Stanford | Sustainable Finance Initiative
Precourt Institute for Energy

FEBRUARY 2022

Restoring Carbon Sinks in Agriculture through Carbon Credits

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ABSTRACT

When the world ceases emitting CO_2, the atmospheric concentration of CO_2e will decline very slowly and it will take centuries to return to pre-industrial levels. As such, carbon sinks that absorb carbon dioxide from the atmosphere are critical to limiting global temperature increases to 1.5 degrees. Given that half of habitable land is used for agriculture, turning agricultural lands back into carbon sinks is a critical climate adaptation strategy. Players have leveraged the voluntary carbon credit market as a financing mechanism to monetize and scale this strategy. This paper will describe the state of play in developed and emerging countries and the critical issues that need to be resolved. In the end, it highlights startups, technological innovations, and policies that are needed to scale these initiatives.

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WHY AGRICULTURE AND WHY NOW

The 2021 IPCC report provided stark news. The budget associated with a 50% chance of keeping warming below 1.5 degrees Celsius allows for only 500 billion tonnes more to be emitted. This equates to 15 years of industrial emissions at current rates. To avoid breaking that budget would require the whole world to get net emissions of carbon dioxide down to zero before 2050 - a tremendous feat (IPCC, 2021). Even if the world manages to get to net-zero emissions, it will take a long time for surface air temperatures and the ocean to cool because the excess carbon dioxide equivalent in the atmosphere will remain and continue to exert a warming effect (Zickfeld, K. Z., 2013). Rebuilding carbon sinks such as forests, oceans, and soil that absorb carbon dioxide from the atmosphere is an essential part of the climate solution. According to the Ecological Society of America, although oceans store most of the earth's carbon, soils contain approximately 75% of the carbon pool on land—three times more than the amount stored in living plants and animals.

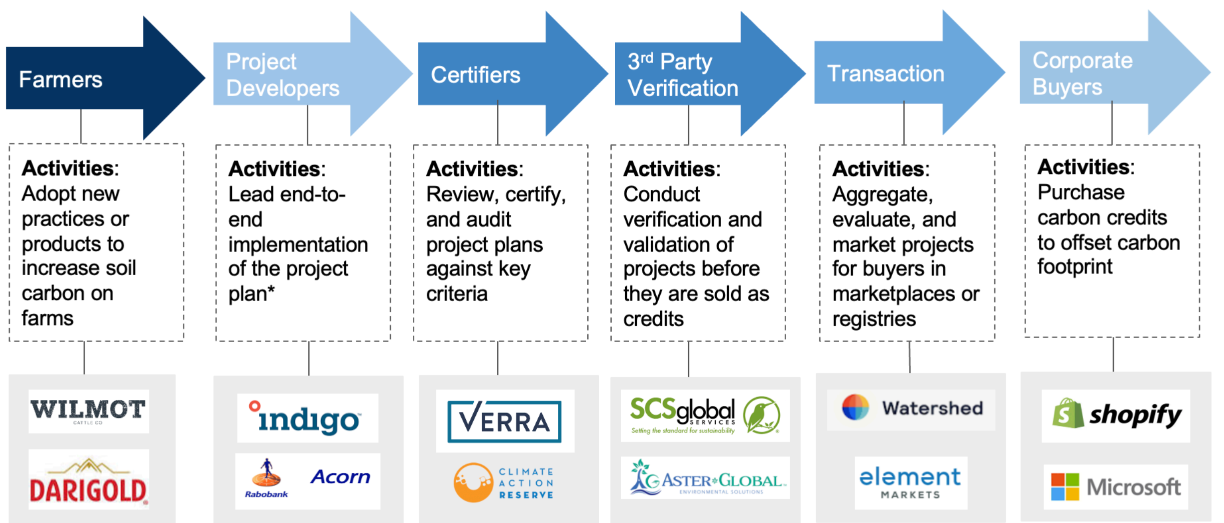
Millions of acres of forest, a critical carbon sink, have been cut down for agriculture to support the development of modern civilization. Soils that store carbon dioxide have been disrupted by agricultural practices that till the ground and release the carbon dioxide that has been stored back into the atmosphere. Agriculture currently occupies at least half of all habitable land on the planet, and more will be required to feed the world's growing population (Ritchie and Roser, 2013). The World Resources Institute estimates that agricultural lands will need to expand by 593 million hectares, an area twice the size of India (World Resources Institute, 2018).

