Private Carbon Credit Initiatives in the Agricultural Sector: Investigating Motivations and Understanding Their Effects

by

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A thesis

presented to the University Of Waterloo

in fulfilment of the

thesis requirement for the degree of

Master of Environmental Sciences

in

Social and Ecological Sustainability

Waterloo, Ontario, Canada, 2023

Author's Declaration

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

Abstract

This thesis project examines the emergence of privately led soil carbon sequestration (SCS) credit programs, specifically for traditional cropping systems, in the agriculture sector in North America. Carbon credits have received renewed attention and legitimacy as a policy response to climate change in the wake of corporate net-zero and sustainability goals, as well as the Paris Climate Agreement's establishment of a new carbon trading system. The climate-food nexus has become the focus of many international organizations and climate change mitigation initiatives. One proposed mitigation solution is the creation of carbon credit programs in the agricultural sector, particularly for the implementation of new cropping practices for soil carbon sequestration. While some of these carbon credit programs are government-run, most agricultural carbon credit programs are run by private agri-business firms in voluntary carbon markets. Employing a critical political economic theoretical framework, this study examines some of the motivating factors for agribusinesses to engage with private SCS credit initiatives, as well as the consequences that these initiatives have for agricultural practices, the economics of agriculture, and farmers in North America.

Utilizing scholarly literature, document analysis, and interviews, this study demonstrates that agribusinesses have three main motivations for engaging with SCS credit initiatives: pre-emptive action and reactive responses to changing regulations; bolstering corporate reputations; and avenues for new profit through SCS initiatives, especially the use of farmer data collected through new digital monitoring technologies. These motivations demonstrate the desire of agribusinesses to shape responses to climate change in their favour, sustaining "business as usual" business practices, thereby maintaining and expanding opportunities for profit.

The thesis also shows that private SCS credit initiatives encourage a lock-in of agriculture into industrial farming methods while precluding discussion on substantive change in the agriculture sector. SCS credit initiatives also continue the trend of the economization process that have been prevalent under neoliberal capitalism. By taking a market-based instrument approach to climate change, agribusinesses create new spaces for profit and control of agriculture supply chains. These initiatives also pose justice issues, with farmers likely bearing the cost of pursuing these private carbon credit programs. Lock-in of ecologically harmful farming practices, economization, and subsequent justice issues generated through private SCS credit initiatives create adverse effects for both farmers and the environment.

Acknowledgments

Land Acknowledgment

I wrote this thesis on the traditional and present land of the Anishinabewaki, Haudenosaunee, Attiwonderonk, and the Mississaugas. This land that I live on currently is part of the Haldimand Treaty of 1784. The following land acknowledgment comes from Protect the Tract:

> "The land where we have gathered today is within the Haldimand Tract. Affirmed in 1784, the Haldimand Proclamation reserves six miles on either side of the Grand River for the use and enjoyment of the Six Nations and their descendants forever.
>
> The Haldimand Tract represents a small portion of Haudenosaunee territory, which is further affirmed through the Nanfan Treaty.
>
> The Haudenosaunee Confederacy Chiefs Council, the inherent governance structure of the Six Nations, has put in place a moratorium on development within the Haldimand Tract. No development can proceed without the consent of the Haudenosaunee.
>
> The Haudenosaunee have stated that restoring their relationship to the land through exercising stewardship over lands and waters is the greatest priority to healing families from the colonial violence and dispossession they have endured. We join the Haudenosaunee in calling for an end to the exploitation of their territory without their consent and ask that those gathered here today join the Haudenosaunee in their quest for justice, bringing to life the legal principles embedded in the Two Row Wampum, Dish with One Spoon and Covenant Chain.
>
> We commit to working together to respect Haudenosaunee sovereignty that visions a future where Haudenosaunee children, plants, animals, waters, and lands that are safe, healthy, and free from colonial violence."

On April 20, 2021, the Haudenosaunee Confederacy Chiefs Council announced a moratorium on development along the Haldimand Tract. This moratorium has not been respected. Land defenders who have laboured rightfully to uphold this moratorium have been subjected to undue and discriminatory state violence in their resistance. As the University of Waterloo is situated on the Haldimand Tract, I am implicated in this violence and have a duty to resist as well in solidarity.

There will be no sustainable agriculture without reconciliation and that cannot happen unless Indigenous peoples are able to govern their lands again. In other words, land back.

Personal Acknowledgments

This thesis project could not have been completed without the wisdom, knowledge, guidance, and encouragement of Dr. Jennifer Clapp. Jennifer, every conversation that I had with you regarding my thesis got me excited to do research. I sometimes forgot the importance of my research, or got lost in larger questions during my work, but you were always able to rekindle the fire that I had for my research while keeping me grounded in answerable questions. I have been very fortunate to have the opportunity to do research work with Jennifer and assist as a teaching assistant. The passion that Jennifer has for food, agriculture, and political economy is inspiring and she has served as a great role model for my work and my hopes as a future academic. Jennifer also graciously provided me with funding that sustained me through my degree.

I was equally supported by Dr. Michael Drescher during my MES. Michael hired me on as a research assistant in my second semester of my masters. It has been a pleasure to work on research with him. Michael, thank you for all of the teaching opportunities you have provided me, in doing research, data analysis, and writing. I am very privileged to have had the opportunity to have published research with you. The funding provided through this research work was also crucial for the completion of, and for that I am deeply appreciative Thank you also for welcoming me into the NRCPM lab group, even though I am not a planner. It has been a joy to work with you.

I must also thank Dr. Andrea Collins who has served as my committee on this project and who I also had the pleasure of TAing for in my first term at the University of Waterloo. Thank you very much for your feedback and comments on my thesis, it was truly invaluable.

I would also like to thank the professors who taught my courses during my MES degree: Dr. Bob Gibson, Dr. Derek Armitage, Dr. Brad Fedy, Dr. Eric Helleiner, as well as Dr. Heather Whiteside who allowed me to audit her course.

Beyond the amazing academics who I had the pleasure of working with, my MES degree would not be complete without the support and camaraderie of my classmates. I especially thank Arsenii, Kevin, Liya, and Thy who made my classes fun, for teasing me, for inviting me out for beers, for putting up with my antics, and for sending me memes during those trying times.

I would also like to thank my Mom, Dad, Grandma, and my sister. My family is very important to me, and each of them have provided me with encouragement, love, kindness, patience, paper edits, good advice, and reminders to “not work too hard.”

My friends were another important aspect of my support network, particularly AP, JD, DZ, KL, JF, JT, CD, and ZG. You are all so important to me and I am very lucky to have you all in my corner.

For everyone who was thanked here, I hope to continue to work with you to ensure a liveable and healthy earth for our future generations, for everyone to enjoy.

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List of Acronyms and Abbreviations

ACR	American Carbon Registry
BMP	Best management practice
CAR	Climate Action Reserve
CBAM	Carbon border adjustment mechanism
CCP	Conservation Cropping Protocol
CCX	Chicago Climate Exchange
CDM	Clean Development Mechanism
CO_2	Carbon dioxide
COP	Conference of Parties
CSA	Climate smart agriculture
CSCP	Climate Smart Commodities Partnership
CSR	Corporate social responsibility
ESG	Environmental, social, and governance
ESMC	Ecosystem Services Market Consortium
ET	Emissions Trading
ETS	Emissions Trading System
EU	European Union
FAO	Food and Agriculture Organization
FSB	Financial Stability Board
G20	Group of Twenty
GHG	Greenhouse gas
GPS	Global Positioning System
IFRS	International Financial Reporting Standards
IOSCO	International Organization of Securities Commissions
ISB	International Sustainability Standards
ITMO	Internationally Transferred Mitigation Outcome
JI	Joint Implementation
MBI	Market-based instrument
MNC	Multinational corporation
MRV	Monitoring, reporting, verification
NGO	Non-governmental organization
US SEC	United States Securities and Exchange Commission
SCS	Soil carbon sequestration
SO_4	Sulfate
SOC	Soil organic carbon
SOM	Soil organic matter
TCFD	Task Force on Climate-Related Financial Disclosures
tCO_2e	Tonne of CO_2 equivalent

TIC	Techno-industrial complex
UNFCCC	United Nations Framework Conventions on Climate Change
US SEC	United States Securities and Exchange Commission
USD	United States Dollar
USDA	United States Department of Agriculture
VCM	Voluntary carbon market
VRT	Variable rate technology

Chapter 1: Introduction

Many initiatives to combat climate change have focused on reducing emissions generated by agricultural practices, including the implementation of carbon credit initiatives operating in voluntary carbon markets (Oldfield et al. 2021). Greenhouse gas (GHG) emissions from on-farm agricultural activity account for roughly 16-27% of all anthropogenic GHG emissions, contributing greatly to climate change and land desertification (Shukla et al. 2019, 13). In response, agribusiness corporations have developed initiatives employing climate smart agriculture (CSA) practices which utilize farm data and digital tools to reduce emissions and provide higher crop yields (Lipper et al. 2014). Within this frame, many agribusiness firms have developed private agricultural carbon credit schemes, which pay farmers to sequester carbon in soils via the implementation of new farming practices.

Private carbon credit initiatives overwhelmingly require farmers to implement novel farming practices on their farms, particularly the implementation of reduced- or no-till practices and cover crops. Changes to farming practices and the validation of carbon sequestration in agriculture soils are dictated by monitoring, reporting, and verification principles that are created and administered by agribusiness firms. Beyond the creation of frameworks to generate soil carbon credits, these initiatives also involve the development of low-carbon agriculture commodity markets, verified through these carbon credit initiatives. Important to these initiatives too, is the implementation of digital farming practices, including the implementation of sensing equipment on the field-level, aerial and satellite imaging, and the collection of data to feed prediction systems about farm operations (Balafoutis et al. 2017; Pham & Stack 2018).

The overarching objective of this thesis is to provide an initial evaluation of emerging private carbon credit initiatives. To meet this objective, the thesis is focused on the following research questions: (1) Why are private sector carbon credit schemes appearing in the agricultural sector at this time? (2) How are private corporations utilizing the power at their disposal to shape these initiatives? And (3) What are the implications of these schemes for farmers? The answers to these questions will provide a fuller understanding of this development in the agricultural sector and its viability as a response to climate change in the sector. Similarly, it will provide better insight to corporate responses to climate change and pressure to change practices due to climate change in the agriculture sector.

1.2: Conceptual approach

This thesis project utilizes theory from critical political economy and geography, particularly Marxist and neo-Marxist theory, to analyze these private soil carbon sequestration (SCS) initiatives, and accessory trends such as CSA and digital agriculture, which are critical to the operation of SCS initiatives. Interviews; analysis of corporate environmental, social, and governance (ESG) documentation and program documentation; and scholarly literature are used as data to provide answers to the three questions posed above.

The paradigm of neoliberal capitalism[1] that has involved privatization, the reification of market-based economies, as well as the retreat of the state, have set the stage for "governance" regimes that have expanded the involvement in "governing" and "rulemaking" beyond the state (Strange 1998). Neoliberalism has privileged the expansion of the authority of private actors (Strange 1998; Wright & Nyberg 2015). The ability of corporations to exercise authority in influencing policy is a well-studied area in political economy, with a multitude of theories that have been developed to understand the role of private corporations in governance (Castree 2008 A & B; Clapp & Fuchs 2009; Meckling 2011; Green 2014; Bulkeley & Newell 2014). Jessica

[1] One could argue that neoliberalism is no longer the dominant global paradigm due to fracturing and restructuring in different national political and economic systems, however (Grabel 2020).

Green (2014) defines private authority as "situations in which nonstate actors make rules or set standards that other actors in world politics adopt" (6). The exercise of corporate power in exerting authority over key political and economic issues directs us to a key element in the study of political economy and theories on the role of private corporations which are also used to understand how corporations exercise their power, and to what end.

The legitimacy basis for a corporation's authority arises in numerous ways, depending on the theoretical standpoint. Jessica Green argues that legitimacy can be derived from expertise as well as morality claims made by the corporation (Green 2014, 31). Critical political economy scholars on the other hand, argue that legitimacy can also be derived from the overarching neoliberal paradigm that reinforces self-regulation by the market, and therefore the corporation, the privatization of economic activity, and the ownership of the means of production and structural power in the political and economic system (Bieler & Morton 2004; Wright & Nyberg 2015). Doris Fuchs has theorized corporations have three forms of power: instrumental, structural, and discursive (Fuchs 2007). Instrumental power refers to the ability of corporations to lobby politicians and organizations to change policy. Structural power refers to the economic capability of corporations to make manufacturing, investment, and market-making decisions (Fuchs 2009). Discursive power denotes the capability of corporations to opinion-shaping, and policy debates and issue debates in order to generate legitimacy around their activities, promote their products or services, or advance policy positions that they promote (Fuchs 2009).

When discussing the types of power that corporations hold and how they exercise it, scholars in critical political economy literature focus on the power of corporations to commodify, create market, financialize, and enclose increasingly more aspects of the economy in order to expand profit opportunities, while depoliticizing or legitimizing these actions (Bieler & Morton

2004; Swyngedouw 2013; Wright & Nyberg 2015). This is particularly pertinent in discussions of corporate involvement in policy responses to climate change. The centrality of markets and commodification to climate change solutions are central to Christopher Wright and Daniel Nyberg's book *Creative Self-Destruction: The climate crisis and the myth of 'green' capitalism*. In this work, the authors examine the role of corporations in assembling responses to the climate crisis. The authors argue that the form of neoliberal capitalism that dominates currently figures capitalism as a response to the climate crisis, with markets and growth essential to its solution (Wright & Nyberg 2015). Corporations are staunch advocates of markets and growth as solutions to climate change, which in turn, figures them as important actors in figuring capitalism as a viable response to climate change. They further characterize "the link between economic growth, corporate innovation, and environmental destruction as a process of 'creative *self*-destruction' in which economic expansion *relies on* the continued exploitation of natural resources" (Wright & Nyberg 2015, 6). Climate change, then, is not only a threat to current business practices, but an opportunity to spin this threat to advance the expansion market forces and commodification, therefore generating new opportunities for profit.

Purely private governance, or authority, arises through rulemaking, standard setting, or market-making to regulate their own activity (Green 2014; Bulkeley & Newell 2015). This distinction is important to make in this case, as SCS credit initiatives are an example of purely private governance and authority, whereby agribusiness corporations are market-makers, provide private authority on the operation of these markets, as well as collaborating with other private organizations to develop standards to legitimate new SCS markets.

It is also important to note that corporate responses to climate change are largely voluntary, meaning that they are not mandated by the state or state actors. Clapp and Fuchs

(2009), as well as Green (2014), argue that corporations can act rule makers and standard setters (6). Corporate social responsibility (CSR) initiatives are attempts at rule making and standard setting, with CSR initiatives often setting guidelines on corporate emissions targets, emissions reporting, or involvement in offsetting projects. Green posits that corporations act as entrepreneurs to cultivate authority and legitimacy through rulemaking and standards setting (2014, 7). CSR initiatives do not have to include only rulemaking or standards setting, but also the use of market pressure, as well as generating authority and legitimacy to enter new markets (Green 2014, 7). Green argues further that entrepreneurial authority cultivated by private actors is beneficial to them because it helps to improve their reputation: "It is not secret that many multinational companies adopt various forms of entrepreneurial authority with the hopes of greening their reputation (Green 2014, 15)." This line of thinking is similar to other studies on private authority, including Doris Fuchs' (2007) discussion of 'discursive' and 'structural' power of corporations to legitimize their actions or improve their reputation. What is important in this description of entrepreneurial authority is the theorization of corporate action that figures corporate action as movements to gain or maintain power and legitimacy in order to continue to shape outcomes that are favorable to corporate operations.

How corporations operate in policy spaces, however, is theorized differently within political economy. Two popular theories in political economy utilized to understand corporate activity in climate change policy are pluralist and neo-Gramscian theories. Pluralism theorizes interest-group and corporate-based policymaking as a "competition" between interests, where interest groups, corporations, and the state participate in the same policy arena on equal footing (Meckling 2011; Knill & Tosun 2012). This means that each actor has equal opportunity and access to policy-making and prevailing policies are the preferred choices of the winning actor or coalition (Meckling 2011). In pluralist models, political economy scholars might be interested in how corporations used the power that they have at their disposal to win other actors over and outcompete to ensure that policy outcomes are shaped in their favour. Neo-Gramscian theory differentiates from pluralism in that it inherently understands corporations and the state as holding outsized power (Bieler & Morton 2004; Budd 2013). Neo-Gramscian theorists follow neo-Marxist theory and seek to study prevailing forms of hegemony (Bieler & Morton 2004; Budd 2013). In this theorizing, corporations are a part of the hegemonic order, looking to maintain market-based economies that promote privatization, the commodification of nature, lax environmental regulations, and little state interference.

I take a critical view informed by neo-Marxist theorizing but do not engage with neo-Gramscian literature in my analysis. I understand corporate activity in self-regulation, market-making, and responding to climate change regulation as being important to understanding the operation of capitalism and therefore the political economy. Agribusiness corporations especially hold outsized power, and it is important to understand how they are able to shape economic production and policy in response to the threat of climate change (Clapp 2015 & 2021). This critical view allows me to assess the outsized power that corporations have in working to maintain capitalist modes of production and preserving consent for these practices. I do not see corporations maintain hegemonic positions, as climate policy represents a general threat to corporate activities and therefore forms of dissent are maintained. I do understand the structural power that is held by corporations, however, and more critical views of this structural power. Similarly, while I take a critical view of corporate activity, the use of more traditional theory such as that of private authority and corporate power (Fuchs 2007; Green 2014) are still central to my analysis. Understanding the types of power that corporations have at their disposal and understanding how they shape politics, and the economy is important for understanding current private SCS credit programs, as they represent a form of private governance of resources and a corporate response to climate change.

In sum, the study of critical political economy provides a view of both political and economic power, and how these forces shape production and political systems in tandem. When studying corporations and power, issues such as the profit-motive, sustenance of "business-as-usual" practices, and justice issues with regards to who loses in power struggles, become important. As such, this thesis touches upon new avenues of profit available to corporations through the deployment of surveillance and digital agriculture tools and the power they are afforded through this deployment (Zuboff 2016). Power also extends to issues of commodification and enclosure, as mentioned above, with regards to SCS credit initiatives, as well as how corporate initiatives to combat climate change affect the livelihoods of farmers as an issue of justice.

1.3: Summary of the Argument

The climate-food nexus has become the focus of many international organizations, and climate change mitigation initiatives. Emissions reductions in the agriculture sector is one form of mitigation that is being pursued through the implementation of CSA practices and digital agriculture tools to increase efficiency on farms. Related to CSA and digital agriculture, one proposed mitigation solution is the creation of carbon credit programs in the agricultural sector, particularly for the implementation of new cropping practices for soil carbon sequestration (Oldfield et al. 2021). While some of these carbon credit programs are government-run,[2] most

[2] See Appendix C for a summary of these programs.

agricultural carbon credit programs are run by private agri-business firms in voluntary carbon markets (Lokuge & Anders 2022).

Utilizing scholarly literature, document analysis, and interviews, agribusinesses are shown to have three main motivations for engaging with SCS credit initiatives: pre-emptive action and reactive responses to changing regulations; bolstering corporate reputations; and avenues for new profit through SCS initiatives, especially the use of farmer data collected through new digital monitoring technologies. These responses demonstrate the desire of agribusinesses to shape responses to climate change in their favour, sustaining "business as usual" business practices, thereby maintain and expanding opportunities for profit.

Private SCS credit initiatives are likely to lock agriculture into industrial farming methods while precluding discussion on substantive change in the agriculture sector. SCS credit initiatives also continue the trend of the economization process in neoliberal capitalism. By taking a market-based instrument approach to climate change, agribusinesses create new spaces for profit and control of agriculture supply chains. These initiatives also pose justice issues. Descheneau and Paterson argue that carbon markets are a "means to internalize the costs created by pollution", but there is little evidence to show that farmers will not be the ones bearing the cost of pursuing these private carbon credit programs (Descheneau & Paterson 2011, 662). Lock-in, economization, and subsequent justice issues generated through private SCS credit initiatives create adverse effects for both farmers and the environment. The implications of these SCS initiatives support systems that subordinate environmental health and farmer labour, while providing new avenues for agribusiness to increase their power.

1.3 Outline of the Thesis

This thesis proceeds as follows: Chapter 2 sets the stage for understanding the rise of SCS by providing the necessary background on carbon markets and the history of market-based approaches to emissions reductions. It provides an overview of early carbon markets and examines flaws and critiques of emissions markets, following with a brief discussion of resurgence of emissions markets post-2016. Chapter 2 also gives a brief background on soil science literature to demonstrate why SCS process is possible, how it happens, and how it has been discussed as a climate mitigation strategy. It then moves on to discuss how carbon credits are assembled through monitoring, reporting, and verification protocols, as well as models. It also provides background to accessory trends essential to understanding SCS credit initiatives, such as digitalisation of agriculture and CSA.

Chapter 3 outlines the methods and results of this study. Results from document analysis are presented in tables[3]. Chapter 4 is the first discussion section of this paper, answering the first question two questions posed above: "what motivates private agribusiness firms to engage in SCS credit initiatives? How are private corporations utilizing the power at their disposal to shape these initiatives?" This chapter reviews novel and emerging policy surrounding SCS and agriculture, as well as agribusiness practices, as they seek to maintain profitable business in the face of climate change and pressure to change their business practices. Finally, Chapter 5 answers the third question posed above: "What are the implications of these schemes for farmers?" This chapter provides an analysis of the implications of private SCS credit initiatives for the agribusiness sector, for farmers, and for agriculture practices in North America. Specifically, this chapter examines how SCS credit programs lock agriculture into suboptimal

[3] See Appendix D.

practices in the face of climate change, how they contribute to commodification of nature and corporate concentration, and how these programs contribute to justice issues,

Chapter 2: Carbon Markets and Soil Carbon Sequestration

To understand soil carbon initiatives, it is first important to outline the history of carbon markets, as these new SCS initiatives are effectively a new form of carbon market. This chapter presents a literature review to provide a base understanding and timeline of the evolution of carbon markets beginning with the origins of market-based approaches to environmental externalities, the development of the voluntary carbon market (VCM) and explaining the “rules of the game” for carbon markets. It also provides an overview of the critical political economy literature with respect to the development of these markets. The second half of the chapter outlines the soil science literature that outlines how SCS works, as well as how SCS initiatives are assembled through monitoring, reporting, and verification.

2.1: Origins of market-based mechanisms

French economist Arthur Pigou was the first economist to integrate the cost of air pollution into market modelling in *The Economics of Welfare* (1920). The goal was to determine “socially optimal” levels of pollution per production unit, thereby incorporating negative externalities and deterring them by assigning these costs to polluters. This type of approach is known as Pigouvian taxes (Pigou 1920). In Ronald Coase’s 1960 work *The Problem of Social Cost,* Coase argued that taxes were an inefficient policy for reducing emissions (Coase 2013). Coase instead posited that negative externalities could be resolved by assigning liability and property rights to emitters, and that there would be an efficient set of negotiated solutions.[4] In the 1970s TD Crocker and JH Dales separately developed Coase’s theory into a permit trading system further to be operationalized for policy implementation (Lane 2012; Calel 2013). Work by the Environmental

[4] The efficient solution is figured as compensation in his original formulation, between both emitters and victims of emission. Also worth noting that Coase argued that this system of property-rights assignment could be extended into air and water pollution management, but was not operationalized as permits trading policy in his formulation (Coase 2013).

Protection Agency on permits systems materialized into the US *Clean Air Act*, creating "flexible" permit-trading systems for the reduction of leaded petrol, and later amended to include sulfur-dioxide (SO_2) emissions (Lane 2012, Calel 2013). The use of market-based policies for emissions reductions generated relative success in the reduction of SO_2, creating a model for future emissions permit-trading markets.[5]

Lane (2012) argues that the replacement of Pigouvian taxes in the U.S. with market- and property rights-based approaches was heavily influenced by the cost-saving and efficiency promises of market-based approaches (597). This allowed "property rights to flow to their highest value" while creating a certain level of flexibility in how companies could approach emissions reductions (Lane 2012, 597).[6]

2.3: The Kyoto Protocol

The Kyoto Protocol was the next advancement in the creation of market-based mechanisms for emissions reductions. The process of creating the Kyoto Protocol began in the first Conference of Parties (COP1) of the United Nations Framework Convention on Climate Change (UNFCCC) in Berlin, where the U.S. battled against an international agreement on emissions reductions (Calel 2013). This position reversed at COP2, where the U.S. delegation proposed the idea of emissions markets.[7] This was formalized in the Kyoto Protocol at COP3 in Kyoto, Japan. The Kyoto Protocol created three mechanisms for emissions trading: the Clean

[5] Development of this type of policy in the US was actively continued by Robert Stavins and the bipartisan thinktank "Project 88" that was convened by American senators Tim Wirth and John Heinz. For more see: Stavins et al. (1988)

[6] Calel (2013) sees the institution of market mechanisms as a compromise between business and the growing environmental movement in the U.S (107).

[7] It is interesting to note that the EU was heavily against the use of emissions or permit-trading markets as the European Council was working towards passing a carbon tax at the supranational level. This ultimately failed due to the focus of the Kyoto Protocol on emissions markets and internal dissent to carbon trading (Calel 2013).

Development Mechanism (CDM), Joint Implementation (JI), and Emissions Trading (ET) (37 I.L.M. 22 (1998); 2303 U.N.T.S. 148; U.N. Doc FCCC/CP/1997/7/Add.1).

It is important to distinguish between two types of emissions trading systems, cap-and-trade and baseline-and-credit systems. Cap-and-trade systems rely on limits set by a government, allocating emissions permits for a certain number of emissions units (Meckling 2011). These units can be traded between entities, but cap-and-trade systems are a “closed” system where no “new” credits can be generated by overcompliance (Meckling 2011). The ET system under the Kyoto Protocol is a cap-and-trade system.

Baseline-and-credit systems, on the other hand, are project-based systems, where overcompliance with emissions reductions or mitigation are transformed into credits which can be sold to entities which are looking to “offset” their emissions (Meckling 2011). The CDM and the JI systems are baseline-and-credit systems, for example. Baseline-and-credit systems, as the name infers, requires a baseline against which to measure what emissions reductions are considered “additional” (Meckling 2011). Scholars argue that the creation of such baselines for sectors and project types is a contested area and has been considered inaccurate or lenient for the volume of reductions needed to meet emissions targets (Blum 2020).[8]

The Kyoto Protocol established guidelines for carbon emissions-trading projects and what sorts of activities were valid for accreditation. Importantly, it established the concept of additionality. A project can be additional in two ways: additionality through environmental impact and additionality through finance (Lovell 2010; Paterson 2010, 354; Boyd et al. 2011). Additionality through environmental impact is the requirement to demonstrate that carbon

[8] Baseline-and-credit systems specifically and the establishment of climate baselines more broadly meet a scientific and legitimation challenge of what is considered “business as usual” and how well that can be estimated, creating issues of “relying on ‘counterfactual assumptions’ and ‘if–then-scenarios’.” (Blum 2020, 232)

sequestration would not have happened without changes to management practices (Lovell 2010; Boyd et al. 2011; Michaelowa et al. 2019). Additionality through finance is the requirement to demonstrate that changes to management for the mitigation of carbon would not have happened without the flow of extra financial resources to a project (Kollmuss et al. 2008; Paterson 2010). Additionality is crucial to the understanding of carbon credits, as it is additionality that determines the "validity" of a carbon credit, as do the methods for establishing additionality.

Another important aspect of carbon credit schemes, originating in the Kyoto Protocol, are the monitoring, verification, and reporting (MRV) practices that are used in the formal creation of offset credits from project activities (Lee et al. 2016; Michaelowa et al. 2019).[9] MRV practices differ between countries, international organizations, and third-party verification agencies including private corporations and NGOs (Benessaiah 2012; Lang et al. 2019; Wongpiyabovorn et al. 2022). Understanding the diversity of verifiers are important because they use different baselines, measuring methodologies, and recognize different project standards, which affects additionality, verifiability, and ultimately the ways in which and how much carbon is stored.

Understanding the historical construction of valid carbon credits is pertinent to understanding current carbon credit initiatives, including those in the agricultural sector. Baseline-and-credit systems are the predominate systems for generating carbon credits, particularly in SCS initiatives. The function of baseline-and-credit systems to "offset" emissions is an important component of the "net-zero" paradigm, where emissions are allowed, as long as they are "offset" by a corresponding reduction in emission elsewhere. MRV principles guide the

[9] MRV is sometimes written as MMRV, which features the inclusion of "measurement" as the second "M" in the acronym. I will use MRV from this point onward because this version of the acronym is the most commonly used.

construction of carbon credit initiatives and are important rules in the establishment of new marketplaces while demonstrating an interpretation of science that is considered “legitimate”.

