The Impact of Data-Sharing Technology on Farmers' Sustainability Work

A study of Arla's climate calculation tool

Annie Emilsson & Martin Fornander

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Abstract

The food industry and agriculture are facing pressure to implement sustainable processes and reduce environmental impact while meeting the needs of a growing population. The European Union has adopted the new Corporate Sustainability Reporting Directive, putting pressure on corporations to adopt more sustainable practises and become more sustainable. The agricultural sector is experiencing an increase in digitisation, which has enabled farms to use data to develop initiatives aimed at increasing sustainability in their businesses. However, the heavy reliance on data, digital solutions, and systems that do not interact with each other makes it difficult for farmers to keep track of and measure sustainability performance and climate impact. Data-sharing technology is addressed as a crucial aspect of developing more sustainable practises and increased profitability in agriculture. However, few studies have addressed the use of data-sharing technology on a farm level and its correlation to increased sustainability. This study aims to gain a deeper understanding of how data-sharing technology is affecting small-firm behaviour and sustainability work.

To fulfil the aim of this study, a case study of farmers using Arla Food's climate calculation tool has been conducted. Arla is a global dairy corporation and has implemented a digital tool that uses data-sharing technology as part of its sustainability strategy to achieve net zero greenhouse gases in the entire value chain by 2050. The tool calculates the carbon footprint of an agricultural business by collecting data on animals, feed, plant cultivation, energy use etc.

The study has an exploratory design based on a qualitative case study. The empirical results have been collected through four interviews with farmers using Arla's climate calculation tool. The collected data has been analysed with thematic analysis to find commonly emerging themes and produce a nuanced result. The empirical findings have been analysed using a conceptual framework addressing the triple bottom line framework, sustainability reporting, and benchmarking theory.

It is concluded that farmers have implemented sustainability practises and made improvements in their sustainability work by using the tool. The findings indicate that data-sharing technology has a positive impact on small firms' behaviour and their sustainability work, but it is unclear whether data-sharing technology itself has enabled the improvements. The farm businesses have mostly been affected by the possibility of collecting and storing data in a comprehensive system that offers an overall understanding of the farm's data and sustainability performance. This study, therefore, contributes to a deeper understanding of data-sharing technology in agriculture and its correlation to sustainability.

Keywords: Data-sharing, Sustainability, Sustainable Agriculture, Agricultural Data, Arla Foods, Triple Bottom Line, Sustainability Reporting, Benchmarking

Sammanfattning

Livsmedelsindustrin och jordbruket pressas ständigt för att implementera hållbara processer och minska sin miljöpåverkan samtidigt som de ska tillgodose behoven hos en växande befolkning. Europeiska unionen har antagit nya direktiv om hållbarhetsrapportering, vilket sätter press på företag att implementera hållbara metoder och ta ansvar för hållbarhet. Lantbrukssektorn upplever en ökad digitalisering, vilket har gjort det möjligt för gårdar att använda sin data för att utveckla initiativ som syftar till att öka hållbarheten i sin verksamhet. Det stora beroendet av data, digitala lösningar och system som inte interagerar med varandra gör det svårt för lantbrukare att styra och mäta hållbarhetsprestanda och klimatpåverkan. Olika tekniker för datadelning tas upp som en avgörande aspekt av utvecklingen av mer hållbara metoder och ökad lönsamhet inom jordbruket. Få studier har behandlat användningen av datadelningsteknik på gårdsnivå och dess samband med ökad hållbarhet. Denna studie syftar till att få en djupare förståelse för hur datadelningsteknologi påverkar småföretags beteende och hållbarhetsarbete.

För att uppfylla syftet med denna studie har en fallstudie av lantbrukare som använder Arla Foods klimatberäkningsverktyg, som kan ses som en typ av datadelningsteknologi genomförts. Arla är ett globalt mejeriföretag och har implementerat detta digitala datadelningsverktyg som en del av sin hållbarhetsstrategi för att uppnå “nettonoll”-växthusgaser i hela värdekedjan år 2050. Verktyget beräknar koldioxidavtrycket för ett jordbruksföretag genom att samla in data om bland annat djur, foder, växtodling och energianvändning.

Studien har en utforskande design baserad på en kvalitativ fallstudie. Den empiriska datan har samlats in genom fyra intervjuer med lantbrukare som använder klimatberäkningsverktyget. Den insamlade datan har analyserats med tematisk analys för att hitta vanligt förekommande teman för att ge nyanserade resultat. De empiriska resultaten har analyserats med hjälp av ett konceptuellt ramverk som inkluderar hållbarhetsramverket “Triple Bottom Line”, hållbarhetsrapportering och benchmarkingteorin.

Studiens slutsatsen påvisar att lantbrukarna har implementerat hållbarhetsmetoder och gjort förbättringar i sitt hållbarhetsarbete genom att använda verktyget. Resultaten tyder på att datadelningsteknologi har en positiv inverkan på småföretags beteende och deras hållbarhetsarbete, men det är inte är helt tydligt om datadelningsteknologi i sig har möjliggjort de uppnådda förbättringarna. Bönderna har mestadels påverkats av möjligheten att samla in och lagra data i ett heltäckande system som ger en övergripande förståelse för gårdens data och hållbarhetsprestanda. Denna studie bidrar därför till en djupare förståelse av datadelningsteknologi inom lantbruk och deras samband med hållbarhet

Nyckelord: Datadelning, Hållbarhet, Hållbart Jordbruk, Jordbruksdata, Arla Foods, Triple Bottom Line, Hållbarhetsrapportering, Benchmarking

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1. Introduction

This chapter begins by presenting the background and problem statement of this study, which are followed by a case description. The chapter continues by presenting the aim, the research questions, and the delimitations of the study. It concludes by presenting how this study will contribute to research and an illustration of the study's outline.

1.1 Background

The food industry and agriculture are facing increased pressure from stakeholders to implement more sustainable processes and take responsibility for the climate footprint they leave on the planet (Garnett 2013; Lynch et al. 2021). The climate crisis has become increasingly relevant, and the food industry needs to produce food with less environmental impact while meeting the needs of a growing population (Garnett 2013). To respond to stakeholder pressure, accounting for sustainability in the food sector has never been more critical (Karwacka et al. 2020). According to Liljeström et al. (2023), the emerging need for businesses to be sustainable and have a low climate impact will be a prerequisite and a survival question in the future. Swedish agriculture is recognised as one of the most sustainable in the world, but it still faces criticism for perceived unsustainability despite the farmers' dedicated efforts in sustainability work (Rise 2023).

Accordingly, the European Union recently adopted the new Corporate Sustainability Reporting Directive (CSRD) which implies new requirements regarding sustainability reporting for corporations (European Commission 2023). It aims to encourage businesses to adopt more sustainable practises and will represent a compelling shift in how businesses approach sustainability. The food industry is especially exposed to these requirements, accounting for one-third of global emissions (Crippa et al. 2021). Agricultural businesses in the food industry must take responsibility for their environmental impact and how they approach sustainability. The food industry functions as a collaborating value chain network, where actors work together to efficiently coordinate resources, share knowledge, enable transparency and trust, ensure a sufficient flow of goods while meeting the demands of the market, and address sustainability challenges (Matopoulos et al.

2007). Supply chain collaboration is of significant importance where farm businesses, as primary producers play a crucial role. To achieve well-functioning collaboration, information sharing is crucial (Glenn et al. 2010).

The new sustainability reporting directive requires an increased number of corporations to track their sustainability performance and climate impact, which will increase pressure on agricultural businesses as part of food supply chains to keep track of data affecting their climate impact (Karwacka et al. 2020). Arla Foods, which is a major actor in the food industry, has developed a climate calculation tool that functions as a data-sharing platform as a response to help farmers keep track of and reduce their climate impact (Nørgaard & Søndergaard 2022).

1.2 Problem Background

In recent decades, corporations have acknowledged the importance of sustainable development and realised the potential benefits of not solely focusing on profit maximisation efforts (Fallah Shayan et al. 2022). The agricultural sector is currently experiencing a surge in digitalisation which has enabled corporations to utilise farm data to develop initiatives to increase sustainability (Nordin 2021; MacPherson et al. 2022). Digitalisation has great potential to address agriculture's sustainability, productivity, and resilience challenges (McFadden et al. 2022).

