Towards (re)generative agriculture
- An analysis of farms and gardens on Gotland

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- An analysis of farms and gardens on Gotland

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Abstract

The challenges of adapting farming in response to climate change, degraded soils, depleted natural resources and an increasing population have created new agricultural concepts with focus on an environmentally long-term sustainable way of producing food. One possible solution presented is regenerative agriculture, an alternative form of food production that focus on building and re-forming resilient ecological systems supported by ecosystem processes. Regenerative agriculture works with various agricultural practices and management techniques and focus on the entire ecosystems to be able to establish a selfsustained well functional system. Techniques and practises used within the concept also contributes to building carbon in the soil, which leads to less impact on the climate. - However, the concept lacks a formalized definition and critical voices have been raised regarding its presumed positive impact on soil health, biodiversity, and carbon sequestration. This study thus aims to investigates farmers and gardeners currently practise regenerative agriculture on Gotland, Sweden's largest island, to enabling future studies. A mixed method was used to enabling both collection of data in terms of management practises and techniques through a questionnaire and investigating thoughts and ideas about the concept with semi-structured interviews. The results illustrated regenerative agriculture as a flexible concept both in terms of practises and techniques used on the farm and gardens and as well the ideas and thoughts expressed.

Keywords: Regenerative Agriculture, Gotland, climate change, soil health, sustainable food production.

Popular scientific summary

Challenges of adapting farming in response to climate change, damaged soils, ending natural resources and a growing population have created new agricultural concepts with focus on an environmentally long-term sustainable way of producing food.

One possible solution raised to these problems is regenerative agriculture. Regenerative agriculture is an alternative way of producing food that focus on not harming the environment and rebuild the ecosystem. Techniques and practises within regenerative agriculture are reduced or no ploughing, application of organic materials such as manure or-, compost, plantation of plants and crops that permanent cover the soil, minimize the use of synthetic inputs, for instance stop using insect and weed sprays and integrating animals into the system. However, regenerative agriculture does not have a formal definition, it is used in different ways and with various understandings what it means. Critical opinions have been raised regarding it´s believed positive impact on soil health, biodiversity, and carbon sequestration. Regenerative agriculture is still a fairly new concept among Swedish farmers and there is lack of research on this topic in Sweden, especially on farm level. More research is needed on the topic to meet critical voices and to bring light into some general confusion of the definition of regenerative agriculture.

The purpose of this study was therefore to investigate farmers and gardeners who currently practise regenerative agriculture on Gotland, Sweden's largest island. The aim was to collect baseline data of practises regenerative techniques and methods, to enabling future research where these practises can be connected to certain outcomes. Since a general confusion of the definition of regenerative agriculture is present, the farmers and gardeners' beliefs and ideas about the concept were explored. The thesis is part of the project Time Zero! Land surveys during farm conversion from abandoned land to regenerative agriculture performed at the Department of Soil and Environment at the Swedish University of Agriculture, Uppsala.

A flexible research design was used in this study, and both quantitative and qualitative data was collected. The data gathering consisted of a questionnaire and semi-structured interviews. The results from the questionnaire showed that the framers and gardeners use regenerative agriculture practises and techniques to different extent and in various combinations. When investigating the farmers and gardeners' beliefs and ideas about the concept, the result illustrated that most of them understand it as a farming concept that doses good for the environment. There was also a common feeling of ambiguity between if regenerative agriculture should be an open and flexible approach, more as it is now, but the same time the uncertainty of the possibility that the term is used "wrong" or will become a new "buzzword".

The conclusions from this study are that regenerative agriculture may hold the potential to a part of the solution to climate change, land degradation and future food production, but more research is needed. The results and the discussion also showed the importance of clarifying the meaning of regenerative agriculture for each situation when it is used, due to that consumer can be misled and confused, decision makers who make policy's and to prevent the concept of being greenwashed. It also concluded the importance of including farmers and their perspectives, since they are ones who will be dealing and working with upcoming challenges connected to climate change and food production in the future.

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Abbreviations

GHG	Greenhouse gas
RA	Regenerative agriculture

1. Introduction

Chapter one introduces the environmental sustainability challenges within the current agricultural system and it´s connection to climate change. The chapter further present the SLU project that the thesis is a part of and the aim and research questions.

The way we are producing food within the current agricultural system contributes to a long list of environmental problems such as degradation of land and soil, impact on the biosphere through greenhouse gas emissions (GHG), biodiversity loss, eutrophication, and depletion of natural resources (Foley et al. 2005). The food systems in total are responsible for a third of the global GHG emissions, and hence a large contributor to climate change. The main contributor within agriculture are land use/land-use change activities with 71% of the total (Poore & Nemecek 2018; Crippa et al. 2021). Consequences directly connected to climate change are increasing temperatures, changed precipitation rates and higher risks of extreme weather events, which will put pressure on the agricultural system and the production of food (Wheeler & von Braun 2014). The agricultural sector consequently stands in front of the paradox to both reduce emissions and at the same time adapt to a changing climate.

Furthermore, two evolving threats towards the production of food are degradation of soils and loss of biodiversity. Healthy soils are one of the fundamental resources for agricultural production (Schreefel et al. 2020) and estimations illustrates that approximately 11.9–13.4% of the global agricultural supply of soil has been lost in the past five decades and will continue to degrade (Jie et al. 2002). Soil degradation is additionally considered as one of the main causes of declining yields (FAO 2015). As for biodiversity, agriculture has been pointed out as the primary driver of biodiversity loss and there has been a lot of anxiety about the extinction of bees and other pollinators (Hall & Martins 2020).

Simultaneously, the world population is estimated to grow from 7.8 billion at present to 9.7 billion by 2050 and 10.9 billion by the end of the century, resulting in a likely increase in demand for food and fodder (Alexandratos & Bruinsma 2012; Hunter et al. 2017). Estimations done to the UN's agricultural agency FAO reveals

that the food production may need to increase by 60 percent by 2050 due to the population growth (FAO 2017).

Consequently, the agricultural production in the future will held a great challenge to both increase and sustain food production in a changing climate, with degraded soils and loss of biodiversity, while at the same time reducing the environmental impact and maintaining natural resources for future generations (Kok et al. 2014).

In 2017, the Swedish government published goals for the national future food production. The national food production should both increase whilst at the same time achieve related environmental goals, creating economic growth and contribute to higher employment rates within the sector. As the government has settled that the national agricultural production should increase, both GHG emissions are estimated to increase during the coming years as the overall negative environmental impact, problems that the government have identified but try to avoid (Swedish Ministry of Enterprise and Innovation 2017).

The challenges of adapting farming in response to climate change, soil degradation and biodiversity loss, and depletion of recourse has created new ideas of alternative agricultural concepts. One promising concept is regenerative agriculture (RA)(Rhodes 2012). RA provides alternative methods and management techniques to produce and provide food with an environmentally long-term sustainable approach (Lal 2020). The aim of RA is to produce adequate amount of food in a system where the soil ecosystem is enhanced, and the environment regenerated by improving the relationship between plants, water, nutrients, and people. This is carried out through a holistic system-based approach which consists of various farming practices and management techniques which are intended to restore soil health while at the same time sequester soil organic carbon (Giller et al. n.d.; Burgess et al. 2019; Lal 2020).

However, much is yet unknown about RA, and a clear and distinct definitions is lacking. Critical voices have as well been raised about its presumed advantages and claim of a more sustainable way of farming and producing food. The Washington State University based researcher Andrew McGuire for instance argue that there is a lack of evidence connected to the advantage the concept of RA and that "extraordinary claims require extraordinary evidence" (McGuire 2018).

Therefore, the aim of this study is to contribute to the field of research by conducting a farm level study on farms and gardens on Gotland, Sweden's largest island. The study is conducted within the frame of the ongoing research project *TimeZero! From abandoned agricultural land to regenerative agriculture: soil physical and chemical studies during farm conversion,* at SLU and the Department of Soil and Environment.

1.1. Problem background

"The combination of advancing climate change and an already-vulnerable industrial system is a "perfect storm" that threatens farmers' livelihoods and our food supply."

Union of Concerned Scientists (2019)

Agriculture contributes to climate change through the release of greenhouse gases into the atmosphere but is at the same time highly exposed to changes in the climate, as farming activities directly depend on climate conditions. In order to prevent climate change and related disasters, the agricultural systems need to both mitigate and adapt at the same time. A more sustainable, robust, and resilient way of producing food is as well essential for future food security. Swedish agriculture as on many other places, is expected to encounter several challenges in the coming years due to a changing climate, loss of biodiversity, degraded soils, which call for both, mitigation, adaptation, and innovation within the agricultural sector (Jie et al. 2002; Foley et al. 2005; Wheeler & von Braun 2014).

To enable forthcoming studies, regarding RA: s impact on parameters such as soil health, biodiversity, and carbon sequestration, baseline data from practitioners of RA management practises and techniques are needed to in the future determine if these practises can be part of the solution towards a future regenerative food system.

A literature study performed by Newton et al. (2020) illustrated "that much of the innovative thinking about regenerative agriculture has been done by farmers and other stakeholders whose ideas and experiences may not be well represented" from the publications they reviewed. The decision to adopt strategies or practises are too high extent, but not solely, made by the farmers themselves. It could therefore be of interest to explore practitioners of RAs thoughts and ideas about the concept as well. Farm level studies are in addition of great importance to gain more knowledge about non-conventional climate-smart agricultural methods, tackling future challenges within food production.

1.2. Towards regenerative agriculture – the project

This thesis is a part of the ongoing newly started research project about regenerative agriculture at SLU and the Department of Soil and Environment. The project is titled *TimeZero! From abandoned agricultural land to regenerative agriculture: soil physical and chemical studies during farm conversion/ TidNoll! Från övergiven jordbruksmark till regenerativt jordbruk: markfysikaliska- och kemiska undersökningar vid gårdsomställning.*

When started, the purpose of the project was to perform a long term-study on one recently started regenerative farm and investigate changes in soil health and carbon sequestration in the soil from a baseline year, starting from August 2020. The project in addition aimed at investigating how different regenerative agricultural management practises and techniques can contribute to building more robust and resilient food systems. Within the project, various student research projects will help to investigate different aspects and perspectives of the topic.

During the spring semester of 2021, we were three master students working in the project. The purpose within the frame of this thesis was to collect baseline data from more farms and gardens to enabling the two other students' thesis within the project to connect specific management techniques and practises to possible positive impacts on the soil health and the amount of carbon sequestered in the soil. The other student thesis during this semester is titled *''Relating the impacts of regenerative farming practices to soil health and carbon sequestration on Gotland, Sweden.*

Throughout this semester, the project developed and included ten more participants (farms and gardens) to the project. The intentions are in addition that soil samples will be collected on the same spots in the future to comprehensively examine the impacts and outcomes over a longer period.

1.3. Aim and research question

RA is still an emerging concept among Swedish farmer and there is a significant absence of research on this topic in Sweden, especially on farm level. More research is needed on the topic of RA to meet critical voices and to bring light into some general confusion of the definition of RA.

The purpose of this thesis is therefore to collect baseline data from farms and gardens who currently practises regenerative techniques and methods, to enabling future research where practises can be connected to certain outcomes. Since a general confusion of the definition of RA is present, the farmers and gardeners' perception and thoughts about the concept and term will additionally be explored.

This study, therefore, aims to answer these research questions:

- Which regenerative agriculture techniques are used and have been used in the last five years by the farmers and gardeners?
- What are the farmers and gardeners´ thoughts and ideas of practicing regenerative agriculture? What does the term mean for them?
- Which future challenges do they see for regenerative agriculture as a concept?

2. Methodological approach

The following chapter presents the methodological approach. The section begins with a description of the research design, sampling process and a presentation of chosen methods of data collection. The section ends with ethical considerations, limitations, and methodological considerations, including quality assurance of the research process.

2.1. Research design

In order to investigate the chosen field of research, a flexible research design was chosen. A flexible research design suited well since the work within the project developed continuously and were challenging to completely plan the data collection methods on beforehand (Robson, 2011). In flexible designs it is possible to change approach during the project due to findings both from early involvement in for instance data collection, new ideas arising from findings or if the research questions are changed or clarified and call for another type of data collection. Idea generation, designing, data collection and analysis and writing develops together or in interactions rather than in separate stages (ibid).

All activities during the thesis are listed in table 1. The formal invitation to interested farmers and the survey were planned to be achieved from the beginning, however the field trip to Gotland and the interviews were decided to be performed in a later stage of the thesis. All data collection methods were not decided from the start due both to the interconnected work within the project between the thesis´s and restrictions connected to the Covid- 19 pandemic and travel restrictions.

