281/zenodo.14912002

Miller-Klugesherz, J. A., & Flora, C. B. (2025). *3C dataverse: Community capitals, cover crops, & conservation agriculture*, *version 2.2* [Xlsv]. Zenodo. https://doi.org/10.5281/zenodo.14782849

Montgomery, D. R. (2018). *Growing a revolution: Bringing our soil back to life* (Reprint). W. W. Norton.

Mortensen, D. A., Ryan, M. R., & Smith, R. G. (2024). Another step on the transgene-facilitated herbicide treadmill. *Pest Management Science*, *80*(9), 4145–4149. https://doi.org/10.1002/ps.8105

Mwangi, H. W., Kihurani, A. W., Wesonga, J. M., Ariga, E. S., & Kanampiu, F. (2015). Factors influencing adoption of cover crops for weed management in Machakos and Makueni counties of Kenya. *European Journal of Agronomy*, *69*, 1–9. https://doi.org/10.1016/j.eja.2015.05.001

Myers, R., Weber, A., & Tellatin, S. (2019). *Creating a baseline for cover crop costs and returns* (SARE Technical Bulletin, Ag Innovations Series). USDA SARE. https://www.sare.org/publications/cover-crop-economics/how-to-get-a-faster-return-from-cover-crops/creating-a-baseline-for-cover-crop-costs-and-returns/

Myers, R. L., & Wilson, K. R. (2023). Farmer perspectives about cover crops by non-adopters. *Frontiers in Sustainable Food Systems*, *7*, Article 1011201. https://doi.org/10.3389/fsufs.2023.1011201

Naeem, M., Ozuem, W., Howell, K., & Ranfagni, S. (2023). A step-by-step process of thematic analysis to develop a conceptual model in qualitative research. *International Journal of Qualitative Methods*, *22*, 1–18. https://doi.org/10.1177/16094069231205789

National Atmospheric and Oceanic Administration, National Centers for Environmental Information [NOAA NCEI]. (2026, February 9). *Primary corn and soybean belt*. NOAA NCEI Geographical Reference Maps. Retrieved September 2, 2023, from https://www.ncei.noaa.gov/access/monitoring/reference-maps/primary-corn-and-soybean-belt

National Institutes of Health. Office of Behavioral and Social Sciences. (2018). *Best practices for mixed methods research in the health sciences* (2nd ed.). https://implementationscience-gacd.org/wp-content/uploads/2020/11/Best-Practices-for-Mixed-Methods-Research-in-the-Health-Sciences-2018-01-25-1.pdf

Nogueira Bandeira, J., Pacheco Batista, L., das Chagas, P. S. F., Severo Silva, T., Fernandes, B. C. C., de Andrade, E. M., & Valadão Silva, D. (2022). Leaching of herbicides in soil under the influence of different rainfall intensities. *Water, Air, & Soil Pollution*, *233*, Article 188. https://doi.org/10.1007/s11270-022-05661-2

Nouri, A., Lukas, S., Singh, S., Singh, S., & Machado, S. (2022). When do cover crops reduce nitrate leaching? A global meta-analysis. *Global Change Biology, 28*(15), 4736–4749. https://doi.org/10.1111/gcb.16269

Noy, C. (2008). Sampling knowledge: The hermeneutics of snowball sampling in qualitative research. *International Journal of Social Research Methodology*, *11*(4), 327–344. https://doi.org/10.1080/13645570701401305

Palhano, M. G., Norsworthy, J. K., & Barber, T. (2018). Evaluation of chemical termination options for cover crops. *Weed Technology*, *32*(3), 227–235. https://doi.org/10.1017/wet.2017.113

Palinkas, L. A., Horwitz, S. M., Green, C. A., Wisdom, J. P., Duan, N., & Hoagwood, K. (2015). Purposeful sampling for qualitative data collection and analysis in mixed method implementation research. *Administration and Policy in Mental Health and Mental Health Services Research*, *42*, 533–544. https://doi.org/10.1007/s10488-013-0528-y

