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Climate Change Consideration in Agricultural Businesses
- a case study of crop farmers' risk management in the region of Mälardalen

Klimatförändringarnas betydelse i lantbruksföretag – en fallstudie om spannmålsodlares riskhantering i Mälardalen

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Abstract

Farmers are constantly exposed to different types of risks within their business. Agricultural production is typically characterized by uncertain outcomes and serious difficulties to measure and estimate the possibility of unfavourable events. Therefore, agriculture belongs to one of the most vulnerable sectors of the economy. What poses a major risk to agriculture is climate change, along with the increased frequency of variability and extremes. Various future climate scenarios for Sweden show an expected drier climate that largely affects the environment and thus the crop production.

Previous studies have evaluated and examined farmers' perception of risk and their risk management strategies, all using a quantitative approach. In this study, a qualitative case study is used to investigate farmers' considerations of climate change from a risk management perspective. The lenses through which we see and view the world can be described as mental models. Further, a person's ability to assess a situation relates to experiences that develop a person's mental models. If a farmer does not have enough information or have insufficiently developed mental models, there may arise difficulties when managing risk. The aim of this thesis is to examine if and how climate change is considered in farmers' mental models and thus in their risk management.

The results are based on twelve interviews with crop farmers in the region of Mälardalen in middle Sweden. Empirical data has been collected via semi-structured interviews, which have been analysed through thematic coding. An interview guide with open-ended questions based on different themes has been used to get the farmers' answers and thoughts on the subject. This study can help confirm assumptions of previous studies or to bring new insights into the subject matter. The result of the study indicates that the majority of the farmers do not consider climate change in their mental models and thus not in their risk management. The farmers' perception of what caused the previous year's drought is mainly due to the assumption of natural variations rather than climate change.

Sammanfattning

Lantbrukare ingår i en yrkeskategori som konstant utsätts för olika typer av risker. Det som främst kategoriserar lantbruket är osäkra utfall samt svårigheten i att mäta och uppskatta sannolikheten för ogynnsamma händelser. Därför är det en produktionsgren som hör till en av de mest sårbara branscherna i ekonomin. Något som utgör en stor risk för jordbruket är klimatförändringarna tillsammans med ökad frekvens av föränderlighet och extremiteter. Olika framtida klimatscenarier för Sverige visar ett förväntat torrare klimat som i hög grad påverkar miljön och därmed även odlingsklimatet. Under året 2018 upplevde Sverige en varmare vår och sommar än normalt vilket påverkat lantbrukarna på olika sätt.

Tidigare studier har genom en kvantitativ ansats utvärderat och undersökt lantbrukares riskuppfattning och deras riskhanteringsstrategier. I denna studie används en kvalitativ fallstudie för att utreda lantbrukares medvetenhet om klimatförändringar ur ett riskhanteringsperspektiv. De linser genom vilka vi ser och betraktar omvärlden kan beskrivas som mentala modeller. En persons förmåga att bedöma en situation relaterar till erfarenheter som utvecklar en persons mentala modeller. Om en lantbrukare inte har tillräckligt utvecklade mentala modeller, alternativt inte har tillräcklig information vad gäller vissa fenomen, kan det uppstå svårigheter vid deras riskhantering. Målet med denna studie är att undersöka om och hur klimatförändringar beaktas i lantbrukares mentala modeller och därmed i deras riskhantering.

Resultaten är baserade på tolv intervjuer med spannmålsodlare i regionen Mälardalen i mellersta Sverige. Empiriska data har samlats in via semistrukturerade intervjuer vilka analyserats genom tematisk kodning. En intervjuguide med öppna frågor med utgångspunkt från olika teman har använts för att få lantbrukarnas svar och tankar. Denna studie kan bidra med att bekräfta antaganden tidigare studier gjort eller med att framföra nya insikter inom det aktuella ämnet. Studiens resultat visar att majoriteten av lantbrukarna i intervjun inte är medvetna om klimatförändringarna i sina mentala modeller och i sin riskhantering. Lantbrukarnas uppfattning om vad som orsakat föregående års torka härrör främst till antagandet om naturliga variationer snarare än klimatförändringar.

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1 Introduction

Farmers are constantly exposed to different types of risks within their business (Nilsson, 2001; Miller *et al*., 2004; Hansson & Lagerkvist, 2012; Hardaker *et al.*, 2015). Managing risks in agriculture are something that, due to agricultural trade liberalization and the dismantling of traditional means of income support becomes even more important (Boehlje & Lins, 1998). Agricultural production is typically characterized by uncertain outcomes and serious difficulties to measure and estimate the possibility of unfavourable events (Kostov & Lingard, 2003). Agriculture, therefore, belongs to one of the most vulnerable sectors of the economy. It is the farmer's mental models and the business structure that is the base for the risk management work to cope with unpredictable outcomes on the farm (Huirne *et al*., 2000; Huirne *et al*., 2007; Hardaker *et al*., 2015). Hardaker *et al.* (2015) describe risk management as a systematic procedure to manage interventions and practices by identifying, analysing, assessing and monitoring risks and uncertainties. Wandel and Smit (2000) state that decision making in agriculture includes both risk and assessing a risk to reduce, hedge or, mitigate risk. Reducing risk can be achieved by implementing risk management strategies and adopting various risk management tools and is the most complex decision for farmers to make (Coble *et al*., 2000).

The phenomenon of climate change, along with the increased frequency of variability and extremes, is an extensive source of risk to agricultural production (Parry & Carter, 1989; Smit *et al.*, 2000). The human impacts on the climate are obvious, and the effects are visible on all continents and in the oceans (IPCC, 2014). Climate change results in temperature changes and other climate factors that vary between geographical regions (Albertsson *et al*., 2007; IPCC, 2014). Extreme weather, for example, dry periods and floods are becoming more common, and the variation between years is greater. Allen *et al.* (2018) believe that in areas with a high level of rainfall, the average precipitation will increase while the average precipitation will reduce in regions with low rainfall. Dry areas increase in size, and the freshwater supply decreases in most regions except in areas at higher latitudes, where the water supply generally increases. Water saturation and flooding cause pollution to be leached out into lakes and seas (Allen *et al*., 2018). Various future climate scenarios for Sweden, produced by the Swedish Meteorological and Hydrological Institute (SMHI), show an expected drier climate affecting the environment to a large extent (Andréasson *et al*., 2014; SMHI, 2019).

During the year of 2018, Sweden experienced a warmer spring and summer than normal while the autumn of 2017 was unusually rainy and denoted higher precipitation than average (Regeringen, 2018). The month of July 2018 showed a temperature of 3-5 degrees Celsius warmer than normal and in most places in Sweden, even the warmest month registered so far (SMHI, 2018a). This had a negative impact on agriculture throughout the country as it resulted in poorer autumn crops and less stocking than normal. The harvest of forage and the supply of pasture for the animals was lower than normal, which also applied to the expected grain harvest. Allen *et al.* (2018) believe that the temperature and precipitation generally will increase in Sweden, mostly in the northern parts of the country. The precipitation tends to increase most during the winter and spring, and the water supply is generally expected to increase on an annual basis, mainly in northern Sweden and along the west coast. In south-eastern Sweden, the water supply is expected to decrease. The climate in Sweden is expected to be generally more humid, but heat waves and droughts are also expected to become more common. The vegetation period is expected to increase by 10-30 days in the next 20 years. A higher frequency of heavy rainfall increases the risks of flooding but also erosion, landslides and the spread of unwanted substances. Although, climate change entails both opportunities and challenges for the Swedish food sector (Livsmedelsverket, 2018; SJV, 2018a). The opportunities are associated with a

longer growing season, growing other crops and possibilities for animals to reside outside a longer period (SJV, 2018a). These opportunities are accompanied by challenges that require that both primary production and subsequent stages of the food sector and society in general, must be adapted to climate change. At the same time, the harvesting conditions can deteriorate, and there are risks and challenges with increased and reduced precipitation during different seasons. The risks with diseases and pests, as well as heat stress in plants and animals, may increase. There will also be challenges for the farmers in planning their business in a changing climate (Albertsson *et al*., 2007).

As mentioned above, climate change, including variability and extremes, is a major source of risk in agriculture (Parry & Carter, 1989; Smit *et al.*, 2000). In Sweden, the recent period of drought has resulted in increased expenses and the price development of agricultural products has been affected as well as the price of milk and meat has changed as a result of the weather situation (LRF Konsult, 2018). Also, energy prices and feed costs have increased during 2018. The crops are estimated to be 30 to 40 percent lower than normal, and the sale price of cereals is expected to be about 30 percent higher than the previous year. This contributes to the necessity to identify and analyse future adaptation options for farmers concerning climate change.

1.1 Problem

Like many other countries in the world, Sweden is vulnerable to various types of natural disasters (SJV, 2017). Such disasters can be described as unexpected, negative, and unintentional events. Torrential rain, flood, drought (both extreme short-term heat and prolonged drought), storm and fire are all such events that are expected to increase in frequency and intensity. Major parts of the Swedish agriculture have been affected to a large extent by the hot and dry summer of 2018, the crops of grain, oilseeds, and roughage have been significantly less than normal (SJV, 2018b). According to an economic calculation for the preliminary development for 2017-2018 done by SJV (2018b), shows that the total production value of the agricultural sector in 2018 is expected to decrease by 2,1 billion SEK or 3,5 percent compared to 2017.

Distinctive for agriculture is the high level of production, market, and financial risks that the producers are facing (Velandia *et al*., 2009). These risks have enabled the development of various agricultural risk management tools and strategies. Also, due to unpredictable weather conditions, farmers take a risk every time planting a crop (Drollette, 2009). Even though farmers are rather used to cope with changes from one year to another, climate change is expected to increase the need and magnitude of farmers' adaptation even more (Wheeler & Tiffin, 2009; Niles & Mueller, 2016; Arndal Woods *et al.*, 2017). Climate change, along with variability and extremes, is stated to be an increased risk in agricultural production (Parry & Carter, 1989; Smit *et al*., 2000). Because of this, it is interesting to investigate if climate change is considered in farmers' mental models and the impact on their risk management. We argue that it is important to understand how farmers consider climate change in their risk management and this could be the basis for a contribution to policymakers, advisors, and banks within the agricultural sector when developing future risk management strategies and evaluating today's risk management strategies.

There are several earlier empirical studies in the available literature about the impact of climate change on the level of yields (Antón *et al*., 2012). For example, Arbuckle *et al*. (2013)

conducted a quantitative study on farmers in Iowa, USA, which suggests that farmers generally view their responses to adapting to changing climate conditions as risk management strategies. Another study made by Arndal Woods *et al*. (2017) on farmers across Denmark, showed that farmers were not significantly concerned about climate change but that they were likely to undertake adaptive and mitigative actions in the future. Other previous studies, such as the one by Meuwisssen *et al*. (2001) of farmers' attitudes and perception of risk management in the EU, used a quantitative approach to examine the usage and choices of risk management tools. However, the information is somewhat limited when it comes to farmers' awareness associated with mitigating the risks of yield variability caused by climate change. It is important to develop an enhanced understanding of farmers' mental models and how climate change is considered in their risk management, especially since the variability of weather conditions and the frequency of extreme events are expected to increase which implies changes in yields (OECD, 2011).

A person's mental models refer to how close to reality the personal assessment comes (Hogarth, 1987). If a farmer does not have enough information or have insufficiently developed mental models, there may arise difficulties when managing risk. This encourages the need for an enhanced understanding of farmers' mental models and awareness of climate change in their risk management. This is important for external parties, such as policymakers, banks, and advisors, to be able to help farmers and to adapt measures and risk management strategies in the best possible way.

1.2 Aim and Contribution

The aim of this thesis is to examine if and how climate change is considered in farmers' mental models and thus in their risk management. This is done by conducting a qualitative case study, interviewing twelve farmers from the region of Mälardalen, in the middle part of Sweden. With its flexible and fluid form, semi-structured interviews were chosen for this study. Other qualitative methods could also have been performed in this study to fulfil the aim, such as group interviews. This interview method could have resulted in more analysed answers from the farmers as they get influenced by each other (Bryman & Bell, 2015). However, we wanted to bring out the farmers' spontaneous and first thoughts on the subject, and therefore, individual depth interviews were better suited for this study.

The selection was made through purposive non-probability sampling with a set of criteria that the respondents needed to achieve to be included in the study. There was a delimitation regarding the size of the farm where the selected respondents should grow at least 100 hectares. The main source of income should be from crop production, and the farmers should also work with their agricultural business fulltime. The delimitations of certain farm size and specialization were made to reach farmers having a full-time job with the agricultural production where the potential other off-farm incomes were restricted.

The aim of this study could have been fulfilled by interviewing farmers in other parts of Sweden, such as in the southern part, or in other parts of Europe. We chose to demarcate to the region of Mälardalen because it is one of the areas that has been severely affected by the drought in 2018 (Regeringen, 2018), and because it was more time and cost-effective for this study. Another focus, for example, choosing farmers with animal production as their main source of income, could also be possible to fulfil the study's aim. However, we have chosen to focus on farmers who are dependent on their crop production. This choice is based on our interest in

looking more closely at crop farmers as their production is extra vulnerable to possible extreme weather such as the drought in 2018. This is due to the specific growing season and that the crop production represents most of the annual income for these farmers.

Earlier studies on farmers' risk preferences, such as the one made by van Winsen *et al.* (2016), used in general a quantitative approach and empirical data collected through larger samples and surveys. There are also studies on farmers' beliefs and concerns about climate change, see for example Prokopy *et al.* (2015), where farmers in high-income countries were questioned via surveys to develop appropriate policies and strategies. Despite previous studies on agricultural risk and climate, the research is rather limited regarding the role of climate change related to the farmers' risk management. When it comes to examining this with a qualitative approach in regions in Northern Europe, such as Sweden, where areas have been affected by drought like the dry summer of 2018, the literature is somewhat limited. The dry and warm summer has affected the farmers, resulting in severe economic consequences within all directions in agricultural production (LRF Konsult, 2018). This creates an issue that is of interest to examine further, what importance climate change has in farmers' risk management.

