The “wild west” of carbon offsets: Farmer perspectives on carbon markets incentivizing agricultural soil carbon sequestration

Aaron Strong (astrong@hamilton.edu)
Hamilton College
Clare Barbato
Hamilton College

Article

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Abstract

Climate change mitigation efforts to achieve net-zero emissions require not only decreasing current greenhouse gas emissions, but also the deployment of negative emissions technologies. Soil organic carbon sequestration in agricultural lands is one such negative emissions strategy, currently being incentivized predominantly through voluntary carbon offset markets. Here, through semi-structured interviews, we assess both conventional and organic farmer perspectives on soil carbon offset programs that have been created in the United States since 2017. The perspectives of farmers both participating and not participating in agricultural soil carbon markets were similar and consistent. Farmers in both groups expressed concerns about the convoluted, burdensome and unpredictable nature of receiving offset credits and emphasized that they were implementing practices for their own business interests and sustainability concerns, not the financial incentive of the generation of carbon credits. Based on our research, carbon offset credit payments for agricultural soil carbon sequestration are largely reaching farmers who were already implementing these beneficial practices or were already strongly interested in implementing these practices, and the payments for the offset credits are seen as a 'gravy on top', suggesting that these offset markets face strong challenges of ensuring true additionality essential to effective climate mitigation.

1. Introduction

Humanity continues to face the impacts of the climate crisis: extreme heat, increased rainfall, increased severity of tropical storms, increased prevalence of wildfire, sea level rise, and increased severity of droughts (IPCC, 2021). While it is fundamentally necessary to drastically reduce current and future anthropogenic greenhouse gas emissions to mitigate the climate crisis, pathways to avoid catastrophic climate change and hold warming below 2°C also necessitate the implementation of negative emissions technologies (NET) that remove greenhouse gases from the atmosphere (Minx et. al., 2018, Clarke et. al., 2014). NETs include afforestation, reforestation, forest management, coastal and marine carbon sequestration, and soil carbon sequestration in agricultural lands (Fuss et. al., 2018).

Even though agricultural lands generally hold less soil organic carbon than wild lands (Lal et. al., 2015), agriculture has the capacity to be a major source of negative emissions because of the sheer size it covers: almost 50% of potentially vegetated land surface has been converted to crop and pasture land (Zomer et. al., 2017). Soil carbon sequestration refers to the accumulation of soil organic carbon (SOC) in terrestrial soils. Soil organic carbon accumulates as a result of the balance between carbon inputs to the soil – like biomass – and pathways for losses of carbon from the soil, such as respiration, decomposition and erosion (Bai et. al., 2019). When carbon inputs to soils exceed losses from decomposition and erosion, SOC accumulates and soils are a net carbon sink. Soil carbon sequestration on agricultural lands requires increasing carbon inputs and/or decreasing carbon losses, which can be accomplished through a variety of activities, including conservation tillage, mulching, cover-cropping and integrated nutrient management (Bai et. al., 2019), as shown in Fig. 1. Conservation tillage reduces soil disturbance and the soil organic matter decomposition rate (Salinas-Garcia et. al., 1997), while cover

crops provide additional biomass inputs (Blanco-Canqui et. al., 2011). These soil management strategies seek to increase the concentration of soil organic carbon and can be accompanied by co-benefits in overall soil quality and disease resistance, decreased erosion, and increased productivity. Because of the substantial soil organic carbon storage potential of agricultural soils as a key component of natural and working lands-based negative emissions strategies, there has been increasing attention, by both governments and the private sector, toward incentivizing farmers to adopt beneficial cultivation practices to enhance carbon sequestration as part of climate change mitigation strategies.

Globally, both national-level and subnational climate policies have increasingly included a variety of incentive programs to encourage farmers to undertake on-farm activities that sequester soil carbon (Newell Price et al. 2022). For such incentives to be effective in inducing farmers to implement on-farm activities, they need to be functional for farmers who are implementing them. Previous survey and interview-based research has examined both the barriers to and facilitators of farmers and other landowners adopting these activities. In interviews with rangeland owners in Utah, Cook and Ma (2014) found that ranchers were primarily motivated by local environmental co-benefits, rather than the climate benefits of on-farm activities. In a survey of landowners in Australia, Torabi et al. (2016) found that farmers were motivated to participate in carbon sequestering activities largely because of the biodiversity benefits of the activities, rather than because of payment incentives. Kragt et al. (2017) also found that environmental co-benefits like soil health were a driver of adoption, along with social networking to other farmers who had already had experience with adoption of new activities. In a review of 37 studies of farmer preferences for soil carbon sequestration methods, Buck and Palumbo-Compton (2022) found that implementation of soil carbon sequestration activities is primarily driven by perceptions of environmental co-benefits like soil health and biodiversity. Taken as a whole, there is consistent social-scientific evidence that farmer motivations for adoption of carbon sequestering activities on their land is driven by perceptions about the co-benefits of such activities, rather than by financial returns or the idea of sequestering carbon.

By contrast, previous work has identified numerous barriers to farmer adoption of soil carbon sequestering activities, despite financial incentives in place. In Kragt et al. (2017)'s survey of farmers in Australia, they found that unfamiliarity with practices, lack of information about activities, and concerns about the costs of implementing new activities, despite financial incentives, all contributed to hesitancy to adopt. In a hypothetical choice experiment with row-crop farmers, Gramig and Widmar (2017) found that payments of $40 per acre were needed to incentivize farmers to adopt new conservation practices – payments that are generally higher than existing per acre government incentive programs. Buck and Palumbo-Compton (2022)'s review of the existing literature also highlights that information/educational barriers and uncertainties about the policy structures that underlie incentives are also restricting farmer uptake of beneficial practices. Notably, in a study of farmer preferences in Scotland, Feliciano et al. (2014) found that farmers who were already implementing some activities that sequester carbon were more willing to implement more – suggesting that education and information can help overcome issues around barriers that are due to a lack of familiarity.

Much of the previous research has been conducted not with row-crop farmers, but with rangeland and other landowners who have participated in biodiversity conservation programs that have additional climate benefits, and many of these studies were conducted using hypothetical surveys prior to the actual implementation of real-world incentive programs. Further, despite the centrality of perceived environmental co-benefits in shaping farmer adoption of carbon sequestering activities, previous research has not focused on organic farmer adoption. And finally the majority of this research has been conducted with farmers who are not participating actively in financial incentive programs like carbon offset markets.

