Sveriges lantbruksuniversitet
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Faculty of Landscape Architecture, Horticulture and Crop Production Science

Farmers' perceptions of climate change

– A quantitative study of Scanian farmers

Lantbrukares uppfattningar om klimatförändringar

– En kvantitativ studie av skånska lantbrukare

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Foreword

During my previous Bachelor in Geography, at the University of Gothenburg, I had the opportunity to visit interesting places and interact with local farmers. I did not know it then, but perhaps a seed to this master thesis was sown during that time. For two weeks we travelled the Chinese countryside and interviewed farmers about their opinions on climate change. It was an unforgettable experience and my interest in agriculture and particularly sustainable development issues was deepened and there to stay. The next excursion went to Uganda where we were instructed to set up our own mini-project, over three days. Me and my colleague were full of enthusiasm and wanted to examine whether the rural population in the area felt that their standard of living had improved or deteriorated over the years. The encounters with the locals were rewarding but the distances to cover, by foot, were long and we only had time to interview six farmers. As I had finished my Bachelor, I was delighted to discover that a program existed, which was devoted to those issues I found most interesting from my previous studies. This was the master program in Agroecology, at the University of Agricultural Sciences, SLU, Alnarp. During the program I have met people from different parts of the world and with different educational backgrounds, which has very much enriched the studies and created a stimulating and diverse study environment. We have learnt about many relevant aspects of agricultural development and, most importantly, to embrace a holistic perspective on the issues we study, the Ecology of Food Systems. The encounters with farmers have continued, and it has been among the most developing and rewarding experiences of the program. However, I have kept that small stitch of frustration I picked up already in Uganda. I wanted to investigate more and be able to tell what a large group of farmers think about a particular topic. Therefore, this thesis has been a natural and satisfying closure of my studies, where I finally had the time and resources available to carry out a quantitative investigation of farmers' opinions on climate change. It has been an interesting experience where I have substantially improved my capability to plan and conduct a larger study and learnt a lot on how to construct and analyze questionnaires. At the end of my work, I now feel ready to take the step out in the "reality" and apply my knowledge to real life working conditions. With confidence I look forward to devoting my career to issues that really matters, the development of a sustainable agriculture.

Falkenberg, Sweden, December 2018

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I am very grateful to Partnerskap Alnarp who has provided me with funds for this project, without which I could not have conducted it. Also, I am thankful to Länsstyrelsen in Scania who has shown an interest in my work.

Lastly, I want to direct a great thank you to all the Scanian farmers who has participated in my study. I am very grateful to all of you, who, regardless of the stressful conditions of a hot and dry summer, have taken your time to answer my questions!

Abstract

In this thesis, farmers` perceptions of climate change have been examined. Questionnaires were sent to 400 cereal farmers in the southernmost county of Sweden, Scania, of whom 221 replied. Four themes have been investigated: the farmers perceptions on past climate changes, their perceptions on future climate changes, their opinions on how the authorities are managing the climate change issue and their opinions on adaptation to climate change.

Study results indicate that 9 out of 10 farmers had experienced some type of climate change over the last 15 years. The most common notion was that the climate has become more "periodized" and that winters have become milder. As many as 97% of the farmers thought that the climate will change during the coming 30 years, but only 67% believes that temperatures will rise. There are different opinions on whether climate change will be mostly positive or negative for agriculture in Scania, although most of the farmers think that the negative consequences will dominate.

Most respondents think that the amount of information they receive from authorities, about climate change, is satisfactory. However, the majority thinks that the quality, or relevance, of the information is poor. They also think that more should be done in Sweden in order both to mitigate- and adapt to climate change. Large differences occur about the opinions on the EU-membership, in light of climate change, but most respondents are positive towards the membership.

Nine out of ten farmers have already started to adapt to climate change or consider doing so. The adaptations preferred by most farmers concern water management. Both improved drainage and expanded irrigation are seen as relevant adaptation measures. Many farmers also consider "reduced soil disturbance" as an adaptation measure to climate change. When it comes to crop choice, it seems as most adaptations are done as preventive measures to reduce risks rather than to take advantage of new opportunities.

The results of this study indicate similarities to other studies. In relation to farmers in other contexts i.e. in developed nations, the Scanian farmers are generally more aware of climate change. In some regards the farmers expectations for future climate change are in line with scientific predictions for Scania, but for other aspects, there are discrepancies. The farmers tend to underestimate the future temperature rises but overestimate the increase in periodized and more extreme weather.

The current study can be of good value for the authorities engaged in agriculture and climate change related issues. To possess knowledge of the farmers` opinions may facilitate the cooperation between authorities and farmers. This is an aspect of high importance from an agroecological viewpoint, where good communication and integration of different actors in the food system web, is emphasized.

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1 Introduction

Climate change is one of the major concerns in today's society. It has become, perhaps, the most important environmental issue, both globally and in Sweden (Steffen et al., 2015). A lot of resources are spent both on how to predict future changes accurately and on how to mitigate climate change (IPCC, 2014). Efforts are also being made to convince people of the seriousness of this issue since many people still are sceptical towards the alarming future scenarios scientists are predicting (Hart & Nisbet, 2011).

Agriculture stands in the centre of the complex issues of climate change, for at least two reasons. Firstly, one of the major concerns about future climate change is that agricultural systems will not be able to produce at the same level as today because of changing conditions, mainly drought (Rosenzweig et al., 2013). Secondly, agriculture is a key factor in mitigating climate change. Depending on how agricultural systems are designed, they can either significantly enhance or mitigate climate change (Gliessman, 2015). This property is emphasized within Agroecology (ibid), the discipline within which the current thesis has been conducted. Additionally, even though the effect of climate change upon agriculture globally is predicted to be negative, it seems likely that some regions can benefit. Northern Europe, and thus Scania, is such a region where yields may increase (Bogren, Gustavsson & Loman, 2014).

Agriculture has gained a lot of attention in the climate change debate and research. However, one aspect which may not have been covered to the same extent is the farmers` attitudes to climate change. Such information is important for several reasons. It is important for authorities to know what the farmers think and believe, to achieve an efficient cooperation between the parties. (Grimble & Wellard, 1997). If this information is not provided, bad communication, misunderstandings, mistrust and inefficient utilize of resources are very likely to occur (ibid). Furthermore, it is likely that authorities can learn from listening to the farmers` stories. Their knowledge about the land and their observations of the climate can contribute with important information in this puzzle that climate change mitigation and adaptation is (Thompson & Scoones, 1994). To facilitate such communication and mutual learning between different actors in the agricultural sector, to achieve more efficient and sustainable systems, is an important part of Agroecology (Gliessman, 2015).

Farmers` perceptions of climate change has been investigated before. However, a lot of the studies are performed in developing countries (Temesgen et al., 2009; Truelove et al., 2016), which render them precarious to apply to other contexts. Of the relatively few studies performed in developed nations, following can be mentioned; (Barnes & Toma, 2011; Battaglini et al., 2009; Nguyen et al., 2016). These are conducted in (i) Scotland, (ii) France, Italy and Germany and (iii) Italy. A qualitative study (Rodriguez, 2015), with 16 respondents, has also been conducted in Scania, the dominating agricultural county of Sweden. Therefore, there is a scope for a new study in Scania, with a quantitative approach.

1.1 Aims and objectives

The overall aim of the current study has been to gain knowledge of Scanian farmers` perceptions of climate change. Scania is chosen based on its central role in Swedish agriculture e.g. more cereals are produced here than in any other Swedish county (SCB, 2018a) The study has been conducted with a mainly quantitative approach, which in this case means that a relatively large number of respondents (farmers) has been approached with standardized questions, from which the answers are possible to analyse statistically and to some extent generalize for a larger group of people. Results which can be generalized can be valuable for establishing an understanding of how large share of certain groups holds a certain opinion (Trost, 2001).

In more detail, the aim has been to examine the farmers` perceptions of climate change aspects that can be of value for the scientific community and authorities. To gain knowledge of how farmers perceive the authorities work with climate change, in combination with which adaptations they find relevant, can be of direct use for authorities, extension workers and researchers. Moreover, the farmers` perceptions of past and future climate change are also relevant in order to better understand how they remember and understand the past and how they picture the future. Thus, the questions in the questionnaire (Appendix A) are centred on these four themes,

(i) Perceptions of recent, past climate change,

(ii) Expectations for future climate change,

(iii) Attitudes towards authorities work with climate change

(iv) Opinions on relevant and feasible adaptations to climate change.

1.2 Research questions

1. To what degree do farmers believe that the climate has already changed?
2. To which extent do farmers believe that the climate will change in the future?
3. What are the farmers` opinions towards the authorities work with the climate change issue?
4. To which extent has farmers begun to adapt to a changing climate and which type of adaptations do they prefer to invest in?

2 Background

2.1 Climate change

Climate change refers to the phenomena that climate on Earth, and for different regions, can change (Bogren, Gustavsson & Loman, 2014). It is one of the global environmental issues of highest concern (Steffen et al., 2015). The topic is highly debated and covered by media.

For a long time, it has been known that the climate can change and has done so in the past. The fact that human activity could potentially lead to climate change has also been known. However, the extent to which the climate has changed since the onset of the industrial revolution has been debated and even more so which effects human activity will have on climate in the future. Today, the great majority of scientists agree that the emissions of fossil carbon to the atmosphere has started to change the climate and that it will continue to change (Bogren, Gustavsson & Loman, 2014).

Even though scientists are now virtually certain that humanity has affected the climate on Earth and that this change will continue, there are great uncertainties regarding to which changes and effects that will be seen in the future. This uncertainty is due to the complex nature of climate and weather. Each parameter can be understood by itself, but interactions between many parameters makes it difficult to produce exact predictions (Bogren, Gustavsson & Loman 2014). Some important parameters are unknown, as future emissions, population and land use which makes it impossible to state exactly how the situation will develop in the future. Currently, different scenarios exist and some of the scientific debate is focused upon which of these that are most likely to occur. The Intergovernmental Panel on Climate Change, IPCC, used a new type of scenarios called RPC:s (representative concentration pathways), for their fifth assessment report, which are named after the radiative forcing they will achieve, compared to preindustrial levels. From low to high radiative forcing the scenarios are: RCP 2.6, RCP 4.5, RCP 6 and RCP 8.5 (SMHI, 2014a)

2.1.1 Natural climate change

There are many factors which can lead to "natural" climate change. It has long been known that climate on Earth has varied greatly throughout the planet's history (Heckman et al., 2001). Some of the factors which change throughout time, and can affect the climate, are; Earth's orbit around the sun, solar output, volcanic activity and continental drift (Bogren, Gustavsson & Loman, 2014).

For the last 2.5 million years, the earth has been in a state of cyclical periods of glacials and interglacials. We are currently in an interglacial period, as the last Ice Age ended about 10 000 – 12 000 years ago (Bogren, Gustavsson & Loman, 2014). The time span of these cycles has varied but has consisted approximately of a cold period of 80 000 – 90 000 years and a warm period for some 10 000 years (ibid).

The greenhouse effect is a fundamental conceptual component in climate change theory. The greenhouse effect refers to the warming of the Earth that is achieved by different gases in the

atmosphere, mostly water vapor but also CO_2 and other molecules as methane and nitrous oxide (Jones & Henderson-Sellers, 1990; Schmidt et al., 2010).

The natural greenhouse effect is so strong that Earth would be inhabitable without it. Without any greenhouse effect at all, the average temperature on Earth would drop from around 15º C to -33º C (NASA, 2018; Schmidt et al., 2010). The Swedish scientist, Svante Arrhenius, presented his theory that higher atmospheric concentrations of CO_2 would lead to higher temperatures, in 1896. The calculations he made do not deviate substantially from modern estimates (Bogren, Gustavsson & Loman, 2014).

2.1.2 Anthropogenic climate change

Since the early 20th century it has been suspected that human activity could influence climate (Bogren, Gustavsson & Loman, 2014). In fact, it was known much earlier that this could be the case, but then only at the local or regional level, as literature from the Antiquity explains (Neumann, 1985). In the 1950s, evidence started to appear that anthropogenic climate change was on its way, globally, but no concern was raised at this point. It has been proven since the 1960s that atmospheric CO_2 levels are rising, approximately with the same quantities emitted from combustion of fossil fuels (Keeling, 1960). It was not until 1988, when the American climatologist James E Hansen, participated in a hearing of the US senate, in which he testified that human activity was changing the climate, that the issue arose as one of the most prominent environmental issues on the global agenda (Bogren, Gustavsson & Loman, 2014). The hearing coincided with an unusually strong heat wave and drought which made it thoroughly exploited by media (ibid).

The Intergovernmental Panel on Climate Change, IPCC, was founded the same year, 1988, and has since then, published updated reports with the latest scientific evidence and predictions for future climate change and its effects. The latest report was published in 2014 (fifth assessment report) and the next will be published in 2022 (IPCC, 2017).

The enormous attention that anthropogenic climate change has gained in the last decades is explained by the fact that climate change will affect, agriculture, wildlife, cities, and many other areas. It is estimated that effects will mostly be negative (IPCC, 2014). For example, agricultural production may, in many areas, decline due to climate change (Rosenzweig et al., 2013) and especially due to water and heat stress (Bindi & Olesen, 2010). Natural ecosystems are likely to face such significant changes that a loss in biodiversity is unavoidable (Bellard et al., 2012) and sea level rise may pose severe challenges on coastal communities, among those, many of the world's largest cities (Hinkel et al., 2014).

The Kyoto Protocol, from 1997, was the first major international, binding agreement on reductions of greenhouse gas emissions, GHG, (ibid). It has been commended for its success of establishing an agreement but even more criticised for its shortcomings to reach any substantial reductions in the emissions of GHG. (Rosen, 2015).

At the United Nations, UN, climate conference in Cancun, 2010, it was decided to strive to prevent the global mean temperatures in 2100 to exceed the global mean temperatures of

preindustrial levels with more than 2º C. This was believed by experts to be an acceptable change with not too strong impacts on societies and ecosystems. Since then, it has been questioned whether this 2º target can be reached and most experts now strongly doubt it (Tollefson, 2015; Rockström et al., 2017).

In Dec 2015, the Paris agreement was reached. This was the first major treaty for limiting climate change that includes all major nations (UNFCCC, 2018b). The parties agreed to take measures to limit global warming to well below 2º C, above preindustrial levels and to aim at even lower, 1.5º C (ibid). This prompted the IPCC to prepare a special report on the effects of 1.5 degrees C warming. It was released in October 2018 (IPCC, 2018).