Paris, N., Smith, D., Silva, T. S., DeWerff, R., & Werle, R. (2024). *Herbicide rotational restrictions for cover and forage cropping systems*. University of Wisconsin-Madison Extension. https://cropsandsoils.extension.wisc.edu/articles/herbicide-rotational-restrictions-for-cover-and-forage-cropping-systems/?/

Peterson, C. M., Schomberg, H. H., Thompson, A. I., Mirsky, S. B., & Tully, K. L. (2025). Cover crop termination method has a limited effect on spring soil moisture and temperature in humid mid-Atlantic U.S. *Agricultural Water Management*, *311*, Article 109342. https://doi.org/10.1016/j.agwat.2025.109342

Practical Farmers of Iowa [PFI] (Director). (2023a, July 27). *Planting soybeans green into cereal rye cover crop—Practical cover croppers* [Video]. YouTube. https://www.youtube.com/watch?v=YXBT_MDtlgA

PFI (Director). (2023b, August 3). *Cover crops spur knowledge exchange and extend farmer networks—Practical cover croppers* [Video]. YouTube. https://www.youtube.com/watch?v=A1YCtFfV3Xo

Plastina, A., Sawadgo, W., & Okonkwo, E. (2024). Pervasive disadoption substantially offsets new adoption of cover crops and no-till. *Choices*, *39*(2), 1–14. https://doi.org/10.22004/ag.econ.344738

Popkin, G. (2023, July 13). The Biden Administration bets big on 'climate smart' agriculture. *Yale Environment 360*. https://e360.yale.edu/features/climate-smart-agriculture-usda

Prokopy, L. S., Floress, K., Arbuckle, J. G., Church, S. P., Eanes, F. R., Gao, Y., Gramig, B. M., Ranjan, P., & Singh, A. S. (2019). Adoption of agricultural conservation practices in the United States: Evidence from 35 years of quantitative literature. *Journal of Soil and Water Conservation*, *74*(5), 520–534. https://doi.org/10.2489/jswc.74.5.520

Prokopy, L. S., Floress, K., Klotthor-Weinkauf, D., & Baumgart-Getz, A. (2008). Determinants of agricultural best management practice adoption: Evidence from the literature. *Journal of Soil and Water Conservation*, *63*(5), 300–311. https://doi.org/10.2489/jswc.63.5.300

Regenerative Organic Alliance. (n.d.). *The three pillars of Regenerative Organic Certified*. Retrieved May 2, 2024, from https://regenorganic.org/our-story/

Riley, M., & Robertson, B. (2022). The virtual good farmer: Farmers' use of social media and the (re)presentation of "good farming." *Sociologia Ruralis*, *62*(3), 437–458. https://doi.org/10.1111/soru.12390

Rodale, J. I. (1954). *Organic merry-go-round*. Rodale Books.

Rodale Institute. (2019, January 14). *The original principles of regenerative agriculture*. https://rodaleinstitute.org/blog/original-principles-of-regenerative-agriculture/

Rodale Institute. (n.d.). *Regenerative organic agriculture*. Retrieved March 2, 2021, from https://rodaleinstitute.org/why-organic/organic-basics/regenerative-organic-agriculture/

Roesch-McNally, G. E., Basche, A. D., Arbuckle, J. G., Tyndall, J. C., Miguez, F. E., Bowman, T., & Clay, R. (2018). The trouble with cover crops: Farmers' experiences with overcoming barriers to adoption. *Renewable Agriculture and Food Systems*, *33*(4), 322–333. https://doi.org/10.1017/S1742170517000096

Rogers, E. (2019, May 13). *The 4R's of nutrient management*. Michigan State University Extension. https://www.canr.msu.edu/news/the-4r-s-of-nutrient-management

Sanderson, M. R., & Hughes, V. (2019). Race to the bottom (of the well): Groundwater in an agricultural production treadmill. *Social Problems*, *66*(3), 392–410. https://doi.org/10.1093/socpro/spy011

Sawadgo, W. P. M., Zhang, W., & Plastina, A. (2021). What drives landowners' conservation decisions? Evidence from Iowa. *Journal of Soil and Water Conservation*, *76*(3), 211–221. https://doi.org/10.2489/jswc.2021.00115