Since 2017, new voluntary carbon offset developers have emerged that seek to incentivize U.S. farmers to change on-farm practices to sequester soil carbon through payments for the farmers' generation of voluntary carbon credits that can subsequently be used by emitters to offset existing sources of anthropogenic emissions, as actors seek to reduce the climate impacts of their operations. Building on previous research, this study seeks to understand the motivations and concerns of both organic and conventional farmers about their participation in agricultural soil carbon markets that have developed in the United States since 2017. Understanding their perspectives and lived experiences can help further inform the literature on farmer perceptions of market-based mechanisms for soil carbon sequestration and, can also help evaluate these emergent markets to assess of their effectiveness for achieving climate mitigation.

1.1. Current Soil Carbon Offset Markets in the United States

Carbon credit trading marketplaces provide a space for emitters of greenhouse gases to purchase offsets from farmers and other land managers. There are two primary types of carbon offset markets: compliance offset markets that implement government-mandated emissions reductions and voluntary offset markets, driven by emitters' own desires to purchase offsets, without the presence of a government-imposed cap (Haya et al. 2020).

Private corporations have emerged to develop voluntary carbon offset projects, working with land owners to document the carrying out of activities that sequester carbon and then selling verified carbon credits on the voluntary market. Two corporations – Nori and Indigo – are the two primary offset project producers for agricultural soil carbon offsets for the voluntary market currently in operation in the United States. Indigo began its carbon market program in 2019 and Nori in 2017.

Voluntary offset project developers face several challenges: one is to ensure that the amount of carbon estimated to be sequestered through the implementation of on-farm activities is real and accurate. The other challenge is to ensure that the carbon sequestered is 'additional' to what would have otherwise occurred. This need for additionality arises because the carbon credits will be sold to 'offset' existing sources of emissions.

Assessing the amount of additional carbon sequestered by on-farm activities like covercropping, conservation tillage and soil amendments is not easy. Voluntary carbon credit markets for agricultural soils require exact measurements or estimation for the quantity of carbon sequestered in order for offset

buyers to subtract these credits from their emissions. There are a variety of methods to measure soil organic carbon, including dry or wet combustion, near-infrared and mid-infrared spectroscopy, and empirical regression models (Stockman et. al., 2013). Cullenward et. al. (2020) note that measurement of soil carbon content is especially difficult because it is so variable across soil depth, spatial locations and time, and that soil carbon measurement is relatively new and lacking consistent protocols and verified models. There are also challenges in measurement due to the reversibility of soil carbon sequestration, which produces differences in approaches to permanence and measurement time scales (Rumpel et. al., 2020). To facilitate verification and estimation of the amount of carbon sequestered, both Nori and Indigo use carbon offset 'protocols' that were developed by non-profit organizations known as registries. The protocols in most common use are those developed by Verified Carbon Standard, by the Climate Action Reserve and by American Carbon Registry (Zelikova et. al., 2021). Beyond the uncertainty of sequestration values and permanence, making sure that credits represent new, real, additional carbon sequestration is challenging. Additionality refers to a sequestration project being *caused* by the credit incentive – that it would not have gone forward without the incentive's support (Badgley et. al., 2022). Both Nori and Indigo's certification protocols include standards for additionality. Indigo uses the Climate Action Reserve (CAR) Soil Enrichment Protocol, which "strives to register only projects that yield surplus GHG reductions that are additional to what would have occurred in the absence of a carbon offset market" (Climate Action Reserve, 2020). The CAR protocol also allows for other farmer motivations for practice changes; its core requirement is only that farmers change their soil management practices relative to an established baseline, and it allows for the stacking of incentives, including NRCS subsidies, without disqualifying farmers from eligibility. Zelikova et. al. (2021) found that CAR's protocol "creates the false appearance of additionality standard" while actually treating all practices as additional. Nori's protocol stipulates that carbon credits are only issued for "a discrete and verifiable activity or practice change that is reasonably expected (given the scientific evidence available at the time) to result in a new net CO_2 removal and C retention" (Nori Carbon Removal Marketplace, 2021).

2. Methods

2.1 Study Populations and Interview Solicitation

To assess farmer perspectives on the current state of markets for agricultural soil carbon offsets in the United States now that widespread voluntary offset markets have become established, we examined the perspectives of two groups of farmers: conventional farmers in the Midwest and South (the two regions in the United States where protocols allow for projects to be eligible) who are actively participating or seeking to participate in voluntary carbon markets, and organically certified farmers in New York State who are engaging in soil sequestration practices but are not participating, nor eligible to participate in existing carbon markets. The reason for the selection of these two groups is to assess whether perspectives on these offset programs are shared between groups of farmers who are all engaged in carbon sequestering, but who vary in their abilities to participate within the markets. By interviewing farmers in both groups, we are able to identify universally held perspectives on existing agricultural soil

carbon market mechanisms. In particular, by interviewing farmers who had all chosen to adopt at least some of these practices, we could develop a typology of both the facilitators of practice adoption and concerns about markets and compare whether incentives from voluntary offset payments shaped adoption pathways for eligible farmers, compared to ineligible farmers. In conducting these interviews, our goal was to assess how farmer perspectives on functioning voluntary offset markets for soil carbon compare with previous findings largely derived from theoretical incentivization programs.

Conventional farmer interview participants for this study came from a pool of carbon credit sellers listed on Indigo and Nori's websites. Participants were solicited by email or by phone using the contact information listed either directly on carbon market websites or on other farm websites. Out of thirteen solicitations for interviews, we received nine positive responses, a response rate of 69%. These farmers were all farming in the United States: six in the Midwest and three in the Southeast. Of the farmers we interviewed, four were growing only field crops (including corn, soybeans, cotton and winter wheat), and four were growing field crops and raising livestock in mixed operations. Six of the individuals we interviewed had successfully received payments from carbon credits from Nori or Indigo, while three were farmers working with Indigo and Nori, but had not directly received payments yet. Two farmers identified as female and seven as male. The potential population of eligible farmers to interview was limited by the low number of total farmers actively participating in these programs. While exact figures have not been published, 23 farmers were listed on the two company's websites and in other available documentation, however we were not able to find contact information for them. Thus, our thirteen solicitations represented 57% of the population of farmers whom we could identify.