In order to restore depleted soils into carbon sinks, farmers need to reintroduce perennial vegetation into agricultural lands and minimize soil disturbance to protect carbon dioxide from being released from the earth into the atmosphere. This represents a dramatic change from how agriculture is currently done. To support farmers in this transition, players have leveraged carbon credits as a financing mechanism to pay farmers for their efforts. In the voluntary market, agriculture carbon credit projects have grown dramatically in the past year from 300,000 tons transacted to 3.4 million, an 876% increase (Forest Trends 2021).

The end-to-end value chain for these agriculture carbon credit projects is complex and involves many actors to generate and sell carbon credits. To complicate things further, the strategies being implemented in developed and emerging countries are markedly different. This paper will untangle the state of play and challenges in both contexts.

STATE OF PLAY: THE PROCESS OF GENERATING AND BUYING CARBON CREDITS IN DEVELOPED AND EMERGING COUNTRIES

Soil Carbon Market Value Chain



*Project developers like Acorn and Indigo can also handle transaction of credits

Farmers

Farmers are the critical first step in the process because they are the ones who must implement new management practices or products to increase soil carbon on their farms. Many farmers see carbon markets as a way to increase revenue on their farm, especially since agriculture is a low-margin business.According to a recent research study by the USDA, 73% of the 14,450 farms surveyed have an operating margin of less than 10% (USDA, 2020). Smallholder farmers in the emerging world can earn an average of $2.80 per day per farmer (FAO, 2015).

The types of management practices adopted are different between developed and emerging countries. In the developed world, farmers mainly adopt soil carbon management practices to increase soil organic carbon (SOC) in their fields. Examples of soil carbon management practices include no or minimal tillage, reduced chemical inputs, livestock management, diverse crop rotation, cover crops, biochar, and compost (Climatic Change 2018). These soil carbon management practices retain SOC underground by reducing soil disturbance and add more SOC by planting vegetation. Wilmot Cattle Co., a Macdoch Group-owned New South Wales beef operation, has spent the last 10 years doing livestock rotational grazing and planting deep-rooted perennial pastures. They sold $500,000 worth of 40,000 tons of sequestered soil carbon to Microsoft (Nason J, 2021).

In the emerging world, smallholder farmers are implementing agroforestry. They plant trees that bear fruit such as fruits, rubber, nuts, and spices, which can be consumed by the family and sold as extra income. From an environmental perspective, these trees help filter and capture water and promote biodiversity by providing shelter for plants, insects, and animals. Certain nitrogen-fixing trees can also help restore soil fertility (FAO, 2015).

Project Developers

Project developers partner with farmers to lead the execution of the project. They are responsible for recruiting farmers, supporting the adoption of new management practices through tools or consulting advice, and handling legal contracts. The project developers also often pay for the verification and audit expenses. Their incentives are to run the program profitably by reducing their costs and selling the carbon credits generated at a good price. Indigo Agriculture is an example of a project developer. They have supported 267 farmers through implementation, verification, and payment in the first year of the program launch (Schilling M, 2021).

Food and agriculture companies that are seeking to decarbonize their supply chain are also becoming project developers. Cargill made a public commitment to advance regenerative agriculture across 10 million acres of North American farmland by 2030. The initiative focuses on supporting their farmers to implement crop rotations to meet the company's target of reducing greenhouse gas emissions by 30% in global supply chains by 2030 (Cargill, 2019). Bayer has launched their own Carbon Initiative to help farmers adopt regenerative agriculture and purchase carbon credits from them. This initiative rolls up to their overall commitment to reduce GHG emissions by 30% in 2030 (Bayer, 2020). General Mills made a commitment to advance regenerative agriculture on 1 million acres of farmland by 2030 (General Mills, 2021).

In the emerging world, project developers partner with nonprofit organizations and village leaders to gain buy-in from the smallholder farmers, manage the carbon credit project, support documentation requirements for the protocol, and coordinate carbon credit income for the farmers. For example, the Acorn program, a carbon credit initiative from Rabobank, partnered with reNature, a non-profit focused on agroforestry, to help farmers in Brazil adopt agroforestry for carbon credits (Agfunder, 2021). Alongside the nonprofit organization, getting support from the community is essential in getting a project off the ground. Oftentimes, support comes from a central village leader who wields power and influence among the farmers (IFAD, 2014).