2.1.3 Farmers and Climate change

Farmers are heavily dependent on the weather for their farm operations (Rosenzweig et al., 2013; Ashenfelter & Storchmann, 2014). They are adapted to a certain climate and chose their crops and type of orientation accordingly. Climate change can bring new challenges, as well as opportunities (Bogren, Gustavsson & Loman, 2014). Even if climate change, at a certain location, appears to be positive for agriculture, it may still be challenging to adapt to new conditions, fast enough. Farmers are often thought of as rather conservative (Swanson, 2015). Perhaps, this conception is deceptive, as they can also be innovative (Coughenour, 2003). The attitude towards climate change is a topic where these contrasting characteristics can be examined. As conservative, farmers can be expected to be sceptical towards climate change, which has also been proven by some research (Haden et al. 2012) but due to their dependence on the weather, they are also forced to accept climate change and adapt to it, to be able to continue farming successfully (Howden et al. 2007).

2.2 Agroecology

This study is conducted within the discipline of Agroecology. Agroecology is been defined as "the ecology of food systems" (Francis et al., 2003). It has also been described with the following words; "In Agroecology we move from a narrow concern with farming practices to the whole universe of interactions among crop plants, soil, soil organisms, insects, insect enemies, environmental conditions, and management actions and beyond that to the effects of farming systems on surrounding natural ecosystems" (Gliessman, 2015). It is a broad discipline concerned with sustainable development of agriculture and emerged as a response to the development of "industrial agriculture" after World War 2 and onwards (ibid). In many regards, the development of mainstream, or "industrial", agriculture has been successful (elevated yields, less heavy manual labour, etc) but it has come with negative side effects to the environment and people (Pingali, 2012). Some of these effects include: air and water pollution, soil degradation, diminishing biodiversity, unsustainable consumption of fossil fuels and fresh water, cancer risks for agricultural workers and other health risks (as a result of inappropriate diet as well as food contaminants) for consumers (Horrigan et al., 2002).

Agroecology has not only evolved as a response to such problems, but also as a solution (Gliessman, 2015). Viewing agroecosystems as a whole, holds premise to detect and address potential negative consequences of agricultural practices (ibid).

In Agroecology, much of the attention is directed towards the management of the agroecosystem, but also aspects outside this sphere are recognized as highly important for a successful development of a truly sustainable agriculture. Market structures, consumer behaviour, values and ideas of both producers and consumers and similar features are of great importance to understand the prevalent situation and be able to move towards a more sustainable utilization of resources and land (Francis et al., 2003).

As opposed to mainstream agriculture, quite a lot of attention in Agroecology is directed towards traditional knowledge of small-scale farmers, in Latin America for example (Gliessman, 2015). Such practices can, sometimes complemented with modern research and technology, be very sustainable and often produce good yields (ibid). Although a population which has not been studied to the same degree is farmers in developed nations. Especially, not if they are considered "mainstream" and don't know anything about agroecology. It is likely that if this knowledge gap (the opinions of farmers in developed nations) is addressed, it can facilitate the transition towards a more sustainable agriculture. as the knowledge of different stakeholders` opinions are important for achieving efficient cooperation and development (Grimble & Wallard, 1997). Thus, the current study will contribute to reach some of the objectives relevant in Agroecology.

2.3 Scania

2.3.1 Geography of Scania

Scania is the southernmost county in Sweden. It covers 10 939 km^2 (SCB, 2012) (equivalent to Lebanon or Jamaica) and has 1 322 193 inhabitants (SCB, 2017). County is the administrative level below national level, in Sweden. The population of Scania make up about 13.2% of the total population of Sweden (SCB, 2017). Although the county itself makes up only 2,4% of Sweden´s total area. This makes the population density of Scania much higher than the national average.

The current land use is partly determined by the physical geography and geology. As most of Sweden, much of Scania is covered by moraine soils. Although the parent material of the soil can be of different origin. This is apparent in Scania where the soils to the southwest has a much higher content of particles eroded from the sedimentary bedrock of the former Central European plate. This bedrock is rich in limestone resulting in very fertile, heavy moraine-clay/clay soils of southwestern Scania. Moraine and clay soils in other parts of Scania are not as fertile (Germundsson & Schlyter, 1999). These conditions are important to recognize in order to understand why agriculture differs spatially within the county and in the end to why such a large share of the respondents in this study are located where they are.

2.3.2 Climate of Scania

In Scania, on average, the mean annual temperature is around 7 º C. The mean annual precipitation is around 650-700 mm (Germundsson & Schlyter, 1999). The interior, northern parts of the county are considerably wetter and colder than the southern and coastal areas (ibid). The vegetation period is around 270 days in the southwest and around 230 days in the northeast (SMHI, 2018a).

2.3.3 Agriculture in Scania

Scania is Sweden´s leading agricultural county, in many regards. The most productive soils in the country (actually some of the most fertile in the world) are found in this region, at Söderslätt, (Germundsson & Schlyter, 1999) and 16% of Sweden´s crop lands are located in Scania (2007) (see figure 1) (SCB & Jordbruksverket, 2011). Agricultural land inclusive of pasture and meadows covers about 50% of the surface of the county which is a higher share than for any other Swedish county (ibid).

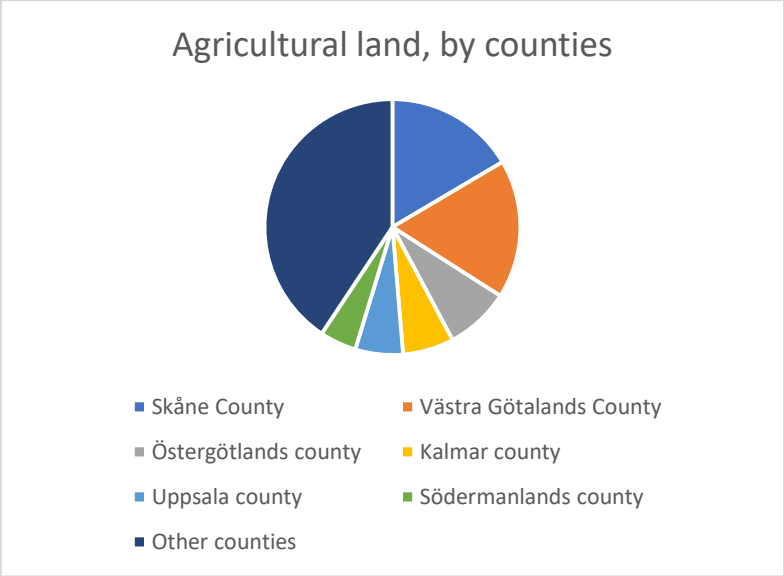

Figure 1: Share of Sweden´s total amount of agricultural land, divided by counties. Only those counties with highest share are named, the rest are put together as "others". Västra Götaland has slightly more agricultural land than Scania but is more than twice as large. SCB & Jordbruksverket, 2011.

Around 25% of Sweden´s total production of cereals is carried out in Scania. The Scanian production share for potatoes is 47% of the national total. As for sugar beets, which is an important crop at a national level, Scania totally dominates the Swedish production with a 96% production share (SCB & Jordbruksverket, 2011).

Scania also has a high number of agricultural enterprises (farms), counting 8196 with 10541 employees in the agricultural sector; the highest number of any Swedish county (ibid).

2.3.4 History of Scanian agriculture

Agriculture in Scania, as in Sweden in general, has gone through many profound changes with time, especially in the postwar era. Many of these changes are relevant in the context of climate change mitigation.

As the agricultural sector has modernized, it has become more efficient in terms of required working hours to produce a certain quantity of goods. The share of the population active in agriculture has declined from around 25% in the 1940s to less than 2% at the beginning of the 21th century (Flygare & Isacsson, 2003). The total area of agricultural land has also declined, but not to the same extent. As a result from mechanization, it has become possible for a single person to cultivate more land than was possible earlier.

External inputs of synthetic fertilizers and pesticides has also increased. For Sweden, on average, the amount of synthetic nitrogen fertilizers applied by hectare increased from less than 10 kg in the 1940s to over 100 kg in the end of the 1990s (Flygare & Isacsson, 2003).

Over the last decade there has been a trend towards a more environmentally friendly agriculture, as a result the use of pesticides has declined. In addition, different strategies to transform agriculture into a more sustainable system, such as precision agriculture (Lindblom, et al, 2016) and organic agriculture (Jordbruksverket, 2017) have spread. Despite this, the demand for few farmers to cultivate large areas remain.

3 Materials & Methods

Questionnaires were used to collect answers from farmers all around Scania. The questionnaires were sent to 400 respondents. Three methods have been used to analyse the retrieved data. Descriptive, statistical analyses of quantitative data have been made using Excel and Interpretive Phenomenological Analysis (IPA) has been conducted for the qualitative questions. Tag clouds has been used as a complementing method on the same questions as the IPA.

3.1 Data source

The approach used in this study necessitates an information source with contact details to possible respondents. Such a file was compiled by Statistiska Centralbyrån and Jordbruksverket in 2016; and it was used as the only information source about the respondents, throughout this study. The file is very extensive and contains all businesses somehow involved in the agricultural production sector, in Sweden. Personal data has to be handled with care. All answers has thus been processed anonymously and the use of the file has been in line with the regulations that was in place when the file was used to contact the respondents. Regarding "sensitive" questions, it was assessed that no estimation by a third part had to be made as this is not necessary for master students who conduct studies with more sensitive questions, regarding health, etc.

3.2 Selection of respondents

The delimitation of respondents (selection process) was made in five steps tallying to the same number of selection criteria.

1. The first delimitation is **geographical**. Only those who are located within the county of Scania were selected. The advantages to use the county level as delimitation is that a reasonable share of the whole population (all farmers who fulfil the criteria set for the study) (Trost, 2001) can be approached. National level could have been chosen but in that case only a very small share of the population could have been included, which would bring implications for the interpretation of the results. County level is then a good choice, as most statistics about agriculture is presented on this level.

2. The second delimitation was based on **working hours**. Only farmers who were assessed to work full time (or close) were included and therefore the minimum number of working hours per year was set to 1600. The file contained categories based on working hours, which is the reason to why 1600 hours, in particular, was chosen as delimitation. The reason to include only full-time farmers was to create a somewhat homogenous population of farmers who had farming as their main occupation.

3. Based on the same reasoning, **only farms operating on more than 10 hectares** were included. It is possible to have a full-time farm business on less than 10 hectares but then the

crop choice is generally of another type than what was aimed at, according to the next step in the selection process.

4. The third delimitation concerned **farm type**. It was decided to focus on those who are mainly cereal farmers. To do so, it was important to understand the classification system used in the file. A publication called "Rapporter från lantbrukets företagsregister 2000 (Reports from the agricultures register of businesses 2000) was used for this purpose (Jordbruksverket, 2000).

The businesses are divided into three levels. *Main type* (huvudtyp), *Base type* (bastyp) and *Detail type* (detaljtyp). For an illustration of how the included categories were selected, see appendix B. Included categories are marked as bold and italic. Of 38 possible categories covered in the file, 7 was included in this study.

When the delimitations had been made, the respondents who fulfilled all requirements were randomly sorted. The selection was of a type called unbound randomized selection (Trost, 2001). This new sheet contained the whole population, all persons who fulfilled the certain criteria outlined above (Trost, 2001). The population was 1055 people. From this population, the selection of respondents was made. It was decided to contact 400 farmers, which corresponds to 38% of the total population.

5. The last delimitation was to exclude those businesses which did **not have contact details** for a specific person. As they were interspersed with the ones with personal contact details, it was decided to just skip those without contact details and continue through the list until 400 respondents were reached. As around one fourth of the posts in the list lacked contact details (these includes not only private, smallholders but also operations such as Alnarps property and Findus), the counting went on up to post number 522, where 400 respondents was reached.

3.3 Population- and selection characteristics

The respondents are based all over Scania but some municipalities are much higher represented in the material since the agricultural sector is not equally important everywhere. The contrast is largest between the southwest, where agriculture is very common, and the northeast where much more of the land is forested (Germundsson & Schlyter, 1999).

Scania is divided into 33 municipalities (Region Skåne, 2018) and 29 of them were represented among the 400 farmers who received questionnaires. Those not represented were: Burlöv, Osby, Örkelljunga and Perstorp. Although Burlöv is located in the otherwise intensively cultivated region of southwestern Scania, it is the smallest commune in Scania (covering only 19 km^2), of which much of it is urban. The rest of the non-represented municipalities are neither small nor heavily urbanized and are located in the north/north-eastern part of the county where agriculture, especially crop production, is not very common any longer. A municipality such as Skurup, smaller in size than Örkelljunga, is represented 21 times among the 400 respondents

and Örkelljunga is not represented once illustrates the spatial differentiation of agriculture and land use in Scania.

3.4 Timeline

The questionnaires were sent to all 400 respondents, accompanied by an introduction letter, in the beginning of June, 2018. About 3.5 weeks after the first wave of questionnaires were sent, a remainder to all who had not yet replied was sent. It contained a new copy of the questionnaire as well as an adjusted introduction letter, stressing the importance of the need of as many as possible responds. The collection of answers finalized the first of September. Before the second wave of questionnaires were sent (the first and only remainder) around 140 questionnaires had been received back. The following days a few more were received, which suggests that around 145 respondents answered on the first consignment and the rest, about 75 respondents, answered on the remainder.

3.5 Questionnaire design

A questionnaire is a tool that researchers use to gather information about people's opinions on something. Questionnaires can be said to be a sub-class of interviews, with the important distinction from other type of interviews that the respondents of questionnaires do the work of noting the answers themselves (Trost, 2001). This method has been in use for over 200 years and can be an efficient way to gather data from a large number of respondents (Bernard, 2006). As a sub-class of interviews, questionnaires can be described as structured, as all respondent are exposed to the same stimuli (questions) (Bernard, 2006). Questionnaires have some important advantages compared to other type of interviews. They are considered cost and time effective; especially if the respondents are spread over a larger area (Ejlertsson, 2005). They also eliminate the "interviewer effect", which is a well-documented phenomenon where respondents adjust their answers to how the interviewer behave. That can be an important benefit if the aim of the study is to remove possible bias (ibid).

The type of questionnaire used in this study is the mailed questionnaire (Trost, 2001). The design was based mainly on recommendations from two books, Enkätboken (The questionnaire book) (Trost, 2001) and Research methods in anthropology (Bernard, 2006).

An important distinction can be made between predominantly quantitative and qualitative questionnaires (Trost, 2001). In reality, most questionnaires contain elements of both types (ibid). Quantitative questions are those which can be analysed statistically, involving numbers. Different scales are used for the respondents to consider. The ratio scale has equal distance between the scale steps and contains a well-defined zero point. Most questions used in this questionnaire use an interval scale. It's similar to a ratio scale, without a zero point. Another scale, used to a limited degree in this study, is the nominal scale. The alternatives cannot be ranked from low to high and does not have an equal distance to each other (ibid). Qualitative

questions, on the other hand, is when scales and numbers are avoided. Usually these questions are answered by the respondent, in her own words (Trost, 2001).