Organic farmer interview participants for this study came from a pool of certified organic vegetable producers in New York. Specifically, farmers were selected from a publicly available registry of farmers certified through the Northeast Organic Farming Association of New York (NOFA-NY), one of the largest organic certifiers in New York State. Participants were solicited by email at the email address listed either directly on the registry or on farm websites. Out of twenty requests for interviews sent, we received nine positive responses, a response rate of 45%. Of the farmers we interviewed, three were growing only vegetables and six were growing vegetables and raising livestock in mixed operations. These farmers were all farming in New York State: three in Western New York, one in Central New York, three in the North Country, and two in the Hudson Valley. None of them were participating in active carbon markets. Four farmers identified as female and five identified as male.

2.2 Semi-Structured Interviews and Coding

Author CTB conducted seventeen individual, semi-structured interviews between January 2021 and February 2022, for a total of seventeen semi-structured interviews. Interviews lasted between 30 minutes and 1.5 hours in length and conducted on Zoom or over the phone. All interviews were recorded and then electronically transcribed using automated voice-to-text software, after which transcripts were manually corrected for minimal transcription errors. We received ethics approval from the Hamilton College Institutional Review Board for this study.

Semi-structured interview questions centered on farming practices and farmer perspectives about carbon markets and other incentives to undertake activities that enhance soil carbon sequestration. The interview guide for semi-structured interviews is shown in Table 1 below.

Table 1
Semi-Structured Interview Guide

1. Tell me a little bit about your farm and what you do.
2. What do you think about your farming as it relates to climate change? In what ways does climate change affect you?
3. Which of the following practices do you currently use on your farm: cover cropping, companion cropping, reduced tillage, or soil amendments and what factors drove your decision to implement these practices?
4. Hypothetically, if you were not already implementing these practices, what regulations, incentives or programs do you think would allow you or encourage you to implement soil carbon sequestration practices?
5a. (if not participating). How would you feel about a carbon farming add-on to the organic certification label? What about a program that paid you for the practices themselves?
5c1. (if participating) How were you farming before you got involved with selling carbon credits and how do you reflect on these practices now? 5c2. (if participating) What has been your experience with the program thus far?
6. Overall, what do you think would make carbon credit programs work better for farmers?
7. How do you think agriculture needs to adapt to address climate change?
8. Where do you see carbon markets for soil carbon sequestration in five years from now? Where would you like to see markets in five years?

Interview transcripts were qualitatively analyzed using a modified grounded-theory approach (Corbin and Strauss, 1990) – an inductive method to assign codes to recurring themes across interviews. In this method, we first established two goals: (1) developing a typology of categories and subcategories of that led to farmer adoption of on-farm carbon sequestering activities and (2) developing a typology of categories and subcategories of concerns about currently functioning offset markets. We then sought to define whether these categories and subcategories were unique to one of our two study populations or were shared across them.

To develop the codebook of categories and subcategories, we first conducted iterative readings of the transcripts by both authors CTB and ALS to develop an initial list of categories and subcategories of responses. We then refined this grounded, inductive list of categories by comparing our categories and subcategories with identified factors that constituted barriers and facilitators from the literature, in particular from Buck and Palumbo-Compton's 2022 review paper. Using this information, we refined our coded categories to develop the two-level code book of categories shown in Fig. 2 below. Readings of transcripts began after twelve interviews had been completed, and continued interview solicitations were

sent out until we determined no new codes were being developed (five additional interviews) and we determined we had achieved saturation within the structure of our code book. After saturation and with our developed codebook, all coding was redone using a combination of NVivo software (Nvivo Version 12 for Mac) and manual coding of anonymized transcripts. Coding was done first by author CTB, then transcripts were re-coded by ALS to ensure intercoder reliability. Re-coded transcripts had a percentage agreement of 91%.

3. Results

3.1 Motivations for Practice Adoption

Based on the core assumption of additionality – that activities that enhance carbon sequestration among conventional farmers should be credited because the financial incentive of the offset credit induces greater participation and increases total carbon sequestration from what would have happened in the absence of the offset credit – we initially hypothesized that the farmers participating in carbon markets had adopted the practices for financial reasons associated with crediting, while organic farmers who are not participating in these markets would adopt these practices for more holistic environmental reasons.

Yet across both groups of farmers, the primary motivations to adopt beneficial farming practices were the same: (1) overall economic profitability and (2) intergenerational resilience due to maintaining healthy soils. As a whole, all farmers were motivated to adopt practices that sequestered carbon because of interests in long-term sustainability, crop health, and farm profitability that extended beyond the desire to be eligible for credit payments.

Farmers who were actively participating in carbon markets for soil carbon sequestration or who had attempted to utilize such carbon markets adopted practices for a number of reasons, but the ability to participate in a carbon market was not the primary reason. As one farmer said of the practice changes encouraged by carbon markets:

We made all those changes to cover crops, no till, and all the things that they want you to do. We did that just for our own profitability and survival, you know? It's a better way to farm.

Roughly a third of these large-scale commodity crop farmers expressed that more conventional practices had brought them into situations of economic hardship that made alternative practices that enhance soil health more appealing, because they made farmers more resilient. While participating farmers were aware that these practices made them eligible to receive carbon credit payments, participating farmers' decision to adopt these practices were universally driven by on-farm concerns. Most (seven of nine) were multi-generation farmers who expressed explicit concerns with maintaining long-term profitability for many years into the future. As one participating farmer said:

Our goal is that we're constantly looking at the future of our operation, and how we can make sure that we're maintaining the soils and the land that we have, so that they're in very high fertility rates, as well as

we're building the organic matter on the farm. So as we start to continue to see, and we have in our area, our weather patterns change, that we can combat by, with hopefully, you know, really, really fertile, healthy soil.

Organic farmers also discussed soil and crop health, economic productivity, and adapting to extreme weather events for future generations. While some of these practices were required for organic certification, most organic farmers had gone beyond the bare minimum requirements for cover cropping and crop rotation because of some other motivator. In general, they were concerned with maintaining the health of microbiotic communities and the whole farm ecosystem, and the corresponding impact on plant health and productivity. One farmer noted the benefits of these practices:

Obviously sequestration is great for [climate mitigation],[but it's] even better for the soil.

A few farmers were also concerned about improving their resiliency in the face of increasingly severe flooding and drought, and thus were interested in building their soil's erosion resistance and water-holding capacity. The majority of organic farmers believed that these practices were chosen out of "enlightened self-interest" - that they were better for farm income, plant health and overall system sustainability. As one carbon markets farmer described:

Well, you're looking at the wrong way, you should put your cover crop out, because it was the right thing for you to do for your operation…Stack the carbon program on top of

that.