Solar Edition. (2021, April 8). *Regenerative agriculture: The solution to climate change may be right below around* [sic] *feet*. https://solaredition.com/regenerative-agriculture-the-solution-to-climate-change-may-be-right-below-around-feet/

Staton, T., Davison, N., Westaway, S., Arguile, L., Adams, N., Aguilera, V., Bellamy, L., Bolger, A., Gantlett, R., Jacobs, S., Noone, N., Staley, J. T., & Smith, L. G. (2024). Leverage points for the uptake of organic food production and consumption in the United Kingdom. *Communications Earth & Environment*, *5*, Article 449. https://doi.org/10.1038/s43247-024-01585-3

Stone, G. D. (2022). *The agricultural dilemma*. Routledge.

The Nature Conservancy [TNC]. (n.d.). *4R Plus: Soil health & conservation practices*. Retrieved January 5, 2024, from https://4rplus.org/

TNC, Regrow Ag, Inc., & CTIC. (2023). *OpTIS and DNDC methodology*. https://www.ctic.org/files/TNC_Methodology_Report_Sept2023.pdf

U.S. Department of Agriculture, National Agricultural Statistics Service [USDA NASS]. (2004). *2002 Census of Agriculture: Kansas: State and county data* (AC-02-A-16; p. 711). https://www.nass.usda.gov/AgCensus/archive/files/2002-Kansas-01-full.pdf

USDA NASS. (2009). *2007 Census of Agriculture: Kansas: State and county data* (AC-07-A-16; p. 783). https://www.nass.usda.gov/AgCensus/archive/files/2007-Kansas-ksv1.pdf

USDA NASS. (2014). *2012 Census of Agriculture: Kansas: State and county data* (AC-12-A-16; p. 775). https://www.nass.usda.gov/AgCensus/archive/files/2012-Kansas-ksv1.pdf

USDA NASS. (2019). *2017 Census of Agriculture: Kansas: State and county data* (AC-17-A-16; p. 920). https://www.nass.usda.gov/Publications/AgCensus/2017/Full_Report/Volume_1,_Chapter_2_County_Level/Kansas/ksv1.pdf

USDA NASS. (2024). *2022 Census of Agriculture: Kansas: State and county data* (AC-22-A-16; p. 855). https://www.nass.usda.gov/Publications/AgCensus/2022/Full_Report/Volume_1,_Chapter_2_County_Level/Kansas/ksv1.pdf

USDA National Institute of Food and Agriculture, Sustainable Agriculture Research and Education [USDA NIFA SARE]. (2024). *Cover crop management options to improve weed control, crop yield and soil health* (Post-Project Impacts, A Case Study Series). https://www.sare.org/wp-content/uploads/Cover-Crop-Management-Options-to-Improve-Weed-Control-Crop-Yield-and-Soil-Health.pdf

USDA Natural Resources Conservation Service [USDA NRCS]. (n.d.-a). *Unlock the secrets in the soil: Principles for high functioning soils* [Fact Sheet]. Retrieved February 1, 2021, from https://farmlandinfo.org/wp-content/uploads/sites/2/2018/10/NRCS_SecretsSoil_Principles_HighFunctioning_Factsheet-2021.pdf

USDA NRCS. (n.d.-b). *Geospatial data gateway*. Retrieved January 5, 2024, from https://datagateway.nrcs.usda.gov/

USDA NRCS. (n.d.-c). *Cover crop performance and adaptation trials at PMCs*. Retrieved April 13, 2025, from https://www.nrcs.usda.gov/plant-materials/cover-crop-performance-and-adaptation-trials

USDA NRCS. (n.d.-d). *Kansas*. Retrieved April 4, 2025, from https://www.nrcs.usda.gov/state-offices/kansas

USDA NRCS. (2019a). *Using a cover crop before corn* (Guide Sheet No. IA-2019). https://www.nrcs.usda.gov/sites/default/files/2022-09/CoverCropBeforeCorn.pdf

USDA NRCS. (2019b). *Using a cover crop before soybeans* (Guide Sheet No. IA-2019). https://acrobat.adobe.com/id/urn:aaid:sc:US:d9ce53a5-6f28-495d-8275-93128125f51a

