“Nature Gives and Nature Takes”

– A Case Study on the Experience of Farming with a Changing Water Resource

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Abstract

Water and the management of it holds a great complexity. We live in a time where adaptation measures often are based on risk calculations made by experts and bureaucrats where they try to measure future dangers of global climate change. This thesis shifts focus from the global crisis narratives to a grounded and experience-based narrative of a group of Swedish farmers. By examining in depth how farmers in the area of Örebro County, Sweden understand changes to water availability I aim to unravel the farmer's water epistemology in relation to climate change. What is found is that rather than basing their adaptation measures on expert risk calculations, their adaptations are based on lived experience. The farmers' water epistemologies consist of their own take on lay- and expert knowledges, and the context they are embedded within. This results in a complex framing of water management moving beyond risk calculations and towards including situated knowledge.

Keywords: Water management, agriculture, climate change, uncertainty, risks, human-nature relations

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1. Introduction

The relationship between society and water is a bricolage of historical events, cultural meanings, and transboundary agreements, holding great complexity. Water, and the management of it, is not only dictated by technical solutions, it also involves human values, affecting the organization and politics of water management (Linton & Budds 2014). To understand the ongoing hydrological changes due to climate change (IPCC 2019), there is not only a need to calculate risks and make future prognosis for how precipitation patterns will change, there is also a need to look at the understanding of water scarcity and the context that water management lies within. In writing this thesis I am inspired by the idea that we need to develop our understanding of water and the relationships humans have with it, in order to manage the effects of climate change and create a sensitive water management.

Today 70% of global freshwater is used within agricultural production (Otto & Schleifer 2020), which means that a conscious water management within agriculture is a key factor in securing future food supplies. Agriculture is often understood as an area of technical innovation, where adaptation measures are focused to just that (Arora & Glover 2017). However, there is a growing body of research focusing on how social and relational aspects of agriculture are affecting adaptation measures (see Scoones & Thompson 1994; O'Brien et al. 2007; Eriksen & Lind 2008; Nightingale 2018; Ensor et al. 2019; Scoones 2019; Wiréhn et al. 2020; Sorvali et al. 2021). To develop a deeper understanding of social and relational aspects of water management in agriculture I will conduct a case study with five farms in Örebro County, Sweden. This as a way to map out farmers' water epistemology, or in other words, the scope of knowledge which shapes their handling of water.

In Sweden, widespread drought in 2018 resulted in large losses in both crop yield and livestock production for the agricultural sector. In the aftermath, Swedish farmers and wider society are beginning to navigate a new future of extreme weather events (Albihn et al. 2021), and also changes to precipitation patterns and water availability (see van Vliet et al. 2015; Distefano & Kelly 2017). Future scenarios show how temperature will rise by 2-6 degrees Celsius (SMHI 2021a)

and that heavy precipitation will increase with 20% (Riksdagsförvaltningen 2021). The Swedish Geological Survey's (SGU) measurements have been increasingly showing both higher and lower water levels throughout the past 30 years (SGU 2018). The consequences this will have on the agricultural sector includes a variety of opportunities and challenges, in relation to longer growing seasons, and an increase of extreme weather events (Olesen & Bindi 2002; Wivstad 2010; Wiréhn 2018). The changes could also result in difficulties in growing crops for human and animal consumption, due to increased flooding as well as droughts (Albihn et al. 2021). In Lantbruksbarometern, an interview survey made by Sweden's Farming Association and two of Sweden's larger banks, farmers answered that water availability, and the need for an increased understanding of climate change are among the most pressing concerns (Lantbruksbarometern 2020). In Sweden today farmers are the main decision-makers on their farms (Käyhkö 2019). Therefore, it is crucial to understand how they perceive changes in water availability in order for society to make adaptation measures and policies that will be useful for the larger farming community. Earlier research on policies regarding climate adaptation (Klein et al. 2014; Nightingale 2018; Ensor et al. 2019) shows that policies have a tendency to overlook local situations, and mainly focus on technical solutions. As a result, they tend to fail to include local perspectives, and seeing the bigger context surrounding farming. If failing to include the surrounding context of farming when implementing adaptation measures, the outcome of extreme weather events can be enhanced rather than ameliorated (see O'Brien et al. 2007).

Inspired by the earlier research presented, the following study shifts focus away from the global crisis narratives of climate change. At the same time letting go of the basic assumption that water management should be considered to be a purely technical endeavour. Instead, this thesis recognizes that water management includes complex social and political dimensions that involve multiple stakeholders. The premise is that water management is built on norms and values which is shaped by the human-water relationship. Therefore, I will in this thesis look further into how farmers relate to and handle water at the farm level. This is done by lifting the grounded and experience-based narratives of the farmers. This will result in an improved understanding of how changes to water availability is being addressed, or not addressed by farmers. Furthermore, this thesis can act as an inspiration for decision makers as a way to make sensitive adaptation policies that can be accepted by a larger farming community.

1.1. Aim and Research Questions

In the aftermath of the drought of 2018 with water management and climate adaptation rising on the public policy agenda, this study contributes a bottom-up perspective of the uncertainties farmers face. This will be done by studying the experience of farming with a changing water resource. The aim of the study is to understand what shapes the farmers' room for action in relation to water management.

Three research questions further refine the aim:

- What kind of changes in water availability do the farmers describe, and how do they talk about their experiences in relation to these changes?
- How do farmers make decisions on what kind of adaptation measures they take?
- Based on the farmers' descriptions, how can we understand their ability to adjust to a future with increased water variability?

1.2. Limitation of Study

The study is focused on the geographical area of Örebro County, located in the south-central area of Sweden. In order to get a deeper understanding of a smaller group of individuals the study has focused on five farms with both livestock and crop production. The research interest is limited to understanding the farmer's relationship to one resource, which is water. It is done since it is beyond the research capacity to create an understanding for the entire effects of climate change, due to their unpredictability and range of outcomes. The following thesis does not explore the technical solutions that are being put in place, the intention is not either to specifically address climate change as a phenomenon. This thesis is limited to looking at how farmers relate to and understand changing water availability on their farms.

2. Implementation and Approach

This chapter will give the reader an understanding of the methodological, analytical, and theoretical processes that have shaped this thesis. The chapter begins with a description of the research design, consisting of a qualitative case study carried out with interviews and observations. The chapter then continues in explaining, in a descriptive way, how the case study was carried out. Starting in the selection of participants; continuing in how the visits, observations, and interviews were shaped; ending in a description of the analytical process. Lastly, in this chapter, you will read about the theoretical and conceptual framework, which has been a large part of analyzing the data and writing this paper.

2.1. Methodology

The case study enables us to understand the human perspective and experience. The case study is usually carried out from start until the end by the same researcher/s and in the physical environment of the people that are to be observed (Öhlander 2011). At the heart of all social research, and in extension to the case study, is the possibility to give an expression for larger societal trends. This is done by looking at a specific context and groups of people, and the everyday life and experience of individuals, thus the researcher can capture the norms and values of the studied group (Kaijser 2011). In this case study I will through interviews and an observation get an understanding of how the farmers experience their everyday life and farming practice in relation to water.

The methodological choice of the case study has helped me to reach my aim and, has helped me to capture the epistemological context of the farmers. Epistemology is the theory of knowledge, where the nature of knowledge is explored. Asking the question of what we know, how we know it and what justifies something to be actual knowledge? To explore what constitutes knowledge in my sample of farmers, I have used a phenomenological approach, meaning that the study derives from explaining reality through the experience of the individual (Kaijser & Öhlander 2011).

2.1.1. Selection of Participants

It is seen as positive that the researcher has required plenty of knowledge of the place where the case study is carried out (Bryman 2021). Therefore, I chose a place that I have a previous knowledge of. Since I grew up in Örebro County, in the countryside, I have a deeper knowledge of the history and geography of the place. This is why I chose to gather information from farmers within Örebro County. The number of participants in this study was limited to five which, according to Creswell & Creswell (2018) is an adequate number for a case study. It is important to limit the material with concern to the time and analytical capacity, enabling the researcher to prioritize depth over breadth of scope (Kaijser & Öhlander 2011). As guidance when finding potential subjects, I had three criteria. The first criteria was for the farms to be located within the same climatic zones, in order to see how farms in the same area adapt. The second criteria was for the farms to have both a livestock and a crop production, to be able to make comparisons between the farms. Also, this would not limit material to either livestock or crop production, enabling a collection of variated experiences of water usage that could be representative to a larger farming population. The third criteria was to achieve a variation in age and gender. Approximately 40% of people who work as farmers are female (Rönnqvist 2016; Landshypoteket 2017; Gohde 2018) and the average farmer is in their mid-50s (ATL 2003).