All farmers who were participating saw carbon market programs as an avenue to get compensated for practices they were already looking to adopt, and which they saw as benefits to their farm operations. One farmer reflected:

The carbon credit thing is just sort of gravy on top of what we already do, and what we think is the right thing to do.

One farmer reflected on the carbon credit payment: I think it's sort of an added bonus.

And another farmer encapsulated this same view:

Like, we don't want to farm differently, to sequester carbon. We are farming differently, because it's the better thing to do. So whatever system whatever carbon credit market or system lets us, y'know, pays us to do what we were already going to do anyway.

Four participating farmers were also open about the fact that they were choosing carbon markets based on which quantification systems would compensate them for practices they were already using.

Farmers also recognized that other incentives exist to engage

3.2. Concerns About Payments

Organic and conventional farmers shared identical views on carbon market payments for beneficial activities. Collectively they viewed the payments as helpful, especially for those who were already doing the on-farm activities, but too low to incentivize any new adoption of carbon sequestering activities among farmers otherwise disinclined to participate. In terms of their perspectives on receiving payments for 'what they were going to do anyway', farmers participating in carbon markets expressed positive sentiment about being paid for their practices. The view was summed up by one farmer:

Why not take the money while it's there?

Another reiterated that carbon payments were a clear benefit to their operation:

If I've gotten an installment today, that's something I can make a difference to my family and my business today.

Organic farmers also acknowledged the benefits of providing farmers another source of income. For a group of farmers who were already farming in a way that sequestered carbon, it seemed like a clear benefit to receive payment without having to put much money or time into changing their methods or doing anything new. They also seemed optimistic about the long-term success of a program that compensated farmers, over one that relied simply on education or shifting ideologies.

Additionally, a few organic farmers reported that a financial incentive might be a good way to convince conventional farmers, who they saw as less ideologically driven than they are, to adopt beneficial practices. Farmers from both groups agreed that farmers tend to be underpaid and overworked, and were appreciative of any incentive that gave them additional income, especially one that supported soil management practices that provide other co-benefits to their operations. One organic farmer spoke positively of carbon markets:

[A]nything that has any sort of monetary value attached to it, I think is gonna be what works in the long run.

Yet, both groups of farmers expressed concerns that the compensation from payments for carbon credits was too low to be meaningful. The most consistent complaint that participating farmers raised about carbon markets is that the payment was simply too low. One organic farmer said:

...we've talked to other folks too, they say, you know, we're just not interested in being involved in the carbon market because we don't feel like it's high enough valued, and I agree. There. It's not high, highly enough valued.

There was complete agreement from every participating farmer we interviewed that the carbon credit payments available currently are too low to drive substantial practice changes on their own farms that they were not planning to adopt for other reasons, and are too low to drive practice changes for non-participating farmers. They expect that carbon credit programs will not be appealing enough to farmers who are not already interested in practice changes until the value of credits increases substantially. While

the universal view was that money for ‘doing nothing new’ was great to receive, farmers viewed the payments as too low to incentivize new activities that a farmer was otherwise not inclined to adopt. One farmer said of the roughly $15 per acre payment that most farmers receive:

No, that's not going to change anybody, nobody's gonna quit doing the way they've always done it, try over something new for that.

Or course, when farmers are paid for doing what they are already doing, low compensation may still be viewed generally positively. When asked whether the carbon credit payments they were receiving were enough money, one farmer said:

I feel like it's enough because again, I didn't change anything to do it, you know what I mean? … You're doing this, you're doing a really good job. Here's almost a half a million dollars. Is that okay? I go, Yeah, that's fine.

Organic farmers felt that carbon markets were built for large, conventional farmers who were not using many beneficial practices already, and elected not to participate because they felt that carbon markets would result in little profit for them. One interviewee said:

From what I have seen in carbon markets that have been established, um, cap and trade has…not paid enough to fund those so that a smaller scale would get enough to even pay for the time they have to spend applying.

3.3. Concerns About Paperwork

Despite the ease of getting paid for doing ‘nothing new’, both groups of farmers saw the paperwork associated with tracking on-farm activities as a barrier to entering into carbon markets. Participating farmers expressed concern that carbon market payments were made more difficult to access because of the hardship of gathering all of the required records and inputting their data into the carbon market system. They complained of the complexity of digitizing older paper-based records, getting records to mesh over the years as fields changed, and converting their data into a precisely specified format. One farmer said of this process:

The data, the data part was, is ridiculous. I mean, everything that you do on every acre for the last 10 years, is what you have to do…you get back to 2010 - one, I wasn't even here, and records were mostly like little scribbly notes on notebook paper. So…maybe you weren't even farming the same fields then or you called them something different, or it used to be six fields, and now you made it one.

Farmers who were participating in carbon credit markets generally felt that their own records were better than most, and that this was part of what allowed them to succeed, but they were concerned that the older or smaller-scale farmers would not be prepared for the level of detail that was required to participate in these programs. They expressed worry that this would limit the adoption of carbon credit programs. One farmer suggested that other farmers may be unprepared for the paperwork burden:

It is a ton of paperwork and a ton of like, proving what you had to do. Yeah, it's pretty extensive…I think the farmers that are looking into these programs are prepared. I think the farmers that maybe are a few steps behind the curve are not prepared.

The main things that participating farmers said helped them overcome the record-keeping and data entry hurdle was having spare time to keep records or having someone on staff whose job was predominantly to keep records, using a digital record-keeping system that was compatible with their carbon market's software, and having someone at their carbon market helping them through the data entry process to clarify what was required.

Organic farmers expressed similar concern that farmers would be overburdened by having to navigate a new record-keeping system and certification process. A few spoke about already being stretched thin by the process of applying for government grants to support their practices. One said simply:

I mean, I like getting grants. I don't like writing grants.

Given the stresses this group of farmers was already operating under, some felt that having to navigate another application process would simply be too much, especially for an uncertain and likely low payout.

3.4 Concerns about a Lack of Predictability

Despite enjoying being paid for doing little extra on their farms, in addition to the drawbacks of paper work, farmers participating in carbon markets also expressed frustration that the eventual payouts from these markets were difficult to predict. The uncertainty of the payment made the work of changing practices and inputting data seem far less worth it. One farmer suggested that other farmers would be unwilling to take the step to participate in the market (and the associated paperwork burden) just for an uncertain payment:

So nobody's gonna do that - they're not going to do all that work on the chance they

might not get paid.