Table 1. Activities conducted within the thesis.

Activities	Date
Formal invitation sent out	16/2 -2021
Survey sent out	14/4 -2021
Field trip	19/4-23/4 -2021
Interviews	20/4 –8/6 – 2021
Follow- up calls	21/6 – 12/8 -2021

2.1.1. Literature review

The aim of the literature review was to describe and provide an understanding of the concept of RA as concept and to investigate its history and development. The review also served as a base for the creation of the conceptual framework and as base for the interview guide (Bryman & Bell 2015).

To locate relevant literature, The Swedish University of Agricultural Sciences (SLU) library search service Primo was used together with scientific articles retrieved from the Web of Science and Google Scholar. To find the relevant literature in the search, specific keywords were used such as 'regenerative agriculture', regenerative farming' 'conservation agriculture', 'holistic management', 'no-till', 'rotational grazing', 'soil health', and 'degradation of soil'. In addition, websites of organizations or other practitioners of RA has as well been used.

2.1.2. Sampling process

The sampling process for the thesis and the project in general contained several steps and was an ongoing activity during a large part of the project.

Several farms and gardens had been informed on beforehand by *Gotland Grönt Centrum* about the upcoming project organised by SLU. Gotland Grönt Centrum is an initiative and collaboration by Hushållningssällskapet, LRF - The Federation of Swedish Farmers and Region Gotland with the aim to educate, to drive positive change for the green business community and to coordinate projects and initiatives within the green industries and to have good connections with farmers and other actors within the food system on Gotland.

The list with potential participants from Gotland Grönt Centrum were passed on to us and were used for the first step of communication. The invitation can be seen appendix 1. The invitation was sent out in both Swedish and English.

To clarify which type of farms or gardens we were searching for, and we stated in the invitation that we wanted *"farms that in some way work to improve soil health as well as increase carbon sequestration in the soil by using regenerative agricultural techniques."*. Techniques that can be linked to RA were additionally presented to clarify what we were looking for.

Since our knowledge about potential farms and gardens on Gotland was lacking, a snowball sampling method was applied. Robson (2011) describes snowball sampling as a useful method when the identification of representatives from the

target group in the population is challenging. In the invitation letter, an encouragement to invite other farms and gardens was added, *"Feel free to spread this invitation to other farms that may want to participate."* The invitation was also posted by Grönt Centrum in Facebook groups for farmers to reach out to other farmers. From the snowball sampling, three more participants were included.

2.2. Data Collection

The collection of data relied on a mixed method. The quantitative data was collected through a self-completing questionnaire with focus on management techniques and practises and the qualitative data from semi-structured interviews with emphasis on ideas and thoughts of the participants.

2.2.1. Mixed methods

According to Robson (2011), a mixed method design is characterized by using both quantitative and qualitative methods within the same research project. The research strategies and methods can be combined in different ways depending on the objective of using different methods. Robson (2011) describe many potential benefits of mixed method designs in research. Some of the potential advantages can for instance be that a combination of methods and research approaches generates a more complete and comprehensive picture of the topic of the study. Qualitative data can in addition help illustrate quantitative results and therefore paint a better picture of the topic of research. Bryman (2006) illustrates this as "putting meat on the bones" of in some ways "dry" quantitative data. Mixed method designs can hence address a wider range of research questions compared to when a single method is applied (Robson 2011).

2.2.2. The questionnaire

A self-completing questionnaire was sent out to all farmers and gardeners who had positively replied on the formal invitation. The purpose of the questionnaire was to collect information and background about the farms and gardens and their management techniques. The questions in the survey were formed together with the two other master students in the project group, since some of the collected data would serve as baseline data in their study. The result from the questionnaire is presented in this thesis.

The survey was as well pilot tested and overlooked by the supervisor, to make sure that the questions were easy to understand, over-all straightforward and to avoid misunderstanding.

The questionnaire contained 28 questions divided into 2 parts, with both closed and open questions. Part one focused on general questions about the farm or gardens characteristics whereas part two aimed at investigating the management techniques and practised at the farm or garden. In part two of the survey, the respondents had the possibility to answer the same set of questions either once or twice. The purpose of this was to be able to collect soil samples (other master students work within the project) from several parts of the farm where different techniques were used or had been used and to connect the baseline data with the analysis of the soil.

The questionnaire was sent out in both Swedish and English. The responses in Swedish were translated to English to enabling the use of answers from the open questions. All questions and the structure of the questionnaire can be seen in appendix 2.

The result of the questionnaire is presented as a summary. Basic excel coding was used to create the tables and figures presented in the result section. The replies from the open answers are as well presented in this section.

2.2.3. Field trip - farm and gardens visits

Between the 19-23 2021 of April, a field trip to Gotland with the research group took place. The main purpose of the field trip for my thesis was to get in contact with the project participants and to coordinate the visits at the farms and gardens during the week. All participants were contacted by phone the week before for reconciliation. Throughout the week, I additionally conduced some of the interviews in line with the aim of this thesis. See table 2. for an overview of completed interviews. - Having organised the schedule, the other master students in the project could collected soil samples from the farms and gardens to further investigate the RA technique's possible impact on soil health and carbon sequestration.

2.2.4. Semi-structured interviews

In order to investigate the farmers and gardeners' thoughts and ideas on the concept of re-generative agriculture and reflections on future challenges of the concept semi structured interviews was conducted. Barriball & While (1994) describe semi-structured interviews as well suitable for investigating ideas, opinions, and thoughts regarding more complex matters.

An interview guide was arranged with help of the literature review and after the survey was completed around the following themes:

1. Beliefs about RA as concept
2. Motives and values behind the choice of RA.
3. Future challenges and possibilities with RA.
4. The potential need for a concrete definition of RA

The full interview guide can be seen in appendix III.

The participants where first offered to do the interview at the time when we visited the farm/garden but due to some participants time limits some of the interviews were held online later over the digital video conferencing tool Zoom. Two participants did not carry through the interview moment due to time constrains from their side.

Hence, eight interviews were conducted in total. Two interviews were held in English and six in Swedish. The interviews where recorded and then transcribed with the online transcript programs Scriptme.io and Otter.ai. Scriptme.io was used for the Swedish interviews and Otter.ai for the English. All transcripts were checked several times to find potential mistakes or mismatches. After transcribed and rigours checked, the transcripts were sent out to the interviewees.

Interview	Date of interview	On site	Zoom	Transcript sent out
Participant 1	20/4 -2021	x		6/9 - 2021
Participant 2	21/4 - 2021	x		6/9 - 2021
Participant 3	22/4 -2021	x		6/9 - 2021
Participant 4	22/4 -2021	x		6/9 - 2021
Participant 5	23/2 -2021	x		6/9 - 2021
Participant 6	29/4 -2021		x	6/9 - 2021
Participant 7	5/5 -2021		x	6/9 - 2021
Participant 8	8/6 -2021		x	6/9 - 2021

Table 2. Schedule for the interviews.

In the invitation to the project the participants were offered to participate anonymously. The results from the questionnaire and the interviews will therefore

be presented without the names of the farmers or gardeners and without their exact location.

2.2.5. Thematic analysis

In order to analyse the transcripts from the interviews, a thematic analysis was performed. Thematic analysis is a method for identifying, examining, and interpreting patterns of meaning in qualitative data (O'Keeffe et al., 2015; Robson, 2011).

A step-to- step guide developed by Braun & Clarke (2006), with the purpose to help the researcher through the analytical process, was followed. The guide consists of six steps, where the **first** one is to familiarize with the material, which implies the researchers to transcribe the data (if needed), reading through the data a couple of times and take notes of early upcoming ideas. From here on the term "data" in terms of the thematic analysis refers the interviews. The **second** step is to generate initial codes, where interesting elements of the data in systematic way across the entire data set are collected. The **third** phase are followed up by grouping the codes into potential themes. In the **fourth** step the themes are reviewed and checked if they agree with the codes generated in the first step and towards the entire data set in the second step and hence generating a thematic 'map' of the analysis. In the **fifth** step the themes are defined and named. The ongoing analysis of the data helps to improve the details of each theme creating a clear definition and name for each theme. The **sixth** step includes the final step in the analysis and where the data are related back to the research question and other literature, for instance previous studies. In this step the researcher is generating a report of the analysis and presenting the results.

2.3. Limitations

The purpose of the thesis is not to determine whether the farms are "regenerative" or not in explicit terms. The aim is solely to collect baseline data from the farm and gardens, with the conceptual framework of regenerative agriculture as base. The reason behind the timeframe of five years and the geographical limitation to only farms and gardens at Gotland, lies within the scope of the research project that the thesis is a part of. There is no intention to generalize the results.

2.4. Ethical considerations

When performing semi-structured interviews, there are some ethical principles to reflect upon. Robson and McCartan (2016) underline the importance of information, agreement, and confidentiality. Before the interview started, all participants were therefore asked if they approved the interview being recorded and that the material would be transcribed and used for research purposes. They were also informed that they would get a copy of the transcription and that they could end the interview at any time.

The physical interview setting is in addition important to reflect upon since the person interviewed should feel comfortable and safe and the surrounding environment should not either contain too many distracting factors (Robson & McCartan 2016). As three of the interviews were performed digitally over zoom and five face to face, there could be a chance that this have affected the result, since it can be more difficult to interpret non-verbal communication activities such as nods and smiles during the digital interviews. - However, all interviewees had their cameras on to enabling a felling of a "real interaction" and there were no clear differences in how the participants acted or behaved in contrast to the five "face to face" interviews.

2.5. Quality insurance

As described by Robson (2011), reliability and validity need to be carefully thought through both when flexible research designs and mixed methods are used.
Therefore, attempts to keep full record of the activities that have been conducted while carrying out this study and attempts to presenting them in a clear way through tables and descriptions were undertaken (Robson, 2011).

Snowball sampling can have the disadvantage to reduce representativeness of different perspectives since participants recommend others with the potential same opinions and views on the subject (Robson, 2011). – However, since the results are not generalized the method was considered valid.

Lastly, according to Robson (2011), issues regarding bias are present in all type of research and all empirical material and analysis techniques are subjective, meaning that the researcher's selections never are neutral which undoubtedly have implications on the result (Robson & McCartan 2016). The researcher's bias can for instance have impact on the design of the study when survey questions or data collection methods are influenced by the preferences of the researcher rather than its suitability to the study. Being a "neutral" moderator during interviews can as well be challenging. For instance, not asking value loaded questions or making the

interviewee understand the situation in a certain way. The analysis can as well be affected when the researcher is sorting and analysing the data. There is a chance that the researcher might focus on results that confirm thoughts, expectations, or personal experiences, both knowingly and unknowingly. Therefore, Robson & McCartan (2016) mean that the researcher needs to show self-awareness, openness and stay flexible through the whole process. Therefore, thoughts, ideas findings have been reviewed and discussed with others in the project. In addition, throughout the interviews, I tried to be understanding and engaged but at the same time remain unbiased and not lead the questions in a certain direction. Several sources of data have as well been collected, which can create more confidence that what the findings are legitimate (Robson 2011).

2.6. Methodological considerations

Even though a flexible design has been useful in terms of the circumstances around the project, it occasionally became difficult to set the boundaries of the study and make the final decisions regarding for instance data collection.

When using the questionnaire to gather data, there are disadvantages that clearly can have implications on the result. Different experience, previous knowledge, and personality can give different outcomes on a questionnaire and respondents won´t necessarily report things accurately. Respondents can in addition answer in a way that make them appear in a certain way or in a good light, which is known as a socially desirable bias (Robson 2011). In term of this thesis, it can for instance be that farmers do not want to revel or give the right information regarding practise that can be seen in a bad manner in a group of "environmentally friendly farmers".

Even though the questionnaire was pilot tested and overlooked by my supervisor, and the other students within the project to make sure that the questions were easy to understand, over-all straightforward and to avoid misunderstanding, the questions were a bit too advanced for a questionnaire. Some of the project participants (farmers and gardeners) did not answer clear enough to be able to connect the certain practises to certain outcomes within the framework of the other thesis within the project. Questions, when respondents were supposed to give very detail information regarding amounts of inputs or how often for instance their herds had been grazing on their fields (question 12, 13 and 19), turned out particularly challenging. Therefore, I had to call several of the participants after our fieldtrip to redo some parts of the questionnaire or ask for specific numbers. It could for instance be the amount of organic amendments added the last five years (question 13 and the two follow up questions). If I would redo the study, structured interviews would be a better option.