To get in touch with farmers the Federation of Swedish Farmers (from now on LRF) was contacted. LRF is an interest organization for Swedish farmers with about 70 000 members (LRF 2019). I contacted the local group of Örebro County informing them of the purpose of the study and asking if they could put me in contact with farmers in their area relevant for the study. LRF put me in touch with four male farmers. When they were asked if they had female farmers, LRF answered that they had none. Since I wanted a variation of male and female farmers, I followed up another trail given to me by the Örebro County Administrative Board. This was the project manager for a project shortened LEVA (writer's translation from Swedish: Local Engagement for Water). This is a project that works to decrease the impact on the water environment from agriculture (Havs- och vattenmyndigheten 2020). The project manager provided contact information to two female farmers. One of them did not fulfil the first criteria of the study, and the second farmer declined to participate in the study. She instead asked me to speak to her husband. He accepted and is one of the participants. Worth mentioning is that one of the participants is an acquaintance, he was chosen since he fulfils the first criteria and is younger than the average farmer. As I did not reach any female farmers in the area, the selection is therefore homogenous in gender but holds a variety when it comes to age, ranging between 35-60 years old. The lack of variation in gender will presumably impact

how the farmers approach the management of their farm and their worldview. Due to the homogeneity of the group, I make no claims for the research to be representative for the entire Swedish farming population. However, the data collected is still valuable in understanding how the participants of this study make sense of the management of a changing water resource. And in extension enable a larger generalizing discussion on the topic.

For ethical reasons, the participants were informed that their names and farms will be anonymized. The anonymization of the farms was done in a way to easily connect the farmer to the farm name, which can be seen in chapter three, where there also is more of a descriptive introduction of the farmers participating in the study. They were informed asked before being taped during the second interview and the material gathered has been used strictly for this study. The presentations in chapter three have been sent to the farmers for proofreading and the results and analysis have been carefully written to avoid misrepresentation. The ethical considerations were weighed when considering how much information the farmers needed beforehand on the aim and purpose of the study. The farmers were informed that the aim was to study how water is managed at a farm level but was not informed of the analytical tools or process beforehand. This is a way to avoid steering the participants into talking about what they believe the researcher finds interesting (Pripp 2011).

2.1.2. Analytical process

It is important to keep a record of how the process and research have been produced. It is a way to assure dependability to one's research (Bryman 2016). After the farm visit, the first step was to assemble the material into comprehensive and chronological texts, consisting of detailed descriptions of each visit. The second step was to extract themes from the material. In this thesis, the process has been to break down the components of the visit to see what parts were interesting and/or frequently occurring. This first part can be seen as a thematization of the material. In this study I have identified themes to later be explained by concepts. Together the concepts and themes have built a model that I have interpreted to explain the farmers' space for action (see Kaijser 2011; Bryman 2016). The study has been based on interviews and observations and has a phenomenological approach, meaning that the analysis is derived from the experience (Kvale & Brinkman 2009) of the farmers. This is done since individuals develop a subjective meaning of the world from their experiences, to understand the world we start to look at the individuals' experience (ibid.).

It can be described that the researcher creates the material. This does not mean that the researcher is making anything up, but rather organizing the material into comprehensive explanations of ”reality” (Kaijser 2011). One of the most important things is to derive the reasoning from the empirical findings, thus maintaining validity to the research (ibid.). To ensure staying true to the empirical data the researcher needs to keep notes and go through them many times (Öhlander 2011). This has been done by keeping a journal of the process and revisiting it repeatedly, but also by revisiting the empirical data. Since the qualitative analysis is derived from people's lived experiences and thinking, every set of qualitative data should be considered unique (Kvale & Brinkmann 2014). Thus, the results that will follow cannot be generalized into becoming something that can be applied to all agricultural practices but should be seen as examples in explaining the context of water management. By using a theoretical framework and earlier research to look at the empirics as a way to place it within a larger context it can contribute to understanding water management as a whole (see Creswell & Creswell; Bryman 2016:) Knowledge in social science is built on comparison between data, either qualitative or quantitative (Kvale and Brinkmann 2009). Meaning that it is the researcher who chooses what it is they want to compare and describe, and in the end what kind of knowledge is produced. My previous knowledge will provide me with a set of assumptions that will shape the perspective of the study. The analysis is a product of the researcher’s interpretations and should be read with that in mind (Creswell & Creswell 2018; Kaijser & Öhlander 2011; Bryman 2016).

In achieving a detailed description, the results presented in chapter five will be written with frequent descriptions. When the result and analysis are presented side by side (Kaijser & Öhlander 2011), it was done to paint a detailed picture of the farmers’ practice and give the material life. The quotes in the text have been translated from Swedish to English by the author. Excessive words have been deleted to give the information provided by the farmers a respectful presentation, but colloquial language and slang have been kept.

2.1.3. Data Collection: A Farm Visit and a Second Interview

The data collection has consisted of interviews and observations. There have been two constraining factors for the data collected during the study, one being the amount of time and the other Covid-19 restrictions during 2021. This has resulted in limiting the number of visits, partially due to the time limit, but mainly because of the Covid-19 restrictions. Usually, a case study consists of multiple visits and with an aspect of observing everyday practice (Kaijser & Öhlander 2011). This study consists of both observations and interviews, but there has been a larger focus the interview part.

The interviews were held as part of the farm visits. They were unstructured and heavily reliant on a combined observation/unstructured interview. The follow-up interview was a semi-structured interview and partially reliant on research questions that were sourced during the analysis of the farm visit. This will be further explained in the following chapter.

The visits were undertaken during the two weeks of February 2021. The case study's main identifier is that it takes place in the social and physical room where the phenomenon that is to be studied occurs (Kaijser & Öhlander 2011). This is why I chose to physically visit the farms to get an idea of what farmers deem important to talk about and show me. The visits were initiated with an email and/or a telephone conversation, where the farmer was informed of the reason for my visit. The farm visit should be categorized as an unstructured interview since there were no prepared questions. I shared with the participants that I wanted them to show me how they use water at their farm in order to understand where in the agricultural process it is important to have available water. The unstructured interview has no set format and allows the interview to become an open-minded conversation (Kvale & Brinkmann 2009). In the beginning stages of this research, I felt it important to keep an open mind since I did not want to precondition myself into presuming what the farmers would deem relevant to speak about. This resulted in variation in how the visits were conducted, since the farmers themselves set the tone. As a result, my observations became an important aspect of the data collection, and in comparison between the farms. By observing and comparing how the visits were carried out and analysing the stories the farmers conveyed, the intent was to grasp the farmers' knowledge and in extension see if there are any overlapping norms or values amongst the participants. The five visits varied in length from one-and-a-half hours to two hours.

During an interview there needs to be a balance between being actively engaged in the present interview setting and gathering the information needed to achieve the aim of the study (Kaijser 2011). To do this I decided to not tape the visits, but instead, take notes and engage in the conversation and the experience of being guided through the farmers' water usage. When driving from the farm visit, I stopped my car and wrote a detailed summary of the whole visit, based on my memory and the notes taken during the visit. The nature of any qualitative study is on the basis that the result of the research is interpretations of the person carrying out the study (Creswell & Creswell 2018). This means that previous experience and bias are unavoidable during the collection and analysis of data. The choice to not record the interviews was based on two things. One that it was impossible to know what the visit would consist of, in one case we were walking around the farm, in another driving in a car, a third visit was conducted in the stables with the cows,

another was sitting at the dining room table, and one was next to the fodder machines in the pig stables. Even though it would have been possible to record the visits in some of the cases, the second reason for not recording was that I wanted to be consistent in my methodology. In retrospect it could have been beneficial to have recorded the interviews. At the same time, I believe that it would have limited our mobility during the visits and the natural flow of the interaction. This was important for me to adjust to the participant's environment and I valued the experience of the visit as unstructured since it gave a sense of sincerity to the conversations.

When the first analysis was completed different themes had emerged (read more under 2.1.2). In preparation for the interviews the themes were summarised into four questions (see appendix 1). The farmers were contacted via telephone or email and we had a follow-up interview during the two last weeks of April. This was a semi-structured interview where the farmers were introduced to the different themes where they nuanced and/or contradicted the findings from the first analytical process. A semi-structured interview consists of open-ended questions with the possibility to ask follow-up questions to deepen the researchers understanding of the participants answers (Kvale & Brinkman 2009). The interviews lasted between thirty minutes and one hour and were conducted over the telephone since the farmers were in the middle of the spring production. Conducting a telephone interview was surprisingly pleasant, it gave the interview a sense of concentration. There were no other impressions but the words themselves.

Applying observations, unstructured and semi-structured interviews was a mean to achieve greater validity to the results, in order to not rely on a single method. The choice of conducting the data collection in two steps has been an important part of the process since I have continuously known that I will be able to validate or contradict my conclusions with the farmers in the second interview. It has created an innovative and bold space for analysing the material since I have known that the farmers will give feedback on the findings. When following up to get feedback from your sources it is called respondent validation and is a part of securing credibility for one's research (Bryman 2016).

2.1.4. The Participants

Following is a description of the people and farms which are participating in the study. This is written as a way to give the reader context and general information about the location and nature of the farm. You will also read a short description of how the farm visit was conducted. The descriptions are mainly based on the farm visit, but some details were added during the second interview.

The Potato Farm

The farm is located next to the lake Hjälmaren, which I am told is one of Sweden's most human modified lakes. The Potato Farm is in the midst of a generation shift, Peter is taking over the farm from his uncle and his father. The farm has mainly been a vegetable and cereal farm, but Peter is interested in developing a branch of cattle production as well, which he has been doing in recent years. The interview starts out with a walk-and-talk. Peter shows me the well where they source water from the lake for the livestock. We then continue to the cattle end up in the potato storage where we are joined by his uncle Patrick. In there we talked for an hour about regulations on the lake, the future of the farm, and the changes in weather patterns. In total the visit lasted two hours.

