ADOPTING CLIMATE SMART AGRICULTURE: A PRACTICE THEORY PERSPECTIVE

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Preface

This thesis concludes my study period for the master of Spatial Planning at Radboud University. Due to being trained as a landscape engineer earlier in my career, this study is an additional study I have chosen to undertake. I had noticed that, while I was trained to work out solutions as an engineer, I did not always understand how and why decisions were made to implement certain solutions. Therefore, I decided to study further as a spatial planner. This provided me with theoretical perspectives on how spatial planning works, giving me more grip on what happens within my field of work.

As I have always been more attracted to rural affairs, I have focused on developments within rural areas. During my work as a landscape engineer, I found out that big developments were happening within rural areas to adapt to the changing climate and to restore biodiversity. However, I wondered how this affected the individuals living in these areas and their livelihoods, particularly farmers. So, for my thesis, I wanted to understand how developments affect landowners and what motivates them to participate in or be against these big developments. After this study, I think I have gained a deeper understanding of how change can take place by coming closer together and understanding each other's motivations. However, I hope this is just one step, which I would like to follow up with work in the field as a professional.

I would like to thank all farmers who have helped me by sharing their experiences with me and being open about their considerations and beliefs. As I know, farming is not just a business, but a way of living and is strongly connected to one's identity. In these uncertain times for farmers, it is hard to make choices that seem to be right for the future.

I would also like to thank the civil servants and experts who helped me gain an understanding of water infiltration systems (WIS) and the policy context, both in interviews and in informal conversations. I would like to thank my supervisor, Prof. dr. S. V. Meijerink, who encouraged me to explore and deeply engage with the material. The same could be said about ir. R. Schaafsma MBA (Waaloord VOF), who has inspired me with his passion for working on lasting solutions that can make a difference.

Abstract

Peat soil subsidence is one of the largest policy challenges within the western Netherlands, as subsidence affects the environment, infrastructure, and water safety. Therefore, measures are being taken by regional governments, one of which is the promotion and funding of innovation within agricultural land-use practices. This study focuses on Water Infiltration Systems (WIS) in peatland meadows.

This study aimed to gain a nuanced understanding of the upscaling of this innovation by trying to understand the motivations of individual landowners (dairy farmers) for adopting WIS. By using social practice theory, this study analyses the innovation based on the elements of materials, competences and meaning. Together, the elements of a social practice can explain how social practices shape change.

The main method used in this study was semi-structured interviews (n=16) with 14 land-owners in *Het Groene Hart,* which had already adopted WIS and two interviews with key civil servants at waterboards providing context. In addition, desk research and observations were used for theory building and providing a deeper understanding of the materials and policy context.

The analysis showed a connection between the material and competence elements. The more complex materials were deemed barriers for adoption as more competencies were required to perform the practice. Once more, meaning was attached to materials such as economic, entrepreneurial, or societal value; these were drivers for adoption, which could outweigh the barriers stemming from material elements.

To conclude, this study provided a detailed understanding of the interplay between elements of social practices and how this hinders or promotes the adoption of the innovation. WIS are not a definitive solution but can drive change with incremental steps. Providing a dynamic in which both land-users and policy makers can profit in an unstable policy environment.

Keywords:
Climate-smart agriculture, Climate adaptation, Social Practice Theory, Scaling Theory, Water management innovation

Contents

1. Introduction

1.1 Research Problem and Aim

Land subsidence is a creeping and growing environmental challenge in the Netherlands, this is seen particularly in the peatland meadow area of the western Netherlands. This region is characterised by peat soils that have been drained for agricultural land-use since the late Middle Ages. This has led to an accumulation of subsidence up to several metres. Currently, peat soils still subside by several millimetres to centimetres each year, leading to damage to infrastructure, rising water management costs, and greenhouse gas (GHG) emissions (Raad voor de Leefomgeving en Infrastructuur, 2020).

From a policy perspective, these environmental pressures complicate national sustainability goals. Notably, the goal to reduce greenhouse gas emissions by 55% by 2030 and comply with the European Union's Water Framework Directive, which mandates minimum water quality standards (Council for the Environment and Infrastructure, 2020; Ministerie van Volkshuisvesting, 2010). The complexity of the problem is exacerbated by the interplay of natural processes, land use and policy choices. As the soil continues to subside, the societal and ecological consequences are becoming increasingly visible. In light of climate change, sustainable land use and the energy transition, reducing soil subsidence is more relevant than ever (Massop et al., 2024; Vermaat et al., 2016).

To mitigate the negative effects of subsidence and play into climate change scenarios, governments have introduced policies aimed at reducing the effects. While specific measures vary across administrative regions, the overarching strategy centres on rewetting peat soils to reduce oxidation. The baseline measure includes raising surface water levels in polders (Provincie Noord-Holland, 2022; Provincie Utrecht, 2022; Provincie Zuid-Holland, 2022). However, the effectiveness of this measure is limited unless changes are made to existing land-use practices. As a result, further reduction of subsidence requires either adapting current practices to wetter conditions or transitioning to entirely different land uses. Given that agriculture is one of the dominant land uses in the region, much of the policy focus has been on adapting agricultural practices to better adapted to future circumstances.

Within the environmental sciences, such sustainable practices in farming are termed climate-smart agriculture (CSA). CSA practices aim to both mitigate impact and adapt to climate change. Currently, several of these CSA practices are being implemented, both at a pilot scale and at a regional scale (Geels & Schot, 2007; Van Den Akker et al., 2016). These practices include a systematic change of practices (transformation), which substitute current practices, but also technical innovations (adaptation), which adapt current practices to be better equipped to deal with environmental degradation and climate change. Within the natural sciences, much research has been done on the impact of CSA practices on the direct environment in the last decades, including the impact on GHG emissions and the ecological impact of CSA practices (Aben et al., 2024; Geurts & Fritz, 2018).

Within the Dutch peat meadow context, several innovations have been experimented with; however, few innovations have achieved widespread upscaling. Although CSA practices have significant geographical scaling potential, their broad adoption is constrained by various barriers, including institutional and cultural obstacles (Turnheim et al., 2018; Van Buuren et al., 2018). This is due to adoption not being merely a technical issue, but a complex process deeply embedded in human decision-making. Consequently, there is a gap between the technological potential of CSA innovations and their real-world uptake.

This study aims to bridge this gap by investigating the adoption process of a specific, CSA innovation: Water Infiltration Systems (WIS). By identifying the conditions that are drivers and barriers for adoption, the gap between technological potential and real-world uptake within a socio-technical system can be better addressed (Geels, 2018).

An in-depth examination of WIS as a CSA practice offers valuable insights for understanding the scaling of CSA practices more broadly. For examining the practices linked to CSA innovation, practice theory by Shove et al. (2012) is used. This lens of analysis differentiates practices in (1) the materials involved with the practice, (2) the competences needed to perform the practice and (3) the meaning attached to the practice for the practitioner.

1.2 Research question

Viewing WIS adoption through the practice theory lens will be done in two phases. The first phase involves deconstructing the practice of implementing and using WIS into its core elements to understand the innovation itself. The second phase involves analysing how the integration of these elements results in drivers and barriers for adoption, and thus the implications for scaling.

The guiding question for this study is:

What are the drivers and barriers for dairy farmers to implement water infiltration systems (WIS) within their social practices, and what does it mean for the scaling of WIS in het Groene Hart?

To properly divide the study into feasible steps, the primary question is broken down into sub-questions that correspond directly to the elements of practice theory. This allows for a structured analysis of the innovation itself before examining its implications for scaling.

SQ1: What materials are involved with water infiltration systems for dairy farmers in het Groene Hart?
SQ2: What competences do dairy farmers need to use water infiltration systems in het Groene Hart?
SQ3: What meanings are attached to water infiltration systems for dairy farmers in het Groene Hart?

Secondly, the study will go into the implications of the adoption of water infiltration systems for farmers and thus for the scaling of the innovation.

SQ4: *What are the implications of the adoption of water infiltration systems as a social practice for peatland dairy farmers in terms of materials, competences and meaning?*

We will now take a further look at the relevance of the study, based on the scientific research conducted so far, and a further deep dive into this study's societal relevance.

1.3 Scientific relevance

Scaling research has been prevalent in sustainability studies for some time now, particularly in the pilot phase (Moore et al., 2015; Vreugdenhil et al., 2021; Westermann et al., 2018). Within agricultural sustainability studies, much focus has been on the individual farmer's psychology in adopting certain practices (Burton, 2004; Sok et al., 2021). Scaling is then seen as an aggregation of adopting individuals. This approach has been criticised for being too focused on individual psychology by some scholars (Glover et al., 2019; Leeuwis & Aarts, 2021), instead of scaling being seen as a result of a wider system, which consists of social relations, material infrastructures and the wider institutional context. In reaction to this, scholars came up with a system approach coined "Agricultural Innovation Systems (AIS)". This approach is instead focused on the networks surrounding CSA practices, which include, for example, the institutional arrangements, business arrangements and regulatory frameworks (Flor et al., 2016; Schut et al., 2014, 2020). While this approach tries to understand how adoption works in the broader context, it does take for granted the individual circumstances that were central in the individual farmers' approach, according to other scholars (Giller et al., 2025).

Recently, scholars have opted for a new approach that aims to capture both the individual perspective of farmers and the overall socio-ecological context of an innovation. Social practice theory aims to understand the network of practices that are linked to an innovation (Shove et al., 2012). This includes both the psychological experience through the element of meaning, the surrounding network of knowledge through the element of competence, and the materials. Using social practice theory to analyse scaling of innovations is not a new approach, which is still underutilised in studies on the adoption of CSA practices. Within CSA studies, scholars have done research on pilot studies (Giller et al., 2025; Ossendorp, 2022). Many studies, however, exclusively focus on the pilot phase. In which the innovation is not fully exposed to the broader socio-ecological system. Therefore, these studies do not provide knowledge on the potential drivers and barriers of a network of CSA practices and are more focused on what prevents scaling from taking place (ex ante). This study will focus on what can be learned from an actively scaling CSA practice (ex post). Thereby, lessons can be learned in a later phase of scaling, which can provide new insights into how scaling processes in CSA work.

1.4 Societal relevance

The western Dutch peatlands are facing many environmental challenges, particularly subsidence, which causes GHG emissions, water management problems and damage to property and infrastructure. Subsidence is the result of drainage of the peatlands since the late Middle Ages to make the land workable for agricultural purposes, in particular, small scale dairy farming (Born et al., 2016). The region is experiencing tension between the agricultural sector and the ecological sustainability of the region. Dairy farming has been an economic pillar for the region historically and the dominant land-use for several centuries. Additionally, due to its long history, dairy farming pastures have become part of the cultural heritage of the peatland meadows, as well as an important identifying factor for the region (van der Ploeg, 2008). However, the need for intervention in agricultural land-use practices to prevent further environmental degradation has become ever more necessary. The environmental sciences have demonstrated that current land-use practices, such as drainage, have led to the release of GHG into the atmosphere and put stress on the ecological system through excess minerals, such as nitrogen oxides, in surface water (Buzacott et al., 2024). The oxidation of peat soils releases large amounts of GHG yearly; both carbon dioxide and the stronger gases of methane are released. This amounts to 3 to 4% of the yearly GHG emissions in the Netherlands (Born et al., 2016)

To deal with flooding and waterlogging problems as a result of subsidence, the water levels have to be adjusted periodically, which has led to a vicious cycle of deeper drainage and subsidence. Since the nineteenth century, drainage has become even more sophisticated through advances in engineering solutions, which have sped up the cycle of continuing subsidence. Recently, this trend has been severely reduced by raising the surface water levels since the 2000s; however, subsidence remains a prominent problem. This has resulted in a growing elevation discrepancy between the polders and main waterbodies. Currently, this has led to a complex waterway network, which needs to be maintained regularly and strictly to flood risk standards. These regular measures are being paid for by public funds. The historical reliance on engineered drainage solutions has created a self-reinforcing cycle of subsidence, costly maintenance, and escalating risks, a pattern that demands rethinking (Born et al., 2016).

Shifting away from deeply entrenched practices is not merely a technical challenge; it is a societal and institutional one. To understand these processes, more abstract perspectives become useful. Theory provides a structured way to analyse why certain water management regimes persist, how alternatives gain legitimacy, and under what conditions transitions can occur. It helps move beyond descriptive accounts of subsidence or case studies of infiltration systems, toward an understanding of the mechanisms that enable or hinder change. By grounding the analysis in theory, this study seeks to identify not just technical solutions, but the leverage points for scaling them effectively and durably within the socio-political context of the peat meadows.

2. Theory

This chapter will put forward the most important theories and concepts used in this study. This study draws on three interrelated theoretical perspectives: innovation theory, which examines the effect of the innovation on the current system; scaling theory, which explores how localised solutions can be expanded or replicated across contexts; and practice theory, which investigates the routines, norms, and institutional behaviours that are connected to practices, in this case, Water Infiltration Systems (WIS).

2.1 Innovations

To deal with the challenges of environmental degradation and climate change as a result of land-use practices, entrepreneurs and scholars in the natural sciences have been introducing innovations that aim to reduce these problems. In the field of agriculture, these innovations are commonly referred to as Climate Smart Agriculture (CSA) (Lipper et al., 2018; Westermann et al., 2018). These innovations aim to either mitigate or adapt to climate change or both; they differ in their impact on the status quo. Innovations that have the least impact on current land-use practices include robustness measures, innovations with moderate impact are adaptive measures, and innovations with high impact are transformative measures. Each of these measures can be categorised as a different type of innovation that has a different level of impact on current practices, both technologically, socially and economically (Geels, 2018).

Robust innovations enhance resilience to climate-related challenges, including drought and flooding, by making incremental adjustments to existing systems. Unlike more disruptive approaches, these practices maintain the status quo, making them easier to adopt. Examples in dairy farming include modified grazing regimes (e.g., adjusting rotational grazing schedules to reduce soil compaction) and lightweight machinery (e.g., lightweight tractors to minimise plot damage). While these adaptations fine-tune current practices, they do not fundamentally alter land-use systems. Instead, they strengthen the system's capacity to cope with environmental stress. The technologies involved are low-complexity, requiring minimal new skills or knowledge, which further facilitates adoption. However, robust innovations are primarily short-term solutions; they improve immediate resilience without addressing systemic vulnerabilities (Darnhofer, 2014; Smit & Wandel, 2006). Their low institutional barriers and compatibility with conventional practices often make them the preferred first step for farmers, even if longer-term, transformative changes may eventually be necessary.

Adaptive innovation significantly enhances resilience by modifying existing systems, making them better equipped to handle negative externalities such as climate change. Unlike less disruptive, robust innovations that strengthen current systems without fundamental changes, adaptive measures are inherently more disruptive. This is because they necessitate modifications to current practices and infrastructure. For instance, within a dairy farming context, adaptive innovations like drip irrigation, seasonal water table management, and the integration of wetland crops require a shift from conventional methods. Consequently, their successful implementation often depends on substantial institutional support and shifts in behaviour. While adaptive measures are particularly effective for fostering mid- to long-term resilience, they can also serve as crucial stepping stones toward more profound, transformative change (Kates et al., 2012; Rickards & Howden, 2012).

Transformative innovations represent a radical departure from current systems, replacing the status quo with fundamentally new land-use practices designed to address environmental and climatic challenges. Examples in agriculture include paludiculture (e.g., cultivating sphagnum moss, cattails, or cranberries in rewetted peatlands), large-scale rewilding, and peatland restoration. All these innovations prioritise long-term ecological resilience over conventional production. Such systemic shifts often face significant institutional resistance, as they challenge embedded cultural, economic, and political norms. While these innovations hold promise for sustainable land-use transitions, their real-world effectiveness remains uncertain, requiring strong drivers, such as policy mandates, financial incentives, or severe ecological crises, to overcome barriers to adoption (Moore et al., 2014; Tanneberger et al., 2021).

These three types of innovations represent archetypes within the broad spectrum of agricultural innovation. However, it is crucial to recognise that the geographical context significantly influences how disruptive or transformative an innovation is perceived to be. What may be considered standard practice in one region could be viewed as groundbreaking in another. In addition, the temporal dimension plays an essential role in shaping perceptions of innovation. Over time, incremental changes can accumulate, altering how an innovation is classified within these archetypes. Innovations may coexist with the status quo or alongside other adaptive innovations; they can either reinforce one another or come into conflict (Termeer et al., 2011; Wise et al., 2014).

Incremental, adaptive steps may be necessary to achieve a more profound transformative change. However, pursuing a specific innovation pathway often involves trade-offs, particularly between short-term robustness and long-term transformation. These decisions carry implications for economic viability, environmental sustainability, and social equity. Therefore, no single pathway can be deemed universally superior. The appropriateness and impact of an innovation are deeply context-dependent, shaped by both place and time.

2.2 Scaling theory

Thoroughly developing innovations is a complicated process due to the amount of effort and perseverance that is required by many actors, may it be organisational, financial or legal. Developing these innovations towards a niche and respectable innovation, due to complications in the current system, is very challenging (Vreugdenhil et al., 2021). To prevent these limitations let innovations fail at first attempt, innovations are first practised in pilot settings. In these settings, which are essentially safe places focused on providing the circumstances for successful implementation, an innovation can be further developed at a technical level. Examples are plot-sized innovations in scientific settings, such as university campuses or experimental farms (Van Buuren et al., 2018).

