Perceptions of barriers to climate change adaptation by Uppsala farmers

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Content
Content...............................................................................................................................................ii
Abstract..............................................................................................................................................iv
Summary...............................................................................................................................................v
Abbreviations ....................................................................................................................................vi

1. Introduction ........................................................................................................................................1
   1.1. Research question .......................................................................................................................3

2. Background .......................................................................................................................................4
   2.1. Barriers to adaptation literature .................................................................................................4
   2.2. Nordic adaptation literature .......................................................................................................6
      2.2.1. Uncertain decision-making context .....................................................................................6
      2.2.2. The perspective of decision-makers ....................................................................................7

3. Conceptual framework ......................................................................................................................10
   3.1. Barriers ........................................................................................................................................10
   3.2. Social understanding of adaptation decision-making .................................................................10
   3.3. Adaptation, vulnerability and resilience .......................................................................................11
   3.4. A socio-cognitive framework ....................................................................................................12

4. Methodology ....................................................................................................................................15
   4.1. Study delimitations .....................................................................................................................15
   4.2. Case study design ......................................................................................................................15
   4.3. Data analysis ..............................................................................................................................17
   4.4. Limitations ..................................................................................................................................17

5. Results and analysis ........................................................................................................................19
   5.1. Adaptation strategies ..................................................................................................................19
      5.1.1. Adaptation ............................................................................................................................19
      5.1.2. Intended adaptation ...............................................................................................................20
   5.2. Risk appraisal ..............................................................................................................................21
      5.2.1. Climate change and perceived risk ......................................................................................21
      5.2.2. Perceived severity of climate change ..................................................................................26
   5.3. Adaptation appraisal ....................................................................................................................31
      5.3.1. Perceived adaptation efficacy ...............................................................................................31
      5.3.2. Perceived adaptation cost .....................................................................................................33
      5.3.3. Perceived self-efficacy ...........................................................................................................34
   5.4. Internal and external barriers .....................................................................................................36
      5.4.1. Internal barriers .....................................................................................................................36
      5.4.2. External barriers ....................................................................................................................37
6. Discussion ......................................................................................................................... 42
   6.1. Risk perception and perceived probability ................................................................. 42
   6.2. Risk experience appraisal .......................................................................................... 42
   6.3. Risk perception influencing the perceived efficacy of adaptation ......................... 44
   6.4. Perceived severity and adaptation cost ....................................................................... 45
   6.5. Internal barriers ........................................................................................................ 47
   6.6. External barriers ......................................................................................................... 47
7. Conclusion ....................................................................................................................... 49
8. Acknowledgements ......................................................................................................... 51
9. References ....................................................................................................................... 52
10. Appendix ....................................................................................................................... 58
    10.1. Interview guide ......................................................................................................... 58
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Abstract:
Current emissions are likely to produce substantial impacts for the agricultural sector and the salience for adapting to these changes in the agricultural sector is increasing. While Nordic agriculture is faced with both opportunities and challenges from climate change, a still developing political and institutional structure in combination with an extreme drought during the summer of 2018 is exacerbating existing long-term trends of financial pressure in the sector, particularly for meat and dairy farmers. Previous research has highlighted that there is a relative lack of studies attempting to understand the decision-making process of climate change adaptation and there is a currently a growing field of research focusing on the barriers to adaptation faced by farmers. This study primarily used Grothmann and Patt’s MCCAPP model in order to determine what factors influenced farmers decision-making when deciding to adapt to climate change. The results of this study found that the predominant barrier to adaptation among farmers were uncertainty regarding future climatic impacts, which resulted in a lower confidence in adaptation strategy efficacy to produce financial stability and returns. Climate mitigation was also identified as a potential trade-off when pursuing adaptation strategies. To a lesser degree, farmers also attested to farm-level differences, such as the availability of water resources as impacting the strategies that they were able to pursue. Opportunities to facilitate adaptation through institutional support was identified, as farmers both require better information regarding adaptation strategies and subsequent trade-offs and synergies it might create in relation to farmers priority issues such as financial viability and climate mitigation. More effective means of financial assistance to counteract the effects of extreme climatic conditions was also identified. Lastly, social capital was an important facilitator of adaptation implementation, but one that is threatened due to the continuingly deteriorating socio-economic conditions that farmers experience in their sector.

Keywords: Sustainable development, Climate Change Adaptation, Nordic Agriculture, Adaptation decisionmaking, Barriers to adaptation, Farmers.

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Summary:
While reducing the greenhouse gases that are causing global warming has been of primary concern for the international community adapting to the effects that already released greenhouse gases will have on the planet is increasingly considered an important issue. Agriculture is considered to be a sector that is vulnerable to future climate change and in need of adaptation. In Sweden, adaptation policies are still developing, and the drought of 2018 has highlighted the vulnerability of the sector. Adaptation is oftentimes focused on increasing knowledge about climate change impacts and studies are increasingly emphasising the importance of understanding the decision-making process of adaptation in order to facilitate its implementation. This study aims to understand the decision-making process of farmers in Uppsala and look at the barrier’s that farmers experience are standing in the way from them implementing adaptation strategies. This was done in order to identify how climate adaptation better can be facilitated in the agricultural sector and among farmers. This question was answered by primarily using a framework from Grothmann and Patt that emphasises social and cognitive variables for understanding adaptation decision-making. The results found in the study highlight that the primary barrier to adaptation experienced by farmers is uncertainty with regards to what challenges climate change would present in the future. Due to uncertainty about these challenges, farmers were uncertain about what strategies to implement in order to minimize the risk that they would sustain financial losses as a consequence of reduced yields. Climate mitigation was also identified as a potential trade-off when pursuing adaptation strategies. Additionally, farmers also experienced barriers particular to their farm, as one farmer attested to not having enough water resources to build an irrigation system. The study also identified factors which might facilitate adaptation, including institutional support that help farmers to strategize for future climate change in a way that creates synergies with farmers priority issues as well as providing more efficient ways to provide financial assistance to farmers in order to mitigate losses due to extreme climatic conditions. Lastly, the study also found that social communities can help members to increase their capacity to deal with climate change, but that farmers attest to the threatened future viability of farming communities due to deteriorating socio-economic conditions.

Keywords: Sustainable development, Climate Change Adaptation, Nordic Agriculture, Adaptation decision-making, Barriers to adaptation, Farmers.

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Abbreviations
COP 21: Conference of the Parties 21
FAO: Food and Agricultural Organization
IPCC: Intergovernmental Panel on Climate Change
IVL: Swedish Environmental Research Institute
MCCAPP: Model of Private Proactive Adaptation to Climate Change
RCP: Representative Concentration Pathways
UNEP: United Nations Environment Programme
UNFCCC: United Nations Framework Convention on Climate Change
1. Introduction

In 2007, a research group writing for the Proceedings of the National Academy of Sciences of the United States of America argued that adaptation in the agricultural sector was necessary due to the amalgam of greenhouse gas already released into the atmosphere in combination with worsening observed trends, such as the continuing rise in CO2 concentrations, faster than expected observations of climate change, climate scenarios becoming increasingly grave in their predictions of future impact, as well as a lack of international engagement and legally binding agreements to reverse the trend (Howden et al., 2007: 19691). More than ten years later, the international community have made commitments to reduce climate change to below 2 and aiming for 1.5 degrees Celsius under the Paris Agreement at COP 21 (UNFCCC, 2019).

Yet the “Emissions Gap Report”, published by the UN in 2018, highlights current commitments as substantially inadequate for reaching both the 1.5- and 2-degree Celsius target (UNEP, 2018: 4). Yearly emissions have been increasing in 2017 and 2018 according to a study by Le Quere et al. (2018: 2167-2170). Further, the IPCC report Global Warming of 1.5 degrees has highlighted that significant difficulties will face human societies already at 1.5 degrees Celsius warming (Roy et al., 2018: 451-456). Given the current trajectory, it therefore seems likely that human societies will have to adapt to a substantial degree of warming.

The agricultural sector features in the IPCC reports as one of the most vulnerable to climate change and likely faces significant challenges in scenarios of climate change. Extreme weather fluctuations among other things threatens yields, spikes in food prices and could subsequently lead to poor health outcomes, particularly in poorer countries due to food insecurity, hunger and subsequent under-nutrition due to lower food production. These challenges are coupled with a global context of increasing demand for crops and uncertain levels of future warming, which might pose more severe and fundamental challenges to the food production system (IPCC, 2014b: 4-8; 18-19). A report from the FAO in 2018 highlights that there are clear links between agricultural production systems and achieving the Sustainable Development Goals, as climate variability and climate extremes has exacerbated hunger and subsequently impacted the health and well-being of many vulnerable populations (FAO, 2018: xiii-xv). Adaptation in agriculture is therefore arguably an important aspect of ensuring the future health and well-being of human societies and the Fifth Assessment Report from the IPCC argues adaptation and mitigation should be complementary strategies that together facilitate sustainable development (IPCC, 2014a: 17-18).

While there is a need to implement adaptation to expected impacts of climate change, there is a lack of studies concerned with its implementation. The literature review by Berrang-Ford reveals that while the adaptation literature had grown, it was more concerned with adaptation conceptually rather than focusing on the implementation process (2011: 31-32). The literature review by Biagini et al. reinforces this finding by highlighting that their review of 92 adaptation projects in 70 countries suggested the majority of projects are focused on capacity building rather than on actual adaptation implementation (2014: 101; 104-106), which suggests implementation is lagging. In the Nordic context, Klein and Juhola affirm the idea that there is a “gap between adaptation research and action” (2014: 102) and argues that research should facilitate action through more closely reflecting the concerns of adaptation decision-makers (Ibid, 105-106). There is therefore a need for research to better understand adaptation in order to better facilitate its implementation.

Climate change adaptation has gradually received more attention in Sweden and a framework for understanding and detailing vulnerabilities and divisions of responsibilities is developing. In the initial
2007 Official Governmental Report on climate change, “Sverige inför klimatförändringarna – hot och möjligheter” (translation: Sweden in the presence of Climate Change – threats and opportunities), the primary conclusions reached was that Swedish agriculture faces primarily benefits from climate change due to a warmer climate and better growing conditions but that substantial challenges in the form of increased instances of for example climatic fluctuations and new pests and diseases might lessen the projected benefits (Swedish Ministry of the Environment, 2007: 12-29). Yet in the Swedish context, concerns for adaptation has in relative terms arguably neglected agricultural concerns. The legal basis of climate adaptation rests on that individual property owners are themselves primarily responsible for climate mitigation (Swedish Ministry of the Environment, 2018: 75), but a Swedish Government Official Report from 2017, “Vem har ansvaret?” (translation: who is responsible?), aimed to crystallise the divisions of responsibilities in implementing adaptation. A focus on built infrastructure resulted in the pushing of key adaptation concerns in the agricultural sector to future investigations (Swedish Ministry of the Environment, 2017: 15-16; 35-41). A subsequent climate adaptation bill in 2018 issued by the government called for a review of the divisions of responsibilities in the event of flooding of agricultural lands in order to rectify the current imbalance in future policymaking (Swedish Ministry of the Environment, 2018: 83). As it stands therefore, farmers are themselves primarily responsible for adaptation on their farm and policy support structures should arguably be characterised as in an early development stage.

Conditions for implementing adaptation are further worsened by an agricultural sector that is increasingly struggling to maintain its financial viability. The national food strategy from 2017 highlights a need to increase competitiveness and productivity as profitable subsectors in agriculture, such as meat and dairy industry, have lost significant market share (Swedish Ministry of Enterprise and Innovation, 2017: 15-16; 20; 27-28). While achieving productivity increases, there are also environmental pressures to mitigate the climatic impact of production, particularly for livestock farmers (Hallgren et al. 2010; Swedish Ministry of Enterprise and Innovation, 2017: 11-13). Tentatively, securing productivity increases while reducing environmental impacts might come with its own challenges in the form of negative feedbacks and unintended consequences (Milestad et al., 2012: 367-370). These pressures are compounded by the structural disadvantages experienced by rural communities in Sweden, who are currently attempting to reverse negative spirals where the closing of farms and key social functions such as hospitals, schools and shops are challenging the socio-economic functions of communities and reducing the ability for rural businesses to thrive (Milestad et al., 2011: 137-138). Lastly, extreme climatic fluctuations have also challenged the sector, as the drought from 2018 led to significant losses for the sector, prompting the government to issue a crisis support fund of 1.2 billion SEK to farmers during the autumn of the same year (Government Offices of Sweden, 2018). Conditions in the agricultural sector are therefore strained.

Adaptation is primarily delegated as the responsibility of regional County Administrative Boards (Swedish Ministry of the Environment, 2009: 161-167) and in Uppsala, the County Administrative Board have published a two-part plan of action, broadly detailing the key vulnerabilities for agriculture in the region (Länsstyrelsen Uppsala län, 2014a: 18-20) and a plan of action for the sector (Länsstyrelsen Uppsala län, 2014b: 16-17). The region has therefore taken a proactive stance towards adaptation, but what is evident in the plan of action is that most support structures for the agricultural sector is in the form of capacity building, such as including climate adaptation in the established consulting services (Länsstyrelsen Uppsala län, 2014b: 16-17). Region specific climate-scenarios have also been made for 2050 and 2098 under 4.5 and 8.5 RCP scenarios, but no specific analysis into the impacts on agriculture were provided (Sjövik et al., 2015: Summary; 7-41; 66). Further, although Uppsala Municipality was ranked number one in the country for their work on adaptation (IVL, 2017: 4), the report from the
County Administrative Board highlights municipalities in the region only to a lesser extent work with climate adaptation in the agricultural sector (Länsstyrelsen Uppsala län, 2014a: 18). A SWOT analysis from 2014 suggests that substantial work remains in order for the agricultural sector to achieve smart and sustainable growth (Länsstyrelsen Uppsala län, 2014c: 3; 11-18). In addition, the extensive work by the more populous municipality of Uppsala is contrasted with many smaller municipalities whose adaptation efforts rank lower by the IVL (IVL, 2017: 4; 11; 23). The area therefore arguably presents an interesting case study of how adaptation strategies are implemented in Sweden.

1.1. Research question

A lacking policy framework, significant cross-sectoral pressures, particularly for livestock and dairy farmers, raises questions of the ability of farmers to implement crucial climate adaptation strategies on their farm, and if not, what barriers and bottlenecks to implementation that they experience. This is particularly relevant in relation to recently experienced extreme weather with significant impacts on the sector and in support of an institutional support structure that is early in its development process. In line with the implementation gap highlighted by previous research, and since farmers are themselves primarily responsible for implementing adaptation strategies on their farm, this study aims to understand how farmers, as decision-makers, conceive of barriers to adaptation in order to make visible whether and why adaptation implementation may be lagging. Highlighting barriers from a decision-makers perspective may in turn help to identify how adaptation better can be facilitated in the sector. This study therefore aims to answer the research question:

*How do livestock and dairy farmers in Uppsala conceptualise barriers to implementing adaptation measures on their farm?*

In answering this question this paper aims to reveal how farmers see climate change impacting their farming businesses, what adaptation needs they perceive and potential leverage points that create better conditions for future climate change adaptation implementation. The study aims to answer the research question in a way that is sensitive to other compounding pressures experienced by the sector.
2. Background

2.1. Barriers to adaptation literature

There is an extensive literature dealing with adaptation and the barriers that might impede its implementation. The review of the literature on the barriers to adaptation by Biesbroek et al. reveals that the topic has been addressed across multiple sectors, settings and academic disciplines. The research is often focused on smaller case-studies and have produced a vast number of context dependent barriers due to the diversity of goals and strategies contained within the study area. The context specific nature of the research is exacerbated by the fact that studies often focus on achieving climate change adaptation, rather than more specific questioning into aspects of adaptation. Due to this diversity, the authors argue that the collective research done is hard to abstract into generalized barriers to adaptation across fields (Biesbroek et al., 2013: 1122-1127). Biesbroek et al. therefore identify an emerging but not yet consolidated field of study in the barrier’s literature (Ibid, 1126).

With regard to agricultural climate adaptation, there is similarly a substantial number of articles addressing the barriers to adaptation, of which only a portion is included here due to time resource and space constraints. This selection shows the importance of perceptions of climate change and adaptation, financial and socio-economic considerations, as well as technical and institutional factors for determining the barriers actors experience to adaptation.

What can primarily be derived from the selected literature is that farmers are already adapting to climate change today. The study by Kabir et al. for instance highlights Bangladeshi farmers are changing cropping systems, crop varieties, changing planting and sowing dates, using more fertilizers and pesticides, and in some cases building irrigation systems. Some farmers were not adapting their farm specifically but instead diversifying their income by seeking wage labour outside of the sector (Kabir et al., 2017: 219; 222-223). Esham and Garforth’s study of Sri Lankan farmers reveal that most of the studied farmers were adapting through for instance changing sowing and harvesting dates, shortening the growing season, switching to new crop varieties, as well as some farmers who were implementing rainwater harvesting systems, although many others could not afford it (2013: 541-543). There is therefore evidence of farmers pursuing some degree of adaptation.

Further, the selected literature shows that many studies highlight the importance of social factors, and the perspectives of decision-makers in particular as important for determining the barriers to adaptation. While there are articles taking a prescriptive approach to decision-making (Descheemaeker, et al., 2016), the majority of articles involves interviews with relevant stakeholders and decision-makers and situates adaptation decision-making in relation to decision-makers perceptions of climate change (Alauddin and Sarker, 2014; Bryan et al., 2009; Deressa et al., 2009; Esham and Garforth, 2013; Fisher, et al., 2015; Kabir et al., 2017; Niles et al., 2016; Panda, 2016).