Certifiers

Carbon offset certifiers are systems for reporting and tracking carbon credit project information, including credits generated, ownership, sale, and retirement (EDF, 2021). Most have their own registries and can handle transactions of credits for corporate buyers. Carbon credit certifiers also review the plan or "protocol" that project developers are executing against key criteria of realness, completeness, consistency, transparency, accuracy, conservativeness, leakage, additionality, permanence, and ownership (Exhibit A). They only certify projects that meet this criterion. Once the protocol is approved by a registry, other project developers can use it, but they need to get their specific project certified first. These certifiers are non-profit organizations or government bodies that are motivated to uphold their standards when reviewing projects. The most well-known certifiers in this space include Verra, Climate Action Reserve, American Carbon Registry, Plan Vivo, and Gold Standard. Emerging certifiers focused on agriculture include the Regen Network and the soil carbon programs from the Australian and Canadian governments. These certifiers have certified 14 different soil carbon protocols that project developers can follow that cover a range of management practices and geographies (EDF, 2021).

Exhibit A. The Key Criteria for Carbon Credit Projects

1	**Realness**	GHG impacts are conservatively and adequately measured
2	**Additionality**	Project activities would not have occurred without carbon finance
3	**Transparency**	There is sufficient and clear information for 3rd party verification
4	**Leakage**	Risks for secondary affects outside the project area are mitigated
5	**Permanence**	Carbon sequestered in the duration of the project represents a permanent storage of carbon
6	**Completeness**	All relevant information is considered
7	**Ownership**	Carbon offsets are unambiguously owned by one person
8	**Accuracy**	Uncertainty is reduced as much as possible
9	**Conservativeness**	The project uses conservative assumptions and values

3rd Party Verification

Third-Party Verifiers focus on validating and verifying a project. On the validation side, they ensure that a proposed project meets a program's eligibility criteria. For verification, they assess projects against the registry rules and the requirements of the applied protocol. Every registry has its own set of requirements for certification and accreditation by an external organization (Verra, 2022). A typical verification process for a carbon credit project can take 3-6 months and includes a site visit and an audit of project documentation. SCS Global is an example of a verification body with expertise in many carbon credit protocols across certifiers, including agriculture. These organizations are private companies that are motivated to scale their verification processes profitably.

Transactions: Marketplaces, Brokers, and Project Developers

Carbon credit marketplaces help buyers discover carbon credit projects and transact carbon credits. These marketplaces conduct their diligence on the carbon credit projects and help buyers identify the carbon credits that fit with their strategy. These marketplaces are private corporations that are incentivized to transact as many carbon credits as possible. Carbon TradeXchange is an example of a marketplace where buyers can purchase carbon offsets and pay Carbon TradeXchange a percentage for every transaction.

Brokers also exist in the market and are embedded in a larger product strategy around carbon accounting and footprint tracking. For instance, Watershed sells climate footprint tracking software and offers clients carbon credits to offset their footprint. Element Market offers a wide range of sustainability consulting services that include helping clients purchase carbon offsets. Players like Patch are automating the process by transacting carbon offsets in the backend on behalf of clients through an API.

Project developers are not only implementing the projects but also selling carbon offsets directly to buyers. For example, Indigo Agriculture sells carbon offsets directly to companies like Barclays, North Face, and BCG. Acorn does the same and sells directly through their own registry to Standard Chartered and Microsoft. Nori, a project developer, developed its cryptocurrency to mint “NRTs” that represent one ton of removed CO_2e stored for a minimum of ten years. The company allows buyers to purchase these NRTs directly from its site in small volumes or automatically through an integration at the consumer point of sale.

Corporate Buyers

Lastly, corporate buyers are seeking carbon credits to offset their carbon footprint and meet their carbon neutrality goals. In the voluntary market, they develop their own standards of quality and rely on certifiers, marketplaces, and consultancy agencies to identify the carbon offsets that match their standards. Shopify identified 10 high potential industries across engineered and nature-based solution areas and set the permanence threshold at a hundred years or more (Shopify, 2021). These corporations are motivated to purchase credits to reduce their carbon footprint and also to minimize the risk of negative PR blowback from controversial carbon credits like what happened with The Nature Conservancy (Bloomberg, 2020).