The biggest problem at the Potato Farm are the floods. Peter's uncle Patrick calls the last ten years "the wet years". At this farm they have built barriers to protect certain areas against floods. There are also human made canals which are used to drain areas from water. There is a pump at the end of the canal that pumps out water from the fields. The main challenge in relation to water at this farm is saturation, another cause for worry is the proximity to the lake since it is (according to the two farmers) heavily regulated and they worry they will be put under heavier restrictions that will affect their access to the lake.

The Combined Farm

The Combined Farm is combined in a sense that it has both a dairy and pig production in addition to having grain production. The farm is located in proximity to the Kilsbergen Mountains. The farm is run by Carl and his wife with help of three employees. Carl's wife is in charge of the cows and dairy farm while Carl is in charge of the crop production and pig farm. This farm has two locations, their "first" location which is the dairy farm is in proximity to their house. The stables are located on a small hill that has a highly producing well, providing water for the 150 animals. The other location, where the pig production resides, was bought in 2016 and is located not more than three kilometres from the first location. They have approximately 3000 pigs, and Carl tells me that he would say his main production is the combined livestock. Not the 500 ha of crops they grow. The visit starts out with a cup of coffee in their house followed by a long conversation. Afterward I followed Carl to the pig stables, where he showed me the solutions/adaptations being made to cope with the lack of water experienced at the pig farm. In total the visit lasted one and a half hours.

At the pig farm, the water is scarce, and they have had trouble with accessing enough water for the feeding of the pigs. This is the main challenge of the farm, but Carl also told me that they have had lower yields in connection to warmer weather and lower precipitation. This has resulted in lower yields of fodder for the dairy

cows and has also been experienced as problematic, especially during 2018. Carl told me that if possible, he would like to water the grasslands that he uses to feed the cows, but he currently does not see this as possible since there is no available water in proximity to those fields and is of the opinion that they manage without.

The Lake Farm

The Lake Farm is located between two lakes in the northern parts of Örebro County. Lasse runs the farm with his wife, son, and in total three full-time employees. The Lake Farms main production is milk, with approximately 300 cows and young animals. They have diversified with a smaller number of sheep; a dairy where they make their own mozzarella; a catering business where they use some of their own produce; and a farm shop. In total they use 360 ha of land and own a third of it. The visit at the Lake Farm starts with a tour of the irrigation system that was bought after the drought of 2018. Afterward we drive around to look at the dam which has been built to irrigate the grasslands; the fields where he has started to grow potatoes after investing in the irrigation system; and the dam that regulates one of the lakes. Lasse shows me where he grows each type of crop and why he does so in that locations. We end the one-and-a-half-hour visit with a coffee in the break room.

The main challenge for the Lake Farm has been getting water for the crops at the right time, especially for the grass which is used to feed the cows. To achieve a high-quality milk production and sustain the well-being of the cows there is a need for fodder with a high nutrition value. Right now, there are plans and ideas of how to optimize the irrigation system to develop the farms' production and keep up with a changing climate and changing demand.

The Pig Farm

The Pig Farm is run by Per and is located on the Närke plains next to the river Svartån. The river feeds the city of Örebro with drinking water, and the farm is located upstream of Örebro. The main production at this farm is the pigs. Per has approximately 4500 of them at a time. In addition, he farms 275 ha of land, where he grows different grains and also potatoes. Per has a smaller production of potatoes that he exclusively sells at a self-serve farm shop. Our visit is held inside, and Per has printed out maps and pictures of his farm so he can point to the locations he is referring to. The visit is approximately one and a half-hour long.

There are two main challenges regarding water at the Pig Farm. The first is that the fields closest to the river are prone to flooding. To adapt they have built barriers and also the five canals that are equipped with pumps that remove water when needed. He tells me that the pumps have saved the crops on numerous occasions. During dry periods he turns the pumps off to keep the water in his fields. The fields

that are located further from the river and on higher grounds are more drought sensitive than the fields closer to the river. This is not perceived to be a large problem at this time. The second challenge is water usage in the pig production Per shows me a balance sheet of water usage that he uses to map out actual usage in the pig production. The biggest problem for his farm would be if he needs to increase the water usage form his own wells to provide fodder for the livestock, right now he uses residue from the food production industry that is mixed in with the fodder, thus keeping down the water usage from his wells.

The Milk Farm

The Milk Farm is located on the Närke plains, the area surrounding the farm is wide stretched and flat. The Milk farm has been run by Morgan the last couple of years, after he took over the farm from his father. The main production at the farm is the dairy production and taking care of the approximately 200 cows and young animals. In addition, Morgan has a cereal and grass production to sustain the livestock with fodder. The visit starts out with a tour of the farm, we visit the water pump, the stables and then the discussion moves on to the crop production. The visits last for one-and-a-half hours.

The biggest problem in connection to water was faced during the summer of 2018. The widespread drought resulted in a grass shortage and Morgan told me he had to drive far in his tractor to get fodder and silage for the animals. I am told that the animals were stunted in growth, due to lack of fodder and it took about two years for them to catch up in production. The Milk Farm is the place which has experienced the least number of problems in connection to water availability, and at this moment there are no plans to make any adaptations in that area. Even though Morgan expresses the wish to irrigate some of his grasslands in order to secure fodder and not be as sensitive to the less reliable weather patterns he has been experiencing during the years.

2.2. Theoretical and Conceptual Framework

The case study is partially distinguished by the choice of study subject but also by the choice of theory (Kaijser 2011). Using a section of the thesis to further explain the theoretical and conceptual framework will help clarifying how the empirical data has been approached, both during the collection and the analysis. “All empirical evidence is theory-impregnated” (Kaijser 2011:25), which means the research is inevitably intertwined with theoretical choices. During the process of writing the thesis, there has been a continuous interplay between theory and

method. In practice this means that I have revisited both theory and data repeatedly by constantly mirroring them against each other, as a way to contradict and/or confirm my findings and theory. By drawing on concepts from the book *Political uncertainties* (Scoones & Sterling 2020) this enables an exploration of the epistemological horizons the farmers live and work within, creating their space for action when it comes to water management. The concepts to be used are uncertainty, ontological security, risks, human-nature relations. Following I will outline the four concepts and how they will be applied to the material.

The first concept is uncertainty. Across domains and societies, there are attempts to calculate the future outcomes of events, for example, the event of a changing access to water. For some events, the probabilities of future outcomes are known, but in some cases, they are not. Scoones and Stirling (2020) write about the uncertainties we live with and the risks we can see when dealing with, for example, the outcomes of changing precipitation patterns. How we approach these outcomes is affected by our perception of the future and has effects on our practice of how we explore different possibilities (Scoones & Stirling 2020). But we cannot predict the future since the uncertainty of the future is an unavoidable fact of life. Scoones and Stirling advocate for embracing uncertainty as a way of approaching difficult problems, such as changing water resources. The thesis is inspired by their encouragement to draw on different knowledges to enable an effective response to the uncertainties of life. In this setting it means looking at how uncertainty is experienced based on different aspects such as social, political, ecological, and economic ones in relation to how the farmers approach the event of a changing water resource. Thus, rejecting single solutions and looking at the whole context. The concept of uncertainty will be to enable discussion and analysis of the space in which the farmers act.

To further analyse and understand the farmer's space for action the second concept to be used is *ontological security*. In this paper, I am influenced by Anthony Giddens (1991) idea that we have a practical consciousness that makes up our natural attitude to everyday life. This is our feeling of ontological security, which is an emotional phenomenon rooted in our mind (ibid.). In order to maintain stability in life, we cannot walk around and constantly question the notion of reality (Giddens 1991), thus we rely on our ontological security. If not maintaining this state we would plummet into insecurity and chaos, resulting in the opposite of ontological insecurity. This concept will be used to explain the farmers' relationship to a changing water resource and as a way to analyse their attitude towards uncertainty.

The third concept is *risk*. Scoones and Stirling (2020) define risks as follows: If uncertainty is something unmeasurable that we cannot predict, risk should be seen

as something that humans predict as a measurable outcome of an event (Scoones & Stirling 2020). This explanation shapes risks into something calculable that can be used in order to make adaptations. What Scoones and Stirling wants to do is take into account that there will always be a proportion of uncertainty on when the risk will occur. But there has long been an argument to nuance this definition of risk and involve the surrounding context in order to move beyond simple risks framings including the subjectively shaped perspectives (Wynne 1992). Therefore, to further explain the concept of risk I have been inspired by Ulrich Beck's theory of risk societies. In his theory risks are not simply a matter of fate, but an outcome of decisions, politics, capital and culture (Beck 1992). Risk is something emerging from society as a construction made by humans (ibid.). Not to say hazards are not real but the understanding of them is subjectively made through particular styles of decision making. In this paper I will therefore explore the farmers' approach in two different ways, either as a measurable risk, closely connected to something that can be calculated; or as a contextually shaped risk, closely connected to Ulrich Becks theory of risk society.