Corporations that emphasise sustainable development focus on addressing issues in the triple bottom line, which means considering the social, environmental and financial aspects of a business (Elkington 1999). Stakeholders, including non-governmental organisations, the media, customers, suppliers, and governments, are increasingly putting pressure on corporations to be more sustainable (Amaladoss & Manohar 2013). Agriculture and the food industry are especially exposed to this pressure due to complex supply chains with high environmental and social impacts in terms of food production, processing of products, distribution, and retailing to customers (Garnett 2013). The industry needs to be transparent in its accounting for sustainability throughout the whole supply chain, including farm production level, food safety, transportation and the origin of products to meet customer demands (Wognum et al. 2011). This emphasises the importance of keeping track of sustainability-related data at farms and working with sustainability practises.

Digitalisation implies increased use of digital technologies, information communication technologies, digital products, and tools, resulting in a lot of collected data and accelerating agriculture’s dependence on data (Wysel et al. 2021). Research demonstrates that it does not exist an efficient system for retrieving, processing, or recording agricultural production data (Ratual Amin et al.

2020; Poppe et al. 2013). Emphasises the need for a data management system in the agricultural sector, as there must be access to the collected data in order to derive beneficial values and use it for management and decision-making (Nordin 2021). Systems to connect data and enable data-sharing at a large scale are under development, which have the potential to optimise existing products, increase product development, and make processes more efficient (ibid.).

Data-sharing contributes to environmental and economic sustainability as data become available and used as a basis for analysis and management (Nordin 2021). It is seen as a crucial aspect of developing more sustainable practises, and increasing profitability in agriculture (Sundberg et al. 2021; Nordin 2021). There are different digital solutions that use data-sharing technology, such as application programming interfaces (API), blockchain technology, or data-sharing platforms; this study will focus on data-sharing technology through a platform tool.

Data-sharing in farm businesses contributes to collaboration in the food industry and the possibility to track and communicate sustainability data (Matopoulos et al. 2007). It can be used to manage complex systems, coordinate multiple actors and enable transparency. The use of data and the implementation of new practises and tools in agriculture have the potential to significantly change how agriculture functions as it drives production, sustainability and business efficiency. Additionally, it can also improve, simplify, and streamline the entire food system, agriculture, and society (Nordin 2021).

1.3 Problem Statement

Digital technologies, such as data-sharing tools, have the potential to improve and make agriculture more sustainable (MacPherson et al. 2022). Still, the heavy dependence on data, digital components, and systems that do not interact with each other makes it difficult to keep track of and measure sustainability performance and climate impact (El Bilai & Allahyari 2018; McFadden et al. 2022). The vast majority of previous research has focused on blockchain technology, precision agriculture, and smart farming to bring value from data and improve sustainability in agri-food chains (George et al. 2021; Zhu & Li 2021; Poppe et al 2013; El Bilai & Allahyari 2018; Jonkman et al. 2022), while few studies have focused on the impacts of digital solutions and particularly data-sharing technology on agricultural businesses and sustainability work at a farm level (El Bilai & Allahyari 2018; MacPherson et al. 2022).

Filling this research gap is essential because farm businesses play an important role in working with these technologies and making decisions about how to run the farm

in a sustainable way. In terms of theoretical contribution, this study wants to gain a deeper understanding of how data-sharing technology is affecting small-firm businesses and managers in their work with sustainability.

Even though research indicates that new technologies can make agriculture more sustainable, efficient, and profitable (McFadden et al. 2022; MacPherson et al. 2022). The increased use of and dependence on data in agriculture implies high complexity and challenges for farm businesses, including data management, infrastructure, data privacy, security, data interpretation and analysis (Liljeström et al. 2023). Currently, agricultural-related data is collected and stored in different systems, digital components, or products, which means that crucial data is tied up in individual information systems owned by individual companies or actors (Nordin 2021; Eichler Inwood & Dale 2019). This makes it difficult for farmers to use the data, and gain an overall understanding of farm performance and sustainability. At the same time, sustainability reporting is becoming mandatory for larger corporations, and there is an increased demand for corporations to take responsibility for their sustainability performance (Amran & Keat Ooi 2014; CSRD 2022). This increases the pressure on agriculture to take responsibility for its climate impact and communicate its sustainability performance and efforts to meet the demands of stakeholders and customers.

The fragmented data landscape and interoperability of systems make it challenging for farm managers to make sustainable decisions, improve sustainability performance, and communicate sustainability efforts and work to society (Liljeström e al. 2023). At the same time, various stakeholders need to know the climate impact caused by agriculture as they may be required to conduct sustainability reporting, hence, several different reports and ways of calculating climate impact are demanded by the farmers. Consequently, more research is needed to understand how digital solutions and data-sharing technology are being used to address agricultural sustainability and help farm businesses communicate sustainability performance. Departing from the identified gaps, this study will analyse Arla's climate calculation tool to understand the correlation between data-sharing technology and farm businesses' sustainability work.

In summary, the theoretical problem of this study covers the existing knowledge gap on the linkage between data-sharing technology and increased sustainability in farm businesses, and the empirical problem addresses the complex and fragmented data landscape in the context of increased pressure on farmers to take responsibility for their sustainability impact.

1.4 Arla's Climate Calculation Tool

Arla is the world's fourth largest dairy company measured by the amount of milk raw material weighed, Scandinavia's largest producer of dairy products, and the world's largest manufacturer of organic dairy products, hence a major actor in the food industry (Arla 2023a). Arla is a farmer-owned cooperative consisting of 8 956 farmers from Belgium, Denmark, Luxembourg, the Netherlands, the United Kingdom, and Sweden. In 2019, Arla implemented a sustainability strategy aimed at reaching net zero greenhouse gases in the entire value chain by 2050 (ibid.). As a sub-goal, Arla has committed to reducing its own logistics and energy use emissions by 63 percent by 2030, a goal that has been approved by the Science Based Targets Initiative (SBTi) (Nørgaard & Søndergaard 2022). Arla has a unique position to contribute to reducing emissions at the farm level because farmers own the cooperative and can take responsibility for this strategy. In 2019, Arla also launched a customised climate calculation tool as a strategy to reach this goal (ibid.). The system acquires and evaluates farm data and associated emissions to determine optimal strategies for achieving the intended objective and mitigating the climate footprint.

Arla's climate calculation tool works from the shape and feature of a data-sharing platform. The tool uses over 200 questions to collect data about subjects such as animals, feed, milk quantity, plant cultivation, fertiliser management, fuel consumption, and energy use to calculate the climate footprint for every kilo of milk produced at the farms (Nørgaard & Søndergaard 2022). The reporting and climate calculation are done once a year and when data is reported, farmers receive a free-of-charge advisory meeting and a bonus payment for their milk as economic compensation for their time and shared data. The advisor uses the reported data to help the farmers set strategies to reduce the climate impact.

Arla has identified five key areas that have the biggest impact on the climate footprint. These are feed efficiency, protein efficiency, sustainable animals, fertiliser use, and land use (Nørgaard & Søndergaard 2022). Based on the reported data, key indicators are calculated within these areas. Farmers share their data with Arla through the tool's platform, which is visible to advisors. The results and key indicators are shown collectively to other farms in the Arla cooperative, and general results from other countries are visible. The collected data is stored in the platform's database, making it possible to measure changes over time, compare results against other framers, and share experiences about strategies (Arla 2023b).

If the farmers handle these particular key areas with precision, it is stated that Arla will reach their sustainability goals (Nørgaard & Søndergaard 2022). Hence, Arla is operating a data-sharing system to collect crucial data that contributes to

understanding the whole corporation's climate footprint and developing sustainability strategies. This drives beneficial value for their farmers, the whole cooperative, and society. The farm businesses' data is fundamental for operating such a system.

1.5 Aim and Research Questions

The aim of this study is to gain a deeper understanding of how data-sharing technology is affecting small-firms behaviour and sustainability work. Based on this aim, the following research questions have been formulated:

- *How have farm businesses been affected by using Arla's climate calculation tool?*
- *How does this data-sharing move farm businesses toward implementing new sustainability practises?*

1.6 Unit of Analysis

According to Yin (2013), the unit of analysis is the major entity studied and analysed in the research. The unit of analysis in this study is farm businesses using Arla's climate calculation tool. Climate calculation tools have emerged as an important strategy to combat climate change in society and agriculture (Dwivedi et al. 2022). Because of this emerging trend of calculating climate impact in an industry exposed to sustainability pressure, farm businesses' experiences from working with and using the tool will be the unit of analysis.