Underneath this surge of activity is a myriad of challenges to marrying the dynamic nature of farming with the quality standards around carbon credits. When a company purchases 1 ton of carbon offsets, there is an expectation that an equivalent amount will be removed from the atmosphere. Anything less would result in a net increase of CO_2 in the atmosphere, raising the risk of doing more harm than good. With this lens, the following challenges summarized below must be addressed and resolved to enable agriculture carbon credits to drive the climate impact that the world needs.

THE CHALLENGES WITH SOIL CARBON CREDITS IN DEVELOPED COUNTRIES

Additionality Challenge: The Common Practice Approach

Many protocols evoke the “common practice” method to determine additionality, but the current definition conflicts with the realities on the ground. The common practice approach to additionality defines activities below an adoption threshold as additional, and those above it as non-additional. It is reasoned that if a management practice is widely adopted in a county, then this means that new farmers who adopt that practice in that county would have likely adopted it without requiring carbon credit financing. Some protocols use a high threshold (50% adoption), which is evaluated on a county level, while other protocols use a low threshold (5-20%). While this rule is easy to monitor, the static nature of the threshold ignores the fact that adoption rates for different regenerative agriculture practices can fluctuate up and down over time. The USDA Agricultural Resources Management Survey monitored fall cover crop adoption by commodity crop and found that cover crop adoption ranged from just over 5% for corn-to-grain to 25% for corn-for-silage (USDA, 2021). As such, the adoption rate for a specific management practice could look high in one year and low in the next due to how farmers in a region plan their crop rotations. Moreover, picking the right threshold hurdle can be widely debated. Experts have argued that a 5% adoption threshold is too low since farmers are risk-averse and will only adopt practices if a majority of farmers have had success with them (Verra, 2020). However, a 50% adoption rate risks crediting existing practices that are already quite common but nevertheless satisfy the protocol’s threshold (CarbonPlan, 2021). The adoption threshold can also conflate the frequency of adoption with the scale of adoption. It ignores the possibility that farmers who have already adopted a sequestering practice on a small scale want to increase their scale of adoption. For example, suppose that 30% of farmers have adopted a sequestering practice (exceeding a threshold for additionality) but each has adopted it on only 5% of their land. Suppose that if they were eligible to participate in the sequestration program, they would have scaled the practice to 50% of their land. The extra 45% adoption would be consistent with the spirit of additionality but would be ineligible with the common practice approach (Climate Policy, 2015).

Verification Challenge: Below Ground Measurements

<u>Scientific Disagreements around Soil Organic Carbon Storage</u>

Soil scientists disagree about how much and how long carbon can be stored in soils (Quanta, 2021; Frontiers in Environmental Science, 2021; National Academy of Sciences, 2018).Several recent studies contradict the assumption in the IPCC models that the carbon sequestered in soils will stay there for hundreds or thousands of years due to future global temperature increases (Nature, 2020). Moreover, the carbon impacts of different management practices also vary considerably between expert opinions by a factor of two (Climatic Change, 2018). This uncertainty is driven by the heterogeneity of cropland and rangeland soils. One expert was quoted saying, "I do not find it very useful to think about a typical soil or farm; when I talk about soil carbon sequestration to farmers, I always tell them that these average published rates may very well be meaningless for their particular farm because of the local climate or particular soil conditions (Climatic Change, 2018). No-till, in particular, is widely debated as some scientists have found that it helps bury existing soil organic carbon vertically rather than increase the net overall soil organic carbon (Nature, 2020). Additionally, notes Hanna Poffenbarger, a soil scientist at the University of Kentucky, "No soil is a bottomless carbon sink. Even topsoil, where potential carbon gains are best documented, re-equilibrates to a stable carbon concentration after a few decades of no-till farming or cover cropping" (Greenbiz, 2020). As a result, any averages or assumptions used in models can conceal a wide range of variance on soil type, management practice deployed, and subsequent amount of soil organic carbon stored.