Farmers felt that it was risky to put effort into substantially changing practices solely to participate in a carbon credit program because of the chance that they would not receive any money. The cost of changing practices, they felt, should be compensated no matter what, or else farmers would be hesitant to take a "leap of faith" on a carbon market.

I mean, it's gotta be something that's a for sure thing if they make the changes. That's the other thing that's always frustrated me. You might make all the changes and then not get paid? That's crazy.

Farmers' perception that carbon markets were unreliable was heightened by the fact that payouts were calculated differently from program to program, generally totally out of the view of the farmer. This uncertainty put farmers in the situation of inputting data into a "black box" and hoping that it would

result in a payout, a risk that they recognize others might not be willing to take, hindering wider adoption of carbon market programs.

One farmer summarized other farmers' worry about how opaque carbon markets are: It makes people a little nervous, because it's not a tangible thing. And then, like the model that they're using is very complicated. It's kind of a black box. So you don't know what's actually happening. So there's some distrust going on.

In order to avoid the distrust and confusion bred by the unpredictability of payouts, the majority of farmers participating in carbon markets voiced support for a more standardized system, with clearer and more consistent rules for setting the value of a credit. One farmer said simply:

I would like to see one standardized set of rules. So it wasn't such a wild wild west.

3.5 Concerns that Markets are Biased to Benefit Large Industrial Agriculture

Beyond the barriers of predictability and paperwork, all farmers expressed some concerns that existing voluntary carbon markets contain biases and are poorly structured to try to incentivize non-optimal activities or for the benefit of other actors. They viewed market operators skeptically and thus these concerns about bias can represent a form of barrier to participation. Some of these concerns focused on concerns that markets would incentivize activities that required heavy chemical inputs, which a farmer would have to purchase from a chemical company. Chemical companies tend to emphasize the role of no-till in sequestering carbon above other practices like cover cropping and nutrient management, because no-till often requires heavy pesticide and herbicide inputs to replace the disruption of weed root systems and pest life cycles that normally occurs through tillage (Jacobsen & Ørum, 2009). Participating farmers expressed concern that these companies could be involved in setting national government standards for carbon markets, which would then skew all carbon markets toward a specific style of farming and ignore other beneficial practices for carbon sequestration.

One farmer spoke negatively about other programs that were closely associated with chemical companies:

If a large chemical dealer wants to sell you a chemical that if you use, they promise you'll sequester more carbon, and then they're going to pay you for that carbon, but you can only get that payment if you buy their chemical…like it's pretty obvious what's happening there. And you know, it's just another way for farmers to be taken advantage of by input dealers…you're basically sequestering carbon with the intent that this company is going to buy your credit to offset the cost of producing the chemical that they sold you to sequester the carbon…that's dumb. I'm not interested in that at all.

Organic farmers were especially concerned about carbon markets privileging a specific style of large-scale monocrop farming. They worry that many currently active carbon markets are rooted in models based on pilot phase testing on large-scale commodity crop farms. An industrial-scale model would put

small-scale, diversified organic farms at the disadvantage of entering an incentive structure that was not built to adequately capture or account for the way their farms operate and the practices that they're using. Organic farmers were even more concerned than participating farmers that carbon markets would narrowly support only a subset of valuable farming practices, but both groups of farmers frequently raised concerns that carbon markets would inadequately support a full range of beneficial soil management practices. Farmers from both groups expressed that it was a priority that carbon markets be protected from unfair industry bias.

I can see already that…there's already the major ag players that are kind of trying to write the rules for the programs and design the standards…around…no till and that approach to farming is where it will get tilted towards…because their incentive is to sell…seed and chemicals and fertilizers.

Organic farmers also felt boxed out because of a sense that carbon markets were built on an industrial monocrop model that would not be easily applied to their small, diversified farms. One participant said of carbon markets:

[S]o maybe eventually they do approach, you know, a 30 acre diversified vegetable operation, but if their data and their models are based on a corn and soy operation in Iowa, is that going to make sense?

Farmers were left with the perception that some carbon markets were set up just for the purpose of enriching the companies that run them. This leads to a distrust of carbon markets in general, and participating farmers worry that this distrust will hinder wider adoption of these programs by other farmers. Farmers were also concerned about the involvement of large chemical companies when they look forward toward more potential government regulation of carbon markets. One farmer expressed this anxiety:

3.6 Concerns About Fairness

About half of participating farmers expressed concern that carbon credit programs were not set up to reward all farmers who used beneficial practices, because those same practices would sequester less carbon depending on geographic location (and especially the length of the growing season) and soil type. They were aware that different practices were most effective at sequestering carbon in different areas, and that some areas were better able to sequester carbon than others. One farmer in the Southeast who had been unable to participate in carbon markets because of this geographic variability reflected:

But you know, down in the South, where we have active soil all year long, that model didn't work, because our microbes in soil are eating all the carbon all year long, so…we're sequestering carbon constantly. But it's an energy source…it's cycling through the system, and we're not able to accumulate tons of carbon. Even though we're probably sequestering more carbon than our counterpart up North that can…because they have dormant soil half the year when it's frozen.

Farmers in the Southeast expressed concern that the models used to estimate soil carbon sequestration that Indigo and Nori use to calculate credit values have not been created with their soils in mind. They

expressed that the standards felt tailored to farmers in the Midwest, where most American agriculture is concentrated, and that those standards apply poorly to their farms and leave them eligible to receive less money. One expressed particular concern that many carbon markets programs were not even available in their state because there was simply not enough agricultural acreage to make it worthwhile for markets to set up programs.

Both groups of farmers expressed hesitancy about the fairness of a carbon market structure based on the fact that different types of soil have inherently different holding capacities for carbon. One conventional farmer with clay soils noted that they could unfairly benefit under this system regardless of their good management practices. They said:

[D]ifferent soil types have inherent, you know, inherently different carbon values to begin with. Clay or loam is going to naturally, all other things be equal, have a higher carbon and organic matter percentage than, uh, uh, say a sandy soil or gravelly soil. Um, and you know, so if you bought a peat bog and didn't do anything to it, it's going to be really high...I mean we would do better because we already have clay soil...inherently higher in carbon, but our practices have also been working to build it.

They recognized that their soil allows them to receive greater benefits in the same way another farmer with sandier soil could be arbitrarily penalized under a carbon credit system.