The fourth concept is human-nature relations. Scoones and Stirling (2020) argue that human agents do not simply act within an isolated space but in reaction to nature. Inspired by Bruno Latour (2007) I have chosen to apply the concept of human-nature relations as a way to adapt and adjust the idea of non-human actors enabling water to become an actant. Not with its own will per se, but as something that shapes a situation, and in interaction with other entities creates action. This can help clarify and make it possible to discuss in which ways humans and non-humans play a part in structuring the uncertainties of the world (Latour 2007; Scoones & Stirling 2020). Bruno Latour's idea is that there should not be a sharp divide between humans and non-humans in relation to what creates events and relations. Latour claims there being an assemblage of social, ecological and technical entities that make up the world. These entities and events make up the assemblage of reality (ibid.), meaning that everything plays a role in shaping the water epistemology that shapes human action. In this paper, I have simplified Latour's theories by scaling back on the assemblage and purely focusing on making the water into an entity that in relation to other entities result in action, together the human-nature relations takes part in shaping water management at a farm level.

The concepts need no further introduction at this stage of the thesis but will be explained and exemplified alongside the empirical data.

3. Empirical Findings

In the following sections the empirical data will be presented, analyzed and discussed within the conceptual framework. This will be done in frequent descriptions which means that the result, analysis and discussion are done side by side with the intention of making the material come to life. You will read about the experience of working with a changing water resource; the adaptation measures that has been taken; how the farmers source their knowledge; their contextual surroundings, and lastly an illustration of the farmers relationship to nature and water.

3.1. The Experience of Changing Waterflows

Data from the Swedish Meteorological and Hydrological Institute (SMHI) show that the groundwater level in several parts of Sweden are below average in January of 2021 (SMHI 2021b). This is a trend that has been on track for the last 30 years (SGU 2018). The trend in groundwater levels over the last 30 years has been quite erratic showing both higher and lower levels. This is a testament to the fact that water availability for humans in Sweden is changing (ibid.). We can conclude that there are and will continue to be changes in the water availability in Sweden. When embarking on this study my initial instincts were telling me that the experiences of the farmers would confirm the recorded changes and be perceived as a problem. But this is not precisely what was found. The combined experiences of the farmers presented in this chapter illustrate a paradoxical relation between them telling me they have not experienced any trouble with water, and at the same time conveying stories of, what I would identify as, a problematic change in water availability, witnessing that climate change is affecting the farmers' practice. In the following chapter the farmers relationship to water will be illustrated by the empirical findings and then analysed, answering the research question: *What kind of changes in the water availability do the farmers describe, and how do they talk about their experiences?*

A picture which is shared by the farmers is indeed that the weather patterns have become less reliable during the past years. Morgan at the Milk Farm exemplifies

the changes to the weather pattern as water flows becoming irregular during summertime. His earlier experience is that there has been a steady flow of water coming from the ditches surrounding his fields; nowadays the ditches can be completely dry.

Lasse from the Lake Farm explains, to the contrary, how he has been experiencing a more "stable weather pattern" than before. He exemplifies this by referring to the weather we are witnessing in February of 2021. During this time there was a four-week stretch of temperatures below -10 Celsius. Lasse tells me that twenty years ago there was more of a fluctuant pattern in the weather. His experience is that the water flows and rainfall have been unbalanced and there can be very abrupt changes to the weather. He continues to say that four weeks of more than 20+ Celsius without rain during summertime is devastating for his production, and this kind of weather is more recurrent.

The farmers experience illustrate that the weather patterns are becoming erratic and less reliable, and that water flows are shifting. Their experience is one of warmer winters and drier springs; wetter falls; and summers being characterized by heavier and more scattered rainfall. The less reliant weather is not experienced in the same way by all of the farmers but is mentioned as an observation made and something they have to live with. To be human includes having an ontological awareness of one's surroundings (Giddens 1992). This means that the individual does not just accept reality but creates an ontological reference point, in order to make sense of their surroundings. This gives a sense of continuity to everyday life, to avoid constantly questioning one's surroundings. To exist is to create a pregiven idea of what the world consists of, and how it is put together. The farmers are observing a change to the precipitation patterns and to water availability, which could be seen as a part of a process of reshaping their ontological reference point.

The spring and summer of 2018 is a catalyst, helping the farmers to remember what extreme weather conditions can look like at their farms. All of the farmers I talked to experienced drought during the season of 2018. Although the extent of the impact was perceived differently amongst the participants. In general, at the farms, the conditions of 2018 resulted in lower yields of both grains and grass and less water and fodder for the livestock. The farmers with milk production experienced a fodder shortage, which caused stress for both farmer and livestock. Carl from the Combined Farm tells me about that summer. He estimates for the three grass harvests they usually take during a season, the first one providing 75% of the normal yield, the second harvest there was no grass at all, and for the third one he said the harvest was a "colossal" one.

Carl continues to say that grass production is heavily reliant on rain and if it does not come, the grass does not grow. During this time the cows did not produce as much milk, and the younger animals were stunted in growth. His experience is production first came back to normal during the fall of 2020. Carl points out that he did not feel any fear for his business during the summer of 2018, or after. Morgan puts more emphasis on the hard work he had to put in to get enough fodder for his cows, he drove about 30 kilometres by tractor to get the grass needed for his animals. Lasse is even more articulate about how stressed he was during this time, and it is affecting his sleep. He jokes and tells me that if the cows do not eat, then he does not eat.

In relation to the extreme weather events and the effects on water, not all of the farms experienced a large impact during the summer of 2018. The Potato farm had one of their best years when it comes to potatoes but had a lower grain yield than usual. Peter did not linger on this since the potato yield was over expectation and compensated for the other losses made. What has been shown during the interviews are that some of the farms have been more heavily impacted by wetter years. Patrick from the Potato Farm, Peter's uncle, tells me that he would never have thought that his last ten years of farming would be the toughest. At the farm they have had continued trouble with saturation and flooding's. At the Potato Farm they have had two larger floods, one in the winter of 2019 and one in 2012. Peter, the younger of the two, and Patricks nephew, explains that the stream that runs through their fields takes a sharp turn at one point. This area is prone to overflow during heavy rainfall. During the two years he mentioned there was a larger flow of water and the protective barriers built could not handle the excessive amount of water. Peter tells me that the water flooding out on the fields during that last time was about 100 litres/second. To stop the flow of water they had to fill the barrier with gravel. This, he tells me, was an emergency measure. There are similar accounts from the Pig Farm. Per tells me they have experienced flooding for as long as he can remember. In the year 2000 they had one of the worst floods. It was a rainy summer with large amounts of precipitation during a short period of time. They had to use a canoe to access the fields that were submerged under 1,5-meter-high water levels. The flooding is seen as more extreme events, but all the farmers tell of being impacted more often by extreme rainfall, hindering them when they need to till and harvest.

The changes experienced at the farms are regarding an increase in irregularities of precipitation, resulting in both wetter and drier conditions with outcomes they are not used to. One important aspect to keep in mind is that the farmers have not experienced all the irregularities at once. They experience them often one at a time and, then have the chance to recover. For example, the floods at the Potato Farm were experienced during the winter, and then they have had less severe floods and

droughts during summertime. The farms that have experienced the worst droughts are not the ones that are experiencing the worst floods. The examples from the participants show that the effects of the changing hydrological condition are also based on the local geographical conditions, such as topology and soil composition.

At the farm visits, four out of the five farmers looked at me with confusion when telling them I wanted to talk about water access at their farm and how it has changed. I was told they had not experienced any trouble with water. The combined experiences of the farmers presented in this chapter illustrate a paradoxical relation between them telling me they have not experienced any trouble with water, and the stories of what I would identify as problematic in relation to changing water availability. Giddens (1991) divides one's ontological understanding as practical and discursive. The practical understanding being what the farmers rely on when handling the practical outcomes of changes to the water access. When emerging into the topic of understanding how access to water will change over time, we move closer to the discursive understanding of one's surroundings (see Giddens 1991). It is when we start to question our surroundings and understanding of it, that we move towards an ontological insecurity that could result in an insecurity towards the world (see Giddens 1991). During the second interview Per gives me his view of how he relates to changes to the water access, this quote is representative to the experience that the farmers have been telling me about:

> We [farmers] are used to that nature gives and nature takes. You can be the most optimistic person in the world. For example, I have colleague from Dalarna [County]. We were catching up and talking about how far we had come with the spring farming, and I said that I had started planting, whilst in Dalarna there is still snow. And he said, "Well everything points towards a record year", and that is his approach even before getting started. This is what we hope for, and then sometimes we get a different outcome. But we will handle that first when we know. There is no alternative, the only thing we can do is establish that "this is how it turned out" when it is over. (Per 30-04-21)

There is a culture within the agricultural sector that consists of a pregiven assumption that a lack of control is granted (Wynne 1998). In the previous quote it becomes clear that the farmers know of their situation and accept the uncertainty of future outcomes. This approach can be seen as part of their ontological security. To avoid anxiety the individual is reliant on having the ability to give meaning to their life by making sense of their experiences (Giddens 1991). The farmers do not need to make sense of what is happening in a larger context, because they are secure in their ability handling and coping with what is at hand. The farmers are making sense of the witnessed changes to the water access, and the changes to the weather patterns with ease, because this is their way of approaching the uncertainties they face.