1.7 Contribution

The study will contribute to understanding how data-sharing and digital technology can improve efficiency, sustainability, and competitiveness. The results can have particular implications for enterprises engaged in the food industry because an understanding of how digital solutions impact farm business and agriculture can unlock new business opportunities and sustainable development initiatives in the industry. The increased use of digital technologies in agriculture has great potential to improve efficiency, sustainability, and competitiveness. Consequently, the food industry will benefit from such development and potentially become more efficient, sustainable, and resilient. The use of technology in agriculture is emerging, but the research field on how technologies are used and affect farm businesses' sustainability work is limited. This study will contribute to filling the identified

research gap by providing insights and knowledge from farm businesses and managers using the climate calculation tool.

The results of this study can also provide guidance to practitioners in the technology innovation sector and the agricultural sector on how to implement and use digital solutions and data-sharing technology in the context of sustainability at a farm level.

1.8 Delimitations

This study focuses on data-sharing technology in the agricultural sector. Data-sharing technology is used in different tools and systems, such as Application Programming Interfaces (APIs), Blockchain protocols, and data-sharing platforms. This study is limited to studying digital solutions and data-sharing technology when used in a platform tool. This delimitation has been done to only focus on data-sharing technology in this particular context and not investigate other forms of data-sharing technologies. Thereby contributing to the existing research gap.

The shared data enables individualised calculations and results as the data is integrated into the calculator. Data is not directly shared with others as it can be in supply chain management tools based on, for example, blockchain technology (Demestichas et al. 2020).

Sustainability is a broad and complex concept with many different approaches. This study's theoretical delimitations are restricted by the theoretical framework presented in Chapter 3, where the Triple Bottom Line framework by Elkington (1999) is used to address sustainability. The concept of sustainability reporting is limited to the initial phases of data collection, measurement, and communication and will not cover the concluding sustainability report (Cerin 2002). Consequently, these delimitations are essential to consider when assessing the applicability of the study's results and when interpreting and using the findings.

1.9 Outline

This thesis starts with an introductory chapter that provides contextual information on the topic being studied. The background to the studied topic, the problem statement, and a description of the case under investigation are presented. Additionally, the chapter outlines the study's aim and research questions, thoroughly presenting the unit of analysis and the study's delimitations. The second chapter presents the method used when conducting the research and how certain methodological choices may have had an effect on the results. The chapter ends by

highlighting criticism of the chosen method and its implications. The third chapter presents the literature review and the theoretical framework. It concludes with an empirical framework that forms the basis for analysing the empirical data. Chapter four presents the results of the empirical study, which are followed by an analysis and discussion in Chapter five. Chapter six presents the conclusions, and the thesis ends with a bibliography and an appendix containing the interview guide. This outline is illustrated in *Figure 1*.

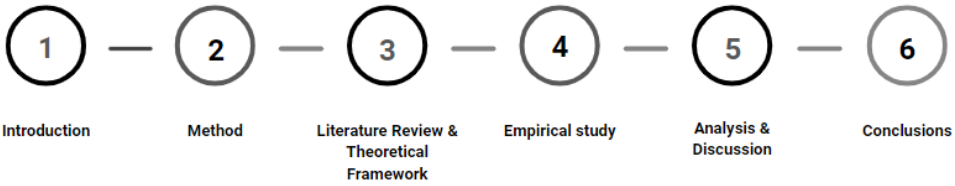

Figure 1. Outline of the thesis, own illustration.

2. Method

This chapter presents the method used in this study. The research philosophy, research design, and data collection are described to give a comprehensive understanding of the conducted study and the methodological choices. Furthermore, quality assurance and ethical considerations are discussed, and the chapter ends with criticism of the chosen methodology

2.1 Research Philosophy

The epistemological and ontological positions of research within the field of business administration are important aspects related to research strategy (Bryman & Bell 2015). Regardless of the research approach, philosophical perspectives are critical to understanding the research paradigm (Myers 2020). According to Guba & Lincoln (1994), the researcher's epistemological and ontological position should be reflected when choosing the methodology.

The ontological position refers to the relationship between reality and social actors (Bryman & Bell 2015). This study has a constructionist view, which asserts that reality is created through communication with social actors, where several variables, such as experiences, perspectives, and interests, affect this creation (Allwood 2021). Interactions between individuals result in social phenomena, where social actors continuously change reality through their social interactions, perceptions, and actions. The researchers are given a subjective role because these phenomena are studied from an interpretation perspective.

The epistemological position covers what should be regarded as acceptable knowledge and how to study the social world based on what acceptable knowledge is (Guba & Lincoln 1994). This study's epistemological approach takes an interpretivist position, which, according to Bryman & Bell (2015), allows subjective interpretations of social actions and situations. Thus, social reality is studied in different ways. However, social reality is under constant change and implies a subjective meaning, indicating that the researcher can interpret reality from different perspectives (ibid.). Additionally, researchers can make different interpretations of the same social situation or action.

These positions have been taken because they reflect the researchers' view of reality and social actors. According to Bryman & Bell (2015), these positions are in line with the characteristics of a qualitative research strategy.

2.2 Research Design

This study uses an exploratory design based on a qualitative case study. The research design of a study depends on the topic of investigation and will affect the study's structure and data collection (Bryman & Bell 2015). The research design can have a qualitative or quantitative approach. The qualitative approach aims to establish an understanding of and describe the socially constructed words and meanings that arise in the studied context rather than quantifying characteristics of a population like the quantitative approach does (Bell et al. 2019; Creswell & Creswell 2018). A qualitative research approach has been used in this study to explore the subjective experiences and perspectives of farm businesses using the climate calculation tool.

Another characteristic of a qualitative approach is the recognition of multiple possible realities due to the interaction between individuals (Bell et al. 2019). Reality is made real through an interpretation of conversations and through interpreting activities and the meanings individuals attach to them (Merriam 1994). Conversely, the quantitative research design focuses on measuring and quantifying collected data and accepting that there is only one objective reality (Bell et al. 2019). Merriam (1994) argues that a qualitative approach is explorative and focuses on the processes and how interactions influence the respondents' surroundings and experiences in the studied context rather than the final result. Thus, it is also described as a flexible approach that is preferable when studying phenomena in a complex context (Kvale & Brinkmann 2014). Therefore, the qualitative approach is suitable for this study as it investigates farm businesses' experiences using data-sharing technology and how it affects sustainability work.

This study is not set out to quantify or measure the effects of using the climate calculation tool, but rather to gain a deeper understanding of the phenomenon of data-sharing technology in this particular context. However, by analysing, interpreting, and describing the collected data, this study will gain a deeper understanding of how data-sharing technology is affecting farm businesses and their sustainability work. Consequently, a qualitative research design is the most appropriate approach.

This study has taken an inductive research approach to the relationship between theory and research. It is a bottom-up approach that departs from specific

observations, analyses them, and identifies trends and patterns to generate generalisations about the observed social reality (Lodico et al. 2010). The inductive approach is based on the idea that observations and empirical evidence will contribute to theory (Bryman & Bell 2015). Conversely, the deductive approach departs from existing theories and hypotheses to generate results about whether the hypotheses are true or false. This study focuses on the respondents' experiences in the studied context. Therefore, subjective perceptions are of interest, for which an inductive approach is used.

2.3 Exploratory Design

Exploratory research is described as research conducted to address an issue that is not yet well understood, and few studies for reference exist (Brink 1998). It is carried out to gain a deeper understanding of the current research issue, but it will not produce definitive findings. When conducting this type of study, the researcher begins with a broad concept and uses research as a tool to specify potential research topics (ibid.). It's crucial that the researcher is open to altering courses in response to the discovery of new information or insights (Aspers & Corte 2019). This study started with the idea of studying the circular economy in agriculture without having a specific idea of what phenomena would be interesting to study. The research process evolved, and a deeper understanding of the circular economy and data-sharing in agriculture was gained. This resulted in a deeper understanding of sustainability, as these two concepts are closely related (Geissdoerfer et al. 2017). Furthermore, the circular economy was not possible to study in the scope of this research, and sustainability was chosen to proceed with.

Using an exploratory design gives the researcher the freedom to be adaptable and unrestricted in their data collection (Brink 1998). Allowing the researcher to examine the individualised experiences and perspectives of the investigated subjects, which aligns with the research philosophy.