One of the primary findings here is a problematisation of individual perception and climate change action where the idea that individuals would act to mitigate the effects of climate change if only they knew about the impacts and effects of it, also called the “knowledge-deficit model” (Niles et al., 2016: 290), is critiqued as the only solution facilitating adaptation decision-making. While studies show that information about climate change is an important facilitator for action with regards to climate change, such as Esham and Garforth’s study showing that risk perception of decision-makers in relation to climate change is a statistically significant factor for determining the likelihood of an actor to adapt (2013: 543), the selected studies seemingly imply that decision-making is more complex than simply being a function of awareness about climate change. The literature shows decision-makers are also susceptible to different kinds of information. In particular, Berrang-Ford et al. writes about availability
heuristics as an important aspect for stimulating decision-making. The study suggests that extreme weather events serve more frequently as “evidence” of climate change, while slow and progressive change is “hidden” (Berrang-Ford et al., 2011: 32).

Further, in a study attempting to separate intended and actual adaptation decision-making, the results from Niles et al. suggest that perceived efficacy, or the ability of an actor to achieve successful adaptation, is more important in terms of explaining actual adaptation, whereas attitudes and beliefs about climate change led to intention but not necessarily to action in itself (2016: 289-292). The study by Esham and Garforth reaffirm the findings by Niles et al. through their own results, which suggest that increased pessimism about the ability to adapt acts as a bottleneck for adaptation (2013: 545).

The importance of perceptions about efficacy of adaptation is confirmed by other studies. Panda highlights climate and weather information, information about climate change adaptation, as well as implementation strategies such as the appropriate crop varieties to use, was seen by participants as barriers to implementation (2016: 791-792). Alauddin and Sarkers study of Bangladeshi farmers highlights farmers are perceiving climate change impacts and sees a lack of information about it as a barrier, alongside lacking knowledge about “appropriate adaptation measures” and “drought-resistant rice varieties” (2014: 207). The participants in the study by Kabir et al. mention the lack of support from extension services about “appropriate adaptation measures” as a key barrier to adaptation (2017: 220). The findings therefore seemingly suggest that information about climate change needs to be coupled with an empowering of decision-makers through helping and facilitating their implementation strategies.

Efficacy is often linked to the importance of technological and institutional support for facilitating adaptation decision-making. The participants in the study by Kabir et al. argued that adaptation strategies could be improved through stronger public policy and funding for good extension services, price guarantees, credits, and access to technologies such as new crop varieties (2017: 223). Alauddin and Sarker argue that among the primary barriers of adaptation were knowledge about strategies and impacts of climate change, as well as the development of drought resistant rice variants (2014: 211). Deressa et al. argue that adaptation in Ethiopia would be greatly enhanced through agroecological research that provides and improves adaptation technologies (2009: 254). Interestingly, all three authors connect the role of extension services as providing farmers with strategies to adapt to climate change, signalling the importance, not only of awareness about the impacts of climate change, but also of ways of dealing with it (Alauddin and Sarker, 2014: 212; Deressa et al., 2009: 254; Kabir et al., 2017: 223). Technological and institutional support to the agricultural sector has therefore been seen as an important facilitator to adaptation in previous studies.

Almost all studies were sensitive to the importance of financial barriers for explaining adaptation decision-making (Alauddin and Sarker, 2014: 211; Bryan et al., 2009: 424-425; Deressa et al., 2009: 252-254; Descheemaeker, et al., 2016: 2338-2339; Esham and Garforth, 2013: 540-545; Fisher et al., 2015: 297; Kabir et al., 2017: 222-223; Panda, 2016: 792). Esham and Garforth’s findings suggest that climate related obstacles were not the most important reason for adaptation taking place, instead arguing that the participants were more concerned about economic constraints (2013: 540-541). Berrang-Ford et al. similarly suggests decision-makers take into consideration multiple stimuli when deciding to adapt and that adaptation takes place more often due to “financial stimuli” than because of a general concern for climate change (2011: 28-32). Financial decisions should therefore be considered in order to understand adaptation decision-making.

Socio-economic considerations are also seen as important for explaining decision-making. For instance,
Alauddin and Sarker’s study highlight land ownership status and labour shortage as partial barriers of consequence (2014: 207-209). The study by Deressa et al. links education, gender and age of the head of household, farm income, access to credit, among other variables, as being consequential in explaining the decision to pursue given adaptation strategies (2009: 252-253). Community factors are also considered important for explaining barriers to adaptation strategies. Deressa et al. argues that social capital is a relevant factor, as information sharing between farmers enhances the implementation of adaptive measures (2009: 254). Socio-economic factors and social capital were therefore seen as important for determining adaptation responses.

In sum, the selected literature on barriers to adaptation seemingly suggest that there are many potential barriers to adaptation and that they function through complex and context-dependent interactions. There is largely a consensus around the idea that perceptions of climate change impacts, adaptation strategies and their efficacy are important factors for explaining decision-making. Further, previous studies have found barriers to adaptation both at the both farm-level and more broadly in society. As highlighted by Biesbroek et al., the barriers to adaptation seemingly range from “cognitive and motivational barriers to systemic and institutional barriers” (2013: 1126).

2.2. Nordic adaptation literature

The literature on Nordic agricultural adaptation vary in context, scientific fields and addressing a variety of issues. Klein and Juhola argue that the primary bottlenecks in adaptation research in the Nordic context come from research which on spatially, temporally and in its theoretical understanding too far removed from the decision-makers. Decision-makers are also uncertain as to the future impacts of climate change and therefore hesitate to act. Crucially, adaptation is also argued to be hindered by an inadequate anchoring in the understanding of adaptation as existing within a continuum of other concerns facing the decision-maker (Klein and Juhola, 2014: 105-106). There is therefore seemingly a need for research which more closely interacts with adaptation decision-making with a nuanced understanding for its implementation. This literature review reflects this need and argues for the importance of considering the highly contextual nature of adaptation decision-making in research.

2.2.1. Uncertain decision-making context

Previous research has highlighted that there is uncertainty as to what impacts Nordic farmers will experience from climate change. While there is a general understanding for that the sector will benefit from climate change (Swedish Ministry of the Environment, 2007: 12-29), the study by Rötter et al. highlights that there is great uncertainty in the climate models on expected impacts from climate change on agricultural production (2012: 171-178). New phenomena such as increases in freeze and thaw fluctuations could also impact soil quality and growing conditions (Kvalvik et al., 2012: 33-35). Moreover, spatial contexts further bear on the vulnerability of communities. Previous research has shown that vulnerability may differ due to the interaction between local environments and climatic impacts (Neset et al., 2018: 8-9), and a Norwegian study by Uleberg et al. has shown that climate impacts differed across 6 municipalities studied (2014: 29-34).

This uncertainty is further exacerbated by an uncertainty reflected in the literature of how farmers should adapt to climate change. Previous studies highlight that there are trade-offs between adaptation strategies, where tillage for instance, could improve drainage and reduce weeds and pests, but simultaneously create the risk of nutrient leakage (Wiréhn, 2018: 70). Certain adaptation strategies might also be favoured ahead of others, as drainage is often prioritised over developing infrastructure for drought (Neset et al., 2019b: 84-85), particularly in the south-east of Sweden (Wiréhn, 2017: 74-75). Uncertain impact projections are therefore coupled with difficulties for decision-makers in
balancing trade-offs between objectives and managing risks from maladaptation that could increase their vulnerability. Vulnerability among farmers therefore differs and previous research on climate change impacts and adaptation reflects a substantial degree of uncertainty for decision-makers regarding likely outcomes. This echoes the findings from Klein and Juhola’s study (2014: 105-106).

Further, the socio-economic and political contexts are widely considered important for determining relative vulnerability and ability to adapt. Kvalvik et al. argue that financial strain due to market prices and the development of less but larger farms, increasing individual farmers workload and decreasing detailed knowledge about the land they work on, have impacted farmers ability to adapt (2011: 34-35). Agricultural experts in the study by Nøset et al. agree on farm income as a relevant factor for adaptive capacity, while the influence of farm size was contested (2018: 8). The studies by O’Brien et al. argues agricultural grants and socio-economic differences between communities and regions might determine the capacity to deal with climate change (2006: 50-54), and Juhola et al. similarly highlights adaptive capacity might differ between Nordic regions broadly due to differences in knowledge, resources and institutional support (Juhola et al., 2012: 723-729). Social capital in communities is also important for adaptation decision-making, as Eriksen and Selboe argue that a mountain farming community in Norway has been able to deal with climate variability through for instance sharing knowledge, workload and renting equipment (2012: 165-166).

What emerges from these studies is therefore a complex understanding of vulnerabilities that is dependent on uncertain climate predictions and a range of spatial, socio-economic and cultural factors. In line with Wiréhn’s argument, capturing this complex picture of vulnerability and adaptation requires a socio-ecological systems perspective, which considers the impacts of climate change alongside contextual societal factors which might lead a community to be more susceptible to harm (Wiréhn, 2017: 50-53).

2.2.2. The perspective of decision-makers

The systemic literature review of Wiréhn also highlights the prevalence of adaptation trade-offs that are made on the basis of “different environmental, social and economic goals” (Wiréhn, 2018: 69). Similarly, Klein and Juhola argue that adaptation research needs to consider a wider set of objectives that decision-makers are faced with, since adaptation decision-making might conflict with other interests, such as financial or aesthetic considerations made by actors (2014: 106).

Understanding adaptive behaviour through the perspectives of decision-makers is reflected in the literature. Two studies by Asplund examine the perspectives of farmers in relation to climate change discourses. In Asplund’s 2016 study the author explores how farmers conceptualise climate change and concludes that participants were primarily “sceptical of climate change” (Asplund, 2016: 565), though a particular figure was not given. Using their own experience of long-term perspectives, farmers argue for changes in weather being due to natural variation rather than climate change. The author highlights the interesting dichotomy between societal discourse and individual experiences, as the viewpoints of farmers of climate change runs counter to the view held by the general Swedish population, who believe in climate change. The author argues that motivations to pursue climate mitigation might suffer from not believing in climate change, although the author does not necessarily see it as inhibiting adaptation decision-making (Ibid, 564-572). Asplund’s 2018 study on the credibility of climate change communication among farmers finds that farmers use experiential knowledge, metaphors and comparisons to understand climate change, concluding that colleagues and extension services were seen as the most credible source of information about climate change (Asplund, 2018: 32-35). Asplund’s study underscore that individual internalisations of climate change differ.
Recently, there have been studies that have more closely studied the link between perceptions about climate change and adaptation implementation (Juhola et al., 2017; Jørgensen and Termansen, 2016; Neset et al., 2019a; Woods et al., 2017). The study by Juhola et al. looks at the intersection between perceptions of vulnerability and actions taken to adapt to it by farmers in Sweden and Finland and finds that farmers are worried about exacerbated conditions regarding drier summers and associated water stress, fungus and pests, as well as regarding increasing unpredictability in the climate. While it does not say specifically that farmers believe in anthropogenic climate change, it argues that farmers are aware of its projected impacts. The study showed that farmers were implementing both incremental and systemic adaptation strategies but that farmers did not see climate change as warranting immediate action compared to more pressing concerns stemming from policy and market forces (Juhola et al., 2017: 29-35).

Jørgensen and Termansen explores how perceptions shape the probability of Danish farmers to pursue mitigation and adaptation strategies. The study found that farmers believe in climate change, are aware of the risks and are pursuing adaptation and mitigation strategies. Yet it only finds a link between socio-economic factors and implementing adaptation strategies. Interestingly, the study finds that while farmers on an abstract level believe in climate change, they do not couple their own experiences as being evidence of climate change phenomena (2016: 293-294). The study by Woods et al. analyses perceptions of Danish farmers to climate change, concluding that most farmers believe in climate change, but considers risks to be low. Farmers were more likely to understand economic concerns as more pressing, preferred to adapt in order to gain opportunities rather than to minimise losses, responded better to short-term rather than long-term trends and frequently saw adaptation in an integrated sense alongside other concerns on the farm. Interestingly, farmers perceived of several barriers to adaptation, but the authors found no connection between perceived barriers and adaptation implementation as the authors reason this might be because individuals who want to adapt might be more likely to know about barriers to adaptation (Woods et al., 2017: 109-116). Neset et al. explored farmers’ perceptions of maladaptation and found that alongside environmental concerns, farmers were balancing adaptation strategies in relation to other concerns and competing values including, among other things, uncertainty, financial considerations and in relation to perceptions regarding inherent trade-offs, thus reaching different conclusions about the viability or risks associated with given strategies (Neset et al., 2019a: 2-10).

Finally, the study by Chongtham et al. explored differences in perceptions and adaptive strategies between organic and conventional farmers in Uppsala, Sweden. The study shows that organic farmers and fewer conventional farmers think that the climate is getting warmer and that the growing seasons were getting longer, as well as a more general consensus regarding the increased frequency of extreme climatic fluctuations. Interestingly, the study shows variation between farmers in their perceptions of change within the same geographic location and different perceptions of whether the effects were positive or negative. While some argued for the positive effects of longer growing seasons, for instance, others argued that the climate was becoming drier and more unpredictable, as well as some observing that the winter of 2010-2011 was particularly extreme. There was also a concern for more pests, weeds and insects, which have resulted in more labour and in some cases chemicals to deal with the problem. The study subsequently displays a variety of strategies to deal with new phenomena that emerge due to climate change, concluding that organic farmers, for instance, were more likely to diversify their income compared to conventional farmers. Another example is that many farmers were sowing crops later in the season due to milder winters (Chongtham et al., 2016: 5-8). The study finally highlighted that there was an observed disconnect between perception and action with regards to climate change, arguing that “the lack of resources and knowledge, the unpredictable nature of change/variability and the
intensity of risks associated with climate change” (Ibid, 8) were pivotal factors in order to explain this disconnect.

What can primarily be derived from the literature review of both the barriers literature and the literature on Nordic adaptation is that adaptation decision-making needs to be understood through a complex systems understanding that accounts for the influence of context-specific social, political, economic and environmental systems. Similar to Juhola et al., Jørgensen and Termansen, and Woods et al., this paper will therefore situate itself within the barriers literature and through a socio-ecological systems-perspective that takes particular note of the continuum of concerns that farmers face, attempt to reveal the interlinkages and dynamic relationship between farmers perceptions and understandings of climate change and their socio-economic circumstances in order to reach a conclusion about their perceived barriers to adaptation. The study will add to the results obtained by Chongtham et al. through considering the adaptation of livestock and dairy farmers, rather than the difference between organic and conventional farmers. It will through its theoretical framework more directly focus on barriers of adaptation, rather than accounting for the variety of strategies used. While interviews were not done with the same sample, in some sense, this paper will also provide continuity as the interviews done in the study by Chongtham et al. were conducted in 2011.
3. Conceptual framework

3.1. Barriers

The focus of the study will be on the barriers to adaptation faced by farmers as individual decision-makers. In so doing, it will aim to be sensitive to both barriers as well as the converse, opportunities to adapt. This study understands barriers as something which hinders the subjectively interpreted goal of individual farmers, meaning that barriers are likely to differ between farmers and their contextual circumstances. The weakness of this is highlighted by Biesbroek et al., who argue that an overarching understanding of subjectively defined successful adaptation is difficult to conceptualise (2013: 1123; 1126-1127). As previously highlighted with reference to the article by Adger et al., adaptation decision-making is often limited by social and individual factors (2009: 341). This study aims to tackle this problem through the MCCAPP framework, which arguably allows for reflexivity in accounting for individual decision-makers and their respective goals. While the study does not provide a clear understanding for what type of adaptation should be strived for, it attempts to account for the desired outcomes of farmers through exploring their understanding of their own agricultural practices, social discourses and their surrounding society.

3.2. Social understanding of adaptation decision-making

In adaptation research, the barriers to adaptation are often described in terms of economic, technological, and biophysical factors, but there is a growing literature and recognition for the added importance of considering contextual social factors as important determinants to whether and subsequently how societies chose to adapt to climate change (Adger, 2009: 337-338).

Adaptation has to contend with the fact that it does not provide a clear conceptual framework for the kind of society that should be developed as a consequence of its implementation. Hulme highlights that there are no categorical assessments available of ‘good’ or ‘bad’ climate, as humans have adjusted to climatic systems as disparate as those that exist in Saudi Arabia and the North-Pole (Hulme, 2009: 2-5). In addition, there is a great difficulty in ascertaining the effects of climate change as distinct from other natural phenomena (Ibid, 192). The nebulous characteristic of climate change informs Hulme’s characterisation of it as an “unsituated risk”, which gives rise to the influence of both affective and analytical reasoning regarding its nature (Ibid, 196-200).

In order to gain insight into how adaptation implementation can be facilitated, a social constructionist understanding of knowledge that is sensitive to contextual variables that inform decision-making will be used. Social constructionism provides a critical basis for understanding individuals not as rational entities that observe the world in an objective sense (Burr, 2015: 2-3) but rather as having a perspective which is informed by the cultural and historical context within which they live (Ibid, 4). Contextually constituted knowledge is explained by constructionists as inter-relationally founded, in that knowledge is constituted and subsequently developed through interactions between individuals in society (Ibid, 4-5). Consequently, the epistemological focus of this study is on “process”, which means that social constructionism is interested in explaining individual behaviour through placing it in a continuum of social, political and economic forces that we interact with and that shape our identities and how we view the world (Ibid, 4).

Previous studies have noted the importance of contextual social factors for determining differing responses to climate change. The study by Nielsen and Reenberg in Northern Burkina Faso exploring two farming tribes’ stances towards diversifying their livelihoods and Sakakibara’s study of the Iñupiat in Alaska and their coping strategies towards environmental degradation that are destroying their
livelihoods are examples of studies that reveal the importance of social values and culture for determining how communities decide to adapt (Nielsen and Reenberg, 2010: 148-151; Sakakibara, 2008: 463-473). Social and cultural understandings condition how different communities pursue adaptation in relation to climate change. Adger et al. argue that the limits to adaptation

“are endogenous and emerge from ‘inside’ society. In this reading, what is or is not a limit to adaptation becomes a contingent question. It all depends on goals, values, risk and social choice. These limits to adaptation are mutable, subjective and socially constructed. How limits to adaptation become constructed, rather than how they are discovered, becomes the operative question.” (2009: 338).