<u>Expensive Direct Soil Sampling Process</u>

Thus, it is only with robust and frequent direct soil sampling that the change in soil carbon can be calculated and measured site by site. Alarmingly, 9 out of the 14 soil carbon protocols do not require direct soil sampling (CarbonPlan, 2020). This is partly due to how expensive direct soil sampling can be. Traditional lab-based dry combustion methods combined with bulk density tests are the gold standard for SOC quantification, but direct sampling and laboratory analysis are costly and time-intensive. The costs include transportation to the site, expert labor to pull samples, shipment to the lab, soil sample processing, and laboratory testing (Climate Action Reserve, 2019). Even this gold standard method is plagued with uncertainty. It is difficult to know how to extrapolate results from a single sample to the overall field or understand how many samples to take since, in seemingly 'uniform' fields, SOC content may vary by as much as 5-fold or more (Carbon Management, 2019).

Permanence Challenge: Managing Reversal Risks

Only one soil carbon protocol, CAR Soil, requires a permanence period of 100 years while other protocols adopt permanence periods between 8 and 40 years. To bolster this permanence time horizon claim, the majority of protocols have adopted buffer pools that have been used in forestry carbon credit projects, which typically involve setting aside a number of credits in a registry-managed buffer pool that can be drawn down to account for "reversals" (or carbon loss) over time (CarbonPlan, 2020). The intention behind the buffer pool in forestry is to protect against unforeseen natural disturbance risks—such as fire or drought affecting forests and soils (Carbon Offset Guide, 2020). However, in agriculture, there is a reversal risk every year when a farmer reevaluates the management practices and products to deploy against new weather or market conditions. A case study from the USDA elucidates this point; in 2021, the USDA conducted a study on the Environmental Quality Incentives Program (EQIP) where they provided grant money to farmers to increase the adoption of cover crops. To examine the efficacy of the program, they calculated the correlation between the county-level change in adoption between 2012 and 2017 and the total planned acres of cover crop in EQIP for 2013 to 2017 by county. If financial assistance were the only driver of changes in cover crop adoption, then there should be a 1-to-1 correlation between the share of acreage enrolled in EQIP cover crop practices and the change in the cover crop rate of adoption. However, there ended up being a 1-percentage-point enrollment of county-harvested cropland in EQIP is associated with a 0.5 percentage-point increase in cover crop adoption. As such, there was a lot of variation in cover crop adoption rates not explained by EQIP funding. The study cited the influence of external factors such as the weather, shifts in cash crop acreage, and cover crop seed availability (USDA, 2021). Even more meaningfully, that this correlation is less than 1-to-1 insinuates that not all farmers will continue the use of cover crops after the EQIP expires, and that some farmers receiving financial assistance would have adopted the cover crops without the payments. The time horizon expectations of these soil carbon protocols are incompatible with the realities of a dynamic farming system that will need to adapt to a changing environment.

THE EVOLUTION OF AGROFORESTRY IN THE EMERGING WORLD AND OPEN CHALLENGES

In the emerging world, these challenges are more acute in the context of smallholder farming. About 2/3rds of the emerging world's rural population work on farmland plots smaller than 2 hectares. Many are poor, food insecure, and live in remote areas, making coordination extremely difficult for project developers (FAO, 2015). Local soil sampling labs are nonexistent, and collecting data on adoption rates of different management practices for the common practice approach is costly.

As a result, many players have opted into avoiding the soil organic carbon protocols completely and getting smallholder farmers to implement agroforestry due to its relative simplicity and cost-effectiveness. Farmers are paid for the carbon stored in the trees they plant, rather than changing their core management practices. Instead of needing to take soil samples from the ground, they can take measurements of the trees planted. The ability to monitor the trees cost-effectively through remote sensing makes this especially appealing. Remote sensing has matured enough to easily detect the number of trees planted across different periods which can help verify permanence. Rabobank's Acorn project is an example of a project developer leveraging this technology to handle verification at scale with its 10,000+ smallholder farmers.

Financing agroforestry projects through the carbon credit market is still nascent due to challenges around cost, land title ownership, and equity.

High Costs

In the emerging world, costs around data collection and certification make it difficult for a project developer to be profitable.

While remote sensing can detect the number of trees planted, there are no off-the-shelf tools that can automate the data collection required to calculate the total carbon stored in trees such as tree species, trunk width, and other attributes. Project developers still need to collect that data manually.

