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'Carbon farming' needs consideration

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Editor's note: Several agricultural economists at Purdue University recently published a paper on the opportunities and challenges associated with sequestering carbon in soils, and questions farmers have about carbon-credit markets. This is the first of a two-part article on the subject. The second article will address practices that sequester carbon as well as questions such as how farmers will be paid, contractual obligations and more.

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A KUHN Krause 5200 no-till drill is demonstrated in 2016 during a Yahara Pride Farms Ag Innovation Day in Wisconsin's Dane County. Of the 396 million cropland acres in the United States, the 2017 U.S. Census of Agriculture reported that more than half are in no-till - 104 million acres or 26 percent - or other conservation-tillage practices - 98 million acres or 25 percent. Eligibility for soil-carbon programs requires farmers to implement practices that sequester carbon. Two of the most frequently discussed practices are no-till-conservation tillage and cover crops.

Alternatives for addressing climate change are varied. Once such alternative that's receiving increasing attention is sequestering carbon in agricultural soils.

The soil-carbon pool plays an important role in the global carbon cycle. But expansion of agriculture and modern agricultural practices have contributed to the release of soil carbon into the atmosphere. While it's estimated that much of the losses can be re-sequestered, carbon-soil dynamics are complex. The amount of carbon that can actually be sequestered depends on the practices implemented, crop rotation, soil type, soil drainage, topography and climate.

Thompson

Nonetheless the potential to sequester carbon has spurred an increase in public and private interest in markets that pay farmers to sequester carbon in their soils as a means for mitigating climate change. Proponents of the programs posit agricultural soil-carbon sequestration as a win-win, serving as a climate solution and a supplemental source of revenue for farmers. But this view is naïve to the significant challenges associated with successful implementation of a voluntary soil-carbon market.

Soil scientists agree there are agronomic and environmental benefits associated with rebuilding soil organic carbon in agricultural soils. It also has been well demonstrated through scientific study that the impact of no-till and cover crops on soil organic carbon change can be detected after long-term management changes – greater than 10 years. But there remains uncertainty regarding the ability to measure year-to-year changes in soil organic carbon. That's required by a soil-carbon market that makes annual payments.

That has caused many in the soil-science community to raise concerns regarding expectations of measurement of soil organic carbon in agricultural soils. Some say that focusing on soils as a climate-change solution could undermine broader efforts to restore agricultural soils. In addition to challenges associated with the physical science, social-science challenges – such as cultural, economic and political constraints – are just as problematic and are often overlooked. Therefore the objectives of our discussion are listed.

- provide information about emerging opportunities for row-crop producers to receive payments for sequestering carbon in their soils;
- examine the carbon-sequestration potential of common carbon-sequestering practices on U.S. cropland acres; and
- add transparency to discussions by outlining some important challenges and questions that remain.

Cover crops increase soil organic carbon by adding biomass carbon input. Unlike conservation-tillage practices the 2017 U.S. Census of Agriculture reported that cover crops have been adopted on only about 4 percent - 15 million acres - of U.S. cropland acres. The cover crops featured were part of a 2020 farm tour hosted by the Lafayette Ag Stewardship Alliance in Wisconsin's Lafayette County.

A John Deere 1590 no-till drill is demonstrated in 2016 during a Yahara Pride Farms Ag Innovation Day in Wisconsin's Dane County. Assuming sequestration rate, current no-till and conservation tillage on U.S. cropland sequesters 52 million metric tons of carbon per year. That's equivalent to taking 11 million passenger vehicles off the road each year.

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A number of opportunities exist for farmers to receive payments for sequestering carbon in their soils. The crediting mechanism underlying those programs generally takes on one of two broad structures – offset or inset markets.

Offset markets described

Carbon offsets are generated by those who can reduce emissions or sequester carbon. The offsets are then verified and sold to emitters as a means of offsetting their carbon emissions. Offsets can be sold through voluntary offset programs or to polluters regulated through carbon cap-and-trade programs.

A number of emerging programs seek to enhance agriculture's role in climate mitigation by supporting offset production from agricultural soil carbon sequestration, with the goal of selling the offsets in voluntary offset markets. Examples are Indigo Carbon, Nori, Truterra's TruCarbon program, Soil and Water Outcomes Fund, and Ecosystem Services Market Consortium. Although each program is unique, they generally work with farmers to implement practices that sequester carbon, provide measurement and verification of carbon offsets, and sell those offsets to buyers interested in offsetting carbon emissions.