The authors subsequently highlight that adaptation decision-making is underpinned by differing ethical and cultural principles that shape what we aim to achieve and protect, how different knowledge claims are perceived and acted upon, and how society and individuals in society understand risk (Adger et al., 2009: 337-339). In line with Adger et al., the research of this essay will build on an understanding of adaptation decision-making through rooting inquiry into the perspectives held by relevant stakeholders. In so doing, it will attempt to critically engage with and provide insight into the social values and goals that condition their decision-making.

3.3. Adaptation, vulnerability and resilience

The key phenomena and concept studied in this paper is adaptation. This essay will use the definition of adaptation provided by Adger et al., which states that:

“Adaptation to climate change takes place through adjustments to reduce vulnerability or enhance resilience in response to observed or expected changes in climate and associated extreme weather events. Adaptation occurs in physical, ecological and human systems. It involves changes in social and environmental processes, perceptions of climate risk, practices and functions to reduce potential damages or to realise new opportunities.” (2007: 720).

The understanding of adaptation provided by Adger et al. (2007) requires an understanding of concepts of vulnerability, who argue an aspect of achieving adaptation is to reduce vulnerability. The same author’s definition of vulnerability will be used.

“Vulnerability to climate change refers to the propensity of human and ecological systems to suffer harm and their ability to respond to stresses imposed as a result of climate change effects. The vulnerability of a society is influenced by its development path, physical exposures, the distribution of resources, prior stresses and social and government institutions” (Ibid, 720).

Lastly, the definition by Adger et al. relies on a conceptual understanding of resilience, which in line with the definition provided is often an outcome to be strive for in adaptation processes. The definition of Walker et al. will be used:

“Resilience is the capacity of a system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks.” (2004: 2).

As Milestad et al. highlights, resilience is intimately involved with vulnerability as, often when resilience decreases, vulnerability increases, as society becomes less capable of dealing with different
stresses (2012: 372-373). This understanding is present in the definition of Adger et al., who argue that adaptation should strive to reduce vulnerability or increase resilience (2007: 720).

The use of a flexible understanding of adaptation, vulnerability and resilience has implications for the focus of the study. Termed a socio-ecological system by Milestad et al. (2012: 369-373), this underlying conception moves the unit of analysis from the specific subject under study to capturing dynamic relationships between an object of study and its surrounding environment – social and biophysical systems (Turner et al., 2003: 8074-8076). Rather than pursing a linear reasoning model where actors are conceptualised as responding to climatic stress in isolation to other concerns (Basset and Fogelman, 2013: 51-52), the definitions used in this study aim to move the line of inquiry to how social, political and economic contexts create complex interactions that influence decision-making (Turner et al., 2003: 8075). Adger et al. states that:

_In practice, adaptations tend to be ongoing processes, reflecting many factors or stresses, rather than discrete measures to address climate change specifically._ (2007, 720).

In line with this understanding, the scope of research will seemingly accommodate for the possibility of interactions between a wider scope of variables. Further, in line with social constructionistic research, detailing the complexity of human and environmental systems means that the results of the study are somewhat anchored in a context-specific understanding (Burr, 2015: 4; Turner et al., 2003: 8075-8076). The central conceptual understanding therefore lends itself to an understanding of complex interactions between decision-makers, societies and the environment.

3.4. A socio-cognitive framework

Similar to the study by Esham and Garforth (2013: 538) the barriers to adaptation will be explored through using an applied version of Grothmann and Patt’s “Model of Private Proactive Adaptation to Climate Change”, or MPPACC for short (2005).

The MPPACC is premised on proactive and individual decision-making and argues for the importance of considering psychological factors when explaining decision-making. Psychological factors that determine adaptation action are underemphasised in adaptation literature but is crucial to understanding the bottlenecks in implementation. While not discounting the importance of socio-economic factors for influencing the scope of possible actions, understanding the perceived adaptive capacity in relation to these factors arguably more directly relates inquiries into understanding adaptation bottlenecks affecting individual decision-makers (Grothmann and Patt, 2005: 200-203).

The model centres around understanding two primary factors, an actors’ risk and adaptation appraisals, which ultimately either results in reducing damage through “adaptation” or increasing it through “maladaptation” (Grothmann and Patt, 2005: 203). Under risk appraisal, the model argues that the perceived probability of damage from climate change as well as the perceived severity influence behaviour. Interestingly, the authors’ understanding of perceived severity is intimately intertwined with motivation. Severity not only relates to the amount of damage the actor foresees, but it is also a relative measurement made by the actor, where concern and subsequent action in response to severity is judged in relation to other factors that an actor deems as important to their enterprise. Grothmann and Patt argues for a “nominal and actual value” comparison where the probability of an actor acting on perceived severity is judged in relation to the relative disparity between desired and expected outcome (2005: 202-203).
Adaptation appraisal is determined through the “perceived adaptation efficacy”, the actors’ “perceived self-efficacy”, and the “perceived adaptation costs” (Grothmann and Patt, 2005: 203). These first two factors are a function of an actor’s assessment of the general as well as their own capability to adapt, and the third an assessment of the perceived cost of adapting. The authors highlight that cost can be conceptualised in multiple ways and does not only equate to monetary value but can for instance also include the time that has to be spent on an activity. The author highlights that the process of adaptation appraisal typically happens after a critical threshold of perceived risk is reached (Ibid, 203-204).

The model includes a few variables as bearing on the risk and adaptation appraisal processes. Primarily, actors’ previous experience with risk and cognitive and heuristic factors that detail the thinking patterns that characterise an individual’s rationality impacts both the risk and adaptation appraisal. From outside, actors’ perceptions regarding overarching social discourses that relate to how climate change risk and adaptation are understood by the society the actor lives in affects the decision-making process (Grothmann and Patt, 2005: 204-205).

The model includes “adaptation incentives”, “reliance on public adaptation”, as well as “objective factors”, in order to explain the factors that bear on adaptation decision-making (Grothmann and Patt, 2005: 204). While social constructionist inquiries primarily focuses on processes rather than static structures (Burr, 2015: 2-3; 11-12) and is arguably incompatible the categorisation of “objective adaptive capacity”, the focus of the model is ascertaining actors’ perceptions of these factors, such as money, entitlements, and institutional support (Grothmann and Patt, 2005: 204). The classification of objective factors nonetheless creates a seemingly simplistic characterisation of the type of socio-economic and political factors the framework aims to assess the influence of. These three factors will therefore instead be captured through a classification of internal and external conditions taken from a study by Abid et al (2015). Internal factors are those endogenous to the unit of analysis, which for instance includes a farmers’ assets, and external factors for example institutional support or financing that may impact adaptation implementation (Abid et al., 2015: 238). This arguably creates a more sophisticated structure where internal factors tie more closely to the general and self-efficacy aspect of the adaptation appraisal process and external factors more directly inquiries into the dynamic between individual decision-makers and the society they live in. It also arguably allows actors more freely to describe how they view the barriers and their connections in relation to their adaptation strategies. Note however that what internal and external factors that are relevant for a given case might differ and does not necessarily reflect the factors included in the model by Abid et al. (2015: 238).

As mentioned, this process either leads to a reduction of damage through “adaptation” or increased damage through “maladaptation” (Grothmann and Patt, 2005: 203). Interestingly, maladaptation is not only understood here as relating directly to adaptation action but instead as actions or inaction in general which will result in greater damage due to climate change impacts. Maladaptation itself is subsequently linked to different cognitive biases which are present in actors’ initial risk and adaptation appraisal processes. Moreover, the authors separate between “adaptation intentions” and “adaptation” as they highlight that intentions are not always followed by subsequent action (Ibid, 204). Importantly, understanding decision-making through this multifaceted process does not presuppose actors who are perfectly rational in their decision-making process. Rather, it allows for understanding decision-making through perceived understandings informed by previous experience, biases, societal incentives, social discourses and socio-economic and political conditions (Ibid, 203-205). Further, the authors concede that decision-making processes are messy and often lack predetermined patterns (Ibid, 201-203). The study will therefore use the MPPACC framework and look particularly at actors’ risk and adaptation appraisal processes but simultaneously grant that individual actors’ decision-making might follow different patterns and relate to different parts of the model according to their circumstances.
The theoretical framework informs a primary focus on the perceptions of farmers rather than an assessment of their capabilities based on a standardized scale. In line with the theoretical approach of social constructionism and Grothmann and Patt’s model, decision-making will be accounted for through exploring psychological variables and participants conceptualisations and understanding of their socio-economic surroundings (2005: 200-205). While attempting to explain the perspectives of participating farmers through answering the question of how they conceptualise barriers to adaptation, the extent to which specific hypotheses will be juxtaposed to farmers behaviour is limited to the relatively broad boundaries detailed in the theoretical framework.
4. Methodology

4.1. Study delimitations

The unit of analysis are individual farmers and their farm. Rather than reflecting normative judgements regarding who is responsible for implementing adaptation measures against climate change this choice reflects the current legal framework, which places the responsibility for implementing adaptation measures to individual farmers (Länsstyrelsen Uppsala län, 2014a: 18-19). This allows for conclusions regarding the functioning of the current system for facilitating adaptation implementation.

4.2. Case study design

Semi-structured interviews were used for this study. Semi-structured interviews are conducted by the researcher developing an overarching plan of topics that are of interest and with potential follow-ups, while at the same time allowing for a varied structure and with spontaneous follow-up questions on issues of relevance. Allowing for flexibility in the direction the interview takes provided opportunity for deeper inquiry into the participants beliefs and values (Robson and McCartan, 2016: 285-290), which was a useful pairing with Grothmann and Patt’s model, which requires an in-depth understanding of participants decision-making through psychological and heuristic internalisation (2005: 200-205).

An interview guide was developed with inspiration from the adaptation cycle framework by Wheaton and Maciver (1999) as well as the narrative storytelling approach of Bartels et al. (2013). The adaptation cycle framework inquiries into the values and perceptions of actors without inserting the perspective of the researcher through phrasings such as “how” and “why”, with concerns for “constraints” and “incentives” in implementation, that are open probes (Robson and McCartan, 2016: 287-289) and left open to the answers provided by participant (Wheaton and Maciver, 1999: 218). This was combined with the narrative approach of Bartels et al. which ostensibly allows participants to shape and direct the line of inquiry in line with their own understandings and further emphasise participants own perceptions (Bartels et al., 2013: 46-49).

In line with the approach taken by Bartels et al., (2013: 47-48) the narratives of farmers were accentuated through asking broader questions about how the farm has changed over time. The interview guide subsequently asks about the overarching challenges faced by the farm over the timeframe provided by the participant and whether, and if so how, climate change has been an area of concern alongside other challenges. Finally, the questions inquire into adaptation strategies that farmers desire, are planning to, or have implemented on their farm. The focus is on potential adaptation barriers and trade-offs or prioritisations in relation to other objectives entailed in their business. The interview questions are geared towards getting a comprehensive view of how adaptation is integrated into the overarching operating of the farm.

The interview guide also tried to avoid unnecessary or loaded academic concepts through considering the distinction between ‘emic’ and ‘etic’, which details whether communication reflects an “insider” or “outsider” perspective, respectively (Darling, 2016: 2; Pike, 1967: 37-42). The most relevant instance of consideration taken to this is the use of ‘vulnerability’ in the study. In this study it is a central and complex concept with an ontological basis in socio-ecological systems thinking, but a study by Spiers has highlighted how the use of ‘vulnerability’ in either emic or etic settings can change the line of inquiry (2000: 716-719). Beyond open-ended and straight-forward questions (Robson and McCartan, 2016: 286-287), the word ‘vulnerability’ in the interview guide has been changed to the arguably more neutral formulation ‘challenges’. While Darling notes that similar issues of interpretation by the researcher is present in the subsequent analysis of the results gathered (2016: 2-7), this essay attempts
to mitigate this by reflexively accounting for the steps taken in interpreting the results of the study (Robson and McCartan, 2016: 170-173).

Interviews were conducted in Swedish, audio-taped and subsequently transcribed in Swedish, with relevant sections featured in the interview being translated into English. Interviews were transcribed through a de-naturalized transcription approach with primary focus on achieving an accurate account of the perceptions and understandings of participants (Oliver et al., 2005: 1275-1279). Transcripts were sent back to participants in order to ensure that they accurately reflected the views of participants (Robson and McCartan, 2016: 172). The subsequent excerpts that are included in the study were translated into English. Excerpts from the full transcription in the form of quotes were used in this study, linking it directly with the data and providing a thorough accounting of the process of interpretation, as a way through which the rationale of the researcher was shown more openly and the interpretive influence of the researcher diminished (Nikander, 2008: 225-226; Robson and McCartan, 2016: 170-173; 287). This was an important aspect of ensuring that the research was conducted in a “thorough, careful and honest” way (Robson and McCartan, 2016: 173).

5 interviews were conducted with farmers from Uppsala County. Initial contact was established through contact with the Uppsala County Administrative Board as well as with several local farmer organisations. Contact with individual farmers was subsequently made through email and followed up by telephone calls after respondents agreed to participate in the study in order to decide on logistical issues related to conducting the interview.

The study aims to protect the identity of respondents in response to potentially sensitive material being obtained in the interview process. The anonymity of participants was therefore protected through using pseudonyms throughout the study rather than referring to the participants by name. Farmers are called Farmer 1, 2, 3, 4 and 5 in the study. An effort was also made to remove personal details which might reveal the identity of participants in the transcripts (Robson and McCartan, 2016: 219-220). In addition to this, transcripts were not included in the study, in order to protect the identity of participants. Instead, excerpts from the interviews were used.

Of the 5 farmers, Farmer 1 is an ecological farmer with a diversified farm of crops, pasture, woodlands, as well as livestock in the form of suckler cows, sheep and hens. Farmer 2 is a conventional dairy farmer and Farmer 3 is an ecological dairy farmer. Farmer 4 produces animal feed, cereals and has suckler cows where the calves are raised for meat production. Farmer 5 is an ecological dairy farmer and also has woodlands on their farm.

In obtaining research results, the study was mindful of obtaining prior consent from the participants as well as ensuring that participants were aware of what type of study they were consenting to (Robson and McCartan, 2016: 212-216). Prior to the interview starting, the participants were informed about the general focus of the study and the ethical considerations that inform the project. They were informed that the study was interested in the bottlenecks and barriers that exist in implementation of adaptation on their farm. Further, it was explained that the interview would follow a thematic structure. The starting point would be a general conversation about their farm and what they do, followed by their understanding of general challenges and challenges related specifically to climate change, the strategies that they are using or want to use to meet these challenges, and finally the barriers to them implementing those strategies. It was highlighted that the focus of the study was interested in the views and perspectives of the participants and that if they had any questions or thoughts throughout the interviews, they should feel free to interrupt. After the interview was done participants were asked how they thought the interview went and whether they thought they had been given space to express their opinions freely.
Finally, participants were ensured that if they desired to, they could withdraw from the study at any time.

On the other hand, there was an attempt not to reveal specific hypothesis or findings from the research that might skew or mould the answers by the participant in relation to the predetermined conceptions of the researcher. As the research was interested in the narratives that inform the decision-making of individual farmers, ensuring an open-ended environment for participants was an important factor that had to be weighed up with ensuring that participants were informed about the general focus area of the study (Robson and McCartan, 2016: 213-216; 289). To this end, a conscious effort was made to for questions to be straight forward and without cues to elicit certain responses (Ibid, 287).

Lastly, interview excerpts were edited to make sure that they accurately reflected the arguments made by interviewees without being superfluous, as well as to assure the anonymity of participants. With regards to anonymity, excerpts with personal information were edited, either removing the personal information entirely or removing the personal information and substituting it with a related generic term to ensure that the sentence is still understandable. While not specifying whether editing is done for anonymity or editorial purposes, in order to show when editing was done and in order to separate it from a pause from an interview participant, a […] in the excerpts mean that a few words from a sentence were removed, and [---] that several sentences have been removed (Bryman, Nilsson, 2011: 431). When signalling that there is a pause in the answer by the interviewee, there are three dots without a parenthesis.

4.3. Data analysis
The data was primarily analysed in accordance with the model and primary sub-headings provided in Grothmann and Patt’s MPPACC (2005), supplemented by the distinction of internal and external factors provided by Abid et al. (2015).

The transcription data gathered from the interviews were first analysed individually in order to get a good understanding of what the main arguments of each farmer was and how they were arguing for their viewpoint. Using the theoretical framework as a reference point, the primary viewpoints of individual farmers relating to the categories risk perception, adaptation efficacy and capacity, adaptation strategies and internal and external barriers, as well as general sentiments held by farmers about climate change and surrounding issues were documented. These were found through reading through each transcript several times and subsequently using search functions to find given excerpts. These main arguments were paraphrased under the respective pseudonyms. Each argument was subsequently revisited in order to see how arguments are situated in the larger context of farmers perceptions and to see if there were any backings for given arguments that were not previously identified.

The primary arguments were subsequently brought together to under the different sub-headings detailed above and major similarities and disagreements between farmers were drawn out. While overarching trends between the 5 interviews are observed in the results and arguments are divided into sub-sections, emphasis was put on giving a fuller account of individual farmers and their conceptions, in order to adequately anchor the findings in the data (Robson and McCartan, 2016, 172). Lastly, the interview transcripts were printed into physical copies and control-checked in accordance with the results to assess the accuracy of the portrayal of each farmer through grouping sections thematically and underlining important sentences that inform each argument.