Some studies have investigated farmers' awareness of risk and how they handle risk within their business (Koesling *et al*., 2004; Flaten *et al*., 2005). Other previous studies further investigated factors affecting farmers' decision, but with the delimitation to crop insurance (Brånstrand & Wester, 2014; Enström & Eriksson, 2018). Brånstrand and Wester (2014) used a quantitative approach, while Enström and Eriksson (2018) investigated the subject from a qualitative perspective. Reducing risk can be achieved by implementing risk management strategies and adopting various risk management tools, which is complex for the farmer to handle (Coble *et al*., 2000). It can be difficult to receive a broader understanding of this complexity with a quantitative approach. Such a method would require more time, and therefore, we chose not to conduct a quantitative study. Using a qualitative approach enables us to acquire an understanding of thoughts and ideas that cause the farmers actions.

Previous studies on climate change and agriculture investigated the impact of climate change on productivity and yield, focused mainly on technical evidence (Miller *et al.*, 2004; Head *et al*., 2011). Yung *et al*. (2015), on the other hand, investigated how farmers in Montana, Western USA, responded to a drought that hit the country in 2012. Yung *et al.* (2015) used a qualitative method, conducting case studies to build a knowledge of the farmers' views and actions after the drought of 2012. In this study, a specific drought that hit Sweden in 2018 is used as an example that can be seen as extreme weather caused by climate change. Prior studies argue that farmers experience extreme weather events, such as drought, as local environmental changes rather than as a result of global climate change (Milne *et al*., 2008; Saleh Safi *et al*., 2012). By conducting this study, it may contribute to either confirming or bringing new insights to this current topic, which can provide valuable input to agricultural advisors and policymakers, for instance.

A person's ability to assess a certain situation relates to experiences that develop a person's mental models which can be described as the lenses through which we view the world (Lee *et al*., 1999; Johnson-Laird, 2005). We argue that it is important to understand how farmers consider climate change in their mental models and thus in their risk management. This could serve as the basis for a contribution to policymakers, advisors, and banks among others in the agricultural sector when developing future risk management strategies and evaluating todays' strategies. Also, by gaining a broader understanding of how farmers consider climate change in their mental models, appropriate adaptation measures can be realized and further evaluated.

1.3 Outline

In this section, the outline is presented, which will give the reader a structural overview of the thesis, see Figure 1. This first chapter began with an introduction of the subject, followed by the problem of the thesis. Chapter one also presented the aim of the study, what the study contributes with, and what delimitations we have made. The next chapter, Climate Change, provides the reader with background information on climate change and external factors linked to agriculture that are considered important for this study. Chapter three, Literature review and Theoretical framework, presents previous research within the risk management field and the study's theories. The chapter concludes with a theoretical synthesis. In chapter four, the used method is presented. The chapter includes the course of action with a description of a case study design, how the cases have been selected, the interviewing process, and how the collected material has been analysed. A critical discussion of the method followed by ethical aspects, concludes the method chapter. The next chapter summarizes the results of our empirical data, which is divided into different subject headings. Finally, in chapter six, our discussion and the conclusion are presented, followed by the implications of the study and suggestions for future research.

Figure 1. Outline of the thesis (Own illustration).

2 Climate change

This chapter provides background information regarding climate change and external factors that are important for this study and to fulfil the aim. The chapter presents general facts on climate change worldwide as well as locally and the impacts on agriculture in particular.

Climate change and its impacts on agriculture

Climate change can be defined as a change in the state of the climate that can be identified by variations in the mean or the variability of its properties, and that endures for decades or more (IPCC, 2018). The phenomena of climate change may be caused by natural internal processes or by external forcings. Those external forcings are, for example, volcanic eruptions, the modulations of the solar cycles, and persistent anthropogenic changes in the composition of the atmosphere or in land use. UNFCCC (1992) defines climate change as: "*a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods*".

Climate change is contributing to one of the most important challenges in the 21st century which is to ensure global food security, to supply sufficient food for the increasing population while sustaining the environment (Lal *et al*., 2005). An essential amount of evidence shows that Earth has warmed since the mid-19th century. With the warming trend viewed in three independent temperature records taken over land, seas and in ocean surface water, the global mean temperature has increased by 0.8°C since the 1850s (Solomon *et al.*, 2007). Data from the United Nations International Strategy of Disaster Reduction also show an increase in the frequency of natural disasters (OECD, 2009). Reports are showing increased numbers of hydro-meteorological disasters such as droughts, extreme temperatures, and floods since the late 1990s compared to the previous decade (Hoyois *et al.*, 2007).

Global warming and the increased occurrence of catastrophic events are expected to affect yields and their variability or agricultural and livestock production (OECD, 2009). Studies also imply that there are other factors apart from climate change, such as technological developments, that are likely to impact the levels of agricultural productivity. Farmers' risk environment is changing due to increasing market liberalization and industrialization of agriculture (Boehlje & Lins, 1998). This requires that the farmers adapt to these changes in productivity levels to respond to a new climate with a new type of comparative advantage.

A key factor determining achieved crop yields is undoubtedly climate, and one of the most critical parameters of climate change impact on crop productivity is the atmospheric concentration of CO_2 (Lobell & Field, 2008; Antón *et al.*, 2012). Such greenhouse gas emissions can be characterized in two ways (Antón *et al.*, 2012). Initially, increased atmospheric concentrations of CO_2 can directly affect the growth rate of crop plants and weeds. Secondly, CO_2-induced alterations of climate may change the variability of factors that can affect plant productivity, such as temperature, rainfall, and sunlight. The climate models show that the likelihood of several extreme weather conditions, such as heat waves, droughts, and floods increase in a warmer climate (SMHI, 2019). At the same time, the probability of intensive and prolonged cooling decreases.

With collected evidence on the warming effects that greenhouse gas concentrations have on the world's climate, research has been focusing on estimating the possible impacts of such warming

scenarios (Schlenker & Roberts, 2008). Several studies concentrate on the agricultural sector and the impacts of how it might adapt to variations in climatic conditions. Changes in temperatures and precipitation have a greater impact on agricultural production than in other sectors. Agricultural production and consumption still make up a great part of the income in developing countries, which also adds to the increased research of the climatic impacts on the agricultural sector. Data from 2016 showed that nearly 38 percent of the total land area in the world consists of agricultural land (The World Bank, 2019). Being such a large economic, social, and cultural activity, supplying various ecosystem services, agriculture is highly sensitive to climate variations.

A crucial component of climate change impact and vulnerability assessment is adaptation**.** It is also one of the policy options in reaction to climate change impacts (Fankhauser, 1996; Smith & Lenhart, 1996; Smit *et al.*, 2000). Agricultural adaptation options can be categorized, as by Skinner and Smit (2002); 1) technological developments, 2) government programs and insurances, 3) farm production practices and 4) farm financial management. The first two options are associated with planned adaptation and responsibility by agri-businesses and public agents. The following two categories relate to farm-level decisions. The study by Skinner and Smit (2002), was conducted on conditions in Canadian agriculture where a typology of adaptation was developed to classify and characterize adaptation options to climate change.

The phenomenon of climate change, along with variability and extremes, is an extensive source of risk to the agricultural sector (Parry & Carter, 1989; Smit *et al*., 2000). There are studies on crop productivity and soil water balance using parameters from different climate models, where it was stated that climate variability is one of the most critical factors affecting year to year crop production in all types of agricultural areas (Reddy & Pachepsky, 2000). Also, during the past years, the attention of the risks linked to climate change has increased, which will raise uncertainty considering food production. Dong *et al.* (2016) used a quantitative method based on the IPCC assessment reports to evaluate agricultural risks due to climate change. The results showed that the variability of spring wheat yield in Wuchuan County of Inner Mongolia increased with the warming and drying climate trend. Climate change is a major concern for agricultural production globally, and since climate change is expressed via changes in variability at numerous temporal ranges, the main adaptation strategy is therefore to enhance the capacity to manage climate risk.

3 Literature review and Theoretical framework

In this chapter, the literature review and theoretical framework are presented. The literature review is based on previous research within the field of risk in agriculture, and the chapter begins with a presentation of risk in agriculture, previous research on risk domains within the agricultural sector, followed by existing risk management strategies within the literature. Later, we describe the concepts of mental models and risk preferences associated with the aim of this study. The chapter is concluded with a theoretical synthesis that is compiled with a figure.

The literature review was carried out to create an understanding of what already is known in the research area. In this thesis, a narrative literature review was applied to create a replicable, scientific, and transparent process that aims to minimize distortions. An extensive literature search about published and unpublished material presented an exhaustive description of existing knowledge within the field without the distortions being caused by the authors (Bryman & Bell, 2015). The literary sources were scientific articles, legal texts, subject literature, dissertations, reports, and degree projects. The main focus of the literature study has been the concept of risk, risk domains, and risk management in agriculture, but also previous studies on farmers risk preferences, mental models, and climate change.

3.1 Risk in agriculture

The concepts of risk and uncertainty can be defined in various ways. According to Harwood *et al*. (1999), risk is referred to as uncertainty that affects a person's welfare. Uncertainty is characterized by a situation in which an individual does not know for a fact what will happen. Uncertainty is essential for risk to occur, although uncertainty does not necessarily lead to a risky situation (Harwood *et al*., 1999). Hardaker *et al.* (2015) describe risk as uncertain consequences, with possible exposure to unfavourable results. By taking a risk, it is likely that one is being exposed to the possibility of losing something or getting hurt. Risk can also refer to the expected value of the potential loss (Miller *et al.*, 2004). When it comes to business decisions or greater life decisions, a larger part of the uncertainty is included. Such decisions often result in a distinct difference between better and worse consequences, and risk is perceived to be of great importance in these types of events. According to Hardaker *et al.* (2015), several farm management decisions can be taken without needing to consider the risks involved. But some risky decisions linked to the agricultural production probably require more attention to the selection among the available alternatives of risk management strategies. Harwood *et al.* (1999) describe risk management as a way of choosing between alternatives to reduce the impact of risk in agriculture, and by doing so, affecting the welfare position of the farm. Earlier research on risk management also reveals that agriculture includes both risk estimation and certain measures taken to reduce, hedge, transfer, or mitigate risk (Wandel & Smit, 2000). Adaptation is typically considered as a reaction to financial risk in agriculture, whether it is climatic or not (Barry & Baker, 1984). Skinner and Smit (2002) further state that those seeking to promote adaptation need to acknowledge that producers take climate change into account, if at all, in their continuous management decision-making.

Research on risk and risk management reveals that people have different perceptions regarding risk (Pindyck & Rubinfeld, 2005) and that risk management strategies used by farmers are expected to reflect their perceptions of risk (Beal, 1996). When managing significantly risky incomes or prosperity outcomes, most people tend to be risk-averse (Hardaker *et al.*, 2015). A

risk-averse person is willing to give up some expected return for a reduction in risk. Farmers typically refer to potential losses when thinking about risk, according to Miller *et al.* (2004). Generally, the reasons are initially the fact that most people dislike risk and secondly, the so-called downside risk. Farmers, as well as most people, do not make choices based on what is the most profitable in the long run if it means exposing themselves to a high and unacceptable risk of losing something. Downside risk is, according to Hardaker *et al.* (2015), defined as those situations where the usual norm somehow changes the results into worse outcomes. In agriculture, downside risk may occur where an outcome relies upon non-linear interaction among various random variables, for example, a yield of a crop. Such a situation depends on numerous uncertainty factors, such as rainfall and temperature during the whole growing process where major deviations in these variables in any way other than the expected value, probably have unfavourable effects. The loss related to major deviation from the mean level, such as rainfall, is higher than the benefit from a more positive deviation of a comparable significance.

Risk management is known as a systematic procedure for managing interventions and practices by identifying, analysing, assessing, and monitoring risks and uncertainties (Hardaker *et al*., 2015). This is a way for individuals or businesses to avoid losses and maximize opportunities. Based on previous research, the different types of risks in the agricultural sector can be described in numerous ways, and most of the agricultural risks can be categorized by both business risks and financial risks. In the classification by Hardaker *et al.* (2015), business risks consist of production risks that are characterized by unpredictable weather and diseases that affect crop yields, livestock health, and production. Based on the definitions by OECD (2009), agricultural risks can be classified into three specific layers. Risks occurring frequently and that are often managed by using on-farm instruments belong to the first layer. The second layer consists of events that occur more rarely, and that can be managed by using various risk-sharing tools, private insurance schemes, for example. Included in the third layer are risks of a catastrophically character, such as rare events with a low probability of occurrence, which could lead to great and permanent losses. Since the middle of the 20th century, many regions of the world have experienced significant changes like extreme weather conditions such as droughts, floods, and events of extreme temperatures (IPCC, 2012). In agricultural areas, a disaster caused by extreme weather can result in major damage to crops and food system infrastructure. The warm and dry summer of 2018 might, in some regions, be characterized as a risk in the third layer (OECD, 2009).

The risk of extreme weather events shaping peoples' awareness on climate change beliefs and adaptation has been widely studied (Arbuckle *et al*., 2013; Carlton *et al*., 2016). In a study by Carlton *et al*. (2016), data from pre- and post-extreme event surveys were used to examine the impacts of the 2012 Midwestern US drought. The study focused on its effect on agricultural advisors' climate change beliefs and attitudes towards adaptation and perceptions of risk. It suggested that extreme climate events such as the drought might not cause a major shift in climate beliefs, especially not immediately. Further, the result of a study by Arbuckle *et al.* (2013) indicated that Iowa farmers were willing to adapt to changing climate conditions and view their responses as various risk management strategies to preserve crop productivity. Also, Reid *et al*. (2007) did a study on farms in Perth County, Ontario where the aim was to identify climate risks on farms and to investigate farmers' responses to risks associated with climate and weather. The result indicated that climate and weather are characterized as a force strongly influencing management decisions as well as farm operations. In a more recent, global review of farmers' perceptions of agricultural risks and risk management strategies by Duong *et al.* (2019), it was presented that more than half of the studies stated that farmers identified weather

and climate change as the main risk to their farm businesses. In the crop sector, weather risk, human risk, and biosecurity threats were the most frequently pointed out by the farmers.

