Carbon farming practices through a soil perspective

Farmers perceptions on carbon farming and their relations to soil

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Kolinlagrande jordbruksmetoder från ett jordperspektiv. Lantbrukares uppfattningar om kolinlagrande jordbruk och deras relation till jorden

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Abstract

With increasing demands on governments and private companies to reduce their emissions of greenhouse gases, changed land management is viewed as a possible way forward to sequester carbon. When it comes to agriculture a popular idea has been to increase soil organic carbon in cropland and pastures by multiple methods gathered under the umbrella term “carbon farming”. In this setting soil becomes the centrepiece that governments, companies and farmers hope to relieve them of their respective challenges. The capacity and success for farming to achieve carbon sequestration is however highly dependent on local contexts such as climate and soil properties, making the efficiency of carbon farming as a climate change mitigation tool questioned. The purpose of this thesis is to investigate carbon farming in a Swedish context, highlighting the farmer's perspective on the practice and understanding their reasoning for entering the practice. Furthermore, an aim for this thesis is to unpack the soils role in carbon farming, stressing the soils agency in affecting the farmer as the farmer tries to affect the soil in return. Questions were investigated using qualitative methods relying on semi-structured farmer interviews. Theoretically the study is guided by Social Practice Theory in combination with utilizing the soil as a lens for analysis. Results show that farmers are not adopting carbon farming due to climate-related goals or economic subsidies, but instead improved soil capacities. Increasing capacities such as drainage, water retention and nutrient availability build long-term stability both economically and biophysically. Although *material* motivations were primary, they must be seen in the light of *meanings* and *competences* attached, such as biodiversity, soil health and curiosity. Moreover the interviews highlight how farmers are facing peer pressure from other farmers and actors due to negative *meanings* associated with carbon farming. Peer pressure forces “carbon farmers” to redefine themselves as they also redefine their soil as a living entity. Soil was central, as it was not an passive agent in these processes, creating the frames of the choice-set farmers could act within. This study adds to the knowledgebase on carbon farming, especially as there is a lack of studies covering farmer perspectives on carbon farming in Sweden. Furthermore the study is significant as it combines Social Practice with a soil perspective which illuminates how *materials*, *competences* and *meanings* works in tandem with soil-human relations.

Keywords: carbon farming, social practice, soil perpectives

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Abbreviations

Abbreviation	Description
SPT	Social Practice Theory
SK	Svensk Kolinlagring
SOM	Soil Organic Matter
MRV	Monitoring, reporting and verification
GHG	Greenhouse gases
No-till	Reduced or absent tillage

1. Introduction

Food production is responsible for around a quarter of the world's greenhouse gas (GHG) emissions (Nabuurs, 2022), which has raised questions about the need for mitigation in the last decades. At the same time as emissions from the agricultural sector are considerable, IPCC points to the fact that this is one of the few sectors that also acts as a carbon sink (Nabuurs, 2022). In the light of the Paris Agreement initiatives like the "4‰ Initiative" have risen in response, putting hope to sequestering atmospheric carbon into agricultural soils (Ministère de l'Agriculture et de la Souveraineté Alimentaire, 2017).

In recent years this idea of forests, cropland and pastures acting as a carbon sink has injected a lot of confidence in some circles. Scientists from different disciplines have jumped on the opportunity to research the capacities of these solutions (Figueredo 2024). Within agriculture focus has partly been on carbon farming, meaning the act of sequestering carbon in farmland by different methods. Carbon farming includes practices such as minimizing tillage, cover-cropping, perennial crop rotations, agroforestry and incorporation of additives such as biochar et cetera (Mills *et al*., 2020). Aside from mitigating GHG emissions, the act of increasing soil organic carbon often results in improved soil health, which can imply positive long-term effects for agricultural production (Johansson, Brogaard and Brodin, 2022).

Carbon farming can be conducted voluntarily by farmers for various reasons like increased soil health, reducing inputs or personal beliefs (Buck and Palumbo-Compton, 2022). However sometimes the actions are promoted through payments by actors that connect GHG emissions with carbon sequestration on farmland. The farmer is offered financial compensation for applying methods that capture carbon, carbon credits can then be used in a wider system of emission compensation (Barbato and Strong, 2022). However, the process of reaching reliable carbon sequestration over time in agricultural soils is easier said than done. There are multiple issues connected to local climatic conditions, temporal aspects and soil properties that influence the carbon storing capacity of the soil, and these factors are not stable or always easily predictable (Chenu *et al*., 2019). With this in mind, some even argue that carbon credits is not a suitable way of regulating carbon farming, due to uncertainties and difficulties connected to measurement and monitoring (Paul *et al*., 2023). Despite questions and concerns regarding the actual efficiency of carbon farming as a tool for climate change mitigation, companies and governments have shown great interest in the matter (Buck and Palumbo-Compton, 2022).

As farmers are the actors who ultimately will decide to implement carbon farming or not on their land, and also the actors who will most directly be affected by a change in practices, it is relevant to investigate farmers' perspectives and perceptions of carbon farming and carbon credit schemes (Amin *et al*., 2020). Studies show that there are many factors influencing farmers when they consider carbon farming, such as knowledge (Ingram *et al*., 2014), biophysical conditions (Waade and Claasen, 2017), peer pressure (Kawa, 2021), economy and risk taking (Jassim *et al*., 2022). Depending on the context of where farmers are located their reasoning differs, which makes it important to further investigate the underlying justifications for carbon farming in new contexts.

In this setting I aim to examine carbon farming in Sweden, focusing on farmers who participate in carbon farming practices. I utilize a combination of Social Practice Theory (SPT) and a soil perspective in hopes of illuminating valuable perspectives on carbon farming. Through SPT, I want to highlight how farmers' make use of different *materials* and *competences* and how they create *meanings* connected to carbon farming, where soil is the fundamental *material* as it is the vessel of the stored carbon. Soil is central both in regard to climate change mitigation and farm production due to its properties and capacities. An aim for this thesis is to illustrate farmer-soil relations and how they may be changing within the practice of carbon farming.

1.1 Purpose and research questions

With carbon farming increasing in popularity as a concept and practice both among companies, authorities and farmers, new aspects are attached to soil, practicing farming and to being a farmer. External actors hope to utilize carbon farming as a tool for climate change mitigation, but do farmers share this motivation or do they have other grounds for their decisions to opt for carbon farming? Farmers' contexts vary in terms of factors such as production orientation, size, family situation, geographical location etc. Such factors impact the choices they make, making it important to investigate such factors when studying farmers' reasoning around carbon farming. Soils can be seen as a key contextual factor when it comes to carbon farming. Soil positions itself at the centre for farming in general and carbon farming in particular, as it is the *material* that these practices work through. Without soil, no food production can take place and in the case of carbon farming, no carbon sequestration, and different soils have different *material* features that accommodate carbon farming practices in differential ways.

Previous studies have investigated motivations and barriers for entering carbon farming as well as soil-human relationships in connection to alternative farming, an area I also hope to contribute to. However, my combination of SPT and the soil perspective will hopefully illustrate what role farmer-soil relations play in farmers underlying decision-making for conducting the practice, in a way that has not been done before, as such adding an important new perspective to the issue. The purpose of the thesis is thus to illuminate Swedish farmers underlying justification of the practice and how these justifications are connected to soil-human relations. Additionally, I am curious about how the farmer who conducts carbon farming positions themselves in relation to other "normal" farmers and agriculture in general as they start to attach new values to the soil and themselves.

To successfully investigate the abovementioned purpose the following questions will be answered in this thesis:

⇒ How is the practice of carbon farming justified by its practitioners in regards to *materials*, *competences* and *meanings*?

⇒ Are farmers redefining their role as a farmer in the light of climate change mitigation efforts and in that case, how?

⇒ How can the soil as an agent be seen to interact with the farmer to create the practice of carbon farming?

2. Background

2.1 What is soil?

There are many definitions to describe what soil is, from a natural science perspective we can describe it from its properties and capacities. Osman (2013) describes soil as a three-dimensional natural body consisting of minerals, organic matter, liquids and gases. Differences between soils are characterized by what sorts of components and their ratios that make up the soil. Moreover, soils distinguish themselves by their horizons, which are the different layers found when digging a hole in the ground. Within the soil there are many physical, chemical and biological processes.

In order to understand the gathered material of this thesis, some basic concepts regarding soil structure, texture and soil organic material are needed. Farmers often differentiate between their soils in general terms as being “heavy” or “light”, “clayey” or “sandy”, but what does this mean in soil scientific terms? Soils are divided into groups with regard to soil texture which depends on the present majority granular size e.g. clay, silt, sand gravel. The finest particles being clay, while gravel being the coarsest. Depending on the proportions of particles soil characteristics change and thereby the description of it. For example, a soil with over 40% clay is considered a “heavy clay”, while a soil almost devoid of clay consisting mostly of sand is a “sandy soil” (Fogelfors, 2015).

Soil is as previously mentioned not only made up of inorganic minerals, but also organic material, air and liquids. In general soil is made up of 50% solid material (minerals, organic material) and 50% potentially empty space called pores. How particles are organized is called the soil structure, where clay, silt and organic particles can create larger aggregates while sand and gravel remain as single grains. Depending on their size, pores can retain water to different extents, larger pores allow water to drain easily while finer pores make water remain longer. Organic material has an important role in soil structure as it helps to stabilize soil aggregates created. A soil can be more or less susceptible to soil compaction, depending on its composition. Clayey soils with little organic material are especially vulnerable to soil compaction, whereas sandy soils have more structural integrity. Soil compaction should be avoided for multiple reasons as it affects irrigation, drainage, root penetration, erosion et cetera (Fogelfors, 2015; Osman, 2013).

Organic material in soil, often referred to as humus, is made up of mostly dead plant tissue and other residues. The majority of biological material is broken down by microorganisms and released as CO2, however the most stable elements remain in the soil to form humus. The accumulation of stable organic material in soils depends on multiple factors such as humidity, temperature, soil texture, vegetation and aeration. Soil organic content changes continuously until it reaches a stable level, an equilibrium. Due to only a small amount of the total organic material staying in the soil as stable compounds, the build-up of soil organic matter is a slow process occurring over long time horizons. Depending on the location of the soil and its composition it also has different capacities to effectively store organic matter long-term (Fogelfors, 2015; Osman, 2013). Apart from contributing to a good soil structure and thereby drainage capacity as well as water holding capacity, organic material increases nutritional uptake for plants as release of nutrients is promoted (Fogelfors, 2015).

Combining these soil features, some general conclusions about soil management can be drawn. A farmer with sandy soils may struggle with retaining enough water for crops due to the low water holding capacity, as water drains through at a high pace. For this farmer there is an incentive to increase soil organic matter (SOM) as this can increase water and nutrient retention. A farmer with clayey soils can have more complex issues depending on the existing structure, moisture et cetera. Some farmers with clayey soil may struggle with low drainage capacity and soil compaction resulting in standing water suffocating crops as well as run-off creating erosion. In this case increasing SOM will create a better soil structure allowing for greater drainage and less compaction.

Table 1: General summary of the differences between sandy and clayey soil capacities based on Fogelfors (2015) and Osman (2013)

	Sandy soils	**Clayey soils**
Drainage capacity	Good (due to large pores)	Medium- Bad (depending on structure)
Water holding capacity	Bad (due to large pores)	Good (due to small pores)
Risk for soil compaction	Low (due to single large grain structure)	Medium- High (depending on structure and moisture)
Risk of erosion	High (due to large granules)	Medium- Low (due to cohesion of clay particle)

2.2 Carbon credit schemes & regulations

In order to incentivize farmers to enter carbon farming and actively sequester GHG different economic schemes have been developed. Raina *et al*. (2024) differentiate three types of schemes: result-based, action-based and hybrid. Result-based schemes rely on monitoring and measuring results from the practice, focusing on the actual amounts of soil organic carbon increase. In contrast, action-based schemes are based on the methods that farmers sign up to conduct, methods that are already known to increase carbon sequestration. Lastly, hybrid-based schemes are a mix of the two former mechanisms (Raina *et al*., 2024).

McDonald *et al*. (2021 and Raina *et al*. (2024) illuminate pros and cons with the different types of carbon credit schemes, where questions of monitoring, reporting and verification (MRV) are significant. Result-based schemes have the advantage of ensuring measurable carbon sequestration, giving legitimacy to the practice. However, the costs of MRV are the highest in these schemes, due to the large costs of measuring soil organic carbon over time. In contrast, the action-based schemes ensure low MRV costs but less reliable carbon sequestration and thereby legitimacy for external actors. The third option, hybrid-schemes, place themselves somewhere in between, where farmers can for example receive a fixed payment for entering the practice and additional payments based on measured results (McDonald e al., 2021; Raina *et al*., 2024).