In addition, I also struggled with the survey programs and the creation of the questionnaire. I did not calculate for the time it takes to create a good questionnaire or survey within different data programs. I also had to shift the programs two times due to the limited possibilities within the programs to have certain types of structures on the questions.

Since both Swedish and English have been used in the communication with the participants, during data collection and during the translations of the Swedish interview to English, there were risks of misunderstandings and different interpretations of word and meanings, both from my side as a researcher and from the participant's side, which of course have implications on the result. One clear example during the work with the questionnaire was the translation of cover crops to Swedish. During the creation of the questionnaire, several words were found for the Swedish translation and rigours investigations had to be made to clarify the meaning of the word both in English and in Swedish to make sure it means the same.

3. Literature review

In this chapter the emergence of regenerative agriculture and connections to other concepts are presented. The chapter furthermore describe the concept in a Swedish context and the conceptual framework created and used within the frame of this thesis.

3.1. Regenerative agriculture – the emergence

The origin of the term *"Regenerative Agriculture"* is not clearly known. Francis et al. (1986), one of the earliest peer-reviewed papers on the subject, state that the term was presented by Medard Gabel in his paper *Hoping: Food for Everyone* (1979), but the source has been problematic to determine. However, the term came into wider circulation in the early 1980s when the ideas were picked up and further formulated by Robert Rodale (Francis et al. 1986; Gosnell et al. 2019). Rodale, the son of the organic pioneer Jeremy Rodale, funder of the Rodale institute, raised the call for an approach that would not destroy and deplete resources but rather improve and regenerate them. Rodale framed RA as *"a long-term, holistic design that attempts to grow as much food using as few resources as possible in a way that revitalises the soil rather than depleting it, while offering a solution to carbon sequestration"* (Rhodes 2017, 108).

After the initial flood of interest, mostly connected to the Rodale Institute, Regenerative Agriculture disappeared from the debate for almost two decades before entering the scene again. During the 1990s and the beginning of the new millennium, the term became nearly unnoticed in agricultural literature, research, and newspapers (Hermani 2020, Giller et al. 2021). Hermani (2020) described this decline in appearance connected to the development of the organic certification and institutionalization of organic agriculture.

Hermani (2020) illustrate a breakthrough for the concept with increased attention, both in mainstream media and in the academia in 2015 with the non-profit foundation Regeneration Internationals statement and extensive goal "to reverse

global warming and end world hunger by facilitating and accelerating the global transition to regenerative agriculture and land management" (Regeneration International 2019). Regeneration International sees regenerative agriculture as a possible tool to both slow down climate change and reversing it by high carbon sequestration rates (Leu 2018). Many other organisations supporting regenerative agriculture that has emerged in the last few years and some have as well adapted their focus towards the goal of decreasing and reversing climate change by carbon sequestration (Hermani 2020).

Since 2015, the term has gained huge revival and started to occur significantly more in news, books, on internet and in the academia. In 2019, RA gained political awareness as well, when it was listed as a *"sustainable land management practice"* in IPCC's special report on Climate Change and Land in 2019 (IPCC, 2019a). Giller et al. (2021), imply that this growth in occurrence reflects the adoption of the term by a wide range of actors. NGOs such as GREEN PEACE, -(2020) and World Wildlife fund (Hooker n.d.) have embraced the term and concept as well as global corporations within the food system. For instance, corporations like Danone, -(2020) and General Mills, - (2020) have recently integrated the concept into their businesses.

3.2. Connections and differences with other concepts

During the last century, various alternative agriculture concepts have emerged as a reaction to the conventional agricultural paradigm. RA as concept has co-developed and inherited large parts are from several other concepts such as agroecology, organic production, and results in soil science. Therefore, RA often is identified and connected with other disciplines and concepts. Other examples of movement and concepts that have contributed to RA are Conservation Agriculture, Holistic Management, Permaculture, Carbon Farming, and the No-till movement.

Early (and continuing) efforts have however struggled to draw a clear distinction between regenerative agriculture and the other concepts but should according to Gosnell et al. (2019) be better understood as an umbrella concept. The reason behind the difficulties to sometimes draw a clear distinction between the concepts is due to that RA both has co-developed and drawn ideas and methods from several of the other concepts through its emergence. However, the aim of RA can be seen as going above and beyond these concepts in that manner that it encompasses a holistic system- based view with the aim to first restore and then enhance and regenerative and create a resilient agricultural system (Perkins 2019).

The key difference between regenerative agriculture and sustainable agriculture is RA: s intention to regenerate or renew. (Behrend 2018). The word "regeneration" itself signifies "the capacity to bring into existence again" (Burgess et al. 2019; White 2020) and derives from the Latin word genero [to produce or procreate] and re- [back or again] (Olivetti n.d.). Within the field of biology, the term "regeneration" is the process of renewal, restoration, and growth (Johnson Goss, 2019). From an agricultural perspective it can be seen as a way of farming that re-create the ecosystem wherein it is present. Instead of harm reduction, the discourse of "regeneration" is present (i.e., to do less bad) and to create net-positive outcome on the ecosystem (Robinson and Cole 2015). Behrend (2018) however argues that regenerative and sustainable actions can basically be the same practices, the difference is the application and the management of these practises. - Burgess et al. (2019) made the comparison between FAOs (2014) definition of "sustainable agriculture" that *"conserves land, water, and plant and animal genetic resources, and is environmentally non-degrading"* with the concept of RA and made the conclusion that RA aims to go further, connecting back to the meaning of the word ´regenerate´ (Burgess et al. 2019; White 2020).

Figure 1. Aim of regenerative agriculture.
Regenerative agriculture intends to go further than sustainable agriculture. Figure modified from Burgess et al. (2019).

3.3. Contemporary regenerative agriculture

Within the recent revival and growing interest for RA, there is still an absence of consensus regarding any specific definition. Current academic literature acknowledges that there is a substantial diversity in the definitions and descriptions of regenerative agriculture used, both among practitioner organizations and in research (Burgess et al. 2019; Lal 2020; Newton et al. 2020. Some disagreements stand between the interpretation of RA a set of agricultural practices that can be used individually or in combination or the view of RA as a holistic system-based concept, where all actions are entwined (Newton et al. 2020). Newton et al. (2020) illustrate additionally that some definitions and descriptions focused more on processes and others on outcomes, and some definitions included both components.

Definitions and descriptions based on processes focused on agricultural principles and/or practices that represent "RA". While the outcome-based focused on one or more agricultural outcomes, for instance carbon sequestration, changes in soil health, and increased biodiversity, outcomes that can be considered as "regenerative". However, the authors state that both ways of defining and describing the concept come with implications.

A third way of understanding the definition evolves from authors and organisations that reject a consistent definition of RA. - Soloviev & Landua (2016) describe the importance of an evolving definition due to the concepts overall aim of regeneration. They also see the importance of an evolving and flexible definition in relation to the endless diverse circumstances the farmers encounter at their specific farm: *"Each community of practitioners in each bioregion of the world has the opportunity to re-generate the ecocultural meaning of "Regenerative Agriculture". They will do so in a way that is unique to their place, history and whole living ecosystem"*(Soloviev & Landua 2016). Soloviev & Landua (2016) illustrate this as a living level -based framework enabling an effective and holistic system of farming. Corresponding to this, Terra Genesis International has initiated a collaborating project where participants can update their definition of RA continuously (Hermani 2020).

Although a variety of definitions and descriptions are present, and there are common themes within the concept most promoting users of the term agree upon Newton et al. (2020).

The most common practices are:

- Minimizing soil disturbance through No-till, reduced tillage, or conservation tillage.
- Application of organic matters through manure, compost, green manures, biochar.
- Plantation of cover crops or other permanent soil cover and integration of livestock.

The most important outcomes are

- carbon sequestration,
- increased soil health and fertility and,
- enhanced biodiversity and resiliency within the ecosystem

RA is in addition frequently described as an opposition to conventional or industrial farming by supporters of holistic interpretations of the term (Lal 2020).

Nevertheless, this wide variance in the definitions used and interpretations of the concept may lead to uncertainty about what different actors mean when they talk

about regenerative agriculture. According to Newton et al. (2020), three main issues and challenges appear when RA continues to being a vague and undefined term. Firstly, without clear terminology challenges can occur within the academia when researchers try to confirm and validating claims about the impact of RA practises and methods or compare results from different studies. A second aspect is labelling, and marketing towards consumers. If the “RA label” means different things, it will be misleading and problematic for the consumer. Incentives to support RA are within the public sector (laws and polices) will be complicated without a commonly accepted definition of the concept.

Newton et al. (2020) therefore advise individual users of the term “regenerative agriculture” to define it well and comprehensive in line with their own aim and context. Therefore, a conceptual framework of regenerative agriculture is created and presented in chapter 4.

3.4. Regenerative agriculture within a Swedish context

Research about RA in Sweden is still an evolving field. Even though research exists regarding the certain management practises impact on soil health, the use of synthetic inputs effect on biodiversity or for subject such as agroforestry and organic agriculture, there is a lack of studies regarding RA in Sweden. The concept is however present among many farmers across the whole country, within the business sector, and among actors within civil society. This section gives a brief overview of various actors in Sweden conducting “regenerative agriculture” and conducted students projects.

Axfoundation, an independent non-profit organization working practically and concretely towards building a sustainable society for instance collaborates with researchers and farmers who apply regenerative agriculture. At their test farm in Torsåker they apply an agricultural method called "Sättra method" which they call a "light" version of regenerative agriculture. The purpose is to investigate different techniques and cultivation methods that can contribute to better soil health and carbon sequestration. The Sättra-method leaves the ground mostly undisturbed. No tilling is applied the autumn, however during spring cultivation, disk harrows are used before sowing. When the seeds are sown a seed drill is used. According to Axfoundation, and Mats Eriksson, who runs and owns the farm and developer of the method, the fields where the Sättra-method has been used demonstrates several positive outcomes. The fertility has increased, problems with soil erosion has decreased, the biological activity have improved, more birds are around, there are more earth worms in the soil, and the drainage (problems with surface water) have been enhanced, due to less packed soil. Axfoundation´s aim is to help researchers

to scientifically identify whether these methods used on Sättra are contributing to increased carbon storage and improved soil fertility. They in addition want to spread their knowledge as widely as possible and help Swedish farmers adapt to more sustainable farming methods without risking soil health, loss of crop yields or profits.

Märta Johannson the CEO of Gröna Gårdar, an association of 40 independent meat farms selling organic and grass-fed meat since 2001, has been a promotor of regenerative agriculture for a long time. From an interview last year with the magazine *"Framtidens hållbara matsystem"* she replied" *Basically, regenerative agriculture is about enabling the highest possible vitality in ecosystems, while satisfying human needs such as food and fiber".* However, Gröna Gårdar has no formal requirement regarding regenerative agriculture practises or methods but encourage and supports their farmers to work with nature instead of trying to fight and dominate it. On the question: how does the development of regenerative agriculture in the future look like? She replies – *"We have everything to learn. There are still few who practice this in the Nordic countries, but there is a network called the Nordic network for regenerative agriculture. They have a website and run a Facebook group, which has become a good meeting place and platform where very practical knowledge can be shared-"* (Von Essen, 2020).

The Nordic network for regenerative agriculture is a self-organizing network of people and companies who want to develop the potential within agriculture to restore ecosystems while at the same time produce high-quality food. The network is facilitated by the Nordic Savory Hub, which is part of the Savory Institute Global. The network works with organizations and companies in all branches of the food system that wish to improve the conditions for food production in the future. The competencies in the network consist of organization and leadership, biology, ecosystem rehabilitation, livestock production, breeding, animal health, plant breeding, finance, and strategic planning (Nordiskt nätverk för regenerativt lantbruk n.d.).

Richard Perkins is an internationally known, innovative farmer, and a promotor of Regenerative Agriculture. Perkins operates the farm Ridgedale located in Värmland, Sweden, where they offer courses in for instance Farm Scale Permaculture Design, Regenerative Agriculture, Keyline Design, Agroforestry, Pasture based livestock enterprises, Managing Holistically, No-Dig Market Gardening among others. Perkins has published several books within the subject, such as "Regenerative Agriculture- a practical whole system guide to make small scale farms work" (Ridgedale Farm AB 2021).