The certification process to get a project approved by a registry can be expensive. For the Gold Standard certifier, the cost of getting one project off the ground for a new program is $27,500. Annual validation and verification costs per project are $7,500 (The Gold Standard, 2021). This can make it prohibitively expensive for a project developer to get started and requires the program to scale to thousands of farmers before it's profitable.

Uniqueness and Permanence Challenges: Lack of Land Ownership Documentation

The lack of documentation around land ownership makes it hard to ensure the uniqueness and permanence of carbon credits. Currently, only around 30% of the world's population has a legally registered title to their land

(World Bank, 2017). Exchanges of land can happen informally over a handshake, making it impossible to formally track reversals of land tenure changes (Environment and Urbanization, 2020). Ensuring the uniqueness of a carbon credit can be challenging without a central repository of land rights since a project could be double-counted on the same piece of land.

Equity Challenge: Inequitable Distribution of Capital

The reliance on an NGO or village leader helps project developers reach smallholder farmers, but there have been instances where this intermediary pockets the money instead of distributing equally to smallholder farmers. An analogous situation to carbon markets is food aid which has historically been a challenge in the emerging world because of bad actors who intercept aid before it reaches its intended beneficiaries (BBC News, 2021). Additionally, other intermediaries like traders and brokers, who are adding minimal value, are often taking large percentages of revenues as well that aren't getting back to the farmers.

THE WAY FORWARD

Conservatively Standardize Additionality and Common Practice

1. Improve and Standardize Barrier Analysis and Tests for Agriculture

Some protocols, like Verra Fire + Grazing and Verra Improved Ag, attempt to account for nuance for additionality by allowing farmers to submit documentation related to barriers to implementation (Verified Carbon Standard, 2012; Verra, 2020). While this is a step in the right direction, the barrier tests and analyses are neither stringent nor robust. In the Verra Improved Ag protocol, a farmer can cite barriers with one's identity as a farmer or a self-perceived inability to adopt practices. The Verra Fire + Grazing protocols offer vague barriers such as "unfavorable course of ecological succession" and "social conflict among interest groups." While the Verra Fire + Grazing protocol does not allow anecdotal evidence, it does allow the project developer to offer documentation on behalf of a farmer and provide documentation from previous projects. The vagueness in these barrier analyses and tests opens up the possibility of loopholes. These barrier tests need to be reevaluated for strictness and robustness as well as mandated across the soil carbon protocols since a few do not even have any tests associated with additionality.

2. Set conservative baselines

There is no clear agreement around how baselines should be calculated and set. As a result, project developers can misuse baselines, resulting in inflated carbon credit values. Baselines need to be set conservatively with limited backdating so project developers can not claim carbon financing for a beneficial management practice before the carbon credit project starts (CarbonPlan, 2020).

Address Verification Challenges

1. Establish Interdisciplinary Soil Science, Policy, and Technology Forums

The difference in the claims of soil carbon storage among soil scientists, policymakers, and certifiers can be addressed through greater dialogue among these stakeholders. In 2016, the White House Office of Science and Technology released a federal framework for soil science, developed in collaboration with more than a dozen federal agencies with input from approximately 80 stakeholders from academia, industry, non-profit organizations, and the agricultural community. The subsequent National Call to Action acknowledged the gaps in soil data available and the need for high-quality data to underpin solutions (White House, 2016). More recently, the National Academy hosted a similar interdisciplinary stakeholder discussion on soils (The National Academies of Sciences, Engineering, and Medicine, 2021). Interdisciplinary forums should be frequent and focus on identifying solutions for the critical issues of permanence, additionality, and verification.

2. Scale Cost Effective Soil Sampling Technologies

New innovations in remote sensing and spectral imaging promise to lower the cost of measuring soil organic carbon in soils. Early research has shown the potential for satellites to detect the attributes of soil like clay content and the relationship between vegetation and soil organic carbon (Remote Sensing of Environment, 2018; Geocarto International, 2019). Spectral imaging that measures how soils interact with light radiation of various wavelengths can yield information on soil organic carbon as well as other chemical or physical properties of soil. Since spectral imaging measures light through sensors, a higher throughput of samples is possible compared to dry combustion methods. The most ambitious applications include handheld field scanners or sensors attached to tractors. Both remote sensing and spectral imaging still require direct soil samples to calibrate them accurately, posing high implementation costs and challenges in scaling the technology across regions that have different soil types (Geocarto International, 2019).