USDA NRCS. (2023, November). *Climate-Smart Agriculture and Forestry (CSAF) mitigation activities list for FY2024*. https://web.archive.org/web/20231217143255/https://www.nrcs.usda.gov/conservation-basics/natural-resource-concerns/climate/climate-smart-mitigation-activities

USDA Risk Management Agency [USDA RMA]. (2022, March). *USDA pandemic assistance for producers* [Fact sheet]. https://www.rma.usda.gov/sites/default/files/2024-02/Pandemic-Cover-Crop-Program-Fact-Sheet.pdf

USDA Sustainable Agriculture Research and Education [USDA SARE]. (2007). *Managing cover crops profitably* (3rd ed., Handbook Series Book 9). https://www.sare.org/wp-content/uploads/Managing-Cover-Crops-Profitably.pdf

van der Ploeg, J. D. (1994). Styles of farming: An introductory note on concepts and methodology. In J. D. van der Ploeg & A. Long (Eds.), *Born from within: Practice and perspectives of endogenous rural development* (pp. 7–31). Van Gorcum. https://edepot.wur.nl/359337

van der Ploeg, J. D. (2022). *The sociology of farming: Concepts and methods*. Routledge.

Van Eerd, L. L., Chahal, I., Peng, Y., & Awrey, J. C. (2023). Influence of cover crops at the four spheres: A review of ecosystem services, potential barriers, and future directions for North America. *Science of The Total Environment*, *858*(Part 3), Article 159990. https://doi.org/10.1016/j.scitotenv.2022.159990

Vanclay, F., & Enticott, G. (2011). The role and functioning of cultural scripts in farming and agriculture. *Sociologia Ruralis*, *51*(3), 256–271. https://doi.org/10.1111/j.1467-9523.2011.00537.x

Vanover, C., Mihas, P., & Saldaña, J. (2021). *Analyzing and interpreting qualitative research: After the interview*. SAGE.

Wallander, S., Smith, D., Bowman, M., & Claassen, R. (2021). *Cover crop trends, programs, and practices in the United States* (Economic Information Bulletin No. 222). U.S. Department of Agriculture, Economic Research Service. https://web.archive.org/web/20221208052012/https://www.ers.usda.gov/webdocs/publications/100551/eib-222.pdf

Wang, J., Zhang, S., Sainju, U. M., Ghimire, R., & Zhao, F. (2021). A meta-analysis on cover crop impact on soil water storage, succeeding crop yield, and water-use efficiency. *Agricultural Water Management*, *256*, Article 107085. https://doi.org/10.1016/j.agwat.2021.107085

Won, S., Rejesus, R. M., Goodwin, B. K., & Aglasan, S. (2023). Understanding the effect of cover crop use on prevented planting losses. *American Journal of Agricultural Economics*, *106*(2), 659–683. https://doi.org/10.1111/ajae.12396

Zhou, Q., Guan, K., Wang, S., Jiang, C., Huang, Y., Peng, B., Chen, Z., Wang, S., Hipple, J., Schaefer, D., Qin, Z., Stroebel, S., Coppess, J., Khanna, M., & Cai, Y. (2022). Recent rapid increase of cover crop adoption across the U.S. Midwest detected by fusing multi-source satellite data. *Geophysical Research Letters*, *49*(22), Article e2022GL100249. https://doi.org/10.1029/2022GL100249

Zulauf, C., Schnitkey, G., Paulson, N., & Coppess, J. (2024). Cover crops and covered cropland, 2022 US Census of Agriculture. *Farmdoc Daily*, *14*(37), 1–6. https://farmdocdaily.illinois.edu/2024/02/cover-crops-and-covered-cropland-2022-us-census-of-agriculture.html

Appendix. Supplementary Findings and Discussion

I asked interviewed farmers to provide their level of agreement with 23 statements related to CC benefits and influences on their decision-making (Table A1).