2.4: The Establishment of the Voluntary Market

Authors examining the early development of the Voluntary Carbon Market (VCM) argue that the VCM exists as a parallel market to the Kyoto Protocol, arising alongside the CDM markets.[10] The VCM was established to achieve a few goals: to provide companies and individuals with the opportunity to offset their emissions; to provide an innovative space for new forms of carbon projects; and to provide additional sustainable development benefits not possible in regulatory markets. While the VCM is argued to be a space of innovation, it has garnered scholarly and activist attention for its inability to create lasting impacts, where estimates demonstrate that 90% of voluntary offset scheme carbon reductions have been leaked outside the project boundaries (Monsterrat & Sohngen 2009; Thamo and Pannell 2016).

Bellassen and Leguet argue that participation the VCM provide a chance for companies to “better their image” (Bellassen and Leuget 2007). They might also participate due to social pressures, ethical considerations, stockholder pressures, creation of new value, or to gain experience in carbon markets as they develop to gain a competitive advantage in the future (Bellassen and Leguet 2007). Other academics have also argued that the flexibility of the lower bar of entry for VCM projects allows a wider variety of projects that would be too costly to implement under regulatory markets (Harris 2006; Bryan et al. 2010; Benessaiah 2012; Lang et al. 2019). Flexibility allows for the piloting of new types of projects (Lang et al. 2019; Kizzier et

[10] The most commonly cited early case is the American power producer, AES, pursuance of an agroforestry project in Guatemala in 1989 (Bellassen and Leguet 2007, 10; Corbera et al. 2009). This was to offset the emissions of AES’s new thermal power station, based in the US. While there may have been a smattering of privately funded projects for the purpose of offsetting emissions, the voluntary market did not experience significant growth until the establishment of the Kyoto Protocol.

al. 2021). In the post-2006 era, VCM projects have also had a focus on development priorities as well, going beyond the objective of creating offsets or emissions reduction, focusing on stimulating development and providing other co-benefits (Faecks 2022). Authors argue that the VCM fills the development gap that is left behind by regulatory markets and is therefore viewed as a unique trait (Baiely et al. 2011; Benessaiah 2012).[11] In the present state of the carbon market, the VCM represents a space for innovation rather than a space for economic development. Particularly in the case of SCS initiatives, as demonstrated in detail later, payments to farmers for carbon sequestration is not material enough for development to occur.

2.5: Carbon Market Downswings

Between 2008-2015 carbon markets experienced several setbacks stemming from a variety of sources. The first event was the price collapses spurred by the 2008 financial crisis and accompanying emissions reductions that occurred due to reduced economic activity related to the recession (Michaelowa et al. 2019; Kizzier et al. 2021). These collapses seem to be minor setbacks in the grand scheme of carbon markets, especially for VCMs, which were robust in the face of the recession and even managed to show growth during this period (Lovell 2010). The next two major events that affected carbon markets could be labelled as national regulatory failures to either implement cap-and-trade or execute it properly. In the first case, the U.S. Congress failed to pass national-binding cap-and-trade policy, helping to lead to the collapse of the Chicago Climate Exchange (CCX), a voluntary cap-and-trade institution (Bell 2010; Barnes 2016). This failure was more damaging to reputation than it was to actual VCMs, however, as the CCX comprised about 3% of carbon trading in the VCM landscape (Kollmuss et al. 2008) The third event constitutes similar regulatory failure when the price collapse of the EU

[11] Bailey et al. (2011) argue, however, that this is a negative trait. Rejected CDM projects go to the voluntary market to gain legitimacy and approval where they would not be able to do so under regulatory markets.

Emissions Trading System (ETS) occurred in 2012. The EU ETS was the largest regulatory market outside of the CDM at the time but experienced a steep price collapse due to an over-allocation of emissions permits (Meckling 2014).[12] The fourth and final event that affected carbon markets significantly, was the non-renewal of the Kyoto Protocol (Michaelowa et al. 2019). The first period of the Kyoto Protocol was set for 2005-2012, with a renewal of emissions reductions commitments at COP18 in Doha to be scheduled. The uncertainty that was generated in regulatory markets certainly had a knock-on effect on voluntary markets, with regulatory failure demonstrating a lack of confidence in carbon markets (Michaelowa et al. 2019).

2.6: Renewed Interest and Net-Zero Commitments

While carbon offset trading and the voluntary carbon market have experienced steady growth since the early-2000s, except for a few periods of slow or no growth, the period from 2015-present is unprecedented. *Figure 1* demonstrates the explosion of growth that the VCM has experienced since 2015.

[12] This over allocation of permits is one piece of a larger issue that the EU ETS, amongst other trading schemes, experienced with allocating permits to large emitters, providing them with "permits" to emit and an avenue for selling permits for profit (Meckling 2014).

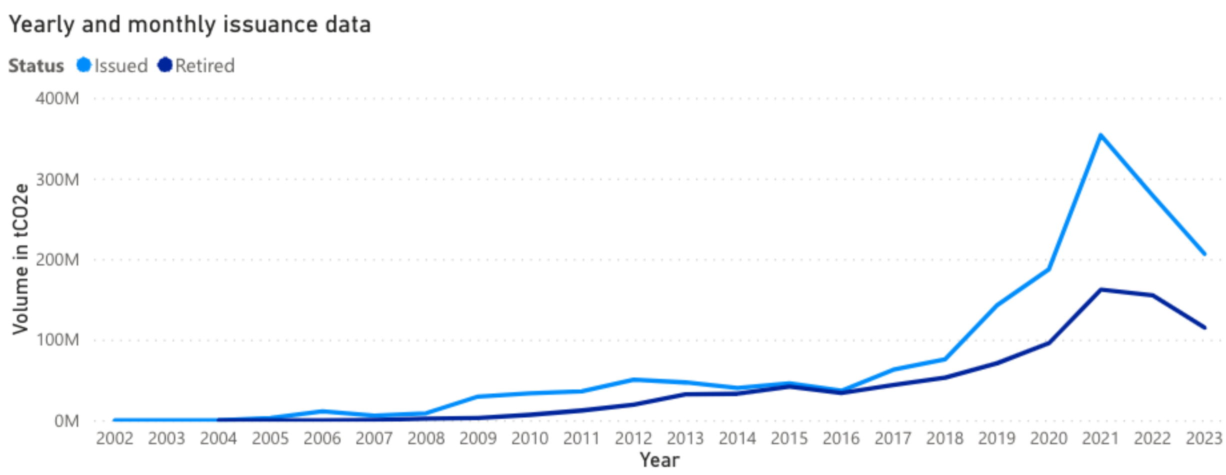

Figure 1:Growth in the issuance and retirement of VCM credits from 2002-present.[13,14,]

Figure 1 only demonstrates the enormous increase in the supply of carbon credits through a portion of the VCM, as opposed to the growth in demand for carbon credits which is estimated to vastly outpace supply of carbon credits (Cornillie et al. 2021; Kizzier et al. 2021). Further, this only demonstrates the supply of credits in voluntary markets.

There have been significant developments around carbon offset credits that have contributed to the increased supply of carbon including the clarification of Article 6 in the Paris Climate Agreement and the rapid increase of corporate net-zero commitments and organizations created to help coordinate these commitments.

[13] The light-blue line depicts issued credits, while the dark blue line represents the volume of VCM credits that have been retired (Source: Bravo & Mikolajczyk 2023). "Issued credits" refer to the creation of new carbon credits in the VCM. "Retired credits" refer to the "claiming" of credits against an entity's emissions, effectively consuming the credit.

[14] Climate Focus has compiled this data from seven VCM standards: Verra Carbon Standard, Gold Standard, American Carbon Registry, Climate Action Reserve, Plan Vivo, Global Carbon Council, and Climate Forward.

COP26 in 2021 in Glasgow focussed heavily on properly delineating and defining the provisions of Article 6 of the 2015 Paris Climate Agreement. Article 6.2 of the Paris Agreement states that:

> "Parties shall, where engaging on a voluntary basis in cooperative approaches that involve the use of internationally transferred mitigation outcomes towards nationally determined contributions, promote sustainable development and ensure environmental integrity and transparency…" (U.N. Doc. FCCC/CP/2015/L.9/Rev/1 (Dec. 12, 2015))

The remainder of Article 6 goes on to outline the vague structure of the "internationally transferred mitigation outcomes" that are first mentioned in Article 6.2. The result of the discussion at COP26 about Article 6 was the creation of an instrument similar to the CDM of the Kyoto Protocol (Depledge et al. 2022). This has opened the door to the explosion of demand in the VCM in advance of this new instrument similar to the CDM (Pigeolet and Waeyenberge 2019, 11).

The elaboration of the Article 6 mechanism stimulates the VCM through creating guaranteed demand as well as expectations that regulatory markets will either be created or expand (Blüm & Lovebrand 2019; Depledge et al. 2022). This expectation creates incentives for corporations to develop the competencies and capabilities in advance of new regulatory markets. The expectation of new carbon market mechanisms as a motivating factor for SCS credit initiatives will be discussed in more detail below.

2.7: Insetting vs. Offsetting

Insetting emissions has become popular within corporate climate activism in recent years, providing an alternative to traditional offsetting activities. Before providing the definitions of offsetting and insetting, it is crucial to explore how emissions in a company's supply chain are defined. This is important given the rise in attention given to measuring and reducing supply chain emissions. Corporate emissions are divided into three "scopes." This accounting system originates in the Greenhouse Gas Protocol Corporate Standard.[15] This document presents definitions for emissions scoping that are used now. Figure 2 gives an overview of the "scoping" system. Scope 1 emissions are "direct GHG emissions occur from sources that are owned or controlled by the company (GHG Protocol 2004, 25)." Scope 2 emissions refer to emissions generated by electricity used by corporations in their business activities (GHG Protocol 2004, 25). Scope 3 emissions occur due to the "consequence of the activities of the company" but are not directly attributable to the corporation's immediate activities. Scope 3 emissions, therefore, refer to emissions created by the production of materials used by a corporation, or the emissions created through the use of products sold by the corporation (GHG Protocol 2004, 25). It is possible to buy offsets to cover emissions of all three scopes, but corporations are shifting towards the use of insetting activities to meet their climate commitments.

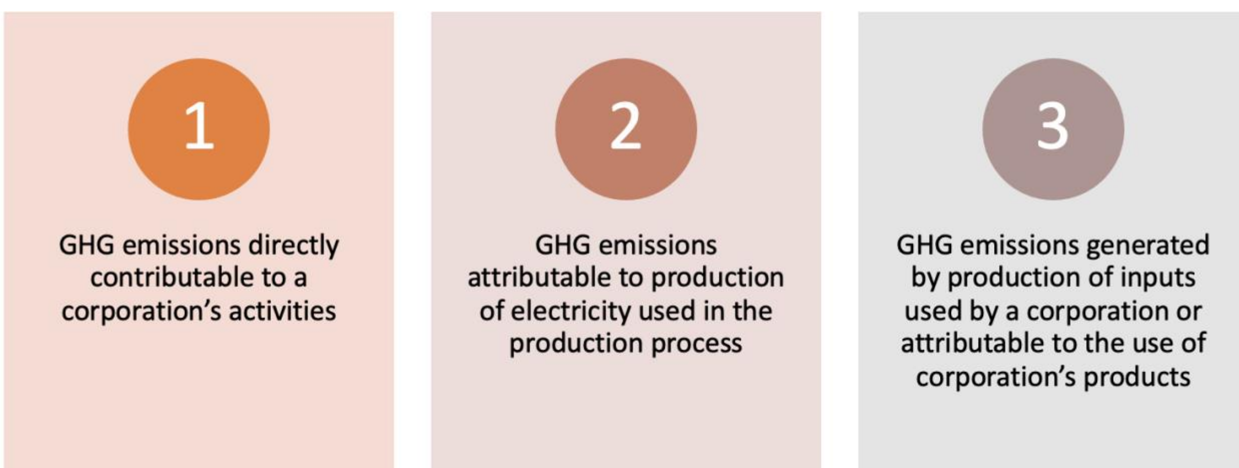

Figure 2: Scoping systems for emissions accounting from 2004 GHG Protocol

Carbon offsetting and insetting are similar activities; both entail the reduction or mitigation of GHG emissions associated with a corporation's emissions, and this objective is

[15] First published in 2001 and revised in 2004 by the World Resources Institute and World Business Council for Sustainable Development.

often met in the same way in both cases. Carbon offsetting entails the purchase of verified carbon credits from external actors (Buckley Biggs et al. 2021, 6). Insetting, on the other hand, "entails reducing GHG emissions or sequestering carbon through an activity linked to a supply chain of a given actor or an activity in its direct sphere of influence" (Phelan 2015, 54). The extent to which insetting takes place also depends on the scope of a corporation's ambitions, where they can target upstream suppliers or go beyond to include downstream actors in their supply chain or emissions beyond carbon (Anacampora et al. 2022). Insetting has advantages in being more cost-effective than offsetting schemes for corporations and delivers co-benefits alongside emissions reductions (Tipper et al. 2009; Phelan 2015).

Insetting activities also allow corporations to develop new capacities in managing their supply chain and having control over offsetting activities. These new capacities include a greater ability to measure carbon emissions, as well as the ability to create offsetting solutions that are optimal for each corporation. It is also possible for corporations to derive further value from marketing their products as "traceable" and "net zero" or meeting other certification programs, advertising their products as "sustainable" to consumers for a premium (Phelan 2015; Anacampora et al. 2022).[16] One concern about insetting activities, however, is that the offsets generated through insetting investments are not consistently verified through third-party MRV practices or through established protocols, with corporations opting for their own MRV systems (Chartier & Tsayem Demaze 2022). This could mean that corporations are opting to use less stringent MRV practices or standards to generate carbon credits, bringing the legitimacy of generated offsets, as well as the amount of carbon sequestered, into question.

[16] One concern about certification schemes in general, but relevant to insetting activities, is whether or not the price increases from certification premiums reach upstream producers (Chartier & Tsayem Demaze 2022).

2.8: Critiques of Carbon Offsets and Markets

Carbon offset markets have failed to deliver substantial emissions reductions, for all the time and political (and real) capital that was poured into them (Harvey 2012; Böhm 2013; Blum & Lövbrand 2019). At the end of his article on the evolution of carbon markets, Calel (2013) confronts the oft heard argument by market fundamentalists that markets are not working because they still need time to develop or that there needs to be less regulation. “We are still at a steeply rising part of the learning curve, one hears. But in light of historical experiences, one must ask whether the problems run deeper” (Calel, 2013, p. 116). As I explain below, critical political economy literature has highlighted issues of commodification, abstraction, neocolonialism through carbon markets, legitimation of continued emissions, and the foreclosure of other climate change policy pathways.

Within the critical political economy literature on payment for ecosystem services, carbon credits are discussed in the same vein as “fictitious commodities.” Where commodities are products created for exchange on the market, “fictitious commodities” are commodities that are not produced by human labour but are integrated into markets systems nonetheless (Polanyi 1944). Originally, Karl Polanyi posited three fictitious commodities, land, labour, and money, none of which are producible products (Polanyi 1944). Carbon credits are figured as fictitious commodities as carbon dioxide molecules are invisible and intangible, requiring a lengthy process of political and economic manipulation to be “created” as a tradeable commodity (Lohmann 2011). Carbon credits, as Descheneau and Paterson (2011) argue, has no use value, but simply refers to a unit of measurement (667). It is important to note that this unit of measurement, which is formally known as “1 tonne of Carbon Dioxide Equivalent”, or tCO2E requires a more complex formula, which equates it with other “equivalent” measurements of greenhouse gas (Paterson & Stripple 2012; Boyd et al. 2011; Buckley-Biggs et al. 2021).[17] This equivalency formula allows for the creation of a highly fungible, highly tradable commodity. In this way, carbon credits are simply "imagined units" that exist by way of government regulation or by voluntary agreement (Descheneau & Paterson 2011; Lohmann 2011). It is important to consider carbon credits as fictitious commodities because carbon credits are not produced, but rather carbon molecules and property rights to them are fit into existing market mechanisms in order to manage them.

This commodification process is further exacerbated by the "pixelation" of carbon and the "virtuality" of carbon trading that conforms to computer-generated models of finance and climate change, as well where carbon trading takes place, virtually (Descheneau & Paterson 2011; Huff 2021). The commodification process helps to integrate nature further into processes of accumulation and the faceless forces of the market, obfuscating the socio-ecological and material movements of capital accumulation, which Huff draws connections to Marx's commodity fetishism (Huff 2021). This obfuscation is observed most clearly in the abstractions caused by carbon credits, whereby carbon molecules, figured as tradeable property rights, obfuscate the complex socio-ecological process that mitigate pollution, but also the production processes that create pollution in the first place. This obfuscation hides an underlying contradiction between continued emissions and the destruction of nature which allows for production of goods in the first place. The ability to "offset" emissions does not address levels of current emissions damaging complex socio-ecological processes that have local and global value for sustaining life. It also hides the inability of the "net zero" paradigm to address the possibility that current emissions levels are dangerous more generally (Blum & Lövbrand 2019; Carton et

[17] By equivalent measurements, I mean equivalent in units to other GHGs such that they achieve the same global warming potential measurement (Paterson & Stripple 2012)

al. 2020). The goal of "netting" emissions through carbon offsets is often rarely achieved, especially in voluntary carbon credit projects, when considering the failure of VCM projects to retain carbon that is sequestered (Monsterrat & Sohngen 2009; Thamo and Pannell 2016).

The abstraction warned about by political economists arises through the distancing of carbon sequestration practices, which are embedded in local land-use and social practices, and a commodity, in the form of carbon credits (Lohman 2010, 2011). To be fully fungible, carbon credits have to be made equivalent as discussed above with the common unit of CO2E, but the processes through which credits are generated must also be made equivalent. This equivalency, then, implies that a tonne of carbon stored through afforestation is the same as a tonne of carbon abated by changing industrial practices. Boyd et al. (2011) argue that this equivalency does not fit neatly with both the history of carbon and its modern storage, which are products of "socioecological complexity of locally produced natures" (607). At the same time, however, project-based credit programs must be connected to particular processes. Boyd et al. therefore points to the importance of "institutions and the work of imagery and narrative in constructing convincing stories which connect abstract commodities to particular places" (Boyd et al. 2011, 609). Indeed, carbon markets are still advertised broadly as a solution to climate change, and this figuring of "abstract commodities to particular places" is imperative. This abstraction is particularly clear in the aggregation activities that take place in bundling of carbon projects, where two activities in different localities are packaged as one credit (Lovell & Liverman 2010). Along with the issues discussed above, carbon markets have allowed for continued emissions, as well as the foreclosure of other climate change solution pathways. Scholars have likened carbon credit markets to a "pay-for-pollution" system that is similar to the indulgence system of the Catholic Church, where sinners could pay for their forgiveness instead of changing their behaviour (Paterson 2010). In effect, large corporations, the major GHG emitters, are allowed to continue to emit (Espinosa-Flor 2022; Dhanda & Hartman 2011). Enabling carbon markets to operate is the principle of "net zero", stating that as long as GHG emissions are counteracted by an equal amount of GHG stored, then there is an environmental "good" generated (Dhanda & Hartman 2011). Net-zero does not contend with historic emissions, nor does it address the problematic assumption that current emissions levels are safe (Blum & Lövbrand 2019). Larry Lohmann goes as far to argue that carbon credit systems will contribute to lock-in of fossil fuel infrastructures, pulling away from substantive climate action (Lohmann 2011).

Indeed, the utilization of markets as the vehicle for incentivizing emissions reductions comes with its own set of problems. Dominating neoliberal market ideology places markets as the most efficient, and realistically, the only way to internalise emissions and stimulate GHG emissions reductions (Lohmann 2011; Boyd et al. 2011). This internalisation, as well as markets generally, have continued to fail, with the reasoning outlined by Calel above noted by other scholars (Spash 2020; Calel 2013). For Lohmann and Leonardi, separately, failure seems to be the constant state of carbon markets, with Leonardi arguing that failure is the ideal "state" for carbon markets as polluters have an excuse for shortcomings (Leonardi 2011; Lohmann 2011). This failure resonates with critical geography literature that outlines the inability of neoliberal market tendencies to not fit "neatly" among geographic, political, economic, and ecological variations (McCarthy & Prudham 2004; Castree 2008a & 2008b). The inability of markets to create "neatness" is particularly true for commodifying and marketizing components of nature, which also do not fit "neatly" into these mechanisms.

Carbon markets have become an end in themselves, with focuses on profit-making and value extraction (Bumpus & Liverman 2008). This wealth extraction is related to issues such as the setting of high counter-factual emissions baselines, creation of further financial derivatives contributing to abstraction, and growth-oriented economies (Paterson & Stripple 2011). Markets come to dominate as a politically acceptable, "better than nothing solution" (Lohman 2011). Less radical solutions preclude bans on fossil fuels and more radical shifts in climate change policy, while allowing large corporate actors to legitimate themselves in climate change discussions as contributing to climate change solutions (Lohman 2011; Paterson 2010). As discussed above, the attraction to emissions markets was the "flexibility" in the ability to meet emissions reductions, providing the least-cost solution to climate change (Buckley-Biggs et al. 2011). Flexibility provided by carbon markets have enabled corporations to pursue only the "low-hanging fruit" of emissions reductions while having the ability to claim that they are "eco-friendly" (Lohman 2011; Descheneau & Paterson 2011).

Historical critiques of carbon credits form the basis for concerns about present-day concerns about "offsetting" and "net-zero" initiatives that are being adopted by corporations. It is important to understand these historical critiques in order to compare historical carbon credit initiatives to new initiatives that have novel arrangements, such as low-carbon commodities, as well as expanding into new sectors, such as agriculture. Historical carbon credit initiatives bear a close resemblance to new initiatives, meaning that implications drawn from previous initiatives are relevant now, with new arrangements providing opportunity to explore nuances in new market arrangements.

2.9: Soil Carbon Sequestration

This section zooms in from the VCM space into soil carbon sequestration projects more specifically. The aim of this section is to review the literature on the basic ecological and soil science workings of soil carbon sequestration projects and how soil carbon sequestration is measured and transformed into a tradable credit. I examine the rationale for pursuing soil carbon sequestration projects in the climate change mitigation space as well as the scholarly debate surrounding the soil science and uncertainty of soil carbon sequestration projects. I then show how monitoring, reporting, and verification (MRV) standards and additionality and permanence principles are applied and executed in soil carbon sequestration projects. The issue of permanence examined in detail due to the disproportionately large role it plays in soil carbon projects and accounting.

The potential for soil to sequester carbon has been discussed in academic literature for over thirty years.[18] Scholarly attention has been given to SCS due to concerns about soil fertility, desertification, erosion, and its potential in storing carbon and reversing historical carbon loss (Bossio et al. 2020). There has been massive historical soil organic carbon (SOC) loss due to conversion of land to agricultural production ecosystems. In the midwestern U.S., for example, this loss amounts to 30%-50% of their original SOC stocks (Lal 2002). In a meta-analysis of soil science literature, Sanderman et al. found that SOC loss ranges from 61%-78%, depending on soil depth (Sanderman et al. 2017). Soil cultivation contributes over 1.7 petagrams (1 billion tons) of carbon every year to anthropogenic emissions, with a historical contribution of 116PgC (Lal 2008; Schlesinger & Amundson 2019). These emissions can be attributed to release of SOC from land cultivation, deforestation, and grassland conversion (Shukla et al. 2019). Focus on SCS is important as soils hold a larger stock of carbon than the atmosphere and it is important that the soil carbon stock is both protected and restored (Bossio et al. 2020, Ontl et al. 2015).

[18] A good indicator of the timespan of SCS study is a hint I found in an article published in 2001, that stated that: "Over the last decade there has been a high level of interest in carbon (C) sequestration as an efficient means for offsetting GHG emissions (See Antle et al. 2001)."

The potential of SCS to contribute to meaningful climate change mitigation is contentious in the field of soil science. Some studies estimate that between 63TgC/yr and 83TgC/yr of SCS is possible on US croplands and 500-800KgC/yr for US rangelands (Sperow et al. 2003; Sperow et al. 2016; Lal 2002).[19] This is significant because sequestration on this level could offset nearly all, or completely offset, U.S. agriculture emissions, which were 80.34Tg/Cyr in 2021 (EPA 2023). Globally, SCS has the potential to store between 1.6PgC/year and 5PgC/year (Smith et al. 2008; Zomer et al. 2017). This level of sequestration represents the offsetting of 8-10% of agriculture emissions globally (Shukla et al. 2019).

Soil degradation[20] has contributed to the need for increased fertilizer usage as well as land desertification,[21] which poses a further threat to adaptability to climate change (Shukla et al. 2019). The co-benefit of restored soil health is greater agricultural productivity, with the presence of increased SOC contributing to bettered soil health, which is particularly pressing due to the increased need for new food sources to feed an increasing global population (Lorenz & Lal 2018; Smith et al. 2019). Improved soil health also helps to combat land desertification mentioned above (Lal 2008). Increasing SOC stocks, then, generates adaptability effects that creates resilience to the effects of climate change and soil erosion (Vermeulen et al. 2019).[22]

2.10: Soil Carbon Sequestration in Soil Science

Soil carbon sequestration refers to the accrual of SOC in agricultural soils (Bossio et al. 2020), SOC content is heavily related to the levels of soil organic matter (SOM) that is present in

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[19] 1 teragram (Tg) is equal to 1 million tons, where 1 picogram (Pg) is equal to 1 gigaton.
[20] Soil degradation, also known as land degradation, can be defined as “a negative trend in land condition, caused by direct or indirect human induced processes, including anthropogenic climate change, expressed as long-term reduction and as a loss of the following: biological productivity; ecological integrity; or value to humans.” See Shukla et al. 2019
[21] Desertification can be defined as “land degradation in arid, semi-arid, and dry sub-humid areas resulting from many factors, including climatic variations and human activities. See. Shukla et al. 2019
[22] This is mostly due to the fact that best management practices that contribute to SCS also stop or slow soil erosion, particularly windbreaks, fencerows, and cover crops (Bai et al. 2018).

agricultural soils (Ontl et al. 2015). SCS is mediated by the three processes of photosynthesis, decomposition, and respiration (Ontl et al. 2015). Photosynthesis is the process in which atmospheric CO2 is absorbed by plant matter and eventually deposited into the soil through symbiotic relationships with fungi or depositing of carbon through plant roots (Ontl et al. 2015). The decomposition is the stage at which plant matter dies or remains 'recalcitrant' to decomposition, determining whether or not the SOC that was stored in it is released through the respiration process (Ontl et al. 2015). The recalcitrance of SOC in soil is also determined by soil erosion conditions, climatic character, and soil texture and composition (Ontl et al. 2015; Simone et al. 2017; Bai et al. 2018). A majority of SOC is found in the topsoil layer, within the top 100-120cm of the soil structure (Lal 2008; Bai et al. 2018).[23] The ability for soil to absorb and store carbon varies at different soil depths as well (Sperow 2016; Zomer et al. 2017). SOC levels and rate of sequestration of SOC are also affected by nitrogen fertilizer application rates, with evidence pointing to increased levels of nitrogen fertilizer application allowing for increased SOC levels due to increased vegetation growth stimulated by fertilizers (Powlson et al. 2011; Simone et al. 2017; Bai et al. 2018).[24]

Methods for increasing or maintaining SOM and therefore SOC in agricultural soils that are widely accepted as being "best management practices" (BMP) include reduced or no-till farming, residue management, integrated nutrient management, buffer strips, field borders, crop rotation, windbreaks, use of biochar, and the planting of cover crops (Smith et al. 2007; Lal 2008; USDA 2016, Bai et al. 2018). Studies in the U.S. have demonstrated that the planting of

[23] Wet climates, for example, are more conducive to SOC sequestration than warm and dry climates (Rusco et al. 2001). This, however, is not true for biochar applications (Bai et al. 2018).