This thesis concerns farmers who are all members of a network called the Carbon Club (Kolklubben), which is connected to and started by the carbon credit company Svensk Kolinlagring (SK). The company does not exclusively work with carbon credits. They also run two other farmer schemes which are more individually adapted to specific cases, were the farmer and the company works out a plan to create biodiversity, soil health and sustainable food chains (Svensk Kolinlagring, 2024). The purpose of all three programs is to work with transformation of the food system, with a focus on soil health. SK:s carbon credit scheme could be identified as a hybrid scheme in terms of Raina *et al*. (2024) classification. Farmers who enter the scheme need to adhere to three out of four action-based requirements; keeping the field planted, crop diversity, soil coverage, and continuous biomass growth. Moreover, SK offers a farm advisory session each year and conducts result-based soil measurements the first and last year of the carbon contract period. In addition to these comprehensive measurements in the start and end of the contract period, there is a yearly soil health assessment (Svensk Kolinlagring, 2024).

According to SK, they have based their carbon credit scheme on current soil science research in the field of carbon sequestration. Furthermore, they have

designed the system in harmony with upcoming EU legislation for the voluntary carbon credit market for carbon farming, Carbon Removals and Carbon Farming Certification (CRCF) (Svensk Kolinlagring, 2024). The goal for CRCF is to regulate and establish harmonised standards across the EU for voluntary carbon credit markets for carbon farming as well as other practices e.g rewetting peatland (European Parliament and Council, 2024/3012).

Two important aspects for carbon credit schemes according to CRCF, SK and researchers is additionality and permanence (European Parliament and Council, 2024/3012; Svensk Kolinlagring, 2024). The former requirement is based on the idea that carbon sequestration must be additional to a scenario where "business as usual" practice is performed. Carbon sequestration in a "business as usual" scenario is termed as the baseline in CRCF. Additional sequestration past the baseline is considered as carbon eligible for economic compensation. The requirement of permanence regards the fact that carbon sequestered needs to stay in the soil for a considerable amount of time. An issue connected to the permanence requirement is that farmland when transitioned to a new owner, new practices may be employed that releases the carbon previously stored. There are many other issues regarding security, lock-in effects and farmers' perception of these schemes, which are highlighted in section 2.4.

2.3 Carbon farming

The practice of sequestering carbon dioxide from the air as soil organic matter is, as described previously in this thesis, sometimes referred to as carbon farming. There are other terms that entail similar practices such as regenerative agriculture and conservation agriculture, however they generally entail more than just carbon sequestration and carbon sequestration is not at the centre of these definitions. Carbon farming is also the term used by institutions like the EU, Swedish government agencies and businesses working with carbon credits (EU, 2024/3012; Sveriges Riksdag, 2024/25:FPM20; Svensk Kolinlagring, 2024).

In essence, carbon farming is about accumulating organic matter from plant tissues or other organic substances while minimizing the losses of organic matter through decomposition, respiration and erosion. It is a process of having a higher accumulation than loss of organic matter in order to achieve a net sink for carbon in the ground (Barbato and Strong, 2022). The main principles include: reducing tillage that usually enhances the composition rate (Amin *et al*, 2023), cover cropping to accumulate more biomass (Ullah, Oladosu and Crooks, 2023), having a greater crop diversity and diverse rotation (Rosinger *et al*., 2023) managing the inputs of soil nutrients (Ingram *et al*., 2014), managing grazing land (often through e.g. rotational grazing, or managing stocking densities) (Amin *et al*,

2023), and including trees on parts of the land (Yu, Yao and Zhang, 2014). Table 2 summarize these practices and their effects in an overview.

Table 2: Summary of methods used in carbon farming that increase SOM

Practice	Reduced tillage	Cover cropping and mulching	Crop diversity and crop rotations	Managing soil nutrients	Planting trees
Effect	Reduced rate of composition of organic materials.	Increased accumulation of organic material from residues and decreased erosion.	Increased accumulation of organic material from root residues and reduced erosion.	Organic fertilizers may increase SOM while synthetic fertilizers may increase rate of decomposition of SOM. Accurate fertilizing increases biomass production	Growing trees accumulate organic materials both above and below ground.
Method	Instead of practicing "conventional" heavy tillage by ploughing, lighter equipment like a harrow or cultivator is used.	Trying to keep the cropland covered in vegetation as long as possible. Incorporating residues from vegetation into the soil.	Increasing the diversity of crops with different kinds of root systems and including perennials into the crop rotations.	Apply the appropriate amount of mainly organic fertilizers at the right time.	Planting trees in the field as rows, leaving space for crops in between or planting trees at the edges of the fields.

2.4 Farmers perspectives on carbon farming and carbon credit systems

Carbon farming and carbon credit schemes are often entangled when discussed in their relation to farmers. Figueredo (2024) points to the importance of trying to separate these concepts even though they overlap. Farmers may have different reasons behind and values attached to conducting carbon farming practices and entering carbon credit schemes. In the following section I will first engage with the former topic and end with the latter. Moreover, some studies focus on the material conditions of farmers in connection to carbon farming while others consider social and behavioral factors.

Buck and Palumbo-Comptons (2022) conduct a literature review on carbon farming, focusing on the farmers own perspective, a point of view often left uninvestigated according to the authors. The fact that practices to enhance carbon sequestration in soils, as well as the carbon sequestration in itself lead to important co-benefits for the farming, was seen as the greatest driver for farmers to join the practice (Buck and Palumbo-Comptons, 2022). Co-benefits are most importantly effects on soil properties such as water holding capacity, reduced erosion, increased soil fertility. Another important finding was that co-benefits of carbon farming were valued higher than economic incentives from credit-schemes, partly due to low compensation (Buck and Palumbo-Compton, 2022). The way in which Buck and Palumbo-Comptons (2022) frame co-benefits that

mostly concerning biophysical factors aligns with other studies from for example Waade and Claasen (2017), Payen *et al*. (2023) and Hijbeek *et al*. (2018).

Waade and Claasen (2017) present how soy and maize farmers in the United States adopt reduced/no-tillage practices because of biophysical factors. According to the authors the biggest driver is if the farm possesses erosion prone soils and to what extent the fields have sufficient drainage. Farmers who own land with a risk of erosion are more prone to adopt no-till, while farmers with insufficient drainage are less likely to adopt no-till. Farmers with eroded soils do no-till partly because it improves soil structure but also because they receive extra subsidies. The reason to not adapt no-till when drainage is unsatisfactory is partly due to no-till reducing drainage even more with the organic material left on the field. Reducing erosion is thereby another co-benefit, if we use Buck and Palumbo-Comptons (2022) terms, while insufficient drainage is a barrier. Other studies, have found that a motivator for adopting no-till can also be the economic incentive of reducing fuel costs (Ingram *et al*.,2014).

In line with Waade and Claasen (2017), Payen *et al*. (2023) point to material reasons for entering carbon farming in the case of French wine producers. In surveying motivations for conducting different carbon farming practices such as cover cropping, no-tillage, returning crop residues etc. they found the greatest driver to be improving biophysical conditions, especially soil fertility. The farmers saw advantages in reducing erosion risk, retaining water and increasing soil life, properties that contribute to a more productive farm.

Hijbeek *et al*. (2018), go more into depth on how specific soil properties are valued in connection to carbon farming. Based in the Netherlands, Hijbeek *et al*. (2018) conduct a survey measuring farmers' attitudes in relation to different carbon farming methods. In general, improved soil structure was valued as the most impactful change by carbon farming, however depending on soil type, farmers appreciated different effects. Farmers with sandy soils valued increased water holding capacity while those with clayey soils valued increased workability of the field (Hijbeek *et al*., 2018). Furthermore, a study by Kawa (2021), showed that farmers who employed reduced tillage experienced a "win-win" with reduced fuel costs and working hours in combination with increased soil health.

Moving on from the material motivations of carbon farming, there are studies that highlighted questions of knowledge and know-how. Buck and Palumbo-Compton (2022) suggest that the lack of knowledge about carbon farming is a barrier to enter the practice. Ingram *et al*. (2014) reason in a similar manner in their study, where they identify barriers and motivations for carbon farming in six

case study regions in Europe. Although varying between regions, farmers perceived that agricultural advisors had a low level of knowledge regarding carbon farming. Another barrier to enter the practice was few existing examples of other farmers successfully employing methods of carbon sequestration.

Other studies that also focus on social factors affecting farmers' adoption of carbon farming, highlight peer pressure experienced from other farmers. Gosnell (2022), reason about internal and external pressures affecting farmers' choice, in the case of Australian farmers' adoption of regenerative agriculture. A barrier is the fact that regenerative farming/carbon farming is often entailed by not having a "tidy" and well-ordered field in comparison with conventional farming. As Gosnell (2022) suggests, the norm of a "farm in order" is set by conventional farming standard, where a clean, heavy tilled field is preferred over a no-till field with crop residues.

The study on regenerative crop farmers set in the United States by Kawa (2021) shows similar findings about a resistance against the ugly farm. In his study, Kawa (2021), points to farmers conducting field assessments by visually assessing their own fields as well as neighbours. When doing so they often judge the field according to the standard set by conventional farming, where anything diverting from that picture is deemed untidy. However, as farmers in Kawa's (2021) study argue, these untidy fields may still yield as good of a harvest as the tidy ones do, thereby making the idea of an ugly farm corresponding to an unproductive one, a false image. Regardless, the norm set by conventional farming creates a barrier to enter carbon farming practices like no-till and cover-cropping, as farmers want to avoid judgment from the farmer collective.

In essence, multiple studies show how material aspects concerning soil, economy and labour are primary reasons for farmers to enter carbon farming (Buck and Palumbo-Compton, 2022; Waade and Claasen 2017; Payen *et al*. 2023; Hijbeek *et al*. 2018). However, this is in no way homogenous for the farmer community, as it differs largely between region and context (Waade and Claasen 2017; Hijbeek *et al*. 2018; Buck and Palumbo-Compton, 2022). There are multiple barriers identified to adopt the practice, such as knowledge-gaps (Ingram *et al*. 2014), norms and peer pressure (Kawa, 2021).

Moving from farmers' perspectives on carbon farming practices, I will now go on to summarise the literature on farmers' perception on carbon credit systems. There are multiple ways to structure carbon credit systems, as explained in section 2.2, but how are these economic schemes perceived by farmers? Rouchecouste *et al* (2017) investigate Australian cereal farmers' views on the government

programme “Carbon Farming Initiative”. One point of criticism from land managers was the potential transaction costs for entering the scheme (administration, monitoring etc.), a barrier also pointed out in the overview study by Raina *et al*. (2024) for other credit schemes. In Rouchecouste *et al*. (2017) study, farmers voiced concerns about the demands on “permanence” (McDonald *et al*., 2021) and “additionality” (Raina *et al*. 2024), as these may create situations where they lose control of their own land. According to Rouchecouste *et al*. (2017), farmers feared lock-in effects as cropland were to be bound to long-term contracts where soil organic matter must increase. Farmers voiced concerns that they would not be able to take future decisions about their land that contradicts carbon contracts, thereby losing control.

Carbon credits as an economic incentive for farmers to adopt the practice has varying success depending on contextual factors such as climate, profitability, contracts etc. As suggested by previous studies, co-benefits have been seen as the driving factor rather than economic compensation for carbon credits (Buck and Palumbo-Compton, 2022). However, Jassim *et al*.’s (2022) study on farmers' adoption of carbon farming in semi-arid environments in Australia do stress the importance of economic incentive. Farmers perceived carbon credit schemes as a motivation due to it offering a chance for economic diversification in a context where farmers are experiencing instability due to financial and ecological stress. Waade and Claasens (2017), who emphasised material drivers for adoption also mentioned that government subsidies did play a role for undertaking no-till methods. Another study based in a different region of Australia by Dumbrell (2017) did instead once again emphasise co-benefits of for example increased soil health as the primary driver for adoption. These differences among studies shows the importance of investigating motivations for joining carbon credit schemes in different contexts due to the large heterogeneity among farmers and their wider farming contexts.