A recently conducted master thesis by Emma Stockvall Carlsson (2021) at Uppsala University investigated how regenerative farmers feel about the barriers and possibilities for regenerative agriculture in Sweden. Stockvall Carlsson (2021) conducted interviews with regenerative producers in Sweden and analysed the result through a combination of the zones of friction and traction theory (Head-, et al., 2013) and the three spheres of transformation (O'Brien & Sygna, 2013) to identify the experienced frictions and traction. - The results demonstrated an apparent frustration and dissatisfaction with the Swedish agricultural system regarding subsidies and regulations, as well as a clear personal philosophical "strong personal ideological motivation for regenerative practices amongst the participants". The results argue in addition that a restructure of the Swedish agricultural system is crucial if innovative and sustainable alternatives, such as Regenerative agriculture, are to thrive and the national sustainability- and food security goals are to be achieved.

4. Conceptual framework

In this chapter, the conceptual framework of regenerative agriculture is presented. The concept was used in the creation of questionnaire, composition of interview guide and for the analysis of the result.

4.1. Regenerative agriculture

Since the purpose of this thesis is to twofold, both to map out what type of management practises and techniques the farms and gardens are using and to investigate the participants thoughts and ideas about the concept, a combined definitions of RA with both processes and outcomes is used. Although, its more focused on the processes, since it lies outside the scope of this thesis to investigate the potential outcomes. - The outcomes can however be of interest in line with the interviews with the participants.

Definition:

Regenerative agriculture is a holistic system-based concept consisting of farming practices and management methods that aims to improve soil health and fertility, promote biodiversity, enhance the water cycle, boosting organic matter in soil, reverse climate change by shifting carbon from the atmosphere to the soil.

(Merfield 2019; Lal 2020; Giller et al. 2021).

The broad goals (outcomes) of RA retrieved trough the literature review can be summarized into practices that should:

- Contribute and generating healthy and fertile soils
- Promote biodiversity and the overall health and resiliency of the ecosystem
- Reverse the carbon emissions from agriculture and sequester carbon
- Increase water filtration and water retention

Improving soil health, is considered to be the core purpose and issue of RA (Schreefel et al. 2020). Hence, contribute and generating healthy soils (outcome) is mostly typically managed by practises minimizing soil disturbance such as

decreasing or stop tilling (processes). Reduced tillage can contribute to many advantages such as healthy fungal and microbiological communities within the soil. The absence of heavy tillage machinery is in addition allowing earthworms to ventilate the soil and potentially improve nutrient distribution (Shah et al. 2017). Avoiding bare soil and keeping the soil always covered with living plants prevents the soil from wind and water erosion as well. However, reduced tillage can as well contribute to reduced emissions of carbon dioxide from the soil into the atmosphere and contribute to a higher rate of carbon sequestration and can therefore be seen as a practise connected to goals "promote biodiversity and the overall health of the ecosystem" (Elevitch et al. 2018; Giller et al. 2021).

To increase biodiversity and ecosystem health, management techniques such as crop rotation schemes, cover and inter-cropping, multi- cropping systems, mulching, plantation of perennials, trees and shrubs, and agroforestry are applied. - To give one more example of the difficulties to separate the goals from the practise is the use of perennial crops instead of annual crops. Perennial crops contribute for instance both to reduced erosion and nutrition leakage since they have deeper root systems and do not leave soils bare between growing seasons (Pimentel et al. 1997; Teague 2018) are more resilient to extreme water conditions (LaCanne & Lundgren 2018), and improve water conservation (Glover et al. 2010). Plantation of trees and shrubs both contribute to carbon sequestration, increased biodiversity, and more resilient production systems (Elevitch et al. 2018). Livestock management with rotational grazing system for instance stimulates increased both plant growth and therefore contributes to higher soil carbon deposits in the soil, reduce overall GHG emissions and contributes to higher insect and plant biodiversity (Teague 2018).

The concept additionally avoids the use of synthetic inputs such as pesticides, fungicides, herbicides, and try to rely on the ecological system and use practices such as integrated pest and weed management and application of compost, manure, and biochar over chemical fertilizers (Pearson 2007). The reason behind avoiding synthetic inputs such as pesticides, fungicides, herbicides is connected to the risks that the inputs damage all other faunal and floral life around the crop. There are also a possibilitie that the inputs "travel" outside of the production site and harm other non-target species. The energy costs of production and transportation of the inputs is in addition contributing to climate change. Since synthetic fertilizers rarely are used within RA, other organic inputs are more important. Degraded biological materials such as crop residues, food waste, and animal waste (manure), and biochar are crucial both in term of supply of nutrients for plants but to build soil organic matter as well. These materials contain carbon, that when incorporated into soils breaks down slowly, building stable organic matter.
- However, the process for materials to break down and being converted into soil is a slow process (Burgess et al. 2019).

Detected management practices and techniques connected to RA (Regenerative International et al. 2017; Burgess et al. 2019; Merfield 2019; Lal 2020; Newton et al. 2020) are presented in table 2.

Table 3. Practises connected to goals within regenerative agriculture.

Practices connected to RA	**Themes**
No- tillage	Minimizing soil disturbance
Reduced tillage	
Conservation tillage	
Crop diversification	Biodiversity,
Crop rotation	ecosystem health and minimize carbon
Perennial crops	and nitrogen emissions
Cover cropping	
Inter cropping	
Mulching	
Plantation of nitrogen fixing plants	
Leaving living roots in the soil for as long as possible	
Livestock management	
Agroforestry	
Planting trees and shrubs	
Silvopasture	
Application of organic amendments	Build soil organic matter
Minimizing use of synthetic fertilizers	Minimizing use of synthetic inputs
Minimizing use of synthetic pesticides	
Minimizing use of synthetic herbicides	
Minimizing use of synthetic fungicides	
Water conservation	Water management
Keyline design	
Swales	
Ponds	

5. Empirical findings and analysis

This chapter begins with a presentation of the results from the questionnaire and continues with the result and an analysis of the interviews. The result from the questionnaire is presented as a summary and the results from the interviews are presented in themes discovered during the thematic analysis.

5.1. Information about the farms and gardens

The results for this study are based on the questionnaire answered by nine and the interviews conducted with eight farmers and gardeners. Figure 3 illustrates the approximate location of the participants on Gotland.

Figure 2. Approximate location of the participated farms and gardens.

Figure 4. illustrates information about the farms and gardens collected from the first section the questionnaire. As mentioned in the method chapter, the farms and gardens were guarantee that the result would be published anonymously, therefore they are assigned a number, P stands for participant. The numbers are the same for each participant from here and on.

As demonstrated in figure 4. the participants answered that they produce different things on the farm or garden and four replied "one" type of production. Most of the project participants run their farms organic and only one out of nine consider itself as a conventional farm. The sizes of the farms and gardens differentiate from small areas such as P4 with 0,25 hectares of farmland to P6 with 650 hectares of farmland. In addition, these areas are the whole farms and garden areas in total. The actual cultivated area can be to a lesser extent.

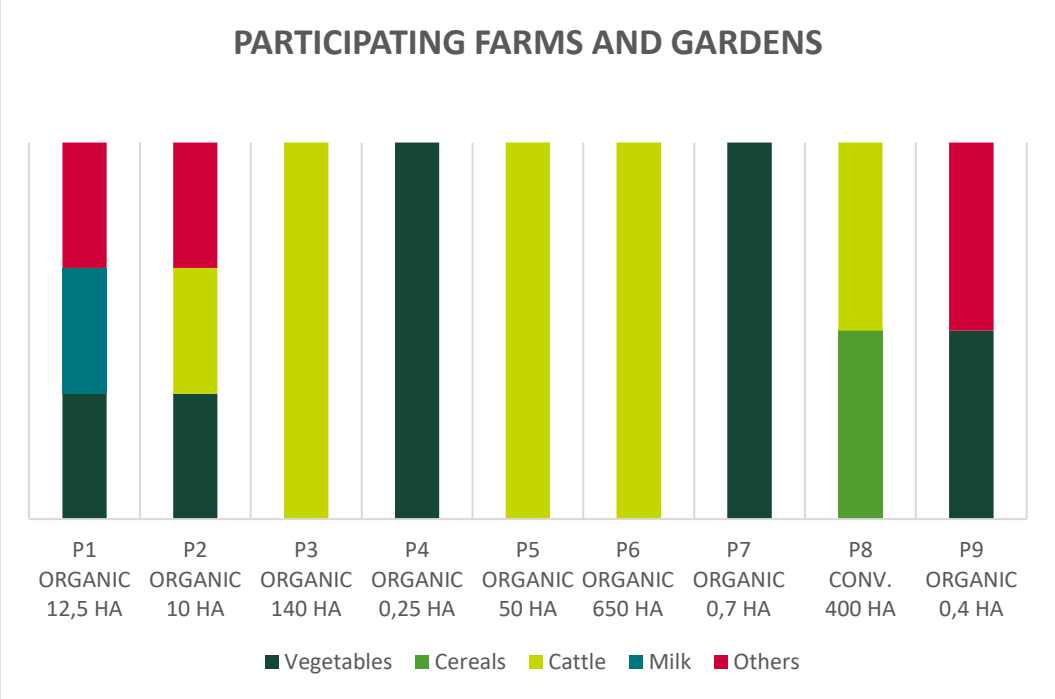

Figure 3. Basic information about the farms and gardens.

Figure 5. illustrates the division of production types within the project. Most of the participated farms and gardens produced cattle (38 %), followed by vegetables (31 %), cereals (15%) and milk (8 %) or other (8 %).

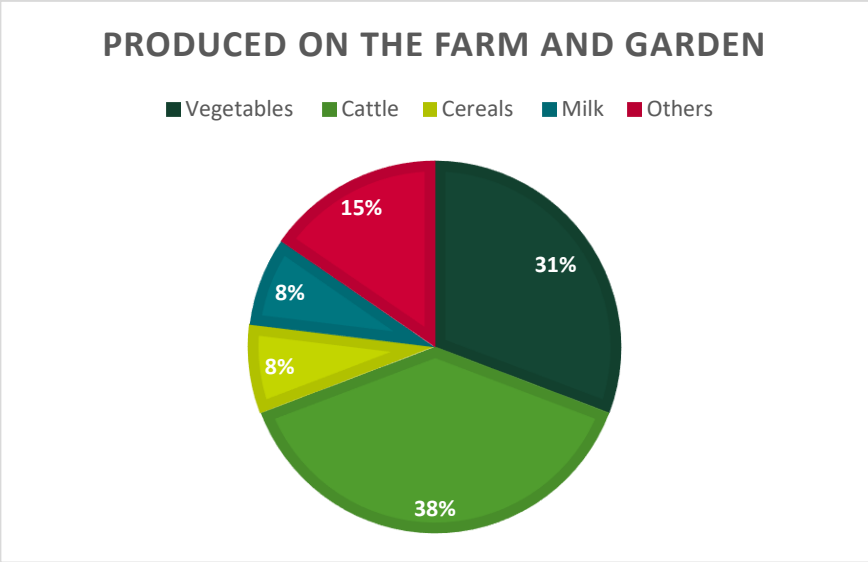

Figure 4. Farms and gardens shown by their production.

The purposes of farming and cultivation varied between the participants. The results from the questioner showed that 56 % of the project participants conduct their production in a commercial purpose, 33 % for small scale sales and 11 % for own consumption (Figure 6).

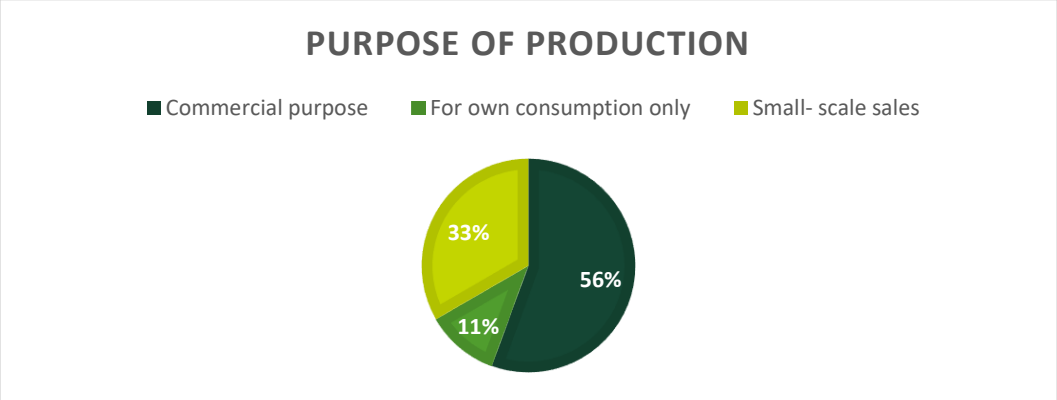

Figure 5. Purpose of production.