Their ontological security includes the notion of not being certain of what the future holds and could be seen as a tool in handling the situations that occur. Like the event of fodder shortage at Morgans Milk Farm. Or as Per at the Pig Farm when he gleefully told me of having to use a canoe to reach the fields during a flooding. He did not focus on losing a part of his yield but highlighted it as a serendipity that resulted in him canoeing in his own field. This is a different approach compared to the expert epistemologies, with the scientific culture of relying on the ability to predict and control one's surroundings (Wynne 1998). This is how I initially entered this study, assuming that the farmers would have a need to control the situation. But what can be shown is the farmers not wanting to identify the witnessed changes to the water availability as problematic, but as something they have to adjust to and live with. Earlier studies (see Wynne 1998; Krätli 2016) have shown showing that confronting uncertainty is not seen as a problem to be overcome by people working with nature, but a way of life.

3.2. Adjusting to Measurable Risks

This chapter concentrates on understanding how the farmers approach adaptation at their farm. When visiting the farms one topic discussed was the adaptations put in place to manage the changing water patterns. There was an array of examples like the farmers investing in new drainage systems, changing the time of harvest and planting, investing in irrigation systems and dams, and building canals and barriers to protect the fields from flooding. By using the concepts of *risk* and *uncertainty* this chapter will begin to answer the question: *what kind of adaptation measures are the farmers taking, and how are their actions motivated?*

The notion of risk can be explained as a calculated danger. When you are able to see with certainty a specific outcome it is easier to find adaptations to lessen the impact (Scoones 2019). The water shortage is a recurring danger at the Combined Farm. This has resulted in knowing there will not be enough water for the fodder. This has in turn resulted in the specific adaptive measurement of installing the plastic tubs. This is one example of many that the farmers have done, but they are explained in the same way. The farmer has seen a recurring danger. After initially trying to make adaptations to the danger and understanding what adaptation is suitable, they make a larger investment to invest in a permanent solution. There are both smaller and larger adaptations that have been made, which can be seen as based on a measurable risk calculated by the farmer. This is in line with Scoones and Stirling (2020) definition of risk as something that is calculated.

At the Combined Farm, Carl fed the pigs during the interview. The feeding is done through a mechanical feeding system. It consists of a large tank that first mixes the dry and wet ingredients together before feeding it through tubes that are spread throughout the stables. Carl points to a computer where he can monitor how much the pigs are being fed, monitor their weight, and also see the status of the mixing tanks. Raising pigs is more of a technical business than raising cows, Carl tells me. For the pigs to gain the right amount of weight the feeding is done at specific times. Thus, they need access to a reliable water resource, to be able to mix the fodder. Ever since they bought the pig farm, they have been experiencing low levels of water in the wells leading to recurring water shortages. They have seven drilled wells and have still not found enough water to sustain the feeding of the pigs. It is explained to be an effect of a recurring seasonal droughts. The problem is that the wells empty during the fodder mixing and sometimes there is not enough water to sustain the entire feeding when it needs to take place. Carl points to a large plastic tub that is standing next to the mixing tank, this is the adaptation measure put in place to adapt to the water shortage. The plastic tubs are meant to be a storage of water that fills up in between the feedings therefore securing access to water.

The farmers approach to adaptation can strengthen the idea that people choose to react to what is perceived as the most pressing matter at hand. In a Swedish study by Olofsson and Öhman (2007) they researched what risks people deem most pressing and what risks they are most likely would react to. The result showed that the risks that directly affect the individual is the one that engages them. Instead of looking at risks as something purely driven by a calculated danger, it can be nuanced by looking at risks as something constructed by human decision and strategy (Beck 1992) adaptation becomes something driven by human priority rather than the risk itself. From the interviews it seems like the investments and adaptations made by the farmers are based on what the farmers themselves experience as a measurable risk. Lupton and Tulloch (2002) conclude in their research on the theory of risk society, that it can be confirmed to the extent that people are highly aware of risk, and they react to risk in a rational way. The awareness of risk and the rational approach to risk can be observed from the farmers' explanations as well. Based on their experience it is logical for them to prioritize the most pressing danger at hand, and to make economical investments that they know will pay off.

At the Lake Farm Lasse has invested in an irrigation system and has built an irrigation dam to provide the pastures with water. In his mind there is no doubt that water will become even more scarce at his farm. The other farmers are not making the same adaptations even though they have had similar experiences. It becomes clear that some events have left a bigger impact on the farmers, and that some

adaptations are not based on a purely calculated risk. When asked about why he thinks the farmers in this study has been prioritizing some adaptations over others, even though they are experiencing trouble with both, Per gives the following insight:

> "Humans are a bit remiss; we do not want to do anything until it is necessary, we are a bit lazy. But if you wait too long, until there is a definite need, well then you have already lost a lot of income" (Per 30-04-21)

This can be seen as one explanation from Per, on why there is not a larger interest for investing in an irrigation system among the farmers I have talked to. Even though all of them carry witness to an increase in periods of drought, they are not experiencing the urgent need for that type adaptation. Important to relay is that the farmers who have been mostly impacted by too much water are focusing their adaptations to handle those events. The farmers who have had most pressing matters in relation to too little water, are making adaptations to handle those events. It could be argued that this is based on economic considerations, but it seems to be more to it. Because when asked if they would make adaptations if they had unlimited economic resources, the farmers are still reluctant to say they have a need to adapt.

The study by Olofsson & Öhman (2007) showed it is more difficult to associate with impending global risks and dangers. If we relate the adaptations being made at a farm level with the impending global risk of climate change, the farmers are not preparing for a possible uncertain future, but they are adapting to a known present. Similar results can be shown in Lupton and Tullochs (2002) research as well, where their respondents rather focus on local risks than global ones. An important aspect to bring in the concluding parts of this chapter is that lay knowledges of risks are highly contextual (Lupton & Tulloch 2002; Olofsson & Öhman 2007). It is also important to point out that age and sex makes up a part in the construction and meanings of risks (Lupton & Tulloch 2002), which leads to address that the participants in this study are all male within the age span of 30-60 years old.

In an article Possamai-Inesedy (2002:30) argues "that living in what Beck would term a 'risk society' does indeed threaten one's 'ontological security". This would imply that if the farmers would have to reassess their notion of reality and what the uncertain future can hold it could threaten their ontological security. With the fear of increasing their ontological insecurity it is easier to make the adaptations that are safe within the calculated realm of the present. Because otherwise it could mean they have to readdress their notion of reality by including the uncertainties of the future. Who people are and what values they apply to the world, fundamentally

affects how risks and uncertainties are being experienced (Scoones 2019). There has long been an argument among constructivist theorists to move beyond the simple framings of risk to embrace the more subjective perspectives of uncertainty (ibid.). Scoones and Stirling (2020) argue that it is not possible to calculate the outcome of a hazard since all systems are complex and non-linear, thus rationality should be seen as a condition of knowledge, of how we frame and see possible futures in order to adapt to them.

In conclusion the adaptive measures taken by the farmers are based on what the farmers deem as a calculated danger, or a measurable risk. Pointing out that the measurable risks are actual dangers that surely needs to be addressed. At the same time as the farmers adapt to what is the most problematic at their farm, it unintentionally leads to that the adaptations which could help address future dangers are, for now, being left for later.

3.3. Contextual Factors Shaping Farmers' Understandings of Water

In the earlier chapters there has been an exploration of how the farmers experience changes to the weather, what effects hydrological changes have on their farms and how they have adapted to these through the ideas of risk and uncertainty. The experience of uncertainty and risk is affected by different aspects of the surrounding social, political, ecological and economic context (Scoones and Stirling 2020). How the farmers approach the event of a changing water resource therefore has to be studied not just through the framing of risk but by looking at the whole context (ibid.). We will use the ideas of Beck (1992) and Giddens (1991) to understand the contextual nature of water management, deriving from the ideas that our perception of a situation is not created in a vacuum. We will now explore how the farmers source their knowledge and what contexts they have brought up as being a part of. In order to build a deeper understanding for *how farmers make their decisions on adaptation?*

3.3.1. Producing knowledge for adaptation

As shown in the earlier chapter the adaptation measures taken are varied in extent and size. What they have in common is being practical solutions put into place to take care of physical outcomes, based on experienced2 changes to the water resource. Since individuals develop the meaning of the world through their experiences which helps to constructs one's knowledge of the world (Kvale &

Brinkman 2009), this chapter will look closer into how the farmers source their knowledge.

When making adaptations at farm level the participants continuously imply, they based their adaptations on previously held knowledge, and took inspiration from colleagues and/or consultants from both private and public sector. At the Potato Farm Peter chuckles when I ask him how he knew how to handle the flooding they experienced during Christmas of 2019. Peter tells me the water flooding the fields made them cancel their Christmas plans to address the problem. They filled up the holes in the barriers with gravel and have not made any other efforts to fix it since. He continues to talk about ditches and drainage and the continuous up-keep of them. I ask him again how he gains knowledge on how to maintain them, again, he chuckles and tells me they have been building ditches and drainage systems for a very long time (referring to his father and grandfather before him), and he just knows how to do it.