Arbuckle *et al.* (2013) stated in their study that Iowa farmers generally view their responses to adapting to changing climate conditions as risk management strategies to maintain crop productivity. The farmers generally seemed to be willing to adapt to the variations in climate. Other studies have been conducted to study the role of certain risk management strategies, such as financial insurance in farmers' welfare under uncertainty (di Falco *et al.*, 2014). Di Falco *et al.* (2014) stated that the demand for crop insurance products was likely to increase as a result of climatic conditions. Also, other case studies have been made in Australia, one of the risky farming environments in the world, where issues of farming risks and risk management strategies were examined (Nguyen *et al.*, 2007). Unpredictable weather, financial risk, marketing risk, and personal risk were accounted for the largest sources of risk among farmers. Despite a lot of research on agricultural risk and risk management, few studies comprehensively view the factors determining farmers' awareness of risk and their risk management strategies (Duong *et al.*, 2019). This supports the need for studies that investigate farmers' mental models of climate change from a risk management perspective for policymakers to develop the options of risk management strategies.

3.2 Risk domains

There are different types of risk sources that can be identified within agricultural businesses, and Hardaker *et al.* (2015) describe some of them. *Production risk* is typically characterized by the uncertainty of the factors beyond the knowledge and the influence of the farmer. Significant factors that affect the uncertainty about the crop yield or livestock are weather conditions, for example, drought, frost, and large amounts of rain during harvesting. The event of unforeseen pests or diseases in crop cultivation and livestock production are also included. Production risks may affect the farmers' financial position since the weather conditions, and eventual diseases can affect the yield, and hence, this is also connected to financial risks (Selvaraju, 2010). Climate change and the increased events of extreme weather can be perceived as major production risks in agriculture because of its impact on crop yield (Parry & Carter, 1989; Smit *et al*., 2000).

Other risks in the risk literature are identified as *financial risks* that occur because a business' various parts must be financed (Hardaker *et al.*, 2015). It is important to maintain the cash flow level at a steady level to cover debts and other financial needs. Increasing interest rates, and if capital as collateral decreases in value, financial risk may occur. There are studies that highlight the importance of relating climate change risk to financial risk as it may be an effective means to nudge financial advisors to include climate and weather tools into risk management advice (Church *et al.*, 2018). The incorporation of new weather and climate tools and sources of information among producers and advisors could, therefore, result in enhanced on-farm decision making and more realistic assessments of the financial risks in agricultural production.

Farm inputs and outputs that lead to unpredictable changes in supply and demand are sources of *price and market risks* (Hardaker *et al.*, 2015). Since prices of agricultural inputs and products usually are unknown when the farmer makes the decisions on what input goods are to be purchased and what quantities of a product should be produced, price risks may arise. Unforeseen changes in the exchange rate can also cause price risks. Price and market risks can be related to the drought of 2018 in Sweden, where the crop yields were significantly lower

than normal, which caused a higher price of grain (LRF Konsult, 2018). There are agricultural businesses that earlier secured prices on grain to a lower price, and when they are not able to deliver the expected volume, they have to pay a fee to compensate which also lowers the crop revenues. This can be referred to as a result of the drought in 2018 - extreme climatic conditions that can lead to higher prices and market risks to the agricultural production and the individual farmer. Both production and market risks have an impact on the income variability in agriculture (Lehmann *et al.*, 2013). To cope with such risks, farmers usually have various risk mitigation measures to protect against income variability.

Another source of risk for the farm business' profitability and sustainability are the people themselves operating the farm (Hardaker *et al.*, 2015). *Human or personal risks* that can affect the existence of the farm involve life crises such as the illness or death of the owner or divorces where one or both parties are co-owner of the farm business. The carelessness of the farmer or the employees also refers to human risks as it might lead to major losses or injuries when being incautious and handling livestock or using different machines, for instance. There are studies suggesting that public opinions around climate change remain polarized and that the engagement stays rather low (Pew Research Center 2014; Hamilton *et al.*, 2015), despite the observed impacts of anthropogenic climate change (IPCC, 2014). Howden *et al.* (2007), for instance, argue that people are more likely to act and support mitigation if they can refer to it as a human or personal risk. Although, few people perceive this personal risk in the context of climate change, probably due to its creeping nature of and the feeling of the impacts being distant (Leiserowitz, 2005; Nisbet & Myers, 2007).

Institutional organizations establishing laws and regulations pose a major risk to farmers (Hardaker *et al.*, 2015). So-called *institutional risks* also include political, foreign, and environmental risks. Changes in laws and regulations can affect the profitability and survival for how a production develops. New rules concerning EU subsidies, taxes, and restrictions on pesticides can have variable effects, but it poses a large risk and can significantly change the situation of agriculture. The International Panel on Climate Change (IPCC) has required a new balance between diminishing the risks from climate extremes and to transfer them through insurance, for instance, to prepare for and manage disaster effects in a changing climate (IPCC, 2012).

3.3 Risk management strategies

The purpose of a risk management strategy is to reduce the potential vulnerability in a business (Asravor, 2018). It is the individual's perception and attitude to risk that affect what risk management strategies are used (Harwood *et al*., 1999; Patrick, 2000; Lumby & Jones, 2011). In turn, individuals' risk preferences are affected by several socio-economic variables such as information availability (Asravor, 2018), experiences and beliefs (Sitkin & Pablo, 1992; Debertin, 2012) and the individuals' goal and financial situation (Boehlje & Eidman, 1984). We argue that it can be interpreted as individuals', or in our case, farmers' mental models and risk preferences determine what risk management strategies are used.

There are different types of strategies to manage risk within agricultural businesses, and Holzmann and Jørgensen (2001) are describing three strategies, *prevention strategy*, *mitigation strategy*, and *coping strategy*. The first mentioned, p*revention strategy*, is implemented before the risk occurs intending to reduce the probability of negative risks and thus reduce the variation in the farmers' expected income (Holzmann & Jørgensen, 2001; OECD, 2009). Prevention

strategies can be based on different arrangements that the farmer cannot affect, such as governmental policies, unexpected extreme weather, and market-based mechanisms. On the other hand, the ability to choose technology and investing in education is something that the farmer can affect.

Mitigation strategy is, as a prevention strategy, implemented before the risk occurs, but instead of reducing the probability of negative risks, the mitigation strategy aims to reduce the potential impact of future risk (Holzmann & Jørgensen, 2001; OECD, 2009). There are different ways for farmers to implement a mitigation strategy. Holzmann and Jørgensen (2001) describe production diversification as a common way to mitigate risks because it enables the farmer to provide returns at different times instead of all at one time. For example, the farmer can choose to grow several different crops that have different harvesting times, or the farmer obtains a job alongside his agricultural business to ensure additional income. Another way to mitigate the risks is to sell assets at different times or to trade with counterparts. Insurance is also a way of managing risks, and today, several private insurance companies offer, for instance, crop insurance, animal insurance, and insurance of machinery and buildings. Crop insurance is a way to ensure against unexpected weather conditions that can affect crop yields, and according to Moschini and Hennessy (2001), this type of insurance has been used for a long time and was developed for over 200 years ago (Smith & Glauber, 2012).

The third strategy described, *coping strategy*, is being used once the risk has occurred to relieve the impact of the risk (Holzmann & Jørgensen, 2001). When all available tools and resources have been used to prevent and mitigate risk, coping strategies are the only available. The government may have strong political incentives to assist with necessary funds, where agricultural support programs and catastrophically relief are examples of coping strategies (OECD, 2009).

Available tools and strategies may vary in different countries and for different farmers (OECD, 2009). For example, the size of the business can be an influencing factor, as well as the location of the farm and the availability of information. According to Meraner and Finger (2017), farmers usually choose to combine several different strategies instead of using one alone. Van Winsen *et al.* (2016) argues that an individual's experience of the risk source has no significant impact on the propensity to implement any risk strategy, but rather the attitude to the risk has a significant impact on the choice of risk management strategy. However, we argue that the farmers' mental models, and hence their risk preferences, determine which risk management strategies are used.

3.4 Mental models

A person's ability to assess a situation is related to experience which develops a person's mental models (Lee *et al*., 1999). Mental models can be explained as the lenses through which we see the world (Johnson-Laird, 2005). Hogarth (1987) believes that a person's perception of reality is a result of comparisons between different reference points. The reference points are found in a person's mental models and are, in turn, the result of the person's previous experiences. The amount of information and how developed an individual's mental model is, determines how close to reality the personal assessment comes. If a farmer does not have sufficient information or does not have sufficiently developed mental models, difficulties may occur when managing risk.

A person's mental models are important for the intuitive ability, where intuition can be described as a sense of what is right. Lee *et al.* (1999) define intuition as a part of an individual's subconscious thought process. Hogarth (1987) believes that the meaning of intuition is that they can be reached with minimal effort, and often completely subconscious. Analytical thinking, on the other hand, is the opposite of intuition and is a process that is made consciously and freely.

Previous research claims that mental models are often shared between people who live in the same social context or interact socially with each other (Freeman *et al*., 1987; Guest *et al.*, 2006; Thagard, 2012). Mental models have been proven to be important in processes such as problem-solving (Bagdasarov *et al*., 2016), which in this study can be derived to the risk management in relation to climate change. Otto-Banaszak *et al*. (2011) investigate how different groups of stakeholders perceive and deal with adaptation and climate change impacts and show that mental models can differ greatly from each other. Hansson and Kokko (2018) argue that whether farmers adapt to renewal and changes depends on their mental models.

In this study, different answers will be received from the farmers depending on their background and previous experiences, as this affects the farmers' intuitive ability. Van Winsen *et al.* (2016) argue that an individual's experience of the risk source has no significant impact on the propensity to implement any risk strategy, but rather the attitude to the risk has a significant impact on the choice of risk management strategy. We interpret this as the fact that the farmers' mental models are crucial for how they ultimately manage risks in their agricultural business. Mental models are useful in this study since an understanding of farmers' mental models would be helpful to examine if and how farmers consider climate change in their risk management.

There is a need for an enhanced understanding of why there is a disparity between farmers' perceived agricultural risk sources and risk management strategies (Doung *et al*., 2019). A better comprehension of why risk management strategies that seem to be a suitable choice to certain risks are not used could highlight further barriers to agricultural risk management. That could improve the productivity of agricultural systems and, the knowledge could be useful for advisors and policymakers when evaluating the current risk management strategies.

3.5 Risk preferences

Risk can be described as the possibility that an actual value differs from the expected and Hardaker *et al.* (2015) and van Winsen *et al.* (2016) argue that people handle risk in different ways. Dillon (1979) and Hansson and Lagerkvist (2012) mean that individuals' values affect how someone responds to risk. Further, risk preferences are a general risk orientation tendency that is associated with a person's experiences and beliefs (Sitkin & Pablo, 1992; Debertin, 2012). Individuals have various risk preferences and the attitude towards risk may also vary depending on the source of the risk (Slovic *et al*., 1982; Miller, 2004; Varian, 2006; van Winsen *et al*., 2016; Meraner & Finger, 2017). Farmers' risk preferences are dependent on the contextual situation (Meraner & Finger, 2017) but also on the individuals' goal and financial situation (Boehlje & Eidman, 1984). Barry *et al.* (2004) and Hardaker *et al.* (2015) mention demographic and social factors, such as age, experiences, education, farm size and geographic location as other factors affecting farmers' risk preferences. Asravor (2018) argues that information availability affects an individual's risk preferences as well as an individual's mental models (Hogarth, 1987).

In this study, we have chosen to describe risk preferences using three different categories; *risk-averse, risk-neutral,* and *risk-seeking*. Being *risk-averse* is most common and is distinguished by preferring a safe income before an uncertain income with the same expected value (Pindyck & Rubinfeld, 2005; Hardaker *et al*., 2015). The establishment of various insurance, such as crop insurance, but also the security in a stable income, is related to risk-averse behaviour. Risk-averse individuals completely refrain risk and thus lose the opportunities for achieving higher results, than if they chose to face any risk (Patrick, 2000). Several studies show that farmers generally are risk-averse regarding decisions that affect income and welfare (Hazell & Norton, 1986; Hardaker *et al*., 2015). This can be substantiated by Hansson and Lagerkvist (2012) who argue that farmers are risk-averse in all risk domains.

Risk-neutral preferences are indifferent between a certain income and an uncertain income with the same expected value (Pindyck & Rubinfeld, 2005; Hardaker *et al*., 2015). A *risk-seeking* person, prefers an uncertain income before a safe, even if the expected value of the uncertain income is lower than the given income. Patrick (2000) describes risk-seeking individuals as challenging and who want to seek excitement by taking more risks. This behaviour increases the possibility of achieving higher results.

According to the expected utility theory, individuals are acting rationally and make optimal decisions, which maximizes the individual's utility (March & Shapia, 1987; Lumby & Jones, 2011). This means that cultural, social, and psychological aspects are not taken into account (Davidson *et al*., 2003). Edwards (1954) argues that by having complete information, being infinitely sensitive and completely rational, individuals can make optimal decisions. The expected utility theory also assumes individuals to have stable and well-organized systems of preferences, for example being aware of his or her aims and values (Edwards, 1954; Simon, 1955; Hardaker *et al.,* 2015). Hammond (1998) argues that the expected utility theory disrespects the individual's subjective emotions and perceptions because not all uncertainty can be described as an objective probability. Not only Hammond (1998) is criticizing the usage of the theory, but several studies mean that the expected utility theory does not describe behaviour in real life situations (Flaten *et al*., 2005). Schoemaker (1990) argues that individuals are not consequent with being only risk-averse or risk-seeking in different situations, since it may differ from one situation to another. However, Hansson and Lagerkvist (2012) mean that farmers are risk-averse in all risk domains.

3.6 Theoretical synthesis

To fulfil the aim of this study which is to examine if and how farmers consider climate change, theories have been chosen that gives an approach to what risk is and entails for farmers and how it affects the farmers' mental models and preferences to risk. The synthesis aims to show how the individual theories and the literature review together form a whole unit which becomes our theoretical model. In this study, we use two established psychological theories, mental models, and risk preferences, each of which can explain how farmers experience risk. By combining these, using the literature review, we can gain an understanding of if and how farmers consider climate change in their risk management.