2.3.1 Literature Search and Review

To obtain a deep understanding of the selected research area and to identify existing literature related to the topic, an extensive literature search was conducted (Bryman & Bell 2015). Library searches, searches in electronic databases, and other search engines were used to find eligible material. Robson (2011) highlights the importance of determining the relevance of the chosen literature, where the authors have been thorough and only used literature that is eligible and can contribute to answering the aim of the study. Eligible papers, such as peer-reviewed articles and published reports, were identified across the Web of Science, Primo, ScienceDirect,

Scopus, and Google Scholar using explicit search methods. These formed the basis for the theoretical framework and problem statement.

This study has a narrative literature review, which is qualitative and involves examining the literature from an interpretive perspective (Bell et al. 2019). According to Ridley (2012), the narrative approach gives a broad and comprehensive understanding of the knowledge in a particular field and is commonly used when conducting qualitative research studies as the open structure allows a more general focus on a topic (Bryman & Bell 2015). This enables the discovery of a broader area that can be used to advance the study

The literature review is essential for conducting research and will contribute to identifying research gaps and creating justified research questions (Ridley 2012). Based on searching and reviewing existing literature, the researchers were able to gain a comprehensive understanding of the studied topic and obtain rich material.

Research papers were collected if they addressed aspects of sustainability, sustainable development, digital solutions, data-sharing technology, climate calculation tools, and sustainable practises in agriculture. Enabling different perspectives to approach the studied topic.

2.3.2 Case Study

This study is carried out as a case study of Arla’s climate calculation tool which uses data-sharing technology. The case study format is common within qualitative research and in small-scale research projects as it creates a deep understanding of one particular case in its specific context (Bryman & Bell 2015). The aim is to increase knowledge about the phenomenon being studied and conduct an in-depth investigation. Case studies are preferable when a project aims to analyse situations that occur in social contexts (Yin 2006). Using a case study makes it possible to understand complex social environments, exploit real experiences, and retain their meanings (Bryman & Bell 2015). A case study is therefore appropriate for this research, as it aims to gain an in-depth understanding of the data-sharing phenomenon studied in the context of farm businesses using it.

Bryman and Bell (2015) highlight that a case study must have a logical structure, a predetermined data collection method, and data analysis techniques to be acceptable for answering "why" or "how" questions in the research. This has been assured by a clearly stated research design. To fully comprehend a variety of complex aspects, taking a user's (i.e., farmer managers') point of view has been crucial to understanding why and how their business has been affected by using the climate calculation tool. A case study enabled this specific understanding.

Choice of Case

The choice of case for this study was made using purposive sampling. Purposive sampling is a non-probability sample based on the idea that the researcher should decide the case to ensure gaining as much knowledge as possible about the research topic (Merriam 1994). Bryman and Bell (2015) emphasise the importance of selecting the case according to its relevance in addressing the research field and the study's research questions.

Arla operates in the food industry, which is highly affected by the use of digital technologies and by the demand to take responsibility for sustainability impacts. They have responded by developing a climate calculation tool to take action and help their farmers reduce climate impacts. The literature suggests that digital technologies have great potential to improve agricultural businesses and sustainability (Nordin 2021), which makes it a good case to study whether there is a correlation between such technology and sustainability on farms. The lack of research on digital solutions and how they contribute to sustainability at the farm level additionally motivated the choice of the case. This study is limited to studying farm businesses with dairy production, as Arla is a dairy cooperative and the tool is only used by its farmers and owners. However, the results will be discussed to understand the applicability of the study's results to a broader population of small firms.

Selection of Respondents

To fulfil the aim of the study, purposive sampling was used to select the participants. This is a non-probability sampling method that entails strategically choosing respondents based on the research questions (Bryman & Bell 2015). This method enables the selection of relevant respondents that have a high probability of answering the research questions. Unlike probability sampling, purposive sampling does not aim to obtain a representative sample of the population being studied, but rather a sample suitable for answering the research question (Guest et al. 2006). However, it is crucial for the researcher to be transparent and clear about what constitutes a relevant sample for the study.

Guest et al. (2006) state that respondents are identified based on specific characteristics or qualities. The respondents of this study were chosen based on the criteria that they use Arla's climate calculation tool and are knowledgeable in the field. To obtain a relevant sample, the respondents needed to be the manager of the farm and the ones reporting data in the tool. This provides rich and diverse experiences and perspectives related to the research questions and ensures a relevant sample.

The purposive sampling technique is often used when the aim is to understand a particular phenomenon in depth, which is suitable when conducting a case study (Bryman & Bell 2015; Guest et al. 2006). The studied population was easy to reach and identify, which made it more efficient than using the snowball sampling method, another commonly used non-probability sampling method.

When using this method, it is important to consider possible sampling biases (Bryman & Bell 2015). The respondents are chosen based on the researchers' networks and subjective assumptions, which causes bias as it can make the sample narrow in terms of low diversity of perspectives and opinions. The respondents can also be more or less connected to the population; however, the aim of using this method is not to reach a statistical representation of the greater population of interest but to gain as much deep knowledge of the studied context as possible (Bryman & Bell 2015; Guest et al. 2006). These limitations have been accounted for by making sure the sample of respondents has different characteristics such as geographic location, age, technological interest, farm size, and background.

2.3.3 Data Collection

According to Fusch et al. (2018), the triangulation method entails investigating a topic using various sources of information and methodologies. To accomplish the triangulation for this study, data were gathered in three different ways: by completing a thorough literature search, collecting information from secondary sources, and conducting interviews with farm managers using the climate calculation tool. Using several sources when doing data collection strengthens the quality of a qualitative study (Bryman & Bell 2015). Below, *Figure 2* describes the triangulation of data collection used for this study, where broad data was collected in the beginning and narrowed down to specific cases.

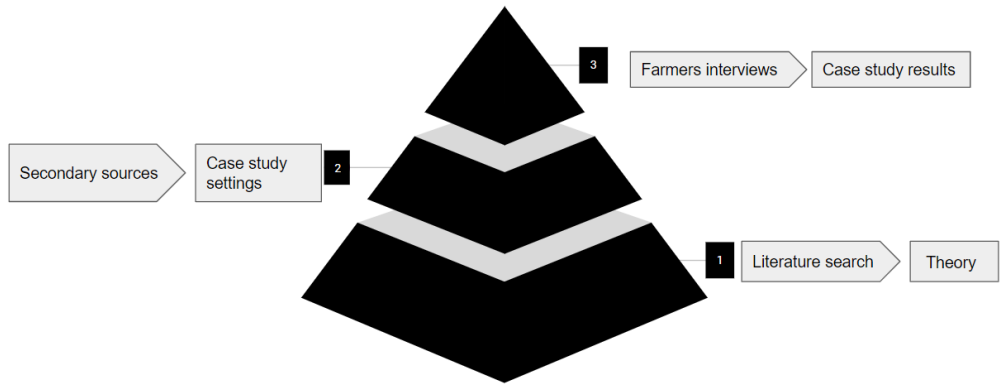

Figure 2. Triangulation of the data collection, own processing.

Interviews

Semi-structured interviews have been used to collect empirical data. These are recommended when the study is exploratory, as they allow for detailed and rich explanations by the respondents and give the researcher the possibility to ask for clarification and elaboration (Bryman & Bell 2015). It is therefore possible to broaden the study with unknown perspectives on the research area (Ruslin et al. 2022). These types of interviews depart from a pre-prepared interview guide (*see Appendix 1*), in which the researcher has a general outline of topics to cover (Bryman & Bell 2015). This guide is flexible and adaptable, containing open-ended questions related to the research questions, enabling the researcher to learn more about the subject from the respondent's perspective as the respondent can freely express themselves and give rich explanations (Ruslin et al. 2022).

The interviewer can follow up on specific responses, ask additional questions, and probe deeper into the participant's perceptions and experiences. Compared to other methods, such as structured or unstructured interviews, semi-structured interviews enable flexible and dynamic interaction between the interviewer and the respondent. However, if the questions are too indirect and open-ended, there is a risk of not receiving the required information to conduct the research (Ruslin et al. 2022). Therefore, the interview guide is used as a checklist for what should be covered during the interview to make sure crucial information is collected.

Table 1 presents a summary of the interviews conducted. Video interviews were chosen based on the participants' geographical distance and their less time-consuming nature compared to face-to-face interviews. To make sure extensive material was collected, the researchers made the interviews as interactive as possible and repeatedly asked if the participants had follow-up questions or further thoughts (Robson 2011). The interviews were recorded to reduce the risk of forgetting or losing anything said, which enables more precise data collection, and consistency in the treatment of the participants (Berazneva 2014).

Table 1. Summary of respondents.