Once innovations are thoroughly tested within a pilot setting, they need to be brought to the wider system, which they were designed for, by adapting, replacing or transforming current socio-technical regimes (Geels & Schot, 2007). However, after the initial pilots have been completed, the safe environment in which it was developed fades away. And the innovation has to deal with the broader system. This is problematized in the field of scaling research. The seminal work on which most scaling literature is based is the work by sociologist Rogers (1962). Here, scaling is described as a process of diffusion: "The process by which an innovation is communicated through certain channels over time among the members of a social system (Rogers, 1983)". Within the context of agriculture, the term is described in a more specific way. Wigboldus et al. (2016) reviewed agricultural innovations and described scaling as involving complex interactions among biophysical, social, economic, and institutional factors. All these factors either promote or hinder the process of scaling. (1) Biophysical barriers can manifest in the lack of space for an innovation to scale. (2) Economic barriers include the lack of a potential market or a lack of financial resources. (3) Social barriers include cultural resistance to the perceived innovation (norms or individual preferences), (4) Institutional barriers (regulations block the implementation) or trust issues (with the parties involved) (Geels, 2002; Rogers, 1983). Literature highlights that all these factors are equally important for successful scaling (Van den Broek et al., 2020).

Besides these dimensions of success for scaling, there are also many theories on how scaling processes work as a dynamic. These scaling theories are focused on which routes the scaling of the innovation takes. Turnheim et al. (2018) describe four routes that could be taken in scaling. These include: (1) growth, which is when an innovation is growing an initial project itself throughout a location or network. (2) replication, which is where an innovation is repeated in another context. (3) Circulation is when elements of an innovation are used in another context; however, due to the differing contexts, implementations differ. (4) Institutionalisation is when an innovation is seen as the new status quo, as a result of the alignment of routines, regulations, policies, protocols and standards. Within agricultural research, these concepts can help understand how practices scale throughout a network or space, providing a useful theory on how scaling works in a broad context.

2.3 Adoption of practices

While these conceptualisations do help place scaling in a specific context and explain how scaling may be hindered or promoted, it does not delve into the fact that scaling is also a result of an individual's or a group's choice to adopt a certain practice. This is where a more individual perspective might help. Within agricultural sustainability studies, scholars have also opted for psychological and sociological theories that try to capture human behaviour (Wigboldus et al., 2016). Conceptualisations which capture this idea include Rogers's (1983) theory of diffusion, which is based on the process of an aggregation of adoption. This is based on individuals who are categorised as adopters, including innovators, early adopters, early majority, late majority and laggards. Where innovators face a lot of institutional barriers, later adopters face fewer of them. Other scholars have opted for a psychological perspective, including the theory of planned behaviour by Ajzen (1991), which tries to explain behaviour as a result of attitudes towards the behaviour, subjective norms and perceived behaviour control (Sok et al., 2021). Despite these theories' more social approaches, they can be criticised for being too focused on the individual alone, negating the institutional effects influencing individuals, as if individuals operate in a vacuum.

This is where social practice theory comes in. This theoretical approach is focused on providing a lens for understanding human behaviour and societal change by examining routines, habits, and everyday activities. There are different conceptualisations of this theory (Giddens, 1984), however, the theory provided by Shove et al. (2012) has been most prevalent in scaling research, due to its pragmatic approach, which can help understand material attributes prominent within agriculture. This theory distinguishes between materials, competences and meanings to explain human behaviour within sustainability transitions. It tries to explain practices that are deeply embedded in routine, socially normalised activities by key actors within transitions, as well as the actors' social-ecological environment. By first analysing the practices (materials, competences and meanings) involved in an innovation and then understanding the current practices of the key actors involved it can help understand why actors do or do not adopt certain practices and understand how this leads to scaling of a technology.

2.4 Social practice theory

In contrast to many other scaling research approaches, practice theory is not a multi-level approach (Geels, 2011), which tries to understand the overarching governance processes by zooming in on the micro, meso and macro levels and linking the processes. Practice theory instead uses a flat ontology, which tries to take a network approach. Similar to the actor-network theory and assemblage theory, practice theory does not align with hierarchical structures, as seen in government (Beunen et al., 2021). Lamers (2017) described it as follows: *"Embracing a flat ontology implies that no distinction is made into different social levels or realms with distinct characteristics, as suggested by micro-versus macro-analyses and by the agency-structure dualism. In practice theories, there are no levels of the social at which a different dynamic takes place. Everything happens in the same plenum"*. Using this approach allows the researcher to better delve into the experiences and beliefs of key individuals without ordering them in a hierarchy.

Taking a further look at the practice theory provided by Shove et al. (2012) we can divide practices, as said earlier, into three main components. These include material element, competence element and meaning element. Now, an attempt will be made to explain these elements of social practice within the context of sustainable innovations that were researched in this thesis. Later in the research process, these practices will be further developed through literature research on the innovation at hand.

The material element is most clearly at the surface of innovation research and involves the physical objects, tools, technologies, and resources involved in a practice. Materials provide the tangible basis that enables practices to occur. Without the right materials, the practice cannot take place or might take a different form. The innovations researched in this study include the infiltration systems themselves, the tools needed to construct infiltration systems and the financial resources. The latter is not directly a material element but is related to the material element, due to the requirement of financial resources to get access to the required materials.

The competence element is about the skills involved in using a new set of practices. Competences ensure that practitioners can perform the practice. They are often learned and evolve through experience, training, and social interaction. This involves, for example, the knowledge of how drainage systems can be best used and maintained.

The last element is the least close to the surface. The meaning element is focused on the social and symbolic significance attached to a practice. Meanings provide the motivational and contextual layer, shaping why people engage in a practice and how they perceive it. Changes in meanings can alter the prevalence or form of a practice. Within the research matter, this involves the motivations for farmers to adopt a practice and why to keep the system implemented for a sustained time. This can, for example, be a financial incentive, a feeling of long-term responsibility or societal pressure.

The elements do not only stand alone by themselves; there are always certain interrelationships that either promote or hinder each other. Interrelation between the elements can be described as follows: Firstly, materials and competences are interrelated due to new materials might lead to the requirement of new competences; however, new competences and perceptions might lead towards changes in materials. Secondly, competences and meanings are interrelated due to new competences leading to a new perception of a practice, altering the meaning of the practice, while a changed meaning of the practice might lead to different competences. And lastly, meanings and materials are interconnected due to new meanings can lead to new perceptions of certain materials, and new materials can alter the meaning towards a practice.

2.5 Theoretical framework

Using practice theory as an analytical model allows us to understand how practices emerge, persist, transform, and disappear by analysing the dynamic interplay of their three key elements: materials (e.g., technologies, objects, infrastructure), competences (e.g., skills, know-how, understanding), and meanings (e.g., cultural understandings, purposes, emotions). Instead of seeking to explain why individuals act in certain ways, the analysis seeks to understand how these elements are configured and reconfigured within a practice, how practices are carried by individuals, and how they connect to form a network of activity. Ultimately, shedding light on broader social and environmental changes. In this study, this change is the adoption of an innovation, ultimately leading towards the scaling of an innovation.

Figure 1 visualises a conceptual model of how the social practice elements, as explained by Shove et al. (2012), can either promote or hinder the adoption of an innovation. Eventually leading towards an aggregation of adaptations and thus scaling of the innovation in the context, resembling the diffusion of scaling (Rogers, 1983). The pluses and minuses indicate the drivers and barriers originating from the social practice elements.

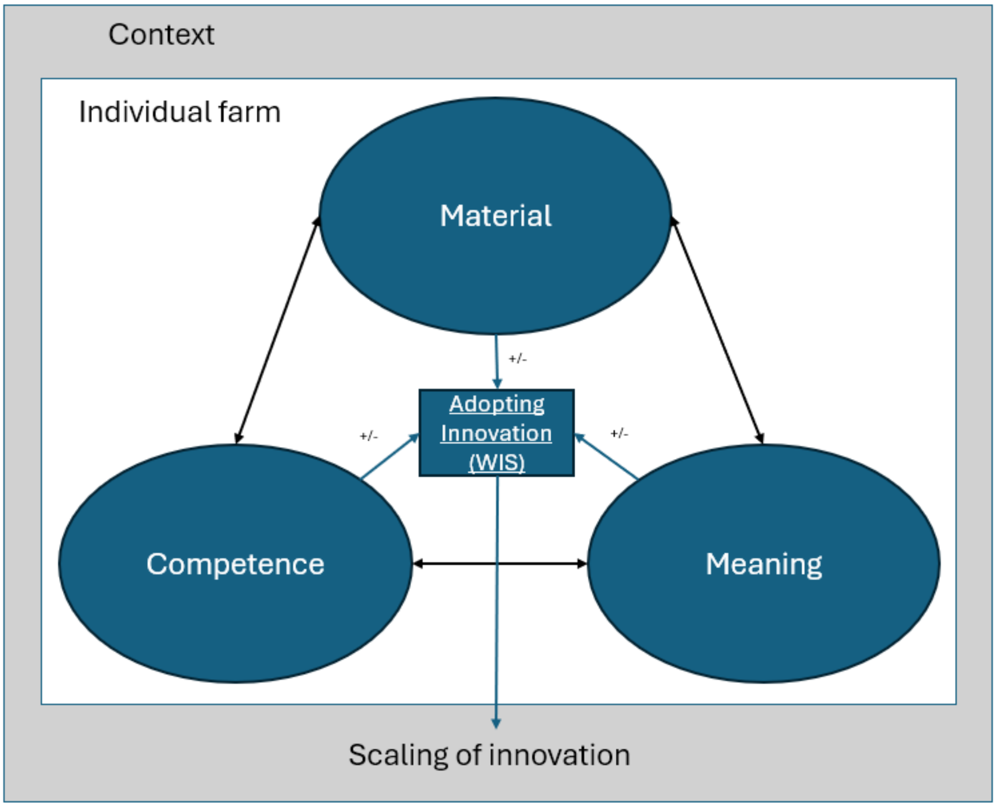

Figure 1: Conceptual framework adapted from practice theory as conceptualised by Shove et al. (2012), (+/- represent the drivers and barriers for adoption stemming from the elements of practice.)

2.6 Operationalisation

While efforts were made to operationalise the components of the innovation's social practice, it is important to clarify that practice theory serves as a guiding framework for this research rather than a strict framework. Through exploratory research including expert interviews (E1, E2) and a literature review of prior studies on similar CSA innovations (Giller et al., 2025), conditions were identified to help apply the theory within the case study context.

The material element in this research is operationalised in three main parts. The plot conditions, the system materials and resources needed for implementation. The plot conditions include the soil conditions, the surface water levels, the vegetation and the dimensions of plots. The system materials include all the materials of the system itself, such as tubes, wells, pumps and monitoring equipment. And thirdly, the resources needed to implement the system, including financial resources and equipment.

The competence element is also operationalised in three main parts. Firstly, the skills needed in soil and water management required to successfully work with the system and take advantage of it for agricultural practices. Secondly, the skills needed to maintain the system and keep it running for an extended period. This includes repairs and regular maintenance. Thirdly, the (non) usability of the system, knowing what the system can and cannot do, allowing farmers to use their system to their full potential.

Lastly, the meaning elements linked to the practices are analysed. Firstly, this includes values towards the economic well-being of the business. What does the innovation mean for the economic prospects of the farm? Secondly, how does the system cause infringement or add to the entrepreneurial capabilities of farmers in operating their business? And lastly, what does the innovation mean in terms of societal involvement? Are farmers influenced by outside pressures, such as societal pressures to work on climate mitigation and climate adaptation? The operationalisation used in this study can be found in Table 2.1.

Table 2.1: Operationalisation of practice theory by (Shove et al., 2012) based on explorative research and grey literature on WIS innovation.

Social practice elements	**Description of element**	**Measuring conditions**
Material element	The physical objects, tools, technologies, and resources involved in a practice.	1. System materials 2. Plot conditions 3. Implementation
Competence element	The skills, know-how, and techniques required to perform a practice.	1. Soil and water management 2. Maintenance and aftercare 3. (Non) Usability of the system
Meaning element	The social and symbolic significance attached to a practice, including cultural norms, values, and purposes.	1. Economic value 2. Entrepreneurial value 3. Societal value

Building on the theoretical framework of practice theory, which conceptualises social life as shaped by the interplay of meanings, materials, and competences (Shove et al., 2012), the following section outlines the methodological approach used to study these elements in the case study context.

3. Methodology

This chapter describes the main research strategy that was used in the study. The chronological steps taken within the research are described and explained. This starts with an overview of the case study, to then delve into the research strategy, followed by a further description of the methods that were used for data collection and data analysis. Following this, both the reliability and validity of this research will be elaborated on, secured, and a description of how research ethics were considered. Lastly, a reflection will be done on the research philosophy on which this study is based.

3.1 Research Design

To explore the complex social processes involved in scaling climate-smart agricultural (CSA) innovations, this research adopted a qualitative, single-case study design. This approach is chosen to gain a deep, context-specific understanding of the scaling process (Van Thiel, 2014). The goal of this research is to understand the range of interpretations; therefore, an exploratory approach was found to be most suitable, with the primary method of data collection being semi-structured interviews. Now, the rationale behind the case study selection will be elaborated on.

3.1.1 Case study: Het Groene hart

The case study for this research is the western Dutch peat meadows, more specifically: Het Groene Hart (figure 2). This region, situated among the Randstad cities, is known for its rural character, which is protected by national planning policy (Rijksoverheid, 2023). The case study was selected for two primary reasons:

Firstly, compared to other Dutch peat meadow regions found in the northern provinces, this region has experienced more policy interventions aimed at reducing subsidence, including rewetting policies and innovative measures. Furthermore, it is the only region in the Netherlands with polder-wide adoption of Water Infiltration Systems (WIS). This unique status enabled the recruitment of interview participants with direct experience implementing this Climate Smart Agricultural innovation. Het Groene Hart is an overarching region in three provinces, South-Holland, Utrecht and North-Holland (see figure 2).

Secondly, within the region, several research programmes are underway, such as Nationaal Onderzoeksprogramma Broeikasgassen Veenweiden (NOBV), Veenweiden Innovatie Centrum (VIC), het Veenweiden Innovatie Programma Nederland (VIPNL), producing knowledge for subsidence reduction policy. There are also implementation projects ongoing, most prominently, Klimaat Slim

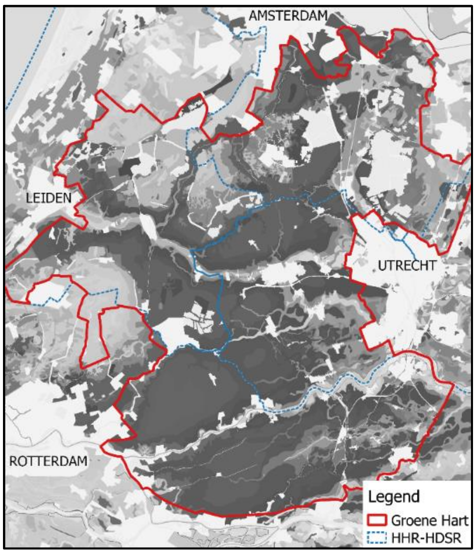

Figure 2: Map of het Groene Hart; Peat soils indicated by darker colour grades, Source: PDOK, (n.d.)

Boeren op Veen: Groene Hart (translates to: Climate Smart Farming on Peatland: Groene Hart). Which works on facilitating and promoting Climate Smart Agricultural measures in the region. The author's participation in meetings within these programs provided valuable contextual insight. Additionally, documentation built up throughout the last several years allowed for document analysis.

3.1.2 Research Design

This study was conducted in an iterative process to ensure a systematic, but flexible approach, fitting to social practice theory. The process, visualised in Figure 3, comprised six core phases. (1) After having the research aim and questions established in the first phase, (2) the second phase involved conducting a literature review on underlying theories, which included innovation, scaling, and practice theory. This was supplemented by a review of scientific and technical documents specific to WIS. Furthermore, the theory was operationalised in line with the innovation and the geographical context. To get a grip on the relevant factors for operationalisation within the context, two explorative semi-structured interviews were carried out (interview E1 & E2). This helped to get a better understanding of what might be some of the main themes for the overall participant selection and thus make a better interview guide. (3) In the third phase of the study, the methodology for this study was further developed to prepare for the data collection. This meant that a selection of interviewees was made, and the interview guide was developed. To properly conduct observations, a notebook was used in which observations could be written down. For the literature review, the available technical documentation found online was used. Afterwards, the data collection began with the conduction of interviews, participation in meetings and document analysis. (4) In the fourth phase, the results were analysed. The data that was collected through the three methods was analysed using the framework. To do this Atlas.ti was used, with coding focused on open and axial coding. (5) In the fifth phase of research, the results were interpreted, which resulted in discussions and conclusions. (6) Finally, recommendations for both further research and policy practice were developed. An overview of the research design is visualised in Figure 3.