De Pinto *et al*. (2013) argue that heterogeneity in soil, climate and farm size have a great effect on how economically viable carbon farming is and to what extent carbon sequestration can occur. Moreover, De Pinto *et al*. (2013) reason that the individual farmers risk aversion is often overlooked in studies about carbon farming. The ability or will of the landowner to take risks affect their will to adopt new practices. Even if economic incentives exist these do not always compensate for the costs of adopting new practices due to contextual factors (De Pinto *et al*., 2013).

2.5 Description of the case

Farmers in Sweden is the focus in this thesis, with emphasis on farmers in the regions of Uppsala, Västmanland and Stockholm, however two informants were located in the southern region of Skåne. The regions that I describe as "middle Sweden" in this thesis consists of Uppsala, Västmanland and Stockholm, also called "Mälardalen". The region is characterised by large amounts of heavy clay soils, which has led to cereal production being dominating in the landscape (Mälarens Vattenvårdsförbund, 2013). Conditions for crop production in middle Sweden is partly influenced by the somewhat drier springs and summers in contrast to the southeastern parts of the country. Differences between middle Sweden and Skåne can be seen in regards to climate, precipitation and soils. In general Skåne has more beneficial conditions for crop production in comparison to middle Sweden (Fogelfors, 2015).

The agricultural sector in Sweden is partly characterized by the rationalization efforts that occurred following the second world war, a process that continues today due to market competition (Flygare and Isacson, 2003). In the 1940s there were over 350 000 farm companies, where a majority of cropland was owned by farms below 30 ha in size. Currently there are roughly 50 000 farm companies left, where 60% of cropland belongs to farms with more than 100 ha. Moreover, an average cereal harvest in the 1940s was between 2-3 tonnes per hectare while in 2020 the same number is between 5-6 tonnes per hectare (Jordbruksverket, 2021). Today, farms below 100 hectares continues to decrease in numbers while farms with more than 200 hectares increase, showing that the rationalization continues (Hajdu *et al*. 2020).

Swedish farmers struggle with creating economic viability for their companies as investment costs for machinery, inputs and land are high. New technology and its implementation are important if size rationalisation is the path a farmer choose. The requirement to create economic viability has also created a more specialised agricultural sector, were farmers have to focus on a few income sources such as being a grain farmer or a dairy farmer respectively. There are however other paths, if size rationalization is not a possibility, such as having off-farm work or processing food products on farm in small-scale and selling directly to consumer (Hadju *et al*., 2020).

Farmers as a group, is sometimes considered to be more conservative than the general public when it comes to viewing climate change as a problem. Kröner *et al*. (2025) reflects this pattern in their study on European farmers views on climate change in comparison with the general public. The authors present that there does exist a gap between farmers and general public when it comes to

climate change scepticism, but the results differ widely between countries. Kröner *et al*. (2025) show that farmers in northern Europe, who have experienced less climate related issues, are more sceptical of problems related to climate change. In comparison, farmers in southern Europe are more inclined to consider climate change as serious problem. Moreover Kröner *et al*. (2025) highlight that the gap in views on climate change between farmers and the general public is larger in northern countries such as Sweden. At the same time, farmers in Sweden seem to become increasingly more aware about the negative impact of climate change, as a survey by Landshypotek bank (2024) highlights. The survey presented that in 2019, 35% of farmers did not believe that climate change would affect their business negatively while in 2024 this number had gone down to only 17% (Landshypotek bank, 2024).

Ibrahim and Johansson (2021) highlight that farmers in Europe have a far lower rate of adoption when it comes to methods such as reduced tillage in comparison with other regions of the world. Swedish farmers are falling behind other European countries when it comes to adoption of for example no/reduced tillage (Ibrahim and Johansson, 2021). Furthermore, Ibrahim and Johansson (2021) displays how education levels affect farmers understanding of conventional farming's environmental effects. An educational background in agriculture from either secondary school or university resulted in farmers having a greater understanding of agricultures effects on the environment. This was one of multiple factors affecting reduced tillage practices. Other factors included the lack of appropriate agricultural advisory, individual farmer personality and negative meanings attributed to new practices.

3. Theoretical framework and concepts

3.1 Social Practice Theory (SPT)

In this thesis I aim to make use of Social Practice Theory (SPT) in order to answer my research questions. For this aim "The Dynamics of Social Practice" from Shove *et al*. (2012), has given me the essential tools for understanding social practice. Shove *et al*. (2012), take inspiration from Schatski (1996), and Reckwitz (2002), in order to position their explanation of social practice theory. I believe that SPT is relevant for studying carbon farming as the practice and its components becomes central in the analysis. The theory will illuminate crucial aspects such as *materials*, *competences* and *meanings*, moreover how do they fit together to form farmers decision making.

Schatski (1996) argued that routine-behaviour of humans, i.e. practices, should be seen as the foundation for social life. Each practice is made up of its three building blocks; understanding (knowledge, experience), rules (law, norms) and teleoaffective structures (emotions connected to actions, purpose). Reckwitz (2002) continues in a similar manner by focusing on how practices are built by bodily and mental activities, *material* objects and knowledge. Terming these building blocks as elements, Reckwitz (2002) goes on to stress the inherent linkages between elements and their ability to build a practice together.

Shove *et al*. (2012), in a similar manner as previous authors, constitutes that the aim of social practice theory is to comprehend people's practices, the common themes in how they repeatedly act. A social practice can be things as simple as driving a vehicle or getting dressed in the morning. These practices entail their own building blocks called elements. Driving a vehicle includes elements such as the vehicle itself, how you operate it, why you choose it in the first place. To describe this phenomenon Shove *et al*. (2012) categorise these elements as: *Materials*, *Competences* and *Meanings*. Drawing from Reckwitz's (2002) description below, they define the elements,

> 'forms of bodily activities, forms of mental activities, "things" and their use, a background knowledge in the form of understanding, know-how, states of emotion and motivational knowledge' (2002: 249)

Materials are the "things", which is constituted by physical entities such as fields, tractors, crops, soil and living things like the body itself and other beings. *Competence* is different kinds of knowledge and know-how. For example, how do

you operate a tractor? What kind of crops are appropriate with given conditions? Lastly *meanings*, can be described as the symbols and significance placed by individuals to their actions. Perhaps you choose to go by public transport because of environmental concerns or a vegetarian diet due to worries about animal cruelty (Shove *et al*. 2012).

Webb and Tarleton (2018) provide an easy-to-follow guide of applying social practice theory in their booklet "Getting things changed". Focusing on everyday social practices like independent living, cooking and parking but by putting disabled people at the centre, the authors highlight the struggles of conforming to practices that are not adapted for disabilities.

One example they make is the practice of getting dressed in the morning, an act many do not reflect upon. However, it includes *materials*, clothes to choose from, *competences* in the form of deciding on the appropriate clothes as well as putting them on. Lastly it involves *meanings* as the person has to understand why getting dressed is important and how symbolism differs between social settings. For a disabled person issues can arise at all three elements. For example, a wheelchair user may lack the physical *competence* to put on the clothes. While a person with cognitive disabilities may lack the ability to accurately decipher the *meanings* with getting dressed (Webb and Tarleton, 2018).

3.2 Connections between and life of elements in SPT

In order to explain the links between the different elements of social practice, Shove *et al* (2012) take the process of learning how to drive a car as a practice in its early stages. *Materials* and *competences* for this practice are in many ways passed on from previous practices such as cycling and horse carriage driving. The cars themselves share physical properties with the carriages because they were often designed by and for the same people. However, the engine was a new concept, presenting challenges to the ones hoping to manoeuvre an automobile. The knowledge of how to steer a carriage or a bike at different speeds could also be used when driving a car. Nonetheless the operation of a car demanded new *competences*, like being able to perform mechanic tasks as these early cars often broke down. Moving on to the *meanings*, the act of driving a car was for a time considered as an activity for the wealthy as well as an healthy procedure. The ability to access fresh air and nature was a luxury. Due to issues of *materials* and *competences* (engines being unstable and hard to operate), driving was also a thrilling journey to undertake, giving it certain accompanying *meanings* (Shove *et al*, 2012).

Elements are thus interdependent on each other with links being created and broken at different points in time. Returning to driving, with the *material* developments of the car, previous *competences* (like shifting gears) could be passed down from humans to automobiles. When cars took over tasks from the driver, the practice became a less knowledge intensive task. Furthermore, this went hand in hand with changes of *meanings*, where driving went from a mechanical adventure to a task of getting to new places. This resulted in operators just wanting the car to work without having to tinker (Shove *et al*, 2012).

As social practices evolve, links to some elements may be broken and a specific element itself might even be left behind. Shove *et al*. (2012) describe how *competences* can also lie dormant for a long while, but eventually they will disappear if they are not used. However, elements can also leave one practice and enter another. This raises questions about practices being coherent at all, which depends on the characteristics of the element in question. Standardization of some elements such as *materials*, can be common, for example automobile construction is fairly standardized around the world. For other elements diversity can exist; *meanings* and *competences* for driving might for example vary across different countries (Shove *et al*. 2012).

Another important point by Shove *et al*. (2012) is the life of elements and the circulation of them. Transportation possibilities, monetary value and weight have been of importance for the spread of many products in the 19th century. These properties largely connect to *material* elements however they also in turn affect *competences* and *meanings*. One example regards the people who could access cast-iron products and what food cultures that were developed because of it.

Based on the previous reasoning that elements have their own "life", elements are in a way more mobile than practices, being able to break off, move into new practices or be left behind. *Competences* for instance can be "downloaded" in a new context but they need to go through abstraction and thereafter fitted in to the new context. The practice itself needs in this way to have the right prerequisite to be able to accept this new element. Similarly *materials* and *meanings* can move between, break off and be left behind, like in the example of driving as a practice (Shove *et al*. 2012; Deuten, 2003).

Abdulai *et al*. (2023) employ social practice theory when analysing change through digitalization of agriculture for rural farming communities in Northern Ghana, showcasing how links between elements can interact. They identify how digital tools such as phones and agronomic software are new *materials* within the social practice of farming. These new *materials* in turn affect the *competences* of

the smallholder farmers, as they can take decisions about planting, harvesting etc. At the same time Abdulai *et al*. (2023) raise that old *competences*, such as relying on experience for taking these operational decisions, are being pushed out. The authors also argue that when old *competences* are left aside it can create a lack of autonomy and resilience due to new *competences* relying on external actors. The reliance on external actors digital tools become fragile when farmers have lost old *competences* they cannot turn back to if digital tools fail.

3.3 Utilizing SPT for analysing carbon farming

In this thesis I utilize social practice theory in order to identify *materials*, *competences* and *meanings* attached to the practice of carbon farming. By capturing these elements and the links inbetween, I want to answer questions regarding farmers' fundamental motivations to opt for carbon farming. Moreover, exposing how their view of themselves as well as the soil changes in the light of climate change. I believe SPT is useful for the aims of this thesis as it can illuminate underlying justification for farmers' relation to carbon farming from a perspective close to the farmer. SPT puts the actual practice in the centre, which is a good focus for the context of agriculture, where being a farmer is not merely a profession, it is a lifestyle with many *meanings* connected to it, which are defined by the practice. In the current section I describe how SPT is operationalized in this thesis.

Defining carbon farming as a practice poses some questions, as carbon farming is not one single act, it is instead built up off many actions like tillage, cover-cropping etc. In previous examples by Shove *et al* (2012);Reckwitz's (2002);Schatski's (1996), practice is mostly discussed as everyday recurring actions, such as driving a car or getting dressed. Carbon farming is not as much of an everyday practice, but it is nonetheless a collection of methods that some farmers utilize. It is thus useful to draw inspiration from Abdulai *et al*. (2023), where they define aspects of farming as social practices.

Abdulai *et al*. (2023) define farming in itself as a practice, including actions such as seeding, tillage, financial planning, harvesting et cetera. Digitalization of agriculture represents changes to the normal actions of farming. Abdulai *et al*. (2023) argue that digitalization of agriculture also can be considered a social practice, made up by its own set off elements. Phones, satellites and computer software are the *materials*, while these require new *competences* such as digital knowledge.

I define carbon farming as a social practice constituted by actions that aim to increase the organic matter content in soil (as discussed in section 2.3). Farmers

who employ methods such as reduced tillage, cover cropping and perennial cropping are thereby conducting carbon farming practices. I do not mean to imply that all farmers who are a part of the practice are doing all of these actions, instead they are in different ways and to different extent part of it.