Respondent	Title	Date	Duration	Format
Farmer A	Farm owner	2023-04-04	30 minutes	Video interview
Farmer B	Farm owner	2023-04-04	25 minutes	Video interview
Farmer C	Farm owner	2023-04-11	30 minutes	Video interview
Farmer D	Farm owner	2023-04-14	35 minutes	Video interview

2.3.4 Data Analysis

Data analysis systematically examines and interprets qualitative data to identify patterns, themes, and relationships (Mihas 2019). The goal of qualitative data analysis is to extract meaningful information from the data and to develop a deeper understanding of the research question or phenomenon being studied.

According to Robson (2011), the collected data needs to be well organised to go through the extensive material and draw conclusions. Therefore, the recorded interviews were transcribed, which allowed the researchers to be fully enlightened with the collected data (ibid.). The exact phrases from the interviews were typed to make sure not to disregard important information. Bryman & Bell (2015) state that it will decrease the risk of disregarding or missing any essential information for the analysis, which otherwise can be a challenge when having a lot of empirical data.

A thematic analysis method was used to analyse the transcribed data. This method aims to identify, analyse, and report patterns and key themes within the data (Bell et al. 2019). These themes and concepts were defined, included, and described in detail. This enabled a clear structure of the empirical findings, gave clear insights into the respondents' answers, and made it possible to detect the most commonly occurring opinions and perspectives (Braun & Clarke 2006). However, this method is criticised for being phrase-based, which does not capture the whole meaning correctly (ibid.). Since the themes do not need to be set up in advance, it is an adaptable method that can easily adjust this disadvantage and make sure to capture the whole understanding.

Compared to other analysis methods such as narrative or content analysis, this method is flexible and adaptable, which suits this type of research as it can be adjusted to suit the research questions and the context being studied (Bell et al.

2019). However, when using a thematic analysis method, it is important to be systematic and transparent when analysing, documenting decisions, and providing evidence to support statements (Braun & Clarke 2006). This is confirmed by being transparent throughout the whole analysis process and continuously returning to the research aim to make sure analyses are done based on the correct purpose

2.4 Quality Assurance

This section gives a comprehensive summary of the actions taken to ensure the credibility and trustworthiness of the study, particularly departing from validity and reliability, which Golafshani (2003) argues are used at an increased rate in qualitative studies when assessing quality assurance.

2.4.1 Validity

Validity refers to the accuracy of a study's methodology and presentation, as well as whether the study examines what it is intended to examine (Bryman & Bell 2017). Validity is important to ensure the trustworthiness and quality of a study, which is particularly important in a qualitative research study as the goal is to understand and interpret the experiences and perspectives of the participants (Morse et al. 2002). For example, a study with low validity may fail to accurately represent the participants' experiences and perspectives, resulting in incorrect conclusions or recommendations. In this study, triangulation has been used to ensure validity because the use of several different sources for data collection strengthens trustworthiness (Fusch et al. 2018). Using the same interview guide and method when conducting interviews with all the participants is also a way of achieving validity (Bell et al. 2019). Hence, the only thing that differs are the answers from the respondents, and thereby, the result of the study is assuredly based on the answers expressed by the respondents themselves and to the same questions.

Using illustrations to assist explanations in the text contributes to ensuring validity (Riege 2003). This is continuously done in this study to facilitate reading. Moreover, respondent validation has been used to ensure the validity of the collected data (Bryman & Bell 2015; Robson 2011). This method gives the respondents access to read and verify the collected data from the interviews. After transcribing the interview, it was sent to the respondent for verification. Thus, the respondent had the opportunity to demand changes and give feedback on the transcribed material before it was analysed. The respondents returned with approval of the material, and validity was ensured.

The extent to which the findings may be generalised beyond the unique sample and setting is referred to as external validity (Flyvbjerg 2006). For example, while this

study investigates Arla's climate calculation tool and farm businesses using it, it is vital to assess if the results apply to other farm businesses. To increase external validity, the social context and its limitations have been stated, and examples of existing literature have been provided and compared in the analysis. Future research should involve a larger and more diversified sample of farmers and investigate the influence of various data-sharing technologies in agriculture, which could improve the external validity of this case.

2.4.2 Reliability

In qualitative research, reliability is closely related to the concept of validity and is defined as the extent to which a completed study can be replicated in another context or not (Bryman & Bell 2015). Yin (2006) states that a reliable study should be possible to conduct again using the same cases and course of action, while still achieving the same results. However, reliability criteria have mainly been used in quantitative research as qualitative studies are focused on interpretation and different interpretations of the same phenomenon or situation will be made by different researchers (Merriam 1994; Bryman & Bell 2015; Golafshani 2003). When striving to achieve reliability, it is important to be detailed and rigorous when describing the research process (Riege 2003). This is ensured by describing exactly why certain choices were made and by openly and thoroughly describing how the research was conducted. For instance, the interview guide is attached to enable the reader to follow what questions the empirical data is based on.

Additionally, to allow other researchers to replicate the study, a transparent and thorough description of the methodology has been provided. Another way of creating reliability is to record and transcribe the interviews (Riege 2003), which has partly been done as an attempt to present a study that is as replicable as possible.

2.5 Ethical Considerations

When conducting a qualitative research study, there are ethical factors that need to be considered to not affect the quality and outcome of the study (Bryman & Bell 2015; Brinkmann & Kvale 2015). The direct involvement of participants in various stages of the study and the interaction between the researchers and participants are likely to create ethical challenges (Sanjari et al. 2014). When conducting interviews, ethical issues are especially important to acknowledge due to the complexity of researching the participants' private lives (Brinkmann & Kvale 2015). This aspect was considered by not specifically asking questions that could provoke the participant, and the questions were only related to their professional lives and farms.

To further ensure the fulfilment of ethical matters, four principles were used: informed consent, consequences, confidentiality, and the role of the researcher (Brinkmann & Kvale 2015). Informed consent is of absolute importance, which was ensured by introducing the intended respondents to the study, its aim, and research questions when first contacted. This allowed the respondents to make a well-informed decision about participation and ensured that they were well-informed about the situation and their expected participation (Bryman & Bell 2015; Brinkmann & Kvale 2015). A transparent dialogue with the respondents about consent, participation, and the content of the study has been held prior to, during, and after the interviews. Moreover, the interview guide was sent to the respondents, enabling them to prepare for and read the questions before participating in the interview. This strategy allows the respondents to reflect on the question beforehand and not be taken by surprise.

To ensure confidentiality, the respondents were informed that they had the opportunity to be anonymous to secure the integrity of sensitive information and to stay confidential (Trost 2010). Prior to the interview, the respondents also got to approve whether the conversation could be recorded or not and were informed that the purpose of recording the interview was solely the purpose of the study in order to better recall the information and not encounter misinterpretations. The participants have been anonymised since using their names would not add any value.

This study is to some extent affected by the researchers, which makes it important for ethical matters to make sure the researchers are positioned in a natural role and stay as objective as possible (Brinkmann & Kvale 2015). This aspect has been considered throughout the research process to not sacrifice the validity of the study.

2.6 Criticism of the Methodology

Critiques have been directed against the qualitative research design by several authors, such as Robson (2011), Yin (2006), and Bryman & Bell (2015). The main criticisms include the lack of statistical generalisability of results, the potential for researcher bias, the difficulty of replicating results, and the time-consuming aspect (Bryman & Bell 2015). They also emphasise criticism against case studies for being difficult to generalise as they appear in unique and special contexts (ibid.) However, Flyvbjerg (2006) argues for the applicability of a case study in a broader context and that it is a misunderstanding that a case study cannot be generalised. In addition, Yin (2013) indicates that the purpose is not to apply the identified conclusions to similar contexts and situations. Instead, a case study aims to use the theoretical ground to identify logical conclusions in other cases. Which is one kind of

generalisation (Yin 2013). This study aims to achieve a deeper understanding of a phenomenon in its specific context and not to generalise, whereas Flyvbjerg (2006), argues that a certain level of generalisation will be possible if using the theoretical background on other cases.

Further, the qualitative approach can be perceived as non-transparent, subjective, and difficult to replicate (Robson 2011). Denscombe (2017) emphasises the concentration on a limited sample size, which is in line with Bryman and Bell (2015) discussing the lack of generalisability when having few interviews. This study wants to understand a rather unexplored topic, which makes the characteristics and knowledge of the respondents more important than the number of respondents (Kvale & Brinkmann 2014).