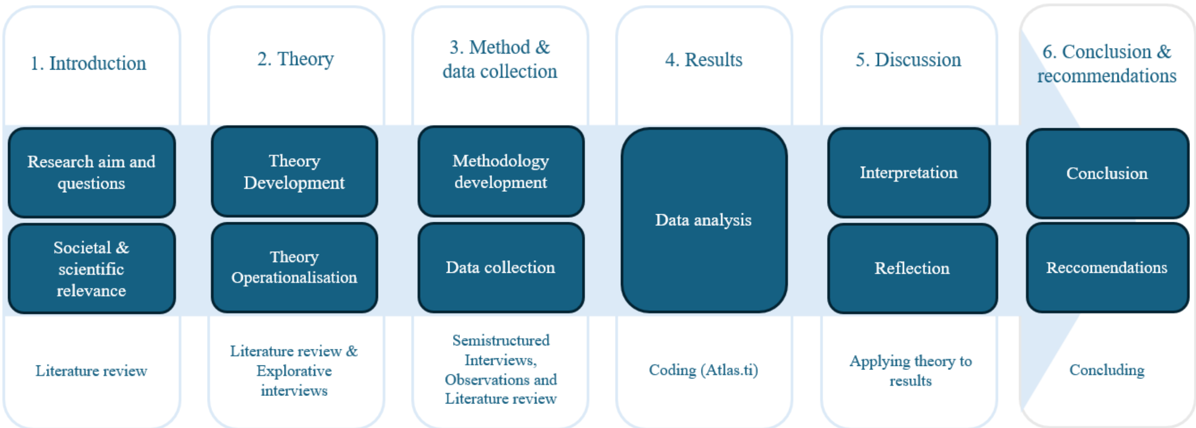

Figure 3: Research design used in this study

3.2 Data collection methods

Now, a deep dive will be done on the three methods of data collection, describing the rationale for using said methods and describing the process itself. Despite this research using multiple methods of data collection, semi-structured interviews are the most important method for data collection, collecting information on the experiences of participants in line with practice theory. Therefore, this interview method will be described first, followed by observations and literature review as supporting data collection methods (Wagenaar, 2014). This resulted in a triangulation of methods.

3.2.1 Primary data collection: Semi-structured interviews

The choice for using semi-structured interviews in this research was based on the emphasis on experiences by participants as an important factor within practice theory. Choosing semi-structured interviews allowed for a structured approach in doing interviews, while allowing participants to speak freely within the thematic context, allowing for unexpected additions by participants (Harrison et al., 2017).

When choosing participants, the author used snowball sampling for participant selection, with the initial participants being contacted within the “Klimaat Slim Boeren Op Veen” platform (further explained in the results section). When selecting participants, attention was paid to having a roughly even geographical spread throughout the Groene Hart region by choosing to interview two participants per polder as a geographical unit (see figure 4). Additionally, attention was paid to the involvement of farmers within the management of WIS installation projects. This meant highly involved farmers were alternated with less involved farmers. To make sure the participant had enough experience with the innovation, two additional interviews were conducted with farmers who were early adopters of the innovation, these were not involved in a polder-wide project recently, adding a broader array of experiences. Finally, 14 farmer interviews were conducted, including 2 explorative interviews conducted in an earlier phase of the study. To provide more context on the interviews, it was decided to interview 2 key civil servants involved in WIS implementation projects from involved waterboards. This not only provided context but also helped reflect on the experiences provided by farmers and either confirm or contradict those experiences. Table 3.1 provides an overview of the conducted interviews, location, date and the version of WIS adopted by the farmer.

Table 3.1: overview of interviews

Location	Participant	System	Location	Date
Explorative interviews	Farmer E1	PWIS	At the farm	March 14th
	Farmer E2	AWIS	Via phone	March 25th
Polder Lange Weide	Farmer 1	PWIS	At the farm	April 29th
	Farmer 2	PWIS	At the farm	April 29th
Polder Stein	Farmer 3	PWIS / AWIS	At the farm	May 15th
	Farmer 8	PWIS	At the farm	May 6th
Polder de Meije	Farmer 10	PWIS / AWIS	At the farm	May 22nd
	Farmer 12	PWIS / AWIS	At the farm	May 29th
Polder de Vlist	Farmer 7	AWIS	At the farm	May 15th
	Farmer 11	PWIS	At the farm	May 26th
Polder Oud Kamerik	Farmer 4	Not installed yet/ but decided upon	At the farm	May 6th
	Farmer 6	AWIS	At the farm	May 12th
Early adopters	Farmer 5	PWIS	At the farm	May 7th
	Farmer 8	PWIS	At the farm	May 19th
Hoogheemraadschap de Stichtse Rijnlanden	Civil Servant 1	-	Waterboard office, Houten	May 9th
Hoogheemraadschap Rijnland	Civil Servant 2	-	Waterboard office, Leiden	May 20th

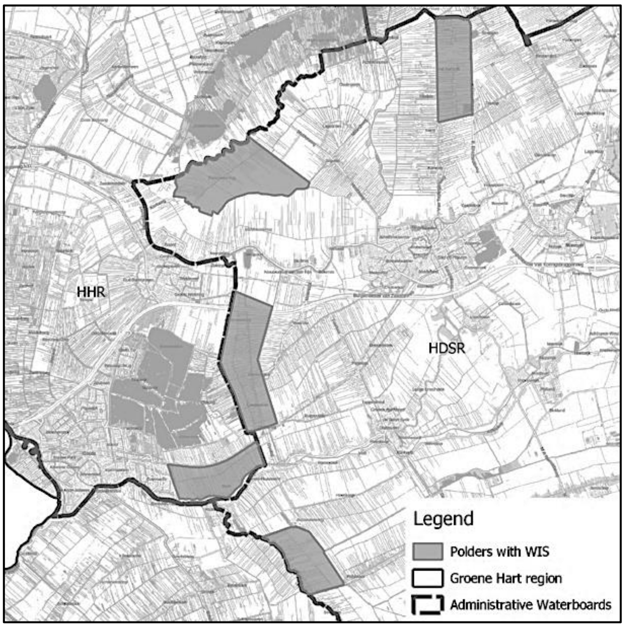

Figure 4: Overview of the polders with interviewed participants, basemap sourced from: PDOK

All but one interview was conducted on location, the location being farms or government buildings. This was done intentionally to make sure the personal interaction would be enhanced. Interviews were conducted in Dutch and took between 30 to 60 minutes, loosely following the operationalised components of practice theory. Interview guides were prepared beforehand, which include themes, questions and probing questions to foster the conversation (interview guide provided in appendices I & II). To ensure informed consent was ensured, participants were asked to fill out an informed consent form (Appendix III). Although participants could either choose to stay anonymous or not, the author chose to anonymise the participants due to this information being of little relevance for the study's outcome. To make sure anonymity was also ensured in later parts of the research, transcripts were stripped of personal information. In addition to anonymity, participants were informed that the content of the interview would only be disclosed with the university supervisor if needed. Any personal data is also stored in secure databases.

3.2.2 Secondary data collection: observations and document analysis

Secondary methods of data collection include observations and document analysis. Both these methods were mainly used to confirm, confound, or add valuable information for the verification of findings. For observations, the researcher participated in several meetings as either a passive or active participant. Observations were written down in an observational notebook. The observer noted any information that was thought to be relevant for either context, parts of practice theory analysis or scaling of the innovation. The meetings in which the researcher participated included meetings part of the "Klimaat Slim Boeren op Veen" governance platform (passive participant), a participatory governance meeting part of an area process (gebiedsproces) in South-Holland (passive participant) and an expert meeting on Water Infiltration Systems (active participant). During these meetings, the researcher was present to make observations which were used as part of the analysis. Table 3.2 gives an overview of the participated events.

Table 3.2: overview of meetings used for observations

Meeting	Participation	Location	Date
Klimaat Slim Boeren op Veen: Groene Hart start bijkeenkomst	Passive participation	Nieuwer-ter-Aa	April 1st 2025
Bijeenkomst Toekomst Wierickerland	Passive participation	Bodegraven	May 27th 2025
VIPNL Expert meeting WIS	Active participation	Vlist	June 13th 2025

Document analysis provided a contextual understanding for the overall analysis. The reviewed literature includes the available policy documents and reporting by the “Klimaat Slim Boeren op Veen” initiative. This includes presentation summaries and reports that have been made over the last five years of the ongoing project, found online on the project’s website. Literature in the results section was used to provide a deeper understanding, building upon the content provided by interviews. Altogether, this mix of data collection methods allows for an in-depth understanding of the experience of the participants and their reality. The observations and literature review confirmed, confounded, or added valuable information for the verification.

3.3 Data analysis

For the data analysis, the interviews were transcribed from a record made during the 16 interviews. Transcriptions were made using transcription software GoodTape.io and manual correction in text editors. Afterwards, the transcriptions were analysed using Atlas.ti as coding software.

Several rounds of coding were used in an iterative process. The initial coding phase started by identifying which parts of the interviews were of relevance in line with the components of social practices and labelling them underneath one of the three components (material, competence and meaning). Additionally, selections were made on information that was relevant as contextual information. This round can be seen as a round of open coding. By taking these steps first, the data was made sense of. Afterwards, steps were taken to interpret the data according to the theory (Wagenaar, 2014). During this phase, memos were made on several of the key characteristics of the interviewees and a reflection upon key observations made during analysis.

In a second round of coding, the initial coding was reviewed and further labelled according to the categories made beforehand to provide more structure in the data. Sometimes, labelling was altered upon second view. Memos were updated as well.

In a third round of coding, the coded quotes were further coded with specific codes roughly describing the content of the quotes. Allowing for a better overview of shared experiences among participants.

In a fourth and last round of coding, axial coding was used to make networks of the codes, and an analysis was conducted on how the codes related to each other within the components of practice theory. But also, across the different components of practice theory.

An attempt was made to be as grounded in the data as possible. Putting effort into trying to stay as close to the resource materials as possible. However, the interpretation of what is considered materials, competence and meaning was influenced by the author's own experience and possibly by the initial explorative interviews, which were used to enhance the operationalisation of the theory.

3.4 Reliability and validity of the research

To make sure that the research is reliable and valid, the criteria of quality by Guba & Lincoln (1989) were used. These criteria include (1) maximising credibility (internal validity), (2) transferability (external validity), (3) dependability (reliability), and (4) confirmability (objectivity). This paragraph will describe how the criteria were considered in this study.

Credibility was an important aspect of this study due to the high amount of technical information used in the study. Making mistakes in the interpretation of the technology leads towards a less credible study. Therefore, a technical expert reviewed the technical information. For the scientific theories, a scientific expert conducted a review. Another measure taken was using a triangulation of data sources on data, allowing for it (interviews, observations and documentation). The researcher was also focused on reaching as much scientific saturation as possible by doing as many interviews as possible within the provided time window, maximising engagement with the source material, as well as understanding the context as best as possible. Transferability is important in any study; however, ensuring transferability in a highly context-dependent qualitative research study is very challenging. To provide transferability as much as possible, given the limitations, this study makes use of thick descriptions in the results sections, mostly involving direct quotes by interviewees. This allows for third readers to make their judgment on applicability in other contexts. Dependability was taken care of in this study by being as transparent as possible about how steps were taken within the study, allowing other researchers to make the same steps in the same context. However, most of the research is based on interpretations by interviewees, which are inherently flexible and change over time. Therefore, dependability is limited but taken care of as best as possible by the author. Confirmability of the study is met by making sure raw data is available if needed, although anonymised. This makes reviewers able to decide whether the researcher has rooted their findings within the raw data (the interpretation of participants) or not.

3.5 Research philosophy

The study adopts a relational ontology, viewing the social world not as composed of discrete entities but as constituted through relations and interactions. Practices, as conceptualised by Shove et al. (2012), are not isolated activities but configurations of meanings, materials, and competences that emerge and evolve through their interconnections. This ontological stance emphasises that phenomena such as innovation adoption are not fixed or solely located within individuals or structures but are continuously shaped through dynamic relations across time and space. In addition, this study takes an interpretivist epistemology approach by recognising that knowledge is co-constructed through social practices and contextual understandings. Rather than seeking universal truths, the research focuses on the lived experiences of humans, which can differ from person to person. This research acknowledges situated meanings and the relational dynamics between actors, materials, and competences as objectively lived experiences. Practice theory, as developed by Shove et al. (2012), aligns with this epistemological stance by focusing on how knowledge emerges through doing, saying, and interacting. This perspective allows for a nuanced exploration of innovation adoption as a socially embedded and evolving process (Moon & Blackman, 2014).

The following results section builds on the methods described, using practice theory to explore how the innovation was adopted in the agricultural practice within the case study context. Focusing on the elements of materials, meanings, and competences (Shove et al., 2012), the analysis moves beyond individual or policy-driven explanations to examine how practices are assembled and sustained. This approach reveals how the innovation became integrated into, or conflicted with, existing routines and organisational norms.

4. Results

This chapter includes the results based upon the analysis conducted on interview transcriptions, observations and documentation (scientific and technical literature). The results section follows the structure of the conceptual model described in the theory section. Starting with defining the context in which the research was conducted, followed by the three elements of practice theory and their implications for scaling.

4.1 Context

The context section will shortly describe WIS itself, followed by the policy context surrounding the scaling process for water infiltration systems. This includes government policies, legal frameworks, the institutional framework and the current scaling status. This section is mostly based on literature review and interviews with civil servants at the waterboards and farmers.

4.1.1 Water Infiltration Systems

Water Infiltration Systems (WIS), previously known as “reversed drainage”, is an innovation introduced to reduce subsidence in peatland meadows (STOWA, n.d.). Peatland subsidence is primarily driven by the aerobic decomposition (oxidation) of organic matter, which constitutes the bulk of peat soil composition, often in conjunction with interspersed clay deposits (Kløve et al., 2010). This phenomenon is particularly pronounced during periods of drought, when a significant decline in groundwater levels occurs. Groundwater depletion is more severe in the central areas of agricultural fields compared to their peripheries, where proximity to surface water bodies facilitates some degree of natural water infiltration. Due to the lack of groundwater flow towards the centre of the fields, subsidence is stronger in the middle of the fields. During the wetter seasons this effect is reversed, leading towards waterlogged fields. This saturation significantly impairs the usability of these fields for agricultural activities for extended durations (Figure 5).

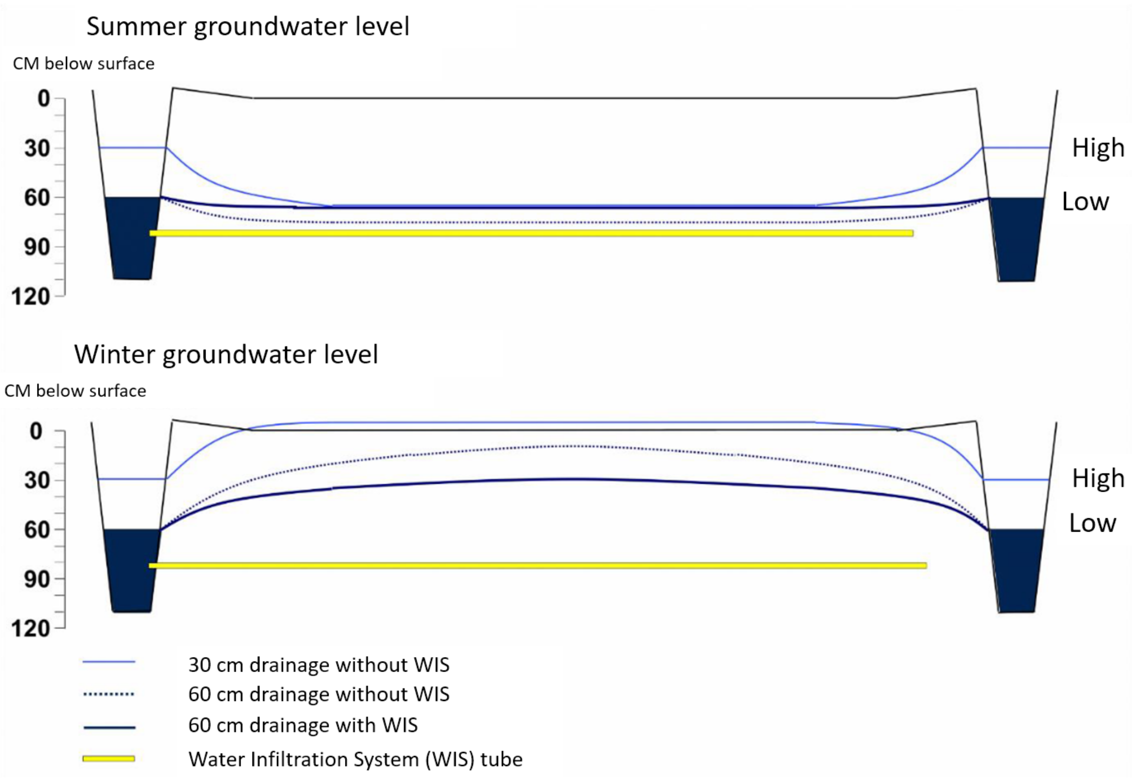

Figure 5: Schematic visualisation of WIS (Source: STOWA, translated to English)

WIS are designed to stabilise groundwater levels within agricultural fields through the strategic installation of horizontal infiltration tubes within the subsurface. These tubes establish a hydraulic connection between surrounding surface water bodies and the field's groundwater table, thereby facilitating further horizontal infiltration of surface water, particularly towards the central regions of the field. WIS can be broadly categorised into passive and active systems, distinguished by their method of water delivery. Passive systems rely on horizontal inflow driven by hydrostatic pressure differentials. In contrast, active systems incorporate a pump to mechanically introduce water into the system, thereby enabling a more controlled and regulated water management approach (Aben et al., 2024).

4.1.2 WIS Projects

Since the early 2000's, research institutes have been experimenting with WIS. At first, within the controlled environment of an experimental farm. After initial promising results, the innovation was branched out to individual farms in het Groene Hart. Afterwards, several plot-sized implementations have been experimented with at various farms throughout the region. These were early adopters of the innovation, allowing lessons to be learned in diverse contexts. Since the late 2010s and early 2020s, the WIS has been implemented on a polder scale. To monitor these systems' effectiveness, researchers and entrepreneurs have been developing models (SOMERS) to measure the effectiveness of WIS on reducing subsidence (NOBV, 2025).