The questionnaire used in this study leans more towards a quantitative approach. The data gathering process was generally quantitative, since most of the questions were answered by choosing a number at an interval scale. In addition to the questions of quantitative nature, there were qualitative elements in the data gathering process, the questions where respondents are supposed to answer in their own words.

As for the quantitative questions, they were also analysed quantitatively. The qualitative questions are analysed qualitatively and to a certain extent quantitatively. A qualitative analysis would focus on why people think as they do. Yet, a quantitative analysis focuses on how large share of the respondents who reason in a certain way (Trost, 2001).

Most of the questions consisted of a scale from 1-7, where only 1 and 7 are labelled with a text description (the normal procedure when dealing with as many alternatives as 7) (Bernard, 2006). In the middle of the bar is number 4, which stands for neutral. At one direction number 1, 2 and 3 are found and 5, 6 and 7 represents the other direction. For example, question 7a demands the respondents which types of climate change they expect in the future, where 1 stands for colder, 7 stands for warmer and 4 is neither, neutral. For other questions a ratio scale is used and there is no neutral point in the middle (question 5a and question 6a).

The questionnaire consisted of 20 main questions, some of them with sub-questions. It may take up to 30 min to complete, depending on the respondent. The questionnaire had four parts, one for each research question, but it is not obvious, from the layout, to see where a new section starts. In addition to the main questions, there are four introducing background questions about year of birth, number of years as a farmer, geographic location (within which municipality) and farm size. Their inclusion has a twofold purpose. Firstly, to accustom the respondent to the process of filling in the questionnaire, giving them a “smooth” start (Trost, 2001). Secondly, they can be used as parameters in the analysis of the answers. The questionnaire can be found in appendix A.

Two important terms related to questionnaires are population and selection.

- Population refers to the all people who fulfil all the different criteria’s to be included as respondents in the study (Trost, 2001). It is important to define the population carefully so that no doubt exists about who is included and who is not. One must also find data of the population to know its size. Once the population is defined, thereafter follows a selection.

- In some cases, the whole population is included in the selection but that is generally too expensive and not necessary (Ejlertsson, 2005). Depending on different factors such as the size of the population, the budget and time budget of the study, etc. The selection can be of different size, everything from just a few percent of the population to the whole population is possible. The fundamental notion is that the selection should represent the population. To generate a representative selection, an unbound, random selection is done. The computer does this by choosing respondents randomly from the

population. There are also other types of selections which can be motivated in some cases, but these are not covered herein.

3.6 Descriptive quantitative analysis

Most of the results were possible to visualize in diagrams. The data from the questionnaires was firstly, transcribed into Excel and thereafter, different calculations and analysis could be made. In most cases, it is displayed how large share of the respondents that chose the different answer categories. The data could very well be used for further statistical analyses, but this was excluded based on time limitations.

3.7 Interpretive Phenomenological Analysis, IPA

IPA is a method for analysis of text. It was chosen to analyse the answers on questions were the respondents replied by writing with their own words. To include such questions was desirable as it appeared to be difficult to capture all aspects of the respondent's opinions (about the chosen topics) otherwise. Naturally, answers on such questions cannot be processed in the same way as for the questions with pre-chosen answer alternatives, i.e. 54% or 68% thinks that it will be considerably warmer in the future, etc. The respondents expressed themselves in many different ways and to produce exact figures from these questions was not considered relevant. Instead, the aim has been to elicit the themes that was found in the respondents' answers. IPA is thus a suitable method for such a purpose.

The method is used to construct themes from the answers of several respondents (Smith, 1999). This is suitable in the case of this study since the respondents of the free text questions often are around 100, rendering deep and careful analysis of each respondents' exact use of words, and so on, overwhelming. Instead, the aim was to examine whether any common themes in their answers could be identified. According to the procedure described by Smith the answers of each respondent are read through and comments are written down in the marginal. These comments do not have to be constructed in any particular way. It can be reflections of how the respondent reason and/or key words that seems important. Since the answers processed in this study often are very short, it was not relevant to elaborate too much about how the respondent reason, what their motives or feelings are in relation to the subject. From an answer of two words, like "milder winters", it is simply not possible to draw too many conclusions about the respondent. On the other hand, the number of answers processed in this work is considerably higher than in most cases where IPA is used. These two circumstances governed the tailor-made adaptations of the method (Smith, 1999) presented below.

1. For each respondent key words were drawn in the marginal. Sometimes it was just a copy of the respondents' own words, sometimes the constructed key words where different from those used by the respondent. The general aim at this stage was to make sense and give the material some structure. The attempt to construct themes directed the creation of key words

in a homogenous way. Responses which contained very similar information were assigned identical key words. However, that could not be done naturally in this first step as it was not yet known how to label the key words in a structured way.

2. When all answers had been accompanied by comments, mostly key words, another column in the marginal of the paper was used to construct themes out of all these comments and key words. At this stage it became clearer what information the answers contained and it was generally easy to group very similar key words together and construct a common theme out of it. However, caution was taken not to group words together which could have different meanings. A good example of how this worked in practice is the presence of the key words "milder winters" and "warmer winters". One could argue that they have slightly different meanings, but my assessment was that they are close to identical and thus they were all grouped together under the label "milder winters".

3. When themes had been created, the next step was to investigate whether the themes could be grouped into "superordinate themes". In some case this was easy, in some cases it took some elaboration and discussion with colleagues to create superordinate themes which made sense. After superordinate themes had been created, the outcome was the final illustration of the IPA, a sheet with information of the respondent's opinions, displayed in three different detail levels, superordinate themes, subthemes and dimensions.

3.8 Tag clouds

To complement the IPA, tag clouds were used to visually display the frequency of different themes in the respondent's answers. IPA does not illustrate how common the different themes are and it was desired to somehow examine this aspect, in a similar way as done for the quantitative questions. The subthemes constructed for the IPA was copied into a blank sheet and written the same number of times as they occurred in the material. For example, if milder winters occurred 11 times, it was written 11 times in the blank sheet. This body of text was then copied into a tag cloud generator. The tag cloud generator counts the words and display them in a new figure, in different sizes according to their frequency (Heimerl et al., 2014; wordclouds.com, 2018).

4 Results

The results are ordered after each research question. Meaning, for each of these four sections, the different methods of analysis are included. The first section describes how the respondents perceive past climate changes. The second section presents their opinions about future climate changes. The third section concerns the farmers` opinions on the authorities work with climate change and the fourth section present the farmers views on adaptation to climate change.

The response rate of the study was 55.3%, which equals 221 received questionnaires. Four of these were not filled in, as the respondent had either died, moved or quit agriculture. Additionally, three questionnaires could not be included in the study as they were received just before the finalization of work. Unfortunately, 17 of the received questionnaires had been printed without back page which means that those respondents only had opportunity to answer half of the questions. As 7 received questionnaires could not be used (see above) 214 respondents were included in the study and of these 197 had the opportunity to send back a complete questionnaire. The average year of birth for the 400 chosen respondents was 1961 and the average year of birth for those who replied was 1959. The year of birth span was from 1918-1997, for the whole selection and from 1929-1991 of those who responded.

4.1 Research question 1:

To what degree do farmers believe that the climate has already changed? (Question 5.a and 5.b in the questionnaire)

5a. Have you noticed any changes in the climate over the last 15 years?

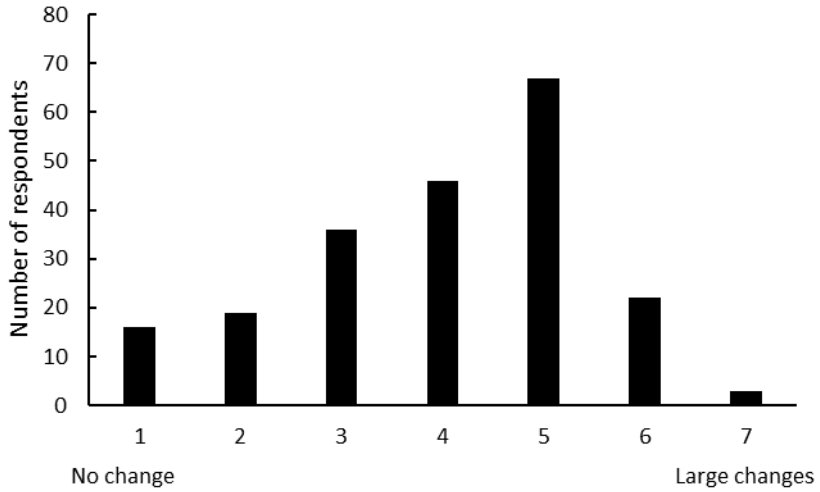

Figure 3: Perceived magnitude of climate change over the last 15 years. Category 1 means no changes and 7 means large changes. Number of respondents: 209.

A great majority of the respondents (92%), report having noticed at least some degree of changes. Category 5, which equals “considerable changes”, gathers the highest number of

respondents. The least amount of answers are found in category 7, which stands for large changes.

5b. If you have noticed any changes in the climate over the last 15 years, which are they?

Table 1. *The IPA table illustrates important themes in the respondents` replies, in three different detail levels, with regard to question 5b.*

Superordinate themes	Subthemes	Dimensions
Climate changes	Warmer climate	Milder autumns and winters, generally warmer, earlier harvests
	Changing patterns	Periodized weather, droughts and rainy periods, different winds, drier springs & summers
	Extreme & unpredictable weather	Heavy rains, droughts, unpredictable, never "normal" conditions for long periods, fast changeovers
No climate changes	No perceived changes	Most years normal, no changes in such short time span
	Natural variations	Climate has always varied, normal yearly variations

Two superordinate themes appeared for this question, those who perceived that they had experienced climate change, *climate change,* and those who had not, *no climate change.*

Climate change

Three subthemes emerged: *warmer climate, changing patterns* and *extreme and unpredictable weather.*

Warmer climate: two closely linked dimensions of this subtheme were milder autumns and milder winters. In most cases, they were not reported together by the same respondent. Milder winters was reported to a higher degree by older farmers than younger ones. One respondent states that; "Milder winters. December and January significantly milder and almost no amounts of snow. The southern climate zone has migrated northwards, for sure." Another dimension was just generally warmer. Some respondents explicitly reported warmer summers or warmer springs, but this was not very common. The dimension earlier harvests, which is a result of warmer climate, was also found several times in the material.

Changing patterns: this subtheme expresses changes that can be seen as some type of "patterns", but which are not explicitly related to warmer climate. A very common dimension is periodized weather which mostly relates to precipitation patterns. The respondents believe that long dry periods, "droughts", and long, rainy periods have been more common than before. Particularly described by one respondent as "The periods with rain or dry weather are longer". Some respondents have used the term periodized, others have described the phenomena with

other words. Changing wind patterns was also reported, but only in a few cases. Drier summers, and especially, springs, was noted by some respondents whereas similar observations for autumns and winters were not made.

Extreme & unpredictable weather: this subtheme is closely related to the previous one, with the distinction that this subtheme covers changes which can be seen more of as extreme events. Results reflect that heavy rains is a common dimension as well as extreme droughts. It was also expressed in the material that the weather has become "unpredictable" and never "normal" for a long period. One respondent says; "More extreme weather, namely cloudbursts, storms, etc, which are close to disasters."

No climate change

Two subthemes emerged, *no perceived changes* and *natural variations.*

No perceived changes: some respondents assert that they have not noted any changes, sometimes with the add that they have noted some changes but not in the latest 15 years. That most years are normal is also expressed. For example; "No, nothing that I can interpret any pattern from."

Natural variations: the label of this subtheme can be interpreted in different ways. Since the question was not for which reason the respondent think that climate has changed but whether they had experienced any changes, the interpretation was made accordingly. Therefore, when natural variations, or similar expressions was found it was interpreted as if the respondent had witnessed variations over the years but that this was not part of climate change. For example, one respondent answered; "Most years are quite normal if you consider the yields. Some years stand out, 1992, 2001, 2017, 2018."

Figure 4: Tag cloud analysis displays the frequency of different themes in the respondents` replies, with regard to question 5b.

The tag cloud analysis illustrates that the term "periodized" is the most common theme. More extreme and milder winters are also very common.

4.2 Research question 2:

To which extent do farmers believe that the climate will change in the future?

6. What do you think the climate will be like in southern Sweden, 30 years from now?

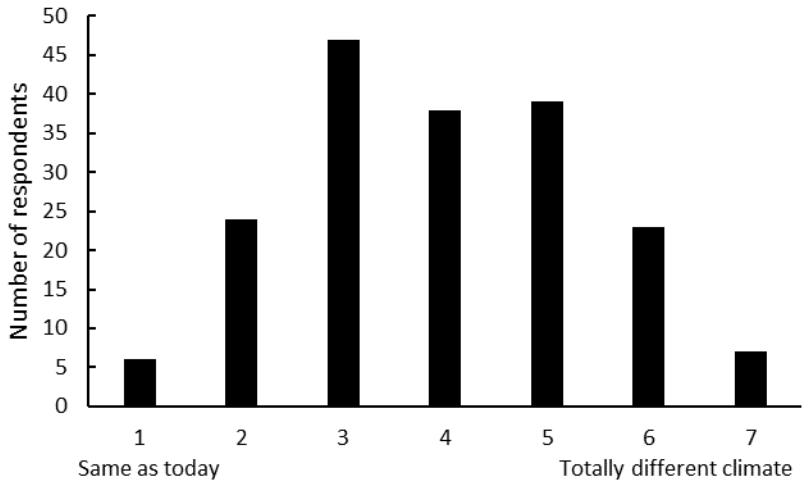

Figure 5: Estimated climate changes for southern Sweden, 30 years from now. 1 stands for no changes and 7 stands for large changes. Number of respondents: 184.

Of the total respondents, 97% believe that the climate will change in the future. Most of the answers are found in category 3, 4 and 5, which stands for moderate changes. Of all the answers, 67% are found in some of these categories. Category 1 (no changes) and category 7 (large changes) has almost the same reply rate, 3% versus 4%.

7. If you believe that the climate will change during coming decades, which changes do you think will occur?

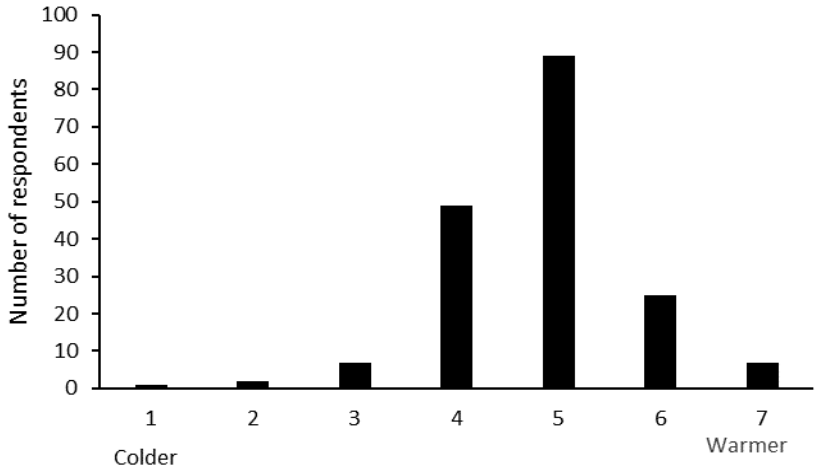

Figure 6: Estimated changes in the temperature climate, in southern Sweden, 30 years from now. 1 stands for colder, 7 stands for warmer and 4 stands for neutral/no changes. Number of respondents: 180.