Table A1. Interviewed Farmer Beliefs About Cover Crops (CCs)

#	Statement	*n*	$\bar{x}$
1	I believe that cover crops decrease the degradation of natural resources (soil organic matter, fertility, water retention, etc.).	14	4.50
2	Cover crops reduce the risk of commodity crop failure.	14	3.14
3*	Cover crops don't reduce dependence on pesticides and herbicides.	13	3.00
4	In general, planting cover crops is better than conventional (monoculture) methods.	13	3.92
5	Cover crops will reduce long-term dependency on external fertilizer inputs.	13	3.23
6	Conservation agriculture allows for optimized and sustainable yields.	13	4.00
7	Cover crops are a win-win for farmers and their agroecosystems.	14	3.93
8*	Cover crops do not help in adequately distributing nutrients in the soil profile.	14	2.36
9	I recommend other farmers in my area adopt cover cropping.	13	3.69
10*	Cover cropping is not applicable to my fields.	13	2.23
11	I believe cover cropping improves production efficiency.	14	3.93
12	Cover cropping requires new management skills.	13	4.31
13	Cover crops balance the soil ecosystem by carefully managing residue and waste.	13	4.15
14	To de-risk cover crop adoption, appropriate technical packages and training programs are needed.	13	3.69
15	Diversity in cover crops can reduce the occurrence of pests and diseases.	13	3.62
16*	Cover crops are ineffective for weed control.	13	2.23
17	Cover crops reduce climate risk.	13	3.54
18	Cover crops reduce soil erosion.	14	4.25
19	I am more likely to plant cover crops if government payments for them are *comparable to* payments for commodity crops.	13	3.62
20	I am more likely to plant cover crops if government payments for them are *more than* payments for commodity crops.	13	3.85
21	Current political and economic structures incentivize farmers to adopt cover crops.	13	3.00
22	I would be willing to try to incorporate groundcover into my cropping systems sometime before 2026.	11	3.91
23	Groundcover seems advantageous to cover crops that need terminated.	12	3.50

Note: Items source from Maria et al.'s (2023, p. 120) reliable "conservation agriculture" scale; s*trongly agree* (5), *agree* (4), *undecided* (3), *disagree* (2), strongly *disagree* (1).
* Reverse coded to ensure respondents paid attention to the directionality of all the questions.

To contextualize and compare interview data, I consulted county-level longitudinal (1997–2023) and cross-sectional (2017, 2022) variables (Miller-Klugesherz, 2025), and rank-compared them to the same variables from the other 859 NOAA NCEI–designated (2024) U.S. Corn-Soybean Belt (CSB) counties (Miller-Klugesherz & Flora, 2025). Table A2 details the residue cover crop ranges from 2005 to 2019.