Figure 2 shows how we have linked the different concepts and theories in this thesis. We believe that how farmers experience risk in agriculture depends on their risk preferences, which in turn depends on several different factors. For example, Barry *et al.* (2004) and Hardaker *et al.* (2015)

are mentioning demographic and social factors, such as age, experiences, education, farm size and geographic location as factors affecting farmers' risk preferences. Furthermore, the risk domain is also linked to the farmer's risk preferences, since one can have different risk preferences in different risk sources (Slovic *et al*., 1982; Miller, 2004; Varian, 2006; van Winsen *et al*., 2016; Meraner & Finger, 2017). How the perceived risk in the different risk domains are managed, also depends on the farmer's risk preferences and there are different types of strategies for farmers to use within agricultural businesses (Holzmann & Jørgensen, 2001). These concepts, *risk preferences, risk in agriculture, risk domains,* and *risk management* are all dependent on the farmer's mental models. We can assume this since mental models can be described as how farmers choose to see the reality (Johnson-Laird, 2005) and an individual's mental model is developed through the ability to assess a situation which in turn depends on the person's experience (Lee *et al*., 1999). By understanding the farmers' mental models within the risk management field, we can gain an understanding of if and how the farmers consider climate change.

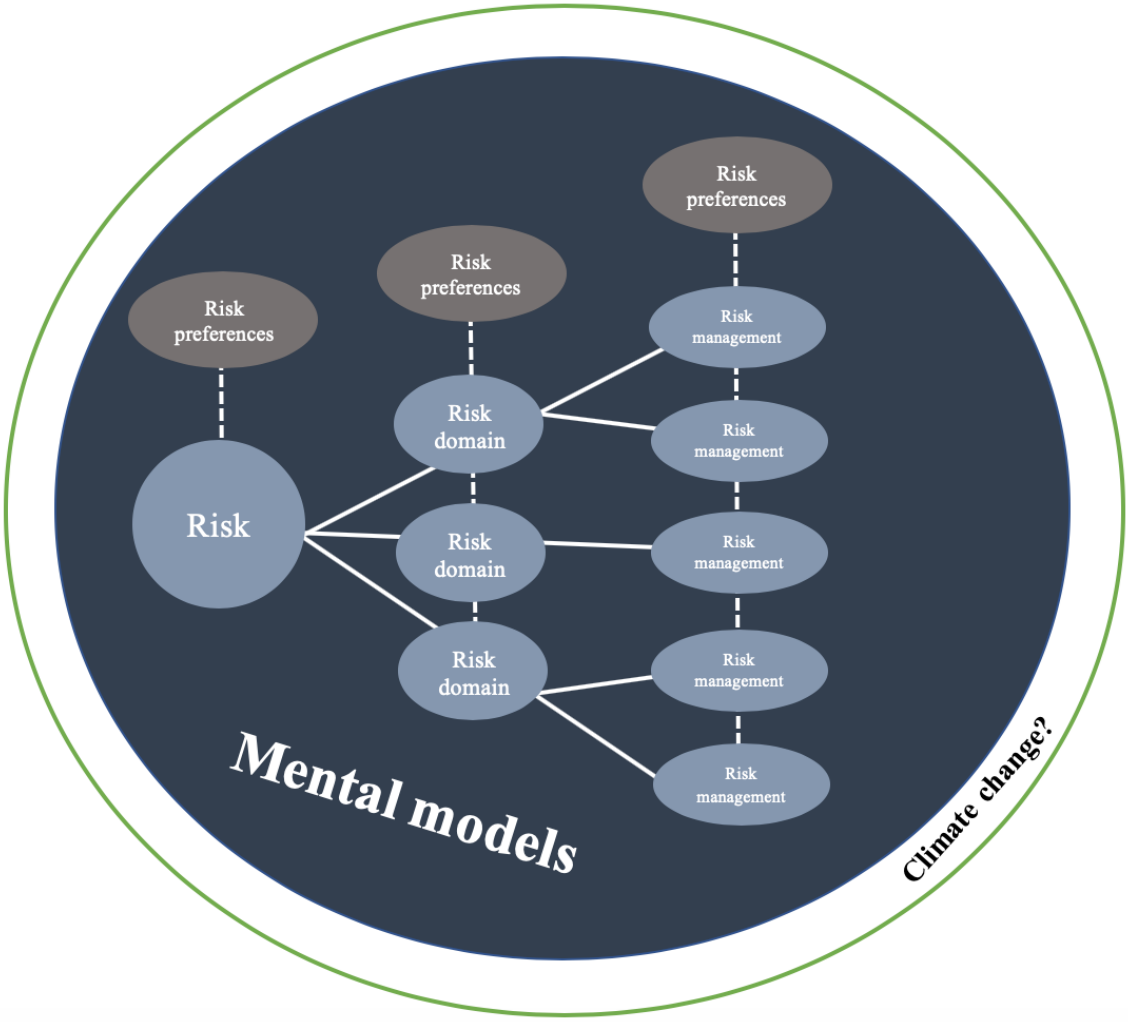

Figure 2. Theoretical synthesis (Own illustration).

4 Method

This chapter presents the method used to achieve the aim of this study, starting with argumentation for the choice of approach. Further, the course of action of the study is presented, including an explanation and motivation of the chosen case studies and how the selection was conducted. This chapter also describes how the empirical data was analysed. The chapter concludes with a discussion of the method and ethical aspects.

4.1 Choice of approach

This study assumed a qualitative approach that infers to interpretative research where our aim was to study cases at a level where we acquired an understanding of attitudes and ideas that caused individuals actions (Bryman & Bell, 2015). In this study, we interpreted the interviews with the respondents to create an image and to understand how their social reality was constructed. The qualitative methodology was preferable for this study since it acquires an understanding of underlying reasons, opinions, motivations, and emotions among the respondents.

A qualitative method is considered to be particularly applicable in the investigation of human behaviour and their actions (Allwood, 2004; Robson, 2011; Bryman & Bell, 2015). Golafshani (2003) describes the aim of a qualitative research method as you understand the opinion of the respondents, and you provide the researcher with a good knowledge of the social reality. Bryman and Bell (2015) state that you can provide insight into the actual problem when using a qualitative methodology. The qualitative approach was a more flexible method for us to use since we could revise new information and findings as soon as it occurred. The results of this study were built on our understanding of what we believed was important and we relied on text data rather than numerical data and thus analysed it in the textual form rather than converting it into numbers (Golafshani, 2003; Carter & Little, 2007; Bryman & Bell, 2015).

Criticism has been directed towards the qualitative research method because it can be considered to be too subjective (Skinner *et al*., 2000; Bryman & Bell, 2015). The researcher's presence at the data collection is inevitable and can, therefore, influence the results collected during the study (Kvale & Brinkmann, 2014). It is also difficult to copy a qualitative study when the aim is to understand and study a specific context, which makes the generalization of the results more difficult. The main strength of the qualitative research method is that it is descriptive and creates a contextual understanding of the studied subject, which is more difficult to obtain from a quantitative study and therefore this research method is used (Kvale & Brinkmann, 2014).

The social reality is perceived differently by different people, and therefore, it cannot be considered objective (Jacobsen, 2002). It is impossible to free oneself from these subjective frames of references (Thurén, 1996). In this study, we believed that social entities such as organizations and businesses should be considered as construction, which is based on the respondents' perceptions and actions. These must thus be seen as socially constructed continuous processes (Bryman & Bell, 2015). Hence, we viewed the social reality as in constant change, as well as the individuals' environment, which can be derived from Bryman and Bell's (2015) definition of constructionist. Knowledge, on the other hand, can be perceived differently. In this study, we viewed social and natural science as diverse concepts, where each

science has different requirements for generating knowledge (Bryman & Bell, 2015). The interpretive approach is mainly associated with qualitative research, and since we aimed to interpret and understand how the respondents' social reality was constructed, this approach was suitable. The theories in this study were determined in advance to use these when analysing the empirical material. The goal was to find patterns, that is, similarities and differences in the collected empirical data to be able to make conclusions.

4.2 Course of action

In this section, the course of action is presented. The first part gives a brief description of the multiple case study design. Then it is defined how the respondents were selected, the interviewing process, and the analysis procedure of the collected data.

Multiple case study

Merriam (1994) argues that the choice of method depends on the focus of the study. In this study, we focused on farmers' thoughts and experiences of the subject. The collection of the empirical data for this study was conducted through case studies, which is the most commonly used method in qualitative research. A case study is defined by Bryman and Bell (2015) as a research design that brings a more detailed and precise analysis of one single case. We acquired an understanding of each case and the context in which it was studied. To compare the results, we chose to do more than one case study. Creswell & Poth (2017), on the other hand, are describing a case study as a methodology, a type of design in qualitative research where the researcher explores one or several bounded systems over time and with great detail. By using case studies, we collected primary data, which enabled us to have full control of the data (Bryman & Bell, 2015).

Choice of cases

To fulfil the aim of this study, we needed to select some cases to interview. We started by assuming a set of different criteria that were relevant for the study and which the respondents needed to fulfil to be included in the sample (Guest *et al*., 2006). The criteria that the respondents needed to achieve were that their business mainly focused on crop production and where the crops mainly were sold externally. It was also a criterion for the respondents to farm at least 100 hectares, which is based on the reasoning about the increased importance of economies of scale (Annerberg, 2015). This also made it possible for us to reach farmers who had full-time jobs in agricultural production, which was another predetermined criterion. The selected cases would be located in the region of Mälardalen, Sweden. We chose to demarcate to this region because it was one of the areas that were severely affected by the drought in 2018 (Regeringen, 2018) and because it was more time and cost-effective for this study.

The strategic selection method enabled us to discover, understand and gain insight into the cases (Merriam, 1994), and it is the most common selection of non-probability sampling (Bryman & Bell, 2015). The non-probability sampling allowed us to choose among the relevant respondents freely, and thus, the method did not provide the opportunity for a randomized sample (Bryman & Bell, 2015). With our predetermined criteria, we also selected our cases purposefully to identify respondents who hopefully would maximize the depths and richness of the interviews to address our research question (DiCicco-Bloom & Crabtree, 2006). With this type of sampling method, we relied on our judgment when choosing respondents to participate in the study. Since

it is difficult to obtain complete information about farmers from companies, due to the General Data Protection Regulation (GDPR), we chose to find and contact the respondents on our own.

After we set up the different criteria, we used of a group on Facebook, "Spannmålsbönderna", ("The crop farmers"), where we briefly presented our topic and wrote that we searched for farmers who wanted to be interviewed and who fulfilled certain criteria (see Appendix 1). In the post on Facebook, we encouraged the reader to forward the message to friends who possibly wanted to be interviewed. In this way, we created a so-called snowball effect that is a method for finding respondents based on established respondents recommending other people who are suitable for being included in the study (Weiss, 1994). A clear advantage of the method is that the response rate is normally considerably higher than if the respondents do not seek any previous contact (Small, 2009). Also, it is an effective way to search for respondents within a defined area where there are not so many respondents available (Thompson, 2002). For this study, the snowball effect was important because of the required criteria that the respondents needed to meet. However, the method is criticized as there is a risk that the respondents know each other, which increases the risk of bias, compared to a random selection (Small, 2009).

Through our Facebook post, we were contacted by a couple of farmers who were interested in being interviewed and included in the study. Furthermore, we used the website www.allabolag.se to find farmers who fulfilled the study's criteria, where we chose the region of Mälardalen and crop farmers as delimitations. With the help of a satellite map on www.eniro.se, we could distinguish farms in the region. When we had selected about 20 farmers, we sent out letters to all where we wrote similar as in the Facebook post (see Appendix 2). We also mentioned that we shortly would contact them and ask if they met the criteria and if they wanted to be included in the study. With some of the farmers, we booked a date and exact time for when the interview was to be carried out, and we contacted some of the farmers the same day and asked if they had time despite the short notice. Being spontaneous at short notice turned out to be more suitable for several of the respondents as they did not know exactly how their schedule would look like the upcoming week due to spring farming. Robson (2011), means that it is of great importance to do an accurate preparation and to plan the study before the actual performance, whereby we prepared ourselves well before the actual interviews took place.

We chose to interview twelve different farmers, which is based on Guest *et al.* (2016), who argues that theoretical saturation is being achieved after the first twelve interviews. Theoretical saturation is often used in qualitative studies in determining the size of the sample (Morse, 1995; Sandelowski, 1995; Bluff, 1997; Byrne, 2001; Fossey *et al.*, 2002; Guest *et al*., 2006) and can be explained as the point when sufficient information has been achieved, and no further data generate different results (Glaser & Strauss, 1967). This was confirmed during our last three interviews since we experienced that no new information was received compared to the previous interviews. We do not believe that further interviews would have contributed to any major difference in the result. Malterud *et al.* (2016), mean that sample adequacy, data quality, and variability of relevant events are often more important than the number of participants. The information power of a sample is, therefore, not very different from being sufficiently large and varied to elucidate the aims of the study. There was a risk of the sample being too substantial because of the time frame, which was important to be aware of.

Semi-structured interviews

To examine if, and how crop farmers consider climate change in their mental models and thus in their risk management, we chose to carry out semi-structured interviews. Semi-structured interviews can be defined as a more flexible and fluid form of an interview where we used an interview guide (see Appendix 3) prepared before the real interview took place (Lewis-Beck *et al.*, 2004; Bryman & Bell, 2015). The interview guide aimed to guide us through the whole interview and enabled us to be flexible about the questions depending on, for example, the social context or the respondent.

The interviews were dependent on our interview technique skills, and to avoid that we influenced the respondents' answers, we used open-ended questions and not leading questions. Before the actual interviews were conducted, we tested the interview guide with the help of a family member who answered the questions. Hence, we were able to change, delete, or add questions that felt right. During the interviews, one of us was responsible for interviewing, while the other was responsible for taking notes. Generally, all meetings with the respondents were initiated with a relaxed conversation that was not included in the actual interview. Our goal was to try to keep the interview as short as possible, preferably 30 minutes since the respondents were quite occupied during this period of the month. However, each interview took an average of 40 minutes. All twelve interviews were conducted for a total of four days, which meant that during one of the days, we performed four interviews. The last interview we performed during that day may have had a different outcome since both of us were relatively tired after a full day of interviewing. This could have been prevented by carrying out the interviews for more than four days.

The interview guide consisted of eleven background questions (see Figure 3) and was intended to be a basis for us when we analysed the collected data and thus understand each respondent's mental model. By knowing the respondents' age, education, previous experiences, and having information about their business, we were able to distinguish similarities and differences and thus draw different conclusions. After we received all the background information needed, we proceeded to the questions of our main themes. The first main theme that we wanted the respondents to talk about was risk preferences, where we asked how risk-averse they considered themselves to be. The second theme, risk in agriculture, included questions such as how they thought about and felt when they heard about risk in an agricultural context, and what they thought caused most risk within agriculture. Then we asked if the annual income varied in the business from one year to another and if it did, we asked what it depended on.