The role of the researcher is constantly under critique, whereas Merriam (1994) argues that the researcher's role in gathering and interpreting data in a qualitative study makes it impossible to be outside the studied phenomena. The researchers have made sure the perspectives of the respondents have been presented in a fair manner and are the foundation of the study. In addition, the authors are aware of the subjectivity and possible biases caused by their observations and contributions to the study.

3. Literature Review & Theoretical Framework

This chapter provides an extensive literature review to give the researcher an understanding of previous research in the field of data-sharing technology in agriculture. The chosen theories are presented and described, which concludes in a conceptual framework. The established conceptual framework is presented at the end of this chapter and will be used to analyse the empirical data

3.1 Data-Sharing Technologies

The process of making the same data resources available to several applications, users, or organisations are known as data sharing (AWS n.d.). It consists of technology, practises, legal frameworks, and cultural components that allow various entities to access data securely without compromising data integrity (Tenopir et al. 2011). Data-sharing increases organisational efficiency and facilitates collaboration with stakeholders and partners. The process requires an understanding of the risks and opportunities associated with shared data (ibid.). There are many technologies that can be seen as data-sharing, for example, data-sharing platforms, application programming interfaces (API), and blockchain technology (AWS n.d.). These technologies enable the transfer of information in diverse ways, with the potential to facilitate collaboration and innovation in multiple fields. This research is focused on data-sharing technology when used in a data-sharing platform. This can be seen as an open data platform that enables various entities to register their datasets. This dataset is then often released for public consumption. The users just need to prepare and submit the data, and the platform provides the infrastructure for the user's storage and access (ibid.).

3.1.1 Data-Sharing in Agriculture

Value creation in agriculture was once tightly linked to labour and capital-intensive activities. Digitalisation implicates change, and value creation today is more linked to the usage of data (Wysel et al. 2021). Agricultural data, such as data on crops, their quality and yield, livestock, soil, weather, pests, and other elements that influence crop development, are valuable for data-sharing in agriculture (ibid.).

Almost all parameters that affect the outcome of production and the results on the farm are valuable for data sharing. Agricultural data can be disseminated in a variety of ways, for example, through internet platforms, data archives, digital tools, and collaborations among farmers, researchers, and other stakeholders. Applying data-intensive, smart practises and Internet of Things (IoT) technologies in agriculture can provide a lens for ensuring the transparency of farming practises and sustainability in production processes in the agricultural sector (Spanaik et al. 2021).

The majority of data-sharing technologies in agriculture involve a user uploading data to a platform from their account or machine, which in turn compiles and displays an output from the data (Ault et al. 2022; Wysell et al. 2022). Ault et al. (2022) states that most farmers share their data without knowing it, just by putting it on such platforms. Advantages such as increased efficiency of agricultural production, operation, and management can be gained by sharing data, as well as contributing to sustainable ecological development (Zhu & Li 2021).

Taking data-sharing into consideration while using the conceptual framework with the concepts presented below will enable an understanding of how farm businesses have experienced the effects of using data-sharing technology.

3.2 Sustainable Development

At the start of the 20th century, there was a surge in the exploitation of the world's natural resources (Heady et al. 1965). Something history has never seen before, which caused material consumption to increase rapidly and played a major role in driving economic growth. Technological development and the discovery of oil are two important explanations for this (ibid.). However, the high dependence on natural resources for material consumption led to various socio-ecological problems (Belz & Peattie 2012).

These issues gained interest in society and academia towards the end of the 20th century, which increased pressure on corporations to take responsibility for their actions (Amaladoss & Manohar 2013). At that time, the widely accepted idea was that corporations' only responsibility was to increase profit, and they were often accused of causing problems (Friedman 1970). However, this highlighted a call for better natural resource management and corporate responsibility in tackling societal problems, which led to the rise of the concept of "sustainable development".

The most commonly used definition of sustainable development was coined in the Bruntland report by the United Nations and is defined as "development that meets the needs of the present without compromising the ability of future generations to

meet their own needs" (United Nations General Assembly, 1987, p. 43). Elkington (1997) further proposed the triple bottom line, indicating that corporations must find a balance between environmental, social, and financial aspects to achieve long-term sustainability. These two concepts have led to the development of Corporate Social Responsibility (CSR), which is a concept that builds upon the idea that corporations should not solely focus on profit maximisation but also generate value for the surrounding society in which they operate (Rainey 2010). Hence, these concepts emphasise that sustainability within a business is achieved when social responsibility, economic growth, and environmental quality are met without negatively affecting each other.

3.3 Triple Bottom Line

The Triple Bottom Line (TBL) framework is used to communicate and measure a company's sustainability performance with both direct and indirect stakeholders, such as customers, suppliers, employees, and governments (Elkington 1999). According to Painter-Morland et al. (2006), the TBL framework aids businesses in understanding the value of their relationships with their stakeholders and the setting in which they operate. The TBL is seen as a transformative framework that aims to make organisations move towards a regenerative and more sustainable future (ibid.).

The TBL theory focuses on three dimensions of sustainability: social, environmental, and economic (Elkington 1999). This theory proposes that organisations should consider their social and environmental impacts in addition to their financial performance. Elkington (1999) established the TBL framework, including the 3Ps: people, planet, and profit (*see Figure 3*).

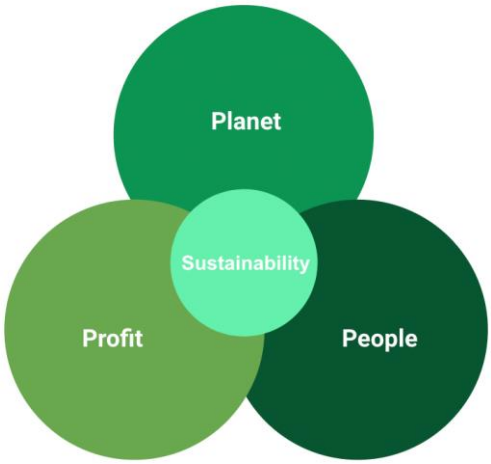

Figure 3. The triple bottom line includes the three dimensions of sustainability, people, planet, and profit (Elkington 1999, own processing).

The framework of TBL implies that businesses must consider all Ps when conducting business and measuring performance (Elkington 1999). It illustrates that if an organisation only focused on profit and ignored people and the planet, it would not achieve long-term sustainability. According to Kleindorfer et al. (2005), sustainability broadens the TBL approach by integrating people, planet, and profit in business strategy, culture, and operations. These dimensions are interconnected, and the foundation of sustainability is systems thinking, hence, initiatives that fall under one P will also generate impacts within the others (Elkington 1999). Furthermore, each P will be further described separately below.

Singh & Srivastava (2022) claim that the TBL incorporates shareholder values, social and environmental capital, and profitability, which encapsulate the essence of sustainability. To measure a company's economic, social, and environmental sustainability performance, TBL is specifically employed as an accounting framework (Singh & Srivastava 2022). It is important to emphasise that measuring and calculating success within these dimensions has no universal standard method and differs a lot depending on the company, industry, or organisation (Hourneaux et al. 2018), but sustainability reporting could be a potential solution (Baron 2014).

3.3.1 People - The Social Bottom Line

The social dimension relates to an organisation's responsibility to satisfy the needs and demands of all relevant parties and stakeholders, such as its customers, employees, communities, and other potentially impacted groups (Elkington 1999). Fair labour practises, community involvement and human rights are a few examples of this. The social dimension of agriculture businesses refers to how farming techniques affect those involved in the production process as well as the larger

community (Detre & Gunderson 2011). It covers, for example, the rights and welfare of employees, guaranteeing safe and healthy working conditions, and making sure salaries are paid.

The social dimension also includes community participation, which entails forging close contacts and alliances with regional groups (Elkington 1999). This may entail interacting with neighbourhood stakeholders, or customers to build trust and knowledge regarding farming techniques and their effects on the region. According to Miller (2020), businesses are also sharing best practises and developing strategic partnerships and collaborations.

3.3.2 Planet - The Environmental Bottom Line

The environmental dimension includes an organisation's obligation to decrease its environmental impact and refer to sustainable environmental practises (Elkington 1999). This dimension covers initiatives to decrease pollution, minimise waste, protect natural resources, minimise environmental impact, and combat climate change. From an environmental perspective, farmers need to consider how their methods would affect the resources they rely on, like soil, water, healthy animals, and biodiversity, as well as how they would contribute to decreasing greenhouse gas emissions and tackling climate change (Singh & Srivastava 2022). It also includes doing as little harm to the planet as possible, carefully managing energy consumption and non-renewables.