4.4. Limitations
One of the primary limitations of this project is that the initial research focus from the perspective of
the researcher was to identify factors that act as facilitators and barriers to the implementation of climate change adaptation. As evident in the framing of the problem-statement, this focus is informed by the premise that there is lacking response toward climate change and adaptation in line with analyses done by for instance the IPCC and UNEP (IPCC, 2014b: 4-8; 18-19; UNEP, 2018: 4). While the study is therefore built on the premise of the necessity to implement climate change adaptation, it is important to note that decision-making towards adaptation does not intrinsically relate to the achievement of better conditions for the environment and sustainable development. To the contrary, the maladaptation literature shows that adaptation decision-making can often result in strategies that are harmful to the environment (Neset et al., 2019b: 84-85). Further, as argued for by Fogelman and Basset, adaptation could simply be a means through which a status quo is attempted to be maintained (2013: 44). As such, an analysis of the relative quality of adaptive decision-making, as is the focus of the study by Neset et al. (2019a) for instance, is lacking. On the other hand, understanding the decision-making process of farmers in relation to adaptation implementation nonetheless provides useful insight into the relative priorities and motivations that guide whether and which adaptation strategies are considered by farmers. An understanding for what motivates decision-making can subsequently inform more nuance into the discussion of how to promote adaptation that simultaneously produces environmental goods. The study should therefore be seen within the context of achieving a larger scope of objectives that is the subject of discussion in the wider literature about adaptation decision-making.

Further, the use of semi-structured interviews followed a general interview guide, but follow-ups and subsequent topics covered were dependent on the responses that were provided by farmers. Due to this, some of the arguments made by farmers were not validated in the interviews with other farmers to see to which extent a given sentiment is shared by all the participants. Therefore, while some arguments by participants are backed by a consensus and others by a lesser number of participants, this in itself does not inform their relative strengths.

One of the limitations of the study is its scope and size. Because of a lack of resources and time, in combination with resource and time-consuming practices such as transcription, 5 interviews have been conducted. Additionally, due to time-constraints, a selection of the literature on barriers to adaptation was covered, rather than providing a more extensive account of the relevant research on the topic. In combination with a wide scope of inquiry, the results are both spatially and temporally contextual (Burr, 2015: 4; Robson and McCartan, 2016: 25; 166-167). Conversely, a low sample case study allows for a greater level of detail due to the ability to allocate a greater amount of resources and space in the study to each case. This has the potential of more accurately reflecting the views of each participant and goes some ways to mitigating the effects of a small sample size. In this sense, standardized theoretical research can benefit from smaller case studies with greater levels of detail in providing what Flyvbjerg calls “real expertise”, detailed learning through case studies (Flyvbjerg, 2006: 221-224; 227-228).

There is an inherent potential for selection bias related to who decides to participate in an interview. Farming organisations were contacted in order to obtain contact information to individual farmers. It is feasible that the subset who decided to participate in the interview study after being informed about the study does not reflect the overall group because of individual rationales that motivated their decision-making (Robson and McCartan, 2016: 166-167). Participants were however not asked to rationalise their participation in the study and there are conceivably several reasons that could influence respondents to participate.
5. Results and analysis

5.1. Adaptation strategies

5.1.1. Adaptation

The results of this study indicate that farmers are both intending to and actually adapting to climate change. As there is unanimity between the farmers that the climate is becoming warmer the most frequently mentioned adaptation strategy in place today is the consideration for the timing of sowing and harvesting crops. Particularly, the majority of farmers highlight that they sow their crops earlier in the year in order to take advantage of the longer growing seasons. The farmers also attest to different sowing and harvesting practices due to better wintering of plants.

Farmers are also adopting new crop varieties in order to both take advantage of new climatic conditions as well as to safeguard against extreme weather. Farmer 2 argues that conventional wisdom two decades back was that growing corn on this latitude was a bad idea, in juxtaposition to now, where the farmer is currently growing corn as they argue it mixes well with the other feed given to the cows, adding that it gives a good harvest. At the same time, the respondent highlights that farmers are also changing crop varieties in order to counteract extreme weather. Farmer 2 says:

“We have, well, how should I say, since we have been here, we have changed the traditional grasslands from clover and timothy to, we mix in Lucerne, cocksfoot and chicory. Drought resistant plants, because we are dependent on three harvests from the grasslands. And we grow more corn because it is also good for the cows as part of the rations and because it gives big harvests.”

Three out of five farmers are growing the drought resistant crop Lucerne in order to counteract drier weather conditions. Farmer 3 is attesting to the popularity of the crop by highlighting that it is difficult to get lucerne seeds as the demand is high this year.

“I have heard and seen that when others are sowing new grasslands this year, they are sowing lucerne. If you have pH in the ground that fits, then it is a good plant.”

Asked to clarify where the farmer has gained this information, the farmer says:

“Yes, I have not heard it from other farmers, but they say that you cannot get a hold of seeds for example.”

Farmer 3, who is an ecological farmer, argues that they try to keep a balance between animals and grassland on the farm, in order to ensure a certain level of self-sufficiency and security. The farmer does not cite a specific ratio but argues that they are trying to keep a good balance.

Farmer 1 was storing winter snow in a large mound that was covered on the surface in order to provide cooling for the warm summer temperatures. The same farmer was also experimenting with growing crops on wetlands, growing food in a mixed forest-crop system as well as testing the viability of different perennial crops in supplanting annual crop varieties. While the farmer accentuates that perennial crops are better equipped for surviving high levels of stress due to greater root systems, the farmer argues the rationale of their decision-making being focused on how to produce in a way that counteracts climate change and ensures a net-positive benefit to the environment. The farmer highlights that one of the guiding principles is this coupling.

“We think that we should push the farm in the direction of being reparative and
productive at the same time. At the same time the farm should produce food, fibre, biodiversity, carbon capture and interesting work tasks for perhaps 12 billion people eventually.”

In relation to adaptation, Farmer 1 argues that their main priority is climate mitigation.

“Yes, yet again, it is not super important for us and others to climate-adapt. It is more important to work with climate mitigation. That is what we want to do. And we do that through for instance introducing perennials in the system. You do not need to till the soil. You can, well you saw the pictures, perhaps you might just be able to harvest and recirculate the fertilizer and residues.”

Evident from the excerpts from this farmer is that there is a well-defined objective that governs the decision-making on the farm and that adaptation is not considered a relevant consideration. Instead, the farmers’ primary consideration is climate mitigation as well as building the foundation from which climate-positive action can be taken. Yet the farmer has nonetheless implemented several measures and has developed systems which according to the farmer, although with other goals in mind, has produced synergies that lead to better resilience and ability to deal with more extreme conditions.

Lastly, Farmer 4 attests to having implemented an irrigation system on their farm several years earlier, in response to the observation that conditions are typically dry on the farm during the early summer. The farmer highlights that conditions subsequent to the installation of the irrigation system were not dry, leading the installation to be left unused. In combination with changing economic conditions in agriculture, the farmer therefore does not use irrigation anymore.

“Then there was a period where we have not had dry conditions during early summer. This area is known for being very dry in the early summer, but we have not experienced that. So we had a period of 15 years where the irrigation was left unused.”

The farmer adds that the price of diesel and crops have changed, changing the economic conditions, finally concluding:

“[---] So we have stopped irrigating”

As a consequence of installing an irrigation system when conditions were subsequently wet, this farmer seemingly perceives their investment in the system as a maladaptive solution, evident in the removal of the system from the farm.

In sum, farmers are pursuing a wide range of climate adaptations, primarily through changing sowing and harvesting practices to take advantage of longer growing seasons and better wintering of plants. Farmers are also using new crops and one farmer is experimenting with perennial crops. Two farmers are trying to keep a balance between animals and grasslands to ensure self-sufficiency and security. One farmer is experimenting with new cropping systems and using innovative solutions such as storing winter snow. Lastly, one farmer removed a previously installed irrigation system due to perceiving it as lacking utility.

5.1.2. Intended adaptation

With regards to intended adaptation, Farmer 5 is considering growing Lucerne in his grasslands, but has trepidations since they are not sure whether to expect increased droughts or increased rainfall from year to year. Farmer 2 says that they are in the midst of implementing an irrigation system and are
currently considering offers. The farmer highlights that the strategy is one part of many already implemented strategies in place to deal with warmer and drier climatic conditions specifically.

With regards to dealing with extreme weather and fluctuations, Farmer 3 and Farmer 5, who are ecological farmers argue that they might have to consider having more margins with regards to their harvest in the future, to ensure that they have enough food for their animals. This strategy should be prefaced by an understanding of ecological farming as entailing a requirement on that 60 percent of the animal feed has to come from the farms’ own production (Swedish Board of Agriculture, 2015: 4). Subsequently, the farmers highlighted that this means that they are open to considering having larger margins with regards to their feed production on the grasslands, consequently meaning that during a year with a bad harvest, hopefully they will still have enough to make their farm go around while making lower profits. On the other hand, as highlighted in the interview with two farmers, the strategy entails some degree of loss regardless of the outcome, because during a good year they will have too much feed and will then instead attempt to sell off the surplus when feed is likely abundant on the market. The farmers also experience opportunity costs as they have more feed than they need and could have grown crops that are more profitable instead. Outside of these two farmers, Farmer 4 also argued that in an exacerbated circumstance they would consider creating greater margins to deal with fluctuations, but instead highlighted that costs could be reduced through having less employees working on the farm and therefore creating a financial buffer. Some farmers are therefore also considering reducing the size of their production and business in order to create greater margins to deal with fluctuations.

In general terms farmers argue that they have a proactive stance towards farm management and highlight that they are continually reconsidering their strategies and their effectiveness in relation to changing climatic conditions. Farmers are considering adapting to climate change through new crops, creating larger margins to resists shocks through reducing the number of animals or staff, as well as one farmer who is considering implementing an irrigation system.

### 5.2. Risk appraisal

#### 5.2.1. Climate change and perceived risk

Firstly, in terms of risk perception from impacts of climate change, farmers are experiencing climate change but draw causal links differently in accordance with observed phenomena. All five participants believe that there is anthropogenic climate change and that human activity is affecting the climate. The most ubiquitous observation of observed climate change was gradual changes towards a warmer and milder climate. A frequently mentioned gradual change was the perceived change towards milder winters. Farmer 1 notes that there have been less winter frosts.

“Well, we have had less night frosts during the spring and autumn, possibly... but... that is our perception. We do not have a lot of winter snow anymore.”

Farmer 3 notes that winters have become milder and that crops are better surviving the winter. Asked to develop his perception of the gradual impact of climate change as being positive, the farmer says:

“Yes, because locally the climate has become milder, better wintering, we have been able to sow different varieties, and maybe gotten better harvest.

Asked to elaborate on how the farmer perceives these changes, the farmer says:

“Well, for example, when you grow winter wheat... when I first started working at home [...] the winter wheat did not always winter, maybe every fourth, fifth year. And
rapeseed wintered two years out of three. But now you can count on that they will winter. No farmer counts on that it will outwinter. It could happen during extreme years, but normally it... if you sow winter wheat in the fall, there is winter wheat in the spring as well.”

These two farmers attest to an observed trend towards a warmer climate where winters are less harsh. Milder winters offer benefits to these farmers as crops have a better chance of surviving to spring.

Farmer 4 note that they have seen a trend towards earlier sowing dates and being able to finish sowing earlier in the year due to a milder climate. The farmer remarks that they are sowing earlier into April, which is compared to the farmers parents who managed the same farm before them, who were finished sowing in late May. In comparing the different time periods, the farmer highlights:

“From what I can remember growing up, although it is not directly comparable because they had different machines, but you still ploughed and harrowed, and I remember that dad, the goal was to finish on the 20th of May.”

To then juxtapose it with the current practice on the farm:

“So, we have finished sowing before the 26th of April three times during the last 19 years and one time we finished the 17th of April.”

The farmer finally concludes:

“To the best of my memory the average sowing times have been much earlier in the year during the last 15 years, without having perfect statistics, but it feels that way.”

Comparing previous and current sowing dates, the farmer therefore concludes that sowing dates on his farm are coming earlier in the year, offering prolonged growing seasons. Farmers are also noticing that crop varieties that previously did not survive the Nordic climate are now surviving at a greater rate. Farmer 2 remarked:

“And there you see that the borders for where you can grow certain crops moves north every year. The ones who had had the greatest harvests of wheat and oilseeds last year were in Hedemora in Dalarna. And that’s very strange. It has never been like that, previously it has always been down in Skåne, but there it was too dry. So the borders for cultivation, or the climate zones are constantly moving north.”

Thus, there is a consensus between the participants that the climate is getting warmer, leading to milder winters and for some earlier sowing dates and the viability of new crops. These gradual changes in climate are seemingly highlighted as creating more favourable conditions for the farmers.

While there is therefore seeming agreement between the farmers that the weather is becoming milder, there is more contention with regards to extreme weather. Two out of five farmers highlight that while they did not argue against the existence of climate change, they remained sceptical to attributing particular instances of observed weather to climate change. With regards to a question of whether the participant has seen a link between climate change and the perceived frequency of extreme weather over time, Farmer 1 compares the extreme heat and subsequent drought experienced in the summer of 2018 to their previous experience of climatic fluctuations.

“No, I don’t think so. We had extreme drought last year, but we have had that before as
Farmer 4 similarly juxtaposes the extreme drought of 2018 with their experience of previous years and argues that it perhaps is the driest year they have experienced, but nonetheless expresses uncertainty with regards to attributing the phenomenon to climate change.

“Very dry. Yes. First, one has to consider, and I do not oppose climate change, I know that the temperature is rising, I know that. But it has been very dry before as well. 1971 to 1976, except 1975, those years were very dry. There was 100 millimetres of precipitation missing every year.”

On the other hand, the farmer highlights that the drought in 2018 was particularly extreme:

”But so it has been dry before as well, although this [the 2018 drought] might have been the driest we have experienced.”

Nonetheless, the farmer concludes:

“As I said, I do not argue against climate change, but that this drought was only because of climate change, that is not necessarily... that everything is because of climate change, I believe that a lot depends on natural variation as well.”

The observed phenomenon is thus contextualised by the participants in relation to previous weather extremes experienced by the farmers. Importantly, these answers do not necessarily categorically discount the possibility that the 2018 summer drought where instances linked with climate change, as Farmer 4 explicitly states that this is not a fundamental critique of the existence of climate change, but instead highlight a scepticism towards drawing such causal links in relation to a short-term observation. Further, as no farmer discounted the existence of anthropogenic climate change, the results instead showing that there was some degree of scepticism with regards to the causal relationship between the observed phenomena of extreme weather and attributed cause as climate change.

The other three farmers draw more direct links between extreme weather and climate change. Farmer 3 juxtaposed the summer drought with his conception of the impact of gradual climate change on agriculture in Sweden.

“Last year was the first year you really got to suffer because of this, if this is what it was. From a historical perspective, from the 1980s and onward, climate change for us farmers up here has been positive. More favourable conditions to cultivate, more and more favourable. But then we did not have this drought, and now it looks as if we will have more extreme weather and then it hits back on us.”

Although not categorically committing to the view that the drought was an instance of climate change, the farmers understanding seemingly leans towards this direction. While the farmer subsequently highlights a general trend where issues with drainage have lessened over time on the farm, tentatively and among other things due to climate change, there is nonetheless a sense in which the farmer sees this instance of extreme weather as a paradigm shift towards a new normal of more extreme weather in the future. This is also highlighted by Farmer 5, who says:

“What you notice too with the drought is that, when it is dry, it is very dry. When it rains, there is a lot of rain instead. It is very big... its ‘either or’ weather. But that is what they have said, that it will be like this with climate change, and that we have to learn to live
with it and deal with it, because that is how it is going to be, and you have noticed that a little already, I think at least, that it will be that way.”

Following up on a conversation about Farmer 2’s observation that there is water shortage on their farm, the farmer affirms the idea of more extreme future weather fluctuations.

“If we look in the long run, we probably have to get used to there being larger differences in the climate. We have noticed that in the last 10 years, that there are more unpredictable storms, there is more wind, which might mean that the rainfall blows away or comes at the wrong time.”

Importantly, the farmers that draw links between extreme weather and climate change are increasingly worried about what these fluctuations will mean for agriculture and their farm. In particular, there is an exacerbated sense of uncertainty about what the future will look like, which is seen as a threat to their business. Farmer 5 says:

“How to deal with it is, as I said not easy when you have… I do not know how much I should sow or how much of the grassland I should plough during autumn in order to… if it is a rainy year and wet it grows. Then I do not need that many hectares of grassland in order to get enough feed to my cows for example. But I do not know that during the autumn. If it is a dry year and I have ploughed up too much grassland, then I do not have enough grassland for feed. If I have saved it and it’s a rainy year, then I have grass up to my ears, too much then. And if I have grass then others usually have it as well, and then I generally cannot sell it.”

The same farmer later juxtaposes his perception of current and past climatic circumstances.

“In the past you knew… then we could have… when we were small… my mom, they had these and these many hectares of grassland and it was always enough, it just kept on going. Now you cannot at all have the same strategy, now you sort of have to hold yourself afloat and accept the present situation in a way.”

From this answer, one gathers that there is a sense in which the farmer sees current extreme weather as a novel phenomenon and something which is much less predictable. This creates a sense of uncertainty which is seemingly associated with an anticipation of future climatic threats to the farm.

Therefore, there is unanimity with regards to climate change as an anthropogenic phenomenon. Farmers are drawing links between climate change and observed phenomena in their surroundings and relating it to their farm. All farmers attest to some degree of warming having taken place during the time that they have been active as farmers. There is also seeming consensus surrounding gradual climate change as being of benefit to their farms, while extreme weather is seen as a threat.

On the other hand, not all farmers link extreme weather events to climate change. This is interesting, because the participants were selected from the same geographic area and can be assumed to have experienced similar climatic conditions, evident by the use of the summer drought of 2018 as a common reference point and example to juxtapose experiential and analytical reasoning against. Nonetheless, different conclusions about what the phenomenon represents were reached.