The building blocks (elements) of carbon farming as Shove *et al* (2012), Reckwitz's (2002) and Schatski's (1996) define can thereby be identified. I will use Shove *et al*. (2012) term elements to illuminate what goes into farmers decisions to opt for carbon farming. *Materials* of carbon farming are primarily made up of the soil, machines, crops, water and other entities but also economic capital. *Competences* consist of knowledge on how to sequester carbon into the soil, which relates to different actors' knowledge and how they interact with each other. Partly it depends on extension services ability to advise farmers on the subject and partly on the farmers own capacity to learn new methods. *Meanings* are the values attributed to carbon farming, which also involve the reasons motivating the farmer to conduct the practice. Some farmers may attach goals of mitigating climate change while others attach issues of soil health and productivity. Moreover, *meanings* come into play in how farmers define themselves as a part of a group and what groups of farmers they themselves differ from.

To illuminate how the farmer views themselves in the light of carbon farming I will include Burtons (2004) concept of "the good farmer", which illustrates how norms from conventional agriculture effect behaviour. Burton (2004) suggests that being a good farmer entails having fields that look a certain way (ploughed and free of weeds) and achieving certain goals like big harvests. The same reasoning was brought up in section 2.4 by Kawa (2021) and Gosnell (2022), were farmers judge each other depending on factors such as having a tidy field, making alternative agriculture less appealing. According to Burton (2004) being a good farmer is not only a matter of economy but of status and social capital, where a good farmer is able to gain respect from peers. The ideal of being a good farmer thereby leads to farmers being less inclined to breaking away from norms set by conventional agriculture. In this thesis "the good farmer" becomes a meaning attached to the practice of farming, which sometimes comes into conflict with *meanings* attached to carbon farming.

In order to pinpoint farmers changed views of themselves and their soil, the interconnections between elements must also be considered. The *material* soil has inherent properties e.g structure, texture, nutrient content, which affect its capacity to sequester carbon, grow crops, mitigate nutrient leakage. These properties and capacities are then also connected to what *meanings* are attached to

the soil. An example is a soil with a great capacity to store carbon may give it meaning as a climate mitigation tool. Depending on what capacities the soil has, the farmer may have to possess certain *competences*, e.g. a soil with low drainage capacity creates a need for water management knowledge. Although all interdependencies are of importance, I will focus on the *material* soil, as the soil is used as a lens. Taking inspiration from multispecies studies, I explain in the next section how SPT and the soil perspective are combined.

3.4 Using the soil as a lens for analysis & soil-human relations

To complement the use of SPT, I will put soil at the centre of analysis, drawing inspiration from multispecies studies and new materialism. Using the soil as a lens is a valuable complement to SPT for the aims of this thesis due to soils inherent role in carbon farming. The practice and success of carbon farming heavily depends on the properties and capacities of the soil as explained in section 2.4. Integrating SPT and soil perspectives will contribute to broader discussions of *meanings* and *competences* connected to soil and farming. As demonstrated by Kirksey and Helmreich (2010) multispecies studies focus on non-human entities and their agency. Moreover, the interdependence between humans and these other entities are central.

Multispecies studies partly build on reasoning from new materialism such as DeLanda (2017) describes. DeLanda (2017) views all entities (e.g. plants, animals, objects) as having inherent properties. Properties can be different metaphysical features, for example, soil has a density, granular structure, pH-value and a knife has a weight and certain sharpness. Properties define the entity's possible capacities, a soil's capacity to grow wheat or a knife's capacity to cut bread. DeLanda (2017) continues by explaining that capacities are virtual until they are actualized. A soil's capacity to grow wheat is not actualized before the wheat is actually planted. Moreover, capacities depend on the other entities involved, and if the other entity can be affected or not. Interdependence exists as a knife's capacity to cut also depends on the entity that is supposed to be cut.

What does this mean for using the soil as a lens for analysis? Salazar *et al*. (2020) goes into depth about soil's role in social science in their book "Thinking with Soils- Material Politics and Social Theory". Their main reasoning, viewing the soils as an integral agent, connects to many aspects of multispecies studies (Kirksey, 2010) and new materialism (DeLanda, 2017). Salazar *et al*. (2020) highlight the fact that natural sciences for a long time have had a monopoly on all things regarding soil. The soil itself has only been engaged as a passive element, dead and non-interacting, whereas questions of land ownership, property and

access have been vividly discussed among social scientists. According to Salazar *et al* (2020) this can partly be explained by the processes dictating soil nature. Pedogenesis, the natural process of soil formation, occurs within a time span far exceeding any form of human timescale. Moreover, most soil processes are occurring far away from the human gaze under our bare feet.

Hugöy's (2024) and Kallio and LaFleur's (2023) studies are examples that focus on alternative farming practices and soil-human relations. In Hugöy's (2024) study the focus is regenerative farmers in Norway and Costa Rica, where they investigate farmers' relations to the soils they care for and its connections to alternative practices. Farmers were entitling soil with aspects of the "living", discussing how their practices were increasing or decreasing soil life. Hugöy (2024) shows the importance of farmers getting to know their soils to notice changes in soil life. Similarly, Kallio and LaFleur's (2023) study, situated in Finland, Norway and Italy, also focuses on alternative farmers and their complex relations to soils and agricultural landscapes. The authors reason that alternative farmers are reinventing their relationship to their fields and soil by attaching agency to them.

In this thesis by operationalizing SPT and especially focusing on the *material* element soil, the soil is given agency. By connecting the properties and capacities of soil to other *materials* and the *meanings* farmers attach to soil I hope to illustrate ongoing change within agriculture. Furthermore, looking into how *competences* of farmers and other actors affect their possibility to work with the soil contributes to this aim. Following DeLanda's logic, soil agency is of interest as the soil is not only affected by *competences* and *meanings* but also itself affecting these elements. An argument that is in line with Salazar *et al*. (2020) reasoning that soil is not a passive player, instead it is highly active in forming farmers and other actors' actions.

I argue that combining the soil lens and SPT is a beneficial way of analysing the *material* as it may highlight aspects of the practice of carbon farming that otherwise may be overlooked.

4. Methods

This section aims to explain how the thesis was executed by describing the process of data collection, delimitations, the informants, what guided the data analysis and reflexivity. The thesis was conducted within a larger ongoing research project on carbon farming in Sweden from a farmer perspective. The research project is a collaboration between the Swedish University of Agriculture (SLU), Lund University (LU) and the carbon farming and credits company Svensk Kolinlagring (SK).

The present thesis is based on a qualitative method, using data gathered through semi-structured interviews with farmers. Interviews were done during a period of five weeks beginning in March. Moreover, I attended a workshop on carbon farming that SK put together, inviting interested parties.

4.1 Delimitations

Informants, 12 in total, vary on multiple parameters such as farm size, production orientation and farmer age, there is however a larger representation of cereal farmers as can be seen in Table 3. The common denominator is these farms' interest and engagement with the practice of carbon farming. All informants are using practices that they believe, partly supported by scientific research, are increasing the carbon stock in their soils. More importantly they have all contacted or been contacted by the carbon farming and credits company Svensk Kolinlagring (SK).

By contact with SK, they have shown interest in the subject and practice and are all part of a network called the Carbon Club. The Carbon Club exists mainly in the form of a group chat, where farmers and representatives for SK share ideas regarding carbon farming. Moreover, they give each other suggestions about other sources of information on the topics such as webinars, courses et cetera.

Table 3: Overview of farm characteristics of the informants

Farmer	Size of farm	Production orientation	Location	Main economic product/part of carbon credit scheme?Yes/No	Relation to farm	Professional background
Allan	- 200 ha cropland	Conventional	Uppsala	Grains/ **No**	5th generation	Mechanical engineer
Bill & Bianca	- 32 ha cropland	Organic	Stockholm	Flour, vegetable oil/ **No**	1st generation	Agronomist & Biologist
Colin	- 68 ha cropland	Organic	Uppsala	Grains/ **No**	Renting farm	Farm operator*, construction work
David	- 250 ha cropland - 25 ha grazing - 200 cows	Conventional	Skåne	Milk/ **Yes**	4th generation	Agricultural technologist**, farm accounting
Erik	- 100 ha cropland - 70 ha grazing	Organic	Skåne	Breeding stock & horses/ **No**	8th generation	Agronomist
Frank	- 1200 ha cropland	Conventional	Stockholm	Grains & contracting/ **Yes**	Renting farm	Farm operator & contracting***
Gabriel	- 700 ha cropland - 200 ha grazing/other - 400 cows	Conventional	Stockholm	Meat & grains/ **Yes**	10th generation	Agricultural technologist
Harry	- 110 ha cropland	Organic	Västmanland	Grains/ **Yes**	1st generation	Agricultural technologist
Iris	- 1 ha cropland	Organic	Stockholm	Vegetables/ **No**	7th generation	Lawyer
Johannes	- 6 ha cropland & grazing	Organic	Stockholm	Vegetables/ **No**	1st generation	Researcher
Kevin	- 300 ha cropland	Organic	Västmanland	Grains/ **No**	3rd generation	Farm work
Laura	- 120 ha cropland	Organic	Uppsala	Grains/ **No**	5th generation	Civil engineer

* in swedish: *driftledare*
** in swedish: *lantmästare*
*** in swedish: *entreprenad*

4.2 Data collection

Interviews were conducted in Swedish together with a research assistant from the project group. One of these interviews was done by the research assistant alone while the another one was done by me alone. The selection of informants was made from the list of members in the Carbon Club, which I and the research assistant were invited to. Members of the network were organized based on their likely location in Sweden, using the area code of their phone number.

Additionally, SK shared information about four farmers from the Carbon Club in the middle Sweden area that had received carbon credit payments. Of these, three were available for an interview.

Due to us wanting to carry out as many on-farm interviews as possible we aimed to interview farmers located in the areas of Uppsala, Stockholm and Västmanland. However, due to a lack of informants and shortage of time, two farmers from the southern region of Skåne were included. The two farmers from Skåne were interviewed digitally via zoom. Including the two farmers from Skåne proved to be a valuable addition as they had agricultural conditions differing from the 10 informants in middle Sweden, which highlighted other aspects.

In total 12 interviews were carried out. Interviews ranged in time from 60-90 minutes and in some cases a small tour of the farm took place outside of the interview itself. As previously described, farmers differ in many aspects but share the interest in and employment of carbon farming methods, although they also differ in what degree their involvement in carbon farming schemes are. Four farmers had received economic compensation for sequestering carbon, while the rest were at different stages of becoming a part of a carbon scheme.

All informants were members of the Carbon Club and had some form of relationship to SK, which could affect their views and answers given. In general, all informants talked positively about SK as an organisation, even those critical to carbon credit schemes thought highly of SK. Multiple informants pointed out that SK was trying to focus less on carbon farming as a tool for climate change mitigation and more as a tool for increased soil health. It could be argued that informants were inclined to answer positively about SK and carbon farming due to their connection, however they were all made aware of their anonymity.

Interviews were performed in a semi-structured manner using an interview guide seen in appendix 1, which was produced in collaboration by the researchers, research assistant and me. I was allowed to add questions that were of specific significance for this thesis. By using a semi-structured approach, we were able to adapt the interviews somewhat to the context and conditions of each informant. Kvale and Brinkman (2014) point out this flexibility as a strength of semi-structured interviews in comparison to structured ones. Flexibility in the case of semi-structured interviews leaves space for informants as well as interviewers to go into depth on subjects that appear interesting.

Semi-structured interviews are fitting when the goal is to receive answers of perceptions and beliefs as Robson (2011) reason. In the case of the current thesis this is highly relevant as I am interested in farmers' *meanings* and *competences* connected to their practices and *materials*.

Our aim to conduct most interviews on farm, face-to-face, was motivated by the fact that such interviews often reveal more information. Robson (2011) argues that face-to-face interviews allows the interviewer to observe non-verbal ques that may signal more than what is being told. Moreover, in the case of farmers, it is fruitful to interview them about their practices on their farm, as they then may point out fields, machines and things of importance.

During the interview, the research assistant and I would divide our roles to make the interview as productive as possible. One would take the role of interviewer while the other would take notes and interject with follow-up questions deemed to be of importance. The strength of this set-up was that central themes were covered, and especially interesting subjects could be followed up more easily than if one person would have had to lead the whole interview while taking notes. With the permission of the informants all interviews were also recorded which enabled me to listen through them later. All informants signed a document were they agreed to their information being used in this thesis and the research project, were anonymity was guaranteed.

Following the interview the research assistant and I would discuss the interview and the themes we thought were of greatest importance which we then noted. At the beginning of every week when interviews were carried out, I would attend a meeting with the research assistant and a researcher from the project. We would discuss practical matters of the interviews as well as topics of interest that had come up during the interviews. This process helped me reflect over the interviews and start initial, rudimentary analysis already straight after data collection.