Regional governments (provinces and waterboards were involved in the project facilitation and funding of WIS projects on a polder scale in Het Groene Hart. Installing WIS systems on a larger scale, allowing for polder-wide subsidence reduction. Waterboard HDSR, located in the eastern region of Het Groene Hart, was the first to facilitate bottom-up initiatives to implement WIS. 2019 onwards, projects have become more streamlined via the facilitation by the Klimaat Slim Boeren op Veen platform (translating to: Climate Smart Agriculture on Peatland, KSBOV), an initiative by farmer collectives and waterboards to facilitate WIS projects and related innovations. The KSBOV platform aims to streamline the project phases, building on knowledge gained from other polders and make the project more financially feasible through standardised procedures, including standard contracts and other guidelines. In 2025 the project was relaunched as Klimaat Slim Boeren op Veen: Groene Hart, thereby becoming part of policy programmes of Het Groene Hart Governance platform (sourced from *Klimaatslimboerenopveen.nl*)

Most projects have been initiated by a group of farmers or farmer collectives via a bottom-up initiative, including farmer collectives or polder-specific groups and facilitated by the local waterboard and private consultants. Civil servants' interviews mentioned the bottom-up approach added to the enthusiasm by farmers to participate by providing a low point of entry in the WIS projects, as relations with government actors were not always sufficient at the start of projects. One of the benefits was having local or known actors promote the innovation, which helped with increased engagement by potential participants. WIS projects are largely paid via public money provided in various public funds, including national funds and European funds via subsidies. This is where the farmers' collectives played an important role, by managing the subsidy money and making sure farmers had no financial burden while waiting for subsidies to be distributed. Because public money is used for these projects, they are required by European law to be publicly tendered. In the tender processes, local farmers were also included in tender committees, a lot of the time. This allowed farmers to influence the quality control and thus added to the bottom-up approach.

After implementation is completed, monitoring of the effectiveness of the system can begin. Both waterboards and research institutes have been monitoring the long-term effectiveness of WIS on groundwater levels

4.1.3 WIS policy context

Although WIS are one of the more prominent measures promoted by regional governments to reduce subsidence in the western peatlands, it is part of broader strategies by provinces and waterboards. Most waterboards are pushing for higher surface water levels in polders across the board to reduce peat oxidation. This is done in combination with flexible surface water levels, which are more in line with seasonal precipitation. WIS play an important role in playing into the wetter conditions, as higher water table levels are not sufficient to prevent subsidence reduction (Provincie Utrecht, 2022).

As of 2025, polder-scale WIS projects have been implemented in many parts of het Groene Hart. However, as of now, most projects have been implemented within the administrative region of waterboard HDSR and to a much lesser extent in other waterboard areas. An interview with a civil servant at waterboard HDSR made clear that other waterboards were more hesitant to implement WIS due to unknown effects on the total water system. As this water system not only provides drainage for using farmland but is also essential to prevent flooding in residential areas. There is also uncertainty on the water usage of WIS during dry periods. The interviewed HDSR civil servant mentioned the following: "*We notice with other water boards that they actually say no to this kind of system. Because they are nervous about the fact that it will require more water. They are nervous, that there will be more flooding. And it is also nerve-wracking, because sometimes we don't meet the standards anymore. And then how do you deal with that? And then how do you deal with the fact that the waterboard is going to get extra claims for damages? Do you dare or don't you dare?"*

HDSR is a waterboard which takes an active role in promoting WIS initiatives in certain polders. Within HDSR's policy rules, the so-called "Yes, unless" principle is used, stipulating that many activities are, in principle, allowed, provided certain conditions are met and due care is observed. The policy is based on the following rationales: (1) Reducing regulatory burden, minimising permit requirements and shifting towards notification requirements when basic conditions are met. (2) Assign More Responsibility to Initiators: Emphasise the duty of care for citizens and businesses, stimulate Innovation: Facilitate quicker and simpler execution of pilot projects and initiatives that contribute to water management objectives, such as mitigating subsidence (HDSR, 2009). Waterboard HDSR sees WIS as an opportunity to learn about the innovations themselves; therefore, they are heavily involved in monitoring and knowledge sharing among WIS users.

Other waterboards, such as waterboard Hoogheemraadschap Rijnland (HHR) have been more in facilitating innovations such as WIS. Taking a more cautious approach and keeping open the possibility for multiple approaches, trying to find the best solution for the specific polder based on the geographical context. According to a waterboard HHR civil servant who was interviewed, this has partly to do with the permanence of implementing solutions such as WIS and the uncertainty of negative effects of the system outweighing positive effects in the long run: "*Here we kept looking a bit wider, I think. We didn't only have our eyes on WIS but also kept looking at others [solutions]. The "Land van Ons" here, in Vrouwenvennenpolder, there are also a lot more things we are looking at. How can we do water infiltration through ditches, by raising the water levels and maybe help in some other way? So, we keep looking at the most natural possible solutions*".

Within a policy document for peat meadows, HHR states that they will actively contribute to projects by working on hydrological scenarios. However, they also state that it is not their role to take the lead in such projects, as this should be the role of provinces that finance the projects. Additionally, the waterboard stipulates that WIS projects need to be part of a greater area plan, as that helps in taking into account the effects on the greater area (HHR, 2024). Although, HHR has been more cautious than HDSR in its approach to WIS, they have been more forthcoming than some of the other waterboards in the region. Recently several WIS projects have been or are being implemented in the administrative area of HHR.

4.1.4 Wider policy context

Although subsidence reduction is an important policy goal within het Groene Hart, it is one of the goals in a wider policy context. One of the other significant developments includes nature restoration projects and the development of new ecological corridors throughout the Groene Hart region, connecting the major protected nature conservation areas. Interviews made clear that there were frictions between stakeholders on how the new ecological corridors were developed. This has influenced the mood among farmers. Famer 7 mentioned the following: *“And that's what has gone wrong in the Krimpenerwaard [polder], for example, I think has gone wrong that they are excavating 2300 hectares and ploughing…… Then it's better to keep it in farmers' hands and do more extensive management and throw a special management contract on that. And that you achieve your goals that way. But not thirty excavators, which have been standing there for 10 years, producing CO2 and ruining nature.”*

Other policy goals include working on reducing the excess nitrogen emissions, overall biodiversity loss, water quality, socio-economic challenges and land-use conflicts. To deal with these problems, regional governments have been initiating governance processes coined: Area processes (gebiedsprocessen) which stem from the national programme for rural areas (NPLG) and are effectuated by regional governments (provinces, waterboards and municipalities). These collaborative governance arrangements include stakeholders such as farmers and the local governments (Rijksoverheid, 2023). Many farmers are involved in these collaborative arrangements to work on long-lasting solutions for the major challenges the western peatland meadows are facing.

Understanding the policy context provides essential insight into the structural conditions that shape how innovations emerge and are taken up within the geographical context. To fully grasp the dynamics of adoption, it is necessary to look beyond policy frameworks and examine the everyday practices through which change occurs. The analysis now shifts focus to the core elements of practice materials, meanings, and competences, which together constitute social practices. By unpacking how these elements are configured, sustained, and reconfigured, we gain a deeper understanding of how the innovation is integrated in this context.

4.2 Social practice: Materials

The material element of the social practice of water infiltration systems consists of several distinguishing parts. This includes the water infiltration system itself, the plot conditions and resources needed for implementing the system.

4.2.1 System materials

Water infiltration systems consist of a network of horizontally installed perforated tubes installed in the subsurface of a peatland meadow. Over the years, several iterations have been developed as a result of a trial-and-error development process. In 2021, a guideline for installation was published to standardise the system's materials and installation (KIWA, 2021). The guidelines state that perforated tubes are to be installed at least 60 cm below ground surface level and at least 20 cm below water surface level to allow for proper water inflow. As peatland meadow pastures are mostly elongated plots, drainage tubes are installed in an elongated manner as well, in parallel to the nearby ditches. To ensure full coverage of water inflow underneath a field, perforated tubes are installed in parallel at a distance of 4 meters. At the ends of drainage tubes, collection-tubes are installed, which connect to an inlet well. Roughly 300 meters of pasture can be infiltrated per inlet well (NKB & NOBV, 2020).

Two main systems of WIS can be distinguished: passive and active WIS (PWIS & AWIS). These systems are identical in their function of stabilising groundwater levels; however, AWIS have additional capacity with an actively pressurised system.

PWIS is the most basic version of WIS, relying on horizontal inflow of water via gravity and pressure within the system itself as a result of capillary action. During times of high precipitation, the system also works the other way around, allowing for the stabilisation of waterlogged fields. Compared to active systems, this system has the least amount of materials involved. PWIS are fully submerged within a peatland meadow, with only the inlet being visible above ground at the ditch. The system is designed to keep the amount of practices needed to keep the system running limited. For the water supply, the system is dependent on the water level in the overall polder relative to the system (NKB & NOBV, 2020).

AWIS are built upon the same idea of horizontal infiltration of water, but have additional capacity via a pressurised pump system. A buffer of water is built up in an external container via an electronic pump, allowing for pressurised infiltration (figure 6). This system has less reliance on overall water surface levels within a polder in comparison to passive systems. Due to the pressure within the system, groundwater levels are able to be pumped up higher and therefore have more capacity. The pump used in AWIS needs to be powered in some way; most of the time, this is done via a power line or via a dedicated power source, such as solar panels or windmills. To make the system remotely controllable, a control unit can also be applied to the pump (NKB & NOBV, 2020). To monitor the effectiveness of WIS, in many of the WIS applied fields, monitoring equipment is installed in the form of monitoring wells. This equipment is managed by waterboards and researchers. In some cases, the data recorded is publicly available to be used by both researchers and farmers using WIS.

WIS systems are built out of conventional drainage tubes, in addition to inlet wells, commonly used in water management in the Netherlands. Due to being conventional materials, these are seen as reliable and predictable. However, some farmers stated concerns about the implications of using plastic materials in the future. Using plastic materials could become a problem in the future, as the plastic materials might become considered pollution in the future after the system has stopped working: "*Just now, the bottom was clean of foreign matter. Yes. And then we voluntarily put plastic hoses in it. Yes. What will we think about that in 20 years?* (farmer 3)"

Within the agricultural water management sector, new biodegradable materials are currently being developed. Tubes made from biodegradable materials have been piloted in a few of the WIS project; however, these pilots were not successful thus far, due to the biodegradable materials decomposing on a short time frame. About the trails Farmer 7 stated the following: "*Farmer A and Farmer B, their neighbour, also conducted a trial with infiltration pipes made from potato starch. They reported that after four weeks, the pipes had broken down and were no longer functioning. So, yes... those are all techniques, and next year we will come up with something [different]....*"

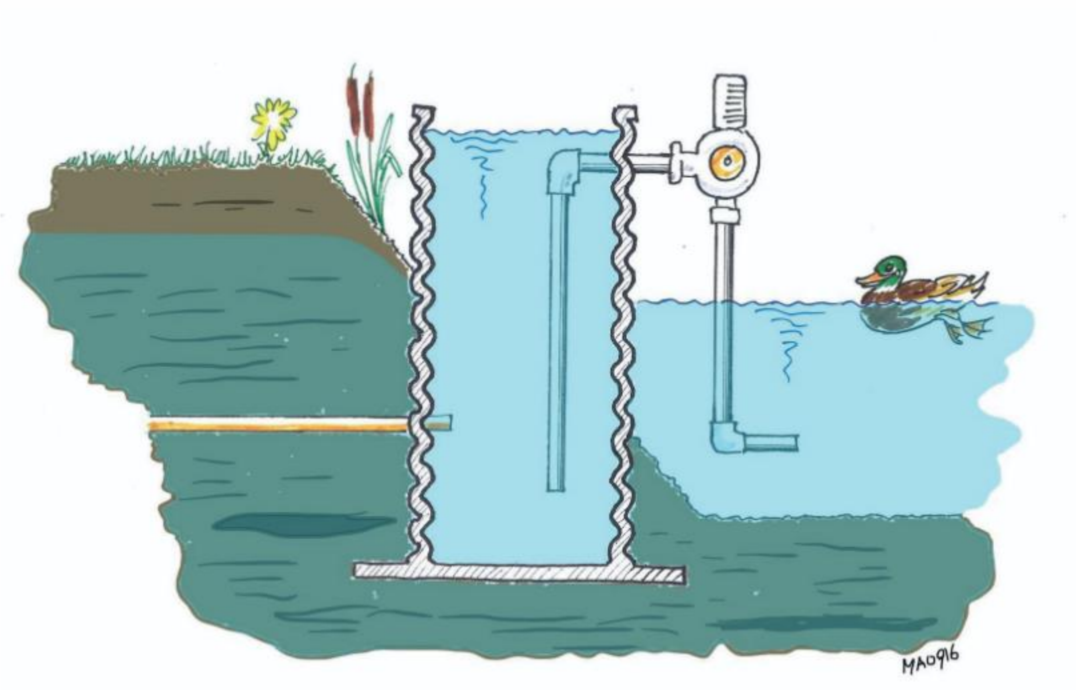

Figure 6: simplified visualisation of AWIS, source: Kenniscentrum Bodemdaling en Funderingen, 2020

Among early adopters of AWIS there were complaints about the unreliability of the older systems, which needed regular repairs to the control units. This was seen as a liability; some farmers who had adopted such systems hoped new developments could potentially solve these problems later down the line. Farmer 6 stated the following: "*You hope that the things that you run into labour-wise, that those get picked up a bit. That through innovation and through improving technology, that it improves. Other than that, I don't expect any changes in.... compared to what is there now in terms of experience. That will be kind of the same.*"

Although roughly two systems can be distinguished, a lot of systems are tailored to the farmer based on their personal preferences, which has led to various systems that differ from the two archetypes (PWIS & AWIS). Some farmers mentioned a preference for more robust materials, such as a system that functions on mechanical windmills. This system heightens water levels in a dedicated ditch, building pressure on a passive system. Farmer 10 stated the following: "*We very quickly ran into the fact that on 55 hectares, you would get eight of those wells that would be placed somewhere in your land. They are always in the way. And we couldn't really work with that. Then we opted for a passive system on the ditch, yes, and there and on that ditch, we put a windmill, so that you do have the robust system. Which you can easily respond to, so to speak, also not that... you don't have all that stuff everywhere on the land, so to speak. You come across something like that three times a year…..*"

4.2.2 Plot conditions

The conditions on a plot play an important role for this innovation, both due to the current plot conditions playing a role in selecting which plots qualify for WIS and due to the plot conditions significantly altering as a result of WIS installation.

When deciding to choose whether WIS is effective to implement on a plot, soil properties are an important selection criterion. Soils containing higher percentages of peat benefit more from the effects of WIS and are therefore more desirable to incorporate WIS. The region of het Groene Hart has several types of peat soils that have different formation origin and have differing percentages of clay. This has affected the amount of subsidence as a result of drainage historically. Peat dominant areas have seen more subsidence over the years, forming depressions in the landscape. The depressions are more likely to be affected by waterlogging and are thus more likely to benefit from WIS. At the same time, there are also clay ridges found in the peatlands which form relative hills and are less affected by subsidence. There are differences in soil properties between polders, but farmers also mentioned height differences within polders affecting subsidence. This influenced in which plots WIS was eventually installed. Farmers themselves and project teams comprised of waterboards, and advisors looked into whether the soil was containing enough peat soil and whether drainage levels were sufficient for WIS to be effective in reducing subsidence.

Another deciding factor were drainage levels, these needed to be at a level, on which WIS could effectively work, being fully submerged underwater. In practice these factors meant that plots were chosen that were currently drained the least, having most waterlogging problems and the occurrence of "hollow" ground water tables resulting in more subsidence in the middle of fields furthest away from ditches. This results in the so called "bathtub" plots, in which waterlogged conditions occur in the middle of fields. This effect also occurred more significantly within wider plots, as a result of natural water infiltration not being strong enough (interview farmer 11). Farmer 1 mentioned the following: *"I have quite highly elevated plots here compared to colleagues in the area itself...(...)...Yes, deposition of the Rhine. So based on aerial maps you see the colours were indicated. And based on certain colours, red or yellow.....Your plot qualified [or not], and that was indeed the slightly lower plots. So yes, I signed up for that."*

Plot conditions that hinder implementation of WIS are a big factor on deciding whether implementation will be successful. Some of the most important hindering conditions include bog wood found in peatlands. Bog wood are undecayed trees that are located within peat layers, these either need to be removed or worked around when a WIS is installed. When bog wood is removed this results in more subsidence on the short term as a result of exposed peat soil. This leaves holes in fields after removal, this was seen as a potential negative by farmers. Too much bogwood can let farmers decide to stop installation. Bog wood within a field can not be visually determined before installation. It can be done with infrared scanning, however, interviewed participants stated that in most cases, the risk was perceived to low.

Another important hindering factor was the potential of finding ditch fillings during installation. During the 1950's to 1980's, the practice of filling ditches with rubble and household waste was common place (OMDH, n.d.). Having knowledge of where ditch filling are located is important to prevent problems during implementation, decreasing the chances of installation failing or equipment being damaged.