3. Develop an Open Soil and Forestry Data Repository

Having greater availability of soil data can help jumpstart the emerging soil sampling technologies above. Unfortunately, soil data samples are currently stored in silos across research institutions and private actors. The ISRIC and various other grassroots soil databases are a good start, but having more granular readings across soil types can enable accurate models (ISRIC, 2021). Kaggle, a giant repository for AI model training, is a good example of what is needed in this space. To support the agroforestry movement, the existing forestry government databases need to be supplemented with data on agricultural lands with trees. Using existing forestry datasets for agroforestry is difficult because it's hard to draw conclusions from two very different landscapes.

Improve Permanence

1. Ground Reversal Risks with Soil Science

The soil carbon protocols mainly attribute reversals to avoidable actions like land-use change or unavoidable events like natural climate disasters. There is a glaring disconnect between reversal risks and research findings from the soil science community that undermines the assumption that soil carbon storage is permanent and stable. Permanence can be strengthened if the reversal risks in the protocols also include risks discovered in soil science research. For one, many studies show the potential for increases in soil carbon to stabilize over time, limiting the amount of soil organic carbon that can be stored in soils. Direct soil sampling frequency could increase near the end of a project's lifespan to detect this. Secondly, the finding that the no-till management practice stores organic carbon deeper vertically instead of contributing to greater net soil carbon storage can be addressed by requiring deeper soil sampling tests for no-till (CarbonPlan, 2021). Finally, given that some protocols have a time period as short as 8 years, there needs to be follow-on soil testing to ensure there isn't a reversal of carbon stocks in the future, especially as global temperatures rise and release organic carbon from soils.

2. Increase Buffer Pool %'s to Account for Risks

The complexity of measuring soil organic carbon storage makes soil carbon protocols inherently riskier than forestry protocols. However, the highest buffer pool contribution observed in the soil organic protocols is 20% from

Gold Standard—the same non-adjusted risk percentage contribution as all other Gold Standard carbon market protocols. All other methods, despite more complex approaches such as weighting projects against dimensions, typically result in a 10-15% buffer contribution (CarbonPlan, 2021). The higher risk of natural reversals of soil organic carbon needs to be factored into the buffer pool.

3. Provide a Payment Structure that Incentivizes Farmers to Commit to the Long Term

The soil organic carbon market programs differ in terms of when farmers are paid for implementing new management practices.Some pay upfront, others wait until the carbon is sequestered before payment, and a few programs structure the payments over time. Structuring the payments over time with the greatest payout happening near the end seems to be the best method for getting the farmer to commit to the program over the long term. In this way, the farmer is motivated to commit to the program in its entirety. Alongside this long-term payment structure, project developers have partnered with nonprofit organizations to secure grants for the upfront cost of transitioning management practices. With this approach, the financial risks and barriers are greatly reduced in the short and long term.

4. Bundle Climate Impacts to Ensure Permanence

If a company pollutes 1 ton of carbon emissions, that ton can stay in the atmosphere for a hundred or thousand years. It is critical to ensure that the carbon credit traded against that also removes an equivalent amount of carbon emissions from the atmosphere. As outlined above, it is challenging for soil organic carbon solutions to meet that threshold due to many natural and unforeseen reversals to the carbon stock. NCX overcame a similar issue with forestry carbon avoidance projects by offering buyers a 1-year payment on many delivery contracts bundled for an equivalent climate impact to one ton stored over 100 years. Underlying this calculation is the assumption that multiple tons of short-term carbon storage in ecosystems can be considered equal in value to one ton of carbon sequestered permanently. Their equivalency calculation suggests that 30.1 tons (30.8 tons if integrated out to infinity) of carbon sequestered from the atmosphere for one year beginning today have the same economic value as one ton withheld from the atmosphere for 100 years (Research Square, 2021). Further research on what an equivalency calculation could look like for soil organic carbon storage can help address concerns regarding permanence.