According to Kneipp et al. (2019), collaboration in environmental sustainability can have a win-win situation based on trust, belief, and transparency between players in the supply chain. Together with traceability, it has the potential to help farmers incorporate sustainability practises and achieve goals within the social and environmental dimensions (Smith 2008).

3.3.3 Profit - The Economic Bottom Line

The economic dimension is focused on an organisation's financial performance, capacity for profit-making, and ability to add value to the market (Elkington 1999). In agricultural businesses, this entails diversifying sources of income, decreasing costs without decreasing yields, and making investments in new markets or technology that will help farmers compete effectively (O'Sullivan et al. 2019). The economic viability of business operations is another key component (Elkington 1999). The business must be profitable to maintain it and ensure a living for the farm owner and the employees. Consequently, precise resource management and financial planning are required to ensure that the farm remains successful over a long period of time (O'Sullivan et al. 2019).

In general, farmers employing the TBL approach must consider the three dimensions of sustainability and not only focus on the financial bottom line (Singh & Srivastava 2022). Balancing these can improve the long-term sustainability and profitability of an agricultural business.

3.4 Sustainability Reporting

Sustainability reporting and the triple bottom line framework are interconnected, as sustainability reporting provides a mechanism to show an organisation's performance across social, environmental, and economic dimensions (Hubbard 2009). Both of these concepts promote transparency and accountability in the pursuit of sustainable development.

Sustainability reporting is the practise of measuring, disclosing, and communicating an organisation's sustainability responsibilities and efforts toward stakeholders (Deegan & Unerman 2011). In this way, corporations can manage and communicate their sustainability activities, aiming at providing a comprehensive and transparent picture of an organisation's corporate sustainability performance, efforts and contribution to sustainable development. A sustainability report includes goals, progress, and activities to reduce the impact (GRI 2017; Cerin 2002). Some countries mandate sustainability reporting, leading to increased reports and regulatory development. Corporations face growing demand and pressure to take responsibility for sustainability, and reporting serves as a means to meet this demand (Manetti & Toccafondi 2012). It builds consumer confidence, enhances corporate reputation, and improves risk management. It is non-financial reporting with the purpose of giving stakeholders access to more information than just financial performance (Turzo et al. 2022). Based on the provided information, stakeholders can assess how sustainable a corporation is over time by benchmarking against other organisations (Deegan & Unerman 2011; Maas et al. 2016; Hrebicek et al. 2015). In line with TBL thinking, sustainability reporting includes environmental, social, and economic aspects and efforts taken in these areas (Cerin 2002).

Manetti & Toccafondi (2012) argue that the main reason for conducting sustainability reporting is to improve corporate legitimacy and generate stakeholder value. The content of interest in sustainability reporting varies depending on the type of company, its location, and its stakeholders. It can be used by an organisation to manage risk, demonstrate sustainability commitment, engage stakeholders, and make informed decisions (ibid.). Researchers also discuss the importance of taking the relevant stakeholder's interest in sustainability reporting into consideration because they have an essential role that can affect the corporation's business

operations (Fortanier et al. 2011). Examples of sustainability reporting include analysing the company's environmental impact and developing strategies to decrease that impact, for example, by implementing new practises and policies or reducing business travel.

Sustainability reporting is not required for every organisation; it is still voluntary for some organisations, including agricultural businesses (European Commission 2023). According to Hrebicek et al. (2015), sustainability reporting is limited in the food and agriculture sectors due to a lack of standardisation. Other challenges, such as identifying performance indicators, greenwashing, complex calculations, and reporting bias, make sustainability reporting limited (Padro-Lorenzo et al. 2009; Cerin 2002).

The absence of a standardised mechanism and reports focusing on descriptive outcomes hinder transparency, comparability, and benchmarking (Turzo et al. 2022). Performance information in sustainability reports is therefore of little value to other stakeholders (Hubbard 2009). Reliable, honest, and transparent reporting is required to build trust and transparency both within organisations and in society (Amran & Keat Ooi 2014). Non-financial reports are more difficult to legitimise than quantitative and verifiable financial reports. High-quality sustainability reports are in demand to ensure consistency, comparability, and reliability (ibid.).

In agriculture, where sustainability reporting is not mandatory and is still limited, there is no efficient way of reporting on climate impact (Spanaki et al. 2021; Lynch et al. 2021). However, the possibility of collecting, storing, and measuring sustainability data in agriculture is advantageous, as well as sharing sustainability performance and data with stakeholders (Spanaki et al. 2021). Research shows that corporations can improve sustainability performance by measuring, managing, and reporting on it (Turzo et al. 2022). Corporations that conduct sustainability reporting and communicate efforts taken in the TBL dimensions effectively are shown to have a positive impact on financial performance (Baron 2014).

3.5 Benchmarking

Benchmarking is the process of improving company performance by seeing and learning from what others are doing (Doorasamy 2015). The purpose is to give companies a system to find the best ways of doing things in their industry. Then the company can make the changes needed to exceed these levels (Elmuti & Kathawala 1997; Presley & Meade 2010). In the context of sustainability, benchmarking is used to assess and compare an organisation's sustainability practises and outcomes with others in the same industry (Snoo 2006). Benchmarks can include comparisons

of products, processes, results, practises, performance, or operations. Benchmarking provides the practitioner with evidence to recognise, use, or support a sustainability initiative or project to achieve sustainability objectives (Snoo 2006). It is an essential tool that enhances the consistency of alignment and performance between the benchmarked entities and improves transparency regarding the operations and performance between the entities (ibid.). Consequently, it has the capacity to enhance rigour and efficiency through a “race to the top" dynamic and establish a reference point for stakeholders to determine what acceptable practise looks like (Iseal Alliance 2019).

Freytag & Hollensen (2001) state that benchmarking involves comparing a company's performance against best practises and recognised standards in the industry, identifying and evaluating areas for improvement, and implementing those improvements to enhance business operations and overall performance. According to Petuskiene & Glinskiene (2011), benchmarking can be viewed as an appropriate technique for the implementation of innovative and proven procedures or methodologies in a company. The triple bottom line framework provides criteria for conducting sustainability, and when incorporating benchmarking, organisations can assess and evaluate performance within the TBL dimensions and compare it to industry standards (Hubbard 2009). When organisations conduct sustainability reporting, they show and disclose their sustainability performance, enabling benchmarking (Adams & Frost 2008). By assessing other farms' sustainability activities, benchmarking enables farmers to improve their economic performance, social impact, and environmental practises. This is important for this study as it provides the possibility to understand how sustainability work has been affected by benchmarking against other farms through the data-sharing platform.

By evaluating an organisation's strengths and limitations, development areas can be recognised and resources can be focused more effectively (Zairi 1996). Benchmarking is not just a technique; it is also a concept that creates change. Both internal and external benchmarking exist (Anton & Gustin 2000). External benchmarking can be referred to as competitive benchmarking, which is a comparison of performance against other companies and competitors (Freytag & Hollensen 2001). It can be carried out by comparing colleagues and competitors within the same industry or across different industries. Internal benchmarking is the process of evaluating the performance of several departments or processes inside the same organisation in order to discover areas for development and share best practises (Anton & Gustin 2000).

For an organisation to succeed with benchmarking, it is required to have a clear picture of what the benchmarking strategy aims to achieve (Anton & Gustin 2000). It is acknowledged that understanding the strategies and processes that exist in the

organisation is a prerequisite for being able to interpret comparisons and thus be receptive to changes that benchmarking can imply.

3.6 Conceptual Framework

The theories and concepts presented in this chapter are compiled into a conceptual framework. This theoretical synthesis will provide a basis for analysing the empirical evidence and answering the research questions. Table 2 explains the summary and contribution of each theory in the conceptual framework developed for analysing the study's empirical data and the specific variables that will be considered.

Table 2. Conceptual Framework: Triple Bottom Line, Sustainability Reporting, and Benchmarking.