These basic questions about risk in agriculture were later of significance for how the respondents responded to the remaining themes that concerned what risk domains that they could identify in their production and how they managed these perceived risks. We also asked how the respondents managed risks today compared to five years ago. The four themes in the interview guide, *risk preferences, risk in agriculture, risk domains,* and *risk management* were the foundation of our fifth theme that focused on *climate change*. In order to investigate whether climate change is included in the farmers' mental models and thus in their risk management, we chose not to mention climate change initially. To gain an understanding of how farmers consider climate change, we used the 2018 drought as a window. We began with asking the respondents how they were affected by the drought and how they handled it, and then we asked whether they had any planned risk management strategies if they were to suffer a similar drought this year, in 2019. Finally, we asked the respondents to discuss whether they considered climate change as a risk or an opportunity.

During the whole interview, we noted, to the best of our ability, everything that was of importance from what the respondents answered. Also, the interviews were recorded after approval from the respondents. All interviews were carried out on the respondents' farms even though this method is rather time-consuming and has geographical limitations. However, it is preferable to carry out the interviews face-to-face in order not to miss out on contextual or non-verbal data (Nocick, 2007; Bryman & Bell, 2015). Since the interviews did not last for longer than an average of 40 minutes, we cannot guarantee that the context itself gave any significant meaning to our results.

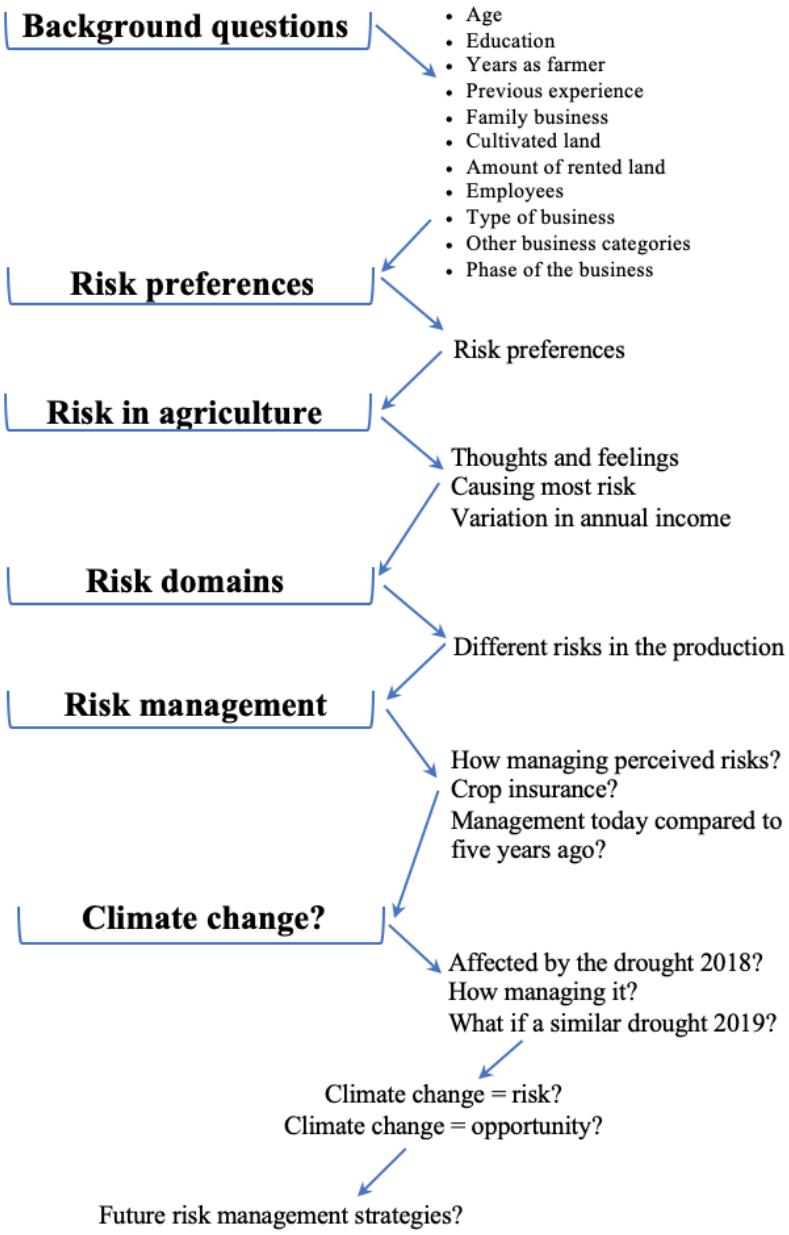

Figure 3. Schematic picture of the interviewing process (Own illustration).

Data analysis

The unit of analysis in this study was the respondents' mental models of risk in agriculture. The respondents' thoughts, feelings, and behaviour about the drought in 2018 as well as climate change were included in the analysis. The fact that in one of the studies' twelve cases a woman was included, and the rest consisted of men, can be explained to that only 10.6% of Sweden's grain farmers are women (SJV, 2011). A previous study means that women tend to be more risk-averse than men in most decisions they encounter (Eckel & Grossman, 2008). If additional women participated in the study, it might have led to different answers, but since the population includes a majority of men, the results should not be misleading.

Analysing qualitative data is an important part of the study, but it can be difficult since there are few accepted methods (Robson, 2011; Yin, 2013; Bryman & Bell, 2015). Each interview was recorded after approval from the respondent, and then we transcribed it to get all the details. These semi-structured interviews generated a lot of information in a short time, and the text material to be analysed became easily unstructured. To structure the collected data, thematic coding was used to create themes and categories. Coding is an important tool that is included in the method of grounded theory (Bryman & Bell, 2015). The themes, *background questions, risk preferences, risk in agriculture, risk domains, risk management*, and *climate change* were created based on our interview guide. After compiling all the interviews, we were able to distinguish different expressions and answers to the questions that we then were able to link to the different themes. When identifying the respondents' expressions of risk in agriculture, we could link these to the risk domains based on Hardaker *et al*. (2015). Further, we connected the respondents' expressions of what risk management tools, both to the risk domains but also to the risk management strategies based on the literature (Holzmann & Jørgensen, 2001).

The method helped us to identify similarities and differences in the individual cases and generated patterns (Braun & Clarke, 2006). Robson and McCartan (2016) argue that different themes facilitate the interpretation and analysis of the data. Thematic coding is a flexible tool for analysing different types of qualitative data (Robson, 2011). Using this method helped us to structure the data and facilitated the understanding of the results.

4.3 Method discussion

A weakness with a qualitative approach is, for example, the risk of the researcher not being as objective as desirable (Bryman & Bell, 2015). There is a risk that we, as interviewers affect the respondents when answering the questions. This risk is greater in a qualitative study than in a study with a quantitative approach. The results in this study were based on our interpretation of what was important, and it depended on our interviewing skills, which can be seen as a weakness, according to Bryman and Bell (2015). The results could, therefore, easily be influenced by our personal feelings and prejudices.

Further criticisms are that it is difficult to replicate a qualitative study since it is the interviewer who is the most important tool when collecting the data (Bryman & Bell, 2015). It is difficult for us people to collect data with a completely open mind without any signs of assumptions or expectations. Even the context where the case studies take place is of great importance in qualitative studies, which makes the results difficult to generalize and transfer to another case (Kvale & Brinkmann, 2014). We aimed to create a deeper understanding of the subject by interviewing different cases and then draw conclusions based on the collected data (Bryman &

Bell, 2015). Because the collected data was subjective, and the social context thus affected the study, we argue that the qualitative method was better suited for this study.

To obtain credibility in the study, so-called respondent validation can be performed (Bryman & Bell, 2015). However, we chose not to carry out any in this study because we wished to analyse the respondents' first and spontaneous thoughts. The respondents' mental models are important for the instinctive ability (Lee *et al*., 1999); that is, the respondents' first thoughts that appeared during the interview were important for this study. The risk with a respondent validation is that the respondents may not approve with what has been sent out and want to change their answers afterward, and thus, the purpose of our interviews would get lost.

4.4 Ethical aspects

When conducting a qualitative research study, it is of great importance to make ethical considerations through the process of using interviews as a choice of method (Kvale & Brinkman, 2014; Bryman & Bell, 2015). It was essential for us to secure the integrity of the respondent being interviewed and also to stay confidential (Trost, 2010). Usually, ethical aspects are associated with the communication between the interviewer and the respondents included in the study (Given, 2008). Also, in qualitative as well as in quantitative research, the criteria of reliability and validity are notably important in establishing and assessing the quality of the research (Bryman & Bell, 2015).

Informed consent, *confidentiality*, *consequences*, and *the role of the researcher* are four ethical guidelines addressed by Kvale and Brinkman (2014). By being aware of what ethical issues that were of relevance for this study, well-founded decisions were made. In this study, the respondents were participating voluntarily, and the collected data was only used to fulfil the aim. It was also of importance that the respondents were informed of the aim of the study before the interview was carried out (Bryman & Bell, 2015). In order to avoid inconvenience and lack of consent, the interviews were recorded after approval from the respondents. We communicated to the respondents that their participation was anonymous to ensure their integrity and to remain confidential (Trost, 2010). Although, there was a risk with anonymity as it may restrict the possibility to describe certain things important for the case studied, and it could interfere with the need to be transparent (Given, 2008).

5 Empirical data

This chapter presents the empirical data that were collected through twelve semi-structured interviews. It starts with a background where we explain the different criteria that the farmers fulfilled to be included in this study. It also contains the farmers' *background information* that is compiled in a table. Subsequently, the chapter is divided into five different main themes, which the interview guide assumes, *risk preferences, risk in agriculture, risk domains, risk management,* and last *climate changes*. The various subheadings include all farmers' thoughts and answers.

5.1 Background information

In total, twelve interviews were conducted with farmers in the region of Mälardalen in the middle part of Sweden (see Figure 4). This geographical delimitation was one of the criteria that the respondents needed to fulfil to be included in the study. The farmers are cultivating at least 100 hectares, and their business mainly focuses on crop production. In one of the twelve cases, both the woman and the man were interviewed because they run their business together. This was the only woman involved in the study, and the remaining respondents were men.

Figure 4. Location of the region of Mälardalen, Sweden.
(https://www.hrf.net/app/uploads/2016/02/map_malardalen.gif).

We have compiled the background information of the farmers using the mean and standard deviation in a table (see Table 1). This to make it easier for the reader to get an overview of the information and also to maintain the respondents' anonymity. The respondents' ages range from 27 to 66 years, with 75 percent that are over 50 years old. The age turns out to correlate with the number of years that the respondents have worked as farmers, that the older they are, the longer they have worked as farmers. Most of the farmers have worked with agriculture throughout their working lives, only two of the respondents have been involved in other

professions for a shorter period, see previous experiences in Table 1. Fifty percent of the farmers have a university education, and the majority of the other 50 percent have an education from agricultural high school.

The size of the farms varies from 160 to 1200 hectares of land, and half of the respondents rent the majority of their arable land. Ten of the twelve farmers' business is a family business where the respondents are the second, third, or in one case, the seventh generation. The number of employees varies from farm to farm, but one-third of the farmers work alone in the business without any employee. The majority of the businesses are run as sole traders, five are limited companies, and one is run as a trading partnership (see Figure 5).

In addition to crop production, ten of the farmers operates other business categories. Snow mowing is the most common activity in addition to crop production among the respondents. Otherwise, animal production, forestry, real estate rental, and machine contracting are conducted among the respondents as side businesses. Regarding in which phase of the life cycle the various businesses are, we get different answers from the farmers. Fifty percent of the farmers consider their business to be in a growth phase or in a continuous growth phase (See Figure 6). The remaining farmers mention phases such as establishment, renewal, expansion, succession, expectant, and conveyance phase. One farmer means that they are in an expectant phase.

Table 1. Background information about the respondents (Own processing).

	Mean	Standard deviation
Age (year)	53.92	12.43
Number of years as farmer	29.58	13.03
Cultivated land (hectares)	615.42	301.67
Amount of rented land (%)	65%	30%
Employees	1.50	1.57
Family business (1 if yes; 0 if no)	0,83	n/a
Generations	2.33	1.78
University education (1 if yes; 0 if no)	0.50	n/a
Previous experience (1 if yes, other experience; 0 if no, only worked as farmer)	0.17	n/a
Other business categories (1 if yes; 0 if no)	0.83	n/a

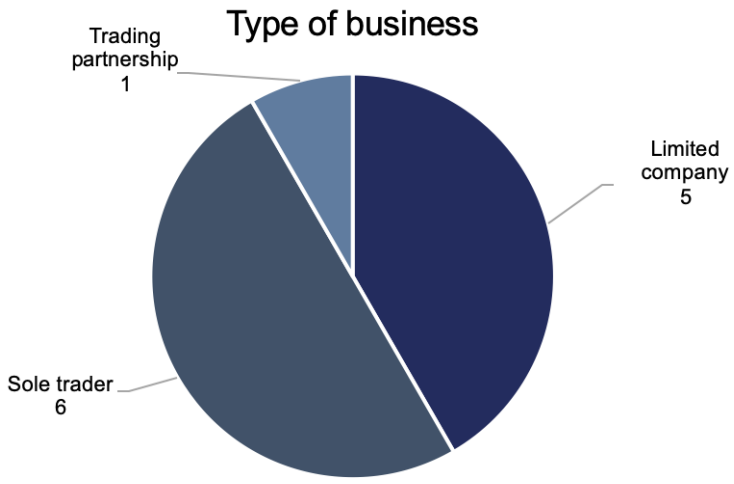

Figure 5. Distribution of the respondents' business types (Own illustration).