For the purpose of anonymity, informants are given fictional names in alphabetical order; Allan, Bill, Colin etc. The farmers genders are however corresponding to their actual one. In Table 3, central characteristics are provided to give an overview of the empirical material. These characteristics are brought up at different instances in connection to the analysis.

4.3 Data analysis

To analyse the material, each interview was uploaded to a transcribing artificial intelligence tool, Sonic. The transcription tool can identify different voices and could thereby create written dialogues of the voice recordings. Furthermore, each written sentence is connected to a timestamp of the recording, allowing me to listen to chosen sentences. In this way I could identify errors done by the AI and correct these myself if needed. Due to the program identifying separate voices I

could then assign each voice with a role such as farmer, interviewer 1, interviewer 2.

With these transcriptions of the interviews, I used the Social Practice framework to identify elements of the practice of carbon farming. I take the term carbon farming to mean activities that potentially increase the carbon stock in soils as described in section 2.3. Carbon farming can be seen as a social practice in the sense that Shove *et al* (2012) define it. As described in section 3.1 a practice is made up of its elements, *materials*, *competences* and *meanings*. These elements are interconnected and affect each other and the practice itself as Shove *et al*. (2012) state.

Moving on, coding was carried out deductively as SPT guided the identification of themes in the form elements. When looking for *materials* it was often matters concerning the soil, inputs and machines in connection to carbon farming. *Competences* were in multiple interviews discussed in connection to extension services, know-how and curiosity. Lastly, different *meanings* are attached to carbon farming and the soil itself, which could regard soil life, biodiversity and the role of being a farmer.

4.4 Reflexivity

It is important to discuss my own role in the thesis and possible areas that could affect the outcome. As previously mentioned, this thesis is written in collaboration with a research project on farmers' perspectives on carbon farming. The interview guide was written together with those who work with the project but many of the questions have also been valuable for my thesis e.g. general questions about perceptions on carbon farming. Furthermore, I have included questions that were of specific importance for this thesis, such as questions regarding soil-human relations.

Moving on, it is important to address the involvement of the carbon credit company SK and their possible effect on results. SK has mostly been relevant in helping me acquire contact with farmers, by including me in the Carbon Club. Additionally, they provided a few informants that had received economic compensation for carbon sequestration and were in the area of middle Sweden. They did not form any requests to me and this thesis regarding things they would have liked to investigate. I did however meet with multiple people working at SK when I attended their workshop on carbon farming, which provided an opportunity to listen on their perspectives.

Lastly the subject of carbon farming, being quite technical when it comes to the soil scientific parts, may have created barriers for me to ask the correct questions. My educational background is more centred around agriculture from a social science perspective and rural development and not primarily soil science. I have however completed some basic courses in soil science but not covered advanced topics that are important to understand the accumulation of organic matter in soil. In the interviews farmers often discuss quite detailed information of carbon farming, which at times have been difficult for me to comprehend. I reason that this is not necessarily a problem, as my aim has been to understand beliefs, questions and general grounds of appeal in connection to carbon farming and not the exact amount of carbon stored.

Farmers understanding of me in connection to my education may also influence them in their answers. In the beginning of each interview, I introduced myself as an agronomy student, which I perceived made them become at-ease. In my opinion they talked quite detailed about their farming practices due to me being agronomy student and the research assistant being an agronomist. The farmer may experience a feeling of trust for people with this profession and education. I reason that this is positive as they may mention matters, they might not mention to someone with a different education. At the same time, my knowledge felt sometimes inadequate as farmers could ask me in the interviews about factual questions on soil.

5. Results

This section displays how the collected data can be interpreted with the Social Practice framework and with the soil as a lens for the analysis. I begin to discuss the *materials* of carbon farming, highlighting how soil can be viewed as a baseline for the practice. Thereafter I reason how *meanings* and *competences* are motivating farmers to conduct carbon farming. The following section continues to connect the different elements to questions of climate change and the farmer identity. Lastly I return to the soil to illustrate farmer-soil relationships in light of the practice.

Important to note is that carbon farming as a practice includes many sub practices, such as described in section 2.3, thereby when informants refer to their carbon farming it differs from other informants' practices. Sometimes informants just refer to their practices as "alternative" in comparison to conventional agriculture. I use the term "carbon farmers" to describe the informants as a group. My definition of a "carbon farmer" is a farmer who employs carbon farming practices to some degree and who also is connected to a network of other farmers doing the same.

5.1 Carbon farming and soil; *material* baselines for the practice

A common bearing for all informants is how the *material* aspects constitute a fundamental answer to the question, why carbon farming? All the farmers have actively chosen to adopt carbon farming practices. All the farmers interviewed had started applying at least some methods before contacting SK or any carbon credit schemes. Other factors than economic subsidies, often connected to *material* circumstances, drove them into this sphere.

Frequently properties of soil, as a *material*, are highlighted by informants. All informants who were located in the regions of Uppsala, Västmanland, Stockholm shared a common context of heavier clay soils. In those ten interviews issues connected to the heavy clay were repeatedly discussed, two representative statements are made by Allan and Harry,

> "If you plough in the spring, it [the soil] will turn dry as a bone. It [the soil] will turn to brick and that is lethal. [for the crop production]" (Allan)

> "It is a challenge and especially here as the soils are very stiff, heavy clay soils and they are not to be trifled with in spring."(Harry)

The clay soils govern what actions can be conducted and not, for example when it comes to ploughing in the spring. This example of issues with spring tillage is raised by all the informants located in Uppsala, Västmanland and Stockholm.

The informants located in Skåne discuss different issues related to their soils; for example Erik, has sandy soils instead of heavy clays. Although his soils differ from those with heavy clays, a common denominator is repeatedly struggling with water management. In the case of Erik, it is about creating water retention,

> "To bring some life into this soil and make it productive on its own, even this sandy soil. To make it work better and get a better nutrient and water cycle. So that we can retain a little more of the rain we get and not become so drought sensitive." (Erik)

With lacking water holding capacity, Erik was led on a path to increase soil organic matter to remedy this problem.

In addition, the farmers with heavy clays worked to achieve greater drainage capacity and drought prevention. Harry, with especially heavy clays as he himself describes, thinks that the carbon farming methods are creating improvement,

> "I think maybe my way of farming makes it [the soil] permeable." (Harry)

Laura with middle heavy clays located in an area with frequently occurring flooding thinks her methods may increase drainage and retention to avoid standing surface water in the field,

> "It is a bit like this with horse manure. We believe that we can build humus with it and that it will have a water-retaining effect." (Laura)

Given examples regard the soils properties e.g. soil texture and structure and the capacities that follow such as retention and drainage of water. Changing to carbon farming practices to both adapt to and affect soil capacities seems to be one of the reasons for entering carbon farming in the case of my informants. There are however other important *material* aspects that regard the soil less directly which also played a significant role, which will be described next.

Farm inputs (fertilizer, pesticides, fuel) and economic capital are *materials* vividly discussed by the farmers in connection to carbon farming. Reducing the amount of inputs needed has been a goal in itself for multiple farmers interviewed, as expressed by Colin,

> "You spend a lot of money [on inputs]. And it is not certain that it will yield anything. So that is why I am now trying to get the soil going and helping it along the way. It has

> been a way to make sure that the soil is healthy so that we can get good harvests based on a good soil less reliant on continuous inputs."(Colin)

David expressed a similar reasoning,

> "Then it is random every year with weather and circumstances that determine whether we make it [achieving a good harvest] or not. But if you take away the inputs, you take away a lot of the uncertainty as well, and then it looks nice on the balance sheet and income statement in the end." (David)

Reducing inputs is connected to reduced risk as investments are lower and thereby a bad harvest is not as big of a gamble. Furthermore, by building up a better soil health the goal is that the soil will be more self-sufficient, relying less on inputs, in the long term. Gabriel expresses this thought in short as:

> "The ideal is being able to become self-sufficient in inputs. Ideally you should have a self-playing piano. Then you have reached your goal and still get an output in the form of a harvest." (Gabriel)

With above given reasoning, *material* factors e.g. soil, inputs, money, have been a primary reason for the farmers interviewed to enter carbon farming in the first place. Although inputs and money is not directly soil, they are indirectly connected to soil due to achieving self-sufficiency depends on soil capacities. In the next section I will discuss how this connects to *meanings* and *competences* as they also influence the farmers' decisions.

5.2 *Meanings* and *competences* influence in decision making

Although aspects regarding the soil, inputs and economy have been central, they are often connected to *meanings* and *competences*. In a few cases it could even be argued that aspects of *meanings* contribute to decision making more than *material* aspects. Some informants like Bill and Bianca have ideological goals, which is visible in their reasoning for taking over land management from the previous farm tenant. For many years they lived on the farm without being active farmers, instead they rented their land to another farmer in the area. However, they did not agree with their tenants' land management, as they state:

> "But that was one of the reasons why we took over [the cropland]. As it were, we found it difficult to cope with conventional farming… It is visible on the soil. We have not been doing this for long, but it is visible in the soils that they have been abused" (Bill)

Other farmers reasoned according to the *meanings* they attached to their practices but connected to other issues. Some discuss more generally about promoting

biodiversity and working with nature. Colin who is an organic farmer as well as practicing carbon farming states:

> "It is much more fun to do it this way. To try to co-operate with nature. Being a colleague to nature and not working against nature." (Colin)

Erik gives an example, of the connection between *materials* and *meanings*, as he has seen physical examples of how his practices change his surroundings,

> "It is this diversity that we try to promote as much as possible. I am a hunter and nature lover myself, and that [biodiversity] is something you appreciate when you see things[species] returning. There are more partridges [a bird species] and we also have a corn bunting [a bird species] that started nesting here a few years ago and it has not nested in the area for 50 years. Such changes are incredibly fun to see." (Erik)

While all informants focused on *meanings* attached to life in the soil and looking at farming from a system perspective, the thoughts specifically about biodiversity, exemplified by the quotation from Erik above, seem to be more outspoken among the organic farmers interviewed.

Building soil health is connected to building a functional system, such as Laura describes,

> "Building the soil organic *material* is fun. It improves soil health, maintains or improves it. Then I believe in the interaction, that you do not just look at the arable land. You have to look at the whole landscape with agriculture and forestry." (Laura)

Another expression for the meaning of soil health is as follows by multiple informants,

> "I want to build up a good soil where I am now. It should be much better when I hand it over." (Colin)

> "It is this regenerative journey and implementing it and building up the organic *material* in the soil. Building a good humus content in the soil to be able to hand over to the next generation." (David)

> "My goal was to leave a better soil behind than the one I took over." (Frank)

This inherent vision of handing over better soil than they themselves started out with is not just a question of economy but both about valuing soil health itself and about feeling a responsibility to the land somehow, to hand over a "better" soil to the next generation of farmers. The *meaning* of creating sound soil health is thereby affecting the *material* soil and motivates the practice of carbon farming.

Besides the *meaning* of soil health another carrying ideal is a general curiosity about the soil, which can be described in both terms of *competences* and *meanings*. Curiosity and a will to experiment is something all informants bring up, not only in connection to carbon farming. Kevin and Frank express this curiosity in comparison to economic rationality,

> "There are other parts that are much, much easier to fix. Because it is actually not that easy to do these things the way we do. I lose like 60% of the harvest when I am doing my experiments. And yet I keep going because I think it can be good and not just for my wallet." (Kevin)

> "I enjoy it [carbon farming], like a lot of things I do, it may not make a lot of money, but it gives me more well-being and satisfies my curiosity a little." (Frank)

Frank and Kevin have a will to expand their knowledge and know-how, which pushes them forward to trying new methods. There are examples of how *meanings* and *competences* are entangled, were it is viewed as meaningful to conduct farming differently, making curiosity motivating in itself, as Allan expresses,

> "It is fun when it is a bit more difficult to do than according to the schoolbook. Were you buy this and then you spray them there and then you drive. It is not just that it feels unnatural and provides rather poor margins, it is also a bit boring." (Allan)

Curiosity is not only satisfied by conducting experiments on the farm but also by getting involved with SK. Wanting to know more about their soil makes it appealing to have SK come and measure soil properties such as soil organic matter. Erik and Bill express the benefits of gaining knowledge in connection to production,

> "Because while we are doing that [carbon credit schemes], we are going to learn things about our own production that we can use strictly from a business perspective. And it is just as concrete as with carbon sequestration. This year we will have access to some satellite data, where you can see at field level how different fields have performed compared to each other, and that will be valuable. So I am very much looking forward to being able to dig into that. So that is a positive aspect." (Erik)

> "What are we doing wrong and what can we do better? It would be nice to get figures on that, because it is a bit of a farmer's dilemma. You cannot do everything so you have to choose your priorities." (Bill)

Expanding the *competences* on how to conduct the practice of carbon farming can thus be done both by on-farm experimenting as well as advisory help from organisations like SK. This highlights the role of external actors in creation of knowledge and know-how as it seems like traditional advisory actors do not

possess the needed *competences*. All farmers interviewed raised this as an issue for further developing and upscaling the practice. Kevin has been seeking for farm advisors on the matter without success,

> "But it is mostly about organic farming [farm advisory]. Nothing about regenerative. No, no, I have not met anyone who directly offers advice on regenerative farming." (Kevin)

Harry has experienced the same problem but also enjoys the experimental part of it all:

> "It is difficult to find an advisor. At the same time, I think it is so much fun, so I want to be my own advisor a little bit and do these tests." (Harry)

The advisors that do exist are more traditionally focused on either conventional or organic farming, which Allan expresses:

> "I do not think those advisors are going to say anything that I might not be able to figure out myself. But if I take out a person who looks at it in this other way [i.e. through the lens of a carbon farming perspective], then that is knowledge that I absolutely do not have." (Allan)

Why traditional advisors do not possess these *competences* is something I return to in section 5.3, where *meanings* are further discussed.