Both Cassidy et al. (2019) and Wójcik et al. (2019) find that information passed on between generations is an important factor for local knowledge. The other farmers from this study imply similar things, that passing on information between colleagues and having local-know-how is important in their work to find solutions for adaptation. Per talks about his knowledge of how the fields respond differently during shifts in water aavailability. For example, the fields closer to the neighboring river are less impacted by drought and more impacted by floods. While the fields located further from the river are affected differently during changes to the water availability. At the same time Per knows where there are patches in the well irrigated fields which are more prone to drought. This has been an increasing problem the past years. There is a specific local geographical knowledge that the farmers rely on, where one part is knowing their soil composition. Scoones (2019:16) claims that local know-how is crucial in managing the mess of the real world and should be seen as something deriving from interactions with other people and the wider society. Which is something the farmers point out in the interviews as well. For example, when generating new ideas for adaptation the farmers talk mainly of one thing, interaction with other farmers.

> The ideas for something you often get from talking to colleagues or when reading a reportage from another colleague in a newspaper, when they have invented something good. It is also about going to visit other farmers, and that is the most fun thing you can do. When visiting you can look at what has been done right and most of the people you visit are also good at saying what they did wrong, even though not everyone does it. Then you do not need to invent the wheel all over again (Lasse 30-04-21)

In this quote Lasse discusses how his adaptations are inspired by reading newspapers and in interaction with other farmers. From this example adaptation is is something that starts with interaction between people and emerges as something social. Thus, the farmers experiences can be seen as shaped by social interactions and the surrounding society. A key feature in adaptation is to learn and experiment together with other people in non-crisis times (Roe and Schulman 2008). Their ontological security emerges as consisting of them relying on their competence and others when it comes to adapting and finding solutions. In ontological frameworks, tradition and cultural surroundings play a part in building the perception of ontological security (Giddens 1992). The farmers knowledge of their surroundings is culturally and socially created by social interaction and experience. Thus, adding a culturally and socially shaped aspect to their ontological security, and in extension their water epistemology.

Even though farmers confide they source inspiration from social interaction, some solutions are more sensitive in their implementation, and due to local conditions, such as compass point or soil composition the farmers need to complement the information sourced from interaction. When having sourced the idea and proceeding to implementation Lasse tells me that "You lean on your own and others experience a lot, that is the most important. But the last ten years there is a lot of googling, you can find anything on Google." (Lasse 30-04-21). Morgan chimes in and tells me that he is not much for reading books, but the internet is a great help. He uses Youtube and social media when finding smart solutions to the problems he faces. Per is different from Morgan and enjoys finding to find information in technical papers, after sourcing his ideas from social interaction whilst Patrick tells me that he enjoys attending seminars and workshops.

In a case study by Neset et al (2019) they conclude that agricultural adaptation depends on farmers' decision-making, and if farmers perceive a potential adaptation to result in a negative outcome they will refrain from implementation. Thus, it is of importance to understand what information they build their knowledge on. In this study the farmers conclude how they are in need of an increased understanding of climate change effect on hydrological patterns, but they do not know where to gather the information from. A few of the farmers bring up lacking technical expertise on how to adapt to changes to the water resource. They also express it to be difficult to access expert knowledge.

> The state used to have it [knowledge on hydrology], or it was Örebro County Board, they used to have people that were experts on water. Engineers and technical expertise, but now they do

> not have that anymore. It is only environmental people[1] that do not hold any substantial knowledge of water consumption and the handling of water, that knowledge is restricted [...] 20 years ago they stopped providing that knowledge [to the farmers]. Even the Swedish Board of Agriculture does not have that [water] competence anymore, or they have started to rethink this and realize that they need some technical expertise as well, not only people who are focused on the environment (Per 30-04-21).

The picture Per paints of the technical expertise disappearing from governmental institutions and the farmers not really knowing how to access the right kind of knowledge is a view shared by the farmers of this study. Per tells me his experience is that the County Board is concentrated on the environment and how farms can mitigate their effects on the climate, less on how they can adapt to the changes. Carl from the Combined Farm wishes he knew where in his area there is available water. Right now, he is expensing drilling for wells and hoping there will be enough water when done. He expresses the wish to get help in mapping out where there is water in the area, and his wishes for the County Board being a part of that process.

In the aftermath of the drought of 2018 there has been a government-driven initiative to strategize and structure the water usage and management in Sweden's different industries (Regeringskansliet 2020). From this different government institutions have been issuing reports and strategies coordinating water usage as a way to adapt to the effects of climate change. One of these reports comes from the Swedish Board of Agriculture (SBoA) with a strategy for how the agricultural sector should work to manage a changing water resource (Jordbruksverket 2020).

> We need scientists, with knowledge of the natural conditions, agronomists with knowledge on the farming conditions and engineers with knowledge on building drainage systems and construction of wetlands. We need lawyers and social scientists to develop rules and regulations. As an effort to work in a broader sense, we need more knowledge on how the rest of society handles water. [...] The farmers need knowledge to handle water in a sustainable way. (Jordbruksverket 2020:21–22)

In this quote you can read an official interpretation of who holds the relevant knowledge, and who does not. It is the scientists, agronomists, lawyers and engineers that hold the relevant knowledge for development. And the farmers need more knowledge. With this said, SBoA emphasizes that the farmers are key actors who should be included. They are also credited with holding their own specific knowledge, but mainly represented as a group that needs to be provided more knowledge on how to handle the changes to the water resource. Several knowledge gaps have been identified in the farming community when it comes to the accelerated changes to weather patterns (Wiréhn 2018). The participants in this

[1] I have interpreted “Environmental people” as people working on biodiversity or pollution control within either public or private sector.

study continuously claim that they want more knowledge on what changes in water access is to be expected, and what kind of solutions they should be investing in.

What is noticeable in the strategy report from SBoA is the emphasis of a need for an increased knowledge exchange between institutions, not between them and the farmers. Ulrich Beck (1992) presents the idea that when inducing the solutions for perceived risks there is a pivoting towards expert knowledge. The experts then become crucial in developing the *right* knowledge for what needs to be done. The expert versus lay epistemologies is often valued differently (Beck 1992). This seems to be the case with SBoA, they relay the idea that it is the experts that hold the current and valid knowledge of how to adapt to the changes to water access. Even though the farmers relay that they find information from more informal channels (as shown earlier in this chapter) they also say that it is the experts that hold current and updated knowledge on how to adapt to changes to water availability. In earlier studies (Nightingale 2018; Neset et al. 2019) there was been an increasing focus on pointing out how local knowledge and know-how needs to be taken into consideration when planning adaptation measures, in order for them to be carried out and embraced by the local communities. With regard to the context in Sweden it is important to keep in mind that farmers are the main decision makers at their farm.

This chapter has shown how farmers source their knowledge from earlier experiences and social interaction with other farmers. When they have decided on what adaptation they will make, they find technical information online, from magazines and/or taking part in seminars and workshops. As shown in this chapter, there is a wish from the farmers to increase the knowledge exchange between government institutions and agriculture. There is a wish from the farmers to collect newer, more specific knowledge on what hydrological changes they can expect, and what technical solutions are sensible to invest in when looking towards the future. The analysis has also shown how farmers and institutions both value expert knowledge highly. Interpreting what the farmers I have talked to tell me there seems to be a gap in the strategizing of agricultural institutions. Consisting in how to reach out with more technical and “up-to-date” knowledge which the institutions could provide to the farmers. As shown in this chapter the farmers source their knowledge by social interaction and the institutions do not strategize to reach out to the farmers in a way that is targeted at the farming population. In earlier studies (Wiréhn 2018; Käyhkö 2019; Neset et al. 2019) and reports (Riksdagsförvaltningen 2021; Lantbruksbaromentern 2020) farmers convey a need for more information on how to be able to adapt to an unpredictable future.

3.3.2. The Social and Economic Context

Uncertainties generated from climate change become increasingly harder to project when combined with economic and socio-political changes (Barros et al. 2012). Vulnerability is not only caused by outcomes of extreme weather, but need to be situated within the social context that the farmers are embedded in (see O'Brien et al. 2007; Scoones 2019). Therefore, the following section will present the different socio-economic and political aspects the farmers have brought up in relation to their business. The three major themes have been consumer trends, financing and regulations.

One aspect the farmers bring up is consumer trends and trends of the surrounding society. These discussions in three of the visits started with the farmers making an effort to point out to me the difference between water usages as an active or passive action. The active action is when sourcing water from a drilled well, and the passive action taking advantage of rainfall. In Sweden the agricultural sector makes up 3% of the total water usage (Jordbruksverket 2018). Of the total cultivation area in Sweden 3,5 % is irrigated, the rest is rain fed (ibid.).

The farmers experience there has been an increase in reports on the agricultural production's impact on the environment and climate. These include calculations of water usage. The calculations emerging from what the farmers name as a lobby industry are perceived as an unfair portrayal of agriculture. They do not consider using water passively, that is taking advantage of precipitation and natural water flows, should be included when calculating the impact of agriculture. The farmers continue to portray the idea that agricultural production is under attack by an unspecified lobby industry and media. They do not want to be the bad guys, but believe they are being portrayed as such. For example, Per has made a water balance sheet with the intention of "showing the truth behind" his water usage. This is a calculation of how much water is used in his pig production. When I ask him to explain who "they" are he tells me that it is the lobby industry advocating for people to eat less meat.