5.2. Use of regenerative management practices and techniques

The results from part two of the questionnaire are presented as a summary under the five themes presented in the conceptual framework; *minimizing soil disturbance, increase biodiversity, ecosystem health and minimize carbon emissions, build soil organic matter, minimizing use of synthetic inputs and water management.*

Minimizing soil disturbance

When investigating the farms and garden´s tilling practises, the result from the questionnaire illustrated that five of the projects' participants are tilling their fields or gardens on a regular basis and four are not tilling at all. The results also demonstrated that tilling have been conducted before 2015 on six farms and gardens. Only two participants could answer that they knew with certainty that tilling did not have been used before 2015 and one that they did not know if the fields or garden had been tilled. The results are illustrated in figure 7.

In addition, two follow-up questions connected to the tilling practises regarding the purposes of tilling and the motives and advantages with no tilling were asked.

Most of the participants responded in line with the view of RA, in a positive manner towards not tilling, even though they stated that they had practised some type of tilling management the previous five years.

One of the participants elaborated *"There are almost only benefits (previous experience from plant cultivation with strict No-till)" but the reason behind doing it is to kill all vegetation and get rid of the upper layer of grass. I probably would not have ploughed if I had been allowed to use Glyphosate (Eco)"* Another participant answered *"I tilled once in spring 2018, no tilling since 2019. Now I using covering methods now to make new areas for vegetable beds, retaining life in the soil."*

A reason brought up by several of the participants as the reason behind tilling, were the advantages of loosening the soil before seeding, and the difficulties connected to a hard soil surface.

The answers on the question why they did not choose to till their fields and gardens continued to be in line with the ideas of the positive outcomes regarding minimising soil disturbance. One participant replied to the question; *"To preserve microorganisms, worms and avoid compaction of the soil, and to keep CO_2 in the soil".* One of the other participants was vaguer answering and just replied *"We see*

no advantage in tilling" and another participant wrote *"It favours soil structure, it´s cheaper and more efficient."*

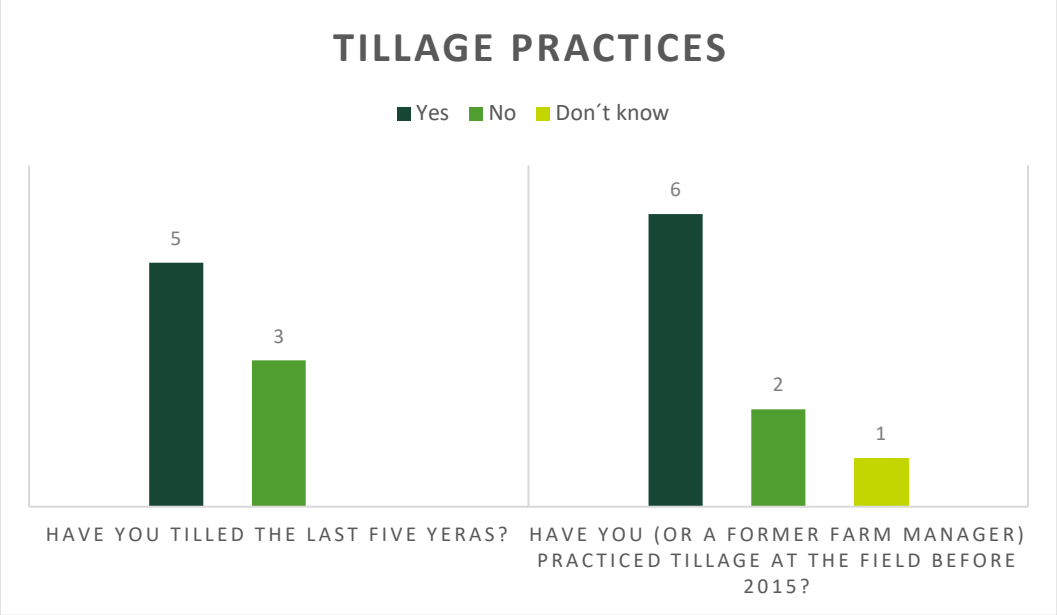

Figure 6. Tillage practices.

Biodiversity, ecosystem health and minimize carbon and nitrogen emissions

The participants were asked to estimate both how many percentages of their main crops which were perennials (excluding shrubs and trees) and how many percentages of their fields and gardens (areas that also is used for growing crops) who was covered by shrubs and trees? This was asked since both perennial crops and shrubs and trees are overall are important factor for strengthen biodiversity, sequester carbon, and reduce soil erosion (Glover et al. 2010; Elevitch et al. 2018). The results from the question are presented in figure. 8. The estimations regarding estimated percentage regarding perennials differed a bit with participants in the lower section with below 10% and 10-30% as well as in the higher section in both categories 50-70% and 70-90%. However, the answers regarding percentages of shrubs and trees on their fields and in their gardens clearly demonstrated a low rate, when 8 participants answered below 10 %. Nevertheless, one participant answered 50-70%.

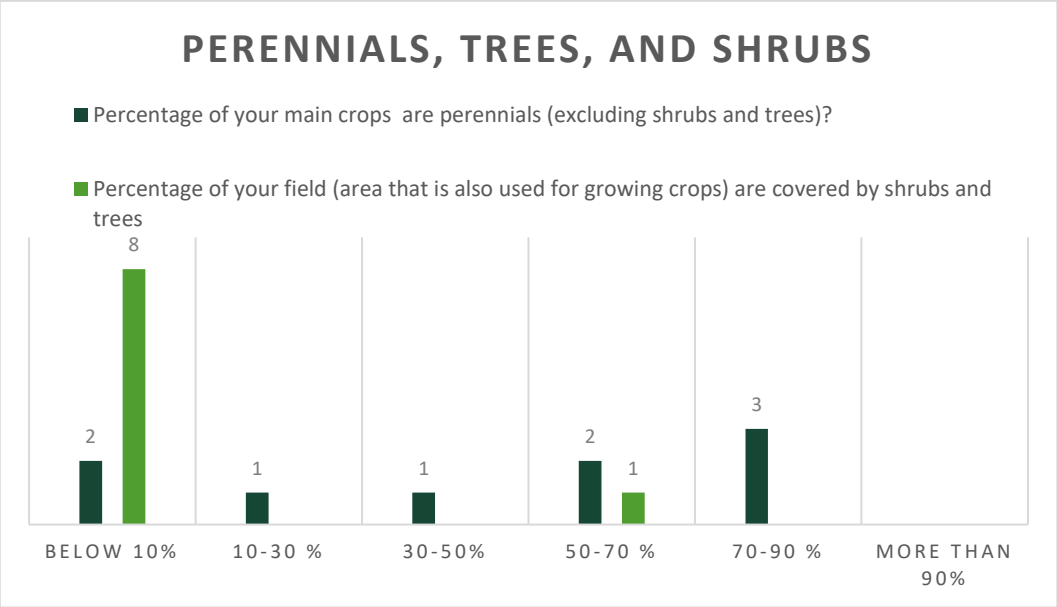

Figure 7. Percentage of perennials, trees, and shrubs.

Five participants answered that they are cultivating ley crops and for cover crops there was one less. Five of the nine participants also replied that they have a crop rotation system. The division between ley crops and cover crops can be seen in figure 9.

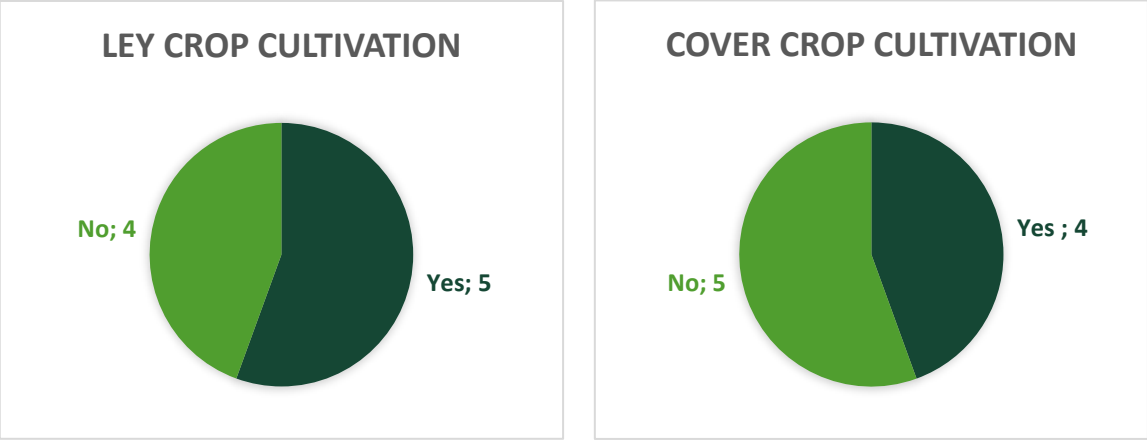

Figure 8. Cultivation of ley crops (a) and cover crops (b).

The questionnaire also explored if the participants are integrating grazing animals into their fields and gardens and if they are rotating them. The results as exemplified in figure. 8 shown that six out of nine participants are integrating animals into their fields and gardens. Integration of animals with rotational grazing is seen as both good for the reduction of overall GHG emissions and contributes to increased

biodiversity, both within plant and insect species (Teague 2018). The participants could in addition answer which type of animal is used for grazing.

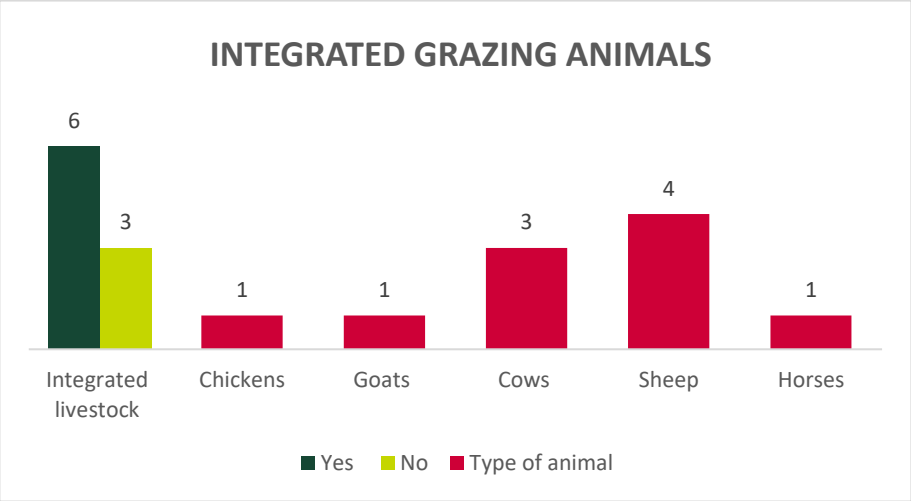

Figure 9. Integrated grazing animals.

Build soil organic matter

In terms of adding organic materials (amendments) which was very important in terms of nutrients for plants but to build soil organic matter (Burgess et al. 2019) to the field and gardens, the result was consent. All participants added organic material in some form during the last five years and more than half of them also before 2015 (figure 11).

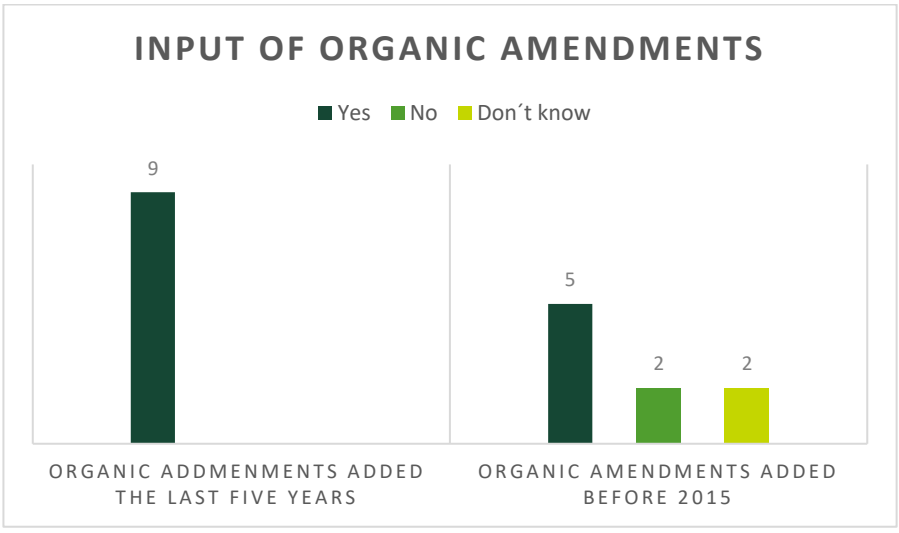

Figure 10. Input of organic amendments.