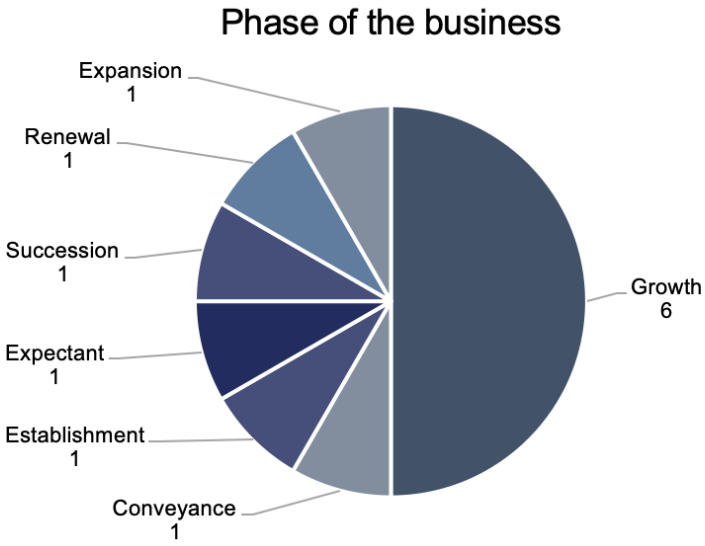

Figure 6. Distribution of the phase of the respondents' businesses (Own illustration).

5.2 Risk preferences

Risk preferences refer to the respondent's individual experiences and beliefs (Sitkin & Pablo, 1992). During the interviews, the respondents were asked to reflect and respond to how risk-averse or risky they considered themselves to be. Only two of the farmers considered themselves to be willing to take risks or to be risk-seeking. One of these two mentions that he takes an increased risk by waiting for the spring to plant crops and that he has a limited amount of winter crops.

"I do take risks but considered and thoughtful risks. I'm aware of what I'm doing, and I do not think that I'm exposing myself to economic danger."

Some of the respondents also suggest they are risk-averse in some situations and other situations not. One of the respondents that considered himself to be risk-averse responded that he views

the price hedging as a risk while others might consider hedging as a strategy used to feel secure and safe. The same respondent claimed that how risky oneself is as a farmer – depends on the situation. During last year with a dry summer, it turned out to be a risk to hedge and other years it might just be the opposite.

"Usually, I do not use hedging or forward contracts. I see hedging as a risk while others find it safe."

About a third of the respondents consider themselves being risk-neutral, in between risk-averse and risk-seeking. Quoting one of those respondents *"... by not acting, you take risks".* It is clear that the ones who consider themselves being risk-neutral, they consider being risky in some ways but not to jeopardize everything. Barely half of the respondents are clear on the fact that they are not willing to take risks. One mention that he takes very few risks as he is afraid to lose capital by taking risky decisions. Another respondent who is in the start-up phase says he considers himself taking very few risks, but starting up an agricultural business can be viewed as a risk itself. On the contrary, another respondent who is older and more experienced considers himself being less willing to take risks now compared to when he was younger and not as experienced. A similar response is given from another respondent with a lot of farming experience, he says that he is not a gambler, and as he does not bet anything, neither does he win anything.

"You have to be prepared to take risks when you are a farmer."

5.3 Risk in agriculture

Risk can be described and experienced in numerous ways, and Hardaker *et al.* (2015) describe risk as uncertain consequences, with possible exposure to unfavourable results. By taking a risk, it is likely that one is being exposed to the possibility of losing something or getting hurt. Risk can also refer to the expected value of the potential loss (Miller *et al.*, 2004). When asking our respondents about what risk in agriculture mean to them, we got different answers (see Figure 7). Some feel that the variation in market prices and crop yields compose a great risk to them as farmers. Respondents with the majority of rented land state that it is a risk with not knowing for how long they are guaranteed the rented land. One of the respondents remembers back to his childhood when his parents did not allow him to reside in a certain part of the farm, where the big machines involved a great risk of injury. The same farmer means that the children are the future, and if there are no longer interested generations on the farms, this could result in a risk for future farming. Even the rapidly developed technology is perceived as a risk.

"It is a risk that, as a farmer, not thinking far enough and that today, you rely on apps and technology. I prefer paper and pencil."

Politics is mentioned as a risk in agriculture by several farmers since political decisions are something that they cannot affect. Regarding input goods, which can be controlled by the farmers, artificial fertilizer is nevertheless considered a risk, economically.

"As soon as the fertilizer is laid on the crop, it means a great risk to us farmers, as it amounts a lot of money."

It is not certain whether there will be rain after the fertilizer is spread and which means that there is a risk that it will not give the desired effect, some farmers state. This leads us to the risk experienced by the majority of the farmers, the weather, which they cannot control. When asking what they consider causing the most risk, 75 percent of the respondents did answer *"the weather"* without hesitating. Not knowing whether the crop is affected by frost, too much rain or drought and the perceived extreme weather, is something that the farmers experience as a major risk in agriculture.

"Agricultural business, in general, is a big risk, but that it is part of the excitement."

On our question, regarding if the annual income in the business varies from one year to another, 75 percent answer yes, that they experience a variation in income. Six of them consider that it depends on the price of the crop and the yield. Another farmer means that the variation may depend on the fact that the hedging prices are not sufficient but that it may also depend on whether the farmer has access to grain storage and drying plant.

"Yes, the annual income varies, but at the same time a situation such as the drought increases the prices of the crops."

Price variation in input is also something that the respondents cite as a reason for variation in the annual income. However, one of the farmers do not think this is a decisive factor but consider that it is, as mentioned earlier, the price of crops and the yield that affect the variation in income in the end. Twenty-five percent of the respondents do not experience any major variation in the annual income between years. However, one says that last year was an exceptional year when the income varied because of the drought.

"We have drying and storage space and have a lot of grain in stock, which means that our annual income does not vary considerably from year to year."

In Figure 7, we have compiled the farmers' expressions of what they perceive as a risk in agriculture, as well as a distribution of how many farmers mentioned the different expressions.

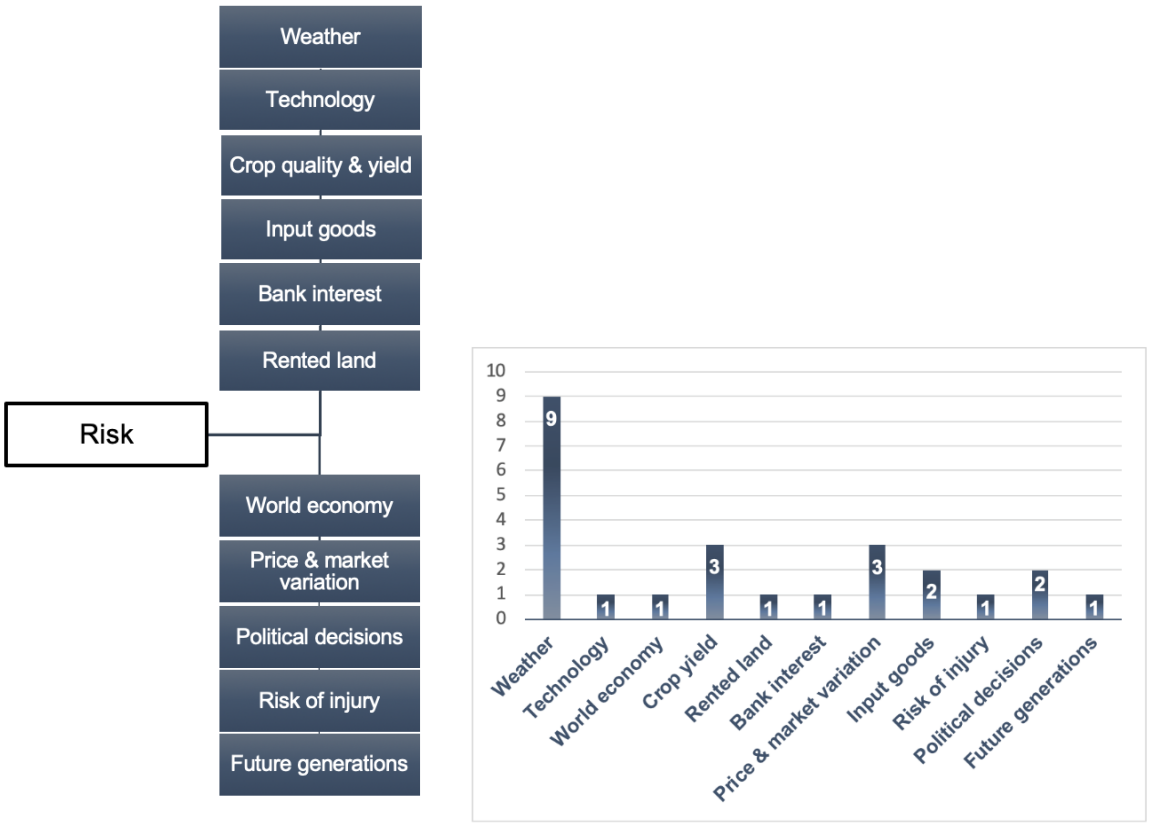

Figure 7. An overview of the respondents' expressions of risk in agriculture (Own illustration).

5.4 Risk domains

Getting into the theme of risk domains, this section reflects our interpretation and the links we do regarding the farmers' expressions of risk to the existing risk domains by Hardaker *et al*. (2015). There are different types of risk sources that can be identified within agricultural businesses, and we have chosen to assume the risk domains that Hardaker *et al.* (2015) describe. As we proceeded the interviews and got further into the theme of risk domains and what kind of risks that can be identified in the agricultural business, about 50 percent of the respondents consider the quality of the crop to be a source of risk. The weather conditions are a contributing factor to risk according to many of the respondents. It is clear that it affects the yield as well as the quality. Production risks that one person does not have an impact on, and that is unpredictable, seems to be one of the greatest risk domains. One of the respondents with a large share of arable land (>700 ha) significantly pointed out the high risk for early summer drought, that it could have an irreversible and damaging effect on the growing crop. As the previous theme, it is shown that production risk is the dominant risk domain.

"The biggest risk appears during the growing season as the risk for early summer drought is very high. That is something that never can be compensated."

Besides the climate and weather risks, about a quarter of the respondents also mention price and market risks as hazards experienced in the production. The input prices are another source of risk that are considered years like the previous one with a dry summer according to two of

the respondents. One respondent experience risks and uncertainty because the prices can be affected as a result of a lower quality of the yield.

"What is most obvious in the crop production are the expensive inputs."

In total, what could be discerned from the answers to the question of where risk could be identified in the production, the quality of the crop as well as "weather and wind" were distinctive in the majority of the respondents' answers, which correlates with the previous responses to the theme of risk in agriculture.

To summarize the respondents' answers on where they experience risks, we have created a figure (see Figure 8). Here we have connected the different expressions of risk to the risk domains mentioned in the literature review.

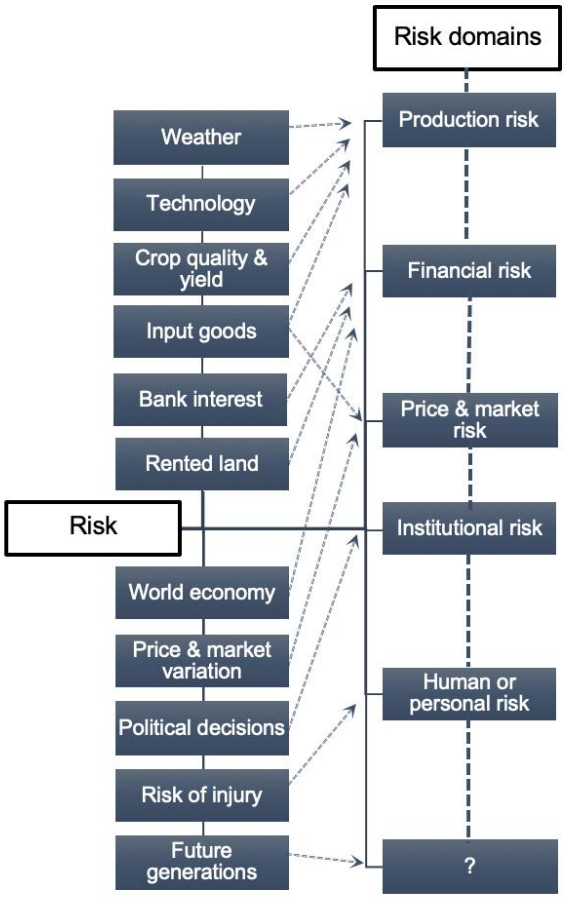

Figure 8. Overview of the respondents' experienced risks linked to the risk domains (Own illustration, with risk domains based on Hardaker et al., 2015).

5.5 Risk management

Risk management is known as a systematic procedure for managing interventions and practices by identifying, analysing, assessing, and monitoring risks and uncertainties (Hardaker *et al*., 2015). Regarding how farmers manage risks in agriculture, the answers vary among the respondents. The majority manage risks by hedging their crops, that is, they choose to sell their crops in advance (see Figure 9). Only two of the farmers say that they do not use hedging as a

risk management strategy. Eight farmers of those who hedge, choose to sell 30-50 percent in advance, one of the farmers hedges 50-75 percent, and the other one chooses to hedge a maximum 25-30 percent of his harvest. Seven of the twelve respondents have crop insurance on all their cultivated land (see Figure 10), which also is a way of managing risks by covering hail damage and reseeding costs. The majority of the ones who have crop insurance mention that they have crop insurance since they experience that hailstorms are quite common in their area.

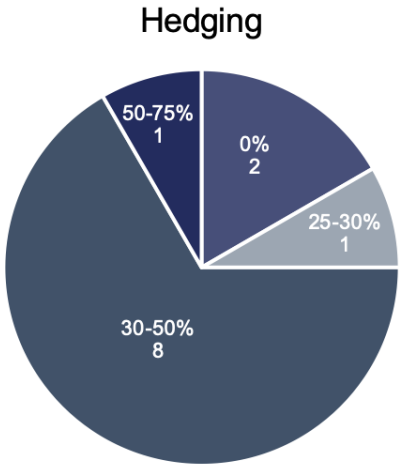

Figure 9. Distribution of how much the respondents are hedging (Own illustration).

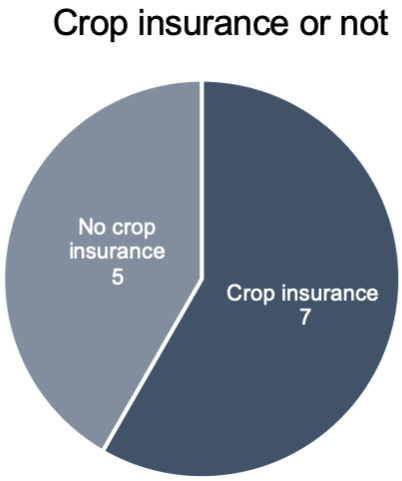

Figure 10. Distribution of how many of the respondents use crop insurance (Own illustration).