> The only trend you hear of is that holding animals is not a good thing. That is why I made this calculation, because you forget the other stuff [the benefits of holding livestock, as contributing to biodiversity]. (Per 30-04-21)

This view, of there not being enough nuance in the debate of holding livestock, is a view Morgan shares with Per. He also considers the agricultural practice being wrongfully portrayed as having too much of an impact on its surrounding environment and using too much water. The consumer is the one to set agricultural trends according to the farmers, and they feel the need to adapt to the demand. As

an example, three out of the five farms have a farm shop where the customers can buy produce directly from the farm. The farmers tell me they have noticed an increase in customers wanting to buy local produce and believe this will continue.

Some of the farmers also predict an increased demand for ”climate friendly” produced food. This is echoed in a report from The Swedish Consumer Agency. During recent years there has been an increased market for climate awareness amongst consumers (*Rapport 2020:2*). The meaning of this is to illustrate how the farmers are part of the society which they live within, and they do want to make adaptations that can be economically beneficial. This can be seen as the farmers being sensitive to social trends and adjusting to the demand of society. The relation to one’s surroundings reflects on the surrounding community (Giddens 1991). All humans monitor their surroundings and can give if asked, discursive interpretations of the reason for their actions based on their surroundings (ibid.). This is what the farmers are doing when speaking of society and customer trends, which is observing their surroundings and giving reason for what adaptations they deem fit based on the society they are embedded within. This example gives nuance to what kind of uncertainties the farmers are basing their adaptations on. Scoones and Stirling (2002) encourages to include a plurality of factors, when looking at what uncertainties we face. The farmers experience a need to adjust and adapt to consumer trends set by the surrounding community, mainly identified as consumer preferences, and as part of the plurality of uncertainties that shape farmer spaces for action.

When making adaptations to handle changing hydrological patterns there is a need for an economic investment. The farmers speak of taking loans from the bank and how the adaptations are financed through their company, by a loan or through a local a cooperative. When speaking to Peter at the Potato Farm about what is stopping him from building some sort of irrigation system, it is partially interest rates/payments, but as we speak more it becomes clear that it is also due to logistics and specifically money. Peter tells me he dreams of having an irrigation dam further away from the lake that could sustain a larger potato production. For now, it is too expensive to invest in such a large system.

In the conversations with the farmers, we land in the issue of subsidies from the state. Subsidies is generally not seen as a positive thing by the farmers, instead of having subsidies the farmers speak of wanting the produce they sell to be priced in a way that reflects the amount of effort and value that the product holds. Meaning the farmers think produce is priced too low but if it is priced right, they believe the market could solve the financial issues that are now restricting the investments they would like to do, the farmers are therefore showing a market economy logic. The

findings in a Spanish study point to subsidies based on irrigation policies tending to benefit large-scale and market-driven agriculture (Albizua et al. 2019) leaving small-scale and diverse farms more vulnerable to climate driven stressors of water availability due to the shaping of the subsidies (ibid.). This is lifted as an example of how subsidies are not always shaped in a way to benefit those who are most vulnerable. As it is now, the farmers of this study cannot make the investments needed to adapt to changing water availability partly due to economic shortcomings restrictions, but also the absence of investments are due to the farmers not being that worried about changing water patterns. At the same time, they do not believe subsidies is the solutions and believe the market solutions to be most beneficial. The more the farmers in this study speak of subsidies and financial aspects, there is another viewpoint that is lifted, that in crisis the state should provide a security for the agricultural sector:

> Like places in Gotland and Öland [known to have reoccurring droughts], those places will have to stop producing if it won't become economically sustainable. And in those cases, the father state will have to come in and pay. It is the people who are affected who should be paid, for dams and stuff. (Morgan 28-04-21)

The farmers illustrate a contradictory picture of wanting market solutions but at the same time showing the need for state interventions in the form of subsidies. Lasse explains it as such:

> It is not the subsidies we long for, it is the consumer realizing the products value. We are a gathering of business owners. But we are far from getting there, and I can tell you that I do not think we will get there either. (Lasse 30-04-21)

Lasse's input deepens the understanding of the difficulty to navigate trends and investments airing a skepticism towards the market being the sole solution to agricultural development. The farmers convey a shared picture of the surrounding society, which gives insight to what their ontological security is shaped by. Sketching the farmer into not a victim but a market reliant person sensitive to societal changes and trends. The farmers have to, (sometimes unwillingly) adapt to what they perhaps not deem as the right development. This is similar to the issues of adapting to rules and regulations.

Peter and his uncle Patrick talk about restrictions on the lake that adjourns their farm. They fear an increase in restrictions since this could result in them not being able to source water for their livestock directly from the lake. This is something Patrick is particularly worried about. He says that if there are more restrictions, he will consider quitting farming. The uneasiness of not being in control of what regulations will be put in place to affect their farms is something Lasse talks about as well. He brings up new regulations on dams, which could force him to take out the dam he uses to regulate the lake, and also enabling him to control the water

flow. These are also examples of the farmers being part of, and sensitive to societal change and in this case, regulations.

In conclusion this section shows how the farmers are situated within a societal context. Their adaptations, plans, and actions are based on their perception of a need. This is not only based on the actual weather and water access but on societal changes, norms, and consumer habits which also shapes their room for action. Managing mess and navigating the complexity of the world includes an ability to reflect upon and handle structural and local conditions (Scoones & Stirling 2020). The farmers in this study are showing a practical space for action and are continuously tracking the wider context and the micro-operation of their day-to-day business. This illustrates the mosaic that builds the farmers' understanding of the world, which makes up their water epistemology.

3.4. The view of Water and Nature

As shown in earlier sections of the thesis, solutions for adaptation are being put in place based on locally held knowledge, and primarily as a reaction to observations made by the farmers, but also as a result of the context that the farmers are embedded within, such as farm economics and trends. Scoones and Stirling (2020) claim the efforts of understanding uncertainty and risk should also include how humans interact with their surroundings. Therefore, the following chapter will explore changes to the water availability and how farmers react to it through the perspective of human-nature relations.

> All settlements on the countryside, well at least here in Bergslagen, can be tracked to it [water], there is no settlements that are not in proximity to water, all human establishment is based on the ability to tame the water and source its power. (Lasse 30-04-21)

What Lasse implies here is that human activity is enabled by the presence of water. The farmers in this case study often imply their actions are a result of what rules nature made for them. The adaptation measures carried out are based on the very local conditions of the farm such as the availability of an open source of water, as in the case of the Lake Farm, enabling an irrigation system. Another example is the ground water availability, as the example at the Combined Farm, where the lack of ground water has resulted in building water tanks. The actions can be seen as dictated of the absence or abundance of water, and in extension tracing the outlines of human-nature relations. Referring to Latour's (2007) idea that no one entity exists in a vacuum, when one entity acts the other reacts.

Referring back to the quote by Lasse, but this time concentrating on the last part, he implies humans can tame water and source its power. In addition to the notion of having to play along with the rules of nature, the farmers also show a belief of being able to control water and nature. In some sense molding it into agricultural benefits they can reap. These are interesting contradictions, having to play by the rules of water and nature, but at the same time being able to control and tame it. The farmers' ontological security can be seen to include the idea of having an ability to control their surroundings, but at the same time they hold a humility to knowing that they are playing by another entities rules. This implies them being in a shifting relationship with water where, sometimes water dictates the rules, and sometimes the farmers are able to shape the waters and source its power. The last part of the quote can be looked at as an illustration of Lasses view of what the purpose of water is.

The farmers tell me about how they work with water and at the same time they convey a shifting view depending on the situation. Leading to the argument of Hillevi Helmdrid (2007), where she claims that one's view of nature, inflicts on how we handle nature. She continues to list views of nature pointing to one idea that nature is wild, and the human's mission is to tame and process nature into something useful, giving nature the role of on object. Another view being that nature as something fragile, complex and finite, giving nature the role of a subject (Helmfrid et al. 2007). What is important to highlight is how the different views of nature are not separate from one another they can be visible in different context and depending on what topic is discussed (ibid.). These two views of water as a subject and an object are present in the farmers' descriptions.

Another interesting aspect is the different values the farmers place on different types of water. For instance, when water comes in the shape of rain, the farmers see the water as free for all. When it comes from a lake, they need to be sensitive to the usage, in order to not strain the lakes capacity. When it is sourced from ground water depots, it is important to the farmers to not strain the usage, and this seems to be the most valuable source of water. I shall exemplify with the following in quote by Morgan:

> If I had the possibility to irrigate, then I would have started to look into it. But there is no idea, because there is not any water that I can take from. I do not live in a good place if you want a lot of water. (Morgan 28-04-21)

Morgan tells me during the second interview, that it is not possible for him to irrigate even though he would see it beneficial for his production. The reason for this is there not being an available open water, like a lake or river. In the quote we can also see that he does not believe there to be an abundance of water in the area.

Simultaneously he claims having enough water to manage his production, since he has such a great ground water resource. When I ask him why he does not use this for irrigation, he tells me that it would be irresponsible. This is something that is upheld by the other farmers as well. The idea of using ground water for irrigation is not in their vocabulary. There are many examples of this not being a sustainable way, but the example is lifted since it illustrated that there are different values put on different bodies of water. Thus, the idea of human-nature relations suggests that the power to shape ones surroundings does not solely reside in human intention, it rather emerges from the relationship between human and non-human actors (see Arora & Glover 2017).