[24] The application of nitrogen fertilizer for the purpose of SOC sequestration creates a dangerous precedent, as they contribute to high levels of water contamination and contribution to mass deaths of pollinators, as well as overlooking the carbon-intensity of fertilizer production methods that emit high amounts of carbon and other GHGs (Smith et al. 2008).

cover crops and decreasing field fallow, along with tillage changes, are the most effective methods for increasing SCS on croplands (Subak 2000; West & Six 2007; Paustian et al. 2016).[25] Cover crops and fallow reduction contribute to SCS as they introduce more organic matter to soils and ensure that soils are not disturbed, respectively. Ideally, these methods would be used in combination to create greater benefits and synergies, increasing the storage potential and permanence of SOC (Bai et al. 2018). Similar to the ability for different soil types in various climate zones to absorb carbon at varied rates, BMPs for SCS have varied impacts on carbon storage depending on where they are used (Bai et al. 2018). Beyond making modifications to farming practices, full-scale land-use changes from croplands to grasslands are effective pathways for achieving SCS. Indeed, cropland conversion to grassland is often more effective for SCS than changes in farming practices (Sperow et al. 2003).

A common theme amongst SCS practices is the level of uncertainty associated with the effectiveness of certain practices. Uncertainty manifests itself in multiple ways throughout the SCS process, including measurement, verification, permanence, and leakage (Cacho et al. 2013; Lorenz & Lal 2018). The underlying uncertainty of the theoretical potential of SCS has been debated in academic literature for the past thirty years (Pinto et al. 2010; Paustian et al. 2016; Oldfield et al. 2021). Disagreements range from debates over measurements, modelling methods, the inclusion or exclusion of certain ecological factors, or questions about whether or not the net flux of carbon in the photosynthesis cycle will bring substantial amounts of carbon into the soil (Pinto et al. 2010; Paustian et al. 2016; Oldfield et al. 2021). Theoretical discussion happens before the introduction of SCS practices into existing socio-ecological systems, economic

[25] Like many aspects of SCS studies, however, the effectiveness of no-till or conservation-till farming is highly varied. There are some authors that argue that minimum tillage helps to incorporate carbon deeper into soils, allowing for greater permanence of SOC as it is less likely to be eroded or re-released at deeper soil depths (Subak 2000; Sperow 2016; Zomer et al. 2017)

configurations, and the political landscape (Antle et al. 2001; Antle et al 2003; Cacho et al. 2013). In light of this uncertainty, the rest of this section examines both the benefits and limitations faced by SCS before examining the history of policies to encourage SCS practices.

2.12: MRV Principles for Soil Carbon Sequestration

The process for creating carbon credits from SCS activities involves numerous methods and standards in the MRV process. The different approaches of assembling carbon credits from SCS practices involve a number of accounting processes and soil carbon models. These differences lend themselves to a diversity of soil carbon protocols in both the regulatory and VCM spaces. Integral to these processes are the concepts of leakage, additionality, and permanency, which will be explored in this section as well. It is important to review these processes to understand how each protocol and, therefore, how each credit program is different. It is also important to explore these distinctions in order to disaggregate credits that are equivalent at the end of this process.

SOC monitoring can take place utilizing two methods. The first method is the direct measurement of SOC levels in soil by taking samples at the same location on a particular site enrolled in a SCS credit program (Mooney et al. 2004b). The soil sample is then sent to a lab for testing (Mooney et al. 2004b). Monitoring can also take place through a practice-based approach. As long as it can be demonstrated that farmers are committing to SCS practices on the land that they have enrolled in the carbon credit program, then monitoring is complete (Mooney et al. 2004a). There is an assumption made in practice-based approaches that commitment to SCS practices will generate a certain amount of carbon sequestration, depending on practice, soil type, climatic zone, amongst other factors (Mooney et al. 2004a). As long as the practices are being continued, farmland is assumed to be continuously storing carbon (Mooney et al. 2004a). The monitoring component also requires corporations and regulators to be clear about whether or not co-benefits are important to the SCS initiative and indicators, baseline assumptions, how data and what data is collected, and responsibilities for gathering data (Oldfield et al. 2021).

Before continuing, a clear distinction needs to be made here about the difference between payment-for-practice and payment-per-tonne programs. Payment-for-practice programs only require farmers enrolled in the program to commit to practices and are paid by corporations for committing to BMPs that create SCS (Antle et al. 2003). Payment-per-tonne programs operate similarly to other carbon credit projects; farmers enrolled in SCS credit programs are paid for each credit, equivalent to one tonne of carbon, that they generate through their BMPs (Mooney et al. 2004).

The reporting component of MRV refers to the delivery of data to verifiers or the compilation of data that is to be verified (Wartmann et al. 2013). Reporting requirements include specifying what format the data is reported in and who to report the data to (Wartmann et al. 2013). Important to SCS initiatives in the reporting process is the degree of aggregation at which data is collected and reported (Wartmann et al. 2013). Due to the verification and measurement costs associated with SCS projects, many soil scientists and SCS programs have encouraged the practice of aggregating farmland into parcels or packages for the creation of carbon credits, with corporations or NGOs serving aggregators in the VCM (Cacho et al. 2013; Oldfield et al. 2021). Aggregation is practiced in order to generate better and more accurate measurements, or to increase the number of carbon credits generated, as it is more costly to enroll in SCS credit programs on smaller areas of farmland due to enrolment costs (Cacho et al. 2013; Oldfield et al. 2021). Aggregation strategies are also pursued to decrease the total MRV costs of SCS projects as soil testing and verification represent high transaction costs which actualize as market barriers

(Oldfield et al. 2021). The practice of aggregation demonstrates that the scale at which data is collected at matters and informs the use of modelling for SCS estimation during the verification stage of MRV practices (Oldfield et al. 2021).

After practices have been confirmed or soil samples have been taken and tested by corporations, NGOs, or governments, the results are extrapolated in models. The practice-based approaches are inputted into models that take base estimations of the potential amount of carbon stored due to changes in practice and the duration of those practices to establish the amount of additional sequestered in soils (Antle et al. 2003). These models also consider the environmental factors mentioned above (Tang et al. 2016; Bai et al. 2019).[26] The models are developed through pilot testing on testing plots and extrapolated to fit larger and more diverse land sizes (Lal 2002). Similarly, the testing method requires the use of modelling unless an adequate number of samples are taken on a plot enrolled in a carbon credit program to extrapolate the amount of additional SOC that has been stored in soils (Lal 2002; Antle 2003; Mooney et al. 2004).

In payment-for-practice models there is no need for testing beyond verification that these practices are being completed on enrolled farmland. Payment-per-tonne models require models and testing to ensure that a change in SOC levels has actually occurred (Frydenberg 2018). Direct testing to get a comprehensive and accurate reading of SOC levels on enrolled farmland is time consuming and expensive, creating restraints on how economically viable such programs are (Mooney et al. 2004). Models, therefore, are utilized to make the verification less costly by applying an existing methodology to soil characteristics, climatic conditions, and practices, to extrapolate carbon sequestration, measured in tonnes, and generate credits from such an estimate.

[26] Examples of these models include the DayCent, RothC, EPIC, ECOSSE, and DeNitrification-DeComposition (DNDC) models.

Leakage refers to the displacement of emissions "outside of the project boundaries" (Murray et al. 2015, 127). This displacement of emissions is considered negative because this displacement of emissions often increases emissions elsewhere, causing the net flux of carbon to be zero or positive in some cases (Murray et al. 2015, 133; Thamo and Pannell 2016). Leakage is particularly important in the development of SCS initiatives due to their largely voluntary nature and consideration the historical leakage patterns of voluntary projects (Monsterrat & Sohngen 2009; Thamo and Pannell 2016).

Leakage can occur through two different avenues: activity shifting and market effects (García-Oliva and Masera, 2004, p. 351). Activity shifting describes effects of changing practices resulting in a shift in practices elsewhere to create a counteracting effect. An example of this would be an afforestation activity that prevents land from being used as agriculture, stimulating deforestation for agriculture elsewhere (García-Oliva and Masera, 2004, p. 351). Market effects refer to the ability of certain projects to have knock-on effects on market supply and demand (García-Oliva and Masera, 2004). A good example of this, while not directly related to SCS, is the growth of crops for biofuels affecting farmland availability and therefore the supply of food, affecting prices (Lee et al. 2004). The corresponding changes in food prices encourages the opening of new farmland, creating new sources of emissions, and therefore, leakage. While the complexity of possible socio-ecological knock-on effects makes preventing leakage difficult and rife with uncertainty, offset schemes have attempted to deal with potential leakage through creation of co-benefits, or through discounting and price adjustment measures (García-Oliva and Masera, 2004, p. 351).

Additionality figures prominently in the SCS initiatives due to the less-than-novel nature of farm management practices in certain cases. Unlike the CDM, ET, or JI projects under the

Kyoto Protocol, farmers changing practices is not novel (Boyd et al. 2011; Ando et al. 2022). Farming practices such as cover-cropping and no-till or conservation tillage have been practiced before the financial incentive of carbon credits existed (Ando et al. 2022). Emissions credit programs require that changes that occur are both financially and environmentally additional. This creates a divide between farmers who are already committed to SCS practices and those who are not (Thamo & Pannell 2016). The requirement to demonstrate "new practices", often incentivizes farmers to discontinue SCS practices, and then restart them in order to be made eligible for the program. This has deleterious effects on carbon sinks, such as soil, that is already vulnerable to reversal (Thamo & Pannell 2016). While additionality figures prominently, discussions in SCS programs about historical payments and historical measurements figure into the payment schemes of some programs (Thamo & Pannell 2016).

Additionality issues in SCS are further complicated by the establishment of different baselines amongst third-party verification organizations, regulatory bodies, and the corporations spearheading private sector SCS initiatives. SCS initiatives operate using a baseline-and-credit system, which requires the establishment of a counter-factual business-as-usual scenario for emissions reductions (García-Oliva and Masera, 2004; Thamo & Pannell 2016).

The establishment of baselines differ amongst scientific sources and therefore amongst organizations and corporations administering SCS credit schemes (García-Oliva and Masera, 2004; Thamo & Pannell 2016). The use of different baselines poses issues for comparability between credits as well as program integrity. Creating comparability between credit schemes is important, as not all SCS credit schemes are the same, will be of different quality, and therefore trade differently, theoretically. Integrity becomes an issue where baseline scenarios establish that SCS practices generate emissions reductions beyond what is actually occurring, generating surplus credits (García-Oliva and Masera, 2004; Thamo & Pannell 2016). The integrity issue amongst baseline scenarios becomes important when considering the accompanying measurement and verification issues associated with SCS credit schemes.

The issue of permanence - how long carbon is stored in soils - for SCS credit initiatives is perhaps the most pressing issue for verifiers and program administrators to grapple with. Permanence is at the mercy of numerous factors in SCS credit schemes, including practice type, natural flux factors, and contract length. Practice type affects how "permanent" SCS storage is by how deep the practice stores sequestered carbon in soils (Smith 2005). As mentioned above, SCS happens at very shallow soil depths, leaving it vulnerable to reversal. Once a field is plowed again, for example, carbon stored in agricultural soils is released, which poses an issue if farmers sell their land to another tenant that does not enroll in BMPs (Bossio et al. 2020). Practices that sequester carbon at deeper soil depths will increase the odds that that storage is "permanent". Similar to the issue of depth, flux factors such as weather events, increased temperature, and soil type, among other factors, also affect the permanency of SCS credit initiatives (Lal 2008; Sperow 2016; Zomer et al. 2017; Bai et al. 2018). The shallow depth of SCS storage leaves it susceptible to release through erosion and natural flux factors.

The most pertinent permanency issue for SCS credit schemes, however, is contract length. Contract length refers to how long farmers who have land enrolled in these programs are obligated to practice the BMPs that are required of them by the SCS program. Contract length ranges between 1-100 years (Cacho et al. 2013). Contract lengths are regularly in the 1–25-year range, after which farmers are allowed to discontinue the BMPs that are conducive to SCS (Oldfield et al. 2021). Discontinuance of these BMPs allow for the release of stored carbon into the atmosphere, effectively nullifying the mitigation during the program.

Contract length poses a dual problem in SCS credit schemes. The first is that contract lengths of 1-25 are years are far too short for storing carbon (Lorenz & Lal 2018). For meaningful reductions and sequestering, the timelines of contracts should fall around the 100-year mark (García-Oliva and Masera, 2004). It could be argued, however, that 100 years is not long enough either, where the residence time of carbon in the atmosphere is much longer in reality, closer to 300 years, which is still an underestimation of the lifespan of atmospheric carbon (Archer 2005).[27] The other side of the permanence and contract-length issue is an inequity of burden of responsibility on farmers to practice BMPs over long periods of time, as well as technology lock-in. Locking farmers in to continuing SCS BMPs on their land for a prolonged period of time precludes them from adopting farming practices that might positively affect their livelihood or which have greater beneficial environmental or productive outcomes. These practices include agroforestry, greater crop diversification, and management of landscape elements such as windbreaks and riparian buffers (Wezel et al. 2014). The advance of farming technology and practice over the past 80 years alone demonstrates the rapid pace at which science and technology have advanced. Locking farmers into such practices for 100 years does not allow them to adapt to technological innovations or to a changing climate, which is inevitable, forcing them to bear the burden of climate action while incurring new costs. This is more evident when considering the legality of such SCS credit scheme contracts, where farmers may be liable for discontinuance of such BMPs (Cacho et al. 2013).

The acceptance of the high-risk impermanence and uncertainty inherent to SCS projects poses serious environmental issues. Kirschbaum (2004) highlights the risks of temporary carbon sequestration to climate change projections. The author demonstrates that carbon released from

[27] The lifespan of carbon in the atmosphere could be observed on the order of thousands of years. See Archer 2005.

temporary storage would increase atmospheric CO2 concentrations beyond the level they would have been at without the temporary storage (Kirschbaum 2004). Increase in CO_2 concentration is due to the allowance of new or continued emissions through the issuance of carbon credits. The impacts of the release of temporary carbon storage are the "instantaneous effect of increased temperature; through the rate of temperature increase; as the cumulative effect of increased temperatures" (Kirschbaum 2004, 1151). Accepting the impermanence of SCS credit schemes, therefore, is at odds with mitigation goals, even if the economic issue of permanence is solved.

2.16: Climate Smart Agriculture & Digital Agriculture

Modern SCS credits programs are closely related to previous SCS credit programs such as the previous CCX No-Till Protocol, Australia's Carbon Farming Program, and Alberta's Conservation Cropping Protocol. New SCS initiatives, however, are driven by and the frame of climate smart agriculture (CSA) and the trend of the digitalisation of agriculture. It is crucial to understand CSA and digitalisation in order to understand how novel private SCS credit initiatives work and how these initiatives are both justified and contribute to the future of agriculture. This subsection first discusses the origins and goals of CSA, and then explores the digitalisation of agriculture.

Climate change demonstrates a threat to food and agricultural systems as increased weather volatility, new diseases, pests, and land degradation are obstacles to food production (Chandra et al. 2018; Lipper et al. 2014; Khatri-Chhetri et al. 2017). This dual relationship between climate-change and agriculture, where agriculture both contributes to and is threatened by climate change, generated interest among UN institutions, particularly the Food and Agriculture Organization (FAO) and the World Bank, in the mid-2000s. To address these issues, the FAO developed the concept of climate smart agriculture. CSA takes a "triple-win" approach to agriculture, with the goals of increasing food production, farmer well-being and income, and improved environmental outcomes. The third "win" of CSA is the integration of adaptation and mitigation planning into agriculture (Lipper et al. 2018). CSA initiatives connect directly to the creation of carbon credit markets. The objective of creating climate change mitigation in CSA initiatives has involved SCS projects since their development. The storage of carbon in soils is a "win-win" of helping to increase food productivity while mitigating climate change. The consideration of climate change in "the planning and implementation of agricultural policies, planning, and investments" is what makes the required increase in production in the agriculture sector "climate smart" (Lipper et al. 2014; Khatri-Chhetri et al. 2017; Chandra et al. 2018; Taylor 2018). Additionally, and important to the advertising of private SCS credit initiatives, is the promise of a new source of revenue from the production and sale of SCS credits, completing the "triple win" objective.

Digital agriculture, smart agriculture, precision agriculture, or "Agriculture 4.0"[28] are all terms used to describe the implementation of new digital monitoring and decision-making tools in agriculture. Digitalisation refers to the mass deployment of equipment sensors, soil sensors, weather sensors, and aerial and satellite monitoring for the collection of mass amounts of "minute field-level data" in real-time (Pham & Stack 2018). Digital agriculture practices also include the use of GPS, geomapping, and mass interconnected communication systems to link data collection from the myriad of sources on the farm to one location (Pham & Stack 2018; Budaev et al. 2018; Carolan 2018). Digitalisation becomes precision farming when the data fed to the cloud system that it is stored on allows for farmers to make management (chemical application or seeding) decisions based on a few square feet, rather than an entire field

[28] There also seems to be some disagreement here. Some have called the digitalisation of agriculture "3.0" while others have called it "4.0".

(Balafoutis et al. 2017; Carolan 2017). Planting and fertilizer decisions can also be suggested to farmers through AI or algorithmic programs that are integrated into the data gathering systems that complete the digital agriculture suites (Clapp & Ruder 2020; Lioutas et al. 2018). Recommendations supplied by digital platforms are based on the vast amounts of data, roughly 7 gigabytes of data produced by farmer activity and collected through digital agriculture platforms per acre of farmland (Carolan 2017). Big data is valuable for its predictive power, and this is especially true for the agriculture sector (Bronson and Knezevic, 2016; Carolan, 2018; Clapp & Ruder 2020**)**.

Digitalisation plays an important role in emerging carbon credit programs that are developing in the private sector as well as CSA programming. Through the application of variable rate technology (VRT), referring to the minute, square-foot level, real-time application of chemicals, digital agriculture proponents argue that farming becomes more efficient (Bronson 2019; Rolandi et al. 2021). Efficiency and minute-level decision-making, the logic goes, leads to selective application of chemicals, and an overall decrease in the amount of chemicals needed, leading to better environmental outcomes (Aubert et al. 2012; Clapp & Ruder 2020). Along with this environmental benefit, digitalisation promises greater efficiency and higher agricultural output, leading to a second “win” in the CSA checklist (Balafoutis et al. 2018; Clapp & Ruder 2020).

Digital agriculture, then, fits neatly into the category of dominant CSA framings. Digital agriculture is also imperative to the deployment of carbon credit initiatives, allowing for monitoring of soil health, best management practices, chemical usage, and fuel usage on farms. As we will come to see, this is particularly true for private carbon credit initiatives in North America, as all of the agribusiness firms with carbon credit programs also encourage or require the use of their digital agriculture platforms. In some cases, North American agribusiness firms have multiple digital services that farmers can (or must) subscribe to. Digitalisation, CSA, and carbon credit initiatives are deeply intertwined with one another, forming a suite of changes in agriculture that will likely work with each other to simultaneously transform and lock-in dominant agriculture practices.

2.16: Current SCS Credit Initiatives

There is a diversity of private SCS credit programs that are operating in the U.S. and Canada at present. Table 1 provides the details of carbon programs, including models used, practices required for eligibility, payment scheme and rate, and acre requirements, if applicable. Notably, all carbon credit programs require the implementation of no- or reduced-tillage farming practices. Many also require the use of cover crops, or where cover crops are optional, the program will pay more for their implementation. Few programs require the implementation of a nutrient or chemical application management program. Interestingly, there is a diversity of payment-for-practice and payment-per-tonne schemes amongst private carbon credit programs, with an almost even split between payment models. Table 2 in Appendix D outlines the contract lengths of these programs, with contract lengths ranging from year-to-year to 10-year contract lengths. For year-to-year contracts, there is no penalty for practice reversion, with most programs paying for years that farmers verifiably implemented eligible SCS practices. Interestingly, corporate documentation and advertisement of SCS credit programs do not mention issues of additionality, leakage, or reversal. While this flexibility is perhaps beneficial for farmers, and is often outside of their control, there are reasons to be skeptical of the effectiveness of private SCS credit programs if they are not addressing these issues which are crucial to demonstrating actual emissions reductions.

Initiative Name	Model	Practices	Payment Scheme	Payment Rate	Acre Requirement
Carbon Program by Farmers Edge	CCP, NERP	reduced or no-till, cover crops	Per acre for practice implementation	$15	Unlisted
U.S. Carbon Program by Bayer	Gold Standard for the Global Goals	no-till, strip-till, cover crops	Per acre of practice, yearly	$5-$6 for tillage, $6 for cover crop, can be combined	10 acres
CIBO Carbon Credits	VM0042/SALUS	Conservation tillage, no-till, crop rotation, cover cropping, reduced chemical application	Payment for practice per acre OR per tonne of carbon sequestered	$35 for cover crop and no-till OR market price	Unlisted
Carbon by Indigo	VM0042, Aster Global	Reduced till, nitrogen management, cover crop, crop diversification	Payment per tonne of carbon sequestered	Producer receivers 75% of credit sale price	Unlisted
Nori Carbon Removal Marketplace	U.S. Croplands Methodology, Aster	Reduced-till, cover crops	Per tonne of carbon sequestered	$15/tonne sequestered	Recommended minimum of 500 acres
RegenConnect by Cargill	CAR Soil Enrichment Protocol, DNDC	Reduced till, cover crops	Per tonne of carbon sequestered	$25/tonne	No minimum
Smart Carbon by Nutrien	CCP, NERP	Cover crops, reduced/no-till, nitrogen management	Per tonne of carbon sequestered	70% of credit sale price	750 acres
CarbonNOW by Locus AG	Internal	Application of Locus AG's probiotics, no-till, cover crops, fertilizer use	Payment per acre of practice	$12 per acre minimum payments plus performance bonuses	Unlisted
TruTerra Carbon	Internal	No-till, conservation tillage, soil cover	Per tonne of carbon sequestered	$25 per tonne of carbon sequestered	Unlisted
Eco-Harvest by ESMC	ESMC Protocol	Cover cropping, conservation tillage, crop rotation, nutrient management	Per tonne of carbon sequestered	Farmers receive market price for carbon, minus ESMC costs	No minimum acreage
Agoro Carbon Alliance	Verra VM0042	Conservation tillage, cover crop, nitrogen and fertilizer management	Per tonne of carbon sequestered	Minimum $16.50 per tonne	500 acres
Gradable Carbon by Farmers Business Network	Internal	reduced or no-till, cover cropping, crop rotation, nitrogen management	Per tonne of carbon sequestered	$20 price floor	Unlisted
Corteva Carbon Initiative	Indigo	Reduced tillage, cover crops, biodiversity, nitrogen management	Per tonne of carbon sequestered	Minimum price of $20 with market upside	Unlisted
Global Carbon Farming Program	Internal	Unlisted	Unlisted	Unlisted	Unlisted
Rabobank	Rabobank	Reduce or no-till, cover cropping, crop rotations, chemical management	Per tonne of carbon sequestered	Market price	1,000 acres

Table 1:Technical details of private SCS initiatives in North America[29]

[29] ESMC 2020; Bayer 2021; Nutrien 2021b; Bayer 2022a; Cargill 2022; TruTerra 2022a; TruTerra 2022b; United Soybean Board 2022a; United Soybean Board 2022b; United Soybean Board 2022c; United Soybean Board 2022d; Agoro 2023a; Agoro 2023b; CIBO 2023a; CIBO 2023d; ESMC 2023e; ESMC 2023f; Indigo 2023a; Indigo 2023b; Locus Agricultural Solution 2023; Nori 2023a; Nutrien 2023b; ReGrow 2023a; ReGrow 2023b; TruTerra 2023a; TruTerra 2023b

2.17: Conclusion

The history of carbon offset trading and markets demonstrate a few key features and issues in their evolution through early economic reasoning, into regulatory markets, and into the creation of parallel VCMs. The first is the importance of flexibility in the ways actors are able to meet their emissions reductions targets. The use of market mechanisms theoretically allows actors to meet their emissions reductions targets through the most cost-effective means available to them. The VCM doubles-down on this aspect of flexibility, creating a low transaction cost environment to experiment with new projects and creating co-benefits in development objectives. The importance of MRV standards, as well as concepts of additionality and permanence will play important roles in later analysis. These shared objectives and requirements are important links from the history of carbon markets into the present as offset schemes are still grappling with these issues. The issues of MRV, additionality, and permanence are equally important for insetting schemes where corporations are the ones undertaking MRV practices and generating definitions of additionality and permanence in creating their own insetting strategies. The importance of carbon emissions pricing in markets and insetting schemes will only increase as corporations continue to make net zero pledges or work to meet their targets. Figure 3 demonstrates the volatility of carbon prices, proxied through carbon emissions futures prices. The "net zero" pledges that corporations are making are increasingly taking the form of insetting initiatives within and beyond company supply chains. Understanding insetting, insetting markets, and MRV protocols that enable this are crucial for understanding new private SCS credit programs in the agriculture sector.

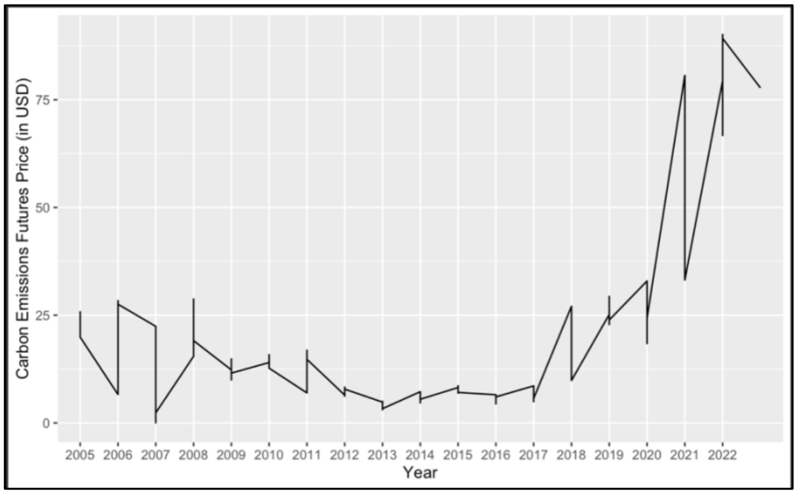

Figure 3: Carbon emissions futures prices from 2005-2022 in USD($)[30]

The increasing price of carbon demonstrates that carbon credits will play an important role in climate policy and beyond as a resurgent potential financial asset and a source of profit-making for traders.

The literature review completed in this chapter also demonstrated that there are numerous issues and considerations surrounding SCS credit programs. Methods for sequestering carbon in soils have reached consensus in the soil science community, coalescing around the increase or preservation of organic material in soils through the implementation of no- or conservation-tillage and the installation of cover crops. The sequestering of carbon in soils is possible due to the historic loss of carbon through industrial farming methods. Carbon depleted soil acts as the baseline from which SCS credits are generated through particular MRV protocols. These protocols operate differently, and function based on different models, assumptions, and stringencies. The section also introduced issues of permanence, additionality, and leakage, and the role they play in implementing SCS credits, as well as in MRV protocols. Corollary trends to SCS credit programs were also investigated, particularly CSA and digitalisation. CSA provides

[30] Source: ca.investor.com

the general sustainability framework under which SCS credits find their legitimation, while digitalisation of agriculture is crucial for the operationalisation of SCS credit systems through monitoring and verification. Finally, some current and historic examples of SCS programs in North America were presented to provide background and a case for comparison for private SCS credit initiatives.

Chapter 3: Methods & Results

This thesis relies on qualitative and quantitative data from interviews and documents. The thesis relies mostly on qualitative data, focusing on exploring aspects of the social world embedded in people's values, experiences, perceptions, and motivations (Mason 2002, 1; Silverman 2007). Qualitative research must formalize institutional and individual interactions into a methodology by asking questions systematically to generate data on how different aspects of the social world generates attitudes, opinions, and perceptions (Mason 2002, 1; Silverman 2007). In this chapter I focus on the development of an interview and document review methodology for my thesis project.

3.1: Why Interviews?

The choice to use interviews for my thesis project originates in the alignment between my ontological and epistemological approaches to my research. Qualitative research takes the ontological position that "knowledge, views, understandings, interpretations, experiences, and interactions" amongst people are meaningful to the understanding of reality. (Mason 2002, 63) This aligns with my questions on motivations to launch private carbon credit initiatives, assuming that these initiatives were a product of a multitude of pressures from controlling shareholders, technology, public opinion, and interests in generating profit, utilizing new technologies, and a concern for sustainability. Similarly, the effects of private carbon credit initiatives on farmers are based on perception and are dependent on factors such as existing farm practices, opinions on sustainability, jurisdictional context, public opinion, availability of technology, and perceptions of personal economic well-being. There are a multitude of factors affecting each actor in complex ways that influences their decisions and values and which, in turn, affect their socio-ecological landscapes (Mason 2002; Roller and Lavrakas 2015).