After WIS are installed, some plot conditions are affected. Some are intentional, but other are not necessarily and can affect agricultural practices. Due to the decreased oxidation of organic material, the mineral release because of decomposition also decreases. This in turn results in less nutrient availability for grass. Some farmers saw this as a potential negative effect. Farmer 5 mentioned: "*Yes,* *because your peat stays wetter, it doesn't oxidise, it doesn't digest. And with digestion, of course, your nutrition is released."*

Another potential negative effect of WIS on soil conditions can be phosphate mobilization. Phosphate mobilisation can lead toward eutrophication in the nearby ditches, decreasing ecological water quality. Phosphate mobilisation is caused by the reduction of iron(III) oxides, releasing bound phosphate, and through pH changes or competition with other ions (Smolders et al., 2006). Although this process is complicated and influenced by several factors, it is seen as a potential negative effect of WIS on the environment. Therefore, some waterboards have looked into making phosphate filters mandatory, these filters can reduce the release of phosphates into the environment. Within interviews it was clear this was still a recent development and has not been implemented so far, however future projects may require phosphate filters.

The implementation of water infiltration systems in peat meadow areas has notable effects on local water management. While the systems help regulate groundwater levels and reduce soil subsidence, they also lead to higher water consumption compared to uninstalled fields. By actively directing water into the soil to maintain optimal ground water levels, infiltration systems require a more consistent and often larger supply of water, especially during dry periods. This makes it that enough water needs to be supplied in the polder. Farmers mentioned this might become a concern in the future. Farmer 6 mentioned the following: *"No, no obstacles. Not for us yet, fortunately. If there really is a water shortage, I don't know what the consequences will be. Yes, if at some point they say we don't have enough water. Because if you're going to use the active infiltration system in a whole polder, I think you'll evaporate quite a bit of extra water."*

Another disadvantage mentioned by farmers was that higher groundwater levels reduce the buffer capacity of peat soils compared to soils without WIS installations. A lower buffer capacity decreases the soil's ability to absorb and infiltrate water, leading to faster saturation of the soil. Farmer 4 mentioned: *"And then of course, your buffer is also gone, of course. So yes, of course, that's the downside again. You can't get it out any more quickly. If the topsoil has dried up, a lot of water can sink in before it gets wet."*

4.2.3 Implementation

Proper implementation of WIS was seen as a vital factor by both farmers and waterboard. Both due to the proper installation being vital for the operation of the system and due to the impact of installation on the plot conditions being disruptive. Farmer 8 stated the following about the installation: "*Look if I had to do it all over again, I would know where I would put more focus. Because you'll never do it again if all goes well. No, it also has a lot of impact on you on your land, actually. Yes it's in there and you can't do it again*."

As previously mentioned, the well-timed installation should align with both the seasonal agricultural practices and weather conditions. Several factors influence this timing. For example, grass height can affect operations, as there is a risk of losing a silage crop during harvest if installation overlaps with key agricultural activities. Weather conditions are particularly important when working on peat soils. Extended periods of rainfall can lead to waterlogged conditions, significantly reducing the soil's bearing capacity. This increases the risk of soil damage during WIS installation. While during dry periods damage can lead to more installation damage as a result of subsidence of exposed soil. In addition, some farmers participate in meadow bird management programs, which provide subsidies for maintaining undisturbed fields during the spring breeding season. This further restricts the timeframe available for WIS implementation. As a result, the window for installing WIS is narrow and must be carefully planned to avoid conflicts with agricultural practices, environmental conditions, and conservation efforts. Due to these narrow timeline, this also requires farmers to sometimes be flexible with their demands. Farmer E2 stated the following about his fellow farmers: "*Too wet that's really not too bad. I don't want to say not, but it's hardly ever too wet. Because they do make a bit of a mess when it's too wet say, so it's all black and it's not green anymore. So, on the day they leave, you really think, 'this has really become a mess.' But then when you wait a while, a fortnight or three weeks, it's not that bad. It will rebound.... That's also the experience of the farmers who instantly regretted it, that they, had let them come. But afterwards, where it was then too wet, it's not too bad. You don't hear those [farmers] anymore. But when its too dry you do hear them. Then you sometimes hear complaints, that it's very much subsiding where they've pulled the strand. So then of course you see all these bumps in the land. And a lot of weeds, where they made the cuts in the topsoil*.''

Implementation of WIS requires thoughtfully worked-out installation plans; most of the engineering is outsourced to the project team engineers. However, farmers are required to point out any potential hindrances and state their personal preferences during the making of such engineering plans. The installation of WIS is done using conventional drainage equipment used in arable agriculture drainage installation practices. This equipment consists of tractors that have a special drainage implement, which allows for tube installation in an efficient workflow. Over the years, lessons were learned on what is important within the peatland meadow context. This included customisation of the equipment in accordance with the peatland context. Examples are customised ploughs and the use of tracked vehicles. Construction of WIS was mostly outsourced to contractors specialised in drainage systems. Despite farmers not having to construct the system themselves, most farmers mentioned having to be involved in the installation via the provision of input, including plot knowledge, instructing the contractors or being involved in the tender process via the project management. Interviewed farmers were not overwhelmed with the amount of their work required in implementation; however, farmers did state the importance of their own input during preparation and installation. Farmer 6 mentioned the following: *".......The weather conditions have to be favourable to carry it out….. after the installation, you do have some damage, that you have to try to repair. Yes. And yes you have to like, in our case they also didn't have overly much experience on peatlands yet. Things also went wrong that had to be repaired later. Wells that were not properly anchored, that came up or were misplaced. It does require being very actively there."*

Most farmers mentioned the fact that the installation of WIS would result in subsidence at the place of installation, resulting in holes in their fields. Particularly in places where a lot of digging had been done (e.g. where inlet wells were installed). By most farmers, this was seen as one of the biggest disadvantages of installation, as they knew from experience that digging in peatland would result in additional subsidence for years to come. Farmer 7 mentioned the following: *"…..On peat soil, a child can dig a ditch, but a grown-up guy will never fill it up.' It will always keep sinking. Compared to sand and clay soils, you fill it up once and it's done. But on peat it always stays sinking. So, I think that filling up those tubes of WIS yes I think…. My successor, if he's 80, that he will still do it every three, four years you know…."* To do something about the subsidence because of installation, farmers are supplied with dirt which they can use to fill up the holes themselves. In most cases, this was paid for within the overall project.

4.2.4 Materials: Implications for adoption

Based on the analysis of materials involved with WIS, several drivers and barriers for the adoption of WIS could be distinguished:

Within the context of peatland meadows, Water Infiltration Systems (WIS) have become an established innovation, with over a decade of application by early adopters. This long-term implementation has resulted in valuable insights into the system's implementation, functionality, and materials. WIS is currently widely recognised among farmers as being a relatively simple technology, primarily constructed from conventional agricultural water management components such as drainage tubes and wells.

PWIS represents the most basic iteration, designed for minimal interference with farmers' routine practices. In comparison, AWIS offers more capacity but is therefore designed with more complex materials. Beyond these archetypes, variations have emerged due to farmer adaptations, reflecting individual preferences and site-specific needs. To successfully integrate WIS, careful consideration must be made on which system is most suitable for the individual farmer and location.

The effectiveness of WIS is contingent upon specific plot conditions, particularly drainage levels and soil properties. Optimal implementation occurs in areas with elevated water tables, where subsidence mitigation is most critical, particularly in low-lying areas within polders. By stabilising groundwater levels, WIS not only reduces subsidence, but also can improve soil conditions for agricultural purposes due to the stabilised groundwater level.

Despite its practical utility, several material-related barriers may impede the broader adoption of WIS. The primary concern is that the process of installation itself can be disruptive. The temporary exposure of peat during installation risks accelerating oxidation and causing short-term topsoil damage; this risk is increased by the potential of finding bogwood and other hindrances in the topsoil. This underscores the importance of clear coordination between landowners and project teams. Successful installation is driven by having experienced and skilled contractors involved who use specialised equipment tailored to peatland environments.

A long-term concern is the system's reliance on plastic materials, as biodegradable alternatives remain unavailable, a factor that farmers perceive as a potential future constraint when governments may decide to implement new regulations.

4.3 Social practice: Competence

Competences include the skills, know-how and techniques required to perform a social practice. Within the WIS context, this can be divided into three main categories, including the soil and water management, the maintenance of the system and the usability of the system.

4.3.1 Soil and water management

Applying WIS in a peatland dairy farming context requires adapting current land-use practices to new additional capabilities. To play into these changes, farmers are required to have know-how of these changes to effectively incorporate WIS.

As stated earlier in the materials paragraph, the two versions of WIS have different levels of capabilities. Whereas passive systems are reliant on natural hydraulic inflow of water into the system, active systems are actively pressurised via pumps that can be remotely controlled. This also means that different competences are needed for each system. Farmers using PWIS mentioned the fact that they had little to no new skills to learn to effectively use the system. As the name suggests, the system is intended to work on a passive basis, and therefore, no input is required from farmers other than the occasional visual checks to see if the system is properly working. Over the years, PWIS systems were optimised to require as little time investment as possible for farmers, this being one of the big hurdles for farmers to participate in WIS projects. Interviews with early adopters (Farmer 5 & 10) made clear that development was made over the years, one of the factors mentioned includes the reduction of labour intensity to use the system in farmers' regular agricultural practices. Early adopters had systems that included more redundant materials, including more objects within the field, hindering regular fieldwork. This was made clear in an interview with farmer 5, who had a 10-year-old PWIS system: "*In this case, we have the disadvantage of the predecessor. That we now have a system that requires a lot of work, while what is being installed today requires much less work*." Newer PWIS require little work to keep running; this was also seen as an advantage by many farmers, who were not convinced to use AWIS systems as a result of the amount of time investment needed. Farmer 8 mentioned the following: "*No, I deliberately didn't take an active WIS. Anything you want to run after takes time and can break.(...) Yes, and I was a bit afraid, looking at myself, that you either act too late or.... Look, if there's a lot of water coming in, then you actually want to pump that soil a bit drier for sure. And if not enough is coming in, then you want to keep it wet. Well, that will still work. But acting on a lot of water, no. I don't think that's for me*."

However, this also means that they require more knowledge and time investment to be effectively used. AWIS farmers mentioned the fact that they had to play into weather conditions at the right time by activating the pump early enough. Farmer 7 mentions that it is important to play into the soil conditions at the right time: *"You have to think a week ahead. Because when you…. yes, especially with pumping in, with pumping out, you have to think three days ahead. It's not like if you want to mow tomorrow and today is sopping wet and you put it on pump out today the tomorrow you can drive. So, you have to think ahead a bit. But that's even worse with pumping in, because if you think 'well it's growing weather' and then because of course there also have an app where you can see how high it is, yes or no. I'm going to put it on pumping in but if you if you have full throttle growing conditions so that you have between 1,500 and 2 tonnes of dry matter standing on a hectare….(..) ….so if it's already too low then and you start pumping in then you're just keeping it at, you won't be able to pump it up any higher."*

All WIS systems have similar advantages as a result of the higher groundwater levels for farmers. Despite WIS primarily being focused on reducing subsidence, which can be advantageous for agricultural purposes in the longer term. WIS also has some advantages for agricultural purposes in the short term. For example, as a result of the moister soil conditions, farmers mentioned the fact that grass would stay green for longer and that growth would recover earlier during and after a prolonged period of drought. Farmer 7 mentioned the following: "*Well, in autumn and all throughout summer, your grass is better utilised in extreme conditions. Because it just stays green for longer or is dry sooner, or whatever. so yes, your opportunity for getting a better economic business result is there."*

AWIS has equipped some farmers with enhanced capabilities for agro-ecological practices, such as creating waterlogged conditions to support meadow birds in early spring. Across Het Groene Hart, many farmers are actively involved in meadow bird conservation. However, effective implementation requires precise timing and expertise. Farmer E2 noted: *"Yes, because you can make the pumps extra dry or extra wet, and if you do that at exactly the wrong time for the birds, they still don't benefit from it."*

Farmers mentioned a few disadvantages they had experienced with WIS within plot management. For example, farmers expressed concerns about objects such as solar panels, monitoring equipment, and wells interfering with regular fieldwork, including mowing and fertilising. Most of the interviewed farmers fertilised their fields using trailing hoses, a common practice in dairy farming. In this method, pressurised hoses transport manure from the barn to the field, where a tractor injects it into the soil. As these hoses are dragged across fields and ditches, any obstacles in the field can hinder the efficiency and feasibility of this regular agricultural practice. Many farmers hire contractors to do this work for them. Having many objects in the way requires more coordination and would increase the amount of time needed to fertilise the field. Farmer 9 mentioned the following: *"If you are going to work with* *wells, you do have to be terribly careful where you put those wells. Because if you are also fertilising with trailing hoses, the wells can sometimes be in the way. (..) Look, you have to uncouple the drag hose sometimes. But nowadays they do that twice a year, so to speak. Then it is important to keep up the pace, because otherwise it is an expensive hobby. Yes, the contractor also has to be able to keep his price down. Yes, if that costs you extra time, 100 euros is nothing, of course."*

4.3.2 Maintenance of the system

Knowing how the keep the system working properly is essential in using WIS for a prolonged time. It is important that the individuals using the technology are aware of what is needed to keep the system running, and whether they can carry out the practice themselves or need help in carrying out this practice. WIS maintenance can be distinguished into two main practices: cleaning the system and repairing the system.

Due to the closed-off design of WIS systems, they are not easily visually inspected for potential problems without severely disrupting the system. Farmers mentioned the fact that they had little knowledge about how the system should be maintained and stated that there was little knowledge available among farmers on how to best maintain the system. Most farmers had WIS installed for only a few years (5 years maximum). However, early adopters mentioned the fact that they had done little maintenance either. They did mention having done the occasional visual checks and cleaning of inlet wells for debris or water plant overgrowth. When asked about maintenance Farmer 12, who has had a similar system installed for more than 20 years, mentioned the following: "*You never actually had to open them [for cleaning]. At most, after cleaning the ditch, if ditch dirt would be on them or something like that, but otherwise, you never really need to open them."*

In conventional drainage systems, known among farmers, periodic flushing is necessary to maintain proper hydraulic capacity. However, water infiltration systems are discouraged from being flushed in peat meadow fields due to the high risk of damaging the fragile peat soil structure and causing pore blockage. Farmer 12, who has extensive experience with both drainage and WIS, stated the following: "*Flushing is completely out of the question here, because then you actually start closing them up. Then you make a kind of mud layer around it, and then the tubes actually clog up. So, you shouldn't spit them out like they want to do on clay and things like that. You absolutely shouldn't do that here, because you actually create a problem at that point."*

In addition to the tubes and inlet wells, AWIS also consists of a control unit and pump; these need to be maintained or repaired periodically. Some farmers experienced this as a potential liability when it becomes too complex and the reliance on third actors, such as mechanics. Farmer 7 mentioned the following: "*If the control unit has a fault in it, you need to get a company in. Then the relays are broken, or the battery has failed. It is very diverse what we have already experienced. The pumps that no longer work. Then you also sometimes find out too late that it actually should have been functioning. If that is on one system.... But if that's on a lot of systems, then you do become vulnerable if the cost is too much time for the average company."*

Farmers using AWIS also mentioned the fact that it was especially important to do maintenance on the system before the evaporation tipping point is reached in spring. During this time, not precipitation but evaporation would become higher, as a result of grass growth and stronger sunlight. This results in a steep drop in groundwater. To play into this, farmers must put groundwater up before it goes down; the pump has to be working properly to effectively use AWIS capabilities. Farmer 6 mentioned the following: *"Yes, so that as soon as you have a lot of maintenance, then of course it's laborious and furthermore it's mainly actually a bit more in the post-season that you have more work on it because* *then you have more often the tipping point of pumping in or out, so to speak. Yes. But like in the middle of summer when then the battery and everything are doing well, it's not too bad*."

As a result of the installation, most farmers experienced subsidence where bog wood was dug out and in locations where digging was done to install inlet wells for the system. To counteract this, farmers were supplied with soil to fill up the resulting holes, paid for by the project's funds. Depending on how much WIS was installed in fields, this was seen as a big part of the maintenance needed as a result of WIS. Although the soil was provided for, farmers mentioned having to put much work in, to fill up the holes. Farmer E1 mentioned the following: "*Yes. Some damage, when you drive, you can still feel from where those trees [bog wood] have been. Then it has subsided again. I have filled it up at least two or three times. It takes some time to sink before you get rid of it.".*

4.3.3 Usability of the system

Like any technology, WIS systems have both applications and limitations, whether inherent to the system itself or influenced by external factors such as resource availability and regulations. Understanding these constraints is essential for effective use.

In general, farmers stated that AWIS were capable of more than PWIS as a result of their additional capacity with a pressurised system. This has led some farmers who currently use PWIS to state they would be tempted to switch to AWIS systems if they had the possibility to do so. WIS aims to stabilise groundwater levels in peatland meadows; the ability to do so is limited to the system's capacity. During the winter, peat meadow areas are not accessible to machines and livestock as a result of waterlogged conditions. Some farmers hoped WIS would allow their pastures to be accessible earlier in spring and thus extend the grazing period. Farmer 2 mentioned the following about how it affected his time window for his cows in early spring grazing: "*Well, the idea was that if you get it dry faster in the spring, you can go outside earlier, and in autumn you can keep grazing longer. Only in practice that doesn't matter.*"

For the supply of water, farmers are limited by the water supply within the polder. PWIS is additionally dependent on a sufficient water level within the polder that allows for the inflow of water from the ditch into the system. This water level is controlled by the waterboard via the polder's pumping stations. To know when water should be pumped up, the waterboard uses its own monitoring information based on polder surface water levels. However, the polder's surface water levels do not correspond with the groundwater levels. To fill this knowledge gap, information about the situation in the fields is shared between farmers and waterboard employees. In some cases, this has led towards a closer collaboration between farmers and the waterboards. Farmer 2 mentioned a closer collaboration on water level management in his polder: *"For them, it was an important thing; they, of course, had a certain level that they had to steer towards. And they also had to let go of that as a kind of thing. Because we have an app group among ourselves with the waterboard."*

For AWIS, the ability to pump water in or out of the field is limited to the capacity of the pump and the power delivery of the power source. Farmer 6 mentioned the following: *"Yes, because now it is sometimes that the capacity is not enough in autumn, so to speak. In summer, it's fine, but if you have fewer hours of sunshine and you do want to pump in, say, our solar panels are not always sufficient. And if it is very heavy rainfall, then it is the other way round, then it is also not sufficient to pump it away, so* to speak."