In this section I have highlighted how *meanings* like biodiversity and soil health are attached to carbon farming which complements *material* motivations for conducting the practice. Moreover, *competences* in the form of curiosity can be argued to be a central part of interviewed farmers' reasoning. The next section will focus on farmers' identity and how they redefine themselves in the light of climate change mitigation.

5.3 Aspects of climate change in carbon farming, norms and peer pressure

Climate change is a central part of carbon farming from the point of view of government agencies, the EU, and external companies, as described in section 1.1 and 2.2. This is however not as central for farmers themselves when they consider entering the practice. In the previous two sections I have described how matters concerning *materials*, *competences* and *meanings* motivate the farmers' practice, not really touching upon climate change itself. Here I present how the informants place themselves in the climate change mitigation debate and how they couple *meanings* of climate to carbon farming. This then leads to how farmers try to define and redefine themselves in relation to various farming practices e.g.

conventional, organic or regenerative agriculture. Moreover, I highlight the informants as "carbon farmers", as they distinguish themselves from other farmers. Discussions between "carbon farmers" also point to the importance of *meanings* connected to the "good farmer" and proving the value of carbon farming.

When asked what farmers should or could contribute to the effort to mitigate climate change, answers differ between informants. Some informants answer quite enthusiastically like Allan or Bill and Bianca,

> "When you start reading that we can sequester, we can store carbon, you can be a carbon sink, you can not only make a small footprint, but you can even have negative emissions. That felt so motivating." (Allan)

> "We want to try to create or recreate more biodiversity. That was kind of the first focus. And then to see how we can minimise our climate impact as much as possible." (Bill)

In these cases, clear *meanings* of climate change mitigation are attached to the practice. Other informants use climate change less of a motivation for entering carbon farming but still stress agriculture's role, as David and Erik do:

> "The simple answer is that agriculture is the only solution, and forestry for that matter. Land management is the key to climate change mitigation." (David)

> "We have great potential to contribute, absolutely. But the journey there is not easy... If we are to focus fully on what is positive for the climate, we need to do many things differently, which may not always benefit the agricultural sector." (Erik)

At the same time, some informants voice a more critical perspective, such as Kevin

> "But let us be honest. I think we can sequester carbon in the ground. We can do that, but it is just a bunch of rubbish. Because in one place in society, nothing should be done to reduce fossil fuel consumption and in other places, we should work like hell to try to sequester carbon." (Kevin)

This critical perspective can be found to some extent with all informants, but it makes itself more visible when discussing carbon credits. Many of the informants describe the idea of them compensating other sectors for their failures in climate mitigation as a bit backwards. At the same time all farmers interviewed agree on the potential of carbon farming such as David and Erik do above or as Gabriel states here:

> "There are probably few industries that have the opportunity to do as much as agriculture could do"... "There is a huge potential in agriculture, which is not really valued at all." (Gabriel)

I would reason that farmers attach the meaning of climate mitigation to carbon farming, however to what extent it is a motivation differs between farmers. For farmers like Bill and Bianca it is a carrying ideal, while for Kevin it is a recognized effect but not as central. Meanwhile all farmers interviewed recognize carbon farming as an active practice in mitigating climate change, pointing to themselves as having a potential active role. They, as land managers, can be active in a way that the general population is unable to. Frank reflects this view when he was asked about agriculture's role in climate change mitigation,

> "We are like 'doers' in a way. The others talk but we do" (Frank)

As Frank says, and as other farmers reflect in previous statements, there is a non-actualized potential for farming in general to mitigate climate change. Here we start to discern how the practice is affecting the farmer identity, as the informants place themselves in a different grouping than "normal" farmers. Kevin, who himself is a bit pessimistic to motivating carbon farming with climate change mitigation, explains what he believes other "normal" farmers think:

> "I think many farmers are perhaps even more pessimistic than I am. I feel that many think we should do nothing at all [about reducing emissions from farming]. That is my feeling. I have not seen a survey on that, but that is my feeling. I see it when people write that they get very annoyed when people think we should change something in what we do." (Kevin)

Colin also mentions conventional farmers as unaware in the context of carbon sequestration:

> "And you wonder how aware conventional farmers are of storing carbon, because I do not feel like they are in that game at all." (Colin)

Alienation by other farmers, advisors and companies seems to also be driving carbon farmers to create their own identity. All informants report how their own practices are stamped as "deviating" and "weird" by others. David has faced a lot of resistance through the years, as he describes:

> "Resistance from colleagues, for example. Why do you do it that way? And why is it like this? If you have to justify everything you do in order to be accepted. That is probably the biggest obstacle I have faced along the way. But I have a pretty strong character, so I have probably run my race independently." (David)

Judgment from others in the agricultural sector is also visible within the extension services as Allan states:

> "I do not think they[advisors] want or dare to use those terms [no-till, regenerative, carbon farming] … Because they are afraid of being labelled as weird." (Allan)

In a way, non-practitioners are attaching negative *meanings* to carbon farming, resulting in a "we" and "them." This is where the network called the Carbon Club becomes an important institution, offering a space for carbon farmers,

> "And that is something you get in other forums too. But only that you can connect people who may have tested something similar to what you are testing, is valuable." (Erik)

The Carbon Club is both a place for farmers who identify themselves in a somewhat similar way but also for knowledge creation as Laura says,

> "But that you become a group that can learn from each other and that you have a greater effect on it. And that it needs to be tested. And these discussions in the little I have seen in the Whatsapp group, for example, that you learn from each other, which I think is important. " (Laura)

The network is nevertheless a very heterogeneous group, as exemplified with the range in size and production of the informants I interviewed. Farmers of different orientations, sizes, production and location are gathered in one space, creating some disagreement. Which is a further reflection of the "carbon farmers" as a group, although they are disentangling themselves from the general farmer collective, they are not a very homogenous group. One point of conflict within the group is between those farmers calling themselves "regenerative" and those who do not, debating the terms ambigouty. Another point is between small scale operations and large-scale ones, where the issue is more about economic viability.

Bill and Bianca are of the opinion that regenerative farming is an ambiguous term with no concrete measures of sustainability,

> "After all, anyone can call themselves regenerative and then it becomes very diluted…Conventional farms can claim that they are regenerative and it is difficult to understand how this can be." (Bianca)

Frank and Gabriel are also against using the term but mostly due to not wanting to be conceived as weird/deviating,

> "We have decided not to do that [use regenerative as a term] anymore because it is too weird and deviating." (Gabriel)

In contrast to Bill and Bianca, Frank and Gabriel there are four informants who explicitly state that they are "regenerative" in their practices. Allan, David, Erik, and Kevin all share an interest in the regenerative movement, they place themselves in an international setting such as David does here,

> "I think I belong to the international part [of the regenerative movement] where you take information that is universal for all arable land in the world, like the foundation of this movement really. And we have not quite gotten there in Sweden yet." (David)

The second divider within the group of informants is scale and economic viability. Frank and Gabriel, cultivating 700 ha and 1200 ha each, shares their opinions about other farmers in the Carbon Club,

> "There are far too many chickens and goats... It does not suit production agriculture. Even if you can pick up ideas from there, it becomes too fluffy somehow. Then again, the spirit of the idea is good." (Frank)

> "The small apple growers who are members of the Carbon Club, they think it is super cozy. The estates in Skåne think it is totally uninteresting if they do not get a penny for their efforts." (Gabriel)

In Frank's and Gabriel's opinion, carbon farming and the network needs to focus more on solutions of scale with economic viability, instead of these small-scale contexts. Two informants who have not been mentioned up until now, Johannes and Iris, can be seen to belong to the category of "small apple growers." None of them define themselves as farmers, instead as landowners and social engineers. They both work with social projects in connection to gardening and learning but occupy themselves quite little with agricultural work itself.

Interestingly enough, Bill and Bianca who are quite small-scale also argue that economic viability is central,

> "It is such an important part [economy] of the farm that you are never going to be an example unless you can show that you can make money from it… Otherwise you become irrelevant in the discussions. If it is just a hobby and this is not a hobby." (Bianca)

I think they pin-point a general feeling among all the informants, there is a need to "prove yourself" or even more accurately "prove the practice." As other actors attach negative *meanings* to carbon farming, the carbon farmers must prove its functionality. Constantly working against the label of being "weird/deviating" could also be a reason for criticising other carbon farmers, who are not rational enough.

To summarize this section, in the case of my informants, climate change is not the primary reason for entering carbon farming. However, I do think that the farmers are connecting *meanings* of climate mitigation to the practice, which is a motivating factor to continue with carbon farming. Instead of being a reason to enter the practice in the first place, the *meanings* of climate change mitigation are changing the farmer's identity. By being a part of the practice, the farmers view

themselves as an active force in climate change mitigation. So not only are *meanings* of climate change mitigation attached to carbon farming but also new values connected to the farmer identity. The identity is created in their differences to other farmers and the alienation they face by others. However, this does not mean that "carbon farmers" as a collective are a homogenous group. My informants show great differences on many points, but similarities in how they distinguish themselves. Moreover they share a goal of proving carbon farming as a viable practice.

5.4 Farmer-soil relations: two entities with agency

In this section the soil, as a *material*, is reintroduced in order to display its agency in relation to the farmer. Section 5.1 focused on how *material* aspects played a key part for farmers to enter the practice, depending on soil properties and capacities. Section 5.2 brought up *meanings* and *competences* attached to the soil and the practice, which highlighted farmers underlying motivations for continuing with carbon farming. Lastly, in section 5.3 I took off in the informant's views on carbon farming and climate mitigation, distinguishing different *meanings*, following up with a reasoning on how farmers are redefining themselves in contrast to other farmers.

As seen in previous sections the soil comes up in multiple contexts when farmers discuss carbon farming. Section 5.1 displays that farmers saw issues with *materials*, most often soil and economy as key reasons for entering carbon farming. This reasoning can be widened to include the fact that farmers are attributing soil agency by "humanizing" it. An introductory example is given by Allan, when asked if he considers his soils as good or bad and then when he reflects on issues with going no-till:

> "I guess you could say it [the soil] is good, as long as you are petting it the right way, as the old man usually says." (Allan)

> "Because the soil is used to being loosened at the surface." (Allan)

Harry also talks about his soils as a living being, which needs to be tamed,

> "I think that if you can tame these clays, then they are good." (Harry)

Allan, who took over the farm from his father who ran the operation for 40 years, argues that the soils are familiar with a certain way of doing things (conventional tillage, as his father practiced). In this way he is attributing a form of "aliveness" to the soil, making him having to adapt to the soils being accustomed to tillage.

Similarly, Harry talks about "taming" the soil, which is due to its heavy clay characteristics, demanding him to put effort in the right practices.

If the soil can be alive, it can also be dead or abused, as Bill and Bianca and Gabriel states,

> "The soil was basically dead. Some conventional farming does not work with the soil, they only work with external inputs" (Bianca)

> "We simply abuse them [the soils] less. That is probably the big difference." (Gabriel)

For them, as previously described, the abuse and death of the soil caused a great deal of concern for them, leading them to try managing their fields differently.