Category 5 is by far the most chosen answer with 49% of the respondents choosing this answer. It can be said to express "slightly warmer climate". A substantial share of the respondents, 27%, thinks that the temperature climate will stay the same (category 4) and 6% of the respondents believes it will be colder in the future (category 1, 2 and 3). Almost one fifth, 18%, thinks it will be significantly warmer (category 6 and 7).

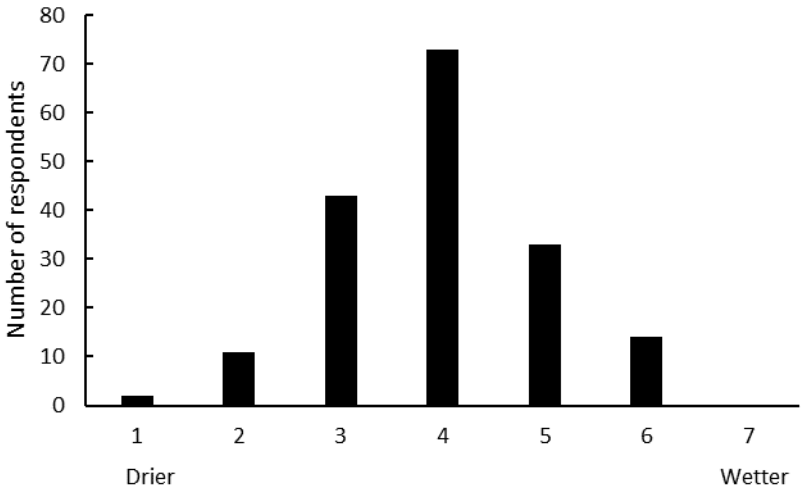

Figure 7: Estimated changes in the precipitation pattern, 30 years from now. 1 stands for drier, 7 stands for wetter and 4 stands for neutral/no changes. Number of respondents: 176.

Category 4 (no changes) is the most common answer with 44%. Slightly more respondents believe that it will be drier, rather than wetter, 32% (category 1, 2 and 3) versus 27% (category 5, 6 and 7). No respondent chose category 7.

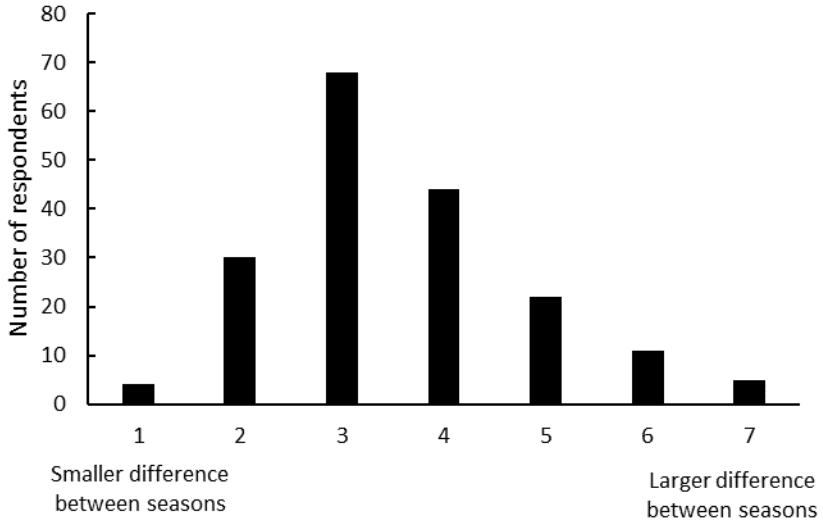

Figure 8: Estimated changes in differences between seasons, 30 years from now. 1 stands for smaller differences between seasons, 7 stands for larger differences between seasons and 4 stands for neutral/no changes. Number of respondents: 184.

The respondents generally think that the differences between seasons (like summer and winter) will be smaller in the future. The most chosen category is 3, with 37% of the replies. Overall, 55% of respondents believe in smaller seasonal differences (categories 1, 2 and 3), 24% do not believe in any changes (category 4) and 26% believes in larger seasonal differences (categories 5, 6 and 7).

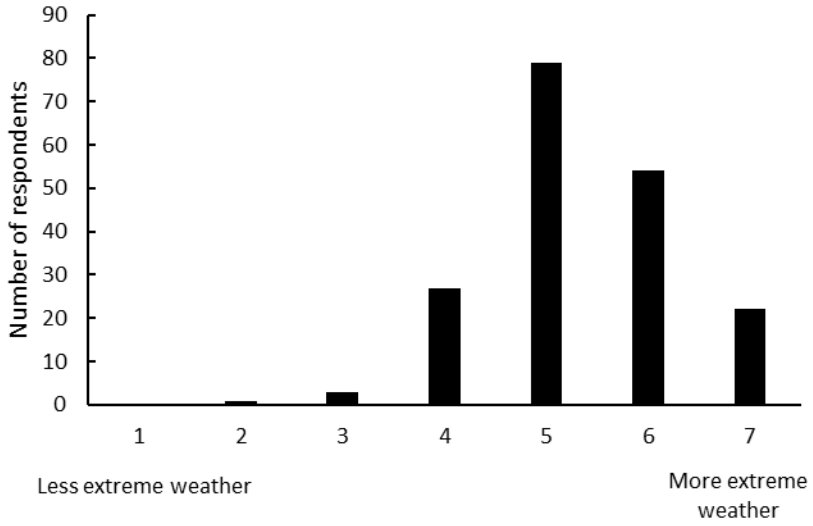

Figure 9: Estimated change in the occurrence of extreme weather. 1 stands for less extreme weather, 7 stands for more extreme weather and 4 stands for neutral/no changes. Number of respondents: 186.

The results show that most of the farmers (83%) believe that more extreme weather events will occur in the future (category 5, 6 and 7). Only 2% think it will become less extreme.

8. How do you think that eventual climate changes will affect agriculture in Scania?

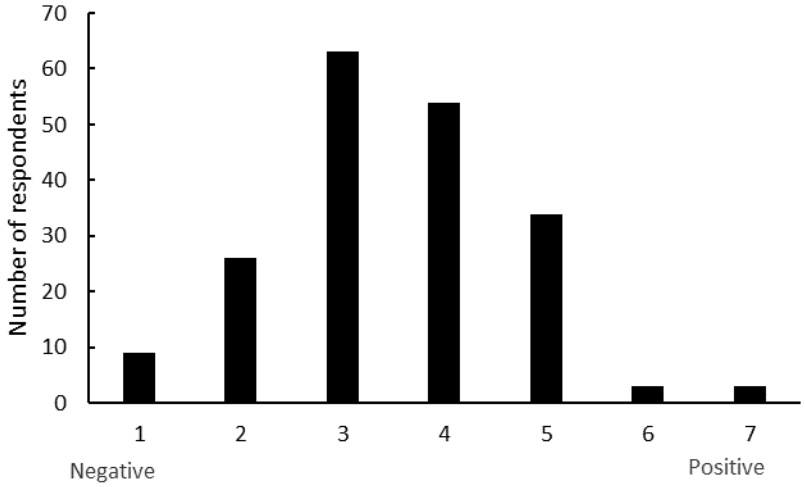

Figure 10: Estimated effect of climate changes on agriculture in Scania. 1 stands for negative, 7 stands for positive and 4 stands for neutral/no changes. Number of respondents: 192.

The majority of the respondents believe that climate change will affect agriculture in Scania negatively, with 51% of the answers (category 1, 2 and 3). Those who think that the effect will be positive are 21% and 28% do not think there will be any effect of climate change.

8b. Why do you think that climate change will have such an effect (positive or negative as indicated by your answer on the previous question) on agriculture in Scania?

Most of the topics mentioned for this question are associated with something negative, as indicated by the respondent's answers on question 8a. Frequently mentioned negative topics are; extreme weather, periodized weather and worse problems with pests. The positive topics include longer growing season and new crops.

9a. Which effects do you think climate change will have on agriculture? Focus on what you think. You can tick all boxes you think are relevant.

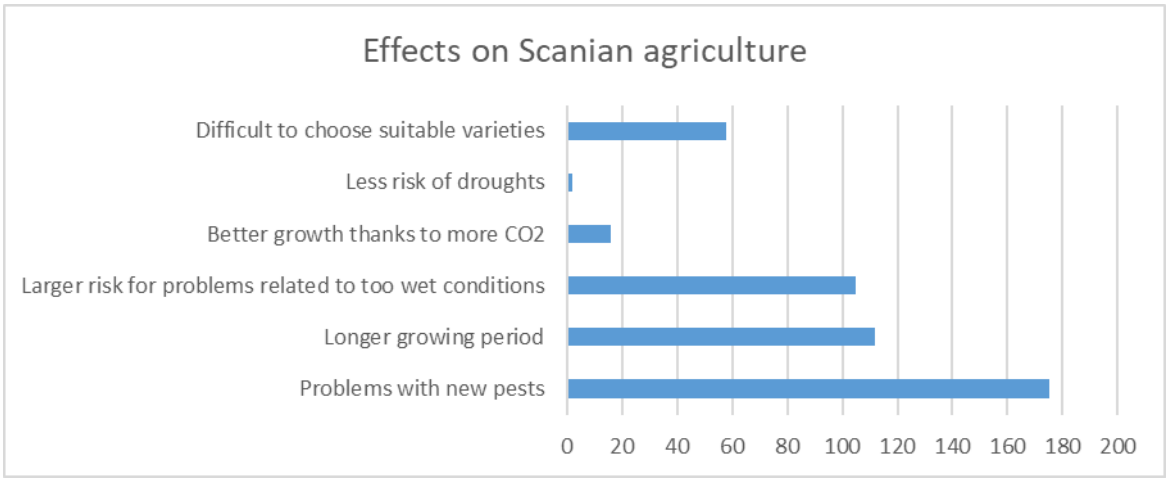

Figure 11: Assumed effects of climate change upon agriculture in Scania. The respondents can choose all statements, thus the total number of answers is higher than the number of respondents in the study.

The effect that most farmers (82%) think will be the outcome of climate change are problems with new pests and crop diseases. The second most anticipated effect is a longer growing season, appreciated by 52% of the respondents. Problem related to wetter conditions is assumed by 49%. The other alternatives are seen as relevant by relatively few respondents. Difficulties to choose suitable varieties is expected by 27% of the respondents, better growth thanks to more CO_2 is anticipated by 7% of the respondents and less risk for drought only gather 1% of the respondents.

14. If you think that the climate is changing now and, in the future, what do you think the reasons are?

Table 2. *IPA illustrating themes connected to beliefs of the causes of climate change. Three different detail levels are displayed, with regard to question 14.*

Superordinate themes	**Subthemes**	**Dimensions**
Anthropogenic climate change	Fossil fuel combustion	Elevated atmospheric CO_2 content, transports, unnecessary overconsumption, other greenhouse gases, poor awareness & legislation, overpopulation
	Land use	Less vegetation, deforestation, desertification, city expansion, overpopulation, inefficient agriculture
	Other human activities	Wars, nuclear tests, poisons, ozone layer depletion, radiation from satellites
No anthropogenic climate change	Natural variations	Natural cycles, huge climate changes in the past, solar activity, changing currents & winds
	No changing climate	Short term variations, speculations, no changes

Two superordinate themes emerged; *anthropogenic climate change* and *no anthropogenic climate change.*

Anthropogenic climate change

Three subthemes appeared; *fossil fuel combustion, land use* and *other human activities.*

Fossil fuel combustion: many dimensions connected to fossil fuel combustion were detected. Elevated CO_2 levels was mentioned frequently, although any reference to "atmosphere" or "atmospheric" was not always seen. Perhaps this was implicit. Transports was a common dimension, illustrated by one respondent; "The cities large vehicle traffic", or another one; "We have combusted way too much fossil energy during a short period of time. And I believe air traffics share is considerable. And then they blame the ruminants."

Unnecessary overconsumption of products was another common dimension, but no specific products were mentioned here, just "crap" and that products lifetimes are too short. That people buy things they don't need was perceived as a problem. Other greenhouse gases than CO_2 was mentioned very sparsely, but it occurred. Poor awareness and legislation is one dimension of why so much fossil fuels has been combusted, which appeared in the material. Overpopulation appears frequently in the material but was hard to place in any of the subthemes. It is never

explicitly mentioned in the material that too many people lead to too high fossil fuel combustion, instead overpopulation is usually mentioned on its own in a separate sentence.

Land use: a significant share of the respondents view land use changes as an important contributor to climate change and all of the dimensions of this subtheme are linked to a diminishing vegetation cover. Deforestation is the most important dimension, but desertification and city expansion are also found. Farmers practices also seem to be of importance as one farmer state; "Too much organic farmers".

Other human activities: this subtheme includes various dimensions which cannot be placed in a homogenized category. The common denominator is that all dimensions are linked to human activities. The dimensions all appear to be rather scary subjects such as wars, nuclear tests and toxic substances. Ozone layer depletion is also linked to climate change by one respondent as well as radiation from satellites.

No anthropogenic climate change

This superordinate theme includes two subthemes; *natural variations* and *no changing climate.*

Natural variations: the dimensions within this theme is closely related and it's a blend of just statements that climate change is natural and arguments for why it's natural. Some respondents refer to that the climate has varied greatly in Earths past; "The climate has always changed. We were a burning ball in the beginning. We have had two Ice Ages. Everything before humanity." Solar activity is mentioned as a reason to why we experience climate change, as well as changing winds and currents.

No changing climate: some respondents did not think that there was any climate change. Such answers are gathered under this subtheme. The dimensions include reasoning like; what we have experienced during recent years are only short time variations and no real climate change and that the future climate change predictions are mainly guesses and/or speculations.

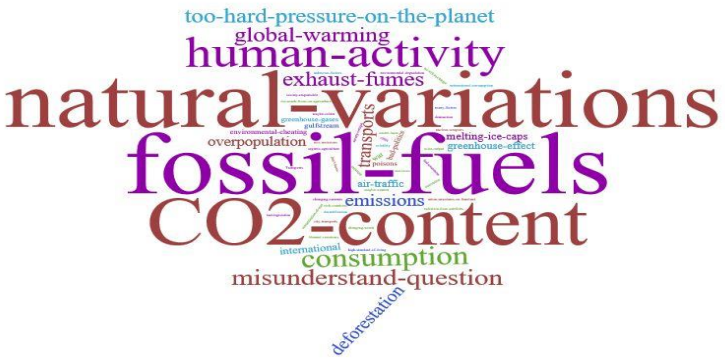

Figure 12: Tag cloud visualizing the frequency of different themes, with regard to question 14.