Active systems give farmers more control of water management on their plots, thereby taking over some of the tasks waterboards normally have. Therefore, farmers are legally allowed to use the however they want. However, farmers interviewed mentioned they had no intention to use it in unintended manners, as it would not benefit them in the long term. Farmer 12 mentioned the following: “*Yes, they don't want you to pump it dry. That's the idea. But that shouldn't really be the goal. On the other hand, it is true, I have constructed the system in such a way that you can use it, exactly as it is intended. That means that you can keep it wetter and wetter in dry periods. But that you can also ensure sufficient drainage of the water from the soil in very wet periods. The system, in my case, in my opinion, is also constructed so robustly that you actually prefer to have as little fluctuation as possible.”*

In general, both systems are limited by the amount of water that is available in the overall water system. WIS systems require a sufficient amount of water to be functional. Farmers were not worried about the water supply overall, as water is abundant in peatland meadows. However, some farmers did mention that this might become a problem in future as it was unknown how much water WIS would use. Farmer 12 mentioned the following: *“Yes, well, the water from the waterboard has already been mentioned in passing, well, that it is underestimated how much water these systems demand. And then I don't even have an active system. I actually have a passive system on a ditch water level. Looking at another farmer who has an active system on the mills at the moment, then you can see how hard they are turning and how high they are putting it up at the moment. And another has water pumps. That one had recently had a fault with the pump, and then the pump had kept running. That one had created waterlogging with WIS. So, I wonder if that waterboard has a full view of what we are going to use as an area of water soon.”*

4.3.4 Competences: Implications for adoption

Based on an analysis of the competencies involved with WIS several key drivers and barriers for adoption could be distinguished:

The two archetypes of WIS, Passive WIS and Active WIS, have distinct competences attached, that either facilitate or hinder their integration into agricultural practices.

PWIS is designed for simplicity and therefore requires minimal technical competency and time investment from the user. The system's simple operation and maintenance mean that farmers can implement it without needing specialised technical expertise. This ease of use is a significant driver for its adoption. As most systems are designed to require as little practice as possible, there was also little knowledge on how the system should be maintained if needed. This meant farmers were not engaging with the system, often taking a passive stance towards it.

In contrast, AWIS has more capabilities and capacity. However, this also means that more competences are needed to operate it effectively. While AWIS offers the significant advantage of being able to independently regulate water levels, this capability comes with additional requirements. Farmers must possess an understanding of how to manage groundwater levels and anticipate weather conditions to use the system effectively. Furthermore, the maintenance of AWIS requires technical expertise or support from third-party professionals. These additional practices may represent a barrier to adopting this specific system.

Overall, the system’s required competences are heavily linked to the materials element, with simpler materials requiring fewer competences but less capabilities and complex materials requiring more competences and time investment to effectively operate.

4.4 Meaning

The meaning element refers to the social and symbolic significance embedded in a practice, shaped by cultural norms, shared values, and collective purposes. This research showed that in the context of WIS, this meaning is primarily associated with values such as economic well-being, entrepreneurial addition, and societal contribution. As an innovation, WIS is not viewed solely through a rational or functional lens; rather, it is understood as a value-driven initiative, deeply influenced by broader cultural and social meanings.

4.4.1 Economic value

Farmers stated several perceived impacts on their economic well-being, influencing their motivation to adopt WIS as a practice. These can be roughly categorised as short-term impacts and longer-term impacts.

Farmers indicated that implementing WIS using their funds would have represented too great an investment in the short term, relative to the expected outcomes in the long term. The implementation costs were perceived as high, particularly without substantial subsidies. To make sure this wasn't a problem for contribution to the WIS project, farmers participating in WIS projects were generally largely or fully compensated (ranging from 80% to 100%). As a result, most farmers viewed the investment not as an issue. However, some farmers mentioned that projects which were not fully compensated could increase in price when relatively large areas were to be installed. Farmer 8 mentioned the following about his financial contribution to the project when asked about his motivation to contribute to the WIS project: "*Yes, purely because the conditions were not so rigid. We had to make a small financial contribution per hectare. But anyway, that was manageable. Look had that contribution been higher or you name it, I don't know if we would have done it. But I don't know for myself anyway, actually, where I would have set that bar then, but yes.".*

While farmers saw potential for long-term economic returns, most were not always convinced of the short-term benefits. However, due to the financial compensation, some viewed it as a zero-loss game. This attitude is best summarised as "if it doesn't help, it doesn't hurt". Farmer 4, who was to be fully compensated in his WIS project, expressed it as follows: *"Look, you also have to be so fair, everything is of course paid now. I think the first scheme was 3 quarters were paid, and you had to contribute the quarter yourself. Now this policy, 100% is paid and also the monitoring and everything else. So yes, that of course makes the step to do it smaller again. If you had to pay X number of 100 euros per hectare, or depending on what kind of WIS you have, and if you then want to put in all your plots. Then it also becomes costly again.... Yes, and how the effect is yes, I find that I actually still hear quite little about the results, I don't know."* Farmer 1 mentioned: *"Even if it doesn't help, it doesn't hurt. It's also partly paid by subsidies. That's always a motivator, I think. To cover part of the cost. And yes, then we will have to see after the fact, if it helps or not. So yes, you have to believe the experts that it helps, but yes that might come up later. I don't see that yet, or it's hard to measure.".*

The perceived short-term drawbacks as a result of installation, such as decreased buffer potential in fields and hindering objects within fields, as well as the damage to soil shortly after installation, were seen as potentially negative factors for the economic results, as it could result in a loss harvest. These were not seen as dealbreakers for farmers as long as these factors were well coordinated within the project. Farmer 10 mentioned a bad experience during installation: "*Drainage contractors are generally used to working in arable areas. Where you have harvested your crop and they have free rein. That is not the same on grassland. The first year we did not like it, that they were driving around in the fields. Well, they think: 'that's bare land then it can be done'. But you can still see it a month later where they drove around. So, stuff like that that was really frustrating though."*

Farmers mentioned that their decision to adopt the practice was strongly influenced by the perceived time investment required to operate the system and the interference it caused with regular agricultural activities. Although the installation of the system would be provided, the ongoing effort to maintain and operate it was seen as additional labour. Particularly given the uncertainty of its outcomes. As a result, farmers emphasised that knowing about the system's effects was crucial to staying motivated to put in the extra effort for WIS in the long term. Farmer 5, an early adopter who had the system installed 10 years ago, mentioned the fact that he needed results to stay motivated: *"…..so that doesn't encourage me to continue with it. I'm actually looking for an incentive to get that work I put into it every year, to get that validated, then you will think, 'yes, you've got results'."*

Some of the farmers hoped they would benefit financially from implementing WIS at a later time. Either through new payment for ecosystem services (PES) policies compensating their efforts, carbon credits or through recognition of their efforts in key performance indicators used by dairy processing companies and banks. Farmers saw adopting WIS as a way of anticipating these future developments. Farmer 8 stated the following: "*Yes, that was a reason to participate, look, if you want financing from the bank, whether you do agricultural nature management, also counts. Of course, and of course it's not that they won't finance you if you don't participate, but you are put under a certain magnifying glass."* Farmer 7, who also was the chair of his local farmers collective mentioned the fact that he was actively pushing the government to give out PES for the maintenance of WIS: *"The province of Utrecht is now working with the people who want AWIS to get compensation for the AWIS farmers, which can be used for 20 years if something breaks down. Currently, WIS project A has been completed, and if a solar panel breaks down or a pump, I have to pay for it myself."*

Another compelling reason for participating in the WIS project was its contribution to the long-term future of their farms. The project was seen as an opportunity to take steps toward making their farms more future-proof. When farmer 2 was asked for his main reason to contribute to his WIS project, he mentioned the following: *"Yes, I think so. I will do it again, yes. Maybe you'll make some minor adjustments again, but that's moving insight. But the concept, the idea that this gives you a future-proof polder for the future, that you can also let the next generation become a farmer, that is the main reason for me to keep participating."* Farmers also perceived the investment by governments in the projects as a symbolic guarantee for the continuation of agricultural land-use. Farmer 4 mentioned the following: "*…Look, first of all, if a province puts, say, a few million euros into a polder or a small area or if it's a large area, you're soon talking about tens of millions of euros. They won't turn around as easily and say: 'well, we'll turn it into a forest or something."*

4.4.2 Entrepreneurial value

An important condition for farmers mentioned in choosing to adopt WIS was the value it provided for their business model as farmers. Farmers attached value to how WIS affected their business model, either by adding capabilities to their farming practices or by restraining their current agricultural practices.

There was a mixed view of WIS as an actual addition to the farm, as not all farmers believed reducing subsidence would help them in their business model; however, some did. This seemed to be affected by the farmer's vision of what was good practice within farming. Early adopter farmer 5, who was convinced WIS would be an addition to his farm, even before he was approached to adopt WIS in his farm, mentioned the following: *"It's because I myself had the idea in advance that this was "THE Egg of Columbus"..... And then there was a subsidy for it, so to speak. I didn't really have to think about that for very long. The waterboard pays three-quarters and then we just go along with it."*

Some farmers also adopted WIS as they were interested in adopting the practice of WIS merely as a way to contribute to innovation. When farmer 3 was asked if this innovation would be a way to contribute to the sustainable development of farming, he answered as follows: *"Yes, otherwise I definitely wouldn't have started it. Yes, that's quite a lot in agriculture anyway. Through innovation and trying and things we are where we are today in agriculture."*

Some farmers mentioned that WIS could be easily connected to other practices they already do, such as agricultural nature management for meadow birds. WIS would make them able to carry out this practice more easily. Farmer E2 mentioned the following: *"Here in the village, there is a farmer who has done it specifically for meadow birds, also in combination with a delayed mowing date, I know. So, he has done that in combination with that package, has uh... done all that for the meadow birds."*

To make sure the innovation was applicable within farmers' business model, farmers emphasised the importance of being able to have influence on the design of the system. For example, Farmer 12 found it important to be able to independently use the system, without relying on third parties, such as civil servants or advisors, as the system's continued operation was viewed as a major limitation. Farmer 12 mentioned the following: *"Well, I wasn't initially convinced to participate, also because it wasn't entirely clear. The preconditions and so on, what drainage levels are we going to? What are the province's conditions? What does the system look like? To what extent do you have decisive power over the system yourself, because ultimately it is funded by province. But to what extent do you remain in control yourself, actually? Those were questions that initially made me decide to be careful in this. And in the end, it turned out, certainly, the way I set up the system, I think, it complements the company. And that's because you have a lot of control over how it works. Yes, anyway, we don't have any electronics here with this system. It's all mechanical."*

4.4.3 Societal value

The innovation of WIS is perceived as contributing to key societal goals, such as reducing CO2 emissions in support of climate change mitigation efforts. A central aspect of WIS is the societal value it offers. While farmers acknowledged WIS could have a positive impact on these societal goals, they also voiced some critical perspectives on the innovation.

Many farmers noted that they saw adopting the innovation as a way to play into societal goals and contribute to them. Some farmers saw this as their duty to contribute to societal goals, as they already did with ecological goals such as meadow bird field management and ecological mowing methods. Famer 11 mentioned the following: *"Well, just a bit of course too, that we actually also want to do a bit for biodiversity and so on and so forth. So, we do that quite fanatically, actually. Also with the ecological ditch cleaning, dredge pumping and so on."*

Farmers also saw contributing to such societal goals as important to show their willingness to adapt their practices in accordance with societal goals. Some farmers mentioned that adopting WIS could be seen as a "license to produce" in the medium to long term. By adopting more sustainable agricultural practices, farmers demonstrated their commitment to broader societal goals and strengthened the legitimacy and continuity of their business. Farmer 2 mentioned the following: *"I think that belongs. It's part of your entrepreneurship; it's part of the way citizens look at the Dutch farmer. I think it's something unique that we can exploit in the long run, and with the right knowledge, you can fit that into a business quite well. To a certain extent, it's a societal task as well."*

While a majority of the farmers perceived land subsidence as a significant concern, this was not always due to subsidence itself. But due to the fact what subsidence policies would mean for their business and their farming practices. With waterboards and provinces aiming for higher water levels as a measure to reduce subsidence, farmers were concerned that it would impact current agricultural practices. Many farmers were concerned not only about what this would mean for themselves, but also for their way of living as farmers and their community. WIS was seen as a pathway to play into these trends as a strategic choice. Being open to change, such as innovations, would also allow them to influence the outcome. Farmer 4 mentioned the following: "*Now it's all paid for out of those climate funds, I believe. So yes, if you don't participate now and you say: 'well, I don't want it' and they say in ten years' time: 'well, you should have participated then, you had that chance then, so now the water levels have to go up'. Or 'well because we don't have enough CO2 reduction' so yes in the end that's obviously behind that that you'd better be ahead and then you'll soon be behind the times....*"

Some farmers expressed having struggled with the thought that WIS would directly result in CO2 reduction. Most scientific evidence for the innovation was done elsewhere, and therefore, the actual effects of WIS could be impacted by circumstantial factors such as the particular soil type. In addition to that, some farmers mentioned not knowing how it would apply to their own farm, as their circumstances may differ from the scientific studies. Farmer 12 mentioned the following: *"There is a lot of talk about the peat and the peat problem. That was actually my first point of criticism that I questioned: the peat problem is actually an issue, so to what extent are we now really sitting on real peat and to what extent is our share of clay in the peat and well, even soil samples taken here in the past showed that we have a considerable share of clay, so you're soon talking about a different problem."*

To make WIS projects financially feasible and the polder-wide installation effective, a minimal amount of area had to be installed with WIS before the project could proceed. Some farmers mentioned that they did not want to be the odd ones out by blocking the project, which could be seen as a sort of peer influence among farmers. Farmer 4 mentioned the following: *"Yes, and also because, of course, as a polder, you have to install 70%, so that is also a reason to participate, even if, of course, you say yes, I'm not participating. There are still a few who don't participate and others who want it very much."*

4.4.4 Meaning: Implications for adoption

Based on an analysis of the Meaning attached to WIS, several key drivers and barriers for adoption could be distinguished: The study showed that farmers' adoption of WIS was fundamentally shaped by the meanings farmers attached to the practice, with distinct drivers and barriers emerging from this meaning analysis.

The initial investment costs posed a potential barrier for adoption, however large subsidies effectively negated this barrier for most participants, resulting in a zero-loss scenario described by the pragmatic attitude: *"if it doesn't help, it doesn't hurt."*

Positive economic value was an important driver for adoption, with some farmers attracted by potential future revenue streams from ecosystem services, such as, carbon credits and subsidies.

These future benefits had to be weighed up against short-term operational challenges. The most substantial adoption barriers stemmed from practical concerns, particularly WIS' impacts on field accessibility, short-term damage to the soil structure, and disruptions in workflow that could harm regular farming operations.

The most important adoption drivers are centred on long-term strategic considerations. Many farmers viewed WIS as a proactive measure to align with anticipated regulatory changes, particularly regarding water table management to combat subsidence, seeing it as a way to secure their future by giving them a *"license to produce"*. However, this perspective varied based on farm-specific conditions; farmers' assessments of WIS's addition to the farm depended heavily on local factors like soil composition and drainage levels, as well as individual philosophies on what is deemed good farming. Some farmers had a strong preference for keeping autonomy in their agricultural practices, with farmers resisting designs that would make them dependent on external support.

The societal value of WIS was deemed to be important. Many participants framed WIS implementation as part of their environmental stewardship, drawing parallels with conservation practices like meadow bird protection. Peer dynamics also influenced decisions, as the collective nature of water management meant some farmers adopted primarily to maintain social cohesion rather than be perceived as obstructing community-driven initiatives. While subsidence mitigation was acknowledged as important, farmers expressed greater concern about restrictive policies, leading some to view WIS adoption as a pragmatic adaptation to inevitable regulatory changes rather than an optimal solution.

For farmers, adopting WIS came down to a personal calculation. Farmers had to weigh up the upfront cost against potential long-term payoffs, to decide if the technology truly worked for their context, and reflect on their responsibilities as stewards of their community. In the end, their decision to adopt WIS or not was based on what WIS meant for them. This could be either an opportunity, a burden or a duty for the community.

5. Discussion

In this chapter, the results will be interpreted. Starting with the most important drivers and barriers according to practice theory. The discussion then branches out to consider these findings within the context of scaling theory, before concluding with the broader implications of the research.