The two farmers who are cautious about attributing extreme weather events to climate change invoke previous personal experience and contrast current weather fluctuations with past fluctuations that they have experienced. From the perspective of these farmers, there is seemingly two issues at stake. Firstly,
for Farmer 4 the observed phenomena have not reoccurred enough times in order for a future trend to be delineated, so as to compare it with the natural state of climatic variations. Secondly, the observed phenomena are not perceived as outliers by Farmer 1, in that they are not more severe than previously experienced climatic variations, therefore challenging the notion of such variation as falling outside the scope of natural climatic variations. While Farmer 4 highlights that the 2018 drought might have been more extreme than previous droughts, there is nonetheless a sense in which the farmer is not prepared to state that the phenomenon falls outside the scope of natural variation. Conversely, the three farmers who are making connections between extreme weather and climate change argue that they have observed increasing fluctuations in weather over the years and, crucially, that variations are more severe than they used to be. Rather than as Farmer 1 and 4, waiting for a clearer trend of future climatic conditions to crystallize, these farmers are abstracting from their observation of more frequent and extreme fluctuations a coupling of uncertainty as to what the future conditions will be, with a foreboding of a potentially deteriorating conditions taken from recently observed phenomena.

All the participants use their personal experience to compare with their conceptual understanding of climate change and the distinguishing factor is thus the differing interpretations of past experience in relation to current trends. This suggests that observed and experienced events of climatic fluctuation is an important factor for explaining whether farmers believe they are experiencing climate change.

Interestingly, the distinguishing factor is not between some farmers using a long-term perspective while others are focusing on the short-term. Neither is it geographical differences, as common reference points of extreme weather are used. Rather, most farmers referenced previously held experience decades back in time of the same geographical area but made different judgements in comparing the different time periods. Importantly, these judgements were not categorical, as farmers concede that their observation could be interpreted differently.

Yet, differently observed causal links influence the threat seen by farmers from climate change. Evident in the previously included excerpts, farmers who are seeing these fluctuations as novel are more likely to express uncertainty in terms of a threat. This is contrasted to farmers who express a more agnostic viewpoint towards future trends. Farmer 4 says:

“I do not know, as I said. We could jokingly say that, okay, climate change for us, if we get Skåne climate, I mean, they have always had better agriculture than us, or better conditions. So, in the short term the downsides would not be so big for us, if you want to see it in crass terms. But it is also very hard to understand it. We have had years when it rains a lot, we have had 2011, 2013 and 2018 which were very dry. Which of those years... no I do not think... I think there is a tendency to talk very much on the short-term, now that the weather was warm last year, there was forest fires and...that everything would be because of climate change.

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And as I said, then you read about some who claim that it will become warmer because of climate change and more forest fires, and that you need to put more money into it, even in the government budget, to counteract it, and others think that there will be more rain, storms and uncontrollable weather. I do not know which direction it is going, or if it is a sign that there will be more big fluctuations, as I said before there have been fluctuations before as well.”

Asked about whether this creates uncertainty, the participant answers:
“No, not short term. It is one thing short term, and another thing long-term with what is going to happen with climate change, if we are talking one or two degrees warming.”

And then adds:

“You have to be flexible, particularly with the tillage. Be open for how the year looks, be flexible and using the knowledge you have in order to make the best of the situation.”

Compared to the farmers who are perceiving recent fluctuations as novel changes which likely is setting a new precedence for the future climate, the response from this farmer suggests a more tentative approach where potential benefits are weighed against potential disadvantages. The farmers answer seems to juxtapose natural variation with climate change in particular, arguing for the inability to distinguish between the two given their current observations. Subsequently, the level of threat perceived by this farmer is tentatively lower than the other group of farmers.

In the face of uncertainty, some degree of decision-making rests on the professed personality traits of individual farmers. Ostensibly, Farmer 1, 3 and while accentuating certain hindering factors in the governance of climate change issues seemingly Farmer 4, argue that they are optimistic with regards to society being able to successfully pursue climate mitigation. For Farmer 1, this creates lower perceived future risks due to the subsequent effect such reasoning has on the projection of future climate impacts. Asked about the probability that we will not be able to mitigate climate change, Farmer 1 says:

“I do not see that risk as being very large. I think that if we want to, we can absolutely counteract climate change. I do not have anything against climate adaptation per se, but the resources have to be put towards climate counteracting.”

Optimism regarding humanity’s ability to successfully pursue climate change mitigation also alters the level of risk posed by climate change and arguably reduces the felt need for adaptation. Yet the link between optimism towards climate mitigation and a lessened need to adapt is not clear, as Farmer 3 is both positive towards the possibility of society to mitigate climate change while simultaneously arguing that recent conditions is signalling a paradigm shift towards more negative climatic conditions befalling the agricultural sector. Farmer 4 is positive towards societies capability to pursue mitigation, but the farmers’ position towards adaptation is seemingly primarily determined by a desire to base decision-making on observable long-term trends, rather than overtly being linked to positive sentiments about the potential for society to successfully pursue climate mitigation.

In sum, all the participants believe in climate change and have observed gradual climatic changes with overarchingly positive impacts. The participants had also experienced extreme weather but disagreed about whether extreme weather was being caused by climate change. This in turn altered the risk perception of participants, as those who argued that recent extreme weather was being caused by climate change had a higher risk perception than those who did not make that causal link. Finally, optimism regarding societies ability to pursue effective climate mitigation seemingly also lowered perceived risk from climate change.

5.2.2. Perceived severity of climate change

The perceived severity of climate change among the participants can partially be explained by the observations of climate change made by particular actors. The severity is seemingly not significantly impacted by the gradual trends of climate change, which are primarily seen as positive. On the other hand, the severity of it does seem to be linked to whether an actor attributes extreme weather to climate change. Actors who draw a link between extreme weather and climate change arguably tend to make
more severe scenarios of the future through projecting current weather fluctuations into the future, whereas actors who take a more tentative approach and do not for the moment make the link, are less likely to commit to this view of the future.

The perceived severity of climate change is impacted by the discourses that farmers are encompassed by and take part in. Firstly, all farmers believe that climate change is real and exhibit signs of engagement with the topic through considering mitigation and adaptation both in society at large and on the farm level. The consequence of farmers taking an active stance in relation to climate change and juxtaposing analytical information with their own experiences, rather than informing a perception of certain anticipated levels of severity of impacts, has led to a degree of confusion and uncertainty. Farmers are aware of that better growing conditions are also coupled with more uncertain growing conditions, due to increasing fluctuations, but seemingly struggle in assessing the future severity of climate change in Sweden and Uppsala. Farmer 4 highlights the difficulty of farmers to plan on their farm according to current discourses on climate change.

“Because some are scared that it will start to rain more, and others think it will become dry and warm, and I cannot make sense of what you are supposed to expect from climate change.”

The trend in four out of five of the interviews are varying degrees of uncertainty that farmers experience when trying to juxtapose and use their conceptual understanding of climate change to understand future circumstances on their farm. One of the particular dynamics that creates uncertainty is evident in the responses above, that of whether future climate change will create drier or wetter conditions in the Uppsala region. As a consequence, the perceived severity stemming from social discourses is difficult to assess. While a tentative link could be made between awareness of climate change and perceived severity, as farmers who connect extreme weather to climate change are likely to see increased future risks in relation to current trends, this is not true for all farmers in the study. Further, rather than inform a perspective which is predominantly positive or negative, the internalisation of societal discourses about impacts of climate change in Sweden on agriculture is seemingly best characterised by a notion of uncertainty, rather than of advantage or disadvantage.

Farmer 2 perceives the severity of climate change impacts as presenting particular challenges to dairy farmers. The farmer argues that high quality food has to be provided to calves in order to ensure that when it becomes a cow, it is productive. The farmer says:

“So everything in milk production is long term, and then you can become vulnerable when there is one or two years in a row when you have bad roughage, because of the climate and the drought that has been now. Then it could be the case that it rains three
to four years in a row. Then we will be drowning in roughage and there will be other problems we have to solve.”

The farmer therefore conceives of dairy farming as particularly vulnerable to perturbations from extreme weather as it impacts the process of raising a calf to a productive cow.

When judging the risk of climate change impacts in relation to other concerns that participants have, there is more unanimity among the participants. Climate change adaptation is neither seen as the largest risk or the biggest priority by any of the participants in the study as other concerns were considered to be more pressing. Rather, four out of five participants rate economic concerns as the most important on the farm level. Asking about climate adaptation strategies and how farming practices have changed over time, Farmer 4 highlights political reforms during the 1990s, which have put pressure on the sector to lower its costs. The farmer says:

“So, what has been driving this change in farming practices is perhaps more to do with the economy than with the climate.”

Asked to elaborate about the relative weight of politics and economics to concerns stemming from climate change, the farmer continues:

“Yes, in some sense the problem is that economic concerns are very direct. If you want to survive next year you have to find solutions now. The economy is in some sense much more direct than climate change. That is the way it is unfortunately, if you want to survive as a business owner you have to solve the problems that are more immediate and then you have to ensure that you have finances which are strong enough to then deal with other problems that you do not feel as if...if you take on costs but do not see any return until 25-30 years, then the belief has to be stronger, I am almost tempted to say, than the financial concerns. The most important factor for a business to maintain itself is to address the short-term problems first.”

There are seemingly two primary factors used by the farmer to justify the prioritization of economic concerns. The farmer views financial concerns as the primary objective of a business owner to address and crucially also conceives of economic concerns as being more of a risk in the short-term than climate change is, which instead is seen as a long-term risk. In relation to questions regarding adaptation strategies pursued, Farmer 3 highlights that:

“Yes, it is economics that guides your decision-making even if you have ideas about how you want to do things, its always the economics that in the ends determines...I mean it is not so profitable that you have entirely new options open to you. You always want to make it as a farmer, be able to pay your employees and take out a wage for yourself as well. So that is what is going to determine things, then you have some ideas and try to do good things within those boundaries.”

Similar to the previous farmer, this farmer highlights that economic constraints are the most important consideration on the farm, but importantly also that there are other values that steer decision-making, evident through the farmers expressed desire of ‘doing good’.

Farmer 1 argues that while the sector should continually adapt to changing circumstances, they prioritize climate mitigation and are concerned that there is a trade-off between focusing on climate adaptation at the expense of climate mitigation efforts. The farmer argues that mitigation efforts are
much more important and says:

“Well I can say that... first and foremost I want to...as I said in my second mail, I am very scared that there is a focus on climate adaptation and that large resources will go to climate adaptation rather than to climate mitigation. That is my main message today.”

When asked about whether the farmer sees adaptation and mitigation as conflicting objectives, the participant affirms this idea.

“Yes. Then we obviously need to adapt to climate change but the resources in the form of students, universities, political systems, peoples’ consciousnesses, should mainly go towards countering a too hot or too cold climate, rather than to adaptation. That is my main message.”

Asked to elaborate, the participant continues:

“Because in the worst-case scenario we will put all of our resources to a problem we are not going to be able to solve, instead of solving the problem, the main problem.”

The perceived importance of adaptation relative to mitigation therefore leads the actor to conclude that mitigation efforts should be prioritized more strongly. While it is clear that the participant desires less engagement with adaptation relative to mitigation, it is not clear whether they desire less engagement with adaptation in absolute terms. Importantly, the actor is not suggesting that adaptation is not a priority at all, as they admit adaptation should take place, but that it is less important relative to climate mitigation, which is prioritized by the actor.

While it is not the primary concern for most farmers, among the farmers professing financial considerations to be most important, climate change adaptation was still viewed amongst the most salient concerns they are faced with, particularly due to a concern for yearly weather fluctuations. While Farmer 4 in overarching terms argued that economic considerations were more important for a farm to tackle than issues related to climate change, the farmer nonetheless says:

“Well if you are going to rank these different concerns, the biggest concern is the lack of water. Threat number two is the acreage, and both the water and the acreage I tie together with an investment in irrigation. And then I guess, then a lot of it is social factors, you never know if the family or...I mean I could break my legs tomorrow and it would be tragedy within the family, you never know what can happen.”
The answers provided by the two farmers are good representation of an overarching perspective held by the participants to climate adaptation. Firstly, while climate change is not seen as the first priority, as most farmers argue that financial interests are foremost considered in decision-making, it is nonetheless seen by most farmers as an important consideration. Second, the two answers suggest that adapting to new climatic conditions is not necessarily seen as a value in its own right. Rather, the participants seemingly are making links between financial concerns and climate change, which increases the salience of dealing with climate change fluctuations. The first farmer relates fluctuations to overarching conditions and concerns the farmer has with the economic market for agricultural commodities they sell and the second is tying irrigation investments to creating more stable foundations for his farming business to grow. The most in-depth example of the intertwining of these concerns is expressed by Farmer 4, who argues for the effect of fluctuations on markets.

“For us then, it is very different things to grow cereals and to grow [...] forage to a completely open market and selling to the end customer. The cereal you can always sell even if the price goes down 20 öre, or 30 or 40 during the year. Here [on the farm] it remains unsold and that is a big difference. Our problem is that if there is a big harvest, that can be fun, but you do not have money in the bank until you have sold and gotten paid for the harvest. The problem is that when the harvest is really big, all the dairy farmers, the acreage that is usually not on the market otherwise, they produce maybe 30 to 40 percent extra that comes out on the market.

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So that is a challenge, because if there is a big harvest it can be a big challenge to sell it, because others have had it [a big harvest] as well.”

Highlighting that the farm had sustained losses during the drought in 2018, the farmer subsequently details the problem further, by arguing that the market does not in the same way adjust to lower harvests through an increase in the price. The farmer highlights that this is because of the contracts that farmers enter with customers every year before the harvests.

“[...] we are currently taking orders right now for the coming season and have put up a price. A lot of people have done the same but then put up the price. The people who have ordered during the ordering period got that price from us, and then the argument made by the Swedish Board of Agriculture falls, that those who grow grass or even cereals have not lost so much, because the price went up. It is the same on the cereal side of things, there are many who have sold, forward-selling, what is it called... on contract, for delivery or harvest at a much lower price than what the price became. Primarily those who have sold too much and were not able to get the volume and had to compensate Lantmännern or Svenska Foder or whoever it was. That became very expensive, they have not made any profits, or not gotten any money on cereals. So that is the reality. With statistics you can show that the harvest became 30 percent lower, but the price has gone up correspondingly, so that really not a lot has happened. But for most people a lot has happened.”

Farmers are therefore displaying a complex understanding for the intersections between climate change, financial interests and in this case the operating of financial markets. In some senses, this creates conceptual obscurity as to the causal elements of perceived risk. While climate change therefore is mainly seen as a risk to farmers in the study, it is not the main priority for farmers, instead posing a
threat to values seen as more salient to the majority of farmers, namely the financial viability of their farm.

The relative importance of given objectives might hinder implementation and act as a barrier to adaptation. For many farmers this means ensuring their financial viability first, to then attend to their other priorities. As previously highlighted, Farmer 4 characterises economic considerations as more immediate and short-term, therefore linking it more closely to the survival of their business, as opposed to long-term trends of climate change. Farmer 1 prioritises pursuing mitigative action ahead of adaptation and argues for their fear that attention and resources might be diverted from mitigation to adaptation efforts and thereby worsening the effects of climate change. Interestingly however, the characterisation of trade-offs between financial and mitigative rationales with adaptation is simplistic, since these factors do not inherently hinder the development of adaptive decision-making. Rather, as shown in previous excerpts, farmers concerned with financial returns are making connections between extreme weather and financial returns. Further, Farmer 1 who is concerned primarily with climate mitigation strategies also identifies synergies between mitigation and adaptation.

“Probably we have to... I think we have to move from annual to perennial plants for food production. In other words, that we go from one annual wheats to winter wheats who have big root systems... spring wheat have much smaller... to perennial cereals that have large root systems. Endures drought, reduces flooding, needs almost no tilling, reduces nutrient leakage. You might also get a low nitrogen fertility since there is a root system in place all the time, not only for a few months during the year. Minimal requirements on managing seeds, stores carbon, produces food for several years, even with poor management and if you were not able use fertilizers. From a preparedness perspective.”

The farmer has seemingly identified a strategy which achieves synergies between important environmental and adaptive goals. While there are other complex interactions that could create trade-offs between environmental and economic factors, economic and mitigative rationales in decision-making could seemingly both create synergies and trade-offs to the implementation of adaptive measures.

In sum, the perceived severity of climate change is primarily related to climatic extremes rather than gradual climate change and differed between actors depending on their internalisations of experienced phenomena. Further, perceptions of severity where lessened as a consequence of farmers judging climate change to be a less important risk as opposed to other priority issues, namely financial interests and climate mitigation. On the other hand, synergies between farmers’ priority issues and climate change were also found.

5.3. Adaptation appraisal

5.3.1. Perceived adaptation efficacy

One of the primary challenge’s farmers perceive is accurately assessing trends in order not to risk maladaptation as well as to ensure future returns on investments. Farmer 2 has an intention to build an irrigation system and describes it as a strategy meant to deal with increasingly drier conditions.

“[...] this region is very dry early in the summer and we have had to adapt to that for a long time. And as I said earlier, we have replaced our grasslands with drought-resistant crops, such as lucerne, cocksfoot and chicory. So, we were not impacted so much last year because we had drought-resistant grasslands. But the rest of Sweden, if you say the coast, both south...the east
coast, south and north have never experienced something like that before, and it was a disaster when nothing was growing. But if you look in the long run, we will probably have to get used to greater differences in the climate. What we have noticed that in the last 10 years is that there are more unpredictable storms, the wind is blowing more, which might mean that the rainfall could blow away or come at the wrong time of year. And in those circumstances, it is irrigation that you can invest in. That way you can yourself control over the rainfall, or primarily water the pastures so that the animals have feed for the summer and so that you can increase your return on the grassland by say 15 to 30 percent perhaps.”