Interviews as a data source become relevant when considering the epistemological position that I believe provides data on motivations and perceptions that can be gathered by talking with corporate actors and farmers, and asking questions of them to access their experiences, knowledge, and understandings (Mason 2002). Open-ended questions provide respondents the opportunity to reconstruct their knowledge and social context in normative language (Kvale 2007; 11). The use of normative language is important as my ontological views validate the value perceptions made by the corporate actors and farmers whom I interviewed. Data on values and perceptions are not readily available, and seeking out this information through interviews provides me with the ability to access this information (Kvale 1996 and 2007; Mason 2002). Further, private agricultural carbon credits are relatively new, meaning that there is little documentation available. Interviews, therefore, are important not only for ontological and epistemological purposes, but also from a data availability standpoint (Mason 2002).

Overall, I take a "localist" approach to understanding interviews (Qu and Dumay 2011). I do not see the interview solely as an opportunity to obtain knowledge, but as a method of obtaining situated accounts of social phenomenon. I am looking to understand complex processes that are interpreted by those involved within them. The interview, then, is understood as a conversation, seeking to both gain and construct knowledge through a set of questions (Kvale 2007; Qu and Dumay 2011).

Semi-structured interviews utilize an interview guide with questions that are based around a few central themes that interest the researcher (Qu and Dumay 2011; Alshenqeeti 2014). Semi-structured interviews give the researcher the ability to ask questions in the interview guide out of order and allows the researcher the opportunity to ask follow-up questions of the respondent based on their responses (Qu and Dumay 2011; Alshenqeeti 2014). The ability to ask follow-up questions provides the semi-structured interview the characteristic of being more like a conversation, where the respondent helps to shape the interview process and the researcher still plays the main role of listener (Mason 2002; Qu and Dumay 2011; Alshenqeeti 2014). Given my localist approach and desire to follow certain themes to understand values, motivations, and perceptions amongst the populations I have selected, I have chosen to conduct semi-structured interviews, allowing me to access further detail on respondent answers.

3.2: Assumptions

In conducting an interview-based study with semi-structured interviews, I am making several assumptions. I am assuming that respondents can provide a relatively accurate recollection or narratives of the motivations about which I am inquiring (Alshenqeeti 2014). Given that the information that I am inquiring, such as motivations and values, can change, this assumption is significant, and is difficult to deal with (Alshenqeeti 2014). Secondly, I am assuming that I can reduce the bias in my interview questions. Finally, I am assuming that there is value in conducting semi-structured interviews and understanding the respondent's knowledge within broader social processes (Mason 2002; Kvale 2007). This assumption is based in my epistemological beliefs that talking with other people to gain their knowledge, experiences, and perceptions is best way of gathering data to support my investigation and answer the questions that I have posed.

3.3: Document Analysis

Document analysis also incorporates a broad range of different methods as well, including content analysis, discourse analysis, or narrative analysis (Yin 2014). Caulley (1983) describes document analysis as "the analysis of documents in order to gather facts" (20). Bowen argues that "document analysis… is not a matter of lining up a series of excerpts from printed material to convey whatever idea comes from the researcher's mind" (Bowen 2009, 6). Document analysis, no matter the type of analysis involves four steps: finding, selecting, appraising, synthesizing.

The finding stage involves determining what sorts of documents are out there and what is available to the researcher. The researcher then collects documents that are available and of interest to them. The selection stage involves parsing through the "found" documents and determining which documents are "valid" and relevant for the research (Bowen 2009). This "validity" test also includes a test of completeness, credibility, accuracy, and representativeness (Bryman 2012; Bowen 2009). The appraisal stage then determines whether the researcher will use methods such as content analysis or discourse analysis (Bowen 2009; Yin 2014). In total, however, the appraisal involves an iterative process skimming of documents for a first pass on relevant text passages; more through reading and examination; and interpretation (Bowen 2009, 4-5). The synthesis stage involves compiling codes or coded sections and creating and interpretation out of the meaning of the coded sections or the occurrences of codes created in the text.

Documents refer to a wide variety of artifacts, such as government reports, quarterly corporate reporting, ESG documents, and newspaper articles. Looking beyond the possible formats that documents can take, Atkinson & Coffey (1997) argue that a document is a "social fact". The stipulation that documents are "social" facts, demonstrates the special nature of documents, being that they were written by certain people for certain purposes (Coffey & Atkinson 1997, 108). Document analysis is unique since it does not require the researcher to go "out" and collect data. As mentioned above, documents are created by certain people for certain purposes or audiences, which means that documents must also reflect certain social or political circumstances (Miller & Alvarado 2005). Indeed, as Atkinson and Coffey (1997) argue, data cannot be collected, rather, it is fashioned out of "transactions" with other people and that "we create worlds and the social actors that we observe" (108). Caulley corroborates this view, stating that "evaluation" of documents means interpretation and reinforcing that "facts do not speak for themselves", but must be interpreted and processed before they can be used (Caulley 1983, 20). A proper representation of documents in research, then, involves understanding the position of the author of the analyzed documents, as well as the purpose of the document. It is then the job of the researcher to place this document within a broader context to be able to analyze documents thoroughly.

3.4: Advantages and Limitations of Document Analysis

Document analysis has the advantage of dealing with data sources that are static and non-reactive. By static I mean that documents, once accessed, do not change (Miller & Alvardo 2005; Bryman 2012). While documents may be updated, they will not generally change after they are published. The static nature of documents is important in allowing reproducibility of the study. Related to the static nature of documents, they are also non-reactive, meaning that the interaction of the researcher with the data source does not affect the source (Atkinson & Coffey 2007; Bryman 2012). Researcher-subject interaction, particularly in interviews or ethnographic studies, has been written about extensively, and stresses the importance of the changing attitudes/views of subjects during the research project (Atkinson & Coffey 2007). Documents as a data source do not face this issue.

In terms of disadvantages of document analysis-based research, document availability and document context and content. Document availability becomes an issue when documents are not made publicly available or are available but have restricted availability. This presents an issue for document analysis studies as lack of available documents limits the scope of the study which might lead to the omission of key context and information (Miller & Alvarado 2005). As mentioned above, documents are written by certain people for a certain purpose, which leads us to question what information could be missing from the studied documents, and the reasons for omitting such information.

3.5: Why Document Analysis?

Document analysis was chosen as a method for this study because corporate documentation contains novel information about private carbon credit initiatives. According to Yin (2014), documents can be a source of novel information for case-study based projects. In this case, the only data available about private carbon credit initiatives comes from self-published corporate documentation about the goals and technical aspects of programs as well as official corporate activity reporting. Document analysis can also act as a data source replacement in cases where other methods cannot be used to access available information (Murphy 1980; Miller & Alvarado 2005; Bowen 2009). In the case of my study, this is particularly true for corporate actors, who, with the exception of one interviewee, were largely unresponsive to requests for interviews, documents can act as an important source of information on motivations, values, and goals embodied in private carbon credit initiatives. Finally, document analysis serves as a method for "triangulation" to understand particular issues or concerns that arose in my literature review and the interviews that were completed. Triangulation helps to increase validity and comprehensiveness, helping to demonstrate where data sources converge (Bowen 2009; McNabb 2010).

The document analysis for this project follows the document analysis process outlined by Bowden, cited above:

1. Finding – the private carbon credit initiatives outlined in Section 6 represent the relevant cases for which documents must be located. Relevant self-published documentation by agribusinesses and NGOs, as well as news articles about each initiative will be collected.
2. Selecting – documentation describing the initiatives as well as their status, technical requirements, and external perspectives will be selected.
3. Appraising – each document will be read and then relevant sections coded based off of established themes from the literature and interviews.
4. Synthesizing – coded sections will be compared for content, rather than number of instances of themes and terms in order to add to a narrative analysis of texts.

3.6: Analyzing Documents

This document analysis will take the form of a narrative analysis. While the main purpose of the document analysis is to gather information about the goals and technical aspects of private carbon credit initiatives, the project aims to provide a narrative about the development of these programs as well as tying in broader socio-ecological and political economic concerns. This means that the gathering of technical information will be further analyzed in the context of climate change, corporate expansion and consolidation in the agribusiness sector, and topics of capitalism and accumulation. The technical information gleaned from the document analysis informs the goals and outcomes of these programs and is triangulated with literature surveying these issues, as well as themes that emerged during interviews. The narrative analysis is systematic in that the technical standards and aspects of each carbon program will be surveyed identically and then synthesized to understand trends from which broader connections can be drawn. (Yin 2014) This is particularly important for political economic analysis of these programs as it allows me to complete power analyses.

3.7: Interview Parameters

Five different populations were selected and contacted for interviews in this project: employees at agribusiness firms with carbon credit programs; employees at NGOs involved with farmer interests; and farmers involved with carbon credit initiatives; public servants in the U.S. Federal Government; public servants in the Canadian Federal Government. Public servants were also selected for interviews in this study to provide a better understanding of changing policies and regulations with regards to carbon markets in the agriculture sector. Prospective participants were contacted through publicly available contact lists, contact forms, or through the direction of organizations contacted through general inquiry emails. Further, interviewees were suggested to me through existing contacts and snowball sampling. In total, 11 U.S. Federal Government employees; 47 Canadian Federal Government employees; 26 NGOs; and 22 agribusiness firms were contacted. This contact list was generated through preliminary research on government departments, NGOs, and corporations involved with carbon credit programs, as well as by the recommendation by interviewees. In order to interview farmers, I contacted farmers unions in the U.S. and Canada to get access to mailing lists in order to source interviews.

In total, 14 online interviews of lengths 30-60 minutes were conducted. The breakdown of interviewees is as follows: 5 U.S. Government employees; 1 Canadian Federal Government employee; 1 corporate agribusiness employee; 3 NGO employees; and 4 NGO employees who are also active farmers. This distribution leads to a potential skewing of responses towards critical views on privately led soil carbon credit initiatives. The purpose of completing a document analysis is to attempt to rectify this data skewing by gaining access to material on corporate viewpoints, procedures, and methodologies. This assumes, however, that documents are a perfect representation of corporate viewpoints. Further, corporations were given equal opportunity to participate in interviews but were unresponsive.

In the case of public service workers in the U.S. and Canada, employees generally responded directly or directed me to coworkers in their department. NGOs generally put me in contact with employees that had special knowledge in carbon markets and agriculture. Corporate contact forms were left unanswered, except for one case where general media inquiries put me in touch with an employee in the firm. Farmers were generally difficult to contact outside of direct referrals, as email inquiries about farmer interviews to farmers unions were left unanswered. After interviews were conducted, they were transcribed through the speech-to-text function in Microsoft Word and edited for grammar and clarity, with changes being confirmed with interviewees. Corporate actors were asked to describe how their carbon credit programs and MRV practices operated, how they saw carbon credits as contributing to sustainability, the implementation of digital technologies in agriculture through these initiatives, and the significance of market structures in guiding these programs. Farmers were asked about their views on sustainability, how practices such as no-till and cover crops contributed to sustainability, their views on the implementation of digital farming technologies, and the role of agribusinesses in responding to climate change. NGO employees were asked about their views on market structures, revenue opportunities for farmers, the operation of MRV practices for carbon credit programs, and whether it was significant that agribusinesses were leaders in the space. Public servants were asked about the significance of the role of agribusiness firms in creating market spaces, whether there has been interaction between agribusiness corporations and the government in these spaces, and how they viewed current and future policy direction vis-à-vis soil carbon credits in regulatory and voluntary markets. Appendix A contains a detailed list of questions that were asked to each group, respectively.

3.8: Document Analysis Results

The document review for this project consisted of gathering documentation by the 15 agribusiness firms that are administering carbon credit programs in North America. Documents such as corporate ESG reporting, annual reports, corporate websites, self-published news releases, documentation outlining carbon credit programs, as well as news releases from news outlets were included in the analysis. The documentation that was gathered was analyzed for selling scheme, contract length, minimum acres, models used for projecting SCS, eligible geographic areas and farming practices, payment arrangements, and the characteristics of any digital agriculture tools used in the SCS credit initiative. The summarized results of the document analysis are included in Tables 1, 2, and 3 in Appendix D. Information about the partnerships between agribusiness firms, agrifood firms, technology companies, buyers, and verifiers were also collected in order to examine the presence of consolidation in the industry.

Chapter 4: Factors Motivating Agribusiness to Engage with SCS Initiatives

This chapter explores the reasons for why agribusinesses in North America might have been motivated to engage in SCS credit programs in order to answer the first set of questions posed by this thesis ask: “Why are carbon credits appearing in the agricultural sector? What interests do private actors have in agricultural carbon credit initiatives?”

I argue that agribusinesses had three main motivations for engaging in SCS credit initiatives: 1) changes to policy surrounding carbon markets, and regulations regarding emissions reporting and carbon tax; 2) opportunities to improve their reputation; and 3) new profit opportunities, particularly the ability of agribusiness firms to utilize data gathered through the surveillance of digital agriculture platforms to exploit farmers more minutely. Each of these motivations and critiques are discussed in separate sections below. This section analyzes interview data, scholarly literature, and information gathered from publications on private SCS initiatives to provide answers to these questions.

4.2: Responding to New Policies and Regulations

Three new policy and regulatory developments including the Paris Climate Agreement, the EU’s Carbon Border Adjustments, and rules proposed by the U.S. Securities and Exchange Commission to standardize climate and emissions reporting represent motivating factors for agribusinesses to engage with carbon credit initiatives. Further, policy changes, particularly in the U.S., such as the United States Department of Agriculture’s Climate Smart Commodities Program and the proposed Growing Solutions Act incentivize agribusinesses to move into SCS credit spaces (14231037).

4.2.1: Paris Climate Agreement

The 2015 Paris Climate Agreement represents the successor to the Kyoto Protocol in terms of its scope as a comprehensive international climate action agreement, but also in the revival of carbon credit markets. As mentioned in Chapter 2, the development and elaboration of Article 6, which establishes Internationally Transferred Mitigation Outcomes (ITMO) and a new carbon credit market, demonstrates a potential market stabilizer and demand driver for carbon credits. While the sales or transfers of ITMOs are meant to take place between and claimed by nation-states, ITMOs generated by states and corporations under Article 6 are able to be bought and claimed by corporations looking to meet voluntary commitments (Fattouh & Maino 2022). It is also unclear who is eligible to generate ITMOs, however, a corollary goal of Article 6 is to create robust, “sovereign markets”. Agribusiness corporations may be looking to get ahead of national policy surrounding carbon markets. In sum, the establishment of Article 6 provides similar market stability to the VCM, similar to the Kyoto Protocol, by providing new demand avenues and legitimation of current VCM activities.[31, 32]

4.2.2: Reporting Standards

When completing document analysis, news reports indicated new changes to SEC reporting rules that would impact corporate reporting on climate change risks and emissions. On March 21, 2022, the SEC released a proposed rule change, entitled: *The Enhancement and Standardization of Climate-Related Disclosures for Investors*, for public comment. The new proposed rules would require corporations to include climate-related risk disclosures on both the

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[31] Fattouh & Maino (2022) point out, however, that the ITMO market could disrupt the VCM.
[32] Surrounding the Paris Climate Agreement, one interviewee pointed to the 4p1000 movement, which seeks to increase the level of carbon in the top 30-40cm of soil by 0.4% every year (Interview 12423335). The movement has gained significant traction at the UN as part of the institutional pivot to nature-based solutions for climate changed (Amelung et al. 2020).

material impacts of climate change on business operations, as well as impacts on financial statements (SEC 2022). It might also require corporations to include select GHG metrics on their statements to help investors evaluate risk. Importantly, Scope 3 emissions are included in the GHG metrics that the SEC is proposing rule changes for. In their rule change document, the SEC acknowledges that: "Depending on the size and complexity of a company and its value chain, the task of calculating Scope 3 emissions could be challenging (SEC 2022, 209)." The SEC goes on to note that data on Scope 3 should become more available as other corporations collect data on Scope 1 and 2 emissions, which supposedly could be data on Scope 3 for another corporation.

The inclusion of Scope 3 emissions is important for agribusinesses and agrifood firms as their supply chain does not consist of corporations but thousands of independent farmers. Scope 3 emissions data accumulation, as described by the SEC, therefore, is not possible for the agriculture and food sectors. Two motivations, then, exist to explain why agribusiness firms might be motivated to involve themselves with SCS credit initiatives.

First, the proposed SEC rule changes require increased transparency about the environmental impacts of agribusiness and agrifood firms. Given the number of emissions generated by both agribusiness and agrifood sectors, the SEC rule changes are a source of risk exposure to these firms. As investors have a better understanding of climate-related risk for agribusiness firms, they may have interest in investing their money elsewhere, while reporting would give public access to emissions data, risking their reputation. Further, having a better understanding of emissions may lead to more stringent regulations, creating regulatory risk as well. Engaging with SCS carbon credit programs provides an opportunity to both of these industries to lower their emissions before reporting is required.

Secondly, the lack of Scope 3 emissions data and the impossibility of data accumulation to facilitate Scope 3 emissions data in the agriculture and food sectors provides new business opportunities for those corporations that are best suited to provide data on farm-level emissions, such as agribusiness firms. SCS credit initiatives and low-carbon grain market programs are a prime opportunity to collect Scope 3 data, as the deployment of digital farming technology through these programs. This farm-level data can then be sold to corporations who are looking to fulfill reporting requirements.

Advertising on the part of agribusinesses for these programs place the emphasis of insetting and meeting the demand of scope 3 emissions reductions in the agriculture and agrifood sector. In CIBO's advertisement of their scope 3 programs, they state that their program will help corporations to:

> "Understand the carbon emissions reduction potential of various regenerative practices, and incent growers to make changes through pay-for-practice programs, carbon farming, carbon offset projects, or even discounts. Monitor, verify, and report on the results (CIBO 2023)."

The implementation of these insetting programs assists corporations in not only calculating their scope 3 emissions but providing traceable agricultural commodities and verification of "climate smart" practices that would lead to scope 3 emissions reductions that corporations can claim in their buying practices. All of the private carbon credit programs, except for Nori, CarbonNOW, and BASF, have initiatives that help corporations determine scope 3 emissions in their agriculture supply chain and help them meet their goals through certified carbon reductions. While less formalized insetting programs within SCS programs administered Nutrien, Farmers Edge, and Cargill exist, more formalized versions can be found elsewhere, particularly in sustainable commodity sourcing. Sustainable commodity markets seek to connect sellers of verified low-carbon agriculture commodities with buyers, in order to lower carbon emissions from upstream sources. CIBO's CarbonLab and Indigo's Market+ Source Program are geared to specifically to the quantification of scope 3 emissions in agricultural supply chains, while Gradable and TruTerra offer similar services (CIBO 2022b; CIBO 2023e; Indigo 2023g; Gradable 2023b; Truterra 2023a & b). ESMC has perhaps the most advanced scope 3 tracking program through their EcoHarvest program, partnering with SustainCert to provide verification of emissions reductions along the supply chain (ESMC 2022; SustainCert 2023).

Gradable's Market+, Indigo's Market+, ESMC's EcoHarvest program, Bayer's fledgling insetting program, and TruTerra's Market Access Program represent formal market arrangements for aggregated and verified "low carbon" grain or other agricultural commodities. The creation of markets for low-carbon commodities is distinguishable from other insetting programs. Marketplaces which are created for the purchase of low carbon commodities is different from the direct offering of incentives to growers through some of these digital agriculture platforms that is often integral to the operation of private SCS credit programs (Cargill 2023b; CIBO 2023a; ESMC 2023f).

A few counterarguments exist to the view that the SEC rule changes as a motivating factor for agribusiness firms to engage with SCS credit initiative. The first is timing, as many SCS credit initiatives began their pilot stages prior to the proposed rule changes in 2022, with most initiatives beginning in 2020 or 2021. The second counterargument is that frameworks for climate-related risk disclosures existed well before the proposed SEC rule changes. The Financial Stability Board (FSB), an international organization under the G20 that monitors the global financial system and provides guidance, has estimated that there are over 400 different organizations with their own sustainability standards (FSB 2015, 2015). These organizations are all NGOs or corporations, rather than regulatory efforts towards sustainability standards (FSB

2015, 2015). The FSB itself commissioned the Task Force on Climate-Related Financial Disclosures in 2016. Since then, the TCFD standards have survived as a template for other sustainability reporting standards, including as an example utilized by the SEC in their proposed rule change. The SEC rule change also comes in response to the establishment of the International Sustainability Standards Board (ISB), a joint venture between the International Financial Reporting Standards (IFRS) Foundation and the International Organization of Securities Commissions (IOSCO)[33] to create an international standard for climate-related disclosures that can be applied by regulators.

These reporting standards, however, are still voluntary. While corporations may submit voluntary sustainability reports, they are often incomplete and missing key information. The proposed SEC rule changes are significant because a full implementation of the proposed rules would legally require publicly-traded corporations to report climate-related risks and GHG metrics (SEC 2022). SCS credit initiatives provide early opportunities for agribusinesses to, on paper, decrease their emissions while positioning themselves to provide valuable Scope 3 accounting services to agrifood companies and other corporations in the agriculture and food sector. Agribusiness firms have an interest in being first movers in these spaces to set standards, build capacity to participate in regulatory markets, and to help shape market structures in the future (Green 2014). The ability for corporations to self-regulate and use the self-regulation they have created is particularly important (Green 2014). Figure 4 demonstrates the tight-knit web of carbon credit verifiers, and more importantly, protocol development organizations, which define MRV standards for SCS projects. Organizations such as the American Carbon Registry (ACR), the Climate Action Reserve (CAR), SustainCert, Verra, and Gold Standard are included in the

[33] Of which U.S. and Canada are a part of.

categories listed above. The coalescence of agribusiness around a small number of verifiers and project developers demonstrates an agreement around standards for SCS credits and the science that informs these standards, demonstrating a form of self-regulation. This network represents the reliance of SCS credit initiatives and sustainable grain markets on a few standards organizations.

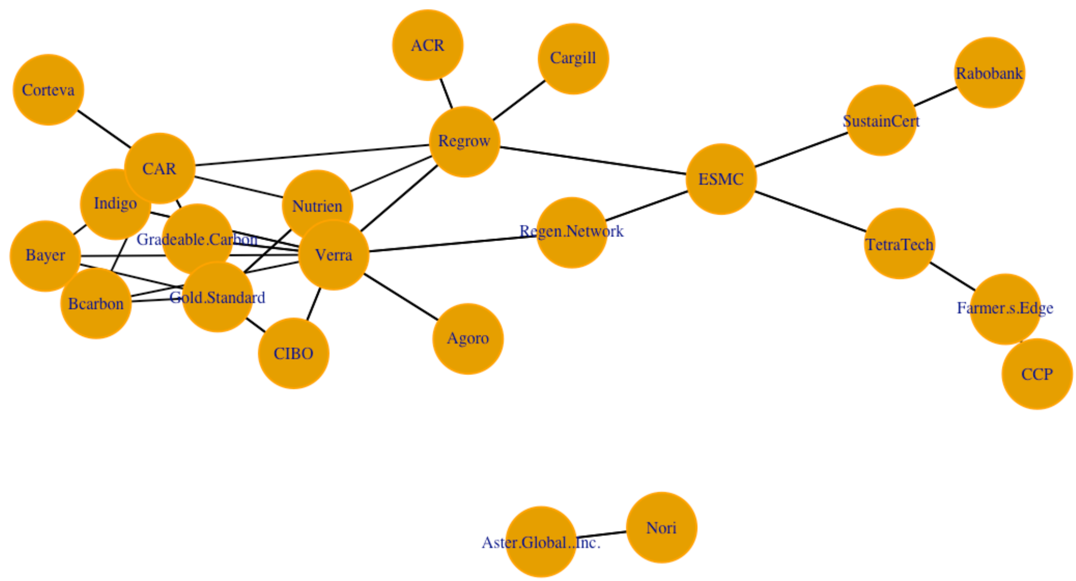

Figure 4: Connections between SCS credit initiatives, standards organizations, and carbon credit verifiers[34,35]

While these standards organizations are responsible for verifying credits, approving protocol designs, and tracking protocol usage, corporations are allowed to submit model protocols for approval by these protocol organizations. While coalescence is happening, the space is still fragmented. Many interviewees across NGOs and government remarked on the novelty of soil carbon markets and the ramifications of this novelty. When asked about details on farmer payment and how different markets are quantifying soil carbon, one NGO employee expressed

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[34] This graph was completed using R version 2022.02.3+492 and the *iGraph* package (Cśardi & Nepusz 2006)

[35] Nutrien 2021b; Clayton 2022; Agoro 2023a; Corteva 2023b; CSA Group 2023; ESMC 2023g; Gradable 2023a; Indigo 2023a; Nori 2023b; Regrow 2023b; Rabobank 2023

that: “A lot of this is hearsay, but I’ve heard it's a confusing landscape for farmers to navigate…as of right now I’d say it’s kind of like a big giant experiment” (12423335). Another farmer, and NGO representative, described the space as the “Wild West,” describing the lack of regulation and agreement on standards, a phrase which has been used previously to describe the soil carbon market space specifically, and carbon markets more generally (2922023245, position 5; Sherman 2013). A U.S. Federal Government employee, when asked about the involvement of agribusinesses in carbon markets mentioned that: “I think they [agribusinesses] are exploring the space as well. I don't think it's clear yet what those markets might look like, rather it's a service that they see potential benefit in so they're willing to extend into them” (512221050, position 66). The establishment of new standards requires time and effort to legitimize but demonstrates that corporations are seeking to dictate the standards that are deemed legitimate by getting ahead of regulations, such as the proposed SEC rule changes. “Getting ahead” of the SEC regulations could come in the form of establishing benchmarks for acceptable data collection methods established through the Scope 3 emissions quantification that is integral to private SCS credit initiatives. Corporations may also be looking to legitimize themselves as valid sources of Scope 3 emissions data, as well as what is reasonable for the SEC to collect, based on the information that corporations are able to gather.

4.2.3: EU Border Carbon Adjustment

In May 2023, the European Parliament passed *REGULATION (EU) 2023/956* which established a carbon border adjustment mechanism (CBAM). According to the regulation: “The CBAM seeks to replace those existing mechanisms by addressing the risk of carbon leakage in a different way, namely by ensuring equivalent carbon pricing for imports and domestic products (EU 2023, 54).” This effectively places the monetary burden for carbon emissions related to products being imported into the EU on producers or exporters of goods and services. The goal of a border carbon adjustment is to "level the playing field" in terms of carbon pricing, essentially placing a price on carbon for jurisdictions that do not currently do so (Böhringer et al. 2022). The EU's CBAM creates carbon pricing on products imported from the U.S., which does not currently price carbon emissions, creating a competitive disadvantage for them in international trade with the EU due to the CBAM.

USDA employees interviewed discussed the importance of the Climate Smart Commodities Partnership (CSCP) program in helping agribusiness and agrifood corporations to adjust to new EU regulations (14231037). The CSCP aims to "expand markets for America's climate-smart commodities, leverage the greenhouse gas benefits of climate-smart commodity production, and provide direct, meaningful benefits to production agriculture" (USDA 2023). With regards to the CBAM, funding through the CSCP seeks to create a competitive advantage by assisting in creating market programs for low-carbon agriculture commodities through grant funding. This grant funding has been received by many of the corporations that are currently administering private SCS credit initiatives.[36] While the CSCP is relatively novel and could be argued to have no effect on incentivizing agribusiness firms to initiate SCS credit programs, the CBAM had been discussed since the early 2010s and hampers movement of goods across borders, directly impacting the function of agribusiness. The CSCP could be seen as an example of the state's involvement and role in building markets. While not directly involved, states help to fund SCS carbon credit structures. Indeed, the involvement of the state seemed preposterous to the USDA employees interviewed for this thesis:

> I mean in the US that's just like a non-starter. I mean there's a California compliance market, but I don't think spoiler carbon is included in that one at least not yet. Canada had

[36] For a summary of USDA CSCP projects, please see: https://www.usda.gov/climate-solutions/climate-smart-commodities/projects.

> a compliance, like the Alberta Conservation Copping Protocol was discontinued, or the program ended. In the USA you know they're not going to subject farmers or anyone to that, so like no one wants to hear the word 'regulations' or 'oversight'. I think it's a "let's see how you know let's let the private sector go and they can scale, they can act quickly" That's just like built in mind set here in the States (12423335, pos. 28).

When presented with a threat to the smooth operation of capital across borders, the state has responded with assistance in market-building those advantages agribusiness corporations, particularly their SCS credit initiatives. Corporations have taken full advantage of this incentive, especially as they are principal recipients of CPSC grants even though the program purports to support "small and underserved producers" (USDA 2023).

4.3 Burnishing reputations

The private SCS initiatives investigated in this thesis are concrete examples of corporate social responsibility (CSR) initiatives, or examples of the creation of governance structures to enable and aid the CSR initiatives of other companies.