Nearly all organic farmers also expressed some concerns about carbon markets' lack of perceived fairness, feeling that markets viewed the farm system too narrowly by boiling practices down to one variable. One interviewee reflected:

When you talk to organic people, what drives them bananas is like, what about all the other smart things I'm doing when I build soil health? And I have, you know, all the, all these benefits - you're going to reduce everything I do to this one number - carbon.

Nearly all organic farmers felt specifically boxed out of carbon market programs, and shared the perspective that they were not the markets' target demographic. Organic farmers felt that carbon markets were mostly set up to inspire conversion, and that they would not reward farmers for practices which they had adopted a number of years ago. Farmers who had been farming organically for many years (some, for decades) would likely not see much money or even be eligible for carbon markets, and there were few new practices they could adopt to become eligible. One participant said:

One special thing I worry about for the, you know, for certified organic or not even certified, but folks have been doing it for a while is at some point, if you're just measuring carbon, that soil is going to get full, right? Like you can't put carbon in soil forever.

Overall, both pools of farmers were keenly aware that their ability to sequester carbon, and their consequent ability to make money from carbon markets, was affected by their soil type and geography. They recognized an unfairness in carbon market programs that could hurt farmers who were using the right practices but were simply victims of geography and thus not able to earn as much money.

3.7 Concerns about Greenwashing

A few farmers in both groups raised concerns that companies that carbon credits used on the voluntary market would use them for marketing and mislead consumers about their practices. They worried that carbon credits would be used in greenwashing campaigns by industries seeking to paint themselves as more environmentally sustainable than they are, producing more revenue for these companies without producing substantive change to address greenhouse gas emissions. One farmer participating in carbon markets offered this detailed critique of the problem of greenwashing that carbon credits facilitate:

[T]he general public, I mean, they, they see these companies buying carbon credits, and they think it's great…but I think they also don't fully understand the whole scope of

everything. Because…well take like a Delta Airlines…you buy a flight with Delta, they say we can fly, you know, carbon neutral for an additional $40, you know, and, I mean, I've seen it, there's people getting out their phones, and they're paying those 40 bucks. And they're like, Wow, this is great, you know, I flew carbon neutral. Okay, but you really didn't. Because, you know, Delta Airlines still burned the same amount of fuel, they still put the same amount of emissions out into the air…these big companies...they're using it to their advantage for marketing

Organic farmers were concerned more broadly with the way that companies, particularly food producers, greenwash themselves as “sustainable”, “climate friendly” or “carbon neutral” and avoid accountability for their harmful practices. One interviewee worried that companies would simply use carbon credits and other market-based climate change approaches as a cover to dodge deeper changes to their practices:

We're not going to shop our way out of industrial agriculture being bad for the climate, because these companies are uniquely gifted at greenwashing themselves.

Both groups of farmers raised concerns about the extent to which market-based solutions can truly and transparently drive climate change mitigation efforts. At the same time that they want recognition of their own climate beneficial practices, farmers worry that the flip-side of that recognition in carbon markets is the obscuring of continuing harmful practices in the industries that purchase their carbon credits. Looking at the fuller picture of carbon markets, farmers seemed concerned that their own positive practice changes might be misappropriated, making those practices a less effective climate solution.

3.8 Concerns about Additionality

Overall, concerns about additionality are central to an evaluation of any functioning voluntary offset program. Yet, for the participants in the program, concerns about additionality requirements centered not on concerns that sequestered carbon was non-additional and that such credits would be used to allow sources of emissions to continue. Rather, for both groups of farmers, concerns about additionality centered on the perverse incentive these requirements created to reward those who more recently adopted beneficial practices or, in some cases, to incentivize farmers to switch back to conventional tillage practices in order to enhance their eligibility for payments in the future.

Farmers participating in carbon markets generally had negative views about existing additionality requirements. They saw them as an unfair burden which prevented farmers using beneficial practices from consistently being compensated and which penalized early adopters of these practices. They generally felt that they should be paid for their beneficial practices, regardless of when they started or whether the practice was additional. One farmer said of their beneficial practices:

I'm still doing it. So if you're gonna pay people for doing that, what difference does it make when they started?

A few participating farmers were only able to enroll a portion of their acres in carbon market programs, because fields they had been farming for a long time did not meet additionality requirements. Others were entirely excluded from carbon markets whose additionality protocols would allow them to look back only a few years. Participating farmers voiced concerns that prioritizing recent practice conversion created a perverse incentive against maintaining beneficial practices over the long term, which would be most beneficial from a climate perspective. One participating farmer said of the additionality requirement:

It kind of is a disincentive. To me, I could see people hopping out of some of these good practices for a year or two just so they can get re-enrolled in them in the future.

Another farmer recalled a conversation with a carbon market representative in which they realized farmers could see the most money by pausing their beneficial practices and then starting over again:

But one of our initial conversations we were kind of joking with him was like, okay, so you're telling me, we'd be better off to go back to tilling for two years? And then go back to how we were doing things? He's like well be better if you didn't. Well I know, but like this is the way this works? Like, that's kind of how it's set up.

Farmers participating in carbon markets felt that additionality requirements “punish the early adopters” and prevent them from seeing as much money as farmers who adopt practices later. Being paid less than farmers who had implemented the same practices that they were using later, most farmers felt that additionality requirements set up an unfair penalty for farmers who had been innovative and forward-thinking enough to adopt beneficial practices years before.

Organic farmers were similarly concerned about additionality, especially because they were almost always early adopters who would be ineligible for payments because they had been using beneficial practices for so long. Some expressed the perspective that a carbon market would function more as an incentive to conversion to beneficial practices for conventional farmers, rather than providing a continuation incentive for farmers already using beneficial carbon sequestration practices. Organic farmers felt that farmers should be supported for using beneficial practices regardless of when they began, in order to incentivize long-term use of good soil health practices and climate change mitigation.

4. Discussion

Our results show that both groups of farmers largely shared the same motivations to undertake beneficial activities: the benefits to soil and crop health and the long-term economic sustainability garnered from those benefits. This finding matches the results of previous studies demonstrating that farmers' adoption of environmentally beneficial practices is primarily motivated by the perceived conservation and environmental benefits of doing so (Greiner & Gregg, 2011; Buck and Palumbo-Compton 2022)

Based on generalized assumptions of additionality requirements, however, we expected that farmers participating in carbon markets would also perceive the financial benefits of payments at least as one of their primary motivations for implementing carbon sequestering practices, but this was very clearly not the case; nearly every participating farmer emphasized that they were implementing beneficial practices for their own business interests and perceived co-benefits, not the financial incentive of the generation of carbon credits. While this raises significant issues of additionality within carbon markets discussed below, it highlights the extent to which farmers want to implement environmentally beneficial practices and those that adopt them view them as being part of the best interest to their land and thus to them as long-term stewards of that land.