Evident here is a linear reasoning from observed climatic trend to adaptation response geared towards solving the long-term problem faced by the farmer. The farmer seemingly perceives their adaptation strategy as efficient since it deals with the problems of dry conditions that they have observed. Conversely, other farmers are observing less linear trends and subsequently judge their adaptive capacity as lower. Farmer 5 says:

“The choice of crops is an alternative in the grassland, with clover and lucerne which have very deep... well at least the lucerne is a very good crop for drought because it has extremely long roots. It grows no matter how dry it is. But then the problem is that the lucerne grows extremely quickly, so preferably you want to plant it by itself, because it grows so quickly that the other plants cannot catch up. Then when its time to harvest the lucerne there is not much of anything else. If you wait until the others grow, the lucerne has turned into firewood and the cows will not eat it, the nutritional value becomes very poor. Since it is supposed to be sowed during spring it is then I have to decide whether to do it. Because if it becomes a wet year, then the lucerne grows to the point to where I cannot keep track of it all. Then I cannot manage it. That is also one of those things, then I have to know if it will become a dry year so that I can sow it in the spring. Preferably the year before, because if I sow crops in the spring and it becomes extremely dry during the summer then that [the lucerne] will grow and then that will die [other crops in the grasslands] and I have to plough it up anyways. I have to do that the year before and then I have to know. That puts me in the same position, how am I supposed to know, if it is a wet or dry year I can expect, and how I should plan?”

Contrary to the first farmer, this respondent is less certain of which future trend to expect on their farm. This creates more uncertainty as to the effectiveness of given adaptation strategies, as the perceived risk of maladaptation increases. The ability to connect strategy to a clearly identifiable trend is an important factor for facilitating adaptation, also evident in the interview with Farmer 4, who is waiting for a clearer trend of climatic impacts to crystallise. Identifying clear trends in climatic conditions is linked among farmers with lowering the risk of maladaptation and financial losses or poor returns on investments. An important facet of this need for certainty is seemingly connected with assuring a given strategy’s financial viability, as farmers are attempting to secure their livelihoods and if possible, increase returns from their investments, as evident in the previous excerpt from Farmer 2, who is intending to build an irrigation system on their farm.

Farmer 3 sees the summer drought of 2018 as a paradigm shift from gradual and benign impacts of climate change to more harmful impacts perceives their capacity to adapt as low. Asked about their capacity to adapt to the new circumstances they see, the farmer answered:

“Yeah it is pretty bad right now. Because the losses on this farm this year will be at least one, one and a half or two million, which I will not recover from in one good year. That is the situation for a lot of farmers I think, that if this year turns out the same a lot of
farmers will quit. I mean if you produce cereals on your farm the harvests have been bad, but the price has also gone up substantially so there it is not as disastrous. And we have received roughage to last us and the production is working decently but we are still very vulnerable. There cannot be another year like that again.”

These instances show the connection between risk perception and perceived adaptive capacity. The perceived capacity and efficacy are seemingly judged both in relation to the predictability of the phenomena as well as the severity of it. In the case of farmer three, perceptions of high risk coupled with low adaptation efficacy results in a response with elements of fatalism present.

Perceptions of the severity of given phenomena can seemingly both positively and negative impact perceived adaptation efficacy. Increased negative impacts can increase the salience of adaptation but might crucially also pass a threshold where farmers feel as if they are unable to deal with the stresses of climate change, thus leading to fatalism and maladaptation in accordance with Grothmann and Patt’s model (2005: 203-204). While extreme weather has signalled the need for adaptation among the majority of farmers, the severity of impacts can seemingly inform both adaptive and maladaptive responses.

Lastly, Farmer 1 argues that adaptation strategies have limited efficacy if relied on solely to address climate change.

“Because in the worst-case scenario we will put all of our resources to a problem we are not going to be able to solve, instead of solving the problem, the main problem.”

The desire for mitigation over adaptation is supported by the belief that the efficacy of adaptation is limited. Crucially, the argument is not an essential critique of adaptation, as it rests on a scenario where there is a lacking mitigative response and arguably posing adaptation and mitigation as mutually exclusive.

In sum, adaptation efficacy is primarily questioned as a consequence of uncertainty felt by the participating farmers of how climate change will impact climatic conditions. One farmer is also questioning the efficacy of adaptation strategies from the presupposition of lacking climate mitigation.

5.3.2. Perceived adaptation cost
As highlighted earlier, the majority of farmers are primarily concerned with the economic impact of adaptation strategies, but no farmer highlighted the cost of a particular adaptive strategy as being the limiting factor in their decision-making. Instead, Farmer 3 for instance observes that they have a lower capacity to cope with loss today due to previously incurred losses from the 2018 drought. On the other hand, the results seemingly suggest some of the farmers are increasingly beginning to view it as costly not to adjust production to deal with observed fluctuations.

Coupled with the feeling of uncertainty as to what the right adaptation strategy is for future climate change, there is uncertainty with regards to adaptation cost as farmers do not know whether they will receive a return on their investment from pursuing certain adaptation strategies. In a previously featured quote, Farmer 4 highlights the distinction between short-term and long-term considerations, characterizing climate change investments as having slow rates of return.

“Yes, in some sense the problem is that economic concerns are very direct. If you want to survive next year you have to find solutions now. The economy is in some sense much more direct than climate change. That is the way it is unfortunately, if you want to survive
as a business owner you have to solve the problems that are more immediate and then you have to ensure that you have finances which are strong enough to then deal with other problems that you do not feel as if...if you take on costs but do not see any return until 25-30 years, then the belief has to be stronger, I am almost tempted to say, than the financial concerns. The most important factor for a business to maintain itself is to address the short-term problems first.”

Evident here is that the farmer argues that climate change considerations are often-times more long-term compared to more short-term economic considerations. By sacrificing short-term considerations for long-term considerations, a farmer might risk going out of business. Further, while unspecific and not juxtaposed in relation to particular strategies, the farmer seemingly argues that there is generally a poor incentive structure for action geared towards counteracting climate change impacts, as returns of investments are only seen in the long-term. While the farmers reach differing conclusions about financial viability and adaptation cost, it is seemingly a common and important measuring stick for assessing adaptation strategies. As previously shown however, there are many areas where synergies are found by farmers.

In sum, rather than highlighting the price of specific adaptation strategies, farmers are concerned with the impact that strategies will have on their overall financial situation. Importantly, farmers are seeing synergies between adaptation strategies and financial returns but there is nonetheless uncertainty with regards to whether they will receive a return on investment on pursuing those strategies.

5.3.3. Perceived self-efficacy

In assessing the options for adaptation in relation to perceived trends, the results show mixed responses from respondents. The majority of farmers perceive themselves as having a generally positive outlook and most also believe that society has the capacity to mitigate climate change. Two farmers highlighted their conviction that the sector has the competency and ability to adjust and adapt to new climatic conditions. In arguing for the relative importance of adaptation and mitigation, Farmer 1 tangentially highlights that they are positive regarding their ability to adapt to climate change.

“And regarding your question, what obstacles you see from climate...adaptation...I don’t care. I mean sure, we know what we can do, we grow lucerne and feed for the animals and things like that, but the big thing is climate mitigation, whether it becomes too warm or too cold.”

There is therefore optimism regarding the self-efficacy of farmers to adapt amidst the uncertainty felt by a majority of the farmers. Yet, differing perceptions and experiences of the challenges that come from future climate change lead to different assessments regarding the capacity to adapt. As previously highlighted, Farmer 3, who has experienced substantial losses due to the 2018 summer drought, argues that their capacity to deal with further fluctuation is currently low. Therefore, the perceived self-efficacy of farmers is somewhat split.

An issue affecting perceived efficacy is the size of the farm. Every farmer interviewed except one attested to their farm having grown significantly in their ownership. One of the many outcomes of having a bigger farm is that it creates pressure to ensure adequate management. While the answers primarily reflect a measured response where the benefits of higher profits are weighed against increased workload, some attested to farm size affecting capacity. Farmer 2 highlights that it has affected their capacity positively. The farmer argues:

“No but I was interested in taking over the farm and developing it, but not in the size it
was then, with tethered cows, and we could only afford an employee half-time. Then you have to work more yourself. Now we have three employees, plus my family. So there are quite a few in the company today. Now there are opportunities to take a week's vacation and get a little more time off, instead of it becoming like the traditional farming business where you work all the time. Instead it becomes 7.00 to 16.00 for the employees and then I take on more work on the evenings and during the weekends.”

This farmer sees the increased size of the farm as having granted more free-time and therefore arguably increasing his capacity. Others perceive a more mixed picture. Farmer 5 highlights that they are more profitable today but that they also have higher costs and that the work is more demanding. The farmer says:

“Yes of course, the bigger you are the more demanding it becomes. There is more paperwork, more work. We have to hire people. When I was little it was only a family farm. Now we have employees and hire in more transport and so on. So that what has happened, with the size, that it has become bigger. Then of course, back then you could live on lower production levels, today you need more. Everything costs more. So, you have had to increase the production [productivity] of the animals and the land. You continually strive towards... and I guess you get the sense that it is not the same as it was when you were small, mom and dad, they ran it, it just kept on going in some way. But that is what happens, when you invest, then it costs more, and you have to produce and become better at what you do.”

Other farmers perceive a larger farm as more of an obstacle. Farmer 3 says:

“Yes, well you might have had different demands on wages 30 to 40 years back. Then it was my parents and I who managed the farm. We thought it was stressful then, but it was calm compared to now.”

Asked about whether this increased workload presented a limitation, the farmer replies:

“Yes, a bit sometimes. In particular it is the timeliness, everything has to be done at the right time. You do not have as large margins, smaller margins.”

Inquiring into the decreasing margins, the farmer argues

“Time-wise, yes both economically and time-wise, but in particular it is that... to get the best harvest you have to do everything at the right time, and it is harder to do all of it. Then economically there are less margins. If something happened there was always margins economically, but that does not exist now and particularly not after a year like this.”

There is therefore a mixed message here. Some farmers argue that the size difference of their farm has led them to have more freedom and therefore higher capacity, whereas others argue that it increases the workload and therefore lowers the ability to manage their farm according to their needs.

In sum, while farmers generally exhibited positive dispositions with regards to the future it is hard to distinguish to see a clear trend in how farmers view their self-efficacy since differing perceptions and experiences of climate change seemingly impact the results. Further, the results of a ubiquitous trend towards larger farms was split, as some farmers viewed a larger farm as an asset whereas others argued it impacted their self-efficacy through greater workload.
5.4. Internal and external barriers

5.4.1. Internal barriers

There exist internal environmental differences which may act as a barrier to certain forms of adaptation. While Farmer 2 is planning to adapt through implementing an irrigation system, they also accentuate that they have good preconditions to do so geographically, due to the proximity of a lake and a lack of nearby residents that would be impacted by the installation. The farmer highlights that groundwater levels in the area are low but the fortuitous placement of the farm nearby a lake enabled the farmer to consider installing such a system. On other farms circumstances are different. Farmer 5 highlights that their farm is located in an area with low groundwater levels and no nearby water bodies.

“Of course, that is something I have seen and heard about. During the summer a lot of farmers were irrigating their crops, irrigation systems were up and running that had not been turned on in 50 years. The problem is, at least here is that I do not have any lakes or thing like that to take up water from, which means I would have to pump groundwater and I cannot do that, because if I take up to much of that then it will run dry in the well and they [the dairy cows] will not have anything to drink. Then the problem is, if it is extremely dry, and you have a creek or a lake, that water will also disappear, because it is not being replenished. Then it is the same, that if I pump the lake dry, I do not have any more water because it will run out as well. So I do not believe that irrigation is…well on some crops and perhaps in some places of the country where there are possibilities to do so. But for me here irrigation is not an alternative.”

The farmer accentuates both the lack of water bodies from which to draw water from to an irrigation system, but also how they perceive it as an unsustainable solution in the long run. The farmer therefore connects the continued functioning of ecological systems with the maintenance of their farming practices. The farmer concludes that an irrigation system might therefore be more of a niche solution.

While certainly influenced by for instance financial viability and conceptualisations about climate change, the response from Farmer 3 highlights that future prospects regarding the farm is also impacted by individual motivations. Farmer 3 highlights that they are reaching the end of their career and was excited by the prospect of one of their children taking over the farm. The farmer therefore started to make investments on the farm, whereas before the farmer wanted to get the greatest possible return on the equipment they already have before retiring. After highlighting that the last year’s drought was a dissuading factor with regards to future prospects for farmers, the farmer subsequently tied together their motivation with their individual circumstances.

“But then my oldest daughter […] said that she wanted to come home and become a dairy farmer. Then I became very positive and bought [milk] robots and started to invest and thought that we could start looking ahead. Otherwise I thought, maybe now we should not develop the farm anymore but instead try to attempt to exploit the fruits of old investments.”

The farmer subsequently highlights that the plan fell through and adds:

“It would have been easier to think positive then, so now she will not become a farmer. None of my children will take over the farm.”

The farmer notes that a positive view of the future led to them starting to invest on new infrastructure on the farm. While robots for dairy production is not an adaptive action, it nonetheless shows how a
belief in the future increased the willingness of the farmer to ensure the thriving of their farm. Ostensibly, a similar dynamic should arguably hold true for adaptation decision-making as well.

In sum, the findings suggest environmental differences and access to water bodies specifically has shaped the possible scope of adaptation decision-making for farmers. Additionally, highly contextual individual factors, in this case the family situation of a farmer, is also shown to impact and shape the motivation of the farmer to continually maintain their farm, subsequently impacting their capacity.

5.4.2. External barriers

With regards to external barriers, farmers brought up uncertainty with regards to future climate projections, financial support, social capital and a conception of a falling level of resilience in society.

Firstly, with regards to climate projections and information about climate trends, there is a level of uncertainty with regards to future trends that is arguably delaying proactive decision-making regarding adaptation strategies. Farmer 5 highlights that the temporal difference between climate research and the reality of their decision-making process on the farm is large, therefore limiting the utility of such projections.

“They argue that they can calculate it, but of course, maybe they will be able to calculate it over a large period of time, but I would need to know from year to year in order to plan my crop production. On that level I do not think they could calculate it.”

Asked about how to improve the state of knowledge, the farmer continues:

“You wish that they could calculate it and get a more precise projection about what will happen, but I understand that it is not so easy. But of course, it would have been desirable if they could find a way to calculate it so you could at least know what will happen within two to three years instead of now where it is in 50 years in the future. To me 50 years is too general.”

The farmer highlights that climate projections have limited utility due to the temporal increments not matching his decision-making reality. Farmer 1 highlights that there needs to be better general information with regards to how climate change impacts the agricultural sector as a basis for decision-making and argues that weather reports do not sufficiently address evaporation.

“We know that we will get an increase in rainfall, but that the more significant factor, the evaporation, will increase. There is a terrible focus on how many millimetres of rainfall we will get, because a rain gauge costs 25 kronor while an evaporimeter is much more expensive. We do not get any reports about evaporation. But so, you can have a dry summer with low evaporation. You can have a wet summer with high evaporation. Evaporation is a really important factor. Also for plants. Raised temperature where the stomata close. It is not only about rain but about evaporation and temperature as well.”

The temporal mismatch and lack of sophistication in weather reporting arguably exacerbates the level of uncertainty that exists among farmers regarding future climate change trends and risks, and seemingly suggests a lack of institutional emphasis on the utility of these services for farmers.

Two farmers also commented on the institutional support received following the extreme drought of 2018 and argued that it was a welcomed gesture of significance in strained circumstances, but that the support did not in any way equate to costs incurred by the drought. Farmer 2 says:
“We have received support and recognition from politicians and that has never happened before. But when it is printed out in the media how many billions the grants are for people think we make money off it, but as a share of the whole our farm does not receive that much money.

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It becomes a symbolic sum that does not live up to what we have lost, but it is a nice gesture nonetheless.”

Farmer 5 touches on the same topic and notes:

“Well... there I do not know what they could have... I mean I know that last year you could apply for some form of drought-compensation. It did not compensate anything, but it got us in a better mood I suppose. But of course, if you are going to compensate a dairy farmer for a year of drought, it could amount to an awful lot of money. If your production drops and you have to buy a lot of feed, it could be a lot of money.”

The farmer subsequently argues that they do not necessarily want a system where taxpayers are supporting the agricultural sector, rather suggesting the need to develop a system where the sector can support itself.

“Because I believe this thing with support and grants, it is not the right way to go. We should not have to live on support and grants. We should be able to support ourselves on what we do. That is my basic idea.”

Both farmers argue that the support is not enough to cover the losses and there is seemingly a lack of institutional support to ensure the continued survival of agricultural businesses who are left dealing with significant financial stress. While one of the farmers highlights that it might not be tenable to compensate the full costs of a year such as 2018, it might be understood by inference that more support could be granted elsewhere to counteract the need for crisis support while maintaining the domestic agricultural sector.

Four farmers also mentioned political decisions as being an important consideration in decision-making. The most frequent framing of political decision-making was their influence of limiting the flexibility of farmers to pursue strategies that benefit their farm. While one of the four rated political decisions as one of the primary challenges faced by the farm, it is unclear what the relative weight of political factors and adaptation is. In some senses, they also represent different categories, as farmers must adjust to political decisions whereas adaptation is a responsibility primarily placed on themselves as individuals.

Further, Farmer 2 highlights the role of their local community as a positive factor in relation to capacity and ability to deal with fluctuations which arguably by inference signals their importance in terms of facilitating adaptation. The farmer highlights that their local community is contributing to the thriving of their farm through the existence of local entrepreneurs and farmers who they exchange services with.