The tag cloud analysis paints a similar picture as the IPA. It can be seen that natural variations are embraced by many respondents but if the two similar themes of fossil fuels and CO_2 content would have been labelled unison, that word would have been significantly larger. Therefore, while analysing the tag cloud, it is important to keep in mind that many factors related to human activities, and especially fossil fuel combustion are spread out with different words.

4.3 Research question 3:

What are the farmers attitudes towards the authorities stand in the climate change issue? (Question 10, 11, 12 13, 15 and 16 in the questionnaire).

10. What do you think about the amount of information that authorities are offering farmers, regarding climate change?

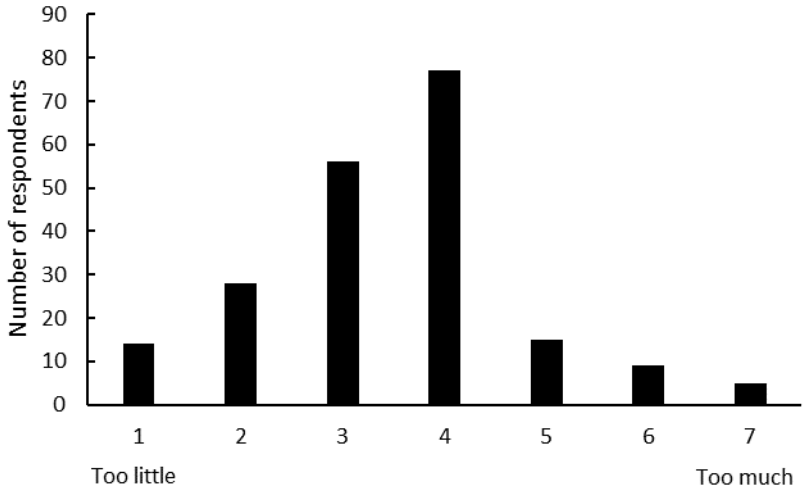

Figure 13: Farmers content with the amount of information, about climate change, provided by authorities. 1 stands for too little, 7 stands for too much and 4 stands for neutral/good amount. Number of respondents: 204.

The respondents are generally quite satisfied with the amount of information that the authorities are offering them since category 4 (the right amount) is chosen by 38% of the respondents. There are more respondents thinking that there is too little, (48%; category 1, 2 and 3) information rather than too much (14% ;category 5, 6 and 7).

11. What do you think about the relevance of the information that authorities are offering to farmers, regarding climate change?

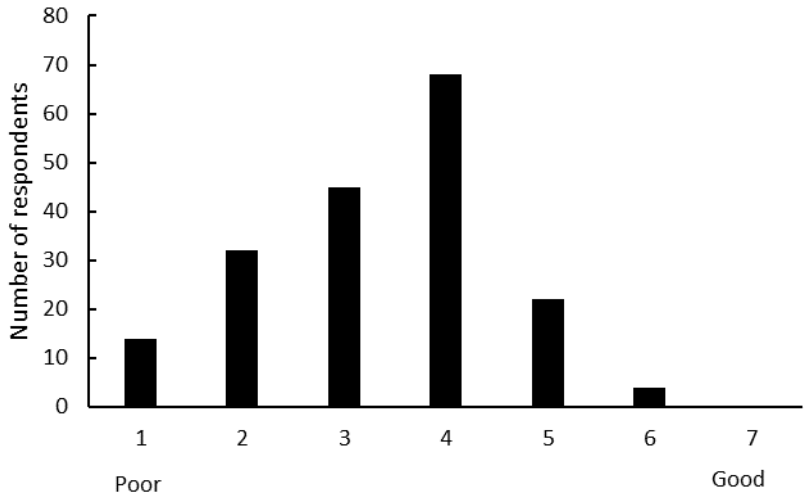

Figure 14: Estimated relevance of the information authorities are offering Scanian farmers. 1 stands for poor, 7 stands for good and 4 stands for neutral/neither good or bad. Number of respondents: 185.

The distribution in figure 14 shows that the respondents are less satisfied with the relevance of the information than the quantity. Half of the respondents, 49%, think that the information is more towards the poor side (category 1, 2 and 3), 14% think the information is somewhat good (5, 6 and 7) and 37% think it is neither good, nor bad (category 4). Category 7, the most positive category, receive no answers at all. The most negative category, on the other hand, receives 7.5% of the respondents' votes.

12. What do you think about the resources that society spends in order to prevent future climate change?

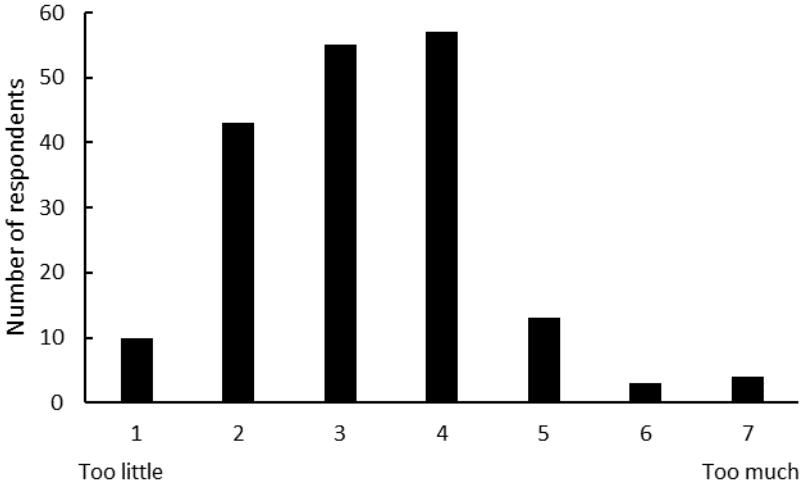

Figure 15: Farmers perceptions of the resources society devotes to prevent climate change. 1 stands for too little, 7 stands for too much and 4 stands for neutral/good amount. Number of respondents: 185.

The results show that the majority of the respondents think that society devote too little resources to prevent climate change. However, they think that it is fairly close to what would be considered appropriate. Of the respondents, 60% chose either 3 (a little too little) or 4 (good amount). Only 11% think that too much resources are spent on preventing climate change (category 5, 6 and 7).

13. What do you think about the resources that society spends in order to adapt to future climate change?

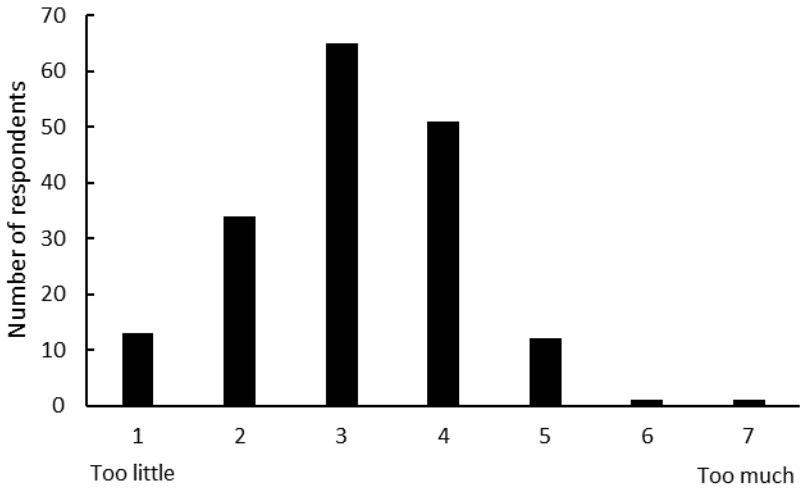

Figure 16: Farmers perceptions of the resources society devote to adapt to future climate change. 1 stands for too little, 7 stands for too much and 4 stands for neutral/appropriate. Number of respondents: 177.

The shape of this figure is similar to the previous one (figure 15), although on this one a slightly larger share think that too little resources are used. Category 3 gathers most assent, 37%. Compared to the previous question, category 3 and 4 stands for 66% here, instead of 60%. An even smaller share than for the previous question think that too much resources are spent, 8% (category 5, 6 and 7).

15. If we face future climate change, how will Scanian farmers be affected by the fact that Sweden is a member of the EU?

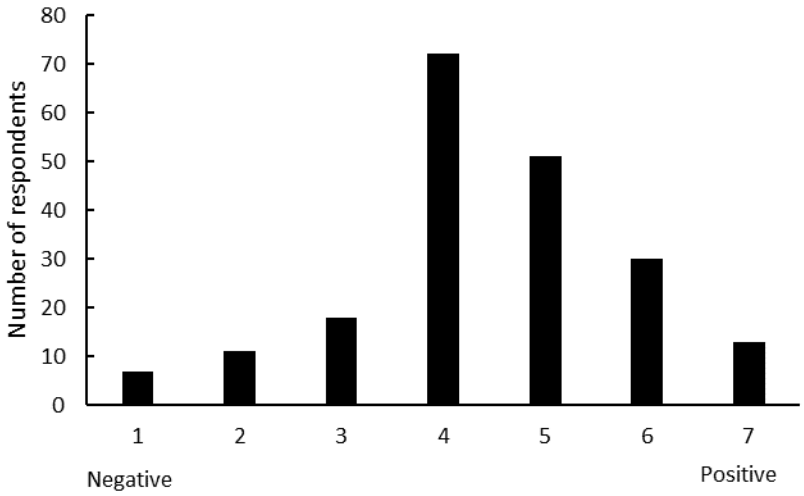

Figure 17: The attitude towards the Swedish EU-membership, in light of future climate change. 1 stands for negative, 7 stands for positive and 4 stands for neutral. Number of respondents: 202.

The respondents are more positive than negative towards the EU-membership, under a changing climate. The positive categories (5, 6 and 7) got 47% of the replies. The negative categories (1, 2 and 3) got 18% and the remaining, 35%, are neutral.

16. What do you think about the fact that Sweden is a member of the EU, from an overall sustainability perspective for Swedish agriculture?

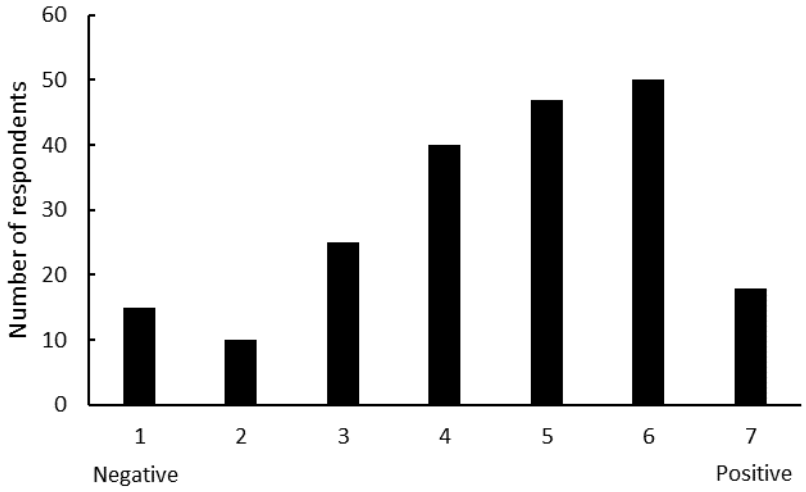

Figure 18: The attitude towards the EU-membership from an overall sustainability perspective, for the Swedish agriculture. 1 stands for negative, 7 stands for positive and 4 stands for neutral. Number of respondents: 205.

The diagram differs from the previous one in that the flanks gets more support, both the negative and positive, but especially the positive. Of the respondents, 56% are positive (5, 6 and 7), 24% are negative and the remaining 20% are neutral.

4.4 Research question 4

To which extent has farmers begun to adapt to a changing climate and which type of adaptations do they prefer to invest in? How do these measures compare to agroecological principles? (Question 17 and 18 in the questionnaire).

17. To which extent have you adapted to a changing climate?

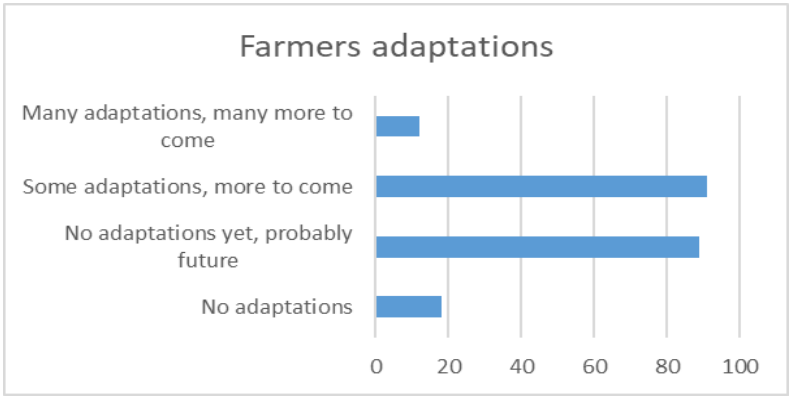

Figure 19: Degree of adaptation to climate change. Number of respondents: 210.

In this question, the respondents were to assess to which extent they have adapted to climate change and how much they assess that they will do so in the future. Most respondents choose the medium alternatives, either no adaptations yet but that they are likely to adapt in the future, or some adaptations already and more to come. Only 8,5% ticked the box which says that they have not done any adaptations yet and will probably not need to do any in the future either. Thus, 92,5% has either already done adaptations to climate change or believe that they will have to do it in the future.

18. If you have started to adapt to a changing climate, which measures have you taken?

Table 3. *IPA illustrating farmers` adaptation preferences. Three different detail levels are displayed, with regard to question 18.*

Superordinate themes	**Subthemes**	**Dimensions**
Water management	Drainage	Prepare for heavy precipitation, keep fields drained, improved pipes
	Irrigation	Prepare for droughts, secure water availability, irrigation infrastructure investments
Crop rotation strategies	New crops	Decrease risk, drought tolerance, new opportunities, biodiversity improvement
	New varieties	Decrease risk for crop failure
	Cover crops	Keep vegetation cover
Field/Soil management	Reduced soil disturbance	Conservation (soil, nutrients, carbon), efficiency, biodiversity
	Other measures	Combat invasive weeds, heavy liming, larger machines
Miscellaneous	Self-sufficiency	Solar power, biomass fuels
	Knowledge	Education to better chose strategies
	Risk minimization	Increased storage capacity, secure foreign currencies

Water Management

The first superordinate theme regards water. Both too little and too much water can be a problem for the farmer and therefore they spend much of their adaptation resources to manage water, satisfactory.