While corporations see these initiatives to improve their reputation or contribute to climate action, critics often claim that corporate climate initiatives are simply greenwashing. When considering CSR initiatives, greenwashing becomes a concern. In 2007, TerraChoice, an environmental marketing company now owned by UL Solutions,[37] published a report titled *The "Six Sins of Greenwashing"*, where they define greenwashing as "the act of misleading consumers regarding the environmental practices of a company or the environmental benefits of a product or service" (TerraChoice 2007, 1). Terrachoice's report provided the first concrete[38] definition of greenwashing which has since been expanded on in academic research.

[37] UL stands for Underwritten Laboratories. The company is a science safety standards corporations based in Illinois.

[38] The term was first used by Jay Westervelt, an American environmental activist, in 1986 (de Freitas Netto et al. 2020).

In a systematic review of greenwashing definitions in academic literature, de Freitas Netto et al. (2020) discuss three forms of greenwashing: greenwashing as selective discourse; greenwashing as decoupling; and signalling and legitimacy-making. Greenwashing as selective discourse refers to misleading consumers and investors about environmental performance or selectively disclosing key environmental metrics. Greenwashing as decoupling is defined as situations in which corporation portray positive environmental behaviours while displaying negative environmental performance or a failure to fulfill commitments. Finally, signalling corporate legitimacy refers to the "taken-for-grantedness" assumptions of an organization's societal environment", moral standing, or perceived benefit from corporate green activity (Seele & Gatti 2015 in de Freitas Netto et al. 2020). What is generally considered in greenwashing definitions are firm- or product-level instances of greenwashing (de Freitas Netto et al. 2020), as greenwashing could also encompass a structural element, where corporations seek to maintain business-as-usual policy frames and economic development. Certainly, SCS credit initiatives are encompassed by the firm- and product-level definitions of greenwashing discussed above, but it is also important to consider the larger structural instances of greenwashing.

Critics argue that carbon credits represent greenwashing through the use of market-based instruments (MBIs) as an approach to solving climate change. MBIs for the management of nature represent a neoliberal-capitalist approach to dealing with climate change (Bigger 2018). In Chapter 3, critiques of carbon credits were presented, including the idea of the "virtuality" of carbon credits The virtuality, this idea that carbon credits are fictitious commodities requiring complicated processes of construction, is particularly salient in private SCS credit initiatives. The use of modeling, rather than direct soil sampling, relies on projections about the effectiveness of changed farming methods in increasing SOC levels. As mentioned in Chapter 3, the cost of direct soil sampling and testing for SOC levels is expensive, creating outsized transaction costs, thereby limiting market functions (Murray 2021) What has replaced direct soil sampling are systems that monitor practice changes, soil quality, weather, and then model SOC levels based on these measurements. While the establishment of market mechanisms represents one instance of structural greenwashing, greenwashing within SCS credits involves firm- and product-level greenwashing specifically.

Interviewees from NGOs expressed doubt and skepticism about the ability for initiatives to measure SCS effectively. This again follows from the concerns noted above, where the skepticism about the ability for SCS projects to fight climate change effectively is compounded by skepticism about measuring the outcomes that SCS practices changes are supposed to generate. One interviewee working for an NGO interfacing with corporations described private or “in-house” SCS measurement systems as a “secret sauce”, where “they are doing the magic work, and then applying it to the project” (712221059, pos. 6). They argued that they are not adding new data to the system, rather, they are just applying pre-existing data and assumptions to complex ecosystems to generate an estimate. This sentiment is found in other interviews, where another NGO employee working with farmers stated that: “Frankly, no one is measuring tonnes. Nobody has any idea. The payment by the tonne is actually a fiction, it's not really happening. They are actually being paid for the practice and then the tonnes are inferred based on a model” (101231006, pos. 30). This is corroborated by an interview with a soil scientist who discussed the use of models in SCS measurement and estimation. This leads to a “mythification” of SCS levels, with observers having a tough time understanding what they might actually be buying or buying into (712221059, position 15). Indeed, an interviewee stated that “It's a whole bunch of layers of bad fiction. We pretend we're paying by tonne, but no one is measuring tonnes”

(101231006, pos. 30). The reduction of highly complex natural systems is simplified and pacified in order to be commodified as tradable credits. To corroborate the point of uncertainty in SCS crediting, a soil scientist at an NGO pointed out that:

> "[soil carbon sequestration] is not permanent. I mean a molecule of carbon does not persist in the soil forever. It's a cycle. When we're talking about carbon sequestration, we're not talking about a chunk of carbon that is sequestered and stays there, we're talking about maintaining a cycle and hoping that that cycle is less leaky essentially. (12423335, Pos. 6)

This quotation demonstrates existing concerns from the soil science community about impermanence of soil carbon and the broader climate science community about temporary carbon sequestration strategies.

SCS credits, then, represent an instance of greenwashing discussed above. SCS activities are not permanent, as demonstrated in Chapter 3, and corroborated by interviews, meaning that their portrayal as definitive solutions to agricultural emissions could be considered as "greenwashing as selective discourse" (de Freitas Netto et al. 2020). As agribusiness firms generally avoid questions of impermanence, reversal, and soil carbon saturation, they mislead and misrepresent the potential effectiveness of SCS credit initiatives as a solution to climate change. This misrepresentation is additional to the structural issues, such as the possible increase of chemical application or removal of structural vegetation elements that are associated with SCS credits initiatives. Falsifying SCS credit initiatives in this way, however, allows agribusiness firms to portray themselves as "good" actors in innovating for climate solutions, as they provide a "silver bullet" fix to agricultural emissions without interfering substantially with "business-as-usual" operations. It is important to consider, then, that agribusiness corporations are exercising their private authority in order to establish SCS credit initiatives as environmentally beneficial activities.

Agribusinesses also face pressure from the public and investors to go carbon neutral or decarbonize their supply chains. One interviewee from an NGO pointed out that the increased pressure on corporations, especially now that the agribusiness sector is receiving more scrutiny, has led to the development of new offsetting schemes in order to avoid full decarbonization (112231133). This comes in the wake of fully realized efficiency gains that allowed corporations to reduce carbon emissions previously. The interviewee also conveyed the importance of climate neutral labeling and the sense that people see corporations as bad actors if they do not make carbon neutrality claims (112231133). More specifically to soils, as with the attention to agriculture at the IPCC, people without direct stakes in the agriculture sector are increasingly realizing the importance of soil health, which is another point of pressure for agribusiness firms that can "easily turn the discussion about soil fertility and soil degradation into carbon market conversation if they do it intelligently" (112231133, position 14). This represents an instance of "greenwashing as decoupling" where corporations attempt to distance themselves from negative environmental performance by drawing attention to positive environmental initiatives, such as SCS credit initiatives in this case.

This ability to turn the soil health discussion into a market conversation is a way for agribusinesses to pre-empt regulation and act on environmental issues proactively to address the pressure faced publicly. It also represents an instance of structural greenwashing. Wright and Nyberg argue that capitalism thrives on the "absorption" of critiques in order to legitimize itself and evolve (Wright & Nyberg 2015). This is not a novel argument, as the term "capitalist realism", referring to the "hegemonic" position of capitalism as the only viable economic system (Fisher 2009). Fisher discusses that the only way to escape this sort of "realism" is to find inconsistencies within capitalism (Fisher 2009). One of these inconsistencies, as many scholars in critical political economy and critical geography point to, is climate change. Wright and Nyberg (2015) note, however, that the integration of nature into markets, as well as posing climate action and continued growth as compatible has allowed for this inconsistency to be “solved”, at least temporarily. Fisher indirectly notes this too: “Over the past thirty years, capitalist realism has successfully installed a 'business ontology' in which it is simply obvious that everything in society, including healthcare and education, should be run as a business” (Fisher 2009).[39] Indeed, this form of structural greenwashing and the reinforcement of capitalism and markets as a solution to climate change also represents a form of signalling and corporate legitimacy that theoretically reconciles growth with climate change (de Freitas Netto et al. 2020). The absorption of critiques of agribusinesses in order to legitimize themselves can be found in the creation of SCS credit initiatives (Wright & Nyberg 2015). The broader critique of greenwashing in this case, demonstrates an attempt to legitimate corporate expansion through climate change and embed unequal distributions of power in responses to climate change that inherently privileges corporations and capital.

4.4: Adjusting Business Plans to Climate Change and Capturing New Profit

The third key motivation for agribusiness firms to engage in SCS credit initiatives is the new opportunities for profit that SCS credit initiatives provide. Demand for credits in the VCM has demonstrated massive increases due to the influx of net-zero pledges by large multinational-corporations (MNC). These MNCs include corporations such as BlackRock, Apple, Exxon, JP Morgan, and Ford. Figure 5 demonstrates the current state of corporate climate targets.

[39] It is argued elsewhere, however, that internalization in market schemes necessarily implies externalization of another form, creating hazards in new ways, providing a scathing critique of markets as the answer to issues of resource management as markets become a source of new environmental issues (Lohmann 2010).

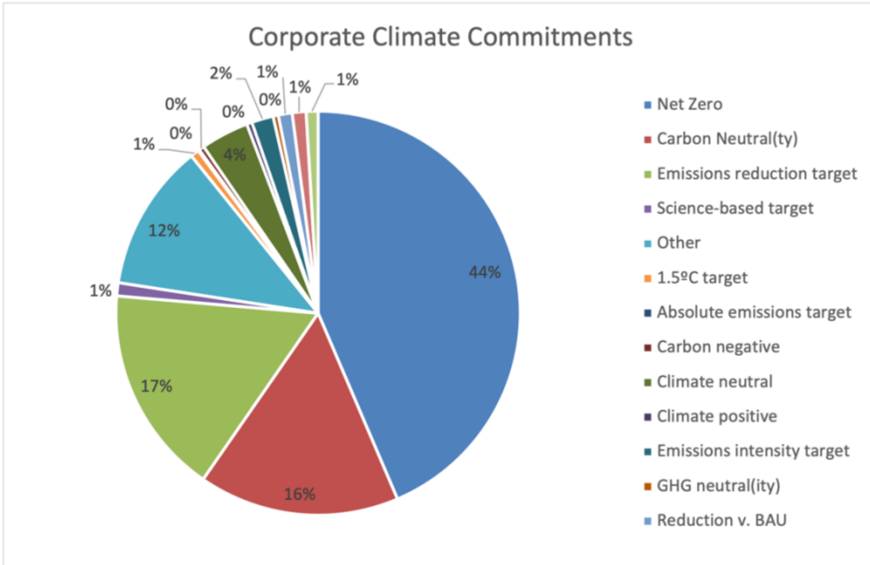

Figure 5: Current corporate climate commitments that have been officially announced. (Source: Net Zero Tracker)[40]

Figure 5 demonstrates that demand is likely to rise for offsets in the coming years. 44% of the 1900 publicly traded corporations in the dataset have committed to net neutral goals, with an additional 16% committing to carbon neutrality (Net Zero Tracker 2022). This data also omits privately traded companies, which might lead to an underestimation of commitments or the demand for carbon credits. Meeting this demand through SCS projects represents new avenues of profit for agribusinesses as they become aggregators and brokers in these projects, and as big agrifood and tech companies, such as Maple Leaf Foods and Microsoft, are looking to go carbon neutral. This opportunity to develop carbon markets also represents a prospect to turn carbon credits into financial assets, which was expressed by three interviewees. One interviewee at an NGO that works with farmers and a farmer who is also employed at an NGO referred to the

[40] Data from Net Zero Tracker was utilized. Net Zero Tracker has a list of the top 2000 publicly traded companies which is regularly updated. Figure 2 was completed using only completed cases (i.e. cases where companies reported a climate commitment. Companies with no official commitments were excluded), leaving 1900 data points in the dataset.

“speculative” business of carbon credits as a financial asset, which was a key component of carbon markets in the late-2000s and early-2010s (112231133). The corporate interviewee mentioned the importance of the development of carbon markets evolving from commodity markets into derivatives and futures markets and becoming fully fledged markets.

Another important component to SCS credit initiatives is the certification of low-carbon agriculture commodities. Academic literature has much to say about certification schemes for organically or sustainably produced agriculture commodities. Separately Renard (2005) and Pichler (2013) have argued that certification schemes both disempower smallholder farmers and producers while privileging business interests. Both authors argue that certification schemes replicate structural differences between producers and businesses, with certification schemes placing burdens on producers, with businesses dictating the terms of certification requirements on producers (Renard 2005; Pichler 2013). It is arguable, however, that the dictation of terms to producers is required to meet the stringencies of sustainability certifications, but it is this manufactured scarcity that is integral to the success of certification labelling programs (Guthman 2004 & 2007).

The investment of agribusiness corporations into SCS credit initiatives also demonstrates trends of corporations investing in new areas in order to find new productive capacities for ensuring return on capital. As mentioned above in the subsection on corporate reputation burnishing, neoliberal capitalism responds to the threat of climate change by posing continued growth and market mechanisms as compatible with climate action (Wright & Nyberg 2015). The enactment of investment into these markets and continued growth in search of new profit in the face of a crisis to profit systems has been spoken about at length by critical geographers. David Harvey coined the term “spatial fix” to describe capital’s tendency to search for new avenues for investment in order to fix issues of reduced returns (McCarthy & Prudham 2004). Indeed, Lohmann has previously made the argument that carbon credit markets are spatial fixes, positing that they are systems: “which moves pollution around the ‘‘capped’’ landscape to wherever it is cheapest to abate…” (Lohman 2011, 103). Ekers and Prudham provide a more direct connection between capital and the environment through the theorization of the “socio-ecological fix” which examines: “how human and nonhuman organisms and socio-natural relationships are transformed, and how labor processes are restructured in order to address or offset (at least temporarily) entangled social and environmental crises of capitalism through conjoined productions of space and nature” (Ekers & Prudham 2015, 2438). Simply put, the crisis that the production processes of capitalism face, including decreasing profits, incentivizes projects that attempt to make nature more profitable, therefore transforming our relationship with nature, while simultaneously adapting to the risk that climate change poses to business as usual (Ekers & Prudham 2017; see also Castree & Christophers 2015). Another component of the “socio-ecological fix” is the function the “fix” plays in legitimation (Ekers & Prudham 2015). This legitimation crisis of reconciling global warming with growth and growth as a solution to climate change is tentatively solved through Wright & Nyberg’s (2015) discussion of the market integration of nature.

The relationship between soil and humans are fundamentally changed as they are brought into market systems, figuring them as new avenues for profit and accumulation. Where soils, renewed through carbon sequestration become more productive, but are also the main “fix” to climate change in the agriculture sector.

A counterargument for SCS carbon credits as the basis for substantial new avenues of profit do exist. The 2023 VCM carbon dashboard shows that less than 2% of all credits issued in the VCM originate through SCS in agriculture systems (Bravo & Mikolajczyk 2023). Further, agricultural SCS credit projects account for less than 3% of projects registered in the VCM Bravo & Mikolajczyk 2023). This point was brought up in an interview with USDA employees noting that offset credits have become less of a focus for the USDA as they have focused on low-carbon commodity certification schemes (14231037, Pos. 7). The reason for this, they cited, was the issues of permanence, MRV costs, and reversal (14231037, Pos. 7). It is far easier for agribusiness corporations to participate in markets for low-carbon agriculture commodities:

> “Because they don't have to adhere to the same stringent rules as the voluntary offset market it's a little bit more flexible. So they can come up with their own internal procedures essentially to like try and quantify those emissions reductions in a way that is more cost effective, which makes a lot of sense for agriculture so that helps them to meet their internal targets for greenhouse gas mitigation. (14231037, Pos. 9)

The creation of low-carbon agricultural commodities markets that are integral to these SCS credit initiatives are crucial, as they provide new forms of profit. Certification schemes for low-carbon and sustainable commodities have their costs passed on to consumers, accruing benefits to agribusiness and agrifood firms (Mutersbaugh 2005; Guthman 2007; Carter & Cachelin 2018). While carbon credit programs and SCS crediting programs generate credits, they are not profitable through credit production on their own. Relevant to this discussion, Guthman (2007) argues that it is not the ability to practice sustainable agriculture or low-carbon farming that is scarce, it is, however, made economically scarce by stringent labelling programs that increase costs and the surveillance of producers through certification programmes. The scarcity created by certification labelling creates a price premium that is generally collected by retailers (Mutersbaugh 2005; Guthman 2007). Elsewhere, Guthman argues that sustainable food certification contributes to upward land valuation, where the rents generated on certification premiums “pass through” to land valuation, leading to higher land prices and an incentive for farmers to grow more profitable crops through more intensive farming methods, which could involve industrial farming methods (Guthman 2004). Certification schemes, then, have the potential for new forms of profit for retailers, agribusinesses in this case, through rent extraction, while risking continued structural inequities between farmers and agribusinesses. Indeed, low-carbon grain certification programmes open up new avenues of profit and accumulation through the “double counting” of carbon sequestration and low-carbon commodities.

The deployment of digital agriculture also provides new avenues for large agribusiness firms to generate profit beyond traditional commodity- and finance-based accumulation strategies. The implementation of equipment sensors, soil sensors, weather sensors, and aerial and satellite monitoring in order to complete geomapping of farm fields implies the collection of massive amounts of data from farms from a variety of sources. When combined through the cloud storage systems within the digital platforms of agribusiness firms, this means data across thousands of farms comprising millions of acres, is able to be compiled and analyzed in one place. The systematic collection of farm data in one location also means this data is available to large corporations that have a high degree of control over both agricultural input manufacturing and output aggregation of agricultural products. The control that agribusiness firms already hold, in addition to the collection and processing of new data, is especially important when considering the amount of control and autonomy that farmers have in their production. Existing academic literature describes the effects of surveillance on farmers (Bronson 2019). Surveillance demonstrates an issue of farmer autonomy and control. This surveillance of farm activity, along with the provision of agronomic advice, planting recommendations, fertilizer usage guidance, among other things, through the extraction of this data could implicate agriculture in a form of surveillance capitalism.

Shoshana Zuboff describes surveillance capitalism as the commodification of data for the purpose of increased profits through personalization (Zuboff 2016). While Zuboff develops this theory vis-a-vis the collection of data through Google searches and the development of targeted ads, the theory still applies to digital agriculture. Zuboff argues that data can be used to optimize systems, in this case, agricultural planting systems, but these data can also be accumulated, packaged, and sold to deliver more accurate predictions about behavior (Zuboff 2016). In the case of private SCS initiatives and the implementation of digital agriculture tools, the measurement and monitoring of soil characteristics, especially SOC levels is the accumulation of data which agribusiness firms can package with weather data and historical planting data, among other things, to sell farmers products based on the predictions generated from this data that has been accumulated.

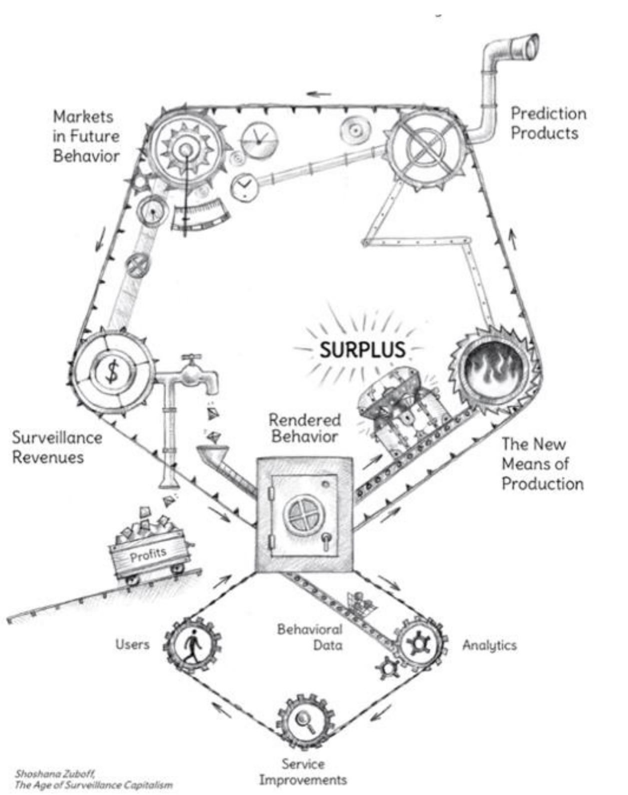

Figure 6*: The Extraction of 'behavioral surplus' in surveillance economies (Zuboff 2016)*

The ability to make predictions about behavior or production choices on farms, which many of these digital platforms advertise as a 'perk' of their program, demonstrates the extraction of "behavioral surplus". This allows agribusiness firms to capitalize and profit on timely recommendations of fertilizer, seeds, or pesticides. The increased data available to input corporations also allows them to tailor inputs to emerging decisions or weather data and market these products back to farmers, or the ability to establish reliance of farmers on input decisions or specialized input products. Zuboff argues that:

> "The commodification of behavior under surveillance capitalism pivots us toward a societal future in which market power is protected by moats of secrecy, indecipherability, and expertise. Even when knowledge derived from our behavior is fed back to us as a quid pro quo for participation, as in the case of so-called 'personalization,' parallel secret operations pursue the conversion of surplus into sales that point far beyond our interests."

Predictions and recommendations provided by agribusiness firms are gained from the collection of farmer data, but the decision-making structures may be hidden from farmers. While predictions and recommendations are made for the benefit of farmers, the interest of agribusiness firms in collecting this data is to further product development and sales. The implication of digital technologies and surveillance capitalism with SCS credit programs is direct through the use of digital monitoring technologies to monitor and verify SCS practices. This deployment of digital technologies and roll-out of surveillance capitalism is also implicated in SCS practices through corporate advertising about increasing value and efficiency, and therefore helping the climate, through the use of digital agriculture technology in order to establish SCS practices. While monitoring and verification may be an excuse to collect data, the deployment of technology lies in the marketing of digital technology as crucial to the success of SCS practices and integral to the transition to a "climate smart" farming operation. As discussed in academic literature, the establishment of digital agriculture demonstrates the narrative that the solution to climate change is mainly an issue of efficiency and therefore can be fixed through technological change (Balafoutis et al. 2017; Klerkx et al. 2019; Clapper & Ruder 2021). Framing sustainable agriculture as a technological problem positions agribusiness firms to accumulate profits in new ways. As mentioned above, the accumulation of accurate, sometimes real-time soil characteristic data allows for new predictive capabilities (Bayer 2023c; CIBO 2023d; Farmers Edge 2023b).

Privacy, an overarching issue in the accumulation of data, surveillance capitalism, and the establishment of insetting programs and carbon credit markets in this case, is the use of data for purposes beyond the stated purpose of verifying carbon sequestration through surveillance of practices or aerial imaging. In the case of Google, search optimization was the driving motivation for data collection (Zuboff 2016). Data collected in both of these cases have been and can be used for purposes outside their original intentions, creating concerns about data privacy. Many agribusinesses, in the deployment of digital agriculture technology through their carbon credit programs have released data privacy statements or have partnered with organizations such as AgData Transparent to certify transparency of data usage and industry-standard privacy practices (AgData Transparent 2023). While data sharing between corporations is an issue that is generally covered by privacy statements, this issue is arguably miniscule compared to the potential usage that the data has within agribusiness corporations. Returning to *Surveillance Capitalism*, Zuboff (2016) argues that:

> Google executives like to claim their privacy purity because they do not sell their raw material. Instead, the company sells the predictions that only it can fabricate from its world-historic private hoard of behavioral surplus (96)

Similar to the Google executives that Zuboff is speaking of, agribusiness firms may not be interested in selling raw weather, production, or soil health data. Instead, agribusiness firms are interested in selling either derivatives of these data, or the prediction material. What sets corporations like Google apart from agribusiness corporations such as Bayer, Nutrien, or Cargill, however, is that Google has little use for their predictive data. Google is more interested in selling predictive data to advertisers (Zuboff 2016). Agribusiness firms, however, have their own direct usage for both the raw data and packaged prediction data. This can be the case due to the outsized market pressure that agribusiness firms, particularly the input manufacturers exert on farmers. Kelly Bronson argues that: “we can infer that the collected data are used for corporate gain, such as profile development for targeted marketing” (Bronson 2019, 4). The collection of massive amounts of data, paired with field recommendations, and specific chemical and input applications lends itself to predictive marketing and a deeper reach of corporate input sales. Important to note also, that the AgData privacy verification document for Bayer notes that “offline” usage of their farming platform might restrict the services available to farmers, and that full data sharing would have to be enabled to use the full suite of tools available through the digital platform (AgData Transparent 2023).

A further implication of the deployment of digital agriculture technology rests in the attempts of agribusiness firms to establish platform economies. Platform economies can be defined as two-sided markets (Evans 2003; Evans & Schmalensee 2016). Examples include Amazon and AirBnB, which coordinate buyers and sellers. SCS programs, particularly in setting programs and new market spaces for sustainable grain, developed by Gradable, Indigo, Bayer, and TruTerra, agribusinesses are slowly moving towards configurations where they no longer just sell inputs. This is particularly true in the examples of Bayer and Nutrien. Bayer has bundled their ForGound, ClimateFieldView, Carbon Program and BayerValue programs together to incentivize farmers to keep their data in one place, with ForGround and BayerValue providing buyer rewards and discounts through continued use of Bayer’s services (Bayer 2022c; 2022d;

2023b; 2023c) Nutrien's suite of Agrible, Nutriscription, and Echelon accomplishes the same goals of providing advice, data collection and processing, and financial services to farmers (Peters 2021; Nutrien 2023) In these new platform economies, they are buyers and sellers of data. This could be information on grain sustainability, or it could be in the form of soil carbon storage, which is re-packaged and commodified as carbon credits or rent extracted through premiums collected on low-carbon agricultural products.

4.5: Conclusion

Through interview data and document analysis, three clear motivations exist for agribusiness firms to pursue SCS credit initiatives. The first, policy changes, demonstrate a multitude of pressures emanating from both international and domestic policy. The elaboration of Article 6 of the Paris Climate Agreement renews and bolsters the VCM, providing stability in carbon credit markets, as international agreements on carbon markets have done so in the past. The Paris Climate Agreement also legitimizes the use of carbon credits, particularly with recent UN attention on agriculture and soil health, pertaining to SCS credits specifically. Domestically, changes to SEC reporting incentivizes agribusiness corporations to collect new forms of data in order to assit other corporations in estimating their Scope 3 emissions, as well as themselves conform to changing climate reporting rules, while also shaping the way in which protocols for measuring SOC levels through SCS credit initiatives look. Back on the international stage, the EU CBAM legislation threatens to hinder business operations across borders providing new incentives for agribusinesses in North America to initiate SCS credit programs and market low-carbon agriculture products.

Second, agribusinesses see opportunities to burnish their reputations through SCS credit initiatives. SCS credit initiatives legitimate SCS as a silver bullet for agriculture, while allowing continued emissions in the agriculture sector. It also implicates farmers in pay-to-pollute systems, strengthening the role of MBIs for the management of nature as a response to climate change, and positioning growth as a solution to climate change.

Finally, SCS credit initiatives provide new opportunities for profit for agribusiness firms. Not only do agribusiness firms create new revenue streams through the sale of carbon credits, even though the market is, they also create new markets for low-carbon agriculture products which they can charge a premium for. Private SCS credit initiatives are also prime opportunities for deployment of digital agriculture, which allows agribusiness firms to penetrate product marketing deeper and more precisely through data collection, surveillance, and prediction.

Chapter 5: Implications of SCS Initiatives for Farmers and Agriculture

SCS credit programs could have wide-ranging effects on North American agriculture. While these programs are fairly new, with most beginning in 2020-2021 or coming out of their pilot phases during those years or within the next few years, several implications arise from existing data. This chapter utilizes interview data, document analysis, and scholarly literature to answer the third question posed by this thesis: "what are the implications of private SCS credit initiatives?" The private nature of these SCS credit initiatives is a significant focus of this analysis. First, SCS credit initiatives have the implication of the lock-in of industrial farming methods in North American agriculture. SCS credit initiatives continue the trend of large-scale monocropping, with heavy use of fertilizers as pre-requisites to programs or to operate efficiently and be profitable ventures for farmers. This lock-in is legitimated by agribusiness firms who utilize arguments for efficiency provided by digital agriculture tools and the CSA paradigm. Digitalisation and CSA figure efficiency fixes in industrial agriculture as compatible with solving climate change. Second, SCS credit initiatives continue the trend of accumulation through multiple avenues. SCS credit initiatives manufacture new commodities and markets through figuring soil as a commodity and subjecting it to an economizing process, which distorts our view of nature while providing new avenues of profit for agribusiness firms. The new markets created for "low-carbon" agriculture products also strengthen already consolidated agribusiness and agrifood sectors through a tight-knit web of interactions through these markets. Finally, issues of responsibility and justice are discussed with reference to shifting responsibility on farmers for solving climate change, as well as questioning the role of agribusiness corporations in perpetuating climate change and the (in)ability of SCS credit initiatives to rectify these wrongs.