Our typology of concerns with carbon markets that emerged from coded interview transcripts also demonstrates that both organic farmers and conventional farmers largely share the same concerns. They all are concerned that markets are structured unfairly to benefit large agricultural corporations and/or offset developers rather than farmers, and that markets are largely a wild-west of unpredictable benefits and burdensome paperwork. These results confirm findings from Kragt et al. (2017) that the costs borne from the burdens of implementation can pose real barriers to participation in payments for carbon sequestration programs.

Our results also suggest that providing more information or experience with programs about programs as a way to address identified barriers around familiarity and information (Buck and Palumbo-Compton 2022) may not be enough not alleviate farmer concerns that are fundamentally rooted in issues of trust. Even farmers participating in the markets do not trust them nor view them as beneficial, but rather view them as a means to earn an extra buck for what they are already doing. This confirms the idea identified by Feliciano et al. (2014) that those who are most likely to participate in markets are those who are already doing on-farm activities hat make them eligible, because the uncertainties and costs associated with participation are seen as lower barriers.

Finally, our results present new and important evidence for how the issue of additionality is perceived by farmers participating in voluntary offset markets, with strong implications for broader concerns about the environmental integrity of voluntary soil carbon offset credits.

While additionality is critical from a broader climate perspective to ensure that carbon is truly being sequestered, the farmers' perspectives that additionality restrictions are unnecessary and convoluted imply that there is a fundamental disjuncture between how carbon markets define themselves, primarily as a climate change mitigation tool built on rigorous, permanent and additional offsets, and the work that farmers want offset markets to be doing, that is, providing one more source of monetary support for soil

management practices. This disjuncture may lead markets to function improperly to address climate change as they are forced by farmer (and buyer) demand to adopt less stringent additionality requirements, or to fail to catch on at all. Farmer desires for practice support also point to the unmet need for educational and monetary support for practice changes, which is now being imperfectly fulfilled by carbon markets.

Further, all farmers interviewed viewed payments for soil carbon offsets as insufficient to incentivize new actions by farmers not otherwise inclined to undertake such activities. Based on our research, carbon market payments through existing markets such as Nori and Indigo for soil carbon sequestration are largely reaching farmers who were already implementing these beneficial practices or were already strongly interested in implementing these practices, and that the payments for the offset credits are seen as a 'gravy on top', suggesting that voluntary market carbon offsets face strong challenges of ensuring true additionality essential to effective climate mitigation.

Yet, under the protocols used to approve offset credits, the additionality standard in practice does not assess or require an assessment of farmer motivations for implementing practices. Rather, the additionality requirement is simply that activities are newly additional relative to a pre-established baseline period – this is why some farmers joked that they should stop cover-cropping for a few years so they could re-start and earn more credits. Both Nori and Indigo's additionality protocols fundamentally require only that practice changes be reasonably expected to sequester additional carbon relative to an established baseline of original practices. This is a comparatively lenient additionality standard which stops short of requiring that practices be driven by the support of the credit, requiring simply that soil organic carbon be higher than a previous baseline established under the old practice regime. While this means that farmers' primary motivations do not in and of themselves violate the requirement, the protocol's lenience may prevent market from meeting the spirit of additionality and effectively reducing net carbon emissions.

Haya et al. (2020) and Badgley et. al. (2022) found similar challenges of potential for over-crediting of projects within California's compliance cap and trade program and historically, offset programs have had a large challenge because they frequently credit non-additional sequestration or emissions reductions to are not real, in part because they are calculated against a hard-to-define counterfactual baseline scenario (Haya et. al., 2020). As the voluntary market for agricultural soil carbon offsets expands, it is increasingly important to ensure that market programs for agricultural soil carbon sequestration are effective at sequestering additional carbon and appealing enough to incentivize farmers to adopt soil carbon sequestration practices.

Overall, our results add to the growing evidence that only those farmers otherwise interested in implementing on-farm activities to sequester carbon are likely to do so. Given this, and the broad set of concerns about voluntary carbon offset markets, further evaluation of the utility of such markets as tools to help achieve climate mitigation goals is merited.

Declarations

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Conflict of Interest Statement

The authors have no relevant financial or non-financial interests to disclose.

Author Contributions

CTB and ALS co-designed the study. CTB conducted interviews, and CTB and ALS analyzed the data and co-developed the code book and coded results. CTB wrote the manuscript. ALS edited the manuscript.

Data Availability

The datasets generated during this study include original interview transcripts. To ensure confidentiality, we are not making these data publicly available, but data are available from the corresponding author on reasonable request.