Table A2. Pottawatomie County, Kansas, Residue Cover Ranges, 2005–2019

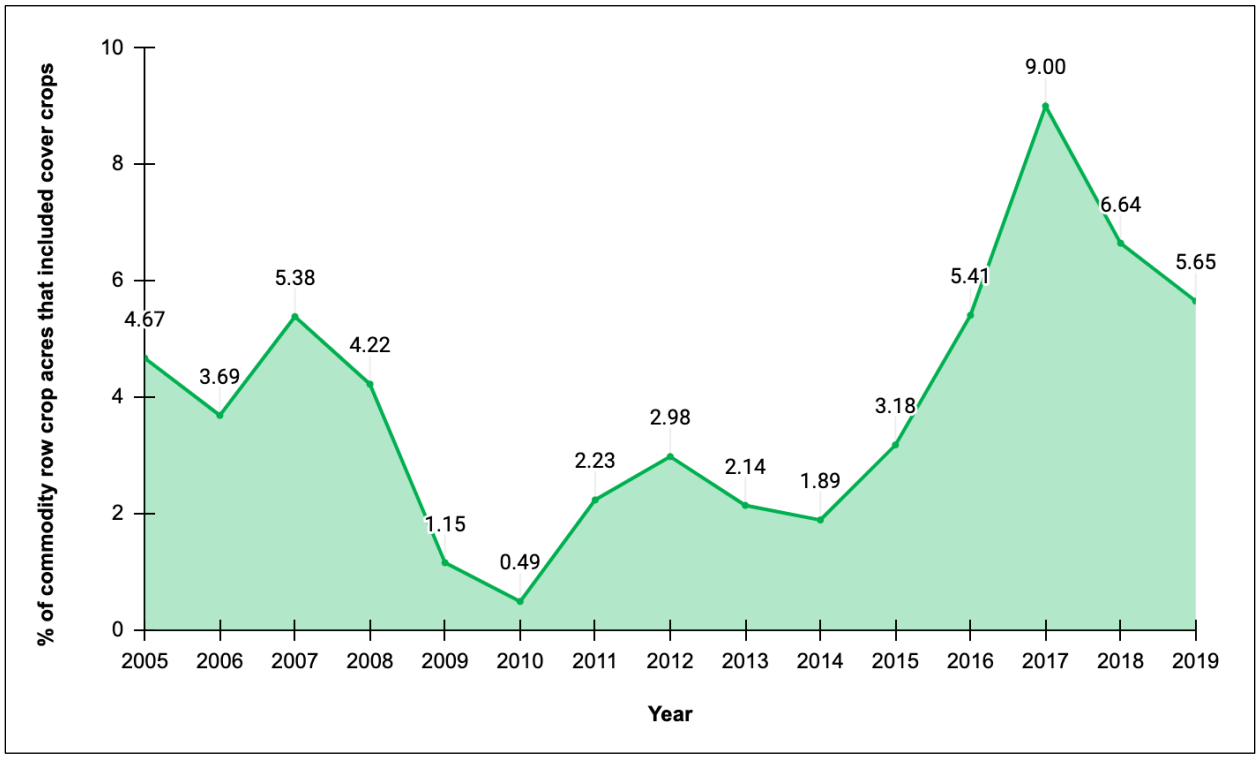
Percent of total acres[a] with …	% residue cover range[b]	% Δ, '05-'19	r^2	Min. (yr.)–Max. (yr.)	CSB '19 Rank %
… conventional tillage, very low residue cover level.	0–15	–27.95	0.217	8.93 ('13)–26.65 ('05)	58.46
… reduced tillage, low residue cover.	16–30	–8.17	0.083	32.75 ('16)–53.74 ('07)	66.57
… reduced tillage, moderate residue cover (all previous year's crops *except corn*).*	31–50	–10.64	0.217	20.81 ('16)–49.02 ('13)	37.96
… reduced tillage, moderate residue cover (*only corn* was the previous year's crop).*	31–50	–28.16	0.019	28.39 ('13)–59.39 ('05)	65.20
… significantly reduced tillage, high residue cover.	51–100	0.91	0.011	15.89 ('06)–26.73 ('10)	51.31
… significantly reduced tillage to no tillage, high residue cover.	51–100	11.10	0.072	3.56 ('15)–19.54 ('08)	27.37
… cover crops.		20.99	0.156	0.49 ('10)–9.00 ('17)	72.90
… winter commodity crops.		–80.44	0.654	2.04 ('17)–18.12 ('05)	70.56
… perennial crops, such as hay(lage) or pasture.		–72.63	0.531	2.73 ('11)–15.37 ('05)	82.81

[a] Total acres were calculated by summing "acres with CCs" and "acres without CCs," and included all previous year crop types (except for asterisked variables).
[b] Residue cover ranges 30% were considered "conservation tillage," whereas ranges ≤30% were considered "conventional tillage."

I used Hagen et al.'s (2020) OpTIS 2.0 data—that was collected via remote sensing and validated with field-level verification data—to determine that the percent of PT acres with CCs peaked at 9% in 2017 (Figure A1), which well above the national or regional average at that time.[4] There was a positive percent change of commodity row crop acres containing CCs from 2005 to 2019 (% Δ = 20.99), although there was a sustained dip below 5% from 2008 to 2016.

[4] There are differences in how USDA NASS and OpTIS measure and calculate of the percent of farmland with cover crops. The former relies on survey responses to the Ag Census, and the latter measures the ratio using remote sensing and ground-truthing. The latter is collected every year, and the former every five years. Therefore, although the ratios are not the same every year, the general direction and degree of the linear trends mirror one another.

Figure A1. Percent of Commodity Row Crop Acres with Cover Crops, 2005–2019



Data source: Hagen et al., 2020.