Section 5.1: Lock-in

SCS credit initiatives demonstrate an entrenchment of industrial farming practices, otherwise known as lock-in. Through a convergence of digitalisation, CSA, and continued ideals of industrial agriculture, adapting to and mitigating climate change is made compatible with the continuation of industrial farming systems, with private SCS credit initiatives providing the technological and managerial fix to carbon emissions in the agriculture sector and abroad. This line of argumentation holds that industrial farming will be able to continue if emissions from agriculture are decreased, with little change having to be made to farming systems by simply making efficiency gains through technology.

The “ideal” of industrial farming, as Deborah Fitzgerald describes it, stems from an interest in the 1920s to equate farms to factories (Fitzgerald 2003). Following this view, farm engineers decided that farm production, like factory production, should benefit from mechanization, substituting labor for capital (Fitzgerald 2003). This reconfiguration of farming shifted from a production system based on ecological capital to one based on external inputs, and new technology (van der Ploeg 2010). These external inputs include machinery such as tractors and sprayers; chemicals such as pesticides, herbicides, and fertilizers; and more recently, genetically modified (GM) seeds that are herbicide and disease resistant (Clapp 2016). The industrialization of farming has also required increasingly larger farms to operate at scale, to pay for and justify the use of large capital investments, particularly machinery (Fitzgerald 2003; Clapp 2016). The expansion of farmland was required from the beginning of industrial farming: “If farms were too small to use such machinery efficiently, then farmers should buy more land to justify having the equipment” (Fitzgerald 2003, 110). Industrial farming, the use of machinery, and the continued reliance of the agriculture sector on chemical inputs for production has dominated farming in North America since before the 1920s. Since the 1920s, the number of farms in the U.S. has declined by ~5 million, while average farm size has increased, although has been stable since the 1980s, from under 200 acres to 446 acres (USDA 2023). Canada has also experienced a decline in the number of farms. Between the 1921 and 1974 census, farm holdings decreased from 711,090 to 366,128, with total farm area increasing from 140,888 acres to 169,669 acres over the same time period (STATCAN, 2023a, STATCAN 2023b). This trend continues in Canada in contemporary data, with farm holdings in the years 2006-2011 decreasing by 10%, with a corresponding increase in the average acreage of farms, by 6.9% (STATCAN, 2011).

Industrial farming has been successful in its mission of "factoryizing" agriculture and creating efficiency and production gains.[41] Industrial farming resulted in agricultural product surplus throughout the rest of the 1900s and into the 2000s (Clapp 2016). In step with these gains, however, industrial farming has also resulted in a suite of serious environmental consequences. As mentioned earlier, agriculture is currently responsible for roughly 30% of anthropogenic GHG emissions **(**Shukla et al. 2019**)**. This is due to the usage of fertilizers, fertilizer production, machinery fuel usage, and expansion of livestock systems. More particular to the case of SCS credit programs is the release of carbon from soils due to near continuous tillage, as well as soil degradation and loss of nutrients due to industrial agriculture practices. Further, monocropping and chemical input usage has resulted in biodiversity loss due to species reduction and direct die off of species due to chemical spillover effects (Clapp 2016).[42] Industrial

[41] These technological advancements were also supplemented with a wave of government policy, particularly in the U.S. and Canada, including price supports and surplus purchasing on the part of the government. It also included farm credit and crop insurance. (Clapp 2016).
[42] A good example of this would be the decline in pollinator populations due to pesticide usage (Clapp 2016).

farming has increased the reliance of the agriculture sector on large farms and few key input manufacturers.[43]

The SCS credit initiatives that are being led by large, private agribusiness firms uphold and further the tenets of industrial farming, perpetuating a phenomenon called “lock-in.” Leibowitz and Margolis describe “lock-in” as a form of path dependence, which is defined as:

> a minor or fleeting advantage or a seemingly inconsequential lead for some technology, product or standard can have important and irreversible influences on the ultimate market allocation of resources, even in a world characterized by voluntary decisions and individually maximizing behavior. (Leibowitz & Margolis 1995, 205)

While the decision to embark in industrial agriculture may seem more than minor for the trajectory and present state of agriculture, the irreversible influences on the allocation of resources is what is important. Leibowitz & Margolis discuss three different forms of path-dependence and corresponding lock-in. Out of the three, the type of path dependence that industrial farming represents could be considered second-degree path-dependence. Second-degree path-dependence describes a situation where it is unclear to decision-makers in markets what the most efficient choice is, given multiple options. The authors continue by stating that: “the inferiority of a chosen path is unknowable at the time a choice was made, but we later recognize that some alternative path would have yielded greater wealth” (Leibowitz & Margolis 1995, 211). But this is only in reference to potential benefits, rather than harms, such as the environmental damages caused by industrial farming.

Gregory Unruh expands on the concept of lock-in to develop “carbon lock-in”, which describes economies that “have become locked into fossil fuel-based technological systems through a path-dependent process driven by technological and institutional increasing returns to scale” (Unruh 2000, 187). Industrial agriculture represents both lock-in in the conventional sense

[43] This is discussed further later.

and a case of carbon lock-in. Manufacturing of chemical fertilizers, pesticides, and herbicides are a carbon-intensive process. Menegat et al. (2022) found that the nitrogen fertilizer supply chain accounted for 1.13GtCO_2e, or 2.1% of global emissions, in 2018. A study of one insecticide for soybeans estimated that the supply chain of that insecticide resulted in 10.6kg of CO_2e per hectare of soybeans, estimating an annual emission level of 300 million kg of C02e (Heimpel et al. 2013). Glyphosate, the most widely sprayed herbicide in the world, is reliant on ammonia in its production as its main ingredient (Duke & Powles 2008; Royal Society of Chemistry 2012). Industrial agriculture is reliant on these carbon-intensive chemical inputs for its success. The large scale at which industrial farming systems operates at, requires machinery, and even seed characteristics, which represent the infrastructure that locks agriculture in North America into the usage of these chemical inputs. Important to political economy studies is the agency and power of actors in constructing these lock-in scenarios.[44] The techno-institutional complex (TIC) is formed through fossil-fuel proponents, in this case agribusinesses, where agribusinesses intertwine themselves with political processes in "efforts to structure institutional rules, norms, and constraints to promote their goals and interests in ways that would not arise otherwise" (Seto et al. 2016, 433). Indeed the state and other political apparatuses are crucial here, as the TIC becomes a powerful source of depoliticization and normalization in order to maintain economic structures that are profitable to industries reliant on fossil fuels, or industrial farming practices in this case.

[44] This consideration is only a footnote in the discussion by Leibowitz and Margolis where Seto et al. expand carbon lock-in to include the interests of powerful actors. If consideration of agency of agribusiness firms, as well as the integration of environmental damages into the definition of "inefficiencies" (as opposed to a mere externality), then lock-in to industrial farming and continued interest in the industrial system by agribusiness firms to uphold it, would shift this scenario from a second-degree lock-in to a third-degree lock-in. (Leibowitz & Margolis 1995)

Eligible practices within private SCS initiatives are fairly uniform. Every program accepts a version of reduced-, conservation-, strip-, or no-till farming (Agoro 2023a; Bayer 2023c; Cargill 2022; CIBO 2023a; Corteva 2023a; ESMC 2023f; Farmers Edge 2023b; United Soybean Board 2022a; Indigo Ag 2023b; Nori 2023a; Nutrien 2023b; United Soybean Board 2023; TruTerra 2023b).[45] Tillage reduction fits into existing soil science research about reduced soil disturbance and higher SOC content. Cover cropping is also universally accepted, a method to introduce more organic matter to soils, as well as prevent soil erosion. Crop rotations and crop diversification is permitted in some programs, similar to fertilizer and other chemical management. Chemical management is generally enabled by the implementation of digital farming practices that are usually required for enrolment in carbon credit programs. A complete list of eligible practices for each program can be found in Table 2. While these practices may contribute to increased SOC levels, they do little to shift farming away from monocropping, large-farm sizes, or continued use of fossil-fuel intensive and ecologically harmful chemical inputs. In some cases, the eligible farming practices under private SCS initiatives are more reliant on chemical inputs.

The usage of no-till or conservation tillage methods that are advocated for and required in private SCS initiatives, exacerbate this lock-in. No-till or conservation tillage practices are reliant on chemical inputs for their success. In an interview, one NGO employee pointed out that no-till "uses a lot of fertilizer, they use a lot of pesticides and herbicides, and a large machinery" (0102231143, pos. 6). This concern about fertilizer use was elaborated on in another NGO interview about dead zones in oceans and the dangers of continued fertilizer usage in the environment. No-till requires that soil is not disturbed, meaning that weeding becomes highly

[45] See Table 1 for a summary of eligible practices.

difficult, requiring higher amounts of herbicide to control weeds, and for ground to be cleared entirely of existing weeds before planting, requiring the use of herbicides, such as glyphosate (Friedrich 2005; Friedrich & Kassam 2012; Clapp 2021a). Friedrich (2005) argues that mechanical weeding has mostly been phased out, meaning that no-till farming does not necessarily mean a dramatic increase in herbicide usage. Clapp (2021) discusses the rise in glyphosate use within the convergence of multiple forces, including the implementation of digital agriculture technologies and increased corporate power in the agricultural inputs sector. The eligibility requirement to switch to no-till farming systems in private SCS initiatives demonstrates this trend clearly, with digital agriculture rationalizing continued chemical use in no-till systems, as well as agribusinesses taking advantage of the "generic" glyphosate market to market newly needed herbicides to farmers (Clapp 2021a).

Promotion of no-till farming in SCS credit programs does not consider the net-negative environmental impact that herbicide usage has, as well as the legitimation of continued herbicide usage through these programs. Herbicides are also used regularly to clear cover crops from cropland once they are harvested, where cover crops are another common practice included in private SCS credit program eligibility (Friedrich 2005). In addition to herbicide usage, the continued use of fertilizers is justified in private SCS credit programs. Scholarly literature in the soil science community has previously discussed the use of fertilizer in stimulating plant organic matter growth, thereby increasing the amount of soil organic matter and SOC levels (Amelung et al. 2020; Simone et al. 2017). This provides theoretical legitimation, but the implementation of no-till farming demonstrates other issues. Soil science scholars have noted that no-till farming disrupts nutrient cycling on farm soils (Weil 2007; Dodla & Bergen 2018; Krauss et al. 2020; Souza et al. 2023). Scholars have observed that, due to lower infiltration rates in no-till systems, nutrients accumulate in the top layers of soil, known as stratification. The inability of nutrients to penetrate to deeper levels of soil might require increased spraying of fertilizer to achieve the same effect, as deeper root growth has experienced decreases in no-till systems (Dodla & Bergen 2018; Krauss et al. 2020). Further, the "stratification" of nutrients in the top layers of soil, combined with decreased water penetration due to a lack of soil turnover means that no-till systems are more vulnerable to increased runoff (Dodla & Bogren 2018).

The promotion of chemically reliant farming systems such as no-till systems in SCS credit programs is unsurprising, however, as most of the corporations administering SCS credit programs are major producers of chemical agriculture chemical inputs. Bayer, Cargill, and Syngenta, owned by ChemChina, are historically major manufacturers of agricultural chemical products. Yara International ASA, the parent company to Agoro Carbon, while not based in North America, has a market capitalization of $9.38 billion USD, while Nutrien, based in Saskatchewan is the second largest fertilizer manufacturer by market capitalization (CompaniesMarketCap.Com 2023a & 2023b). Locus Ag's CarbonNOW program skips the requirement of no-till or cover cropping, simply requiring growers to use their Rhizolier and Pantego products, which are targeted to increasing root mass development, thereby increasing organic matter and SOC levels (CarbonNOW 2023). Where corporations are not manufacturing chemical inputs themselves, they are marketing other products through their marketplaces, such as Indigo's market of Biotrinsic, a biofungicide, and direct connection between Farmers Edge's FarmCommand platform and their CommoditAg market platform (Farmers Edge 2023a).

A counterargument to the increased application of chemicals in no-till systems related to SCS credits could be made, however, with the introduction of microbe-based fertilizers. Indigo Ag, Locus AG Solutions, Nutrien, and Bayer have all begun production, marketing, and sales of microbe-based fertilizers that address the environmental harms discussed above. Locus AG Solution’s CarbonNOW program is based entirely on the use of their microbial fertilizers to create soil conditions conducive to SCS (Locus AG Solutions 2023). The introduction of bacterial- and fungal-based fertilizers comes after the recognition of the depletion of soil nutrients through continuous planting and the use of chemical fertilizers, as well as the negative environmental impacts of both the manufacturing and use of chemical fertilizers (Sharma et al. 2013; Arora et al. 2019; Vishwakarma et al. 2020). Microbe-based fertilizers focus on increasing nutrient solubility and restoring below-ground microbiome in the rhizosphere for increased fertility (Francioli et al. 2016; Vishwakarma et al. 2020; Ray et al. 2020).

These microbe-based fertilizers still rely on genomics and genetic modification, processes, however (Ray et al. 2020; Vishwakarma et al. 2020). Genomics processes are heavily guarded by agribusiness firms, and reliance on genomics and genetic modification could create lock-in effects that guard farmers from knowledge on the operation of their farms and eroding their autonomy (Clapp 2018; Clapp 2021b). Interoperability between fertilizers and seeds from different corporations, or other sources, could also generate lock-in effects, extending the power that agribusiness corporations have over farmer decisions.

Agribusiness corporations all have interest in normalizing and rationalizing chemical input usage in the TIC of industrial farming, perpetuating lock-in. Creating market structures for ecosystem services based on no-till farming and cover cropping; marketing chemical inputs alongside SCS credit programs; and continuing industrial farming practices. What has not been mentioned yet either, is the interactions between chemical inputs, such as glyphosate, and GM crops, which are often manufactured by the same corporations (Clapp 2018; Clapp 2021a). The interactions between genetically modified seeds and chemical inputs are important as they ensure that crops are resistant to herbicides and more receptive fertilizers (Clapp & Ruder 2020). Continued use of herbicides also poses dangers, as weeds become resistant to herbicides and herbicides begin to impact plant growth, particularly the photosynthesis of crops (Clapp & Ruder 2020). All of this points to continued increase in chemical input usage, rather than a reduction.

Beyond the lock-in of the use of chemical inputs, the no-till farming systems required by private SCS credit programs perpetuate the increased size of farmland. There are also concerns about the growing size of farms due to no-till practices, which privileges large farm sizes for efficient chemical spraying (104503102023, pos. 26). Farm size becomes an issue when considering the trends of farmland purchasing by private land trusts or by investment firms as assets. While anecdotal, this demonstrates a turn towards large farm size and correlation with increased ownership of farmland as a financial asset (Gunnoe 2014; Li Murray 2014; Ducastel & Anseeuw 2017; Ouma 2020). The role of farmland as a financial asset was discussed indirectly by agribusinesses administering SCS programs through language such as “building land value with carbon farming” or through direct advertisement to landowners to encourage farmers to enroll in SCS credit programs to guarantee an extra income stream from their property investments (Indigo 2023). This is seen clearly in the partnership between CIBO and Peoples Company, a farmland real estate corporation in the U.S., enrolling 20,000 acres in CIBO’s carbon credit program (CIBO Technologies, 2021). Recall that average farm size in the U.S. is 446 acres, while the average Canadian farm size measured in the 2011 census was 778 acres. Programs such as Agoro’s and Farmers Edge’s carbon programs require farm sizes of 500 and 750 acres, respectively (Agoro 2023a; Farmers Edge 2023b). The continuation of farmland as a financial asset represents a problem in the commodification of food systems. The lock-in and continued increase in farmland ownership presents ecological dangers and economic pitfalls. In the first case, large farm size is correlated with the removal of beneficial farm features, such as windbreaks, hedgerows, and farm forests. Second, the requirement of no-till farming can contribute to increasing farm size, as large machinery is required, which, in turn, contributes to increasing farm size (0102231143, pos. 6).

Lock-in of industrial farming systems is also perpetuated by the implementation of digital agriculture technology (Clapp & Ruder 2020). Every private SCS credit initiative has an associated digital agriculture platform associated with it, with requirements for deployment of digital agriculture to measure and verify SCS practices, and therefore changes in SOC levels. Recall that the industrialization of agriculture was reliant on the substitution of capital for labor to increase productivity (Fitzgerald 2003; Clapp 2016). The ramifications of the deployment of technology for farming were increasing farm sizes for efficiency of scale, but also increasing scale to fund expensive machinery (Fitzgerald 2003). Writing in 1996 when precision agriculture was being rolled out, Wolf & Buttel argued that:

> one can expect that precision farming will be characterized by capital intensity and significant scale economies, and in the long term will contribute to the concentration of agricultural production in fewer hands. In this sense, precision farming is an industrializing technology in that it is consistent with a pattern of "appropriation and substitution (Wolf & Buttel 1270, 1996).

Digital agriculture technology, the successor to precision agriculture, perpetuates lock-in to the industrial farming system by exemplifying the same tendencies of the deployment of earlier farming technologies.[46] Kelly Bronson discusses the cost of digital technology that is generally fitted to other large machinery, privileging large farm sizes while directing small-scale farmers to expand their farms (Bronson 2019). Bronson also points out that the standardization and monocropping systems required by industrial farming systems are replicated in digital

[46] Digital technologies are often viewed as "disruptors" of industries, but they are often vulnerable to capture by existing interests, which is the case here in digital agriculture.

farming technologies. The field maps created through data collected and aggregated by digital agriculture platforms "are made meaningful only if one adheres to a rigid conventional farming strategy of seeding in neat rows separated by areas of soil free of weed" (Bronson 2019, 4). While these maps may be useful to large, neatly monocropped farms, it is of little use to small-scale farmers that may utilize "messier" farming methods (Bronson 2019). Digital agriculture also generates lock-in conditions through contracts that allow digital agribusiness platforms to collect farm data over long periods, precluding farmers from repairing their own equipment, and by alienating the farmer from knowledge about how their farm works or how decision-making plays out on their farm as they receive increasing proportion of advice from digital platforms (Carolan 2018; Rotz et al. 2019; Ingram & Maye 2020). Importantly, then, as farmers hope to take advantage of new market opportunities provided by private SCS initiatives and contribute to environmental action, their decision to opt-in to these programs risks a loss of farmer autonomy.

A counter argument to the negative effects of digitalisation is that data collection allows for a clearer understanding of chemical application needs at the field-level, and therefore more specific chemical spraying, which is more efficient and uses less chemicals (Balafoutis et al. 2017; Lioutas et al. 2021). This VRT methodology is widely deployed through private SCS credit initiatives, as they credit novel fertilizer application programs as part of their eligible practices. The VRT utilized in private SCS credit programs is fully dependent on digital agriculture platforms to collect and operationalize farm-level data. Many digital platforms speak to a goal of identifying unprofitable areas and targeting them for productivity increases. This is corroborated by research in interviews by Bronson, where fertilizer deployment was utilized to stimulate growth, thereby increasing productivity and profit (Bronson 2019). There is concern that VRT will allow for an increase in chemical inputs, which was expressed in an interview with a farmer and NGO member:

> there's no correlation between having the tools and knowledge that could allow you to use less and actually using less… Fertilizer use has almost doubled since 2006. So we've added technology, we've added information, and we added knowledge to the system, and we haven't seen fertilizer use go down (101231006, p
> os. 36).

Indeed, fertilizer usage in Canada has increased by 1.27 million tonnes between 2006 and 2019, while fertilizer usage in the U.S. has stayed stable around 22 million tonnes annually over the same period (Ritchie et al. 2022). The efficiency gains of new agriculture technology with an accompanying increase in emissions, exemplifies the Jevons Paradox, where efficiency gains from technology prompt the increase of consumption, rather than a decrease in consumption (Clark & York 2005). What digital agriculture technology and VRT methods accomplish, however, is continued reliance on chemical inputs in agriculture, a key component of the industrial model.

Behind the lock-in of industrial agriculture through private SCS credit initiatives is the language and messaging of CSA. As Seto et al. posited, carbon lock-in requires the establishment of norms and institutional arrangements to perpetuate fossil-fuel based systems (Seto et al. 2013). The CSA paradigm that SCS carbon credits utilizes as their framing narrative is what helps to legitimize industrial agriculture lock-in. CSA is a common theme amongst the messaging and advertising of private SCS credit initiatives. While not explicitly stated in some cases, agribusinesses administering credit programs follow CSA practices through the Climate Smart Commodities grant program distributed by the USDA. Currently Agoro, ESMC, TruTerra, Bayer, and the Soil and Water Outcomes Fund are receiving grant money from the USDA to support their SCS credit programs. TruTerra implicitly invokes CSA principles in their enrollment advertising:

> It’s not too late to unlock the potential of your soil, which could be an answer to rising input costs, extreme weather, yield instability, and even add extra revenue to your bottom line. Learn more about how your fields could match with a Truterra program (TruTerra 2023).

Language surrounding the realization of value in agricultural soils is common in corporate messaging about SCS credit programs. This is often paired with language around reducing carbon emissions, meeting climate goals, and increasing the resiliency of agriculture in North America to climate change, checking all the boxes of CSA programming. Other programs such as CIBO and CarbonNOW invoke CSA language more explicitly, pointing to the importance of the triple-win outcomes of climate smart agriculture.

In its original form, CSA projects purport to support small-holder farmers in mitigating the effects of climate change, providing them with much needed funding to transition to more sustainable farming. Scholarly work, however, has connected larger land holders to higher amounts of credit received through CSA projects (Makate et al. 2019) This critique is an avenue into deeper critiques of the CSA. Newell and Taylor (2018) argue that while there are no substantive differences between CSA-endorsed practices and existing farming practices, differences must be drawn to get funding. This observation is emblematic of CSA critiques more broadly, with scholars arguing that CSA does little to address underlying, structural issues of agriculture, with issues of access, monocropping, increase in farm size, and issues of power being “swept under the rug” (Taylor 2018). Indeed, CSA nearly conflates small-holder farms with larger farms that have high fertilizer usage (Taylor 2018). The vagueness of the CSA definition lends itself to being a broad label enveloping a large set of practices that may or may not be smart for the climate or for farmers but can be labelled as such (Newell & Taylor

2018). Instead, the focus is shifted to policy, institutions, property rights, and markets and price-signals to lower the barriers to access for farmers to access technologies associated with CSA, or to viably implement CSA practices on farms (Taylor 2018). CSA, while it does mention alternatives, such as agroecology practices, does little to question or substantially envision alternatives to industrial agriculture (Stabinsky 2014; Newell & Taylor 2018). CSA is presented as an apolitical, technological fix to the issue of climate change. This is especially true when considering when uneven power relations between farmers, finance, and agribusinesses are not considered (Taylor 2018). When extending CSA beyond FAO and the World Bank, scholars argue that CSA is particularly advantageous to private-sector agribusiness actors. The focus on technological fixes, efficiency gains, and extension of commodification in the agriculture sector is particularly attractive for private sector actors to latch onto, and CSA has been endorsed by a suite of agribusiness firms (Stabinsky 2014). Bayer's brochure advertising the contributions of digital farming to "saving the climate" is indicative of this: "In addition to helping farmers accomplish more with fewer resources, it [Climate FieldView™] also helps to reduce carbon emissions by maximizing efficiencies" (Bayer n.d.). Indeed, the U.S. Department of Agriculture's CSA Commodity program, which certifies agriculture products, is notably backed by Bayer, Corteva, Cargill, John Deere, Mosaic, Nutrien, Perdue and Land-O-Lakes (Lilliston 2022).

Beyond this connection, Newell and Taylor (2018) argue that "CSA projects have also lent a convenient cover for attempts at introducing controversial technologies into new markets or gaining access to growing markets for their products" (120). These technologies include carbon markets, allowing for the expansion of markets further into agriculture and allowing for the "re-assertion neoliberal solutions" (122). Stabinsky goes as far to label CSA as a "trojan horse for carbon markets”, as quantifying carbon and selling it would bring much needed investment to the agriculture sector (Stabinsky 2014, 2-5). The framing of CSA is important to the continuation of the industrial farming system because it locks-in agriculture technology-focused solutions to climate change and figures yields as the main outcome of agriculture (Carolan 2017). Tech-focused solutions such as CSA are figured as apolitical fixes. Efficiency gains through technology are good for the environment, and therefore should not be questioned, but they do not figure issues of power or other alternatives into the analysis. This depoliticization of climate change, as Swyngedouw argues: “reduces the political terrain to the sphere of consensual governing and policymaking, centred on the technical, managerial and consensual administration (policing) of environmental, social, economic or other domains” (2013, 3). CSA also provides economic rationale, continuing on the reliance on markets, as well as rationale for the continuation of the commodification and financialization of agricultural commodities.

Section 5.2: Capital Accumulation

Chapter 4 discussed the implications of the deployment of digital agriculture for a surveillance-based economy. One interviewee described concerns about SCS projects in the private sector becoming a new extractive economy, where value of farmer labor is extracted for the benefit of corporations, either in avoiding regulations or marketing sustainable agricultural products at higher prices (2922023245, pos. 8). By value extraction, I mean that farmers are removed from the benefits of their labour, as agribusinesses claim the credit for resulting climate adaptation benefits, while farmers are simultaneously undercompensated for their work. Another interviewee expressed this issue as the reaction of capitalism to the existential threat that climate change poses to continued accumulation (0102231143). It is important, then, to explore the implications of SCS credits in the broader context of neoliberal capitalism and its responses to climate change. Investigating SCS credits in this context allows for an understanding of implications of SCS credit initiatives and their contribution to operation of capitalism in the face of climate change. SCS credit initiatives also demonstrate strategies for capital accumulation, commodification, marketization, and financialization more generically. In summary, SCS credit programs demonstrate the process of economizing that provides new opportunities for profit. Economization can be defined as the process in which some 'thing' is made to be economic through "behaviours, organizations, institutions and, more generally, the objects in a particular society which are tentatively and often controversially qualified, by scholars and/or lay people, as 'economic'" (Çalışkan and Callon, 2009, 370). "Economic" can be defined in two ways: instrumental rationality at the individual level, or anything that can be linked to the "arrangements through which a society meets its material needs" (Çalışkan and Callon 2009, 375). What these two definitions of "economic" refer to, however, are theories about how the economy operates, arrangements that "enhance" human cognition to operate economically, and what material 'things' are to be valued and how they might be valued (Çalışkan and Callon 2010). The effort to examine economization, then, is to understand how goods and services come to be valued and exchanged.

The economization of soil in a capitalist system has numerous implications including the capture of new forms of profit by an increasingly consolidated agribusiness industry, which SCS credit initiatives contribute to. Discussion of this process includes the creation of carbon as a "fictitious commodity" in the figuration of Karl Polanyi (1944). The analysis later moves on from the abstraction of materials in economizing processes to understand how farmer labour is also implicated in SCS credit initiatives and how labour is implicated in the maintenance of natural systems.

Beyond the economization of soil and regulating functions of nature, SCS credit initiatives represent an opportunity for agribusinesses to further consolidate power in the agriculture sector. The agricultural input sector represents a highly consolidated sector, with six corporations controlling about 75% of the inputs market in 2009, before the mergers of Dow and Dupont and the acquisitions of Monsanto and Syngenta by Bayer and ChemChina, respectively (Clapp 2018; Clapp 2019).

5.2.1: Economization of Soil and Nature Regulating Systems

The term “economization” has received relatively little critical literature compared to “commodification” and “financialization.” This could partially be due to the fact these are all economizing processes (Çaliskan & Callon 2009). As defined above, economization, especially referring to market economies are about three mechanisms, economic theories to understand or propose how an economy works or should work; “institutional or technical arrangements to enhance capacities of human action” in such economies; and what is to be valued and mechanisms for valuing goods or services. that are deemed economic. Economization, in this definition, encompasses all of “commodification” and “financialization.” These processes are all economizing processes. To be clear, they are all different processes requiring different logics, justifications, and abstractions.