5.1 Interpreting the results

By using practice theory as conceptualised by Shove et al. (2012), the social practices attached to Water Infiltration Systems within the context of Het Groene Hart could be analysed. This study revealed that farmers' adoption of water infiltration systems (WIS) hinges on understanding the social practices associated with WIS and how these interact with existing routines. In comparison to more disruptive innovations, WIS presents relatively low material barriers to adoption, as it integrates easily into daily farming practices without requiring significant changes. When WIS necessitated changes to established routines, this emerged as a significant barrier to adoption. The interplay between materials and competences proved critical: Simpler technologies required fewer new skills, making adoption smoother, whereas complex systems demanded greater expertise, being barriers for adoption. Farmers became more receptive to complex WIS technologies (AWIS) once they attached positive meaning to the innovation, particularly when it offered economic benefits (e.g., carbon credits) or operational advantages (e.g., facilitating meadow bird management). This makes clear how perceived value can outweigh initial resistance to change, even when greater competence is required. This all aligns with the academic perception fundamental in social practice theory, which states that materials, competences, and meanings jointly shape change as they are made, broken, or reconfigured (Shove et al., 2012)

Although farmers recognised that WIS, as an innovation, could be effective in mitigating the effects of subsidence on their farms, it was not valued solely for its potential to reduce subsidence. As for some farmers, the uncertainty about the system's outcomes and the tangible benefits it could offer were deemed too high. However, farmers did appreciate the system for its societal value, as it enabled them to align with broader societal trends. It provided a way for them to demonstrate their willingness to contribute to addressing climate change as a societal issue, thereby granting them a "license to produce", especially helpful in an uncertain policy context characteristic of these times. This, however, does not mean that farmers merely viewed the innovation as the definitive solution, but as one of the ways to play into the current policy context.

To date, the reduction of barriers, driven by institutional support from regional water boards and financial support from provincial governments, has facilitated a relatively smooth scaling process by the implementation of WIS in many polders. As a result, the primary remaining challenges have shifted to the social and biophysical domains (Turnheim et al., 2018). Early adopters easily embraced the innovation, perceiving it as a valuable addition to their operations. However, later adopters showed greater resistance, prioritising individual preferences and prioritising customised solutions. This divergence has led to the development of tailored systems designed to accommodate the specific needs and preferences of specific farmers in their geographical context. Therefore, it could be said that scaling of WIS within het Groene Hart is a process of circulation (Turnheim et al., 2018).

The adoption and sustained implementation of Water Infiltration Systems (WIS) by farmers is currently dependent upon two critical conditions: the low economic barriers through financial support, and the lack of restrictive regulatory frameworks. While regional governments have actively supported WIS projects through these domains, such interventions carry inherent risks due to significant knowledge gaps regarding WIS's systemic hydrological impacts on polder systems. This results in a paradox in which policymakers must balance the urgency of climate adaptation with the precautionary principle taken by water authorities, as unanticipated effects on the wider hydrology in the polder could undermine other policy goals, including water safety objectives (Termeer et al., 2011).

Despite facilitating WIS projects in the overall water system carry inherent risks, these interventions also generate new dynamics that may catalyse change. Many farmers have organised through bottom-up initiatives to implement WIS projects, leading to the emergence of new governance entities. These entities based on end-user input, can both drive further changes as well as drive the maintenance of current practices.

In the end, the future of WIS scaling depends on balancing the embracing of innovation with risk management by ensuring that scaling efforts are both inclusive and ecologically sustainable. The emergence of bottom-up governance structures gives potential for adaptive, farmer-driven solutions, but long-term success will depend on continuous learning, policy coherence, and the ability to harmonise priorities in water management.

5.2 Limitations of this study and future research

Using social practice theory comes with several inherent theoretical limitations that should be taken into consideration. Social practice theory is a qualitative approach that offers depth in understanding practices; however, it faces challenges in terms of generalisability beyond the specific context of Het Groene Hart. The theory's focus on collective routines and shared meanings means findings are deeply embedded in the context, which makes it difficult to assess how readily these insights might transfer to other contexts and other innovations. This context dependence is further complicated by the theory's emphasis on practices rather than individual decision-making processes, which can underexpose or overlook psychological factors that also shape farmers' adoption behaviours. In that case, using the theory of planned behaviour would be beneficial (Ajzen, 1991; Sok et al., 2021).

Operationalising social practice theory presents challenges, as these are deeply embedded in the empirical evidence found within this specific research. Unlike more structured theoretical frameworks, social practice theory does not allow for clear metrics for measurement beforehand because of the studies' explorative nature. An attempt was made to address this with explorative interviews to base the interview guides on; however, this did not fully address this issue. Furthermore, the study captures practices at a particular moment in time, potentially missing how these evolve as farmers gain experience with WIS or as external conditions like policy and climate change. The same could be said about the development of WIS, which continues to evolve, with new knowledge emerging in each project.

Future research could address these limitations and enhance generalizability by employing a more rigorously operationalised approach. For instance, Qualitative Comparative Analysis (QCA) (Witvliet et al., 2024) could be used to identify key causal factors, both drivers and barriers, across multiple cases, helping to isolate more universal conditions.

Despite the constraints posed by social practice theory, the approach remains particularly valuable for uncovering the often-overlooked socio-material dynamics of innovation adoption, providing rich insights that purely economic or technological perspectives might miss. Its strength lies in revealing how innovations become embedded in daily routines, materials, and meanings that constitute agricultural practice. This nuanced understanding is especially crucial for developing policy that aligns with farmers' existing practices.

To build on the insights gained from this study, more research can be done on the policy and governance context within the same geographical region to get a better understanding of how the governance process played a role in the adoption of WIS. Particularly, how the bottom-up initiatives, such as the farmer collectives, played a role in this (De Haas & Westerink, 2025). Additionally, to further build on the drivers and barriers found in this study, similar research can also be done in a different context, including other countries or other peatland meadow regions within the Netherlands. This allows for comparative research, which can either confirm or nuance the findings in this study, allowing for a more general understanding of the researched phenomena.

6. Conclusion

This study focused on qualitative research in a single case study. Methods used included semi-structured interviews, observations and desk research. Semi-structured interviews were the main method used for conducting 16 interviews with 14 farmers who adopted WIS as a practice, spread throughout the Groene Hart and 2 waterboard civil servants involved in the WIS projects throughout the region. This research aimed to find the drivers and barriers for the adoption of a climate-smart agricultural practice. This study focused on Water Infiltration Systems in het Groene Hart. By using practice theory as conceptualised by Shove et al. (2012). The social practices connected to Water Infiltration Systems could be analysed at a deep level. This allowed the study to answer the following research question:

What are drivers and barriers for dairy farmers to implement water infiltration systems (WIS) within their social practices, and what does it mean for the scaling of WIS in het Groene Hart?

The study gained a nuanced understanding of the practices involved with WIS and how they affect the daily routines of farmers. Drivers for adoption were deeply connected to the material complexity and the effect on current routines. Once the lower complexity forms a lower barrier to adoption for farmers. And, when a positive meaning was attached to the social practice, farmers showed to be willing to accept more complexity.

To conclude, this study provided a detailed understanding of the interplay between elements of social practices and how this can thrive and change. Water infiltration systems are not a definitive solution but can drive change with incremental steps. Providing a dynamic in which both land-users and policy makers can profit in an unstable policy environment.

Recommendations for practice

Building upon the nuanced understanding of the social practices surrounding WIS, the following recommendations are offered to inform and guide policymakers seeking to scale the adoption of this climate-smart practice, in addition to the conclusion:

To ensure the long-term success of WIS, farmers should be involved in ongoing research and kept informed of the results. This study found that farmers attach significant meaning to results. Demonstrating tangible outcomes is crucial for maintaining farmers' motivation, which may translate into sustained practices like the systems' maintenance. Additionally, this can help in scaling of WIS, as discourse in the farming community will be affected. For PWIS users, this is additionally important as PWIS users attached the least meaning to the system. Doing this requires effective communication with information which is tailored to farmers.

Policymakers should recognise that promoting an innovation like WIS constitutes a long-term commitment in partnership with farmers, which requires stable financial and regulatory frameworks. This study found that farmers derive significant meaning from the long-term commitment that WIS implementation gives. Therefore, it is highly important that this commitment is reciprocated and enshrined in policy. Governments should avoid stop-start funding cycles and ensure that policy pathways are consistent and reliable to secure farmer trust and investment.

The implementation of practical measures such as WIS are an opportunity for further collaboration between landowners (farmers) and local governments. As they work together on common goals for which constructive partnership is needed. This can bridge the gap between policy and practice. Using this approach in more projects could be advantageous in tackling key environmental and societal challenges. This requires courage from both sides but can lead towards lasting solutions that are much needed for both farmers and societal goals.

7. References

Aben, R. C. H., Van De Craats, D., Boonman, J., Peeters, S. H., Vriend, B., Boonman, C. C. F., Van Der Velde, Y., Erkens, G., & Van Den Berg, M. (2024). CO_2 emissions of drained coastal peatlands in the Netherlands and potential emission reduction by water infiltration systems. *Biogeosciences*, *21*(18), 4099–4118. https://doi.org/10.5194/bg-21-4099-2024

Ajzen, I. (1991). The theory of planned behavior. *Theories of Cognitive Self-Regulation*, *50*(2), 179–211. https://doi.org/10.1016/0749-5978(91)90020-T

Beunen, R., Duineveld, M., & Van Assche, K. (2021). Flat Ontology and Evolving Governance: Consequences for Planning Theory and Practice. *disP - The Planning Review*, *57*(2), 112–123. https://doi.org/10.1080/02513625.2021.1981017

Born, G. J. V. den, Kragt, F., Henkens, D., Rijken, B., Bemmel, B. van, & Sluis, S. van der. (2016). *Dalende bodems, stijgende kosten: Mogelijke maatregelen tegen veenbodemdaling in het landelijk en stedelijk gebied* (No. 1064; p. 92). PBL Planbureau voor de Leefomgeving.

Burton, R. J. (2004). Seeing Through the 'Good Farmer's' Eyes: Towards Developing an Understanding of the Social Symbolic Value of 'Productivist'Behaviour. *Sociologia Ruralis*, *44*(2).

Buzacott, A. J. V., Kruijt, B., Bataille, L., Van Giersbergen, Q., Heuts, T. S., Fritz, C., Nouta, R., Erkens, G., Boonman, J., Van Den Berg, M., Van Huissteden, J., & Van Der Velde, Y. (2024). Drivers and Annual Totals of Methane Emissions From Dutch Peatlands. *Global Change Biology*, *30*(12), e17590. https://doi.org/10.1111/gcb.17590

Council for the Environment and Infrastructure. (2020). *Stop Land Subsidence in Peat Meadow Areas: The 'Green Heart' Area as an Example* (p. 69).

Darnhofer, I. (2014). Resilience and why it matters for farm management. *European Review of Agricultural Economics*, *41*(3), 461–484. https://doi.org/10.1093/erae/jbu012

De Haas, W., & Westerink, J. (2025). Landscape governance as a matter of concern: A relational framework. *Ambio*. https://doi.org/10.1007/s13280-025-02226-5

Flor, R. J., Singleton, G., Casimero, M., Abidin, Z., Razak, N., Maat, H., & Leeuwis, C. (2016). Farmers, institutions and technology in agricultural change processes: Outcomes from Adaptive Research on rice production in Sulawesi, Indonesia. *International Journal of Agricultural Sustainability*, *14*(2), 166–186. https://doi.org/10.1080/14735903.2015.1066976

Geels, F. W. (2002). Technological transitions as evolutionary reconfiguration processes: A multi-level perspective and a case-study. *Research Policy*, *31*(8–9), 1257–1274. https://doi.org/10.1016/S0048-7333(02)00062-8

Geels, F. W. (2011). The multi-level perspective on sustainability transitions: Responses to seven criticisms. *Environmental Innovation and Societal Transitions*, *1*(1), 24–40. https://doi.org/10.1016/j.eist.2011.02.002

Geels, F. W. (2018). Socio-technical transitions to sustainability. In *Oxford Research Encyclopedia of Environmental Science*.

Geels, F. W., & Schot, J. (2007). Typology of sociotechnical transition pathways. *Research Policy*, *36*(3), 399–417. https://doi.org/10.1016/j.respol.2007.01.003

Geurts, J. J. M., & Fritz, C. (2018). *Paludiculture pilots and experiments with focus on cattail and reed in the Netherlands*. https://doi.org/10.13140/RG.2.2.12916.24966

Giddens, A. (1984). *The Constitution of Society: Outline of the Theory of Structuration*. University of California Press. https://books.google.nl/books?id=x2bf4g9Z6ZwC

Giller, O., Ploegmakers, H., & Meijerink, S. (2025). Reconfiguring agricultural water management practices: Lessons from research on scaling of controlled drainage and subirrigation systems. *Agricultural Water Management*, *312*, 109451. https://doi.org/10.1016/j.agwat.2025.109451

Glover, D., Sumberg, J., Ton, G., Andersson, J., & Badstue, L. (2019). Rethinking technological change in smallholder agriculture. *Outlook on Agriculture*, *48*(3), 169–180. https://doi.org/10.1177/0030727019864978

Guba, E. G., & Lincoln, Y. S. (1989). Fourth generation evaluation. *Fourth Generation Evaluation.*, 294–294.

Harrison, H., Birks, M., Franklin, R., & Mills, J. (2017). Case Study Research: Foundations and Methodological Orientations. *Case Study Research*.

HDSR. (2009). *Beleidsregels op grond van de Keur van het Hoogheemraadschap De Stichtse Rijnlanden 2009*.

HHR. (2024, April 18). *[23.074351] Nota veenweide—Hoogheemraadschap van Rijnland*. Hoogheemraadschap van Rijnland.

(Janine) De Wit, J. A., (Coen) Ritsema, C. J., (Jos) Van Dam, J. C., (Gé) Van Den Eertwegh, G. A. P. H., & (Ruud) Bartholomeus, R. P. (2022). Development of subsurface drainage systems: Discharge – retention – recharge. *Agricultural Water Management*, *269*, 107677. https://doi.org/10.1016/j.agwat.2022.107677

Kates, R. W., Travis, W. R., & Wilbanks, T. J. (2012). Transformational adaptation when incremental adaptations to climate change are insufficient. *Proceedings of the National Academy of Sciences*, *109*(19), 7156–7161. https://doi.org/10.1073/pnas.1115521109

KIWA. (2021). *KIWA richtlijn aanleg waterinfiltratiesystemen*.

Kløve, B., Sveistrup, T. E., & Hauge, A. (2010). Leaching of nutrients and emission of greenhouse gases from peatland cultivation at Bodin, Northern Norway. *Geoderma*, *154*(3–4), 219–232. https://doi.org/10.1016/j.geoderma.2009.08.022

Leeuwis, C., & Aarts, N. (2021). Rethinking Adoption and Diffusion as a Collective Social Process: Towards an Interactional Perspective. In H. Campos (Ed.), *The Innovation Revolution in Agriculture* (pp. 95–116). Springer International Publishing. https://doi.org/10.1007/978-3-030-50991-0_4

Lipper, L., McCarthy, N., Zilberman, D., Asfaw, S., & Branca, G. (Eds.). (2018). *Climate Smart Agriculture: Building Resilience to Climate Change* (Vol. 52). Springer International Publishing. https://doi.org/10.1007/978-3-319-61194-5

Massop, H. T. L., Hessel, R., Van Den Akker, J. J. H., Van Asselen, S., Erkens, G., Gerritsen, P. A., & Gerritsen, F. H. G. A. (2024). Monitoring long-term peat subsidence with subsidence platens in Zegveld, The Netherlands. *Geoderma*, *450*, 117039. https://doi.org/10.1016/j.geoderma.2024.117039

Ministerie van Volkshuisvesting, R. O. en M. (2010, September 24). *Voortgang klimaatdoelen—Klimaatverandering—Rijksoverheid.nl* [Onderwerp]. Ministerie van Algemene Zaken. https://www.rijksoverheid.nl/onderwerpen/klimaatverandering/voortgang-klimaatdoelen

Moon, K., & Blackman, D. (2014). A Guide to Understanding Social Science Research for Natural Scientists. *Conservation Biology*, *28*(5), 1167–1177. https://doi.org/10.1111/cobi.12326

Moore, M.-L., Riddell, D., & Vocisano, D. (2015). Scaling Out, Scaling Up, Scaling Deep: Strategies of Non-profits in Advancing Systemic Social Innovation. *Journal of Corporate Citizenship*, *2015*(58), 67–84. https://doi.org/10.9774/GLEAF.4700.2015.ju.00009

Moore, M.-L., Tjornbo, O., Enfors, E., Knapp, C., Hodbod, J., Baggio, J. A., Norström, A., Olsson, P., & Biggs, D. (2014). Studying the complexity of change: Toward an analytical framework for understanding deliberate social-ecological transformations. *Ecology and Society*, *19*(4), art54. https://doi.org/10.5751/ES-06966-190454

NKB, & NOBV. (2020). *Factsheet: Onderwater- en drukdrainage* (p. 29). https://www.kbf.nl/kennisbank/factsheet-deelexpeditie-onderwater-en-drukdrainage/

NOBV. (2025). *SOMERS en Rekenregels – NOBV*. https://www.nobveenweiden.nl/bevindingen-rekenregels/

OMDH. (n.d.). *Slootdempingen Krimpenerwaard* [Overzichtspagina]. Omgevingsdienst Midden-Holland; Omgevingsdienst Midden-Holland. Retrieved 25 July 2025, from https://www.odmh.nl/thema/bodem-archeologie/slootdempingen/

Ossendorp, A. (2022). *MSc Thesis Cattail Cultivation—Network of Practices* [Msc]. Wageningen University and Research.