Two subthemes appeared, *drainage* and *irrigation.*

Drainage: the motives behind investments in drainage is to prepare for heavy precipitation and keep the fields drained. It is seldom explained why this is a good strategy, but the farmers consider it due to expected higher or more intensive precipitation in the future. The reasoning to why it is good to keep the fields drained is probably taken for granted that the reader know of. Sometimes it is mentioned that the drainage system is kept updated but sometimes it is also mentioned that new drainage pipes are laid closer than before and that larger pipes are chosen.

Irrigation: this subtheme is also very common. Dimensions include why irrigation is important and which type of irrigation that is chosen. The farmers want to prepare for future droughts and therefore they invest in irrigation. It is a physical infrastructure investment but also a legal affair since they want to make sure they are allowed to use water for irrigation purposes. Dams are built to receive surplus precipitation to be used in times of droughts. There is a link to the previous subtheme, drainage, since the dams are also used to receive excess water when it is

rainy and thereby, they have a multipurpose. One respondent explains; “Trenching, pipelaying and built water dams which can take care of heavy rains and be used for irrigation.”

Crop rotation strategies

The second superordinate theme for this question is *crop rotation strategies.* It refers to which strategies farmers use for their crop choice. It is evident that some strategies are meant to ripe the benefits from a warming climate, but the majority are developed to reduce future risks. Three subthemes emerged; *new crops, new varieties* and *catch crops.*

New crops: this subtheme refer to different crop species, not previously grown but also the exclusion of some previously grown species. One respondent report; “Abolished the sensitive sugar beet cultivation.” Drought tolerance is a recurring dimension, mostly referring to abolishment of previous crops but new possibilities are also mentioned, for example sorghum. It is mentioned that a warmer climate will offer the opportunity to grow crops which so far have been difficult to grow in Scania, but it seems as none or very few has done it yet.

New varieties: this subtheme refer to the practice of growing a different variety of a crop that is already grown. It is even more connected with risk minimization than the previous subtheme. It seems as no new varieties has been chosen based on their potential for a very high yield, better demand on the market, etc. New varieties are chosen based on their capacity to withstand different environmental stresses, mostly drought but also some other.

Catch crops: catch crops often have many purposes. However, it is rarely stated why catch crops are incorporated in the crop rotation strategies. Sometimes it is mentioned that it is in order to keep the fields with a vegetation cover.

Field/Soil Management

This superordinate theme refers to which strategies farmers consider that are related to the cultivation but not so much to the actual crops. This aspect is also important, and two subthemes emerged; *reduced soil disturbance* and *other measures.*

Reduced soil disturbance: this subtheme is closely connected to conservation agriculture. Different respondents emphasize conservation of different resources. The conservation is mostly achieved by less driving, tilling and so on, which conserves soil (less erosion) and nutrients (less leaching). Some emphasize conservation of a good soil structure rather than the prevention of topsoil being eroded by wind. One respondent explain; “Large efforts to minimize soil compaction and structural damage. Large focus on light machines.” Except for conservation purposes, efficiency with both their time and financial resources is a dimension for this subtheme. Less soil disturbance means that working hours, fuel costs, etc can be saved.

Other measures: this subtheme include dimensions that are difficult to find any connection between, thereof the label of the subtheme. However, the subtheme is related to the superordinate theme since all the dimensions herein is related to measures taken within the field. Three, very different, dimensions appeared for this subtheme. One is to combat invasive weeds. It is not elaborated in detail, but it can be assumed that the farmer suspect that invasive weeds can become a greater problem with climate change, since it was reported for this

question. Heavy liming was also mentioned and the explanation is that the farmer believe that the soil then will become more resistant to extreme weather conditions. Larger machines is the third dimension. It is connected to an apprehension that the number of days in a year when different measures are optimal to implement will decrease. Therefore, heavier machines will be a logical adaptation in order to be able to get things done faster.

Miscellaneous

The last superordinate theme includes three different subthemes which cannot be placed under any of the other superordinate themes. As they are not related to each other the superordinate theme is labelled miscellaneous.

Self-sufficiency: it was not stated by any respondent that they invested in self-sufficiency as an adaptation to future societal changes which would benefit such investments. Examples on what such changes could be are higher electricity prices and an unreliable access. Since it was not stated, one has to be careful to attribute their adaptations to such circumstances. Another possibility is that the respondents have misunderstood the question and reported measures they have taken, not as an adaptation to climate change, but as a prevention of climate change. Solar power is a good example and an important dimension of this subtheme. Some may have installed it as an adaptation to the effects climate change will bring but other may have installed it as a contribution to prevent climate change. Some may also have installed it solely for economic reasons. Except for solar power, biofuel production is a dimension of this subtheme and the same reasoning as outlined above applies to biofuel production.

Knowledge: the second subtheme is knowledge and there are only one wide gripping dimension found. To educate yourself is seen as positive and important in order to assess which adaptation measures that are worth investing in. Knowledge can be gained in different forums, such as courses or home based internet studies.

Risk minimization: risk minimization can be seen in other parts of the material, as well but in those cases other subthemes are more prominent. Two dimensions has been found. One regards to invest in a larger storage capacity, which reduce the risk of getting the harvest spoiled. The other dimension is a strictly financial measure, to secure foreign currencies. It can be assumed that climate change might influence the value of different currencies and as a measure to avoid negative surprises, in that regard, one can make some kind of insurance, even though it is not explained how this is done.

The tag cloud show that drainage is the most mentioned theme, followed by irrigation (see figure 20 below).

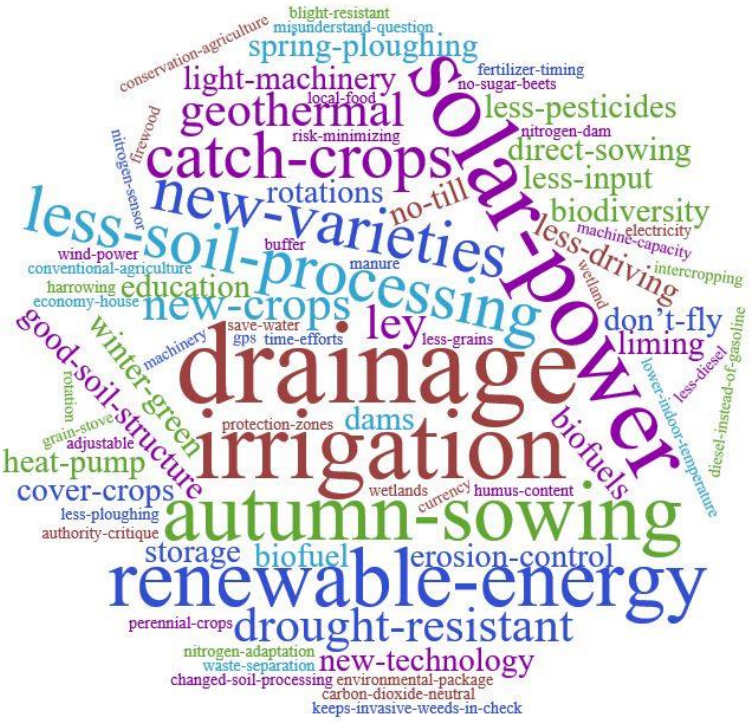

Figure 20: Tag cloud visualizing the frequency of common themes, with regard to question 18.

5 Discussion

5.1 Reliability and validity

High reliability requires the exclusion of "chance" factors, so that the study can be described as stable (Trost, 2001). With questionnaires, some such factors are naturally excluded, such as the "interviewer effect". Others are more difficult to control. For example, some respondents may have gone through an exhausting week prior to filling in a questionnaire, others may be a few days into their vacation and feel very relaxed (ibid). In some cases, it is asserted that high reliability requires that the same study can be repeated, yielding similar results. Thus, the reliability of this study could perhaps be questioned based on the extreme drought prevalent during the time the respondents answered the questionnaires, which may have affected their answers. However, this aspect of reliability is debated and many scholars argue that people are constantly involved in processes changing their lives and opinions. Thus, a similar result from a repeated study is not required to label a study reliable. The time scale is an important factor, in this regard. The results should not change substantially "from one day to another" but for longer periods, it is considered acceptable with a different result (Trost, 2001). How the results of this study were affected by drought can only be answered by repeating the study. However, it can be speculated that the respondents express more concern over future droughts than what would have been the case if they filled in the questionnaire before the drought occurred. Another important factor, related to reliability, is misunderstandings. A high degree of misunderstandings results in a low degree of reliability. This should be avoided by using as clear language and short sentences as possible (Trost, 2001). Some respondents have misunderstood some of the questions. It has not been a major issue, but for some questions it has been noted that a few percent of the respondents have written irrelevant answers. One of the most obvious examples regards the questions about adaptation and mitigation. It seems as if these concepts have been confused, in some cases.

Validity refers to that a question, or a study, measure what is actually meant to be measured. (Ejlertsson, 2005). Often, low validity is caused by questions formulated the wrong way. In some cases, there might not be an obvious "fault" with the question, but the respondents can, anyway, for some reason, state an incorrect answer (ibid). One example: if respondents are asked how many times they have used their credit card the last month, this can be checked with the bank. If it is found that their answers are not in line with the data from the bank, the validity is low (ibid). Thus, to avoid low validity is not only about formulating understandable and precise questions. One should also consider whether (or, if possible, measure) if the respondents can or want to state a truthful answer.

Whether the validity of this study is high is probably best examined by comparing the research questions to the questions used in the questionnaire. Are the chosen questionnaire questions well formulated in order to answer the research questions? There are cases where certain questionnaire questions could have been replaced by others, excluded or where more questions could have been added to examine more aspects, but in general the questions are well adapted

to answer the research questions.It is also important to reflect on whether there are questions that respondents have not answered truthfully or not been able to assess correctly. The former is unlikely since no "threatening" questions are included. Examples on such are questions about sex, crime and drugs (Ejlertsson, 2005). The latter is possible, but it is important to stress that most questions does not ask about factual conditions, but opinions. For example, if the question of how the respondents think that the climate has changed during the last 15 years was put differently, it could be an example of a question which the respondents are not able to answer correctly. As it is put now, this is not a problem since the question is about their perceptions and not factual conditions.

5.2 Response rates & generalizations

There are a number of different factors to consider when making generalizations from a study. Unbound, random selection should usually represent the population well, but if the selection is too small, both in actual numbers and percentages of the population, it can be biased (Esaisson et al., 2005). The response rate is also of high importance. The optimal result is a 100% response rate, but this is seldom reached with mailed questionnaires. Today, 70% is considered a good response rate (the response rate has decreased significantly since the 1950s) but often, it is found to be much lower (Trost, 2001; Bernard, 2006). The reason a low response rate is a problem is that it is likely that the answers received do not represent the whole selection. With a low response rate, it might be that certain opinions are over or underrepresented (Esiasson, et al., 2005). Many measures can be taken to increase response rate, these inclunde; optimizing the questionnaire (it is important) and can be done by using for example Dillmans Total Design Model (Bernard, 2006). Sending remainders is another measure which should be considered. There are different opinions on how many remainders you should be sent (Trost, 2001; Ejlertsson, 2005). It is not governed only by the study's budget but also by ethical and statistical arguments (whether it is worth the effort and cost). Some assert that two remainders is a good choice from an ethical (more than two can be intruding to a person who don't want to participate) and statistical point of view. A third remainder rarely elevate the response rate substantially (Ejlertsson, 2005).

Except for maximizing the response rate, three measures are available to minimize bias regarding the retrieved answers in relation to the selection, and thereby the population, of the study. Changing the definition of the population can be used if it is found that certain groups are very underrepresented. A response analysis can be made, which reveals if the subjects who have responded differ from the selection in terms of demographic data. If that is the case a stratification of the material can be done so that the answers of underrepresented groups are weighed up (Esaiasson et al., 2005).

5.3 Response analysis

The response analysis of the current study suggests that there are no considerable discrepancies between the farmers who answered the questionnaire and those who did not. All relevant demographic factors have not been investigated, though. The ones of most importance are

generally age and gender (Esaisson et al., 2005). In terms of gender, almost the entire selection is made up by men. No analysis is thus needed, in this regard. In terms of age, the mean year of birth of the responding subjects are very close to the mean for the whole selection (1959 to 1961). It suggests that older farmers are slightly more inclined to answer, but the difference is small. Examples of other relevant variables to look at when doing a response analysis are ethnicity, education and economic situation, but for this study, such data was not available.

5.4 Research question 1

The farmers report significant changes in the climate over the last 15 years. At first, it seems as the question is very straightforward, but it may actually be interpreted in different ways, which may affect the results. For example, some may compare the climate of a few years around 2003 to the climate the last few years. Some may incorporate a larger span of years, let's say 2000-2007 to 2011-2018. Some may not think in such terms and just go on "feeling" how it used to be back then and how it is now. Some older farmers may also think of a much greater time span, even though it is stated in the question to focus on the last 15 years. Even though this discrepancy can be problematic for the interpretation of the respondents` answers it is important to remember that the aim is to examine their opinions, thoughts and feelings around climate change, not how it actually has been. I have chosen to interpret the answers as if the respondents have compared a fairly short time span around 15 years ago with a fairly short time span in the last years, but I am aware that some respondents may have reasoned differently.

On the scale 1-7, where 1 equals no changes and 7 equals large changes, the category chosen by most respondents is 5. Even though it is not labelled, category 5 can be described as something like "fairly significant changes". The shape of the diagram is somewhat surprising (see figure 3). It was expected that more respondents would choose a lower number since my preunderstanding of climate change was that no substantial changes have occurred during the last 15 years, even though I know that there has been some "extreme events" (as the hurricane Gudrun, in 2005) which has gained a lot of attention. It really seems as if the farmers believe that the climate has changed and only in such a short period as 15-20 years. How could that be? The scope of the current thesis has left no room to in depth analyses on why the farmers think as they do. However, this is an interesting topic which could be the focus of further studies. Perhaps psychology would be a fruitful aspect to examine how people remember things, how they reason when a question is asked to them in a particular context, how different events affect people's reasoning, etc. The time limitations of the current study has only allowed the farmers` answers to be compared with the results of similar studies.