If the processes of commodification and financialization within market economies require different logics and justifications, then it is possible to identify market-based instruments (MBIs) for the management of nature in different stages of development. This also allows for the identification of the different forces, structures, and logics they are subject to. Referring to figure 1, the left-side of the spectrum is “raw” nature – this has not been incorporated into MBIs yet, or certain aspects of it are not yet included in it (not all things have been included into payment-for-ecosystem-services structures for example). It then experiences economizing processes that may stop at different points and be intelligible as "commodified" or "financialized." I identify "financialization" to be the end-stage of the economizing projects while recognizing that the reflexive aspect of market-making and sustaining is an on-going process. Similarly, market-making and financializing projects may stall out between different stages due to resistance or failure to move onto the next stage. Components of nature integrated into MBIs exist or have existed at some point along the spectrum and are highly contested, with some aspects limiting them from reaching full-fledged financialization, for example. What is most important, is that each stage represents different accumulation strategies and an attempt to internalize harmful externalities that threaten capitalist productive systems.

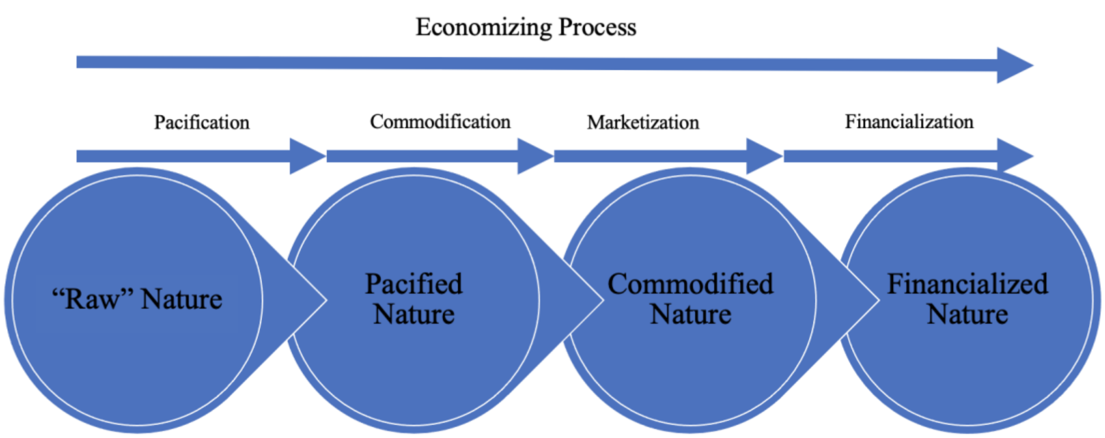

Figure 7: The totalizing economizing process of nature

The creation of the spectrum in Figure 6 outlines an avenue for analyzing the incorporation of nature into markets and the economizing process that it has experienced for the past thirty years and into the present. The remainder of this section explores how SCS credit initiatives economize soils, and some implications for economizing soils in a market capitalist economy.

The first step in the broad economizing processes, or the suite of processes contained in the "-ation" terms outlined above is commodification.[47] The commodification process begins with some "thing", in this case soil, being identified as having value. Soil provides the valuable service of producing food, sustaining livelihoods, and storing carbon. Generally, in the case of MBIs for the management of nature, "nature" becomes valued for its capacity for storing carbon, mitigating climate change, or improving water quality and biodiversity.[48] Soil, or its capacity to store carbon, then, has an identifiable value in the commodification process. Çalışkan and Callon argue that the valuation process results in "entities with pacified agency that can be transferred as property rights" (2010, 5).[49] They further argue that this passivity is what creates goods, the ability to figure the services of soil as a carbon sink, which can be standardized, stabilized, calculated, thereby making them appropriate for exchange. This is, to be sure, an economizing process, but does not distinguish a "good" from a "commodity". In discussions of market-based instruments (MBIs) for the management of nature, this runs into a theoretical obstacle of what a commodity is.

Marx gives the most substantial definition of a commodity and the "commodification" process. Marx argues that commodities represent a crystallization of human labour, which have use value and exchange value (Marx 1887, 28). Use value is a qualitative judgment of a product's utility, while exchange value is quantitative and does not contain a description of a commodity's use value (Marx 1887, 28). Marx goes on to argue that once a commodity's use

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[47] One could also argue that metrics and indicators, indicative of the neoliberal drive to make everything measurable, and therefore subject to performance metrics, is the first step in the economizing process.

[48] This valuation represents a departure from the common valuation of nature as being a stock of resources for production. While it is still regarded as a stock of resources, its valuation as a "sink" for disposing of waste in the production process and its stabilizing role is the novel aspect of these valuation initiatives.

[49] The reference to property rights specifically in this case is particularly interesting, as it leaves room for considering "goods" that are not manufactured to be included in markets. Following this, it is possible that a "good" is not required to be a "commodity" to be traded on the market. This breaks from the Marxist tradition

value is disregarded, we return to the underlying character of commodities: they are products of human labour representing more or less labour time committed to making that commodity (Marx 1887, 28). A commodity is intelligible as a store of quantitative value due to the labour put into it. This follows the classical labour theory of value. This definition of a commodity as requiring human labour to exist faces similar obstacles to Çalışkan and Callon's definition of a pacified good in the case of "nature" that is traded on markets in MBIs. In Marx's case, nature is not produced by human labour, making it difficult to label "nature" as a commodity. Çalışkan and Callon's definition of a pacified good, however, implies the existence of exchange value and use value.

Karl Polanyi's assertion of the three "fictitious commodities" in *The Great Transformation*, fills this gap. The three fictitious commodities include land, labour, and money (Polanyi 1944, 75). Polanyi, following Marx, but in more simple terms, defines a "commodity" as: "objects produced for sale on the market"(1944, 75). Land, labour, and money, in Polanyi's reasoning, then, these three things, while "essential elements of industry" and must be integrated into market systems for this reason, are not commodities because they are not produced. Pertinent to this argument, regarding land specifically, Polanyi states that: "land is only another name for nature, which is not produced by man" (1944, 75). The specification that land is not produced is particularly relevant for the position of the sequestering capabilities of soil as a commodity in MBIs to manage nature. Indeed, soil and soil health is the most essential element in the industry of agriculture, as it is both the source of agricultural commodities, as well as the repository for inputs in the agriculture input sector. Integrating soil as a commodity through SCS credit initiatives, then, helps to figure soil, owned by farmers, as a more visible and known quantity for agribusinesses. Even in this theorizing, we still do not have an answer to the economizing process that figures nature as a commodity. A key challenge following from Polanyi's theory is presented: nature and its regulating services, which are essential for the survival of life on the planet, are being included in MBIs and therefore priced, so how are they created to function as commodities?

To answer this question, literature exists specifically on the creation of carbon as a commodity. In creating carbon credits, the process begins with "pacification." Carbon is valued as a destructive negative externality and subjected to measuring and standardization practices (Lohman 2010; Goodman and Boyd 2011; Boyd 2011). Goodman and Boyd argue that "that which gets measured gets managed" and this is the truth for carbon (Goodman and Boyd 2011, 105). Carbon therefore gets measured and is set to be managed but must be transformed into something intelligible and standardized for a market. From this need comes the creation of the "tCO_2e" – the tonne of carbon dioxide equivalent (Paterson and Stripple 2012). This becomes the unit that is traded on carbon markets as a commodity (Paterson and Stripple 2012). In the case of agricultural carbon credits, two methods exist to generate the same unit that is standardized and traded on the market: carbon credits generated by acre and carbon credits generated per tonne of CO_2. The transformation of agricultural lands' ability to sequester carbon is abstracted into units of carbon mitigation to be sold on the market. This effectively pacifies the carbon cycle, food production, and livelihoods that take place on that land in order to generate new forms of value in the market.

Indeed, the value of carbon is unlocked by measuring it and identifying the threat it poses (Ouma 2020). Paterson and Stripple (2012) argue that carbon is a "virtuality" given its construction, an abstraction from its form as a molecule and into something that is tradeable. It is a simplified form of a suite of greenhouse gas molecules, hence the equivalent, and put under a system of scarcity (Lohmann 2010). The creation of scarcity conditions is crucial, both to the functioning of carbon markets, as limits are identified, but this creates the conditions for it to be viewed as having value (Lohmann 2010). Lohmann argues that the carbon credit can be conceived of "as universally fungible greenhouse gas pollution rights backed by an implicit government guarantee that an optimal 'climatically safe' amount of total rights in circulation can in principle be both specified and mandated" (Lohmann 2010, 237). Dempsey and Robertson argue that commodification of "nature" is possible as it viewed similar to service commodities: services are consumed for the purpose of increasing human utility (Dempsey & Robertson 2012). This is because ecosystems are seen as providing a type of service as a sink for pollution (Dempsey & Robertson 2012). The process of commodifying the carbon cycle and its potential to mitigate climate change on agricultural lands is enabled through the MRV protocols generated by the agribusinesses that are administering SCS credit initiatives. MRV protocols are crucial to SCS credit initiatives as they are the service that carbon credit buyers are paying for but also the key operation in bringing carbon credits into the fold of markets. MRV protocols have an aura of virtuality, in that they make different assumptions across agricultural lands in different environmental contexts but are made comparable and interchangeable.

In the case of carbon credits, the pacification of nature is particularly true: a service is being provided to sequester or mitigate carbon emissions, which is pacified into something that is valuable, the potential of carbon sequestration is measured, and then quantified and standardized into a commodity. This says little of the struggle to create legitimacy and to overcome contradictions posed by figuring carbon, and nature more generally, as a commodity. Huff (2021) argues that there is a drive to commodify nature, as capitalism's "commodity fetish" drives 'accumulation by restoration' or 'accumulation by decarbonisation', economizing nature for the purpose of reshaping it for further accumulation. (Bumpus and Liverman 2008). This is a truly unruly process. Indeed, figuring soil as a commodity is difficult. As mentioned above, soil is both the source of agriculture commodities, as well as the target for agriculture inputs, but this only captures some aspects of the productive nature of soils. Incorporating the regulating nature of soil as a commodity, represented by carbon credits, through SCS initiatives helps to complete the incorporation of soils as a commodity, tradeable on the market. It, however, abstracts soil from its original form in the same way as carbon sinks have been subject to in the past, as described above.

Apart from this abstraction through commodification, another implication for the commodification of agriculture includes financialization. In their book *Speculative Harvests: Financialization, Food, and Agriculture* Clapp and Isakson detail the involvement of finance into food and agriculture. The authors note the increasing role of financial derivatives as methods to manage risk in crop outputs as a form of integration into financial markets (Clapp and Isakson 2018). Financial integration is further seen in the incorporation of commodities into futures and derivatives markets which have deleterious effects on “real” commodity and food prices in primary markets (Clapp and Isakson 2018). The process of financialization, then involves the subjection of commodities and commodity markets to an abstraction process that further removes them from their points of origin, hiding their original characteristics, and creating new ones, in attempts to extract greater amounts of profit. Clapp (2014) argues that this is a form of distancing, divorcing food commodities, in particular, from their original form.

Jennifer Clapp also discusses the reflexive aspects of the financialization process that further contribute to financialization outlined above. Clapp observed that the involvement of finance in food empowered financial actors making speculative investments in land, food commodities, corporate accumulation strategies, and speculative investments in food-related companies up-stream and down-stream in supply chains. (Clapp 2014)

Applying this to carbon credit markets, we see a similar drive towards financialization. Whittaker (2007) argues that carbon markets have reached a sufficient level of financialization due to the creation of derivatives and secondary markets that are sufficiently liquid. In a chapter in *Carbon Finance*, Martin Whittaker outlines the trajectory of carbon market development. The establishment of a commodity market is the first stage (Whittaker 2007, 222). Then, financial markets are created on top of commodity markets:

> "As the secondary market forms, liquidity deepens and fundamentals become more economically rather than politically motivated, the shift toward carbon becoming a genuine asset class will undoubtedly hasten. As this process takes place, carbon will increasingly be seen like other commodities, and will come to be traded and financed and underwritten." (Whittaker, 222)[50]

The economizing process that creates financialized carbon is not finished until it is completely liquid, with underpinning economic processes and "over pinning" secondary markets. What is interesting in this quotation too is the description that carbon will be seen as other commodities once it is financialized. This demonstrates reflexivity for the creation of markets as well as the backwards compatibility of financialization as an "ideal" for the totalizing economizing process. It also demonstrates that there are spaces that commodities can occupy that are not "totally" financialized or non-financialized. This is one of Bigger's contributions, who argues that, in market form, MBIs for nature exist along a spectrum, where some are fully financialized and

[50] What is interesting is White's later acknowledgment of the political process that underpins carbon markets and its inherent volatility: "Underpinning this evolution, however, is the attachment of economic value to avoided greenhouse gas emissions. It is critical to remember at all times that emissions themselves are not an economic good, only the avoidance of emissions as framed by international political convention. Thus, a fundamental political and social commitment to reducing greenhouse gas emissions through the use of market-based policy instruments is the ultimate determinant of carbon value and the viability of carbon as an asset class in the future" (222).

others are essentially become state-supported markets or regulations, a far cry from the ideal. (Bigger 2018).

Thinking beyond the economization of soils, we can look to literature on both the "growth" and expansionary imperative instilled by capitalism as well as the threat that climate change poses to capitalism, the implications of economizing in market societies. In *Capital Vol. 1* Marx demonstrates that capitalism has an expansionary quality, whether it is demonstrated through growth in investment through money in its commodity form, or the increasing commodification of different parts of society (Marx 1887). Integral to the figuring of sustainability within neoliberalism, the ecological modernisation literature seeks to explore the reconciliation of growth with ecological restoration or maintenance (Bailey et al. 2011). This reconciliation of growth and ecological maintenance requires the incorporation of agricultural soils as a method of saving food-producing systems while creating new sites of accumulation and making ecological maintenance intelligible to growth imperatives (Bumpus and Liverman 2008; Bailey et al. 2011). In the face of climate change as an existential threat to capitalism, the ecological modernisation thesis holds up, but capitalism must contend with this issue on its own terms, creating commodities, markets, and financial instruments as methods that make nature in its own image of calculable, exchangeable, and simplified (Wright and Nyberg 2015).

What the spectrum presented above shows is exactly this: the creation of nature in capitalism's own image, with general failure or deficiency. The failure to create or figure nature in this way could partially be due to the logical stretches that are required in crafting agricultural soils as a tradeable commodity,[51] its oversimplification in price systems,[52] or the dispossession of a life-sustaining system.[53]

This is to say little of the labor that is involved in planting, maintaining, and adapting farm activities to the activities and methods that are eligible for SCS credit initiatives. What is unexamined by the literature discussed above in the generation of carbon credits is the shaping of nature or the "manufacturing" of natural processes for the purposes of enabling carbon storage or increased water quality. In many of these analyses, carbon credits are figured as commodities that are generated through accounting methods developed by privileged financiers and managers. The view of ecosystem services as having a sense of "virtuality" or "fictitiousness" does little to account for the labor that is required in generating the conditions for SCS credits in the agriculture sector.

5.2.2: Corporate Consolidation in the Agribusiness Sector

Another development brought by SCS credit initiatives that contributes to new forms of capital accumulation and corporate consolidation, is the creation of new sustainable grain markets. The term "markets'' defined in the neoclassical sense brings forth ideas of anonymous buyers and sellers whose interactions are informed by the price mechanism for the exchange of goods. This traditional mechanism seems not to exist in the agricultural carbon credit market. In this space, agribusinesses act as aggregators *and* brokers. As discussed in Chapter 3, aggregators pool small volumes of credits to manage verification and transaction costs. In each private SCS initiative, credits are measured, verified, and pooled for sale. The transaction costs and

[51] Polanyi's disembodying of the fictitious economies and the deleterious effects of including the three fictitious commodities is particularly salient here. (Polanyi 1944

[52] Ecosystems exhibit complexity, which is necessarily uncertain and utterly immeasurable by pricing systems which are inherently simplifying. For more on uncertainty in ecosystems, see: Kay & Schneider 1994, Holling 2001

[53] The continuation of "anthropocentric" approaches to understanding and "controlling" the environment are certainly reflexive consequences of the construction of MBIs for the management of nature.

verification costs are managed by agribusinesses. After aggregation, agribusinesses look to meet on-the-spot demand for carbon credits by brokering amounts of aggregated carbon credits to other firms. In some cases, such as Indigo, ESMC, and Nori, there is an argument to be made that these are close to true marketplaces. In this case, credits are registered into these marketplaces, sold, and retired through the verification organizations that are affiliated with these marketplaces, of which there is a significant amount of overlap. Many agribusinesses that are selling carbon credits are market-makers in two senses. Agribusinesses such as Corteva, Cargill, and Nutrien are all founding partners in marketplaces such as Indigo Ag, as well as ESMC, making them market-makers in their contributions to the structuring of close-to-perfect market competition in the carbon credit space (Corteva 2023; Cargill 2023; Nutrien 2023; Indigo 2023; ESMC 2023). Similarly, agribusiness looks to establish market credibility and initial demand by operating a brokerage market to meet demand on a tentative basis. These low-carbon grain markets rely on the data generated by private SCS credit initiatives and collected by digital agriculture tools. Market access barriers are another concern with the implementation of these data, especially with the involvement of agrifood companies in insetting initiatives. With new data on farm practices, agrifood companies looking to buy "sustainable" crops could either turn-away or offer discounted prices to farmers who do not enroll in SCS or sustainable supply chain programs. One interviewee put it succinctly:

> The big companies that are promoting this have a lot of the market share for grain sales. If you are a grain farmer and you don't want to sign on to this data gathering, and you say, '*no thanks I do not want Cargill to have all this information about my crop rotations and my land base',* it might be hard to sell your grain. They would say '*Oh well we've got all this sustainable grain, we're actually not taking grain for people that aren't signed up for the program right now we don't have any room so maybe come back next week'* (0102231143, pos. 7).

The ability for agribusinesses to broker deals and create unregulated market access barriers, enabled through the consolidation of surveillance data gained through SCS credit initiatives is both an opportunity to create new forms of accumulation and increase power in the industry. Another interviewee mentioned concerns about consolidation of power in monopolistic and monopsonistic markets in agriculture (2922023245, pos. 8). This consolidation is best demonstrated through the density of connections between agribusiness corporations and agrifood corporations, as well as commodity aggregators. Figure 8 demonstrates these connections.

This network demonstrates that all private SCS initiatives are closely linked to one another. Each major agribusiness firm administering an SCS credit initiative, while not directly linked, are only one connection removed from each other in every case. They are either linked through a marketplace, such as ESMC or Indigo, a technology company, such as RegenConnect, or through purchasers, such as MapleLeaf, Nestle, or General Mills, both major agrifood firms. Cargill, together with Nestlé, have worked together to enroll 1.7 million acres in Cargill's SCS credit program (Beef Magazine 2023). The ownership landscape of the agribusiness sector represents a near oligopoly. Similar to the input sector, the agrifood sector, where there is similar concentration (Deconick 2021). This is also exacerbated by the level of concentration of financial ownership amongst agribusiness and agrifood firms. Asset management and hedge fund groups such as Blackrock, Vanguard, State Street, Capital Group, and Fidelity together own a large number of shares of publicly traded agribusiness firms, including BASF, Syngenta, and Bayer, as well as agrifood firms such as Danone, Nestle, Tyson, Kellogg's, and General Mills (Clapp 2019). Important to note also, that both CIBO and Indigo are backed by Flagship Pioneering, the venture capital arm of Moderna Pharmaceuticals. All of the corporations listed just now are either administering or are participating partners in at least one, sometimes more, of the private SCS credit initiatives that are the topic of this thesis.

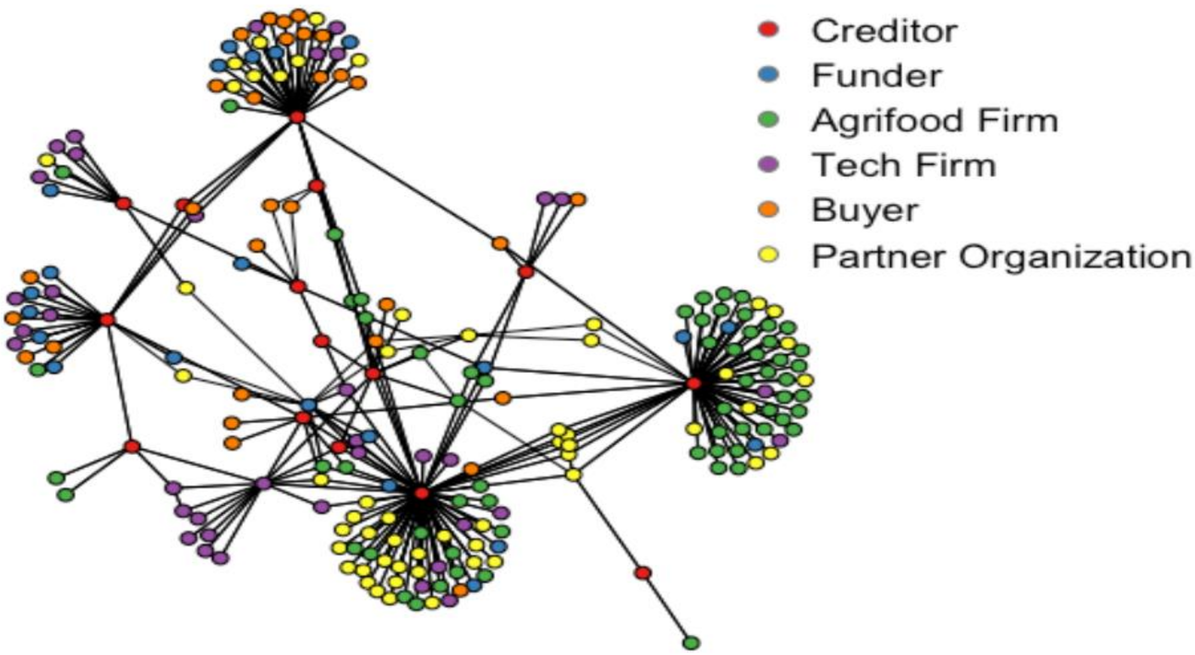

Figure 8: Connections between major agribusiness firms administering private SCS initiatives, agrifood firms, tech firms, venture capital firms, credit buyers, and agriculture organizations.[54]

Section 5.4: Justice Issues

Another set of power concerns is the idea of justice or shifting responsibility onto farmers to deal with climate change. Critical political economy studies the source of power and the exercise of power, but political economy can also be utilized to analyze just distributions of power and the effects of the exercise of power. Schmoller et al. direct attention to the idea of the just distribution of "economic goods" (Schmoller et al. 1894). This can be extrapolated to the just distribution of economic costs as well. Previous discussion of markets and the institutions

[54] CIBO Technologies 2021a Agoro 2023a; Beef Magazine 2023; Corteva 2023a; ESMC 2023b; ESMC 2023c; ESMC 2023d; Gradable 2023b; Indigo 2023d; Nori 2023b; Rabobank 2023; ReGrow 2023a

that allow for the distribution of economic goods, particularly in section 5.3 demonstrate that the mechanisms through which distribution is dictated, and who holds power in these structures and institutions, dictates the distribution of economics goods, necessitating an inquiry into justice. Justice concerns in environmental issues examine the responsibility for mitigating climate change. Referencing the global North-South divide, Chukwumerije Okereke defines climate justice as the historical responsibility for GHG emissions, which rests on the global North, and the responsibility for adaptation and mitigation, which rests on the global South (Okereke 2010). While the concept of climate justice has been developed in reference to the divide between the global North and the global South, it can be applied to the situation of agriculture in North America. In this case, agribusinesses are historically responsible for emissions, while, through SCS credit initiatives, farmers bear the responsibility for climate change mitigation adaptation, even though they possess less structural power.

Climate justice requires viewing climate change as an ethical issue, with solutions taking in considerations of responsibility and capability, rather than a technological or managerial fix (Okereke 2010; Schlosberg 2012; Sultana 2022). Climate justice, then, is "fundamentally about paying attention to how climate change impacts people differently, unevenly, and disproportionately…" (Sultana 2022, 118). In order to understand the different impacts of climate change, it is important to understand the different forms of justice. Gardiner outlines three different forms of justice and their relevance to climate change: procedural justice, distributive justice, and corrective justice (Gardiner 2011). Procedural justice refers to the way in which solutions are both determined and enacted, either through existing or new institutions (Gardiner 2011). Distributive justice refers to who bears burdens and who accrues benefits (Gardiner 2011). With regards to climate change, this refers to who is allowed to emit and "with what justification”, but also who bears the burden of mitigating climate change, and supplies resources to achieve that mitigation (Okereke 2010; Gardiner 2011, 310). Finally, corrective justice tackles questions of past injustices, and determining how failures to act towards mitigating climate change are dealt with (Gardiner 2011). Concerns surrounding each of these forms of justice were present in interviews regarding private SCS credit initiatives, as well as comparing previous scholarly literature on carbon credit programs to current SCS credit initiatives.

Perceptions of procedural injustice were the most salient during interviews. One interviewee questioned: “are farmers willing to make themselves dependent on the good graces of big companies, for their additional income?” (112231133, pos.). As discussed above, an interviewee questioned the motivation for carbon credit programs and whether or not SCS projects and the work of farmers were allowing other organizations to get away with greater environmental harms. An NGO employee highlighted this problem, when discussing the good of SCS projects generally. The interviewee argued for the benefits of a publicly funded program to pay farmers for these practices:

> It gets away from a lot of things. It gets away from forcing farmers who want to do the right thing from taking money from the biggest emitters and thus becoming complicit. I know if I was farming actively right now I wouldn't want my farm to be buoyed up by taking money from the highest emitters that were damaging the climate (101231006, pos. 10).

Farmer concerns about righting the wrongs of large emitters like agribusiness firms is reflective of scholarly debate about the role of previous carbon markets in shifting the onus on decarbonization or carbon sequestration on populations that have less power to resist, while high emitting corporations or countries pay little and can avoid high costs of substantially cutting emissions. Scholars have discussed forms of extractivism through carbon markets, where carbon credits are cheaper to create, rather than reducing fossil fuel usage, while providing benefits and profits to project developers, agribusinesses in this case, who are able to avoid real reductions and gain new avenues for profit (Bumpus & Liverman 2008). This worry about extractionism was touched on in section 5.3 by an interviewee. The extractionist argument warns of both the extractionist nature of these markets and the potential for locations such as farms to become "pollution dumps" (Bumpus & Liverman 2008, 142). A deeper concern is the enclosure of nature by projects that require clear property rights for the commodification and marketisation of carbon. Scholars in political economy and critical geography literature have drawn connections to "accumulation by dispossession", or more saliently as "accumulation by decarbonization" (Bumpus & Liverman 2008; Espinosa-Flor 2022).[55] Carbon markets, and the economizing processes that they include, then, have an extractive and dispossessive tendency associated with them, enclosing local livelihood-ways, restricting access to nature, and disrupting place-bound socio-ecological processes. The ways in which carbon markets operate represent a set of procedures that raise justice concerns, contributing to an unfair distribution of costs.

The use of the word "complicit" in the interview quotation included above implies that participation in these private SCS credit initiatives involves farmers in a broken system. This seems to be true when considering the shift of mitigation responsibility onto farmers in these initiatives but becomes more obvious when considering the critique of carbon credits as "permits to continue to pollute" discussed in Chapter 2. One interviewee questioned: "What are you promising when you sell a carbon credit, and you know are you letting whoever is buying it off

[55] A few other authors have referenced David Harvey's "accumulation by dispossession" argument in reference to carbon projects, but Bumpus & Liverman (2008) make the more specific "accumulation by decarbonization" argument. This argument fits more neatly with literature that examines the role of "climate change action" on the part of corporations and capitalism more broadly to stymy or adapt to the existential threat that climate change present to accumulation.

the hook or something that's a lot worse and they're buying their way out of it? (104503102023, pos. 22)." Worries about complicity in a mitigation system that allows pollution to continue, and may not result in real reductions, is expressed elsewhere in interviews as doubts about the benefits of farming practices encouraged in SCS initiatives to solve climate change. One interviewee stated that: "Unfortunately for all of us that would love the silver bullet "we can sequester carbon" the science is really not showing something that could be the base of a legitimate verification." (2922023245, pos. 6) This compounds on existing concerns about climate change and the limited time to find solutions to a growing problem: "I am very skeptical, and I am concerned just because we're missing the opportunity. The world is on fire so we should be doing something." (2922023245, pos. 6) Figuring SCS as a complete solution to climate change, which is what private SCS initiatives are doing, does not hold up to climate science and this is recognized outside the scientific community creating a wider skeptic base. Another interviewee described this a "diversionary tactic", pursuing SCS initiatives instead of "rapidly reducing emissions, as is called by virtually every scientific body" (101231006, pos. 4). The inability for SCS credit programs to amount to effective climate change mitigation while distracting from real climate action amounts to the creation of future costs for farmers to bear as they seek to adapt their farms, and therefore their income sources, to changing weather patterns.