Type of organic amendments added altered among the participants. Manure was the most common amendment, followed by plant residues, compost, slurry, biochar, and other (figure 12).

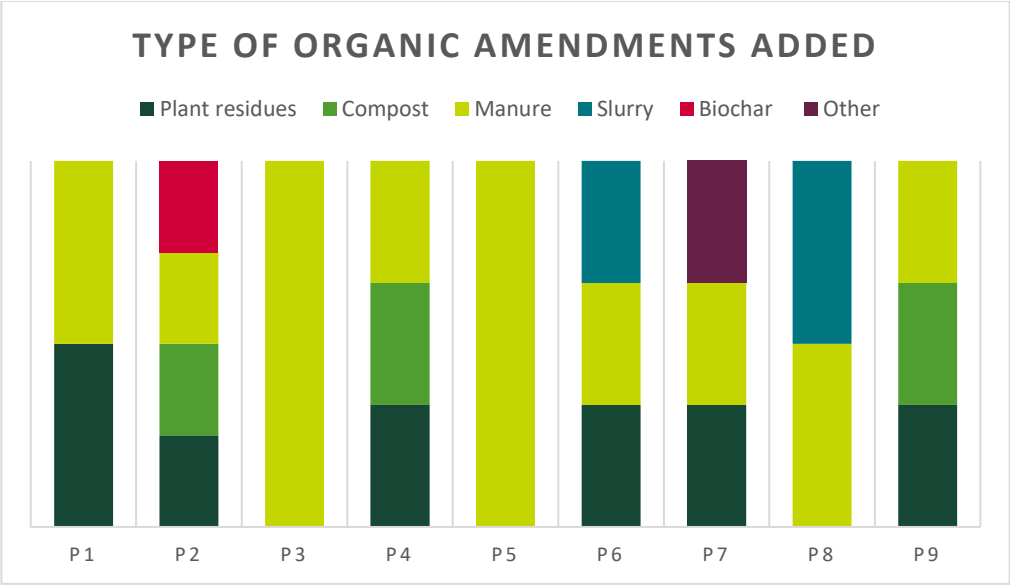

Figure 11. Type of organic amendments added.

Minimizing use of synthetic inputs

Figure 13. illustrates the present and past use of synthetic inputs such as herbicides, pesticides, fungicides, and chemical fertilizers on the farms or gardens. The first staple from left (staple 1) clearly demonstrates that most of the project participants do not use any kind of synthetic inputs on their farm or garden. Only one out of nine participants stated that synthetic inputs are used. However, on four farms and gardens synthetic inputs was used before 2015 and some of the project participants answered that they didn't know if synthetic inputs were used before 2015.

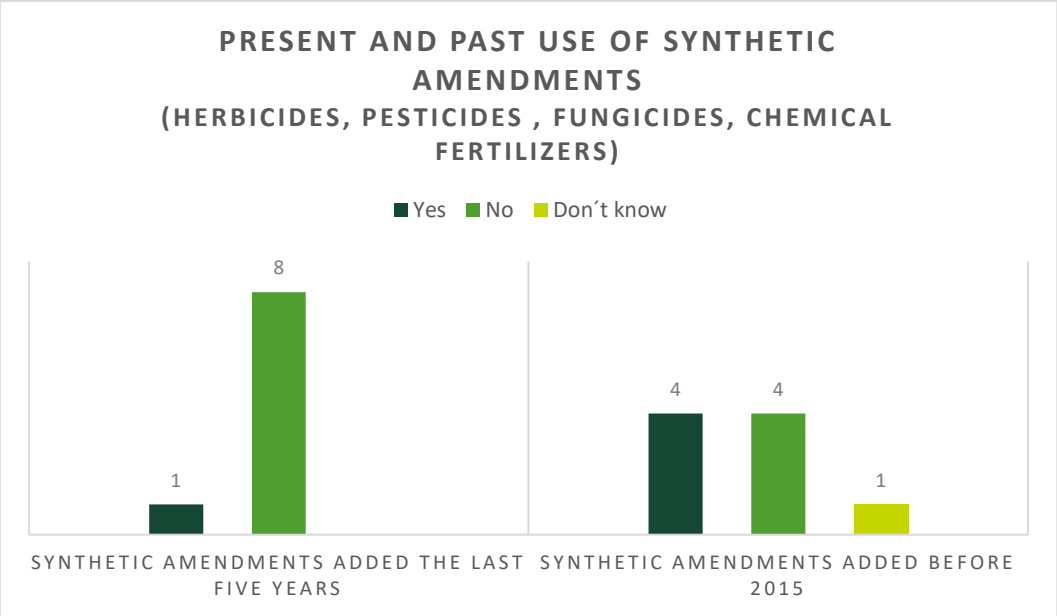

Figure 12. Present and past use of synthetic amendments.

Water management

Concerning the water management techniques and water conservation practise on the farms and gardens, five participants answered that they had included some type of water conservation practise on their fields or in their gardens the last five years. All five participants that answer yes, replied to the follow up question as well, where the participant was promoted to give examples of what type of practises that where including. - Examples of water conservation practise included at the farms and gardens were *"Swales and pocket ponds", "A water pond (the main purpose is water for the sheep)", "Mulching and fleece on the paths", "Mulching"* and *"Dam up the ditches".* - The same division between the number of answers from the respondents applied to the question whether their fields were drained versus not drained and are shown in figure 14.

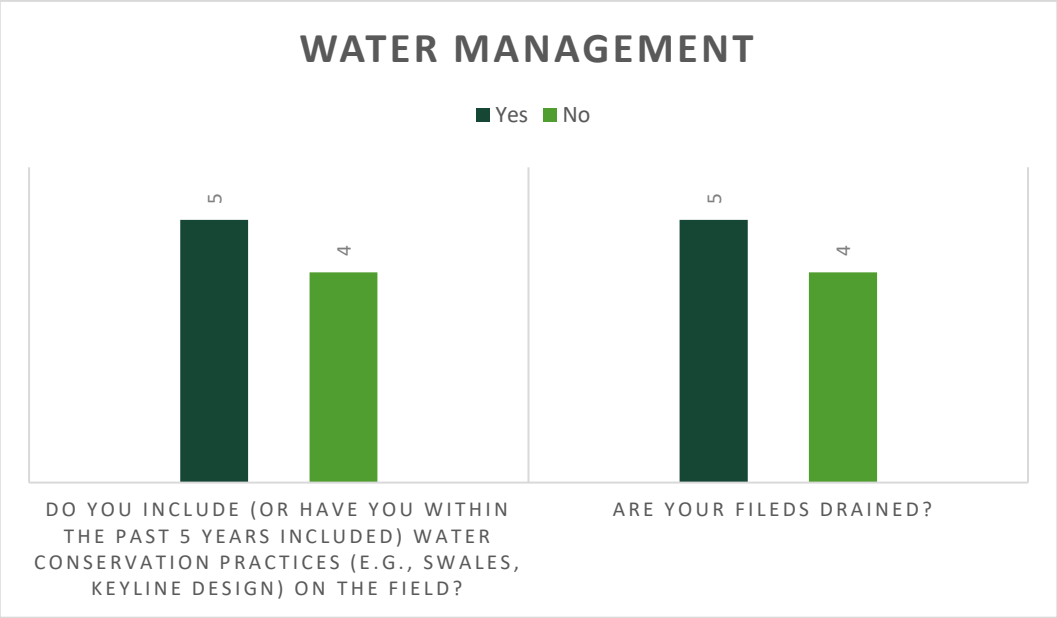

Figure 13. Water management practises.

5.3. Ideas and thoughts about the concept

This chapter presents the result from the thematic analysis. Three main themes were detected through the thematic analysis:

- *Leave it better than you found it*
- *Ambiguity about a future certification or concrete framework and,*
- *Challenges for the future with three subthemes: political engagement, market demand and consumers preferences and economic difficulties and incensements.*

5.3.1. Leave it better than you found it

A common set of thoughts shared with all of the participants are their reflections a of what it means to farm regenerative for them are the intention to do good environmentally good and the high reliance on ecosystems and the natures possibilities to build up itself. Many of the participants mentioned the soil, ecosystems, and the environment.

Participant number 7, who run one of the smaller organic vegetable farms said that to farm regenerative meant; *"That you should leave the soil better than it was from the beginning. "You should fill it with nutrition and fill it with good organisms and everything."*

Another participant, number 4, who grow vegetable organic explained; *"for me, it has started to mean more when I learn, that you improve all the time, ecosystems both in and over the soil, you do things all the time to improve it."* The same participant continued around the scope of regenerative agriculture *"And that often means that you absolutely must avoid chemicals and you must avoid disturbing the soil"…"and at the same time ecosystems in the agricultural landscape above the soil should benefit in every conceivable way. That is probably what I think about regenerative agriculture."*

A participant who run a bigger cattle farm spoke about the belief of the force within nature and the desire to always do better *"well there has been an interest as well, the desire to get better and the belief that nature can make it better"* However, the participant continued further about the difficulties to define what it relay means but mentioned healthy soils and balance *"It is really impossible to put a label on it but, my opinion is that you should build a healthy soil with the help of microorganisms, soil organic matters and everything, so the soil strives and that you have balance."*

Participant number 2, a mixed farm in the middle size range of the participants continues on the same line as number 1 and talks about a quote that have followed for a long time and put a frame around all work on the farm "*the quote; leave the farm better than you found it" and it kind of got stuck, that but you can't actually destroy it"*. The participant further brings up the importance about farming for the soil and its health and all the functions nature offers for free *"And it somehow became so clear to me, that this is what happens if you farm conventionally or even organically, because you "burn" soil and it is not okey. "It's really just that you do not degrade, you build it up, and that you should leave it better than it was when you took over in some way, I mean use them, the cycles and functions that exist in nature in a smart way so that you get what you want and at the same time still build it up ..for me it's very much about soil organic matter and carbon."*

Participant number 3, one of the sheep farmers talked about the feeling for the future, to not leave the farm degraded for coming generations *"there is someone who will take over after us in the family and hopefully the soil is not degraded"*.

Participant number 10 described as well that it is not easy to define but when it all comes down to goals and the realization of what they want with their farm, as many other mentioned "to leave it better than it was before" it means it feels "right" "*for me, it is not really a concept I use. But when I hear that, I think "that's what it's called" what I'm doing" ..." If I describe how I think we want with our farm, it is that it should be better compared to when we got it" ... "Much comes down to build the soil and that it should be more resilient" ... "it should work more on the natures premises".*

For participant number 9, the soil is very important as well and states *"once you start thinking about that and realizing that maybe harming life in the soil by digging it over and not covering between the rolls of vegetables, and not bringing anything in but only taking out…and once you start thinking about that, of the consequences, of course I do not want to do that! I want to be producing more vegetables and I want to help the life in the soil"*

5.3.2. Ambiguity about a certification or concrete framework

As stated in previous chapters, there is a lack of definition of RA. When asking questions connected to the concept and if they saw a need for a stricter framework or certification scheme the answers were in the same direction but contained a lot of ambiguity between an open and flexible approach but the same time the insecurity of the possibility that the term is used "wrong" or will become a new "buzzword".

For instance, participant 4 replied *"So, it must still be a bit open because there are different methods, as long as you can control that the micro-life and the ecosystems and that carbon sequestration increase."* and continues *"You need to be able to in some way you check that it is going in the right direction."* Participant number 7 continued on the same track *"But what does it really mean? Is it something you can use just because it sounds good?"*

Some of the participants made parables to other certifications and perceived disadvantages with them. Participant 2 argued; "*for instance, I don´t have a Krav certification for the simple reason that it is impossible. Because it's, or it's too hard for me at least it's right now…you must go some education here and there and then you must keep a logbook of everything about everything…and there will be a lot of food… if you grow vegetables in small beds that you need to keep record on. So, it gets really weird in the end…So, that is maybe not a desirable development regenerative agriculture if you look at that aspect..."*

However, the same participant adds a concern about the concept being misused and the possibility that the word will become a "buzzword", *"but at the same time it has become a bit like a fast "fashion word…and its really cool to say "regenerative agriculture" and then it can mean "yes, I do not till, so I spray everything with Roundup instead "it is regenerative". I then think this can erode the concept; I don´t think it's obvious in what direction it should go*."