Except from stating how large changes the farmers have noticed over the last 15 years, they were also asked to state which types of changes they have noticed. As this question was answered by the respondent's own text, it was analysed with IPA.The most common themes, from the IPA, were "periodized", followed by "more extreme" and "milder winters". Therefore, it can be rewarding to look at these specific themes in order to examine whether support for them exist in the literature. Firstly, the latest years has shown slightly higher winter temperatures than the mean values from about 15 years ago (SMHI, c 2018) and less maximum

snow depth (SMHI, d 2018). It was noticed that the theme "milder winters" was reported to a higher degree by older than younger farmers. A possible explanation could be that some of the older farmers extend their reference period longer than the last 15 years. It has not been studied in detail how cold the winters were in the 1970s, for example, but the normal period of 1961-1990 was both colder and drier than the period from 1990 and onwards. Periodized and more extreme is more difficult to analyse than milder winters. That is because the definition of these themes are more problematic. According to Sverker Hellström[1], climatologist at SMHI, there are theories that the climate has been more periodized but they are not yet validated due to too limited observation data. The main argument constitutes the fact that the Arctic region is warming more rapidly than the Tropics. That would, theoretically, impact large scale flow patterns and make such flows weaker. A result could then be a more periodized climate with "locked" weather events, such as droughts and long rain periods. The evidence that this is already happening is scarce (Barnes & Screen, 2015). Interestingly, one study found, in direct contrast to the farmers opinions, that both dry spells and wet periods has become shorter over Scandinavia, during the period 1960-2009 (Zolina, 2013).

The existing literature on how farmers perceive recent climate change is scarce, at least considering developed nations. For developing nations, there is a bit more documentation available. There is one study from 2008, in which French, German and Italian wine growers were asked a very similar question about past climate change, as asked in this study (Battaglini et al., 2009). The question was: "Have you noticed a change in the climate conditions of your region over the last 10–20 years?" However, a fundamental difference is that it seems as if the wine growers were not asked to grade how large changes they had experienced. It was a yes or no question. The results are well in line with the current study. On average, 83% of the respondents asserted that they had experienced changes in the climate (Battaglini et al., 2009). For Germany, the country which is closest to Sweden, 94% reported that they had experienced a changing climate, compared to 92% of the respondents from the current study. Perhaps the higher frequency of German respondents, compared to French and Italian, to recognize past climate change can partly be attributed to a stronger warming trend on higher latitudes? It has been observed that higher latitudes warm faster and more then lower latitudes (Deutsch et al., 2008).

The results of 94% of the German farmer respondents who had already noticed climate change, 10 years ago, was a bit surprising. It can be assumed that the topic of climate change was not as familiar as it is today and that potential changes had not been experienced to the same degree as today. How can this high awareness be interpreted? One explanation is that wine growers are very aware of, and sensitive to, changes in the climate (Battaglini et al., 2009) and (Jones et al., 2005). Another, very likely, explanation is that different distribution techniques of questionnaires have been used between the two studies. Battaglini et al used a type called "questionnaires to visitors". This type often yield results which cannot be generalised for the whole population (in this case German wine growers) as those who fill in such questionnaires often are interested in the subject (Ejlertsson, 2005). Another study was conducted in Sardinia, Italy, in 2015. Interviews were used to explore farmers perceptions of climate change. There

[1] Sverker Hellström, SMHI, 2018-10-09

was no question to the Italian farmers very similar to the ones used on past climate change in the current study but it was found that 90% of the Sardinian respondents thought that seasons had changed over the last 20 years and 70% had noticed higher temperatures and more pronounced droughts (Nguyen et al., 2016)

5.5 Research question 2

The respondents are even more convinced that the climate will change in the future than they are that it has already started to change. As much as 97% of the farmers believe in some type of future climate change. They were asked to assess the magnitude of change on a scale 1-7, where 1 corresponds to no changes and 7 corresponds to large changes, and most chose to tick 3. There are no labels for the intermediate numbers (as usual procedure according to Trost, 2001) but it can be suggested that 3 equals something like "small but noticeable changes". The boxes 4 and 5 also receives many votes (see figure 5).

A study conducted in 2009, with dairy farmers from Scotland as respondents found that only half of them thought that temperatures would rise in the future (Barnes & Toma, 2011). In the current study, 67% believed in rising future temperatures. The spatial and temporal differences have obviously led to different results between the two studies and there may be many different reasons for this. It is also interesting to note that even though 97% of the respondents in the current study believed that climate will change in the future, only two thirds thought that temperatures will rise. The analysis can be drawn that close to all of the Scanian cereal farmers believe in climate change but a much lower share believe in one of the most fundamental aspects of scientifically predicted climate change, namely warming. Another study, with farmers in Central California, found that only 37,5% believed that global temperatures are increasing (Haden et al., 2012). It seems likely that this lower degree of belief in global warming is in line with a more climate change sceptical American audience (Stokes, 2015).

Whether the respondents of this study believe that precipitation will increase, or decrease is somewhat ambiguous, most of them think it will stay the same. Moreover, comparison with other studies is not as relevant as for temperatures as precipitation changes is predicted to be regional or even local (Bogren, Gustavsson & Loman, 2014). However, it would have been interesting to look at possible spatial differences in the answers of this study's respondents between those who are located in the wetter, northern, interior parts of the county and those who are situated in drier coastal areas. Perhaps the ones in the southern, drier areas are more sensitive to drought and thus more afraid of a drier future climate? This analysis was not possible to perform due to time limitations, but it is one of many ideas for future studies.

How do the farmers predictions compare to scientific ones? It is hard to tell just from these numbers. There is a scientific consensus that human activities are changing the climate (Cook et al., 2016). It was found that 97% of researchers agreed to this statement (ibid). Interestingly, the share of the farmers who thought that climate will change in the future is also 97%, but the share who thinks it is due to human activities is smaller. There is also a consensus that it is impossible to tell what the climate will look like in the future. It will depend on humanity's future actions, mostly emission rates. Even if this important factor was known, it is impossible

to state the exact conditions 30 years from now, as the present knowledge is too limited to quantify all climatic feedbacks correctly, etc (Bogren, Gustavsson & Loman, 2014).

A report produced by SMHI in 2015 describes scientific predictions for some climatic parameters. Depending on the emissions of greenhouse gases it is thought that the mean temperature for the Scania will increase with 1-1.5 degrees until around 2050, from around 8º C to 9-9.5º C (Ohlsson et al., 2015). Precipitation is also expected to increase. In general, there is an increase in Scania until the mid-century, but it differs between different emission scenarios and the increase is expected to be highest in the northern parts of the county, during winter. Less precipitation will fall as snow, as a result of increasing temperatures. The summer and autumn precipitation are predicted to stay fairly constant. The number of days with more than 10 mm precipitation, the maximal daily precipitation and the maximal precipitation for 7 continuous days are expected to increase but it is unclear if this change comes with any seasonal pattern (Ohlsson et al., 2015).

The respondents of the current study clearly believe that "extreme weather" will become more common in the future and this finding is not unique for this study. In another study, performed with farmers in the "Corn Belt", in USA, it was found that 59% are concerned about future droughts, 52% are concerned about future heat stress and 50% are concerned with more extreme rains, in the future (Arbuckle et al., 2013). There is evidence for "more extreme" future precipitation in the literature (Sillmann & Roeckner, 2007), regarding the unit of Northern Europe but the same study found that the number of consecutive dry days will not increase.

In summary, how does SMHI:s scientific predictions compare with the farmers beliefs? When it comes to temperature, the farmers seem to be a bit conservative as the emission scenarios SMHI has used shows increasing temperatures until the mid-century but only 67% of the farmers stated that they think temperatures will rise. When it comes to precipitation it first seems as if the farmers are generally wrong. Climate models suggest increasing precipitation for Scania, but drier conditions are expected by a higher share of the farmers than wetter. However, if the analysis is deepened their assessment could be more accurate than it seems. As the summer precipitation is expected to stay constant and the temperatures will rise, the result may be drier conditions during summertime. This might also be amplified by more intensive precipitation which can be lost as runoff before it has time to infiltrate the soil.

5.6 Research question 3

The questions examining the farmers perceptions of the authorities work with climate change are number 10, 11, 12, 13, 15, 16. They are grouped into three themes, 1.information 2.prevention, mitigation and adaptation and 3.the EU, of which the first two themes are discussed below.

5.6.1 Information

The Scanian farmers generally think that the amount of information they are provided with from the authorities is satisfactory, but more of the respondents think that the amount is too small, rather than large. When it comes to the relevance of the information they are not as happy. Even though a large number of the respondents think that the information is neither good nor bad, most of them think it is more towards the bad side. From the existing questions in the questionnaire, it is not possible to conclude in detail what this discontent is caused by. Some possible explanations are discussed below, supported by anecdotal evidence from what a few respondents have explained in the last section of the questionnaire, where they were asked to add any remaining thoughts or opinions.

One explanation might be that the predictions are so uncertain. This means that the authorities cannot provide farmers with detailed advice what measures they should take and what they should change in the future. Perhaps that is what the farmers want and if they don't get it, they will be dissatisfied. Another explanation can be a general discontent with authorities. If the respondents think that Swedish authorities are not doing the job they should good enough, they may take the opportunity to complain, even if the discontent is not so much about the particular question. Furthermore, it can concern the emphasis of the information the authorities provide. If the authorities do not have detailed information on how the climate will change in the future and what consequences that will bring to agriculture, they may choose to emphasize other information, which the farmers generally think is not useable or even offensive. For example, one respondent wrote: "too general! A lot of general information of how terrible everything is". Another farmer wrote that the local authorities lacks engagement regarding this issue and think they should shift focus from "nearly police-like supervision" towards arranging more courses, meetings, etc.

There is some evidence that the farmers` satisfaction with the information they get from authorities can be an issue, in other cases as well. A study from Greece found that farmers, and especially organic farmers, are quite dissatisfied with the advisory service they are offered by authorities. On a 1-5 scale on satisfaction, conventional farmers scored 1.63, on average and organic farmers only 1.31 (Charatsari, Papadaki-Klavdianou & Koutsouris, 2012).

5.6.2 Prevention, mitigation and adaptation

At the construction phase of the questionnaires it was expected that the respondents would think that what is done to prevent climate change is enough, or even too much, whereas it was thought that they would regard the adaptation measures too weak. An American study (Arbuckle et al. 2013) suggests that farmers do not think that society must spend more resources to prevent climate change. It was therein found that only 23% of the farmers in the Midwestern states agreed that the "Government should do more to reduce greenhouse gas emissions and other potential sources of climate change" (Arbuckle et al., 2013). On the other hand, there is evidence that climate change concern people. A British study found that people are increasingly willing to accept nuclear power, in order to prevent climate change (Corner, 2011).

The reasoning behind the expectations that the respondents would think that enough is done to prevent climate change was that the farmers would think that Sweden already does much to reduce its emissions while other countries are not doing enough. As Sweden is a small emitter of GHG, globally, it was also thought that the farmers would reason that it doesn't make much difference even if Sweden can reduce emissions further. This attitude is common (according to the authors own experience) among "ordinary" people and it was thus thought that many of the farmers would reason similarly. Further, one measure in order to decrease net emissions from a country is to apply transformations in agriculture. If the respondents view such measures as damaging for their economy, they could be negative towards them. Some respondents of the current study also make such claims, for example that it is not that relevant what a small nation like Sweden does and that less focus should be on how agriculture can reduce its contributions to climate change.

The results from the questionnaires do not support abovementioned reasoning. The farmers definitely think that too little resources are spent to prevent climate change. This benevolent attitude might be useful to possess knowledge about for future investments, as the authorities now have information that supports an assumption that farmers in Scania are generally positive to actions and policies that would lead to less greenhouse gas emissions. How come the farmers still believe that too little resources are spent to prevent climate change, despite the hypothesis that suggested the opposite, based on the reasoning above?

This question cannot be entirely answered herein, only a few, brief suggestions can be made. Perhaps the farmers believe that climate change will affect society in general, and agriculture in particular, in such a severe way that everything possible must be done to mitigate the changes? Their answers on the question of whether agriculture in Scania will be affected positively or negatively by climate change, partly support that. Most of them believe that the negative consequences will outweigh the positive, but there are no indications that they think it will be significantly harmful. It is also possible that they reason that they, as farmers, already does their share of the work and that the rest of society now has to step up their efforts. The question is formulated in such a way that this reasoning very well could be valid for some respondents.

No conclusions about this aspect on why farmers generally think that too little resources are spent to prevent climate change can be presented in the current study, but it is one of many aspects which would be interesting to examine in future studies.Either way, it would be one of many interesting properties illuminated in this report, but not investigated in depth, that could be explored further in future studies.

5.7 Research question 4

It was found that the vast majority of the participants in this study (92,5%) had either already made adaptations to climate change or considered doing so in the future. Such a high share confirms that the farmers are concerned with climate change but also that they are capable of implementing changes to their practices, as a response to a changing climate. There are many types of relevant adaptations and some of them are discussed below.

From the IPA, four superordinate themes emerged, “water management”, “crop rotation strategies”, “field/soil management” and “miscellaneous”. The tag cloud illustration revealed that the superordinate theme of most relevance for the farmers is water management. The subthemes drainage and irrigation are mentioned very frequently in the material. An interpretation can be that the farmers expect the weather to become more extreme (as discussed under the previous research question) and that much of these more extreme conditions are related to precipitation. The farmers perceive it as a problem with too high or too low precipitation and they can imagine very tangible solutions to the problem, namely drainage and irrigation. An improved drainage system can take care of more intensive precipitation and thus keep the fields in good condition and irrigation infrastructure can sustain crop growth during periods of drought.

Water management is a crucial part of climate change adaptation and it is predicted that all environmental regions in Europe will have to adapt their agricultural sectors to changing water cycles. However, the Mediterranean region is expected to face the most severe challenges as water scarcity is likely to increase, from a sometimes already critical level (Iglesias & Garrote, 2015). The same study places Scania in the Atlantic region, which is predicted to face increased floods, increased irrigation needs, sea level rise and shifts in land use (ibid) but the resolution is a bit too low to accurately determine which issues will be of most importance for Scania. Heavy rainfall was predicted to increase in Scania, in the abovementioned report from SMHI, but prolonged droughts are not mentioned in that study. However, some studies suggest that longer dry periods is a likely outcome of climate change, also for Central- and parts of Northern Europe (Schiermeier, 2008). Thus, not only the investments in increased drainage capacity make sense, but also extension of irrigation capacity.

Not many studies on how farmers perceive investments in irrigation and drainage has been found, for a relevant context (preferably developed nations located in a somewhat similar climate zone as southern Scandinavia). However, there are plenty of studies tackling the issue mostly from other perspectives (Fischer et al., 2007; Elliott et al., 2014). One study, focusing on Switzerland, found that although extended irrigation will affect maize yield variability positively, the economic benefits will be small and it is thus unlikely that increased irrigation will be adopted in a large scale (Finger et al., 2010). Another study found that late spring and early summer drought constrains the yields of cereal crops in Scandinavia and that irrigation could be an attractive alternative if early summer drought continues to be a problem and the prices for agricultural products increases (Peltonen-Sainio et al., 2015). Additionally, the authors also emphasize that future precipitation is likely to come in heavier bursts (as predicted also by SMHI) and that this feature makes it less available for the vegetation.