Distributive justice was also mentioned in interviews. As discussed above, the assembling of natural processes to generate increased SOC levels on farms is dependent on farmer labour to install cover crops, adapt to digital practices, and change tillage operations. The accumulation that is enabled through the extraction of value created by farmer labour in SCS initiatives is another concern. One interviewee described concerns about SCS projects in the private sector becoming a new extractive economy, where value of farmer labor is extracted for the benefit of corporations, either in avoiding regulations or marketing sustainable agricultural products at higher prices (2922023245, pos. 8). This is corroborated by interviewee comments that farmers are often not getting paid enough to implement these practices. One interviewee mentioned anecdotally that:

> I have not heard any farmers say that they have done really well and that they have really prospered from these payments. The payments seem relatively small and then they seem to be on for a while and off for a while and they're incredibly slow in coming in. (101231006, pos. 20)"

This sentiment is demonstrated in other interviews that mentioned that farmland prices have "skyrocketed", meaning that these payments are useless. Payment methods amongst programs are fairly uniform. The majority of programs pay for the amount of carbon, in tonnes, stored in soils due to practice changes that are implemented through the program. Only Nutrien, Bayer, CarbonNOW, and CIBO administer SCS credit programs which pay per acre of practice changes. Payment amounts are quite diverse amongst programs, however. Payments range from $12-$35 per tonne of carbon stored or per acre enrolled, or more in some cases: a number of programs have established price floors for their programs with the possibility of higher payments based on market trends. Only a few, Rabobank, Indigo, Farmers Edge, and ESMC administer programs in which payment amounts are fully reliant on market trends (Rabobank 2023; Indigo 2023; Farmers Edge 2023; ESMC 2023). What is interesting too, is the practice of agribusinesses of charging brokerage fees to farmers once carbon credits are sold. While transaction and verification costs are handled by agribusinesses, then, they are not the ones to incur these costs while gaining revenue on the sale of carbon credits, the deals for which they often negotiate themselves. No matter the payment arrangement, however, an interviewee mentioned that $50-$150 would be more realistic of a payment scheme for farmers (2922023245, pos. 10). In opposition, a government employee mentioned that the $30-$40 credit price would be enough to incentivize farmers to change their practices (512221138, pos. 28).

Finally, the idea of corrective justice, particularly in the continuation of emissions without addressing past injustices arose in interviews. As discussed earlier in this chapter, lock-in to industrial farming systems has been, and continues to be, a conscious project of powerful agribusiness firms to ensure continued profit in the face of the existential threat of climate change. The section on procedural injustice covered the market approaches and pitfalls of SOC sequestration as a "silver bullet", where the continuation of emissions is allowed and not properly addressed. The pursuit of corrective justice in SCS credit initiatives would have to address the mass amounts of carbon released through mass rollout of industrial farming. One interviewee argued that crediting new levels of SOC was a false premise in the face of historical agricultural soil emissions:

> counting that current soil sequestration against current industrial emissions is simply logically wrong, if you counted against anything you're you should be counting it against the past emissions from those same soils. Or to put it a different way nobody wants to count huge quantities of carbon that were released from the soil, but they now want to count them the smaller quantities of carbon that are being put back into the soil (101231006, pos. 6).

Corrective justice would address the historical emissions from agriculture soils, rather than crediting new sequestration against baselines established at low levels due to historic levels. Indeed, this interview quotation exposes that private SCS credit initiatives rely on previous environmental damages in order to generate new avenues of profit. As mentioned in Chapter 3, finite amounts of SOC can be sequestered, where current SCS is reliant on historic emissions.

Section 6.5: Conclusion

This section demonstrated that there are numerous, far-reaching implications of private SCS credits on North American agriculture. First, the lock-in effects demonstrate implications for the continuation of harmful industrial agriculture practices in North America by legitimizing large-scale farms and continued fertilizer usage through the lock-in of farmers to practices such as no-till and cover cropping, which encourage both of these trends. Lock-in also occurs through the implementation and roll-out of digital agriculture platforms, requiring "clean" cropping systems, contributing to monocropping. This lock-in is legitimized through CSA language, which is widely used among agribusiness corporations administering SCS credit initiatives and carries a high-degree of legitimacy while precluding alternatives to industrial agriculture and market-based solutions to climate change. Second, utilizing theory from political economy and critical geography, SCS credit initiatives were shown to "economize" soil in a way that distorts both our view of nature and our interactions with it, but also potential solutions to climate change. Again, markets are figured as the primary solution to the ecological crisis. This accumulation through economization provides new opportunities for corporate consolidation through supply chains, as demonstrated through the tight network of connections that agrifood and agribusiness corporations have forged through these SCS initiatives. Finally, private SCS credit initiatives have justice implications, shifting the onus for climate change mitigation on farmers while perpetuating a "pay to pollute" system that is least invasive to agribusiness practices and interest, while creating new dependencies on agribusiness firms.

Chapter 6: Conclusion

This thesis takes a critical political economy position, utilizing theory on the role of corporations, the character of capitalism, and interactions between capitalism and the environment to understand new SCS credit initiatives. The data collection completed for this project demonstrated a number of key issues. The first is the practicality of SCS credit systems, particularly the cost of soil measurements for carbon sequestration monitoring and verification. Overwhelmingly, models are used to measure and verify carbon sequestration which generates concerns about validity. Similarly, payment schemes may not be enough to cover the costs incurred by farmers who are changing practices to qualify for these SCS programs. Regarding the question of motivations, interviews, and scholarly literature point to a desire to shape or "get ahead of" impending regulatory changes, meeting market demand, and greenwashing products and creating new opportunities for profit and accumulation through the threat of climate change, including the roll-out of new digital agriculture technology.

The implications of SCS credit initiatives include lock-in to industrial agriculture systems, further capital accumulation, and justice issues. Lock-in implications include the further utilization of fertilizers, increasing farm size, and the deployment of digital agriculture tools. Capital accumulation refers to the ability for private corporations to create new commodities out of the ecosystem services of soil, create new profit opportunities through data collection and digital agriculture, corporate consolidation, and creation of new market structures for sustainable products. Finally, justice concerns stemming from SCS credit initiatives demonstrate the issues of responsibility for climate change mitigation and increasing power of agribusinesses in the agriculture sector. In total, this project provides an overview of the landscape of novel, private SCS credit initiatives in North America, as well as a critique of the continuance of industrial agriculture, the emergence of digital agriculture and climate-smart agriculture, as well as market-based mechanisms in responding to climate change.

Private SCS initiatives should continue to be studied. Given the novelty of these initiatives, and therefore lack of data on volume of credits generated, number of acres enrolled, and uptake of these programs, effects of these programs can only be spoken about as implications. Economic research on the development of markets, price movements of credits on markets as well as payouts to farmers could be completed to help understand any linkages between markets and adoption rates of SCS practices. Research on the accounting and MRV methodologies used by agribusinesses should also be researched as these initiatives continue to develop. Understanding these methodologies will provide a better understanding of how climate sequestration is being formulated in the VCM.

Political economic research should also continue to be done on SCS credit initiatives. Studying the consolidation of agribusiness firms and supply chains in North America with a political economy approach will provide a better understanding of the trajectory of climate policy in the agriculture sector. With the advent of SCS credit initiatives in the VCM, agribusinesses have a unique material and discursive opportunity to heavily influence the direction of climate policy and political economists are well equipped to analyze the role of agribusiness power in achieving these potential outcomes. Political economy research can also bring together issues outlined above in the participation of farmers, compensation, and methodologies for understanding how farmers and farmer labour is enveloped by these SCS credit initiatives. There is also work to be done on the extension of digital agriculture and its effects on farming systems through SCS credit initiatives. While digital and precision agriculture has existed previous to SCS credit initiatives, these initiatives provide a clearer gateway and incentive to adopt digital agriculture. The role of digital agriculture in private SCS credit initiatives should be studied, as well as the effects of digital agriculture on corporate profits and activity in the agribusiness sector.

The formation of new commodity markets and the advent of low-carbon agriculture commodities is also a ripe area of research for political economists. Creation of new markets by agribusinesses as well as the power that they hold as both input manufacturers and now as commodity aggregators should be studied to understand the changing nature of agribusiness and agrifood companies in the face of climate change. There is also space to expand on the role of capitalism and the profit-motive as a force of adaptation vis-à-vis the existential threat of climate change. Functioning agriculture systems are threatened in the face of climate change, while industrial agriculture is a major source of emissions, therefore contributing to climate change. While SCS credit programs aim to be a solution to climate change in both decreasing emissions and carbon sequestration to undo previous emissions, this study has demonstrated that there are far reaching implications for both climate action and justice issues.

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Appendix A: Prospective Interview Questions for Farmers

Section 1: Rapport building questions

- For how long have you been farming?
- What sorts of activities do you do on your farm? What crops do you keep? Do you keep any livestock?

Section 2: Background

- Which carbon credit initiative are you participating in?
- How did you hear about agricultural carbon credit initiatives?
- How long is your contracted to the agricultural carbon credit initiative?
    - Do you believe that contract length matters?
- Were you encouraged by an agribusiness company participate in these programs?
    - If so, who? What was their messaging?
- Were you encouraged by any government institutions to participate in these programs?
    - If so, who? What was their messaging?
- Were you encouraged by any community or farmer's union to participate in these programs?
    - If so, who? What was their messaging?

Section 3: Climate change and sustainability practices[56],[57]

- Before participating in an agricultural carbon credit program, did you practice sustainable farming?
    - If yes, what were these practices? Have they changed under agricultural carbon credit initiatives?
        - If yes, how have they changed?
- Did concerns about sustainability encourage you to participate in agricultural carbon credit initiatives?
    - If yes, do you believe that caron credit initiatives will generate beneficial change?
    - If no, have you considered other sustainable farming practices since participating in agricultural carbon credit initiatives?
- Do you believe that climate change or pollution are currently affecting your farm operations?
    - If yes, how is it affecting your farm operations?
    - If no, why is this the case?
- Do you believe that climate change or other environmental changes will affect your farm operations in the next 10 years? 20 years?
- Do you believe that agricultural has a role in environmental quality?

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[56] Oldfield, E.E., A.J. Eagle, R.L. Rubin, J. Rudek, J. Sanderman, and D.R. Gordon. *Agricultural Soil Carbon Credits: Making Sense of Protocols for Carbon Sequestration and Net Greenhouse Gas Removals*. New York, New York: Environmental Defence Fund, 2021. edf.org/sites/default/files/content/agricultural-soil-carbon-credits-protocolsynthesis.pdf.

[57] Lipper, Leslie et al. "Climate-Smart Agriculture for Food Security." *Nature Climate Change* 4 (2014): 1068–72. https://doi.org/10.1038/NCLIMATE2437.

Section 4: Farming practices[58]

- Has participating in a carbon credit initiative changed which crops you plant?
- Has participating in a carbon credit initiative changed your planting methods?
- Has participating in a carbon credit initiative changed your fertilizing patterns?

Section 5: Technology[59,60]

- Has the participation in agricultural carbon credits required you to adopt new technology for farming?
  - If yes, what technology is being used now?
- If respondent mentions the use of monitoring technology, ask: how is your data collected?
  - Are there any privacy concerns in monitoring farm data?
- If respondent mentions the use of new technology:
  - Have you had to pay for the technology? Did you install it yourself?

Section 6: Income considerations and carbon markets[61]

- Were you encouraged to participate in an agricultural carbon credit to gain an additional source of income?
- Do you sell your carbon credits directly to the agribusiness or do you sell your carbon credits through a carbon market?
  - If through the agribusiness: do they pay you for tonnes of carbon stored? For number of acres? How much?
  - If through the market: what is the average price that you have been selling your credits for?

Section 7: Extensions

- Do you know anyone else who is participating in agricultural carbon credit programs?
  - If yes, do you know why they decided to participate?
  - If no, do you know what is preventing them from participating?
- Do you know of any organizations that are opposed to agricultural carbon credits?
  - If yes, do you know why they oppose them?
- Have you received any praise for participating in a carbon credit imitative?
- Do you know of any other carbon credit initiatives?
  - If yes, do you believe some are better than others?
    - If yes, why do you believe some initiatives are better than others?

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[58] Taylor, Marcus. "Climate-Smart Agriculture: What Is It Good For?" *The Journal of Peasant Studies* 45, no. 1 (2018): 89–107. https://doi.org/10.1080/03066150.2017.1312355.

[59] Clapp, Jennifer, and Sarah-Louise Ruder. "Precision Technologies for Agriculture: Digital Farming, Gene-Edited Crops, and the Politics of Sustainability." *Global Environmental Politics* 20, no. 3 (August 2020): 48–69. https://doi.org/10.1162/glep_a_00566.

[60] Lioutas, Evagelos D., Chrysanthi Charatsari, and Marcello De Rosa. "Digitalisation of Agriculture: A Way to Solve the Food Problem or a Trolley Dilemma?" *Technology in Society* 67 (2021). https://doi.org/10.1016/j.techsoc.2021.101744.

[61] Rotz, Sarah, Emily Duncan, Matthew Small, Janos Botschner, Rozita Dara, Ian Mosby, Mark Reed, and Evan D.G. Fraser. "The Politics of Digital Agricultural Technologies: A Preliminary Review." *Sociologia Ruralis* 59, no. 2 (April 2019): 203–29. https://doi.org/10.1111/soru.12233.

Appendix B: Draft Interview Questions for Corporate Actors

Section 1: Introduction

- How long have you been working at Corporation X?
- What is your role at Corporation X?

Section 2: Background

- What is an agricultural carbon credit?
- Can you describe how your carbon credit system works?
- Do you buy carbon credits from farmers or run a market for carbon credits?
  - If you buy carbon credits from farmers, do you utilize these carbon credits for ESG purposes?
  - If you buy carbon credits from farmers, do you pay per tonne of carbon stored or per acre?
- How long are carbon credit contracts with farmers?

Section 3: History

- Was there consideration of past carbon credit initiatives when designing your carbon credit initiative?
  - If yes, what initiatives did they draw on?
  - If yes, did they draw on past agricultural carbon credit initiatives?
- How does your carbon credit system differ from previous carbon credit initiatives?
- Who made the decision to engage in carbon credit initiatives?

Section 4: Sustainability considerations

- Does your company have a sustainability mandate?
  - If yes, what is it?
- How does your carbon credit system contribute to your sustainability goals?
- Has there been any pressures from corporate shareholders to consider sustainability concerns more substantially?[62]
  - If yes, what have those concerns been?
  - If yes, what reaction was there to the carbon credit initiative?
- Is there any pressure from government institutions to engage in sustainability practices?
  - If yes, what pressures are they?
  - If yes, what reaction was there to the carbon credit initiative?
- Is there any pressure from the public to engage in sustainability practices?
  - If yes, what pressures are they?
  - If yes, what reaction was there to the carbon credit initiative?
- How much carbon does your carbon credit system currently abate? What is the goal for the carbon credit system?
- Does Corporation X have plans to participate in climate smart agriculture?[63]

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[62] Clapp, Jennifer. "The Rise of Financial Investment and Common Ownership in Global Agrifood Firms." *Review of International Political Economy* 26, no. 4 (2019): 604–29. https://doi.org/10.1080/09692290.2019.1597755.

[63] Taylor, Marcus. "Climate-Smart Agriculture: What Is It Good For?" *The Journal of Peasant Studies* 45, no. 1 (2018): 89–107. https://doi.org/10.1080/03066150.2017.1312355.

Section 5: Technology[64,65,66]

- What technology does Corporation X's carbon credit system use?
- If monitoring technology is mentioned, ask: is any of the farm data made available to anyone other than the farmer and your corporation?
    - How are privacy concerns being handled?
- Are there any plans to use farm data for implementation of other technology?
- Does Corporation X pay for the technology installed on participating farms? Who installs the technology? Who is responsible for the maintenance of technology?
- Does Corporation X have any plans to use digital technologies in the future?

Section 6: Markets

- What attributes does Corporation X believe contribute to a successful carbon credit market?
- Does Corporation X view carbon credit markets as a prospective source of income?

Section 6: Extensions

- Do you know of any other agricultural carbon credit initiatives?
    - If yes, how does Corporation X's system differ?
- Are there plans to expand the carbon credit initiative?

[64] Clapp, Jennifer, and Sarah-Louise Ruder. "Precision Technologies for Agriculture: Digital Farming, Gene-Edited Crops, and the Politics of Sustainability." *Global Environmental Politics* 20, no. 3 (August 2020): 48–69. https://doi.org/10.1162/glep_a_00566.

[65] Lioutas, Evagelos D., Chrysanthi Charatsari, and Marcello De Rosa. "Digitalisation of Agriculture: A Way to Solve the Food Problem or a Trolley Dilemma?" *Technology in Society* 67 (2021). https://doi.org/10.1016/j.techsoc.2021.101744.

[66] Rotz, Sarah, Emily Duncan, Matthew Small, Janos Botschner, Rozita Dara, Ian Mosby, Mark Reed, and Evan D.G. Fraser. "The Politics of Digital Agricultural Technologies: A Preliminary Review." *Sociologia Ruralis* 59, no. 2 (April 2019): 203–29. https://doi.org/10.1111/soru.12233.

Appendix C: Previous Voluntary and Existing Regulatory Soil Carbon Protocols

Previous & Current Regulatory Initiatives

The previous sections in this chapter have demonstrated that although soil scientists and agronomists have studied and monitored the progress of SOC sequestration, there has not been an equally proportionate amount of attention paid to SOC sequestration in environmental policy globally. Rather than global attention, SOC sequestration projects have gained regional attention in select regulatory jurisdictions. This subsection reviews the SOC sequestration protocols that were previously or are currently operating in Alberta, Australia, and California. It also briefly examines one of the few previous voluntary SOC sequestration protocols, the CCX's conservation tillage protocol.

Alberta

Alberta instituted the Conservation Cropping Protocol (CCP) in 2007. The protocol originally only included reduced conservation tillage or no-till practices as eligible practices but was supplemented with the addition of reduced summer fallow in 2012 (Quantification Protocol for Conservation Cropping 2012). The CCP utilizes a performance-based baseline to determine additionality, requiring farmers to demonstrate that they have not practiced reduced-till previously (Quantification Protocol for Conservation Cropping 2012). In cases where farmers had been practicing reduced-till, they could still receive credits at a discounted rate for the previous periods of practice (Quantification Protocol for Conservation Cropping 2012). Under the CCP, individual farmers were required to register under project developers, defined as aggregators. CCP documentation defines aggregators as:

> "An aggregator is a person or company that, through contractual arrangement, works with suppliers of small volumes of offset credits established under the same protocol to pool

> these smaller projects into a sufficiently large volume to manage verification and transaction costs." (Quantification Protocol for Conservation Cropping 2012, 9)

Aggregators play a crucial role, being the program administrators for the CCP in effect. The Alberta Ministry of Agriculture website lists Radicle, Farmer's Edge, and Trimble Aggregation as the approved aggregators for the CCP. This definition of "aggregator" provided by CCP is important in understanding the role of corporations in measuring, compiling, and administering carbon credit projects (Government of Alberta 2022). Aggregators are required to utilize third-party verifiers to verify their projects, but the Quantification Protocol is unclear about who qualifies (Government of Alberta 2022). The CCP utilizes a modelling approach, based on farm practices and climatic region as well as soil type, to determine soil carbon sequestration levels. This model also defines different pricing rates for climatic zones.The program also addresses leakage by defining controlled, related, and affected sinks involved in conservation tillage and reduced summer fallow. The CCP utilizes a discounting method for possible reversals and impermanence (Quantification Protocol for Conservation Cropping 2012). In addition, the CCP stipulates a 20-year permanence period (Quantification Protocol for Conservation Cropping 2012). Finally, the official CCP quantification protocol states that: "Changes in tillage systems from full till to no till will result in a greater use of herbicides to control weeds." Little attention is paid to the significance of this statement (Quantification Protocol for Conservation Cropping 2012, 26). The protocol expired on December 31, 2021 and has not received a renewal (Government of Alberta 2022).

Australia

Australia's Carbon Farming Initiative (CFI) was legislated under the *Carbon Credits (Carbon Farming Initiative) Act 2011*. The CFI represents the most rigorous regulation of soil carbon sequestration, as it exists as a piece of legislation rather than policy. In this case, the state is simultaneously the aggregator, verifier, and final purchaser of carbon credits generated by farms enrolled in CFI. The CFI lists 10 practices, including no-till, soil remediation through soil additives, and permanent pasture on land that has been used for cropping, pasture, or fallow that qualify for the program (Frydenberg 2018). Additionality is determined by a newness factor, but a baseline is established based on soil testing (Frydenberg 2018). Soil testing, rather than the use of modelling, is the primary method for verification and measurement in the CFI. Similar to the CCP, the CFI addresses impermanence with the establishment of discounting of carbon credits generated through the program (Frydenberg 2018). The CFI goes further, however, establishing a "project emissions buffer", adding credits to a buffer fund to account for increased emissions in subsequent testing periods (Frydenberg 2018). The CFI also establishes a 75- and 100-year permanence period for these practices. Carbon credits generated become void if practices are reversed (Frydenberg 2018).

California

California's Healthy Soils Program (HSP) is unique in comparison to the CCP and CFI programs. The HSP pays farmers for particular practices outlined in each round of the HSP grant cycle. The rate at which farmers are paid for eligible practices depends on the practice, and farmers are permitted to practice and be paid for multiple practices at once (CDFA 2021). Farmers must apply to the HSP grant program and is therefore an exclusive program. Beyond paying for practice, the change in soil carbon content is determined by modelling (CDFA 2020). As part of the grant program, farmers must submit the estimated change in soil carbon levels due to change in practices (CDFA 2022). The only form of monitoring verification that is required by the HSP are geotagged photos that provide evidence that farmers are implementing the practices that are outlined in their grant proposal (CDFA 2022). There is no discussion of reversal, permanence, or leakage in the program outline.

Chicago Climate Exchange

The CCX's Continuous Conservation Tillage and Conversion to Grassland Soil Carbon Sequestration project protocol was one of three agriculture project protocols developed by the CCX. The CCX protocol represents one of few voluntary soil carbon project protocols. The CCX's protocol utilizes a dual baseline for no-till, utilizing both definitions of carbon storage additionality as well as financial additionality (CCX 2009). The protocol also requires a 5-year commitment period for change in practices and makes previous practice of conservation tillage eligible at a discounted rate (CCX 2009). CCX also determined crediting rates based on climatic zone (CCX 2009). The CCX demonstrates a heavy use of modelling to determine sequestration rates similar to the CCP. Another major focus of the protocol is the establishment of a permanence reserve, of which a fraction of each credit is added to account for reversals. Any reverals null credits and would require purchasers to buy new credits to account for the emissions "neutralized" by previous credits (CCX 2009). Important to the CCX's protocol is the role that aggregators play in the contracts as the administrators responsible for reporting and verification of projects under their supervision (CCX 2009). Approved verifiers are not specified under the protocol. The CCX also places importance on continuous land ownership, control over practices, and the verification of land ownership for the duration of the sequestration project (CCX 2009).

Appendix D: Details of Private SCS Credit Initiatives

Initiative Name	**Parent Company**	**Date**	**Selling Scheme**	**Contract Length**	**Acres Enrolled**
Carbon Program	Nutrien	2021	Aggregator & Broker	At-will	685,000 across North America
U.S. Carbon Program	Bayer	2016	Aggregator & Consumer	10 years and additional 10 years of carbon practices after program ends	At least 400,000
CIBO Carbon Credits	CIBO	2020	Market	10 years	At least 20,000
Carbon by Indigo	Indigo	2018	Market	5 years + annual renewal	6 million
Nori Carbon Removal Marketplace	Nori	2018	Market	10 years	18 projects, $2M paid
RegenConnect	Cargill	2021	Aggregator, Broker & Consumer	1 year	10,000(pilot)
Smart Carbon	Farmers Edge	2021	Aggregator & Broker	10 years	3,200,000 in Canada
CarbonNOW	Bluesource & Locus AG Solutions	2021	Aggregator	4 years	1,320,000
TruTerra Carbon	Land 'o' Lakes	2016	Aggregator & Broker	Annual	Not listed, but distributed $4M in credit payments in 2021
Eco-Harvest	ESMC	2022	Aggregator & Marketplace	5 years	500,000(pilot)
Agoro Carbon Alliance	Yara	2021	Aggregator & Broker	10 years	Not listed, but distributed $9M in

					credit payments in 2022
Gradable Carbon	Farmers Business Network (FBN)	2021	Aggregator & Broker	5 years	Unlisted but FBN covers 67M acres in the U.S.
Corteva Carbon Initiative	Corteva	2021	Aggregator	5 years	1,000,000
Global Carbon Farming Program	BASF	2022	Aggregator & Broker	Unlisted	Unlisted
Rabobank	Rabobank	2021	Aggregator & Broker	3 years	Unlisted

Table 2: General characteristics of private SCS credit initiatives in North America[67]

Initiative Name	**Digital Platforms**	**Digital Practices**	**Financial Services**
Carbon Program	Agrible, Nutriscription, Echelon	Field and production data, weather data, chemical use recommendations, geomapping	Nutrien does extend financial services to farmers
U.S. Carbon Program	ForGround, Climate FieldView	Collection, storage, and analysis of field data for yield projections, geomapping	Yes
CIBO Carbon Credits	CarbonLab		No
Carbon by Indigo	Carbon Account, Market+	Record keeping, carbon calculator	No
Nori Carbon Removal Marketplace	Nori App - data is also transferable from other platforms	Field and production data, geomapping	No

[67] ESMC 2020; Bayer 2021; Nutrien 2021a; Nutrien 2021b; Bayer 2022a; Bayer 2022c; Cargill 2022; CIBO 2022b; TruTerra 2022a; TruTerra 2022b; United Soybean Board 2022a; United Soybean Board 2022b; United Soybean Board 2022c; United Soybean Board 2022d; Agoro 2023a; Agoro 2023b; Bayer (n.d., 2023b); CIBO 2023a; CIBO 2023d; Corteva 2023a; ESMC 2023e; ESMC 2023f; Farmers Edge 2023c; Indigo 2023a; Indigo 2023b; Indigo 2023g Locus Agricultural Solution 2023; Nori 2023a; Nutrien 2023a; Nutrien 2023b; ReGrow 2023a; ReGrow 2023b; TruTerra 2023a; TruTerra 2023b

	Nori also supports a blockchain and crypto service		
RegenConnect	Regrow, OpTIS	Field and production data, weather data, chemical use recommendations, geomapping	Yes
Smart Carbon	FarmCommand	Field and production data, weather data, chemical use recommendations, geomapping	No
CarbonNOW	Unlisted	N/A	No
TruTerra Carbon	TruTerra Sustainability Tool	Collect & track farm data, yield projections, soil health projections	Yes
Eco-Harvest	Producer Portal	Collect & track farm data pertaining to practice changes	No
Agoro Carbon Alliance	Atfarm	Collect & track farm data pertaining to practice changes, carbon calculator	No
Gradable Carbon	Gradable	Collect & track farm data, yield projections, soil health projections, integrated financial tracker	Yes
Corteva Carbon Initiative	Granular Insights	Field and production data, weather data, chemical use recommendations, yield projections, geomapping	Yes
Global Carbon Farming Program	Xarvio, AgBalance	Field and production data, weather data, chemical use recommendations, yield projections, geomapping	Yes
Rabobank	Unlisted	Unlisted	Yes

Table 3: Details on related digital agriculture services and financial services for private soil carbon credit programs in North America[68]

[68] ESMC 2020; Bayer 2021; Nutrien 2021a; Nutrien 2021b; Bayer 2022a; Bayer 2022c; Cargill 2022; CIBO 2022b; TruTerra 2022a; TruTerra 2022b; United Soybean Board 2022a; United Soybean Board 2022b; United Soybean Board 2022c; United Soybean Board 2022d; Agoro 2023a; Agoro 2023b; Bayer (n.d., 2023b); CIBO 2023a; CIBO

2023d; Corteva 2023b; ESMC 2023e; ESMC 2023f; Farmers Edge 2023c; Indigo 2023a; Indigo 2023b; Indigo 2023g Locus Agricultural Solution 2023; Nori 2023a; Nutrien 2023a; Nutrien 2023b; ReGrow 2023a; ReGrow 2023b; TruTerra 2023a; TruTerra 2023bLocus Agricultural Solution 2023; Nori 2023a; Nutrien 2023b; ReGrow 2023a; ReGrow 2023b; TruTerra 2023a; TruTerra 2023b