Participant number 10 are following the same track of worries and says *"I think as soon as you start defining something, people will start to find new concepts that will replace it, so yes, it does matter if we start to define"…"I do not know if it is true, but I guess the word organic was not very specified from the beginning either. And then we started to put in a lot of classifications, and now it's in this "corner", and then there is all these other "organic" things you can do, but we can´t call it that anymore"* but at the same time brings up the same concern as the other regarding the risk that the term will lose its meaning *"Right now regenerative is like "everything", but if we start saying that, no, it can only be this and that, this*

will be that "corner" and then we will still find new ways, new angles and new approaches"..." However, I don't think we can control how it will be".

Participant number 1, however was more clear about that regenerative agriculture is not possible to define due to its connection to many different concepts *" Regenerative farming is not, cannot be that well defined because it's based on many different locations and different climates...because I think it's sort of adaptable to each farm, some people will have different focuses."* the reasoning continues convinced as well that the flexibility of the concept are applicable to different settings. *"I think we will learn what's best for each region. Gotland is pretty different"* and *"from my point of view, it's really good that it's not so such a narrow definition".*

Participant number 2 talked about the possible financial disadvantages with having a certification and did a comparison with the certification of Krav *"I paid every year to have an organic certification and I do not get any money back, but it does cost money, so I have probably spent twenty thousand on being eco-certified to absolutely no use…it's completely crazy."*

5.3.3. Challenges for the future

Connected to theme *challenge,* three subthemes were discovered: - "*Political engagement"," the market and consumers"* and *Economic difficulties and incensements.*

Political engagement

A common theme in the interviews was the participants dissatisfaction with the political engagement with agriculture in Sweden, both in general terms but especially with the more environmentally friendly concepts and the transition to more environmentally friendly ways of producing food.

Participant 4 were surprised regarding the little attention the agriculture get within the political system and as well the minimal support more environmentally farmers get and said *"It must come from a political point of view as well, we cannot hold on to and believe that small-scale vegetable growers should start "shift the ship", so to speak"...*

"In addition, even Miljöpartiet (the green party) speak very little about agriculture, really. Maybe it's too difficult political to do that? I do not know, but they think they

are pretty good at talking about the forest now"…" however, there are very few within the politics who dare to speak and bring agriculture up for discussion".

Participant 6 also concluded around the same theme of non-existing support and the importance to talk about agricultural challenges *"I think you might need more, like politically support and that shows that agriculture in Sweden is important, we need the animals, we need the ley as well. Instead of saying that everything is environmentally harmful, which may not really be the case…the ley really helps to fix the soil, and someone has to eat it, so we need the animals as well. I think that is very important"*.

One participant concluded that political changes are needed to give the farmers the right support and incentives. The support should in addition be for everyone, not only farms of bigger scale and how small- scale producers and farmers are forgotten. *"what it means is big political changes, it is big decisions and farmers need to be given the right incentives" ... "That much of what's available, that you, that you should have available for smaller farms, put a cap on the size of farm. So, to me to take away the incentive to grow bigger and bigger, make it easier for smaller farms to start."* The participant continued *"considerable amount was a lot of market gardeners who work on a much smaller area. But they can't get that kind of support".*

Market demand and consumers behaviour

Many of the participants mentioned the demand from the market and consumer preferences as one of the future challenges for the concept.

Participant number 10 described the challenge with producing products that there is no demand for and continued arguing regarding the meaningless with expanding their business if no one purchase their products *"the challenge is of course, all the ones who are not interested in products like this. If they do not want it, there is no reason for us to expand"*.

Another participant continued the same track "*if there are many who are starting to get interested in having access to this type of product" … "there must be a possibility to make profit for what they do and there is no profitability if there is no market."* And participant number six stated it´s irritation over consumers choice in the grocery store *"the consumer comes and buys the cheapest available as well, preferably imported because it is cheaper. It's like a giant twist on everything, it does not work, it is not sustainable".*

Participant number 9 discussed hope of how the consumer preferences will change in the future and said *"I hope that it's social change. That people start to realize that's it actually really nice thing to do"*.

Participant number 1 continued in the same direction regarding people´s interest but also education*" So probably education has to happen. But also, they have to be interested, the people. Where does the milk come from? What happens to the animals when I don't pay 35 kronor for a liter?* The same participant concluded *"It's so convenient to just go to the store and get the cheapest crap".*

Economic difficulties and incensements

A subject coming up during many interviews was economic difficulties with running a farm and especially running a farm aiming at being environmentally friendly.

Participant number 6 said *"when we implemented this in reality, it became a flop and we did not get much of the crops as well" ... "It was a little disappointing, when you spend money, and it does not get much of it."* The same participant who has a cattle farm also stated, *"I think that profitability is an issue that makes many young people give up, as it is very poor profitability, in general as well"*.

Another participant who has a smaller mixed organic farm expressed the anxiety of not be able to go around and said *"I work a lot outside the farm right now to manage all the investments, so that it is chaos, but okey..."*.

Participant number 1, who runs a small farm with goats and sheep's states *"You need to pay the farmers for the service they do for society! Because if you want the farmers to sequester carbon, you have to pay them for it, period!"* and continues to argue regarding the low prices farmers get for their products *"Well, I mean, you'll have a lot of shit happens with the market prices being what they are, like, milk costs nothing. A coke is more expensive than the same amount of milk. How do you feed cows that way? And then people get angry when they see that the calf are being separated from their mothers. And I know only a few hours after birth at the same time, they want the cheap milk. Right?"*.

Participant number 10 who run a smaller organic sheep farm concluded what almost all participants said, *"it´s necessary that there is profitability"* for future farmers otherwise it will not be possible to run a farm.

6. Discussion

In this chapter, a discussion is structured with the help of the research questions. It concludes aspects that are considered necessary by the farmers and gardeners. Furthermore, results from the analysis are discussed related to findings from the literature review, problem background, and introduction.

6.1. Flexibility within the concept

Connecting back to the first research question, the results from the questionnaire illustrated that the participants are using management practises and techniques correlating to the concept of RA to different degrees and in various combinations. For instance, most of the participants stated that they do not use any synesthetic inputs within their farm or garden and are adding organic materials. When investigating tilling practises, the results differed in greater extent and many of the participants were using tilling as a management method, even though most of the participants seemed aware of the negative effects of tilling. However, the results are reflecting the diverse type of farmers and gardeners who are participating in the project. A farmer producing smaller amount of vegetables are for instance more likely to have a crop rotation compared to a sheep or cattle farmer, where's ley cultivation and rotational grazing are more expected management practises.

However, RA as concept is not straight forward to understand, not from the literature review nor from the interviews. The lack of definition, co-development with other concepts, and the various interpretations create a flexible approach, which can be seen as both something useful and at the same time problematic. However, there still seems to be an agreement among supporters shown in the literature review and during the interviews regarding the core of RA. The practices that appear to be general are minimisation or elimination of tillage, avoiding bare soil in different ways with for instance cover crops and mulching, minimizing synthetic inputs, application of organic materials with the fundamental aim of improving soil health, particularly increasing soil organic matter and soil micro life.

The literature review in addition illustrated that decreasing climate change through carbon sequestration as one of the main pillars within the concept. However, it did not appear in the same extent in the interviews as in the literature review. The participants talked more in terms of the ecosystem, the environment in a general way and the importance of the wellbeing of the "soil".

The result from the questionnaire demonstrated that each participant has created a flexible way of farming adapted to their farm or gardens circumstances and combined RA practises in different ways. The flexibility surrounding the concept was illustrated as well in the results from the interviews and in the participants ambiguity about a clear definition or a certification. A concreate definition or certification with specific rules would constrain the flexibility for the farmer or grander to adjust the practises and techniques to the farm or gardens specific conditions.

However, from the interview RA can also be seen as much bigger than collection of farm management practices, as it also is a social movement and a philosophy, with the objectives to change the industrial farming paradigm, to repair the damage done to planetary systems by "mainstream" agriculture, on the farm, at the planetary level and in the social aspect.

6.2. Consumer behaviour, eco-labelling, and greenwashing

A returning theme during the interviews was the participants concern for a modest market demand and how consumer preferences influence what is possible to sale or not. Without an increasing interest and demand for regenerative produced products there may arise difficulties to scale up the production and make it profitable for the farmers. Consumers have great influence regarding the development of the agricultural industry, as their preferences and choices have a large impact on the food industry. With their selections they have the ability to support or reward producers within a certain group or niche, such as RA (Tandon et al. 2020).

Even though the participants expressed ambivalent thoughts about a certification or label, eco-labels are common on food products and are an increasing theme in the food industry (Gustafsson & Tamm Hallström 2018). However, the large number of eco-labels on food products is making it challenging for the consumer to decide what distinguishes "sustainable" products from "non-sustainable". - In addition, as Newton et al. (2020) argue the absence of a clear understanding of what RA is,

would make it even more confusing and misleading for consumers. A general confusion about eco-labels can further lead distrust and dissatisfaction among the consumers (Moon et al. 2016). Furthermore, studies indicate the critical role of trust in food labelling demonstrating that it is crucial that consumers trust the authenticity and trustworthiness of the food (Truong et al. 2021).

A third hurdle with a vague definition or understating mentioned by Newton et al. (2020) is that it *"may open the door for unscrupulous commercial interests to exploit the term and use it misleadingly in their marketing, potentially diminishing the value of the term to any producer who is more genuinely involved in efforts to enhance the sustainability of food production"* (Newton et al. 2020, 8).

- As presented in the literature review, corporations as for example Danone and General Mills have started to promote their business with RA in different ways, which make it even more challenging and creating confusion for the consumers to determine whether the label is trustworthy or if the corporations are using it as greenwashing their products. There is as well a possibility that the use of RA as term or label will come to a point where it will be watering down and lose its value. For instance, several food products are labelled "sustainable" or "natural" without transparency or clarification of what the claim actually means and incorporates (Northen 2011). Creating a formalized definition can according to DeLind (2000) reduce these problems to a certain degree, although it is just one part of the challenge and necessarily not the desired outcome for all actors using it, which relates back to the ambiguity shown by the project participants. RA, with or without a labelling or certification, nevertheless of its claimed environmental advantages, will as well have to compete against other eco-labels and 'mainstream' alternatives available on the market, which most often are cheaper and sometimes easier to access (Li 2020).

Some of the participants as well raised that there can be potential financial disadvantages with having a certification when fees are high and did a parallel with the certification of Krav, which according to some of the participants is not suitable for small scale farmers.

6.3. Process vs Outcome

However, if a general RA certification would be applied, it would be necessary to determine whether it should focus on the practises as it within the organic certification systems or on the outcomes. An implication of a definition or certification only focusing on processes may be that supporter or users of it becomes open concerning the possible outcomes of those processes. As Newton et al. (2020,

7) argue “unless one can be absolutely certain that a particular practice always and without exception leads to a particular outcome, a definition of regenerative agriculture that is based on process(es) may imply agnosticism about the outcome(s)”. If an outcome-based definition would be applied, focus would be on factors such as changes in soil health, increase in carbon sequestration and changes in biodiversity. An implication with an outcome-based definition, could be that farmers would be held accountable to provide results and confirm evidence to the claims within the concept Newton et al. (2020).

6.4. Governmental support and policy

The national goals for future food production published in 2017 by the Swedish government stated that the national food production should both increase although at the same time reach environmental goals connected to the sector (Swedish Ministry of Enterprise and Innovation 2017). To meet this higher demand, we must either increase productivity on already existing cultivated areas or expand the amount of cultivated land. However, converting land for agricultural production has both explicit and indirect consequences on soil degradation, habitat and biodiversity loss, changes in water cycles and carbon emissions into the atmosphere (IPCC, 2019b). The project participants further expressed their dissatisfaction with the political engagement and how agricultural policy in Sweden is constructed. In their perspective it is aiming towards industrial production on bigger scale, and many raised the absence of support for environmentally friendly concepts and small-scale production. This in addition connected to the economic difficulties being a farmer. At the same time as being frustrated based on what we know regarding agricultures environmental impact. The participants raised the issue and concern that so much pressure is put on the farmers to develop and do environmentally harm, when no political support is available, and profitability is low. The absence of a clear understanding of what RA is, and whether a potential certification, definition or label should be process- or outcome-based, has implications for policy and program development as well (Goswami et al., 2017).

7. Conclusion

The aim of this study was to investigate both the agricultural methods and techniques used by the farmers and gardeners participating in this project from the conceptual framework of regenerative agriculture, creating a baseline for future research. Furthermore, to explore the farmers and gardeners' ideas and thoughts about the meaning of the concept and perceived challenges for the concept in the future.