One of the farmers believes that knowledge is an essential tool for managing risk. The same farmer also believes that it is important to look and plan a year ahead, for example when several other farmers now are sowing a lot of autumn wheat, this farmer is investing in spring wheat instead because it is a substitute for autumn wheat. He also believes that it is important to follow current trends and to have a market-adapted crop rotation.

"Without knowledge, one cannot identify the risk."

Having good advisors who you trust is mentioned by one farmer as an important risk management strategy. Another farmer believes that they manage risks, among other things, by striving to have 60-70 percent autumn crops and by direct drilling to maintain the moisture in the soil which can be linked to the production risk domain. Three of the respondents mention

diversification as a way of managing risks in agriculture. Two of these three have animal production as a diversification business, and one also has a farm shop where the farm's products, as well as local products, are sold. The third farmer that mentions diversification as a way of managing risks has snow mowing and wood production in addition to the crop production. The strategy of diversification, we have chosen to link to the production risk domain.

The government may have strong political incentives to assist with necessary funds where agricultural support programs and catastrophically relief are examples of coping strategies (OECD, 2009). We relate agricultural support programs as a coping strategy (see Figure 8), and some farmers argue that these supports are important for their future survival.

When we ask the respondents how they manage risks today compare to about five years ago, several respond that they handle risks more or less in the same way as before. However, some of the farmers mean that they no longer dare to hedge as much of the harvest as they did before. One of these farmers mentions that it has to do with the recent drought, that he does not dare to hedge as much as before due to the bad harvest of 2018. At the same time, another farmer says he is hedging more now than five years ago.

"Five years ago, I was able to hedge up to 70 percent of the harvest, but now I do not dare to hedge more than 50 percent of the volume."

The attitude to the crop market is something that differs today from five years ago, one of the farmer states. If something is good now, he does not strive for something that may be better tomorrow but learns to be satisfied as things happen faster on the market today than before.

"Now we can be more aggressive on the crop market than we could before."

One of the younger farmers thinks the crop establishment in the spring is more important now than it was estimated to be before and he experiences the climate as more unpredictable and more extreme now than five years ago. Some of the respondents who answer that they do not manage risk differently today compared to five years ago also mean that they follow their gut feeling, does something feel good then they go for it. One of the farmers says that the difference in their risk management is that they reduce machine investments.

To get a clearer overview of what risk management the farmers are using in the various risk domains, we have created a figure (see Figure 11). Figure 11, like Figure 8, links the farmers' expressions of risk with the risk domains based on Hardaker *et al*. (2015). Figure 11 also links the risk domains with the farmers' expressed risk management tools, which we interpreted and linked to existing risk management strategies, based on Holzmann and Jørgensen (2001).

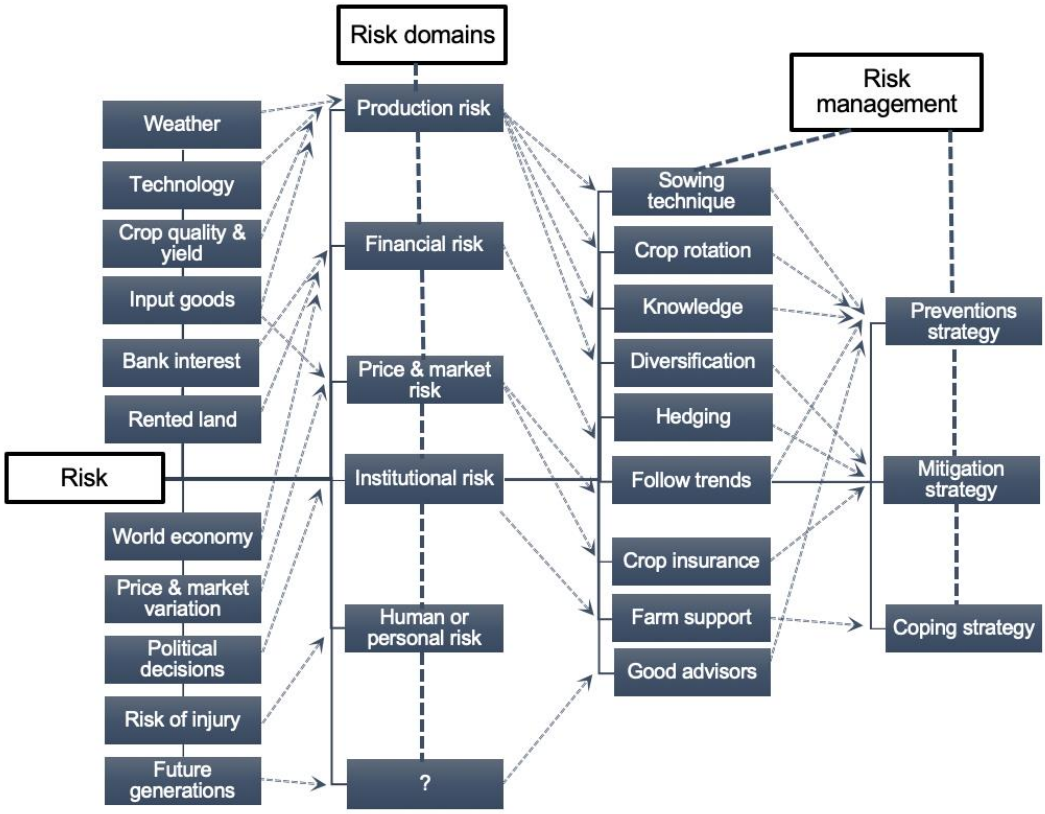

Figure 11. Figure 8 linked to the respondents' expressed risk management tools (Own illustration, with risk management strategies based on Holzmann and Jørgensen, 2001).

5.6 Climate change

The final theme of the interview focuses on the drought and the climate overall. The first question involves how the farmers experienced the drought of 2018 and how they as farmers were affected by it. The majority of the respondents answer that the drought had a major impact on the economy and the business' finances. Several of the respondents mention that getting nearly half of the normal yield resulted in a heavily strained economy. Besides the economic impact from the dry and warm summer, at least a third of the respondents clearly express that they were mentally and emotionally affected by the drought. One of the respondents mentions sleepless nights and mental stress as a result of the low yield.

"I would say that I was mainly economically affected. And also, emotionally due to the fact that it was such a bad harvest, worse than you ever thought it could be."

Further, the next area involves in what way the farmers dealt with the drought. About 50 percent of the respondents say that they tried to cut back on major investments and extensive maintenance since the yield would not pay off as normal. A third of the respondents highlight the increased dependence on other business categories such as various machine contracting and snow mowing to cover up for the losses of incomes from their crop production.

When it comes to the scenario of managing another future drought, at least two of the respondents are quick to mention that they would not hedge as much of the crop as they did this

year and recent years. Partly since they are not willing to guarantee the volumes they want to hedge, and because of the high penalty fees that need to be paid if the demands of the contracts cannot be fulfilled. Other respondents say that they would be faster in repurchasing the contracts. A third of the respondents say they are aiming to work more outside of the crop production if the drought strikes again. The side businesses during winter time would get even more important and necessary, some of the respondents point out. One of the respondents also mentions the difficulty of being strategic as a farmer nowadays and referred to the vulnerability of being a farmer.

"Farmers today are fragile, both mentally and economically."

When asking the respondents on whether they consider climate change as a risk, the answers were fairly scattered. More than half of the respondents do not consider climate change itself as a risk (see Figure 12). These respondents argue that they consider climate change to be more of natural climate variations with a certain impact rather than climate change. At the same time, one of those respondents refers to that a higher frequency of extreme weather events might be a part of climate change. Five of the respondents clearly state that they consider climate change to be a risk. The extreme weather variations and thus an increased uncertainty of the yield are the reasons why climate change is considered as a risk to these respondents. One respondent mentions that he believes that the drought of 2018 increases farmers' awareness and that new ways of thinking are required.

"I'm aware that it will vary even more, but I'm still not afraid of these variations. Old truths do not longer apply, it's time to think new. It's a mental process to put yourself into."

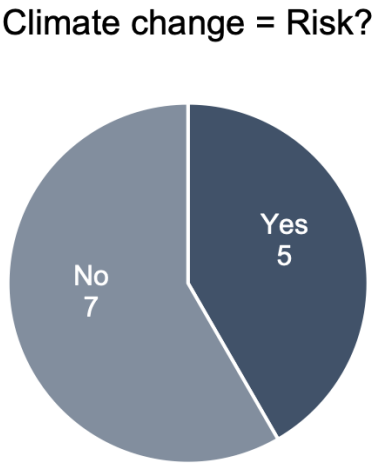

Figure 12. Distribution of how many of the respondents perceive climate change as a risk (Own illustration).

When asking the respondent if they considered climate change as an opportunity, and if so, in what way, the answers varied. About 75 percent mention a longer growing season and the chances of growing other crops. They argue that those opportunities are a result of a warmer climate and higher temperatures, which makes way for other crops and growing techniques. One also mentions the increased chances for the winter crops to hibernate as it gets warmer. Another respondent mention that there are opportunities that you, as a farmer, need to grasp and try to be strategic by thinking from new perspectives. One of the respondents also said that *"...it's basically just to accept the situation and try to be a bit flexible and try to see where the weather is heading".*

“A crisis like the drought can be an opportunity. A crisis can make you adapt more.”

Lastly, we let the respondents reflect regarding future risk management strategies concerning climate change. One of the respondents says he believes that corporations among farms will increase as well as the size rationing of farms. Further, another respondent argues that the range of risk management strategies will increase as a result of the drought, that it serves as an awakening to many active people in the agricultural sector. Other respondents are not convinced that the drought has to do with climate change but that they do believe in a changing climate and that it will somehow affect the range of strategies. Irrigation of fields is also something one of the respondents is mentioning as a future strategy that will have increased importance.

"I believe that there will be an expanded range of risk management strategies in the future since the drought has become an awakening to many."

Not all of the respondents have answers to this question or this subject, but the majority accounted they believed in a change in the climate. At least 25 percent of the respondents once during the interview recalled that *“... I’m not a denier of the climate change”*, as they questioned the reason for the drought. About a third of the respondents mentioned the major reporting from the media regarding climate change and the drought that the phenomena of climate change have gained a lot of media attention during the past couple of years.

In summary, we interpret the results as that climate change is not existing in the majority of the interviewed farmers’ mental models and thus not in their risk management. Since the majority believes that extreme events such as the drought in 2018 are climate variations rather than climate change, these climate variations are those that farmers consider in their mental models and so in their risk management.

6 Discussion and Conclusion

In this chapter, the discussion and conclusion are presented. The first part discusses the results in chapter five, together with the previous literature and the theories from chapter three. This to obtain a greater understanding of the results and their relation to previous literature and theories. The discussion is wrapped up with the conclusion of the study. At the end of this chapter, the implications of the study and suggestions for future research are presented.

6.1 Discussion

Distinctive for farmers is their constant exposure to different types of risk within their business (Nilsson, 2001; Miller *et al*., 2004, Hansson & Lagerkvist, 2012; Hardaker *et al*., 2015). Climate change, along with variability and the increased frequency of extreme weather events, is likely to be an increased risk in agricultural production (Parry & Carter, 1989; Smit *et al*., 2000). The dry and warm summer of 2018 affected a large share of the Swedish farmers within all directions in agricultural production, and they suffered economically (LRF Konsult, 2018). This creates an interest from a risk management perspective to investigate farmers' awareness about the impacts of climate change. The aim of this thesis is to examine if and how climate change is considered in farmers' mental models and thus in their risk management. By doing so, a qualitative case study has been conducted by using interviews with twelve farmers from the region of Mälardalen.

By examining a person's mental models, it can show how close to the reality the personal assessment is (Howarth, 1987). We argue that it is important to understand how farmers consider climate change in their mental models and thus in their risk management and that this could serve as the basis for a contribution to policymakers, advisors, and banks among others in the agricultural sector when developing future risk management strategies and evaluating today's strategies.

There is a range of previous studies that have investigated farmers' risk preferences (van Winsen *et al*., 2016), as well as farmers' beliefs and concerns regarding climate change (Prokopy *et al*., 2015). Although, there are limited research on farmers' risk management and thus how climate change is considered. There are studies about farmers' responses to extreme weather events, such as the one made by Yung *et al*. (2015). The current drought of 2018 that hit large parts of Swedish agriculture makes it essential to investigate this in affected areas here in Sweden. Other prior studies argue that farmers tend to view extreme weather more as local environmental changes rather than as a result from global climate change (Milne *et al*., 2008; Saleh Safi *et al*., 2012). Conducting this study can contribute to either confirming or bringing new insights to this current topic, which can provide valuable input to public and private policymakers as well as advisors in the agricultural sector.

Since the aim of the thesis is to examine if and how climate change is considered in farmers' mental models and thus in their risk management, we argue that it is relevant to initially investigate farmers' risk preferences. A common understanding of risk preferences is that it reflects a general risk orientation tendency associated with a person's experiences and beliefs (Sitkin & Pablo, 1992; Debertin, 2012). Demographic and social factors such as age, experiences, education, farm size, and geographic location are mentioned as factors affecting farmers' risk preferences, according to Hardaker *et al*. (2015). Farmers' risk preferences affect

how they experience risk in agriculture, and one can have different risk preferences in different risk sources (van Winsen *et al*., 2016). Therefore, it is important to examine the farmers' risk preferences regarding risk in agriculture. Further, it can enable us to find out in what risk sources they possibly relate to climate change and if it is considered in their mental models and risk management. The results of this study imply that the majority of the respondents considered themselves to be rather risk-averse or risk-neutral, that they are not willing to take larger risks than necessary. The respondents seem to be aware of that the profession of farming itself includes various risks but that factors such as age, experience and external factors such as world prices and markets are the ones that have major impacts on their risk preferences. These factors are similar to what Hardaker *et al*. (2015) assume that what affects farmers' risk preferences depend on different factors. The results of this study can also contribute to confirm results from other studies suggesting that farmers tend to be risk-averse regarding decisions that affect income and welfare (Hazell & Norton, 1986; Hardaker *et al*., 2015).