“Or other challenges, we haven’t faced those challenges because we have chosen to pursue a different strategy and that is that we do not have all the machines ourselves. We sold the combine harvester and the seed drill when we put in the milk robots and concentrated only on grasslands and corn. So for the cereals we grow, we hire someone to sow, hire someone to spray, hire someone to thresh. And the same thing with the grassland, then we call a machine station that chops the grass, hacks it, and then we
The farmer highlights how this has positively benefited their business and argues that this is possible because of the existence of a vibrant agricultural community where they live.

“Yes, but we live in an area where there are entrepreneurs and other farms that invest in machines. If you compare with the situation on Öland and on Gotland, or in Norrland where it is far between the farms or where everyone want to use the machines at the same time, then you cannot do it to the same extent, buy the service.”

The farmer is not incurring the types of investment costs that might be necessary in less vibrant farming communities and the accumulation of resources in the community seemingly increases the capacity of each member. Farmer 3 highlights that there are opportunities for farmers to facilitate adaptation within the sector through farmers coming together, sharing their experiences and trying to develop strategies and best practice. This farmer particularly sees a role for ecological farmers to share strategies that they have developed over time. While arguing for the importance of crop rotation for counteracting pests and weeds, the farmer says:

“Earlier the solution has been to solve it chemically, fungicides or pesticides. But in the long-term that is not the solution for a sustainable agriculture, in the long run. Ecological crop rotation practices can actually contribute a little bit there, because there you have to think a little more in advance... so there I think you could probably contribute with some knowledge.”

Subsequently asked to clarify whether the farmer implies that farmers help each other through best practice, the farmer answered yes. This seemingly indicates that the farmer sees potential for farmers to assist one another in developing strategies to deal with climate change through sector cooperation.

Some farmers are attesting to a falling level of resilience that could impact the ability to deal with potentially deteriorating conditions. Farmer 1 highlights a general fear that members in society are becoming less resourceful.

“[…] I do not think that that either the agricultural sector or many other parts of society are sustainable and resilient. One of the challenges there is that we lack practical and technical innovation skills and competency. It feels as if it is falling all the time.”

When questioned on whether the farmer conceives of a falling general resilience as well as in the agricultural sector, the farmer responds:

“Yes, I think so because probably we have to transform the agricultural sector so that we maintain its productivity and at the same time repairs life supporting systems. We will not be able to just buy that off the shelf from China.”

The farmer repairs tools and machines on the farm and argues that one of the factors which exacerbates falling resilience is chip-trapping in tractors, which decreases resilience as farmers are dependent on others to repair their tractors if they break.

“That sort of depends on you having older machines. Because you cannot always access the starter engine if you have a new tractor. They are oftentimes chipped. Chip-trapping
is a big problem”

The farmer therefore highlights that the general level of resourcefulness is falling and that societal systems, including in the agricultural sector, is becoming less resilient, therefore lowering the capacity for adapting to new circumstances. Resilience is also touched upon by inference by the previously mentioned Farmer 2, who is able to contract out work that requires heavy machinery. The farmer highlights that they have not had to invest in big machinery, which indebts many other farmers. Indebtedness due to the necessity of large machinery investments potentially limits a farmer’s available options in decision-making due to a reduction in capacity and subsequently a reduction in resilience.

Two farmers connect this fall in resilience with a lopsided urban to rural development. Farmer 2 argues that schools are not enrolling enough new students in agricultural programmes in order to ensure a future labour force in the sector.

“[…] the obstacles we see ahead is acquiring good staff to take care of the animals and work within the agricultural sector. Around 15 years ago, 20 years ago, all agronomics students and veterinarians had practical experience for a few months or half a year, which meant that there was a lot of labour on the market. That is not the case anymore. And then everyone is supposed to have all this education, almost overly qualified, when it is enough that you have a girl who loves animals or a guy that likes to drive a tractor who could get an internship and work their way into the company. And then the problem is that agricultural schools around Sweden are having a very hard time to find students to enrol. The farms are getting fewer and fewer and it becomes an evil circle. It is difficult to get hold of good labour.”

Farmer 4 highlights that his business has difficulty maintaining the labour force when urban regions and in particular Stockholm is going through an economic boom.

“[…] another problem we have, both with the temporary but also other labour, the labour problem is that when there is a boom in Stockholm. To get a truck driver for us, I mean the agricultural sector is not a high wage profession. When there is a boom the wages are much higher in Stockholm.”

The reduced capacity which results from a societal system that is working less well for the agricultural sector reduces its resilience and ability to deal with stresses. The conditions in the sector are seemingly unfavourably juxtaposed in relation to development in urban environments.

Finally, the previously mentioned factor of future prospects is also impacted by external discourses about the merits of dairy and meat production. All the farmers in the study attested to a movement in societal discourse towards highlighting the negative impact of dairy and meat products on the climate, as well as a growing animal rights movement that argues against the ownership and killing of livestock. While no farmer highlighted that this had a tangible impact on how the farm was managed and argued that groups should be allowed to voice different opinions, two of the farmers did highlight that it to some extent impacted their perception of the future. In relation to having experienced pressure from animal rights activist personally, Farmer 3 highlights that it is a psychological strain and says:

“Yes, you have a feeling of that society is more positive to agriculture right now. And really that is the most important thing. Because it can be hard when you think you are doing a good job as a farmer and then you see that it is not appreciated by society or by politicians at all, but that instead you are more of a parasite or a burden.”

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The importance of societal discourses for influencing future prospects among dairy farmers is clear here. Farmer 5 highlights:

“\textit{Yes, the debate that is now is a threat to those that have cows, as the cow is seen as the problem. That is the way it sounds now.}

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\textit{But the day, if they succeed in turning the debate and starting to focus on what is actually the problem, fossil fuels, then I can completely buy the debate and be ready, then I would happily make that change.”}

While the farmer does not highlight any specific ways in which the farm has been impacted, there is a sense in which the farmer both sees the debate as a potential future threat to their farm that deteriorate future prospects, as well as a sense in which the farmer does not want to engage in issues of climate change due to the fact that the they perceive the debate to be misguided in their vilification of the industry the farmer is part of. Future prospects from personal internal factors as well as external and more overarching discourses therefore seemingly impact the motivation and subsequent capacity of farmers to adapt.

In sum, on an institutional level, there is a temporal mismatch between the information needed by decision-makers and local climate scenarios, as well as financial assistance that does not adequately cover the losses incurred by extreme climatic conditions. Social capital was seen as positively linked to adaptation through renting machinery and the possibility of sharing knowledge and best practices. Certain social discourses were perceived as questioning the continued existence of livestock farming, negatively influencing farmers’ perception about their prospects. Finally, participants highlighted a generally falling resilience in society, as well as worsening conditions for the sector due to lacking education systems and poor competitiveness in terms of wages relative to other sectors.
6. Discussion

6.1. Risk perception and perceived probability

The main finding of this study is that the combination of uncertainty in risk and adaptation appraisal has led to a tentative approach to implementing adaptation strategies. In terms of risk appraisal, farmers believe that climate change is happening, but differ in their perception of “risk experience appraisal” (Grothmann and Patt, 2005: 204), subsequently differently impacting the perception of impetus to act to risk.

Firstly, in terms of the “perceived probability” (Grothmann and Patt, 2005: 204) of climate change risk, the primary finding of this study is that all the farmers that were interviewed believe in and are adapting to climate change. Judged in relation to the local climate projections by the Swedish Meteorological and Hydrological Institute (Sjövik et al., 2015) as well as with the Swedish Official Government Reports on agricultural vulnerabilities (2007: 12-29) farmers arguably exhibit a good analytical understanding of regional scenarios for future climate change impacts on the agricultural sector, a balanced understanding for both the opportunities and challenges that climate change poses for farming and are reflecting on the uncertainty of future climate scenarios. Additionally, all farmers argue that they are experiencing a warmer climate with longer growing seasons and better conditions for existing and new crop varieties, which differs from the results from Chongtham et al., in whose study a minority of farmers were attesting to a “longer and warmer growing season” (2016: 5). Three out of five farmers also argue that they are experiencing more extreme weather events today when comparing climatic conditions over the time that they have been active. The results therefore suggest that farmers are both taking part of analytical information regarding climate change and that they are, to differing degrees, linking their own experiences with analytical information about climate change, which runs counter to the findings in the study by Jørgensen and Termansen, in whose sample the participants did not link their own experiences with their analytical knowledge of climate change (2016: 293-294).

Further, the results differ compared to previous studies regarding belief in anthropogenic climate change. While the study from Chongtham et al. does not specify the number of Uppland farmers who believe in anthropogenic climate change, a majority of participants in the studies by Woods et al. (2017), Jørgensen and Termansen (2016) and seemingly Juhola et al. (2017) believe in anthropogenic climate change. This is contradicted by results in Asplund’s study of Swedish farmers, where the author seemingly suggests that a majority do not believe in anthropogenic climate change (2016: 565). While Asplund’s study does not feature specific numbers, the study by Jørgensen and Termansen found 11 percent of participants did not believe in anthropogenic climate change (2016: 294) and the study by Woods et al. 45 percent of participants (2017: 116). Interestingly, although the results from this study affirms the findings of a majority of studies considered here, the results nonetheless stand out as there was unanimity among participants with regards to the belief in anthropogenic climate change.

In terms of barriers to adaptation, the results of this study suggest that belief in climate change, in line with the knowledge-deficit model, is too simplistic and would have questionable effects incentivizing further implementation, given the complexity and internalisation of understanding already held by the interviewed farmers. While the cause for these results may differ, this affirms findings in a previous study by Niles et al. (2016: 290-291).

6.2. Risk experience appraisal

On the other hand, the impetus for adaptation was affected by differing appraisals of “risk experience” (Grothmann and Patt, 2005: 204-205). While there was unanimity with regards to perceptions about the
existence of gradual climate change, linking climate change to extreme climatic events and the drought of 2018 in particular, was contested. Out of the five farmers, three argued that recent climatic extremes were likely due to climate change, while two of the farmers were not ready to say that recent extremes were caused by climate change. This differentiated the risk perception of farmers, as those who believed extreme climatic events were due to climate change where to a greater extent projecting further risk into the future, thus increasing the impetus for change for two of the farmers, as well as one farmer who expressed a fatalistic response to climatic extremes and perceived their capacity to foresee and counteract extreme fluctuations as small. The farmers who did not make the connection between experienced extreme climatic events and climate change attested to a more tentative approach to adaptation decision-making.

In terms of finding leverage points through which the risk perception of tentative farmers could be altered, it is unclear as to exactly what separates the group of farmers who connect recent climatic extremes with climate change, as opposed to those who do not. What is evident from the results is that all the farmers use previous experience of climatic extremes to judge current climatic variations and reference long-term evidence. Seemingly, what differs in this process is an assessment of the severity of the phenomena, as well as the assessment by farmers of what constitutes a trend. With regards to severity, one of the two farmers who do not link recent climatic extremes to climate change argue that they have experienced similar phenomena before, as opposed to the farmers who do and say that the extremes are larger and represent more novel phenomena. The other farmer who does not make the causal link between recent climatic extremes and climate change argues that the drought in 2018 might have been more extreme than what they have previously experienced, but nonetheless argues that it could also be natural variation with reference to previous experiences of climatic extremes. The same farmer argues that there is a lack of long-term observations of climatic variations that forms an observable trend of change, while the sentiment particularly with two of the three farmers who are linking climatic extremes to climate change is that extremes have been more frequent over time.

As is highlighted in the previous literature (Neset et al., 2018: 8-9; Uleberg et al., 2014: 29-34), it is possible that differences in observations could be due to contextual and environmental differences on the farms of the participants, meaning farmers have experienced climatic variations differently. There is some credence to this idea as one of the farmers who links climatic extremes to climate change argues that they have been adapting to dry conditions over a long time, which means that the drought of 2018 affirms a trend the farmer has already observed. One of the farmers who does not link recent climate extremes to climate change argues that a trend is hard to distinguish since they have experienced both wet and dry years in recent experience. The same farmer has previous experience with maladaptation, as wet conditions made a newly installed irrigation system redundant for 15 years, which in turn may reinforce the perception that it is difficult to foresee a clear trend. Further, differing farm practices and production systems may also alter impacts on a farm level, as one farmer accentuates that dairy farming is particularly sensitive to perturbations when raising calves into dairy cows. While the relative vulnerability of farming practices between farmers was not assessed in this study, the three farmers who made causal links between recent extreme climatic conditions and climate change were dairy farmers.

What could be at play in this particular instance is differences in “Cognitive biases/heuristics” in Grothmann and Patt’s model and in particular the ‘availability heuristics’ variable, as the two farmers could be trying to understand events by inferring onto them past experiences (2005: 204-205). On the other hand, the likelihood of this speculation is tempered by the fact that all participating farmers were selected from within Uppsala County borders. Further, the drought of 2018 was a common denominator for judging whether climate change was happening.
An alternative explanation is that slight cognitive and heuristic variations mean that farmers are judging perceived past experiences differently. One of the farmers who link recent extreme climatic variation to climate change argues that up until recently, their perception was that climate change had brought positive changes to the agricultural sectors and that recent extreme climatic conditions tentatively signals a paradigm shift towards more negative impacts from climate change. While the farmer tentatively argues that lessened problems with drainage on the farm overtime could be because of climate change, this understanding of climatic variation nonetheless differs from the assessment made by one of the farmers who argue that differentiating between natural variation and climate change requires longer-term observations. The difference between these two farmers seems to lie in the relative weight that the individuals put into personal experience as opposed to analytical knowledge, as the farmer who makes the connection between climatic extremes and climate change is quicker to attribute his personal experience to analytical knowledge.

Importantly however, this reasoning does not reflect the arguments made by all of the participants, as the other two farmers who connect recent climatic extremes with climate change argue that they have seen large fluctuations over a longer time period. It is worth noting that while the IPCC generally emphasises pre-emptive decision-making as a way of reducing costs (IPCC, 2014a: 19-20), there is a general understanding of that the risks of maladaptation requires of anticipatory strategies well planned context sensitive adaptation (IPCC, 2014b: 28; Neset et al., 2019a; Neset et al., 2019b). On the other hand, as highlighted by Adger et al. it is not clear to what extent past experience can be used to understand novel phenomena under climate change, thus also questioning reasoning based on long-term experience (2009: 346). Since the focus of this study is not on assessing the merits of given adaptation strategies, it is difficult in this case to assess the appropriate level of pre-emptive decision-making in relation to the risk of maladaptation.

While this is a phenomenon that requires more in-depth research, what can tentatively be derived from these results is that farmers seemingly understand climatic variations differently and that drawing causal links to climate change may to a certain extent depend on individual differences in reasoning. Interestingly, the unanimous observations of gradual climate change compared to the contested nature of extreme climatic events runs counter to the particular availability heuristics thesis provided by Berrang-Ford et al., that extreme events are much more potent in terms of triggering perceptions about evidence of a phenomena (2011: 32). The results reflect difficulties underscored by Hulme of climate change as an unsituated risk, as farmers are making value judgements about the nature of their personal experience in relation to analytical information without perfect knowledge (Hulme, 2009: 196-200) and also affirm one of the conclusions drawn by Chongtham et al., that perceptions regarding climatic conditions in the same region differ between farmers (2016: 6-9). Therefore, it is difficult to identify exactly which leverage points might impact the risk perception and subsequently increase the impetus for farmers to implement climate adaptation measures.

6.3. Risk perception influencing the perceived efficacy of adaptation

Risk perception coupled with concerns for the adaptation efficacy of given strategies accounts for one of the most impactful barriers to adaptation identified by farmers. Uncertainty as to what climate to expect in the future was one of the primary concerns for farmers when considering whether to take adaptive action to perceived climate change. Whether drought or extreme rainfall posed the greatest and most frequent risk was of primary concern. The inability to know whether to expect drought, heavy rainfall or simply a normal year, as highlighted by one farmer, opens the potential for both opportunity losses during good years and severe losses during bad years if farmers commit to maladaptation. Other
farmers were more tentative and argued that the overarching trend of climate change and its impact on agriculture were not yet clear. As evident from the farmer who is intending to invest in an irrigation system, confidence in one’s ability to detect future climatic trends impacts the perceived efficacy of targeted strategies and seemingly improves the likelihood of adaptation. A perceived lack of knowledge regarding future trends feed into farmers questioning the efficacy of given adaptation strategies and seemingly stall decision-making as farmers are attempting to minimize the chance of maladaptation. A variety of responses are evident from farmers due to this uncertainty, from tentativeness and waiting for more clear trends to emerge on one end, to a fatalistic response by one farmer who perceives their capacity to foresee and counteract extreme fluctuations as small.

This trend seemingly reflects the uncertainty highlighted by previous research in how climate change will impact the Nordic countries (eg. Rötter et al., 2012: 171-178) and whether to prioritize adaptation against heavy rainfall or droughts (Neset et al., 2019b: 84-85; Wirén, 2017: 74-75). While farmers seemingly accept that there is inherent uncertainty with regards to climate scenarios and forecasting, one farmer echoes a critique in the study by Klein and Juhola, through arguing that there is a temporal mismatch in terms of scientific research aiming to help the agricultural sector (2014: 105-106), as long-term climate scenarios of 50 years and more are not applicable for farmers to use in the short-term to protect the continued viability of their farm.

The importance of perceived adaptation efficacy affirms findings from previous studies of farmers and the barriers they experience to adaptation (Alauddin and Sarkers, 2014: 207; Kabir et al., 2017: 220; Panda, 2016: 791-792). The results on risk perception seemingly affirm the findings in Esham and Garforth’s study showing climate change risk perception as statistically significant (2013: 543), as well as both affirming and adding to the conclusions made by Niles et al. as self-efficacy and perceived capacity is seen as a relevant factor for adaptation implementation when linked to perceptions of climate change risks (2016: 290-291).