The results from the study illustrated an image of a flexible concept both in terms of practises used on the farm and around the ideas and thought the participants had regarding the concept. The results and the discussion demonstrated the importance of clarifying the meaning of RA for each situation when used, due to both implications for consumers, decision makers and to prevent greenwashing.

If regenerative agriculture will be a potential part of the solution to climate change, land degradation and future food production cannot be answered within this thesis, and forthcoming studies and continues research are needed. Farmers and their perspectives will continue to be of great importance, since they are the ones who will be dealing with the upcoming challenges connected to climate change and food production.

Hopefully, the collaboration with the farmers and gardeners within this thesis, and the collection of data in terms of management information, has created a foundation for future research, continuing the journey towards a potential "regenerative" agricultural system and future food security.

7.1. Further research

Topics for future research could for instance be to investigate potential yields within regenerative agricultural production system and explore if RA have the capability to produce enough amount of food for the growing world population while also reducing greenhouse gas emissions. If RA can be a solution to the question of our future food security and decrease the environmental degradation caused by

conventional farming is a highly complex question, which needs further attention and research from many perspectives.

It would further be of great interest to investigate farmers perspective in a more comprehensive manner to be able to give a better picture of the challenges the farmers encounters and what values and motives the leys behind farming in an environmentally friendly way connecting to research regarding agricultural policies and governmental support.

It found further be of interest to continue the questions regarding consumer behaviour and what consequences increasing consumer awareness will have for future food production. Moreover, and what impact "another" eco-label would have. It would as well be of interest to investigate the possibility to create a flexible certification of RA, where every farm is certain circumstances is considered.

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Appendix I Invitation

Sveriges lantbruksuniversitet
Swedish University of Agricultural Sciences

Institutionen för Mark och Miljö
Department of Soil and Environment

INVITATION TO THE PROJECT REGENERATIVE AGRICULTURE

Welcome to the project regenerative agriculture!

The project has its background in the question" Can agriculture help to solve climate crisis?" and is led by Sabine Jordan, researcher at the Department of Soil and Environment at SLU - Swedish University of Agricultural Sciences in close collaboration with Annelie and Magnus Wendeberg, farmers at Gotland Creamery. Within the project, various student projects are conducted with the purpose to investigate different methods and regenerative agricultural techniques to create deeper knowledge and understanding how more resilient and climate-positive food systems can be built.

Annelie and Magnus's farm also serves as a scientific platform for exchange of information between different actors connected to regenerative agriculture. Students also have a possibility to conduct degree projects at the farm.

We are currently three master's students working in the project. Filippa is mapping regenerative farms and gardens on Gotland and Alena and Lærke are investigating the impact of regenerative farming practices on soil health.

For this spring, we are interested in farms that in some way work to improve soil health as well as increase carbon sequestration in the soil by using regenerative agricultural techniques.

Regenerative agriculture includes a diverse range of farming practices such as no-tillage and conservation tillage, plantation of nitrogen fixing plants, crop rotations, cover and inter cropping, compost/manure/organics application, minimizing the use of synthetic inputs such as chemicals fertilizers and pesticides, integrated pest and weed management, Swales (water conservation) and Keyline design, livestock management (e.g. mob grazing or holistic planned grazing).

The schedule will look like following:

Initially, Filippa will conduct a survey and collect information about your farm / garden. This can be, for instance, questions regarding the type of

farm, how long regenerative techniques have been used and to what extent. The survey will be sent out in February/ March.

Later in the spring, Alena and Lærke will collect soil samples. This will happen on two occasions. The first sampling will hopefully take place in March and the second sampling will take place in May/June.

Participation in the project

- Participating in the project will not involve any major efforts from your side. Most of the work is performed by us working in the project. However, we will of course appreciate if you are talkative, answer our questions and to show us from which corner of your farm we can collect the soil samples.
- This is a good opportunity to have your soil analyzed and you will of course get access to the results from the analysis of the soil samples.
- All results and data will also be published anonymously in future degree projects.
- Our hope is also that the project can be used as a basis for knowledge exchange between farmers and other actors within the project.
- The collection of soil samples and interviews will of course be organized in a Corona safe way.

If you are interested in participating in the project, you can reply directly to this email.

Feel free to spread this invitation to other farms that may want to participate.

We look forward to getting started!

Best regards,
Filippa with project group

Appendix II Questionnaire

Welcome to the survey of the project!

The purpose of this survey is to collect data regarding your agricultural management techniques to enable the investigation of the impact of regenerative farming practices on soilhealth and create a base of information regarding farms and gardens that uses regenerative agriculture techniques on Gotland.

Attention will be on what agricultural techniques that you use and have been used for the pastfive years.

All results and data collected will be published anonymously in upcoming student'spublications.

Do not hesitate to contact us if there are any technical problems with the survey or if you haveany other questions.

All the best,
Filippa Ekroth with project group

The design of the survey

The questionnaire contains 28 questions and is divided into 2 parts.

Part one contains general questions about you who manage the farm or garden and somebasic questions about the farm itself.

Part two includes questions about agricultural techniques that can be linked to regenerative agriculture. The questions refer to areas / fields / areas that produce crops, cereals, vegetablesor are used for animal grazing (in rotation).

The questions concentrate on techniques and methods that have been used the last five years.In some questions, it is possible to answer specifically for each year.

In part two, it is possible to answer the same set of questions either once or twice. The purpose is to be able to collect soil samples from several parts of the farm where different techniques are used or has been used. If you consider using the same techniques in an overallmanner, answer only the first set of questions

Section 1

General questions

1. Your name (s)
2. The farms name
3. What is mainly produced on the farm?

   Vegetables ☐
   Cereals ☐
   Cattle ☐
   Milk ☐
   Other:……

4. The production is conducted in
   Commercial purpose ☐
   For own consumption only ☐
   Small- scale sales ☐
   Other:……

5. Is operated conventionally or organically?
   Conventional ☐
   Organic ☐
   Other certifications ☐ Please specify……

6. How much area do you cultivate? (approximately)
   ……
7. Do any of you who manage the farm/ cultivation have any formal education in agriculture?
   No ☐
   Education from high school ☐
   Education from college / university ☐
   Other:…….
8. For how long have you managed the farm/ garden?
   ……..

Section 2

Management practices

9. Are there two (or more) fields on your farm that are managed in a different way?

Yes ☐
No ☐

If yes, answer the same set of questions for two (or more) different fields or areas where you use different management techniques.

If no, answer the first set of questions as an overall description of the techniques you use on the farm or garden.

Field 1 - An overall description of techniques or methods used

Organic amendments

10. Do you add organic amendments to your field? For example: plant residues, compost, manure, slurry or biochar.
    Yes ☐
    No ☐

If yes, what type(s) of amendment(s)?

Plant residues ☐
Compost ☐
Manure ☐
Slurry ☐
Biochar ☐
Other:……..

11. What type of manure do you add? (chicken, pig, horse, cow)
    ……..

12. What type of slurry do you add? (For instance, pig slurry or biogas slurry)
    ……..

If yes, could you specify in which year and what type organic amendments you add?

☐ 2015 ……
☐ 2016 ……
☐ 2017 ……
☐ 2018 ……
☐ 2019 ……
☐ 2020 ……

If possible, could you estimate how often and how much [e.g., kg/ha] organic amendments were added every year?

2015 ……
2016 ……
2017 ……
2018 ……

2019 ……
2020 ……

13. Have you (or a former farm manager) added organic amendments to the farm before 2015?

Yes ☐
No ☐
Don´t know ☐

Synthetic amendments

14. Do you add synthetic amendments to your field? For example: herbicides, pesticides, fungicides, fertilizers.

Yes ☐
No ☐

If yes, what type(s) of amendment(s)?

Herbicides ☐
Pesticides ☐
Fungicides ☐
Fertilizers ☐
Other ☐ Please specify: ……

If yes, could you specify in which year and what type you added synthetic amendments?

☐ 2015 ……
☐ 2016 ……
☐ 2017 ……
☐ 2018 ……
☐ 2019 ……
☐ 2020 ……

If possible, could you estimate how often in every year and how much [e.g. kg/ha] synthetic amendments were added every year?

2015 ……
2016 ……
2017 ……
2018 ……
2019 ……
2020 ……

☐ Don’t know

15. Have you (or a former farm manager) added synthetic amendments to the field before 2015?

    Yes ☐

    No ☐

    Don´t know ☐

Crop diversity

16. What crops have you mainly grown in the last five years? If possible, please specify for every year.

    2015 ……
    2016 ……
    2017 ……
    2018 ……
    2019 ……
    2020 ……

17. Are you planting cover crops?

    Yes ☐

    No ☐

If yes, please specify which cover crop(s) for every year:

    ☐ 2015 ……
    ☐ 2016 ……
    ☐ 2017 ……
    ☐ 2018 ……
    ☐ 2019 ……
    ☐ 2020 ……

18. Are you planting ley crops?

    Yes ☐

    No ☐

If yes, please specify which ley crop(s) for every year:

    2015 ……
    2016 ……
    2017 ……
    2018 ……
    2019 ……
    2020 ……

19. Do you have a crop rotation system?

    Yes ☐

No ☐

If possible, please specify the crop rotation

……

20. Is animal grazing (on the same field) part of your rotation scheme?

Yes ☐
No ☐

If yes, please specify which animals:

Sheep ☐
Goats ☐
Cattle ☐
Chicken ☐
Horse ☐
Other ☐ Please specify…….

If yes, please specify when (e.g., before/after harvest of main/ley/cover crop), how often and for how long each year:

If you do not remember the exact time, cross only the year animals were grazing.

☐ 2015 ……
☐ 2016 ……
☐ 2017 ……
☐ 2018 ……
☐ 2019 ……
☐ 2020 ……

21. Which percentage (%) of your crops (main, cover & ley crops together) are legumes? (Approximately)

☐ below 10%
☐ 10% - 30%
☐ 30 - 50%
☐ 50 - 70%
☐ 70 - 90%
☐ more than 90%

22. Which percentage (%) of your crops (main, cover & ley crops together) are perennials (excluding shrubs and trees)? (Approximately)

☐ below 10%
☐ 10% - 30%
☐ 30 - 50%

☐ 50 - 70%
☐ 70 - 90%
☐ more than 90%

23. Please specify which perennials and for how long they are growing:

……..

24. Which percentage (%) of your field (i.e. area that is also used for growing crops) are covered by shrubs and trees?

☐ below 10%
☐ 10% - 30%
☐ 30 - 50%
☐ 50 - 70%
☐ 70 - 90%
☐ more than 90%

Tillage practices

25. Are you (or have you within the past 5 years been) tilling your field?

Yes☐
No ☐

If yes, could you specify how often you have tilled in every year?

☐ 2015 ……
☐ 2016 ……
☐ 2017 ……
☐ 2018 ……
☐ 2019 ……
☐ 2020 ……

If yes, which machines/ tools/ practices are you using for tillage?

……..

If yes, could you specify for which purpose you are tilling (e.g. soil preparation for seeding, loosening soil, harvest, …)

……

If no, what is your motivation behind no-till? And what advantages do you find by not tilling?

……..

26. Have you (or a former farm manager) practiced tillage at the field before 2015?

☐ Yes
☐ No
☐ Don´t know

Water Management

27. Do you include (or have you within the past 5 years included) water conservation practices (e.g., swales, keyline design) on the field?

☐ Yes
☐ No
☐ Don´t know

If yes, please specify:

……..

28. Is your field drained?

☐ Yes
☐ No
☐ Don´t know

If you answered **Yes** to question 9 “Are there two (or more) fields on your farm that are managed in a different way?” continue and answer the same set of questions again.

If you answered **No**, the survey is finished here, and you can send in the answers. To send in your answers, go back to the first page and click on "skicka formular” (send form) in the upper left corner. Thank you for your time and participation!

Appendix III Interview guide

Interview guide

Values and motives

- How did you become interested in alternatives to conventional agriculture from the beginning?
- Why did you choose to grow / produce with re-generative techniques?

The concept

- What does it mean for you to farm/cultivate re-generatively?
- Doses re-generative agriculture stand for something special for you?
- Do you think a certification is needed?

Support and knowledge

- Have you felt like there is enough knowledge?
- Has it been easy to access?
- Form where do you get the information, inspiration etc.

Future challenges

- What challenges do you see in the future for the concept itself?
- What are you missing in terms of support?
- Do you think it will be possible to scale up?