Incentivize High-Quality Credits

1. Mandate that Buyers Disclose their Carbon Accounting of Carbon Credit Purchases

While some private actors like Piva Capital, Stripe, Microsoft, and Shopify have shared publicly their criteria for purchased carbon credits, many actors only share the high-level contribution of carbon credits for their carbon offset strategy (Piva Capital, 2021; Stripe, 2022; Microsoft, 2022; Shopify, 2021). Delta Airlines discloses the breakdown on carbon credit type and total volume purchased, but does not share if these credits are associated with a reputable registry, the permanence time horizon of the credits, and the quality of the carbon credits (Delta, 2020). This lack of transparency can enable companies to purchase cheaper, low-quality carbon credits to meet their carbon neutrality goals. In the case of Delta Airlines, this seems to be the case; less than 1% of their carbon offset portfolio is focused on carbon removals while 71% is composed of carbon avoidance projects. The current TCFD framework that is getting traction around climate risk disclosure should be expanded to include guidance on corporate disclosure of the quality of carbon offsets purchased and how these offsets are calculated into the company's climate neutrality mandate. This mandatory disclosure can incentivize more companies to purchase higher quality carbon credits and build more confidence in the voluntary carbon credit markets.

Mandate the Uniqueness of Credits

1. Improve Land Rights and Tenure Documentation in the Emerging World

Land rights are at the heart of many developmental challenges, as the majority of people in the emerging world do not own land or have rights to their land. Addressing this issue can not only improve resilience, food security, and poverty, but also contribute to the development of carbon markets (World Bank, 2014). Having a central repository of land rights can help ensure that carbon credit projects are not double-counted. Additionally, it can help bolster permanence; research has shown that secure land tenure provides incentives for farmers to invest in their land and make improvements for the long term. Without land rights, carbon market projects in the emerging world are subject to reversals during land grabs or if the land is informally given to someone else who no longer wants to implement the carbon credit project.

Address Equity Challenges

1. Use Direct SMS Payments to Farmers

Mobile payments and transparency can help ensure that smallholder farmers get the payments they should receive once the credit is sold. 2G services (suitable for voice and short message services (SMSs)) now cover around 84% of croplands globally, enabling SMS payments (Nature, 2021). From a program level, Acorn ensures that all the farmers have access to how much income was earned through the program and allows the farmers to contact them directly instead of going through the local partner. Because remote sensing enables per-plot measurements, Acorn knows exactly how much carbon one farmer has sequestered. This means that exact payments can be made. These best practices can help ensure that income is distributed equitably among the farmers.

Consider Alternative Financing Mechanisms

1. Purchase future offsets, do not count them toward carbon neutrality goals

Some corporate buyers are helping early-stage carbon removal companies scale up by purchasing future carbon offsets from them that do not count toward the company's carbon footprint. The underlying theory of change is to help carbon removal technologies get down the cost curve and up the volume curve so the world will have the portfolio of carbon removal technologies it needs in the future. For example, novel agriculture carbon removal solutions such as growing seaweed and burying it in the ocean are getting off the ground without the need to go through the expensive protocol development process (Stripe, 2021). Given the current verification challenges and reversal risks associated with soil carbon agriculture projects, this alternative financing mechanism can help jumpstart these projects without risking a new increase in CO2 in the atmosphere.

CONCLUDING REMARKS

Restoring carbon sinks is critical to absorbing carbon dioxide and keeping the planetary carbon cycle in balance. In the pursuit of human civilization, forestry and soils have been damaged to feed a growing population. The world cannot forget about repairing and restoring these carbon sinks in tandem with decarbonizing industries to net-zero emissions.

Farmers can adopt new practices to restore the carbon sink in their fields, but this will require financial support. Carbon credit markets could be the financing vehicle to scale these efforts given the demand from corporations who want to meet their net-zero carbon neutrality mandates. However, challenges around permanence, verification, additionality, certification costs, equity, and uniqueness make these carbon credits inherently risky today. Corporate buyers need to be aware of these issues and conduct their diligence before buying agriculture carbon credits.

The growth of the agriculture carbon credit market has sparked the attention of soil scientists, technologists, investors, and policymakers. The market can mature quickly with the right funding and talent working on these issues. With the right data and technology in place, the carbon credit market can be a powerful tool to restore agricultural lands around the world and combat climate change.

ABOUT THE AUTHOR

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