Inset markets described

Insetting represents an initiative taken by a company to combat emissions within its own supply chain. Internalizing the efforts ensures the entity seeking to reduce its emissions is actively engaged in collaboratively providing education, technical assistance and, in many cases, financial assistance. There are currently several examples of carbon insetting where companies have directly targeted the agricultural segments of their supply chains for opportunities to sequester carbon through implementation of regenerative practices. Examples of inset markets include initiatives by Nestlé, Bayer and the Field to Market Alliance.

To watch a webinar recording on carbon markets visit purdue.ag/webinar062421 for more information.

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CROP CONNECTION

Carbon-sequestering practices analyzed

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Editor's note: Several agricultural economists at Purdue University recently published a paper on the opportunities and challenges associated with sequestering carbon in soils, and questions farmers have about carbon-credit markets. This is the last of a two-part article on the subject. It addresses practices that sequester carbon. The accompanying sidebars address questions such as how farmers will be paid, contractual obligations and more.

Eligibility for soil-carbon programs requires farmers to implement practices that sequester carbon. Two of the most frequently discussed practices are no-till-conservation tillage and cover crops.

Transitioning from conventional tillage to no-till reduces the loss of soil carbon by multiple mechanisms. Tillage enhances microbial activity due to aeration and mixes fresh residue from the surface into more favorable decomposition conditions. But

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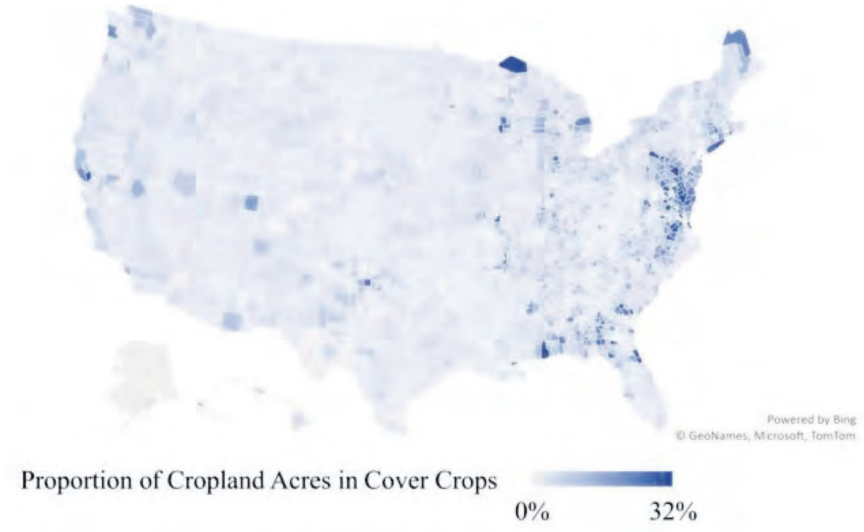