Multiple informants reason in this way of bringing the soil to life and/or feeding the soil in order to make it more self-sufficient,

> "I sow it anyway [despite a high percentage of clover not being advised] and then I only have blood clover and clover, more to stimulate soil life, so to speak. So that they [the soils] have something to live on afterwards[after the cereals are harvested]." (Colin)

> "It is very much about bringing the soil to life and making the soil work better. Seeing the whole farm as an ecosystem where you can make things work together. (Erik)

> "I am trying to make the soil feel better and better and be able to give me nourishment back." (Harry)

> "I feel that it depends a lot on feelings perhaps. But I feel like there is more life in the ground now." (Kevin)

All the farmers who were interviewed attach this meaning of "aliveness" to the *material* soil. Treating the soil as a living being, makes them reason on how one can feed it, abuse it or even kill it. At the same time many of them have issues in explaining how it can be alive, returning to a feeling, something that may be hard to prove with soil scientific measurements. As Kevin says in the quote above or as Harry and Bill state:

> "It is not scientific, but I can feel that when you sort of dig a bit now [in the ground], I think you see more of these plant residues, more worms and such." (Harry)

> "But then you do not really know what is happening [in the soil]. But you do not need to know, it is nature, nature will sort it out. It is difficult to research, it is almost too advanced and it does not really matter." (Bill)

Measuring carbon could be seen as more tangible than measuring "life," which can be connected to *competences*. The farmers are trying to find ways in

estimating life in the soils, by looking at worms, organic *material*, or other characteristics. But as Colin states, it is also about this feeling of doing the right thing despite issues like low harvests:

> "I have it green [clover as lower crop beneath the cereal] when I thresh. It is supposed to be green then, ant it feels so good. Then you look at the neighbour's conventional land and it is all brown, it is a desert. Then I look here, and it is lively and there it is dead. It is so nice that you feel genuine pleasure. You know that this is right, for God's sake! Even though I have a much worse harvest than they do, it feels so good when I am done [harvesting]." (Colin)

In section 5.1 the soils properties and capacities were highlighted as steering farmers' possibilities to conduct farming and leading them to enter carbon farming. The current section explores how farmers are attributing *meanings* of aliveness to the soil as a *material*, which could be seen as a motivator for adapting methods to the needs of the soil. Moreover, *competences* are interacting or even competing with *meanings* regarding the soil, some things are non-measurable, which leads farmers to act on feelings and approximations about "soil life". In section 6.3 this will be discussed further, to connect to theories on soil-human relations.

6. Discussion

The current section connects the findings presented in the results to answer the questions asked in section 1.1 and bring in how this can be connected to previous research. First, I argue that the farmers interviewed primarily enter the practice of carbon farming due to *material* factors, in the form of the tangible co-benefits they can gain. Secondly, I reason that the practice is changing the farmer identity, which is seen in how the informants discuss how they deviate from the ideal of how a proper farmer is considered to practice their farming. Lastly, I argue that soil is at the centre of these processes and also an agent, simultaneously affecting the farmer as the farmer is affecting it.

6.1 Co-benefits instead of climate change mitigation ideals

An aim of this thesis has been to unpack the underlying justifications for Swedish farmers to enter the practice of carbon farming, utilizing SPT. Furthermore, I seek to illuminate how these grounds to opt for the practice are entangled with aspects of soil.

Buck and Palumbo-Comptons (2022) use the term co-benefits, to describe the benefits beyond carbon storage that farmers perceive in practicing carbon farming, stating the value of for example reduced erosion risk, improved water management and reduced fuel costs. Similarly, as seen in section 5.1, farmers I interviewed reasoned about improving soil capacities while also reducing inputs as primary incentives for entering carbon farming. *Material* motivations have thus been a trigger point for informants to start utilizing carbon farming methods, a reasoning in line with the arguments of other studies (Waade and Claasen 2017; Payen *et al*. 2023; Hijbeek *et al*. 2018), although as seen in section 5.2 and 5.3, *meanings* and *competences* should not be disregarded.

There is a general meaning attributed to working with nature and promoting biodiversity that furthers the argument to continue the practice. Furthermore, informants elevated an intent to hand over a better soil then they themselves started out with. These *meanings* as well as *material* intentions work in tandem with a strong will to improve and expand *competences* when farmers go on to conduct alternative methods. Due to these intentions, the farming itself becomes more “difficult” which is not necessarily negative as curiosity and an interest in experimentation was fundamental among informants. Here we can distinguish how *materials* on their own are not the sole motivation, as most farmers experienced economic losses in their experimenting with carbon farming. Despite

economic losses, the *meanings* and *competences* provide incentives to move beyond the realm of strict economic viability. Curiosity is thereby also connected to risk-taking, as it could be argued that the informants are all to some degree taking risks by conducting carbon farming. Other studies such as by De Pinto *et al*. (2013) also point to the ability for farmers to engage with alternative practices as being connected to individual risk-taking behaviour.

The lack of *competence* is a recurring barrier, as knowledge and advice on carbon farming was perceived as scarce. Problems with insufficient knowledge have also been raised in other studies (Buck and Palumbo-Compton, 2022; Ingram *et al*., 2014). I argue that this lack of knowledge, at least on the advisory side, is related to negative *meanings* attached to carbon farming, making agricultural advisors avoid the topic. In section 6.2 this argument regarding negative *meanings* and alienation is further discussed.

Moving on, how are *meanings* related to climate change mitigation integrated to the underlying justifications to conduct carbon farming? In section 5.3, I present how farmers find climate change mitigation motivating to varying degrees. Mostly, informants recognized the ability and function of carbon farming as a mitigation tool but not stating it as a primary reason for conducting the practice. Some informants were even critical of compensating other parts of society's failure to decrease their own GHG emissions.

I argue that the perceived co-benefits in the form of improved soil capacities and reduction of agricultural inputs is a primary entry point for farmers to enter carbon farming. However, these co-benefits are enforced through positive *meanings* and *competences* attached to the practice such as biodiversity, soil health and curiosity. Climate change mitigation can be seen as a *meaning* also attached to the practice but is motivating to a varying degree. The soil is central as the *material* motivation revolves around its properties and capacities. When farmers enter carbon farming, they are being affected by the soil, by alternating their practices, in order to affect the soil capacities. Moreover, the meaning they attach to the practice is also largely connected to the soil. In section 6.3 I return to the argument of viewing the soil as an active agent.

6.2 Struggling against farmer ideals and norms

This thesis aims to not only discuss motivations and barriers for farmers to enter carbon farming but also highlight how the practice is changing their own relation to being a farmer and to the soil itself.

In section 5.3, the alienation from other farmers and advisors was a common theme for informants, related to the negative *meanings* that external actors attached to carbon farming. Although the informants represented a heterogeneous group, they shared experiences of being profiled as deviating from common agricultural practice. Farmers that were interviewed had been stamped as "weird/deviating", due to occupying themselves with carbon farming practices.

The process of other farmers attaching "weird/deviating" *meanings* to the practice of carbon farming, could be connected to the ideal of the "good farm/farmer" (Kawa, 2021; Gosnell, 2022; Burton, 2004). Utilizing carbon farming practices such as cover-cropping and no/reduced-tillage will result in fields that look starkly different from normal conventionally/organically managed fields. Kawa (2021) and Gosnell (2022) describe the importance of what the norm of a "good" or "tidy" farm is, partly due to farmers relying on visual assessment to judge the success of a practice. In the case of my informants this becomes materialized in the perceived alienation they face from colleagues and extensions services. In conducting carbon farming, they are breaking away from the norm of a "good farm," not only resulting in visually different fields but also that they focus on lucid *meanings* like soil health and working in tandem with nature.

One important characteristic of a "good farm" that informants present is economic viability, as they argue that at the end of the season it is the economic outcome that tells the true story. I argue that in order to combat negative *meanings* of being "weird", all informants experience a pressure/motivation to prove the worth of carbon farming as a practice. In order for carbon farming to be taken seriously the farmers need to ensure that it is a viable practice and not a form of nature conservation hobby. At the same time, this necessity to "prove the practice" leads to tensions within the group of "carbon farmers." Some farmers think there needs to be more focus on finding large-scale solutions and others think terms like regenerative should be avoided.

Despite points of conflict within the group of carbon farmers, I would argue that they have a form of community, partly represented by the network "Carbon Club." The informants are integrated to varying degrees in the group, but they do share the alienation from others as well as a will to conduct carbon farming.

Soil, as a *material*, becomes a crucial factor in why farmers are perceived as deviating from the "good farm" as well as in their process of becoming a group. As argued in section 6.1 the primary reason for entering carbon farming regards co-benefits in connection to the soil. Thereby farmers are choosing to focus on the soil instead of "normal farm goals" and jeopardising their reputation as farmers.

In doing so, farmers are attaching *meanings* to the soil, but the soil is affecting the farmer in return by making them face alienation from others and redefining themselves. Soil is the centre point of which the group "carbon farmers" revolves around, because despite heterogeneity they share common *meanings* and *competences* attached to it.

6.3 Soil, a *material* brought alive

Soil is and continues to be the building block of which carbon farming relies on, as illuminated in previous sections, the current section will deepen the argument of soil agency. Farmers are utilizing methods in hopes of affecting the soil, but the soil is likewise affecting the farmers in return.

Using DeLanda's (2017) and Salazar *et al*. (2020) reasoning in viewing non-human entities with agency, we can deepen our understanding of farmers' interaction with the practice of carbon farming. The concept of co-benefits as a motivation for farmers, as discussed in 6.1, can be viewed in DeLanda's (2017) terms as trying to utilize the non-actualized capacities of soils. Soil has properties such as structure, texture, nutrient composition, which affects its capacities to retain/drain water, provide crops with nutrients and risk to erode. Informants motivate their decision to enter carbon farming by improving such capacities of the soil; by changing the way they manage the soil. However, this is not a one-sided action from the farmer, as they must adapt their methods to soil properties such in the case with heavy clay soils.

Prioritizing improved soil capacities is also connected to *meanings* and *competences* regarding the soil. As described in section 5.4, farmers are attaching characteristics of living entities to the soil, which could be argued to redefine the soil from being passive and dead to being active and alive. Informants reason how to feed, not abuse and revitalise their soils in order to reach certain co-benefits but also doing so because it "feels right". An important question is if the informants viewed the soil in this way before entering carbon farming or if this is a change in attitude that has occurred after conducting the practice. I would at least argue that by entering the practice they have increased their interest in soil as an entity. This interest is represented by their curiosity to expand *competences* about soil health, trying to define what "soil life" is despite difficulties finding scientific definitions. Instead, the informants rely on senses such as touch, sight and feelings to prove an increase in "soil life". Attaching *meanings* of aliveness and trying to prove this could be seen as a redefinition of the soil as an active agent. This occurrence can be seen in the light of other studies such as Hugöy's (2024) and Kallio and LaFleur's (2023), which also showed how farmers practicing alternative practices attached living agency to soil.

Soil is affecting the farmer identity as argued in section 5.3, another example of its inherent agency. The informants state that even though co-benefits may have some positive economic results in the long-term, their trials of new methods often implicit economic loss. By moving beyond pure economic viability they have to motivate the practice with *meanings* and *competences*. At the same time, due to carbon farming questionable economic viability and in combination with *meanings* viewed as "weird" by external actors, the carbon farmers are exposing themselves for critique by other farmers and advisors. In this way, the soil can be seen as an agent that changes their role as a farmer and their place in the farmer community.

Depending on the context of the farm, the properties of the soil and the individual farmer, soil-human relations change. If the soil has a heavy clay texture, it affects the farmer in certain ways, while the farmer affects the soil back depending on his/hers range of decision possibilities. Where the farm is located, the orientation of the farm, the main crops/products, are all examples of farm context that matters for farmers' range of decisions possible. Therefore, it continues to be important to investigate farmers' perspective on carbon farming in contextual settings, like this thesis has aimed to do.

7. Conclusion

The aims of this thesis have been to contribute to knowledge about the underlying justifications for carbon farming in a Swedish context, from a farmer's perspective. Utilizing Social Practice and a soil perspective I have highlighted how carbon farming can be interpreted from new points of view. The purpose has also been to illuminate how farmer-soil relations are affecting both agents and in what way they are interacting.