6.4. Perceived severity and adaptation cost

Barriers to adaptation implementation emerge from the trade-offs made by farmers in relation to “perceived severity” (Grothmann and Patt, 2005: 202-205). For four out of five farmers, the primary concern was securing financial interests and subsequently a viable business. One farmer argues that short-term economic interests must be secured first, ahead of long-term climate change decision-making, while another highlights that it is primarily the financial situation of farmers that determine what other priorities farmers can pursue. One farmer argues that their priority is simultaneously production and environmental restoration with a focus on climate mitigation, rather than climate adaptation. For both groups, adaptation is not unimportant but nonetheless considered it a secondary issue to pursuing financial interests and climate mitigation respectively. These findings affirm previous studies who conclude that other concerns that farmers have are considered more important than climate change (eg. Esham and Garforth, 2013: 540-541). This to some extent acts as a barrier to adaptation since seemingly, either farmers’ capacity to pursue several adaptation strategies at once must be high, or alternatively adaptation must be significantly aligned with the priority issue of the farmer thus creating synergies.

The predominance of financial interests is evident in the way that the majority of farmers talk about the risks of climate change. For instance, the risk of extreme weather events is expressed by two farmers in terms of affecting market stability. During wet years when the harvest is high, other farmers are also experiencing good harvests and farmers are having a hard time selling their forage. When the yield is low due to drought, then the price goes up, but farmers have already contracted a given price, volume
or both, which means that a farmer’s losses are exacerbated. Among the four farmers who highlight that extreme weather has impacted their farm, this loss is first and foremost expressed in economic terms. In terms of the efficacy of adaptation strategies, for the farmer who is intending to implement an irrigation system, the increased productivity and subsequent returns from their grasslands is instrumental in their justification of the strategy. Another farmer argues that they are hesitating to adapt through setting aside more acreage towards growing feed for the cows on the grassland, since although it might ameliorate the damage sustained to the farmer during a dry year, it might threaten their financial return on a good year where more profitable crops could have been grown on the fields. Considerations for the economic impact of implementing a given adaptation strategy is seemingly the most frequent and salient measuring stick for evaluating the successful implementation of adaptation.

Financial considerations of farmers seemingly shape their adaptation decision-making. The adaptation pursued by the majority of farmers can primarily be characterised as managerial strategies targeted towards proximately identified risks. While one farmer is implementing more substantial changes on their farm within a systemic vision of climate countering and another is intending to implement a more substantial adaptation strategy in the form of an irrigation system, primarily farmers were implementing smaller changes to their farm that resembles the trend identified by Juhola et al. (2017: 29-35) and Woods et al. (2017: 109-116), of incrementalism. Adjusting the ratio of animals or the number of workers relatively to acreage or sowing drought resistant crops are strategies geared towards reducing the impacts of climatic fluctuations without fundamentally changing the farm. There is an ostensibly counterintuitive trend between farmers whose deliberative process reflects considerations for long-term variables related to experience and analytical knowledge, to a focus on primarily short-term proximate strategies. Yet coupled with the common feeling of uncertainty of future climatic conditions, and in particular uncertainty regarding how to achieve financial returns through implementation strategies, it looks like a general proclivity towards risk averse behaviour is present among the participants, an internal limitation to adaptation identified in the study by Adger et al. (2009: 241). Speculatively then, incremental decision-making reduces costs and subsequent risks for maladaptation. On the other hand, this proclivity arguably does not lend itself towards more systemic changes in adaptation strategies. Financial interests therefore seemingly both shape and limit potential adaptation.

Adaptation implementation seemingly suffering from the reduced financial capabilities of farmers, among who four have sustained losses due to the summer drought in 2018. One of the farmers highlight that due to losses sustained in previous years their farm is vulnerable, adding that they would not be able to sustain financial losses in the coming years and concluding that their perceived capacity to act and adapt to further climatic extremes is low. Two argue that losses sustained were not compensated for by financial aid provided by the government following the drought. There is therefore seemingly a lack of financial capacity among certain farmers that could act as a barrier to pursuing capital intensive adaptation.

Interestingly, farmers are beginning to see synergies between adaptation and their primary issue of concern, as farmers who prioritise financial interests are experiencing losses due to extreme climatic conditions. The farmer concerned with climate mitigation argued for the adaptive merits of perennial plants that the farmer highlighted capture more carbon. While acting as a barrier, synergies between adaptation and priority issues can to some extent bridge the divide created by other priority concerns, as found by the study of Woods et al., which highlighted that perceiving of opportunities to gain from climate change, rather than managing its risks, was found to be a better motivator for adaptation among Danish farmers (2017: 117). Strategies targeted at achieving synergies with farmers’ priority issues therefore seemingly carries potential in terms of incentivizing further implementation. In line with the argument made by the IPCC, finding synergies is particularly important with regard to adaptation and
mitigation efforts in order to ensure sustainable outcomes (IPCC, 2014a: 17-18).

The importance of financial considerations reflects a general trend found in most of the barrier’s literature (e.g. Alauddin and Sarker, 2014: 211; Bryan et al., 2009: 424-425; Deressa et al., 2009: 252-254; Descheemaeker et al., 2016: 2338-2339; Esham and Garforth, 2013: 540-545; Fisher et al., 2015: 297; Kabir et al., 2017: 222-223; Neset et al., 2018: 8; Panda, 2016: 792). Similar to the argument made by Klein and Juhola (2014: 106), as well as Wiréhn (2018: 69), adaptation decision-making is often made with other interests in mind. Creating synergies that incentivize decision-making actively might help facilitate adaptation implementation, lest decision-making is to be relegated to adaptation due to necessity, which as previously argued might be more costly (IPCC, 2014a: 19-20).

6.5. Internal barriers

Context-specific strategies to adaptation, that reflect farm level differences, need to be considered to ensure adaptation strategies are implemented by a greater number of farmers. One farmer argues that they are intending to adapt through implementing an irrigation system and while they have low ground water levels, they highlight that they nonetheless have good conditions to do so due to a nearby water body. Another farmer had considered implementing an irrigation system but has both poor ground water levels and no nearby water bodies. The farmer therefore experiences a barrier to adaptation from the farm specific water resources that they have. This finding affirms the idea of conducting analysis in a way that is sensitive to context-specific variables (Biesbroek et al., 2013: 1127; Uleberg, et al., 2014: 29-34; Wiréhn, 2017: 50-53) and also highlights the necessity to consider maladaptive outcomes to ensure the sustainability of adaptive solutions (Neset et al., 2019a: 2-10).

With regards to other farm-specific characteristics, all of the farmers attest to the substantial growth of their farm over time but the results on farm size is seemingly split. Some farmers highlight that a bigger farm has led to an increased workload as productivity continually has to be improved, as well as a greater emphasis having to be put on timing, whereas others argue that they experience greater margins and therefore have more capacity. The inconclusive role of farm size is also affirmed in previous studies on Nordic agriculture (Neset et al., 2018: 8).

There is also evidence that perceptions of future prospects have an impact on decision-making. While unrelated to climate adaptation, the infrastructure spending committed to by one farmer in response to the possibility that their child would take over the farm, highlights the relevance of future prospects in impacting the willingness and by effect the capacity of the farmer. The future prospects of these subsections of farmers are perceived as particularly threatened, as the majority of farmers noted the concern of criticism and in rare cases hostility from environmental and animal rights groups who to varying degrees are critical of the livestock and dairy industries. On the other hand, no farmer highlighted that it had fundamental changed how they ran their farm. These findings present an interesting case of the impact of the individual heuristics and psychology aspect of the MCCAPP model (Grothmann and Patt, 2005: 203-205).

6.6. External barriers

Institutional support, social capital and the functioning of social systems rurally were found to be important in terms of facilitating climate change adaptation. In terms of institutional support, two farmers highlighted the financial support offered following the drought of 2018 did not cover the financial losses incurred. While farmers highlighted that fully compensating dairy farmers would have been extremely costly, the results nonetheless indicate that the crisis support structure is in need of development to ensure farmers can manage future fluctuations. Further, due to the studies affirmation
of previous studies findings that perceived risk and adaptation efficacy is important in terms of facilitating adaptation (Alauddin and Sarkers, 2014: 207; Kabir et al., 2017: 220, Panda, 2016: 791-792) there is arguably an opportunity for institutional support structures to target information regarding adaptation strategies. In relation to the findings of this study, information would be most impactful dealing with extreme weather fluctuations and context-specific environmental and farm specific variations. Affirming the findings of Klein and Juholaa (2014: 105-106) climate change scenarios and regional scientific research could also be improved through more targeted agricultural-specific analyses that are sensitive to the realities of decision-making in farming-enterprises.

Social capital was highlighted as an important factor for strengthening the adaptive capacity of farmers. One farmer argued that they did not have to make as many large investments in heavy machinery due the fact that they could hire in services from nearby community members, thus experiencing less of a lock-in and benefiting from better equipment as a consequence. Another ecological farmer saw an opportunity to share best practice in the sector, particularly with regards to how to deal with weeds and pests sustainably. These examples show that these farmers are able to increase their adaptive capacity significantly through building networks within the sector, which affirms the results of previous studies highlighting the importance of social capital (Eriksen and Selboe, 2012: 165-166; Deressa et al., 2009: 254). As highlighted by one farmer, the opportunity to build social capital in Uppsala is high due to the relatively speaking high density of farms.

On the other hand, social capital in rural communities in rural communities is threatened as one farmer highlights that it is difficult to find quality labour due to competition from urban centres in other sectors, as well as another farmer who highlights that agricultural education programmes are lacking due to inadequate practical experience. One farmer argues that farmers experience exacerbated conditions due to large machinery investments, as “chip-trapping” results in farmers being unable to repair their broken machinery. Finally, one farmer also accentuated that the general ability in society to repair broken things is a fundamental threat to its resilience and to sustainability. Previous studies have reflected this general sense of deteriorating conditions through highlighting complex interactions resulting in falling socio-economic conditions in rural Sweden (Milestad et al., 2011: 137-138). These trends seemingly hurt the adaptive capacity of farming communities and while farmers therefore conceive of ways in which social capital can improve adaptation in the sector, there is a need for actors outside the farming sector to develop policies targeted at ensuring the continued existence and vibrancy of rural communities, in order to enable their adaptive capacity.
7. Conclusion

This study found perceptions about climate change to be one of the most important factors determining the adaptive behaviour of farmers. In particular, farmers experience barriers to adaptation in the difficulty assessing climatic trends that follow with climate change. In Uppsala, Sweden, recent experiences of drought have created an unclear perception about the relative risks of climatic impacts, with farmers unsure of whether to expect drier or wetter conditions in the future. As a consequence, the majority of farmers in the study expressed a concern for the effectiveness of given adaptation strategies due to the uncertainty of future climatic impacts, which acted as a barrier to decision-making. Risk perceptions between farmers differed as a consequence of certain farmers connecting recent experiences of climatic extremes to climate change, while others were not prepared to make the causal link due to a perceived paucity of experiential evidence. While the study was unable to come to a conclusive answer as to why perceptions of extreme climatic events differed, the findings nonetheless suggest targeted efforts to reduce the perceived uncertainty of climate change risk and the efficacy of given adaptation strategies should be supported in order to facilitate implementation.

The study shows that adaptation is not the foremost priority for farmers, who either see financial or climate mitigation concerns as more pressing. The risk perception and concern for maladaptation in this study was linked to financial risks and rewards. Four out of five farmers were primarily concerned with improving their financial standing and experienced difficulty assessing whether different adaptation strategies would produce a return on investment given the uncertainties of impacts experienced. Farmers are pursuing primarily incremental adaptation strategies in response to proximate risks, which tentatively might reflect risk averse behaviour due to uncertainty in the efficacy of adaptation strategies to reduce vulnerability and cover investment costs. The salience of financial and climate mitigation considerations presents barriers as well as opportunities for the implementation of climate change adaptation. Uppsala farmers are currently experiencing financial hardship, thus reducing their adaptive capacity, which in part is due to weather fluctuations and in particular to the drought experienced in the summer of 2018. This has created a synergy between ensuring financial viability with adaptation to climate change, which might subsequently facilitate its implementation. For the farmer professing to prioritise climate mitigation, synergies were found between mitigative decision-making and reducing risk from climatic extremes. Taken together, under current conditions adaptation implementation would seemingly be improved if farmers were able to see financial returns from pursuing adaptation strategies.

Further, perceptions about future prospects for individual farmers and the sector as a whole tentatively might influence the adaptive capacity of farmers. The results of this study indicate that a majority of farmers perceive of more insecurity about the future due to social discourses that negatively highlight the environmental footprint of livestock and dairy production, as well as one farmer who argued that they were less likely to make investments on the farm as their child was not taking over the family business. There is seemingly a link here between the perceptions of farmers regarding uncertain and deteriorating prospects, with the motivation to continue to work on and improving their farms, which might tentatively affect the adaptive capacity of farmers. Gaining an in-depth contextual understanding of farmers and their motivations may therefore help in gaining a more holistic perspective of as to why adaptation implementation may be lagging.

The study found both internal and external barriers to adaptation. While the impact of farm size was inconclusive in the study, one farmer attested to the impact of specific environmental conditions that hindered them from implementing irrigation. In terms of external factors, opportunities to improve the implementation of adaptation where found on an institutional level, where better information about climate change impacts and associated strategies as well as more effective and targeted financial support
systems were identified. Further, the study suggests an overarching effort to improving the socio-economic viability of rural communities would improve adaptive capacity, as there was evidence of a farmer who was able to avoid incurring large investment costs through hiring services from their surrounding community and another farmer who saw opportunities for knowledge-sharing between farmers to better tackle emerging challenges from climate change. Understanding how such contextual factors differ between farms may help better tailor support for facilitating greater adaptation implementation.

Due to the broad scope of the essay, informed particularly by the use of encompassing conceptual understandings of ‘barriers’, ‘adaptation’ and ‘vulnerability’, there are many ways in which further research could build on the research done here. The essay is mostly concerned with factors which inhibit implementation of adaptation and lacks nuance with regards to the relative trade-offs and synergies created by given adaptation strategies, particularly with regards to their environmental impact. This is an aspect of decision-making better encapsulated by other studies (eg. Neset et al., 2019a). Further, while this study finds that farmers make different causal links between extreme weather events and climate change, this study was not fully able to account for the determining factors that condition these different responses. Future research could tentatively both inquire into differences in individual and psychological variables as well as into socioeconomic variables in order to attempt to explain why different causal links are made and how they impact climate change decision-making. In line with the critique and subsequent suggestion of Biesbroek et al. regarding the conceptual obscurity of ‘barriers’ and ‘adaptation’, future research could also inquire into the barriers of adaptation by inquiring into particular adaptation strategies and thus narrowing the scope of the results (Biesbroek, 2013: 1126).

In sum, the results suggest a nuanced understanding for differing perceptions and contextual differences between farms is important in terms of understanding the barriers that hinder greater implementation of adaptation. Farmers’ perceptions were important for informing their decision-making and a combination of perceived risk and adaptation efficacy accounts for the primary obstacle to the implementation of adaptation among the studied farmers. The results suggest targeted efforts to reduce uncertainty with regards to how climatic extremes will impact the agricultural sector might improve implementation. Further, in line with previous adaptation research, the study finds that adaptation was not the primary priority issue among farmers. Among the interviewed farmers, the majority of farmers’ priority issue was financial considerations and for one it was to improve climate mitigation strategies, which highlights the importance of finding synergies with farmers’ priority issues for facilitating implementation. This is particularly important with reference to the IPCC agenda of pursuing both adaptation and mitigation efforts together (IPCC, 2014a: 17-18). Within and beyond the farm, environmental and socio-economic factors seemingly increase the capacity of farmers to adapt, which highlights the importance of understanding contextual differences between farms, in order to understand the conditions under which adaptation strategies can successfully be implemented.
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10. Appendix

10.1. Interview guide

General framing of farming practice:

Can you tell me about your farm and what it is that you do?

- How long/how many generations?
- How has the farm changed over time?

Vulnerabilities:

What have been the main challenges over this time?

What challenges do you foresee for the future?

- Short term/long term?

How do you aim to address these challenges?

- Values: What is the aim/goal/what is protected through this strategy?
- Temporal aspect: Over which time period are strategies considered?

Climate vulnerabilities:

Do you believe in man-made climate change?

Have you experienced any effects on your farm from changing climate conditions?

Have you experienced any effects on your farm from extreme weather events?

- Have these effects increased over time?

How do you think climate change will impact your farm in the future?

- Challenges/opportunities?
- Short term/long term?

How have you/how will you overcome these challenges?

- Values: What is the aim/goal/what is protected through this strategy?
- Temporal aspect: Over which time period are strategies considered?
- Limitations: What is the limiting factor of your work with adaptation? Does the strategy meet the problems that you foresee?

Enablers and obstacles:

Summarize general threats and vulnerabilities they have mentioned.

How do you manage dealing with these different concerns?

- Trade-offs or synergies in achieving goals? Postponing? Relative weight of concerns?

Do you experience that there are obstacles within your business/farm that hinder you from pursuing
your strategies?

- Internal obstacles such as economics/land use/local environment?

Do you experience obstacles from outside your farm that impact your ability to pursue your strategies?

- External obstacles such as regulation/institutions/financing/competition?

Can you talk about what type of knowledge you use in your business?

- Knowledge for assessing impacts on the farm? Role of advisors? County board?
- Man-made climate change/applicability, adequacy, legitimacy of information/own experience?

Do you experience society as having an influence on your ability to adapt?

- Social responsibility to help farmers adapt/societal perceptions?
- How can the work with adaptation be improved?

Cooldown:

How did you think the interview went?

Do you feel like you got a change to share your perspective on the topic?

Is there anything you would like to add?

Thank you! I will transcribe this interview as soon as possible and send it to you for comment!