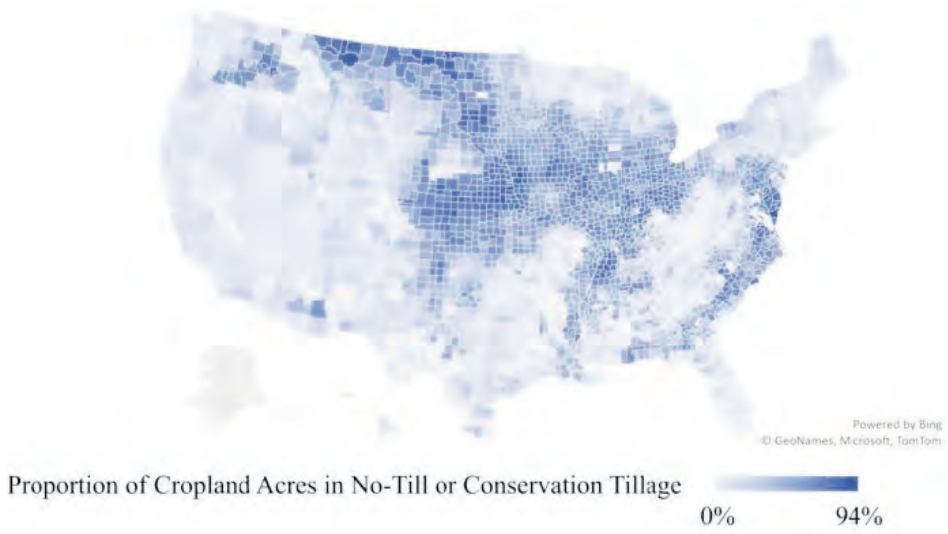

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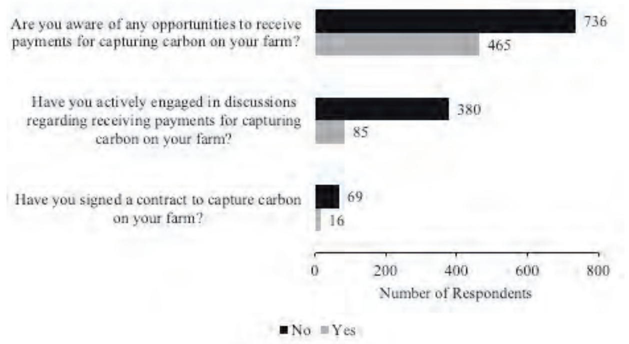

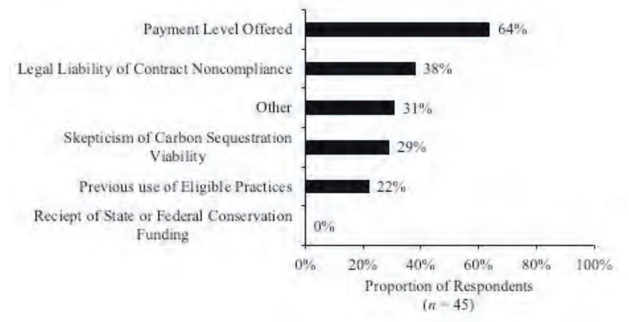

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How much will a farmer be paid?

The price of offsets from carbon sequestration will ultimately be determined by supply and demand. Supply is generally lagging demand in the markets. While 39 percent of producers in the Purdue University-CME Group survey were aware of opportunities to receive payments for storing carbon, only 7 percent have actively engaged in discussions about storing carbon. Just 1 percent have entered into a contract to store carbon.

Demand for carbon offsets is more developed, with companies making carbon-neutrality pledges. But it's important to note that the pledges are voluntary, leaving firms with wide latitude in deciding how to meet them and uncertainty as to their longevity. As a result demand is uncertain and may vary with the quality of carbon offsets generated by a given program.

Factors that affect offset quality include the degree of additionality – whether offsets represent carbon reductions that wouldn't have occurred in the absence of payment – and permanence – the risk that sequestered carbon will be released when offset projects end.

Without those features buyers are likely limited in what they will pay for soil-carbon offsets, potentially stagnating supply.

What does that mean for the price of carbon sequestered? Much of the current discussion seems to indicate prices available to producers are currently $10 per metric ton to $20 per metric ton of carbon sequestered, although that price seems to be arbitrary given there's no actual scarcity of carbon offsets – those are 100 percent voluntary markets – and different offsets represent different commodities. Different programs pay for carbon sequestered at different depths and some programs pay directly for practices implemented.

Current prices are likely too low to provide incentives for widespread participation. Producers most frequently identified the payment level offered as the reason they're not participating in soil carbon markets.

For perspective, a study by Gramig and Widmar in 2018 found that Indiana farmers would have to receive an additional $40 per acre in net revenues to switch from conventional tillage to no-till. At an assumed carbon storage rate of 0.31 metric ton per acre, that would require a carbon price of $129 per metric ton of carbon plus the amount that compensates for increased production costs and potential yield drag in a no-till system.

Further, estimates of the social cost of carbon – or the present value of avoided marginal damages from carbon abatement – are currently about $50 per metric ton. Therefore the price farmers are currently being offered to sequester carbon is less than both the minimum needed to induce widespread adoption as well as the benefit that the carbon sequestration provides to society.

Complicating the discussion is that there's currently little price transparency in the markets. How does a farmer know he or she is receiving the best price for carbon sequestration? How easy is it for a farmer to end a contract to take advantage of better prices in other programs? Those are important questions that need to be addressed.

Who pays for verification?