I have shown that the primary reason for entering carbon farming is related to perceived co-benefits related to *materials*. Co-benefits regarded improving soil capacities in the light of *material* issues such as drainage capacity, water retention but also reducing input dependency and indirectly improving farm economy. However, *material* motivations cannot be viewed independently as they must be connected to *meanings* and *competences* that furthered farmers motivations. *Meanings* such as increased biodiversity, soil health and to varying degrees climate change mitigation all played a significant role. Whereas *competences* in the form of curiosity drove farmers to continue experimenting and learning about their soils.

Furthermore, this thesis has discussed how "carbon farmers" distinguish themselves from the farmer collective due to their practices and relation to soil. Farmers practicing carbon farming experienced alienation from other farmers and farm advisors due to negative *meanings* of "weirdness" attributed to the practice. The norm of what a "tidy and normal" functional farm is contrasts a farm practicing carbon farming. In response to experiencing negative attitudes "carbon farmers" are gathered in their own group which is partly represented by the network the Carbon Club. The group "carbon farmers" is still heterogenous as members vary largely in size, production orientation and conditions, which results in points of conflict within the group. Simultaneously, the points of conflicts concern "carbon farmers" feeling the necessity to prove the functionality of the practice carbon farming.

Soil, as a *material* is integral for all processes described above, as it affects the farmer when the farmer attempts to affect the soil. Farmers goal to improve soil capacities depends on the given soil properties, thereby the range of possible decisions is governed by the soil. The perceived alienation "carbon farmers" faced from others is driven by the fact that they attribute different *meanings* to the soil. As an active agent, soil is pushing "carbon farmers" to distinguish themselves from the farmer collective. These processes should be seen in the light of "carbon farmers" connecting *meanings* of the living to the soil. If the soil is alive, it

viewed as an active collaborator for goals of the farm such as production, nature preservation and economic viability.

Considering farmers' underlying justifications with Social Practice Theory and utilizing the soil as a lens moves the debate from pure economic discussions to considering biophysical aspects and *meanings*. Carbon farming is increasingly discussed as a climate change mitigation tool, where carbon credit schemes are the primary tool used. However, as this thesis has shown, neither pure economic incentives nor climate change is the driving force for farmers to conduct carbon farming. At the same time, as other studies have shown, what motivates farmers is contextual depending on many factors. Investigating what farmers in Sweden perceive about carbon farmers is thereby valuable to continue knowledge development in the area of carbon farming adoption.

This thesis must be seen in the light of its empirical evidence not being representative for all farmers in Sweden. Here I have shown how some farmers, who have an inherent interest in carbon farming reasons. Further research should focus on more representative data and investigate what "normal" conventional and organic farmers discuss. Moreover, future research should highlight if there are differences in how farmers reason depending on what properties their soils have. Another point of interest is if farmers who start practicing carbon farming experience actual change in how they view the soil or if these views existed already before.

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Popular science summary

Lantbruket har de senaste åren fått rampljuset riktat mot sig i och med den pågående klimatdebatten. Sektorn står för 13 respektive 10 procent av Sveriges och EU:s totala utsläpp av växthusgaser. Kanske ännu viktigare är dock lantbrukets möjliga förmåga att utgöra en kolsänka, där sektorn kan kompensera sina egna och andras utsläpp genom att anta vissa jordbruksmetoder. En möjlighet som inte har gått institutioner som EU, Svenska Regeringen och privata företag förbi, aktörer som alla engagerat sig i utvecklingen av kolkreditsystem där lantbrukets jordbruksmarker kan ingå. Det är här kolinlagrande jordbruk kommer in i bilden, ett paraply begrepp för metoder som plöjningsfritt, mellangrödor, fleråriga grödor, trädallér etc. Jorden blir i sig central, då olika förväntningar och förhoppningar ställs i förhållande till den, kan jorden agera kolsänka, producera mat och förhindra näringsläckage?

Har lantbrukare, som använder kolinlagrande jordbruksmetoder, samma motiv kopplade till klimatnytta som dessa centrala institutioner eller finns det andra bevekelsegrunder? I en svensk kontext har inte lantbrukares syn på kolinlagrande jordbruk undersökts till någon större grad, därav hoppas denna studie bidra till ökad kunskap om kolinlagring i en svensk kontext. Uppsatsens syfte är att belysa lantbrukares underliggande motivationer till att anta kolinlagrande jordbruksmetoder och hur dessa motivationer hör samman med jorden som entitet. Vidare är syftet att undersöka huruvida lantbrukaridentiteten förändras i ljuset av klimatförändringar och isåfall på vilket sätt. Teoretiskt så vägleds uppsatsen av teorier om Social Praktik med jorden som analytisk lins. Kolinlagrande jordbruk ses då som en praktik som består av olika byggstenar; material, kompetenser, betydelser och där jorden är ett särskilt centralt material för praktiken. Metodologiskt förlitar sig studien på kvalitativt material som består av semi-strukturerade intervjuer med lantbrukare.

Resultaten visar att informanternas motivationer för att bedriva kolinlagrande jordbruk är primärt kopplade till materiella aspekter som rör jordens kapaciteter. Därav så är det varken ersättning för kolkrediter eller klimatnyttan som driver lantbrukarna i relationen till kolinlagring. Förbättringen av jordens dräneringsförmåga, vattenhållande förmåga och näringscirkulation måste också ses i sammanhanget med aspekter såom betydelser och kompetenser. Betydelser såsom ökad biodiversitet, jordhälsa, tillsammans med kompetenser såsom nyfikenhet fortsätter driva lantbrukare att vara en del av praktiken. Lantbrukare som utövar prakikten hamnar i en egen grupp av ”kol-jordbrukare”, då de möter alienering från andra lantbrukare som dömer ut praktiken som flummig. Slutligen så innehar jorden agens i dessa processer då dess egenskaper påverkar

lantbrukaren i vilka val som blir möjliga och inte. Samtidigt som lantbrukarna tillskriver jorden levandgörande värden och i deras mål att påverka jordens kapaciteter så påverkas de tillbaka av jorden.

Appendix 1

Intervjuer med lantbrukare om inställning till kolinlagring i jordbruksmark
Presentation av oss själva – projektet och samverkan med SK
I projektet undersöker vi lantbrukares perspektiv och inställning till kolinlagring i jordbruksmark. Vi är nyfikna på att höra om era perspektiv kring kolinlagring som klimatåtgärd. Vad det skulle kunna innebära för dig i praktiken, vilka möjligheter och hinder du ser för en omställning mot ökad kolinlagring, och vad jordbrukets roll i klimatarbetet är.

Samtycke – bekräfta att de tagit del av informationen och samtycker till deltagande

Samtycke till inspelning?

Intervjuns upplägg - teman och tidsåtgång

Bakgrundsinformation

1. Berätta om dig själv och din gård
2. Markinnehav? Andel egen egendom vs. arrende? Hur ser fördelningen av mark ut -åker, bete, skog mm?
3. Vad vet du om Svensk kolinlagring?
   a. Har du deltagit i aktiviteter?
   b. Är du pilotgård och får ersättning för kolinlagring?

Lantbrukets historia, produktionsinriktning och visioner

4. Har gården gått i arv? Hur länge?
5. Vad vet du om gårdens historia?
   a. produktionsinriktning, generationsskiften, jordhälsa, roll i lokalsamhället
6. Berätta om din bakgrund som lantbrukare
7. Hur kom det sig att du tog över gården?
8. Vilken utbildning och/ eller annan yrkesbakgrund har du?
9. Hur skulle du beskriva din produktionsinriktning och dina brukningsmetoder?
10. Om produktionsinriktningen har skiftat: Vet du vad gården haft för inriktning innan du tog över den? Varför valde du/ni att ändra produktionsinriktning/brukningsmetoder?
11. Har du någon vision och/eller målbild för lantbruket?
12. Är det något särskilt du vill att lantbruket ska bidra till?
    a. I ditt egna liv eller i samhället i stort?
13. Hur resonerar du kring dina val och beslut kring jordbruksmetoder?
    a. Är det någon faktor som är mest styrande? T.ex lönsamhet, jordbruksstöd och regler, avkastning, jordkvalitet och jordhälsa, arrondering och

gårdens förutsättningar biologisk mångfald och miljö, beredskap och motståndskraft mot extremväder/miljöförändringar, marknadens förutsättning

14. Använder du några metoder som potentiellt ökar kolinlagringen i dina jordar?

a. Vad har lett dig till dessa beslut?

b. Hur fick du kännedom om brukningsmetoden?

15. Har det uppstått avvägningar eller konflikter kring valet av brukningsmetoder?

Jorden

16. Vilka typer av jordar har ni?

17. Har kvaliteten och hälsan förändrats sen du tog över?

18. Anser du själv att du har "bra/bördiga" jordar?

19. Hur ser du på jordkvalitet/hälsa idag och framåt?

20. Möter ni några särskilda utmaningar kring jorden och dess förutsättningar?

Jordbrukets roll i klimatarbetet, relation till Svensk kolinlagring och kolklubben samt kolinlagring i jordbruksmark

21. Varför är du med i Kolklubben?

a. Sedan hur länge?

b. Har du några särskilda förhoppningar kring att vara med?

22. Vad är jordbrukets roll i klimatarbetet? Har lantbrukaren en roll i klimatomställningen? Hur mycket och på vilket sätt?

23. Tror du att denna bild delas av andra?

24. Vilka behöver vara med för att forma jordbrukets roll i klimatarbetet? Vilka ska driva utvecklingen?

a. Jordbrukare, myndigheter, företag, ideella organisationer etc.

25. Vad betyder begreppet kolinlagrande jordbruk/regenerativt jordbruk, utifrån din förståelse?

a. Vad anser du om idén om att främja kolinlagring i jordbruksmark som klimatåtgärd?

26. Hur fick du kännedom om brukningsmetoderna du använder för att öka kolinlagringen?

27. Tar du hjälp av någon för rådgivning och stöd? Vilka?

a. Har du tagit hjälp av släktingar och/eller grannar? Hur?

28. Diskuterar de eller du metoder för kolinlagring, klimatberäkning, jordhälsa och omställning av brukningsmetoder? Hur och kring vad?

29. Vad är viktigt för dig i användningen av eller att börja tillämpa metoder som ökar kolinlagringen?

a. T.ex personlig motivation, ekonomisk ersättning, ökad avkastning, arbetsinsats, förbättrad jordhälsa, intresse, tillräcklig information och kunskap

b. Hur ser du på ekonomisk ersättning kontra andra incitament?

30. Ser du hinder för att använda och tillämpa metoder som ökar kolinlagringen?

a. Nuvarande jordbrukssystem med jordbruksstöd, insatser, styrmedel, jordbruksstöd, kolkrediter på frivillig marknad, kunskap om metoderna

31. Ser du något som främjar användning och tillämpning av metoder som ökar kolinlagringen?

a. Nuvarande jordbrukssystem med jordbruksstöd, insatser, styrmedel, jordbruksstöd, kolkrediter på frivillig marknad, kunskap om metoderna

32. Ser du fördelar eller nackdelar med att vara med i ett kolinlagringsprojekt?

Kolkrediter i lantbruket - permanens och additionalitet

Liten inledning till frågebatteriet och kolkrediter

33. Vad tänker du kring att använda klimatkrediter från jordbruket för att kompensera för andras/företags utsläpp?

a. Skulle det spelar det någon roll för dig vilka företag som sedan köper krediterna?

Inledning till permanens och diskussionen

Permanens innebär att brukningsmetoderna behöver användas i ett långt tidsperspektiv för att göra klimatnytta. För att öka jordhälsa krävs det inte lika långt tidsperspektiv. Därför är permanensen viktig när det gäller kolkrediter.

34. Vad tänker du kring att åtaganden och att brukningsmetoderna behöver praktiseras under en lång tid för att uppnå klimatnytta?

a. I relation till ditt lantbruks framtid?

b. Ser du några utmaningar?

c. Vad är rimliga åtaganden?

Liten inledning till additionalitet och diskussionen

Additionalitet handlar om att det måste ske en ökning av kolet från det man börjar mäta. Därför, har du redan hållt på med kolinlagringsmetoder, har du mycket kol i marken redan och får därmed kanske inte ytterligare en stor ökning och...

35. Strikt tolkat innebär additionalitetskravet att lantbrukare som redan praktiserar en viss metod inte skulle vara berättigade ersättning för det man redan lagrat in.

a. Vad tänker du kring detta—är detta en rimlig modell?

b. Hur skulle en ”rättvis” modell för att främja kolinlagring se ut?

c. Vad ska/bör man mäta? Effekter, metoder? Hur kan man verifiera att kolet binds i marken?

Avslutning

Något som vi missat att prata om?

Något att tillägga?

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