As a society we have long separated humans from nature, placing ourselves outside or above the natural conditions and premises that put limits to what is possible to do (Blok & Jensen 2019). With the ongoing ecological changes there is an urge to understand exactly how humans intertwine with the surroundings. This section was a tidbit of showing how the farmers are intertwined with water and nature. With the intention of illustrating that there are more factors than society and weather events that affect how farmers react and act in order to make sense of their world.

There are two parts in this section that is to be carried on. The first being that the farmers to some extent react and act in relation to the water and nature. The second is that the farmers also hold different views of what nature and water consists of and that different bodies of water seems to hold different values. This results in having a split view of water. One view of ascribing water the role of a subject that to some extent controls and shapes the situation, and in another view the farmers describe the water as an object, which the farmers can tame and control. Undeniably the relationship and view of nature and water that is held by the farmers in this study is not explored to its fullest extent. There are plenty of gaps in the story, but this section was written with the intention to illustrate that water and nature do have an important part as an actant in water management.

4. Concluding Discussion: Moving Beyond Simple Framings

Scoones and Stirling (2020) aim to give a plurality to the many factors of uncertainties that underpin the outcomes of climate change. Their writing inspired me to explore the plurality of uncertainties farmers face in relation to water management in a time of climate change. The following chapter contains a discussion aiming to answer my third research question and will end with a discussion that places water management at a farm level, within a larger context. All of this is done to increase the understanding for water management at the farm level.

4.1. The Farmers' Spaces for Action

In this thesis the farmers have shared their experiences of changes to water availability. They describe how precipitation patterns are becoming irregular when compared to before. The farmers also describe how they have experienced both droughts and floods in off seasons. Important to point out is how these events do not occur all at once but are spread throughout the seasons. The farmers do not frame the changes in water availability as a problem though. In the analysis this is explained by their ontological security, which is shaped by a pre-given assumption of the farmers feeling secure in living with uncertainties. This means that the farmers are used to living with the rules which nature puts in place for them, therefore they handle the shifts in water availability with ease.

The adaptation measures the farmers have been taking vary in size and extent, ranging from building canals to changing time for planting and tilling. The adaptations are often based on calculable risks. Meaning, when the farmers know the danger, they can make the adaptations which they know are suitable. The notion of risk within this selection of farmers is closely connected to what they have observed and experienced. This results in the farmers leaving adaptation measures that could prevent future hazards for later. At the same time there are no secure predictions of future precipitation patterns at this time or how water availability will change over time (IPCC 2019). This makes it difficult for the farmers to know what

kind of adaptations that would be a safe investment for their farm. The thesis identifies demand for an increased knowledge exchange between farmers, universities and state departments in developing a future best practice in adapting to changing water availability at a farm level.

In this thesis the farmers' spaces for action can be further nuanced by the human-nature relations between the farmers and water/nature. The analysis has shown how there is an oscillation between the farmers giving water the role of an object, but at other times giving it the role of a subject. The result is that sometimes water dictates the actions of the farmer as a subject, and at other times the farmers view themselves as being in control and handling the water as an object. Thus, the human-nature relationship becomes an important factor in shaping the farmers' spaces for action when it comes to adaptation measures. What I mean is that when water is described as a subject, the farmers sometimes simply accept the outcome of for example a flooding. But when looking at water as an object, it becomes something that the farmers can tame and control and make adaptations to handle. Therefore, the human-nature relationship becomes an important component in shaping the farmers space for action when it comes to water management, and in extension adaptation to climate change.

This thesis has been supported by Giddens (1992) concept of ontological security. Within this concept lies the idea that an exaggeration of risk could lead to ontological insecurity, meaning that if farmers would start to question their pre-given idea of the world, they would become insecure in how to handle their everyday practice. Possamai-Inesedy (2002) writes that farmers today are becoming increasingly ontologically insecure due to threats to their livelihoods. This is not what I found in this study, the farmers are not exaggerating the threats climate change poses for their livelihoods, but rather balancing uncertainty with the practical reality they face. The farmers put more emphasis on how the surrounding community is developing, and by how they believe market/consumer trends will develop.

The farmers in this manner derive inspiration, and an understanding of the world, from social interactions. This is more in line with Beck's (1992) idea of risk society. This is the idea that it is humans who build risk; thus, risks are based on human values and, ideas and their surrounding community. When adaptation is viewed through the concept of risk societies, there is a need to look at the farmers surrounding community and their understanding of it to understand their water epistemology. Risk societies create potential vulnerability for issues that lie outside of the farmers' water epistemology. This could make farmers vulnerable to seeing issues that lie beyond their community. For example, it could make them vulnerable

in understanding the full complexity of how climate change will affect water availability at a farm level.

The analysis has shown that the farmers' spaces for action emerge as a mosaic of complexity. Relating back to Scoones and Stirling (2020) there is a plurality of uncertainties that frame the outcomes of climate change. Meaning that there is a plurality of uncertainty framing water management at a farm level. This study has shown that the farmers' spaces for action consist of a plurality of factors including social, political, economic, epistemological and ontological framings of water and the context the farmers are within.

4.2. Moving Beyond Simple Framings of Water Management

The thesis should be seen as an outlining of the plural epistemologies that water management at the farm level consists of. The outlining helps to bring into light that water management is more than simple framings of risk, technical innovation or policy development (see Arora & Glover 2017). This conclusion calls for what Nightingale (2016) argues for, that there is a need for climate change research to explore the phenomenon of climate change from different methodological approaches. I agree with her regarding the need for expanding research. In addition to this there is also a need for expanding the structural planning regarding sustainable agriculture to include plural epistemologies (see Healy 2003), basically this means using an array of perspectives when creating policy frameworks on different structural levels. To do so there needs to be a bridging between research, practice and politics. Right now there is a gap between research and action, where it seems like the climate change researchers have failed to relay their findings to practitioners and policy-makers (Klein & Juhola 2014).

The farmers from my study are relaying two messages, one is that they can make the right decisions for their own farms, and the other is that they need more information on climate change and water scarcity to be able to make long-term, secure decisions. Thus, the problem that Klein and Juhola (2014) present of there being a need of bridging between research, policymakers and practice is also repeated by the farmers of this study. The analysis of this thesis has shown that the farmers are asking for a broader understanding of how climate change affects their access to water. There is no lack of adaptation-knowledge being produced, but there is a bottleneck of not transforming this information into practice (Klein & Juhola 2014). What I hope to contribute with is an insight that farmers are making adaptations but are currently in need of more information as they rebuild their water

epistemology. The farmers are asking for knowledge that is place sensitive. This includes a more adaptable governance which encompasses rules and regulations as well.

In order to reach farmers, it is crucial to understand how they currently retrieve information. In this study farmers have informed how they build knowledge from their context, social interaction, the internet and locally-held-knowledge. When developing research, it is important to be sensitive to this, in order to reach the practitioners that could mostly benefit from knowledge on adaptation. Important to keep in mind, is that the knowledge held by the farmers are key when implementing adaptation on a local level (see Eriksen & Lind 2008; Ribot 2014). Therefore, it is of importance to include practitioners as early as possible when planning for adaptation and policies.

Even though the farmers of this study have generously shared their thoughts, ideas and experience of farming with a changing water resource, this study is just touching the surface of the uncertainties farmers face, and what their water epistemologies consist of. The farmers of this study are a small selection of a much larger farming community, therefore there is a need for more studies on farmers' relationships to water and adaptation in order to create a larger understanding for the phenomenon of climate adaptation in the agricultural sector. An interesting angle for further research would be to link practitioners and farmers, to administrative units from municipalities, regions and all the way up to a national level. This is a way to move beyond simple framings of risks and create a water management within agriculture that will be sustainable in an uncertain future affected by climate change.

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Appendix 1

These are the questions from the telephone interview. They have been translated from Swedish.

Introduction:

This interview will be conducted as follows. I have analyzed the material from my farm visit and seen some overarching themes which I have written more about. I will tell you about some of my conclusions and then ask questions in relation to these. The point is for you to reflect on the conclusions and by this help me to contradict my findings or nuance them.

Question one:
The farmers have shown me different adaptational measures. Tell them of examples that they can relate to at their farm. When asking them on how they have sourced information and inspiration on what adaptation measures they should take I have gotten the impression that it is mainly based on talking to other farmers and "people you know". Then you make you adaptations based on that kind of knowledge, often knowledge you already have.

Do you recognize this? Can you fill in some gaps or tell me on how you come up with solutions in relation to water management at your farm?

Question two:
How do you believe the water access will change at your farm in the future?

Helping questions

- What type of adaptations do you think will have to be put in place to be able to continue with agricultural production?
- Imagine you had five years of wet weather what would happen?
- Imagine if you had five years like 2018 in a row, what would happen?

Question three:

One of my conclusions is in contrast to risk and the notion of what is a problem. If I look at myself I went into this study believing the farmers I talked to would feel that the changes in water availability would be a clearly defined problem. But what was found is that the farmers I have talked to have a notion of not being able to predict future happenings and facing this with ease. Do you recognize yourself in the picture that farmers are used to handling unpredictable outcomes and events and used to adapting to them?