The technical challenges associated with measuring and verifying soil carbon are well documented. It's important to understand who bears measurement or verification costs. Currently available soil-carbon programs almost unanimously bear the costs of testing, meaning the farmer doesn't have to worry about paying for soil-carbon verification.

Still most farmers will likely want to understand the process for how carbon will be measured. Unlike yield, which farmers can easily measure, carbon stored in the soil is intangible. Current soil-carbon programs rely on a combination of in-field soil sampling and modeling to measure carbon sequestration. Given high transactions cost, it's infeasible to sample every field in the program. For that reason verifiers rely on biogeochemical modeling to predict soil-carbon sequestration.

The science behind the models is continuously improving, but it's important for farmers to understand they're not necessarily being paid for actual carbon sequestration measured on their farm. Instead, they're likely being paid for predicted carbon sequestration from a model. Companies should be transparent about that and should work on messaging to earn the trust of farmers. Both parties should contemplate how future improvements in biogeochemical prediction and soil-carbon measurement will be factored into contract payments.

There have been questions about the government's role in bringing oversight to soil-carbon markets. The recent U.S. Senate Bill S.1251, "Growing Climate Solutions Act of 2021," seeks to provide a framework that assists farmers participating in carbon markets. It would provide for reliable information and establishing a series of standards for certification for carbon offsets.

The USDA would be the main driving force of the program by setting guidelines for carbon-offset certification by third-party verifiers. While that could help to bring standardization to the marketplace, the parameters of the bill – or government involvement more generally – don't unilaterally resolve other challenges associated with soil-carbon markets.

While implementing practices that sequester carbon can help in the fight against climate change and serve as a source of supplemental revenue for farmers, it's not a panacea. Examining the carbon-sequestration potential of common carbon-sequestering practices indicates that even if the practices were purely additive and implemented on 100 percent of U.S. cropland, they would only sequester about 5 percent of total 2019 U.S. emissions.

While discussions of agriculture as part of the climate solution are a positive development, it's important to be realistic about the potential of cropland to sequester carbon. For soil-carbon markets to be successful in attracting widespread participation, the challenges identified here will need to be addressed.

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Does one qualify if already using eligible practices?

An important aspect of emerging markets for carbon sequestration is the focus on additionality. Currently about all of the programs seek to enroll producers who weren't previously using eligible practices to sequester "new" carbon. That generally means that producers who have previously implemented practices such as no-till and cover crops are ineligible to receive payments for carbon sequestration on land where those practices have been in place.

Only adoption of new practices or implementing practices on new acres qualify for carbon-sequestration programs. While some programs allow producers to receive back payments on previously implemented practices, they only apply to the previous five years or less.

The focus on additionality is intended to incentivize sequestration that wouldn't be captured sans the incentive. But that can be a point of contention for farmers who have implemented the practices for years. Twenty-two percent of the farmers participating in the survey indicated that their previous use of eligible practices disqualified them from participating in a carbon market. While many are looking for ways to reward producers who have long made investments in regenerative practices, no clear solutions currently exist to our knowledge. Ultimately the demand for "vintage" offsets is poor.

When combined with the physical aspects of soil-carbon sequestration, soil-carbon sequestration increases at a decreasing rate and carbon-storage potential is finite and can only be exploited once. Additionality requirements also raise concerns about adverse selection and moral hazard.

The rhetoric of an ever-impending increase in the price of carbon may be adversely impacting farmers' incentive to participate given the option of waiting. Why would a farmer start selling his or her finite ability to sequester carbon today for $15 per metric ton when they could wait and possibly sell that same sequestration for $30 per metric ton or more three to five years from now?

There are also questions about whether producers who receive federal or state funding for conservation-practice adoption are eligible to also receive payments for carbon sequestration, or vice versa. Ultimately, the answer is "it depends." Some programs allow and encourage that sort of program stacking. Others prohibit it.

None of the producers in the survey identified restrictions on program stacking as an impediment to their participation in soil carbon markets. But producers seeking a contract to sequester carbon should ask about opportunities or limitations on receiving additional funding for practices implemented.

What are the producer's contractual obligations?

The second most frequently identified impediment to participation in carbon markets among the farmers in the Purdue-CME Group survey was the legal liability associated with contract noncompliance. One of the challenging aspects of soil-carbon sequestration is that it's extremely impermanent. Carbon may be released from soils if the practice used to sequester carbon is discontinued. Impermanence poses risks to producers who are contractually obligated to sequester carbon.