Pagina niet gevonden – Klimaatslimboerenopveen.nl. (n.d.). Retrieved 12 March 2025, from https://klimaatslimboerenopveen.nl/downloads/wp-content/uploads/2021/10/21021013-Nationaal-Onderzoeksprogramma-Broeikasgassen-Veenweiden_Pui-Mee-Chan-STOWA.pdf

Provincie Noord-Holland. (2022, May 17). *Provinicie Noord-Holland Regionale Veenweidestrategie*. Provincie Noord-Holland.
Provincie Utrecht. (2022, February 9). *Regionale Veenweiden Strategie Utrechtse Veenweiden*.
Provincie Zuid-Holland. (2022, November 22). *Strategie Vitale Veenweiden Zuid-Holland*. Provincie Zuid-Holland. https://www.zuid-holland.nl/publish/besluitenattachments/strategie-vitale-veenweiden/strategie-vitale-veenweiden-nov22-pdf.pdf&ved=2ahUKEwimx4b10aCPAxXF9wIHHSRVHNoQFnoECBsQAQ&usg=AOvVaw20PLXIty0JJ6oHj8R90nJ9
Raad voor de Leefomgeving en Infrastructuur. (2020). *Stop bodemdaling in veenweidegebieden: Het Groene Hart als voorbeeld*.
Rickards, L., & Howden, S. M. (2012). Transformational adaptation: Agriculture and climate change. *Crop and Pasture Science*, *63*(3), 240. https://doi.org/10.1071/CP11172
Rijksoverheid. (2023). *Ontwerp Nationaal Programma Landelijk Gebied*.
Rogers, E. M. (1983). *Diffusion of innovations* (3. ed). Free Press [u.a.].
Schut, M., Leeuwis, C., & Thiele, G. (2020). Science of Scaling: Understanding and guiding the scaling of innovation for societal outcomes. *Agricultural Systems*, *184*, 102908. https://doi.org/10.1016/j.agsy.2020.102908
Schut, M., Van Paassen, A., Leeuwis, C., & Klerkx, L. (2014). Towards dynamic research configurations: A framework for reflection on the contribution of research to policy and innovation processes. *Science and Public Policy*, *41*(2), 207–218. https://doi.org/10.1093/scipol/sct048
Shove, E., Pantzar, M., & Watson, M. (2012). *The Dynamics of Social Practice: Everyday Life and How it Changes*. SAGE Publications Ltd. https://doi.org/10.4135/9781446250655
Smit, B., & Wandel, J. (2006). Adaptation, adaptive capacity and vulnerability. *Global Environmental Change*, *16*(3), 282–292. https://doi.org/10.1016/j.gloenvcha.2006.03.008
Smolders, A. J. P., Lamers, L. P. M., Lucassen, E. C. H. E. T., Van Der Velde, G., & Roelofs, J. G. M. (2006). Internal eutrophication: How it works and what to do about it—a review. *Chemistry and Ecology*, *22*(2), 93–111. https://doi.org/10.1080/02757540600579730
Sok, J., Borges, J. R., Schmidt, P., & Ajzen, I. (2021). Farmer Behaviour as Reasoned Action: A Critical Review of Research with the Theory of Planned Behaviour. *Journal of Agricultural Economics*, *72*(2), 388–412. https://doi.org/10.1111/1477-9552.12408
STOWA. (n.d.). *Delftafact: Onderwaterdrainage*. STOWA. Retrieved 23 January 2025, from https://www.stowa.nl/deltafacts/zoetwatervoorziening/droogte/onderwaterdrainage
Tanneberger, F., Appulo, L., Ewert, S., Lakner, S., Ó Brolcháin, N., Peters, J., & Wichtmann, W. (2021). The Power of Nature-Based Solutions: How Peatlands Can Help Us to Achieve Key EU Sustainability Objectives. *Advanced Sustainable Systems*, *5*(1), 2000146. https://doi.org/10.1002/adsu.202000146
Termeer, C., Dewulf, A., Rijswick, H. V., Buuren, A. V., Huitema, D., Meijerink, S., Rayner, T., & Wiering, M. (2011). The regional governance of climate adaptation: A framework for developing legitimate, effective, and resilient governance arrangements. *Climate Law*, *2*(2), 159–179. https://doi.org/10.1163/CL-2011-032
Turnheim, B., Kivimaa, P., & Berkhout, F. (2018). Beyond Experiments: Innovation in Climate Governance. In B. Turnheim, P. Kivimaa, & F. Berkhout (Eds.), *Innovating Climate Governance* (1st ed., pp. 1–26). Cambridge University Press. https://doi.org/10.1017/9781108277679.002
Van Buuren, A., Vreugdenhil, H., Van Popering-Verkerk, J., Ellen, G. J., Van Leeuwen, C., & Breman, B. (2018). The Pilot Paradox: Exploring Tensions between Internal and External Success Factors in Dutch Climate Adaptation Projects. In B. Turnheim, P. Kivimaa, & F. Berkhout (Eds.), *Innovating Climate Governance* (1st ed., pp. 145–165). Cambridge University Press. https://doi.org/10.1017/9781108277679.011
Van Den Akker, J., Van Diggelen, J. M. H., Van Houwelingen, K., Van Kleef, J., Pleijter, M., Smolders, A. J. P., Turlings, L. G., & Van Der Wielen, S. (2016). *Praktijkproef onderwaterdrains Wormer- en Jisperveld*. Wageningen Environmental Research. https://doi.org/10.18174/396962

Van den Broek, J., Van Elzakker, I., Maas, T., & Deuten, J. (2020). Voorbij lokaal enthousiasme—Lessen voor opschalen van Living labs. *Den Haag: Rathenau Instituut*.
van der Ploeg, J. D. (2008). *The New Peasantries, struggles for autonomy and sustainability in an era of empire and globalization*. Earthscan. https://research.wur.nl/en/publications/the-new-peasantries-struggles-for-autonomy-and-sustainability-in-
Van Thiel, S. (2014). *Research Methods in Public Administration and Public Management: An introduction* (1st ed.). Routledge. https://doi.org/10.4324/9780203078525
Vermaat, J. E., Harmsen, J., Hellmann, F. A., Van Der Geest, H. G., De Klein, J. J. M., Kosten, S., Smolders, A. J. P., Verhoeven, J. T. A., Mes, R. G., & Ouboter, M. (2016). Annual sulfate budgets for Dutch lowland peat polders: The soil is a major sulfate source through peat and pyrite oxidation. *Journal of Hydrology*, *533*, 515–522. https://doi.org/10.1016/j.jhydrol.2015.12.038
Vreugdenhil, H., Van Popering-Verkerk, & Van Buuren, A. (2021). *Leren van Pilots: Hoe pilots echt tot verandering kunnen leiden in de gemeente Rotterdam* (p. 33). Erasmus Universiteit.
Wagenaar, H. (2014). *Meaning in Action: Interpretation and Dialogue in Policy Analysis: Interpretation and Dialogue in Policy Analysis* (0 ed.). Routledge. https://doi.org/10.4324/9781315702476
Westermann, O., Förch, W., Thornton, P., Körner, J., Cramer, L., & Campbell, B. (2018). Scaling up agricultural interventions: Case studies of climate-smart agriculture. *Agricultural Systems*, *165*, 283–293. https://doi.org/10.1016/j.agsy.2018.07.007
Wigboldus, S., Klerkx, L., Leeuwis, C., Schut, M., Muilerman, S., & Jochemsen, H. (2016). Systemic perspectives on scaling agricultural innovations. A review. *Agronomy for Sustainable Development*, *36*(3), 46. https://doi.org/10.1007/s13593-016-0380-z
Wise, R. M., Fazey, I., Stafford Smith, M., Park, S. E., Eakin, H. C., Archer Van Garderen, E. R. M., & Campbell, B. (2014). Reconceptualising adaptation to climate change as part of pathways of change and response. *Global Environmental Change*, *28*, 325–336. https://doi.org/10.1016/j.gloenvcha.2013.12.002
Witvliet, B., Ploegmakers, H., & Meijerink, S. (2024). A theory-driven framework for the design and implementation of successful agri-environmental programmes: Results of a realist review. *International Journal of Agricultural Sustainability*, *22*(1), 2322251. https://doi.org/10.1080/14735903.2024.2322251

Appendix I: Interview guide / checklist – semi structured interview – Farmers

** Voorafgaand aan het interview wordt gevraagd of de geïnterviewde akkoord gaat met de opname van het gesprek. Hierbij wordt anonimiteit gewaarborgd als deze gewenst is. **

(opname start)

I. Introductie van het onderzoek

Introductie van de interviewer

"Met dit onderzoek wordt onderzocht wat boeren tegenkomen en motiveert of tegenhoudt bij het implementeren van WIS binnen hun bedrijf. Hiermee kunnen lessen worden getrokken over de opschaling van deze innovatie in het algemeen en lessen voor de toekomst van het gebied. Daarom worden meerdere boeren geïnterviewd over hun ervaringen."

** Er toegelicht wat met de resultaten van het interview gedaan zal worden. **

II. Introductie

Ik wil beginnen met wat introductie vragen:

1. *Zou u wat willen vertellen over uw bedrijf?*
   - *Hoeveel stuks vee heeft u?*
   - *Hoeveel hectare land heeft u?*
   - *Heeft u andere ondernemingen naast de veehouderij zelf?*

2. *Bent u betrokken bij ontwikkelingen in de omgeving, bijvoorbeeld actief in verenigingen of besturen?*
   - *Welke rol heeft u hierin?*
   - *Wat is uw motivatie om hiermee bezig te zijn?*

III. Water Infiltratie systemen

Nu wil ik het gaan hebben over het project rondom Water Infiltratie Systemen in uw omgeving.

3. *Hoe bent u in aanraking gekomen met het WIS project in uw omgeving?*
   - *Waren dit mensen uit uw netwerk of waren dit onbekende?*

4. *Was u snel overtuigd wel of niet mee te doen?*
   - *Wat waren de punten waarover u twijfelde?*

5. *Hoe zou u, uw algehele ervaring met WIS tot nu toe omschrijven?*
   - *Wat zijn de positieve ervaringen?*
   - *Wat zijn de negatieve ervaringen?*

6. *Zou u het met de huidige ervaringen nog steeds laten aanleggen?*

Vragen ingaande op praktijken rondom WIS

IV. Aanleg van WIS en nazorg (vaardigheden & materialen)

Nu wil ik het graag hebben over WIS zelf, zowel de aanleg en de nazorg/onderhoud.

7. *Hoe is de aanleg van WIS verlopen en kwam hier veel bij kijken?*
   - Heeft u hier veel werk aan gehad?

8. *Hoe heeft u de samenwerking met aannemer en adviseurs ervaren?*
   - Heeft u veel eigen input geleverd?
   - Was er ruimte voor maatwerk?
   - Was er veel flexibiliteit vereist vanuit beide kanten?

9. *Welke lokale factoren waren van invloed op de aanleg?*
   - Verontreinigingen (gedempte sloten, opmaakdek)
   - Obstakels ondergronds (oude bomen, nutsvoorzieningen)
   - Vorm van het perceel
   - Ligging t.o.v. de sloten

10. *Heeft u nazorg gehad na de aanleg van het systeem?*
   - Aanvulling van grond na verzakkingen

V. Gebruik van WIS (vaardigheden)

11. *Heeft u er werk aan om het systeem goed te laten functioneren, buiten de nazorg om?*
   - Doorspuiten van het systeem, vervanging van kapotte materialen, etc.

12. *Als u gebruik maakt van een actief system, welke vaardigheden heeft u moeten leren om het systeem goed te kunnen gebruiken?*
   - *Heeft u hierbij hulp gekregen?*

13. *Zijn er afspraken vastgesteld over hoe u het systeem mag gebruiken?*
   - *Verbod op zelf water inlaten (door het waterschap)?*

VI. Betekenis

14. *Hoe ziet u de rol van boeren in de instandhouding van de natuur en het cultuurlandschap in het Groene Hart?*

15. *Wat was voor u de voornaamste reden om mee toe doen aan dit project?*
   - *Bedrijfseconomische redenen*
   - *Praktische redenen*
   - *Klimaatverandering*
   - *Maatschappelijke betrokkenheid*
   - *Rentmeesterschap*

16. *Ziet u deze innovatie als een manier om het gebied toekomstbestendig te maken?*

VII. Opschaling

17. *Denkt u dat WIS en dit project ook zou kunnen werken in andere gebieden?*

18. *Waar moet goed rekening mee worden gehouden in het beleid om dergelijke innovaties te promoten?*

VIII. Afsluiting

Bedankt voor het mee doen aan dit onderzoek

19. *Heeft u nog verdere vragen of heeft u andere dingen toe te voegen?*

Er wordt nogmaals herhaald of men instemt met de opname en er wordt verteld wat gedaan zal worden met de resultaten. Hierna wordt de opname stil gezet

(einde opname)

Appendix II: Interview guide / checklist – semi-structured interview – Civil Servant Waterboards

* Voorafgaand aan het interview wordt gevraagd of de geïnterviewde akkoord gaat met de opname van het gesprek. Hierbij wordt anonimiteit gewaarborgd als deze gewenst is. *

(opname start)

I. Introductie van het onderzoek

Introductie van de interviewer

"Met dit onderzoek wordt onderzocht wat boeren tegenkomen en motiveert of tegenhoudt bij het implementeren van WIS binnen hun bedrijf. Hiermee kunnen lessen worden getrokken over de opschaling van deze innovatie in het algemeen en lessen voor de toekomst van het gebied. Daarom worden meerdere boeren geïnterviewd over hun ervaringen met WIS zelf en het process er rondom heen. Om dit in een context te plaatsen, wil ik ook graag het perspectief van het waterschap weten."

* Er toegelicht wat met de resultaten van het interview gedaan zal worden. *

II. Introductie

Ik wil beginnen met wat introductie vragen:

1. Zou u wat willen vertellen over uw functie bij het waterschap?

- Hoe lang doet u dit al?

2. Hoe belangrijk is het veenweidegebied voor het waterschap, beslaat dit een groot deel van het werk dat het waterschap doet?

- Hoeveel van de organisatie is hier mee bezig?

- Welke taken heeft het waterschap hier?

3. Wat ziet u als de grootste uitdagingen in het veenweidegebied, nu en in de toekomst?

- Bodemdaling

- Waterkwantiteit

- Waterkwaliteit

- Waterbeheer

III. Water Infiltratie systemen

4. Ziet het waterschap WIS als een goede manier om nu en in de toekomst, uitdagingen in het veenweidegebied aan te pakken?

- Wat zijn de positieve aspecten?

- Wat zijn de negatieve aspecten?

5. Hoe ziet u de rol van het waterschap in het implementeren van deze innovaties?

- Wat kan het waterschap wel doen?
- Wat niet?

6. Wat gaat goed het strategische beleid van het waterschap rondom WIS, wat kan er nog geleerd worden?

7. Kan het waterschap genoeg water blijven leveren om de polders in de huidige manier in stand te houden?

8. Hebben jullie een beeld van wat het effect is van WIS op het waterbeheer en de waterbeschikbaarheid?

IV. Relatie met boeren

9. Hoe is de relatie tussen boeren die WIS implementeren en het waterschap?

- Hebben jullie veel contact?
- Delen jullie gegevens over het effect van WIS op bodemdaling?

10. Hoe belangrijk vindt het waterschap de relatie met boeren belangrijk is om uitdagingen in het Veenweidegebied aan te pakken?

11. Hoe staat het waterschap in het algemeen tegenover innovaties in de agrarische sector, die effect kunnen hebben op het watermanagement?

- Terughoudend of welwereend?

V. Toekomst van het veenweidegebied

12. Tot hoe verre zijn de uitdagingen in het veenweidegebied en de landbouw met elkaar te verenigen?

13. Kan WIS een bijdrage leveren aan een duurzamere manier van landbouw?

14. Wat is het effect van klimaatverandering op de toekomst van het veenweidegebied en het watersysteem?

VI. Afsluiting

Bedankt voor het mee doen aan dit onderzoek

15. Heeft u nog verdere vragen of heeft u andere dingen toe te voegen?

Er wordt nogmaals herhaald of men instemt met de opname en er wordt verteld wat gedaan zal worden met de resultaten. Hierna wordt de opname stil gezet

(einde opname)

Appendix III: Informed consent form / Toestemming verwerken gegevens

Dit gesprek is onderdeel van mijn onderzoek over de opschaling van Water Infiltratie Systemen in het Groene Hart. Dit onderzoek voer ik zelfstandig uit, voor het behalen van mijn afstudeerscriptie aan de Radboud Universiteit en heeft geen verdere doeleinden.

Om goed te kunnen terug lezen wat er allemaal in dit onderzoek gezegd wordt, wil ik dit gesprek graag opnemen. Met de opnames, zal vertrouwelijk worden omgegaan. Het geen wat ik opneem, zal alleen ik en mijn begeleidende docent vanuit de Radboud Universiteit toegang hebben.

Het volgende wil ik met u delen:

● Alle verzamelde gegevens zullen enkel voor het onderzoek gebruikt worden;

● U kunt altijd besluiten om niet te antwoorden;

● U kunt altijd stoppen met dit gesprek als u dat wilt;

● De uitkomsten van het onderzoek zal ik toesturen aan het einde hiervan;

● Als u nog vragen hebt achteraf, kunt mij telefonisch bereiken (06-XXXXXXXX)

Wilt u deze twee vragen beantwoorden:

Bent u akkoord met de opname van dit interview ten behoeve van het onderzoek?

○ Ja

○ Nee

Mag de onderzoeker uw volledige naam, voor- en achternaam gebruiken in het onderzoek om citaten weer te geven?

○ Ja, voornaam en achternaam

○ Ja, alleen voornaam

○ Ja, alleen achternaam

○ Nee (anoniem)

Ondertekende verklaren met bovenstaande akkoord te gaan:

Handtekening Onderzoeker:

Handtekening Geïnterviewde:

Datum: __-__-____ Plaats: ___________