Risk management literature further reveals that agriculture includes a great deal of risk estimation and certain measures taken to reduce and mitigate risk (Wandel & Smit, 2000). The results of this study suggest that what the respondents define as a risk in agriculture is fairly scattered, but the most common expression used for risk turns out to be the weather, crop yield, and price and market variation (see Figure 7). According to the respondents, the main expression of risk is the weather which due to the difficulty in predicting and something that greatly influences the yield. Other expressions of risks mentioned are politics, rented land, and the risk of future generations. The latter refers to the risk of future generations not having an interest in operating the agricultural family business. Previous studies on farmers' responses to risk reveal that farmers tend to consider climate and weather as the major sources of risk (Reid *et al*., 2007; Duong *et al*., 2019). This is similar to the reasoning by the farmers in this study where the weather is the risk source most frequently pointed out.

By referring to Hardaker *et al*. (2015), situations where the usual norm by some means changes the result into worse outcomes are called downside risk. In agriculture, where downside risk occurs, such situations depends on uncertainty factors such as rainfall and temperature during the growing process as major deviations in these variables can have unfavourable effects. The result of this study implies that weather was perceived to be the greatest source of risk, which can be referred to as a downside risk. As the results of this study imply that the majority consider the weather to be a risk in agriculture, it can be related to the second and third layer of agricultural risks (OECD, 2009). Weather events in general and also the extreme weather events are pointed out as major risks in agriculture according to the respondents, which both can be placed in these two layers of agricultural risk. In the theme of risk in agriculture, the results of this study indicate that the phenomena of climate change are not prominent in the first stage of the interviews and is thus not part of their mental models.

Risk in agricultural business can be categorized in different risk domains; *production risk, financial risk, price and market risk, human or personal risk,* and *institutional risk* (Hardaker *et al*., 2015). Investigating how farmers' perceived risk can be linked to these risk domains is of importance for this study in order to fulfil the aim since it all is dependent on the farmers' mental models. Within the theme of risk domains, the risk domains described by Hardaker *et al*. (2015) is used when analysing and interpreting the empirical data. The result of this study implies that all of the perceived factors as agricultural risks above can be linked to a known risk domain, except one. Future generations having no interest in operating the farm business is mentioned by one of the respondents as a risk in agriculture, and this type of risk is difficult to link to any existing risk domain (see Figure 8). Since human or personal risks involve life crises

such as the illness or death of the owner or divorces where one or both parties are co-owner of the farm business (Hardaker *et al*., 2015), it is hard to place the "future generation"-risk in this risk domain. We argue that this could be referred to an uncertainty rather than a risk and can therefore not be distinctly linked to any existing risk domain. Uncertainty is defined as a situation in which an individual does not know for certain what will happen (Harwood *et al*., 1999), which characterises the situation with future generations in this case. The results of this study suggest that the quality of the crop and the weather were identified as the major risk domains according to the majority of the farmers. Both of these two risks have in this study been interpreted as and linked to production risks. The production risks that one person does not have an impact on, and that is unpredictable seems to be one of the greatest risk domains according to the farmers in this study.

As we argue that the farmers' mental models and hence their risk preferences determine what risk management strategies they use, it is important to investigate how the farmers manage risks, and if their strategies have changed during the past years. According to Holzmann and Jørgensen (2001), there are different types of strategies to manage risk within the agricultural business; *prevention strategy*, *mitigation strategy*, and *coping strategy*. The so-called prevention strategy is implemented before the risk occurs with an ambition to reduce the probability of negative risks and hence to reduce the variations in the farmers' income (Holzmann & Jørgensen, 2001). In this study, we managed to acknowledge various strategies used by farmers that can be classified as prevention strategies such as sowing techniques, knowledge, following trends, and the use of good advisors. Mitigation strategies are as prevention strategies used for preventive purposes, but it aims to reduce the potential impact of future risk (Holzmann & Jørgensen, 2001; OECD, 2009). One common way is through diversification, which can be substantiated by the result of this study. Hedging and crop insurance are other prevention strategies used by some of the farmers in this study in order to reduce the impact of future risks due to unfavourable weather conditions affecting the crop. What characterizes a coping strategy is, according to Holzmann and Jørgensen (2001) that it is used once the risk has occurred to relieve the impact of the risk. An example of a coping strategy is the support gained from the government, such as agricultural support programs which are mentioned as a common tool used by the farmers in this study. According to Meraner and Finger (2017) farmers usually choose to combine several different strategies instead of using one alone, which can be confirmed in this study. The results of this study also imply that most farmers, more or less, are using the same risk management strategies as in the last five years. Although, some farmers mention that they do not longer dare to hedge as much as they did before. Some of the farmers that have changed their strategies lately point out the recent drought as a reason. The responses regarding how the farmers manage and experience risks in their businesses do not clearly include preventing climate change.

Climate change is a phenomenon that is expected to increase the need of farmers' risk prevention and adaptation more and more (Wheeler & Tiffin, 2009; Niles & Mueller, 2016; Arndal Woods *et al*., 2017). Along with its variability and extremes, climate change is stated to be an increased risk in agricultural production (Parry & Carter, 1989; Smit *et al*., 2000). Therefore, it is of interest to investigate if and how climate change is considered in farmers' mental models and thus in their risk management. In this study, the results show that more than half of the respondents argued that they did not consider climate change to be a risk. The results further imply that the majority of the respondents were clear about the fact that the drought in 2018 had a major impact on their economy and the business' finances. This can be confirmed by the estimates on the agricultural business in Sweden that has been done by LRF Konsult (2018) as a result of the drought.

A third of the respondents mentioned relying more on other business categories as a way of handling the drought, which is in line with a type of mitigation strategy, according to Holzmann and Jørgensen (2001). Increased diversification was also part of several farmers' future strategies if a drought were to strike again within a short time. The results of this study further state that the majority of the farmers were not perceived to consider or acknowledged the impact of climate change on increased extreme weather, such as the drought of 2018. Many of the interviewed farmers would emphasize increased extreme weather as part of natural variations rather than actual climate change. This can confirm the results from prior studies by Milne *et al*. (2008) and Saleh Safi *et al*. (2012) which state that climate change does not seem to be a major part of farmers' mental models when it comes to risk and risk management.

Although five of the respondents state that they consider climate change to be a risk. The reasons for this, according to these farmers, are the increased extreme weather variations and thus an increased uncertainty of the yield. However, whether the respondents experienced climate change as a risk, some also mentioned the fact that they can identify opportunities with climate change. A longer growing season turns out to be the most obvious mentioned opportunity. This can be substantiated by information from SJV (2018b) which claims a longer growing season is likely to be a result of climate change.

A recurring statement from at least a third of the respondents was "*...I'm not a denier of the climate change*". These farmers mentioned the major impact from media on climate change that they were not convinced that the drought and extreme weather situations mainly could be blamed on climate change. Some also argued that climate change has gained a lot of media attention lately and that it might be misleading.

In conclusion, the majority of the interviewed farmers do not include climate change in their mental models and thus not in their risk management. Although, they mention the weather and extreme weather events as risks in their agricultural production. The outcome of this study shows that the farmers identify various risks in their agricultural production, and the weather is the main source of risk to the majority of the farmers.

6.2 Implications of the study

In this thesis, a study on farmers' mental models of their risk management was conducted. The collected empirical material provides an understanding of how farmers experience risk and risk management and further if and how climate change is considered.

Since we only conducted twelve interviews, and that the selection was done through a non-probability sampling, it is difficult to generalize the results of this study. The choice of only performing twelve interviews was based on Guest *et al.* (2016), who argue that theoretical saturation is being achieved after the first twelve interviews. This was confirmed during our last three interviews since we experienced that no new information was received compared to the previous interviews.

The geographical location is also a crucial factor in making generalizations difficult. During our interviews, we could discern that farmers are experiencing different weather conditions. One example is that some farmers mention that they have crop insurance because they experience that hailstorms are quite common in their area, while some do not have crop

insurance since they do not perceive hailstorms as a problem. These local weather conditions can affect how farmers experience climate change. This, in turn, can be a decisive factor in how the farmers consider climate change in their mental models, and thus how they manage risks in agriculture. If we would examine the same study, but in a different geographical location, it may have resulted in the same way, since we can find local weather variations throughout the entire country (SMHI, 2018b).

Performing a quantitative study, with for example a questionnaire survey, a larger geographical area could have been examined, which may result in different answers and thus in other conclusions. Why we selected cases located in the region of Mälardalen was due to that it is one of the areas that has been severely affected by the drought in 2018 (Regeringen, 2018) and because it was more time and cost-effective for this study.

In this study, the mental models apply to crop farmers and not to other farmers with a different main production, such as animal production. But by changing focus, for example, choosing to examine farmers with animal production could be possible to fulfil the study's aim. However, we chose to focus on farmers who are more or less dependent on their crop production. This choice is based on our interest in looking more closely at crop farmers as their production is extra vulnerable to possible extreme weather such as the drought in 2018. This is due to the specific growing season and that the crop production represents most of the annual income for these farmers.

Studies have been conducted to investigate farmers' views and actions after extreme weather events, such as the drought of 2012 (Prokopy *et al.*, 2015; Yung *et al.*, 2015). Studies examining farmers' perceptions of climate change conclude that farmers tend to view extreme weather events as local environmental changes rather than because of global climate change (Milne *et al*., 2008; Saleh Safi *et al*., 2012). This can be related to a person's mental models as it refers to the lenses through which we view the world (Lee *et al.*, 1999; Johnson-Laird, 2005). By investigating how climate change is considered in farmers' mental models and risk management, this study can lay as a basis for further investigation on the subject of farmers' attitudes toward climate change and what motivates their choices of risk management strategies. Observations made in this study can be useful to understand farmers' views on climate change from a risk management perspective. It could also contribute with insights to policymakers, advisors, and banks, among others in the agricultural sector as future risk management strategies are developed. The results of this study further show that climate change is not that distinctly mentioned by the farmers when discussing risk in agriculture and risk management strategies. This could call for an increased need from private and public policymakers to further raise this issue in the forums where it is needed.

6.3 Future research

This study is limited to the region of Mälardalen in middle Sweden and includes only a fraction of all the farmers in Sweden in total. Due to the difference in local situations and weather conditions, it would be interesting to test if the results are replicable in other areas in Sweden. A study suggests that women tend to be more risk-averse than men in most decisions they encounter (Eckel & Grossman, 2008). Since all the farmers except one in this study were men, it would be of interest to examine if the results are similar in a different group with a larger share of females.

The findings in this study are limited to crop farmers' mental models of risk management, and it would be interesting to further investigate what farmers are missing in their current risk management strategies and tools if they could be developed and if so, how. Also, it would be of interest to apply this study on farmers with different main production than crop production such as animal production for example, if the findings are alike or not and if climate change is considered differently in other farmers' mental models.

In this study, we were able to discern a type of risk that was difficult to place in the existing risk domains based on Hardaker *et al.* (2015). Since our aim does not focus on identifying new risk domains, we have chosen not to further investigate the "future generation" expression. Future studies could, as a matter of course, focus on examine different risk domains to identify new ones.

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Appendix 1 – Cover letter posted on Facebook

We, Hanna Engvall and Cornelia Nilsson, study our last semester at SLU, Uppsala, within the field of Agricultural Economics. We are writing our master's thesis where we will perform a number of interviews with farmers in the region of Mälardalen.

Briefly, our study is about examining how farmers manage risks in agriculture, focusing on last year's drought.

We are looking for farmers with the main focus on crop production, where the cereals are mainly for sale. You should cultivate at least 100 hectares, and work with agriculture on a full-time basis.

If the criteria apply to you, or if you know someone who knows someone, who would be interested in setting up for an interview, please do not hesitate to contact us. If you have any questions or concerns about the subject, please feel free to contact us.

We are easily reached via email:
hael0004@stud.slu.se
coni0001@stud.slu.se

Sincerely, Hanna Engvall and Cornelia Nilsson

Appendix 2 – Cover letter sent to farmers

Sveriges lantbruksuniversitet
Swedish University of Agricultural Sciences
Department of Economics

Uppsala 21 march 2019

Hello,

We are Hanna Engvall and Cornelia Nilsson and we are studying Agricultural Economics at the Swedish University of Agricultural Sciences in Uppsala. We are now reached our final semester and are writing our master thesis where we want to investigate how farmers manage risks within agriculture, focusing on last year's drought. Farmers are constantly affected by changes and are exposed to several risk factors, partly due to price fluctuations on the world market and unpredictable weather conditions. There is increasing demands on the individual farmer today to handle these different risks. This is a current subject and we are interested in investigating more closely on Swedish farmers.

We are looking for farmers with the greatest focus on crop production, where the cereals are mainly for sale. You cultivate at least 100 hectares, and work with farming full-time.

With this letter, we hope that you will comply with the above criteria, and that you are interested in setting up for an interview that will be carried out sometime in early April. We will contact you by phone shortly when you can notify if you want to participate or not for an interview.

If you have any questions, please do not hesitate to contact us via email or phone.

Sincerely

Hanna Engvall
hael0004@stud.slu.se
076-0924264

Cornelia Nilsson
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070-2998593

Appendix 3 – Interview guide

Introduction

A brief summary of what the study is about and the purpose of the interview.
Ask if it's okay to record the interview.

Background

- Age
- Education
- For how long have you worked as a farmer?
- Previous experiences?
- Is the farm a family business? For how many generations?
- How much acreage is cultivated?
- How much land is rented vs owned?
- Do you have any employees?
- What business type do you have?
- What other business categories besides crop production do you have?
- In what phase of the life cycle is your business?

Main questions

Risk preferences

- How risk-averse or risky do you consider yourself to be?

Risk in agriculture

- What does risk in agriculture mean to you?
- What do you perceive causes the most risk in agriculture?
- Does the annual income in your agricultural business vary from one year to another? If so, what does it depend on?

Risk domains

- What kind of different risks can be identified in the agricultural business? Develop!

Risk management

- How do you manage perceived risks? Do you have any special strategy? Develop!
- Do you have crop insurance?
- How do you manage risks today compared to five years ago?

Climate change

- How do you perceive that you have been affected by the drought in 2018? How did you manage it? Develop!
- If it will be another drought in 2019, how do you intend to manage it?
- Do you perceive the climate change as a risk? How? Develop!
- Do you perceive the climate change as an opportunity? How? Develop!
- How do you see on future risk management strategies, with respect to the climate change?