Take, for example, an Eastern Corn Belt producer who faced wet field conditions during planting and harvest of 2019. For some the optimal decision was to do fieldwork in less than ideal conditions. That resulted in field ruts given the cost associated with waiting and not making the ruts. In the absence of a carbon contract a producer who chose to create the ruts would do some tillage in the spring. But with the conditions of a soil-carbon contract, that may violate a carbon-sequestration agreement by re-releasing soil carbon back into the atmosphere.

What's the legal liability in that case? Most programs would deal with it by "pausing" future payments until the farm can re-sequester the carbon released due to the one-time event. If the farmer is unwilling to continue the practices to re-sequester released carbon in the absence of payments, it's unclear what the legal liability would be.

At the very least it would likely require the producer to repurchase carbon offsets he or she had previously sold at the prevailing market price. Bound by contract the producer also may choose not to make the ruts in the first place, but that also comes at a cost.

The discussion of permanence raises another important question. What's the duration of currently available soil-carbon sequestration contracts? In the United States the major programs are currently using 1-year to 20-year contracts.

What happens after the contract ends? Is the farmer obligated to maintain the practice or is he or she free to revert to previous practices without legal liability for re-releasing stored carbon? The answer isn't clear, but it's important for both the producer and the offset purchaser. If there's no legal liability to maintain sequestered carbon beyond the contract term, it's difficult to see how the programs could possibly be helping mitigate the effects of climate change – and helping offset purchasers meet their sustainability goals – given the lack of permanence.

Carbon

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it also disrupts soil aggregates that protect soil organic carbon from decomposition. A meta-analysis on the efficacy of no-till farming for increasing soil carbon confirms that most corn-growing regions would have an increase in soil organic carbon when switching from conventional tillage to no-till.

Of the 396 million cropland acres in the United States, the 2017 U.S. Census of Agriculture reported that more than half are in no-till – 104 million acres or 26 percent – or other conservation-tillage practices – 98 million acres or 25 percent. See **Figure 1.**

Previous research has reported carbon-sequestration potential associated with no-till ranging from less than 0 metric ton per acre per year to more than 0.4 metric ton per acre per year, depending on climate and soil type. The U.S. Department of Agriculture Natural Resource Conservation Service's COMET-Planner tool reports expected carbon sequestration of 0.31 metric ton per acre per year for no-till and 0.20 ton per acre per for reduced tillage for most regions in the United States.

Assuming the sequestration rate, current no-till and conservation tillage on U.S. cropland sequesters 52 million metric tons of carbon per year. That's equivalent to taking 11 million passenger vehicles off the road each year.

Putting all U.S. cropland acres into no-till would sequester 123 million metric tons of carbon per year or about 2 percent of all U.S. carbon-dioxide emissions in 2019, according to the U.S. Environmental Protection Agency.

Cover crops increase soil organic carbon by adding biomass carbon input, improving protection for soil organic carbon in the form of soil aggregation and decreasing carbon loss through soil erosion.

The 2017 U.S. Census of Agriculture reported that cover crops have only been adopted on about 4 percent – 15 million acres – of U.S. cropland acres. See **Figure 2**.

Previous research has shown cover crops to have carbon-sequestration potential ranging from 0.04 metric ton per acre per year to 0.4 metric ton per acre per year. That depends on biomass amount, years in cover crops, and initial soil-carbon levels. The COMET-Planner tool reports expected carbon sequestration of 0.37 metric ton per acre per year for cover crops for most regions in the United States.

Assuming that sequestration rate, current cover-crop adoption sequesters 5.5 million metric tons of carbon per year. Planting all U.S. cropland with cover crops would sequester 147 million metric tons of carbon, or the equivalent of 3 percent of 2019 carbon-dioxide emissions in the United States.

The accompanying sidebars address four of the most frequently asked questions by producers about soil-carbon markets. A random sample of 1,201 U.S. commercial-scale agricultural producers were asked about their awareness of and participation in soil-carbon markets as part of the Purdue University-CME Group Ag Economy Barometer's February, March and April 2021 surveys. See **Figure 3.** An additional question was posed to survey respondents in the March and April 2021 surveys asking them about factors inhibiting their participation in soil-carbon markets. See **Figure 4**.

To watch a webinar recording on carbon markets visit purdue.ag/webinar062421 for more information.

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