In another study it was found that drip irrigation could be an attractive tool to mitigate future heat waves (not as a response to drought, in this case) to cool the crop down (Schaap et al., 2013). If irrigation should be evaluated from an agroecological perspective, there are many factors to take into account. The discussion below is meant more of as a “guide” to use while examining whether irrigation investments are appropriate from an agroecological perspective, then an evaluation whether such measures are appropriate. One of the first prerequisites for extended irrigation is water supply. Despite the lack of any major rivers, the access to fresh

water is generally good in the Scania. This is thanks to the favorable soil and bedrock structures, with good water holding capacity, (Germundsson & Schlyter, 1999). Also, other sources assert that the biggest scope for increased use of fresh water in the county lies in groundwater extraction (Rydèn & Talib, 2018). However, as agriculture has modernized, more precipitation is left as runoff before it can infiltrate the soil (ibid). Thus, one aspect worth examining would be whether the creation of more wetlands, dams, meandering rivers, and the like, could store more precipitation, to be used by farmers. It could be used either directly or as a mean to refill groundwater tables. It is evident from the questionnaires that many farmers already have such plans. To develop this idea further, it could be investigated whether there is any scope for water transfer from the northern part of Scania, to the southern. As noted under research question 2, in the discussion of the current paper, the precipitation is expected to increase in the northern parts of the county, due to climate change. Also (Rydèn & Talib, 2018) notes that there will be a large excess of fresh water in the northern parts of Scania, during wintertime. To store some of this water, for use later could be one way to secure adequate fresh water supply for Scanian farmers.

The Baltic Sea, on the eastern coast of Scania, has a low salt content at 0,8%-0,9%. Thus, sea water can be used for irrigation if done properly, but only at suitable soils and certain crops (Andersson, 1995). One aspect could be to examine whether desalinization is a viable alternative.Another aspect worth considering from an agroecological perspective is the energy needed to operate the irrigation systems. High inputs of fossil fuels should be avoided according to agroecological principles (Gliessman, 2015). In many cases electricity for irrigation is produced with fossil fuels (Maraseni, Cockfield & Maroulis, 2010) Thus, a challenge is the supply of renewable energy.

Agroecology is also about social issues (Gliessman, 2015). Before approving any major irrigation investments, an evaluation of its social effects should preferably be done. Potentially, improved irrigation could benefit large, input-intensive enterprises more than other farmers and in that case, caution should be taken on how to develop the concept. According to Gliessman, the development of agriculture should be directed towards encouraging small-scale, resource use efficient farmers, as well as a deepened contact between the growers (of food) and the consumers (Gliessman, 2015).

Under the superordinate theme “Crop rotation strategies” the three subthemes “new crops”, “new varieties” and “cover crops” were found. The analysis showed that the measures taken under these themes can be mainly described as “risk-reducing”, in contrast to, for example, “yield maximizing”. An interpretation can be that the farmers, in this case, have more of a “defensive” adaptative approach to climate change. This claim is supported by the farmers testimonies on why they have implemented, or plan to implement, a specific adaptative measure. It is often asserted that some crop species, or variety, is abolished because of its inability to withstand extreme conditions but it is rarely mentioned that a specific, new crop, has been selected based on its ability to withstand such conditions. Neither is it anywhere mentioned that a new practice is chosen based on its potential for high economic returns under optimal conditions. The farmers tend to favour more “stable” yields, instead of insecure alternatives which can be great one year but a disaster the next.

Whether this approach has been noted in earlier studies turned out to be difficult to assess. There are many studies on which challenges European farmers face, and how they can adapt to climate change but none have been found which examine how the farmers reason and which approaches they prefer.

The third superordinate theme that emerged in the IPA was "Field/Soil Management". The measures taken in this regard mostly relate to reduced soil disturbance. It includes less driving, less ploughing, etc. As opposed to previous themes, these measures are probably not taken solely as a response to climate change but also for economic reasons (saving fuel, for example) and for other environmental aspects. These measures are likely of high interest for the authorities as they can be multi-beneficial. By incorporating the methods outlined by some of the farmers (winter green fields, less ploughing well-adapted machinery, etc), more nitrogen and phosphorus can be prevented from leaching and reduced emissions of CO_2 from fuel combustion is also evident (Soane et al., 2013). Moreover, it can conserve soil moisture and thereby function as an adaptation to drier conditions. Some researchers advocate conservation agriculture as a means to store carbon in the soil (Spargo et al., 2008) but the evidence for this effect are questioned (Luo, Wang & Sun, 2010) It seems, thus, as if other stakeholders in society can also benefit from the implementation of reduced soil disturbance. In contrast, the implementation of irrigation can entail trade-offs where the use of irrigation water in agriculture can potentially be negative for other stakeholders and natural ecosystems, if the water supply is limited.

5.8 Reflection of working process

To perform such a comprehensive task as a master thesis has been challenging. It turned out that the "art" of establishing a realistic time schedule and to follow this may require a bit of experience. Also, to put focus on the right things, is probably also something one does better after more practice with academic writing. Some stages of the thesis work have been somewhat inefficient and empty of productive work, whereas other stages have been quite intensive. The former relates almost exclusively to the first stage of work. Once a main supervisor had been found and the broad topic been established it turned out difficult to find a co-supervisor with the right competence and get the project going. Some of this time was spent on writing a way to detailed background about the geographical setting of the thesis. Once a co-supervisor had been found, most of the work has went on efficiently and the week prior to sending out the first version of the questionnaire was very work-intensive, in order to get it sent before I had to take a 7-week break to work during summer. The first time schedule was too optimistic. It was established in April and it was estimated that the thesis could be ready in early October. By that time, most of the results were actually compiled but the thesis was far from ready, in terms of how a master thesis is supposed to look like. Two more months were required to get everything in place. A few unexpected delays occurred during the work but for the most part it was a question of insufficient experience about how long time certain things may take. However, the process of managing the questionnaires (everything from writing addresses on the envelopes to structure the respondents answers in an Excel-file) has been time consuming and I am satisfied

with the amount of time and effort I have invested in this project as well as the degree of efficiency achieved during all stages, except the first one, described above.

6 Conclusion

- Scanian farmers have noticed changes in the climate over the last 15 years. Particularly, they believe that wet and dry periods have become longer.
- The farmers believe that future climate change and the abovementioned trend will continue. They also fear the occurrence of more extreme weather events and perceive climate change more of as a threat than an opportunity for agriculture in Scania. Their estimations of future temperature increases are moderate, in comparison to scientific predictions.
- The satisfaction with authorities` performance is varying, depending on aspect. Low degree of satisfaction is found regarding the relevance of information, about climate change, that authorities provide. It is also found that the respondents think that too little is done to prevent and adapt to, climate change.
- The farmers prefer investments in drainage and irrigation as the most relevant adaptation measures for climate change. They also consider “less soil disturbance” and this aspect is likely the one with most benefits, from an agroecological point of view. Hence, authorities are encouraged to develop this concept, in cooperation with local farmers.

7 References

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8 Appendices

8.1 Appendix A

DIN uppfattning om klimatförändringar

1. Vilket år är du född? _____

2. Under hur många år har din huvudsakliga sysselsättning varit inom lantbruket?

(försök ange exakt om du minns) _____

3. Inom vilken kommun är huvuddelen av din verksamhet belägen?

4. Hur stor areal, i hektar (ha), ingår i ditt företag/lantbruk? Både ägd och arrenderad räknas.

   _____ hektar (ha)

5. Har du upplevt några förändringar i klimatet under de senaste 15 åren? Om du inte varit verksam så länge som 15 år, vänligen svara bara på den tid du varit verksam.

   Ta fasta på dina egna iakttagelser och inte vad du läst eller hört om.

   Ringa in den siffra du tycker stämmer bäst där 1= inga förändringar och 7 = stora förändringar

   1 2 3 4 5 6 7

   Inga förändringar Stora förändringar

   Om du har märkt av förändringar, vilken typ av förändringar har du märkt?

   Skriv ditt svar här under.

6. Hur tror du klimatet kommer att se ut i södra Sverige om 30 år?

Ringa in den siffra du tror stämmer bäst där 1= samma som i dag och 7=helt annorlunda

1 2 3 4 5 6 7

Samma som idag Helt annorlunda klimat

Vet inte (kryssa i om du inte vet vad du tror om klimatet i södra Sverige om 30 år) ☐

7. Om du tror att klimatet kommer att förändras under kommande decennier, vilka förändringar tror du i så fall kommer att inträffa? För varje påstående, ringa in den siffra du tror stämmer bäst.

Kallare Varmare

1 2 3 4 5 6 7

Torrare Blötare

1 2 3 4 5 6 7

Mindre skillnad mellan årstider Större skillnad mellan årstider

1 2 3 4 5 6 7

Mindre extremt väder Mer extremt väder

1 2 3 4 5 6 7

8. Hur tror du eventuella klimatförändringar kommer att påverka jordbruket i Skåne? Ringa in den siffra du tycker stämmer bäst med din uppfattning.

1 2 3 4 5 6 7

Negativt Positivt

Varför tror du som du gör? Skriv ditt svar här under.

Vet inte hur eventuella klimatförändringar kommer att påverka jordbruket i Skåne ☐

9. Vilka effekter på jordbruket tror du att klimatförändringar kommer att ge?

Utgå ifrån vad du själv tror. Du kan kryssa för alla alternativ du tror är relevanta.

Problem med nya växtsjukdomar och skadedjur ☐

Längre vegetationsperiod ☐

Större risk för problem relaterade till väta, exempelvis erosion och liggsäd ☐

Bättre tillväxt tack vare mer koldioxid ☐

Mindre risk för torka ☐

Svårt att välja lämpliga sorter ☐

Annat (skriv själv):_____

10. Vad tycker du om mängden information som myndigheter erbjuder till lantbrukare, angående klimatförändringar?

Ringa in den siffra du tycker stämmer bäst.

1 2 3 4 5 6 7

För lite För mycket

11. Vad tycker du om relevansen av den information som myndigheter erbjuder till lantbrukare, angående klimatförändringar?

Ringa in den siffra du tycker stämmer bäst.

1 2 3 4 5 6 7

Dålig Bra

12. Vad tycker du om de resurser som samhället lägger på att förhindra framtida klimatförändringar?

    Ringa in den siffra du tycker stämmer bäst.

    1 2 3 4 5 6 7

    För lite För mycket

13. Vad tycker du om de resurser samhället lägger på att anpassa sig till kommande klimatförändringar? Det kan t.ex. röra sig om forskning och anpassning för nya förutsättningar.

    Ringa in den siffra du tycker stämmer bäst.

    1 2 3 4 5 6 7

    För lite För mycket

14. Om du tror att klimatet förändras, nu och framöver, vad tror du orsaken är? Skriv ditt svar här under.

    Eller:

    Vet inte/ingen uppfattning ☐

    Tror inte klimatet förändras ☐

15. Om vi står inför framtida klimatförändringar, hur påverkas då skånska lantbrukare av att Sverige är medlem i EU?

    Ringa in den siffra du tror stämmer bäst.

    1 2 3 4 5 6 7

    Negativt Positivt

    Tror inte klimatet kommer att förändras (kryssa här om aktuellt) ☐

16. Vad tycker du om att Sverige är medlem i EU, i ett övergripande hållbarhetsperspektiv för lantbruket?

    Ringa in den siffra du tycker stämmer bäst.

    1 2 3 4 5 6 7

    Negativt Positivt

17. Det diskuteras idag mycket om hur vi ska förbereda oss för ett förändrat klimat, både vad gäller jordbruket och samhället i övrigt. Har du själv redan idag vidtagit åtgärder för att anpassa dig till ett förändrat klimat eller planerar du göra det inom de närmsta åren? Det måste inte vara stora, övergripande förändringar utan även små anpassningar räknas.

    Kryssa i DEN ruta du tycker stämmer bäst för dig

    Jag har inte gjort några anpassningar och jag tror inte det kommer behövas i framtiden heller ☐

    Jag har inte gjort några anpassningar men jag tror det kommer att behövas i framtiden ☐

    Jag har gjort några anpassningar och jag tror det kommer att behövas några till i framtiden ☐

    Jag har gjort många anpassningar och jag tror det kommer att behövas många fler i framtiden ☐

18. Om du har börjat anpassa dig till ett förändrat klimat, vilka åtgärder har du vidtagit?

19. Det diskuteras idag mycket om vad vi som privatpersoner kan/bör göra för att minska vårt bidrag till klimatförändringar.

Hur stort ansvar anser du att svenska lantbrukare har för att minska bidraget till eventuella framtida klimatförändringar? Ringa in den siffra du tycker stämmer bäst där 1=inget ansvar och 7=stort ansvar

1	2	3	4	5	6	7
Inget ansvar						Stort ansvar

20. Om du har vidtagit några åtgärder för att minska klimatpåverkan från ditt företag, vilka är det i så fall?

21. Har du något annat du vill tillägga?

TACK för din medverkan!

8.2 Appendix B

Huvudtyp Bastyp Detaljtyp

1 Växtodling

11 Jordbruksväxter

111 Spannmål m.m.

112 Vall, utöver eget behov

113 Jordbruksväxter, mycket potatis

114 Jordbruksväxter, mycket sockerbetor

115 Jordbruksväxter, blandat

12 Köks-, prydnads- och plantskoleväxter

121 Köksväxter på friland

122 Plantskoleväxter m.m. på friland

123 Köksväxter i växthus

124 Prydnadsväxter i växthus

125 Köks-, prydnads- och plantskoleväxter, blandat

13 Frukt och bär

130 Frukt och bär

14 Blandad växtodling

141 Blandad växtodling, mest jordbruksväxter

142 Blandad växtodling, mest köks-, prydnads och plantskoleväxter

143 Blandad växtodling, mest frukt och bär

2 Husdjursskötsel

21 Nötkreatur

211 Mjölkkor 212 Köttdjur 213 Nötkreatur, blandat

22 Får och getter (1)

221 Får

222 Getter (1)

223 Får och getter, blandat (1)

23 Svin

231 Smågrisar

232 Slaktsvin

233 Svin, blandat

24 Fjäderfä

241 Värphöns

242 Slaktkycklingar

243 Fjäderfä, blandat

25 Blandad husdjursskötsel (1)

251 Blandad husdjursskötsel, mest nötkreatur

252 Blandad husdjursskötsel, mest får och getter (1)

253 Blandad husdjursskötsel, mest svin

254 Blandad husdjursskötsel, mest fjäderfä

3 Blandat jordbruk

31 Mest växtodling

311 Mest växtodling (jordbruksväxter)

312 Mest växtodling (köks-, prydnads- och plantskoleväxter)

313 Mest växtodling (frukt och bär)

32 Mest husdjursskötsel (1)

321 Mest husdjursskötsel (nötkreatur)

322 Mest husdjursskötsel (får och getter) (1)

323 Mest husdjursskötsel (svin)

324 Mest husdjursskötsel (fjäderfä)

9 Småbruk 90 Småbruk 900 Småbruk