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Figures

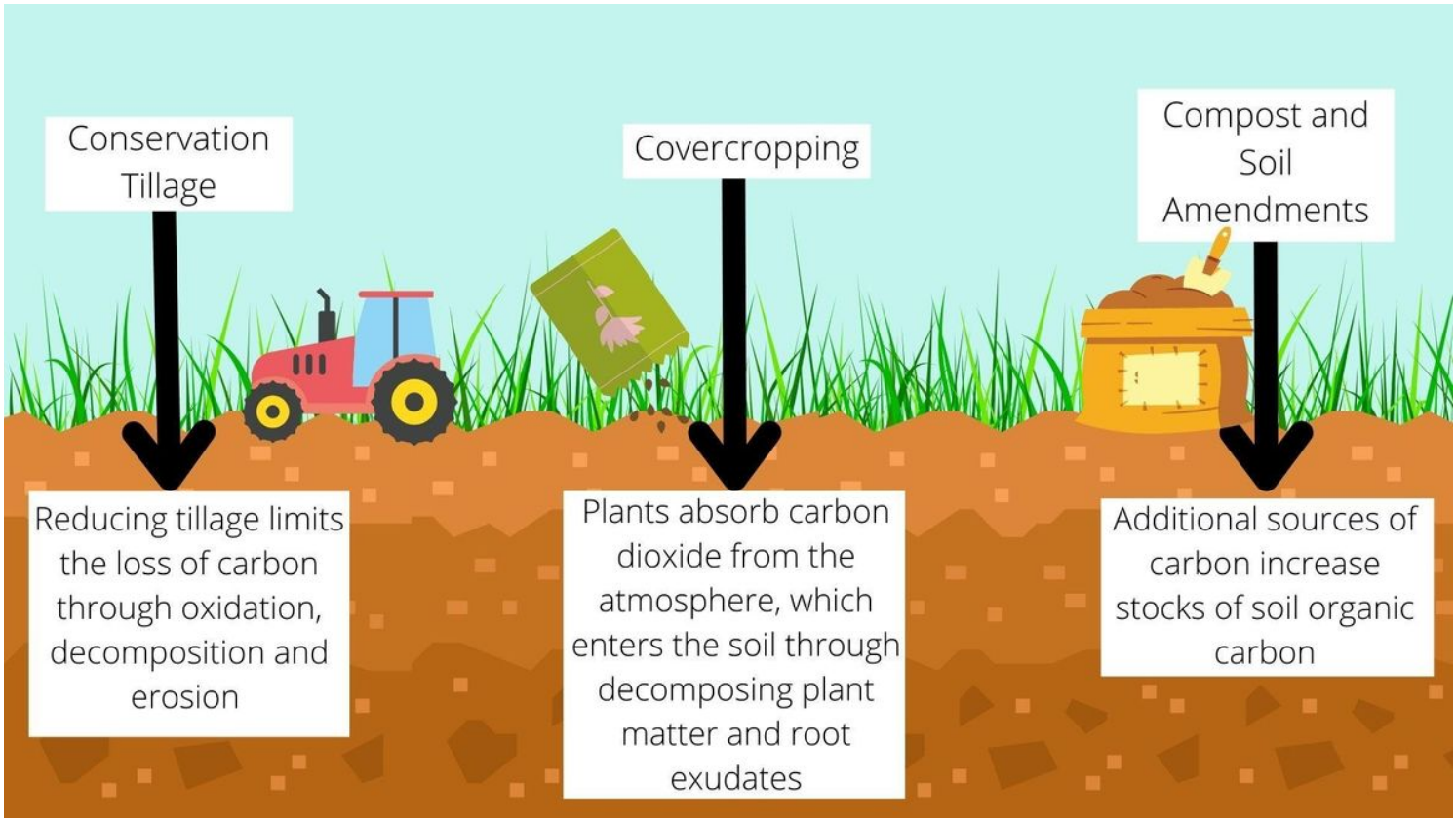

Figure 1

Activities that enhance carbon sequestration in agricultural soils

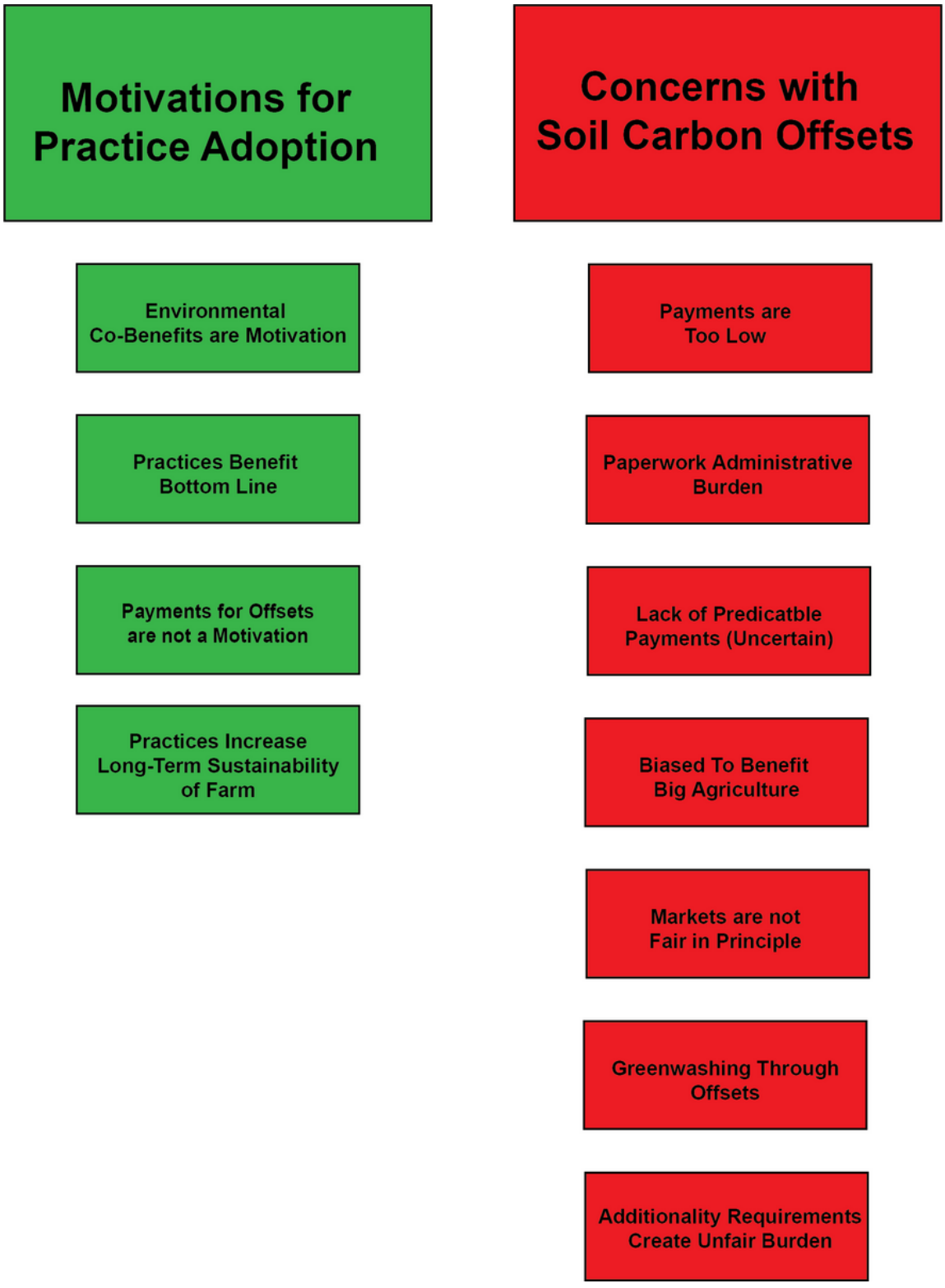

Figure 2

Two-level codebook used to categorize interview transcripts