Theory	Summary	Contribution	Variables
Triple Bottom Line	A business framework that evaluates sustainability based on economic, environmental, and social dimensions.	Emphasises the importance of considering environmental, social, and economic factors to achieve long-term sustainability.	Doing sustainability: • Social • Environmental • Economic
Sustainability Reporting	The practise of disclosing an organisation's social, environmental, and economic performance.	Contributes to transparency, stakeholder engagement, risk management, and achieving sustainability goals.	Showing sustainability: • Measuring • Disclosing • Communicating
Benchmarking	A management strategy to improve the company's performance by seeing and learning from what others are doing.	Provides organisations with a roadmap for continuous improvement in sustainability by setting targets and tracking progress over time.	Assessing sustainability: • Identifying • Evaluating • Implementing

The pressure from stakeholders and society on farm businesses to take responsibility for sustainability issues and take actions to reduce climate impact has increased (Amaladoss & Manohar 2013). To address sustainability issues and actions, the concept of sustainability has been clearly defined based on sustainable development and the Triple Bottom Line framework. The TBL framework presents a comprehensive approach to sustainability with the three obligations of society, environment, and economy, which will provide a contextual understanding of how

farm businesses are doing sustainability through different practises (Elkington 1999). The TBL perspective creates the basis for and underlying view of sustainability in this study, which is further expanded by the concept of sustainability reporting and the benchmarking theory. By departing from the TBL framework, it is possible to evaluate and analyse possible areas for improvement in the three dimensions when farm businesses show their sustainability performance through reporting and assess other farms' performance through benchmarking.

One way of working in line with the TBL framework is for farm businesses to conduct sustainability reporting, which makes it possible to disclose and show their efforts taken to reduce climate impact (Deegan & Unerman 2011). It can be seen as a way of supporting data-sharing in agriculture, where farmers have the possibility to communicate and prove their sustainability efforts with data and share it with society and stakeholders. Every corporation has different sustainability goals and strategies, which are communicated through sustainability reporting (Cerin 2002). Benchmarking is enabled and makes it possible to assess and evaluate a farm's sustainability performance based on communicated strategies and sustainable responsibilities (Doorasamy 2015). The benchmarking theory provides an understanding that farm businesses can use benchmarking as a management tool to account for other corporations and improve their own businesses. Providing and communicating sustainability data and actions is essential for benchmarking and, thus, for farmers to assess the sustainability practises of other farms.

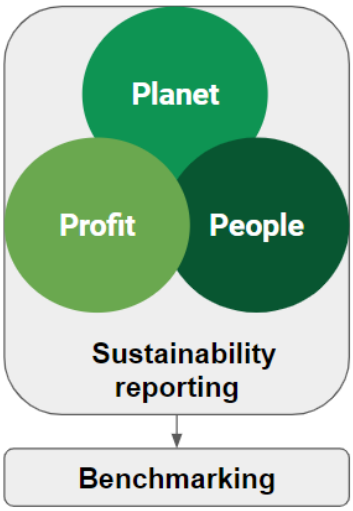

Figure 4. Illustration of the conceptual framework

4. Empirical Study

This chapter presents the empirical results retrieved from interviews with managers of the selected farm businesses using Arla's climate calculation tool. They are responsible for reporting data and managing the tool. This chapter presents the farmers by using the four categories; Background, Areas of usage, New community, and Drawbacks to facilitate the structure.

4.1 Farmer A

Background

Farmer A has 115 cows and 280 cattle on his conventional dairy farm. For sustainability, the farm prioritises production, resource efficiency, and long-lived cows. They have used the climate calculation tool for four years and have not reported on sustainability to external organisations. However, more stakeholder interest is anticipated, and the slaughter organisation will start collecting sustainability data. The farmer uses the tool because it provides additional payment for the milk and gives helpful insights. The farmer states that reducing their carbon footprint will help Arla, their farm, society, and the environment. They emphasise the importance of reducing waste and being efficient, where the tool has helped them monitor how much they waste and make sure they are efficient.

Areas of Usage

The farmer uses the tool for an analysis of the farm and to detect areas where they need to improve their production. The insights gained from using the tool have formed the basis for decision-making.

The ability to determine where the farm has deficiencies and opportunities to improve compared to other farmers has been the biggest advantage of using the tool. Opportunities to work with biogas have been detected, which has made it possible for the farm to reduce the methane in the manure, contributed to cost savings, and reduced climate impact. Thus, the farmer states that the tool "nudges one in the direction of where to make investments." Through the tool, the farmer

has gained more knowledge about where they need to improve and put more effort, which has enabled better decision-making. Decisions that have been made based on their gained insights includethe implementation of hygiene plans on how to reduce mortality among cows and how to prevent diseases. According to the farmer, this is both a production-wise and sustainability strategy.

The tool has made it easier to use key figures and generate almost any key figure they want. The farmer states that the farm's climate impact has been reduced partly because of using the tool. The farmer has worked with practises to make the farm resource efficient and have a low climate impact for several years, but this has not been mentioned as sustainability until now. However, the tool has helped with getting a clear overview of areas where improvements have to be made or where the farm is already doing well. For example, it is shown that for every input they make, they become better and can produce more milk in the same area, which is more efficient and thus contributes to less climate impact. This was not clear before using the tool. The use of the tool has enabled the farmer to show results based on the inputs, which is proof that strengthens arguments in various situations. For example, the farm wants to invest in new and more advanced technology, but state that they lack correct and reliable data to make the investment, where the tool has helped them.

New Community

The farmer uses the tool to compare their results with those of other farmers, and they use it to analyse where and in what areas they have the potential to improve and detect where they need to put resources. The farmer used the tool to detect that if the cows live longer, it will increase their sustainability, and thereby created strategies to solve this issue and become more efficient in their production. Additionally, the farmer wants to belong to the best-performing farms, whereas the tool makes it possible to do comparisons and become as good as possible.

The farmer highlights that the tool has indirectly led to new business collaborations, as a collaboration regarding biogas has emerged. Their neighbour will build a larger biogas plant so that they can collaborate instead of both building their own.

Drawbacks

The farmer states that it would be beneficial if the different data systems they are reporting data to could be connected and automated to save time and not report as much data. There is a lot of data that could be merged into the tool. The tool as it is today requires a lot of time and administrative work for this farmer.

It is possible to download and share the data with other stakeholders, but according to the farmer, most of them are not interested in knowing the farm's climate impact. Hence, the data has not been used in other ways than in the tool; however, the bank, for example, can be interested in production results, key figures, and efficiency. The farmer highlights that when these numbers are good, they also have a low climate impact. However, the main incentive for implementing sustainable practises such as using less diesel, using solar energy from solar cells, or operating machines with electricity is the economy and the financial aspect.

4.2 Farmer B

Background

Farmer B produces conventional milk with 86 cows and 80 hectares of grain. They always strive to maintain the highest possible quality of their milk while producing as much as possible. The farm has used Arla's climate calculation tool for four years, with the main incentive of receiving economic compensation for their milk. The farmer only reports data and does not use it for anything else, however, a belief that increased demand for sustainability data from other stakeholders will become more common in the future is expressed.

Areas of Usage

The tool makes it possible for the farmer to determine which areas have the highest climate impact and, thereby, identify which areas need improvement. However, the farmer states that the results they received were already known problem areas, but the tool might have made these problem areas a bit more clear. Based on the insights gained from using the tool, no processes or changes were made; however, the farmer states that "although I didn't make any big decisions after seeing the results, it was still an eye opener for me to think more about how we can reduce our impact on the environment in the future". The farmer has analysed the deviations and unusual patterns in the results, which made it possible to identify problems and where to take action to improve the business.

Further, it is also mentioned that data from the tool has several potential benefits, such as optimising protein use, improving feeding practises, and investigating high land use in their operation. The data could also be beneficial in discussions where the work on the farm is being questioned, in which the data provides a strong basis for proving the contributions made by production.

By using the tool, the farmer has learned how even feeding and mixing the feed through the use of mixer carts can have a positive effect on the health and

productivity of their cows while reducing the environmental impact. Overall, the farmer clearly states that they have not taken any concrete actions based on the results of using the climate calculation tool.

New Community

Farmer B states that being able to do comparisons against other farmers is used and that inspiration, areas of improvement, and learning from others' experiences are possible and something the farm looks at. However, this has not led to any significant changes in their farming operations. The reason for not taking action on these insights is that the farm has been performing quite well in terms of climate impact. However, if the farm had performed poorly compared to similar farms, the farmer would have considered whether something was wrong with the production and maybe taken action. Consequently, it is also mentioned that the farmer has found it easier to communicate with other farmers based on the results of the tool.

Additionally, the farmer highlights potential areas where collaboration within the company could be improved by using the tool with employees. For example, using it to motivate changes and indicate what goals the company works toward.

Drawbacks

The farmer has been informed that consumers demand information about the farm's climate impact, but the farmer finds it difficult to believe. The perception is that despite Arla's marketing efforts to position its milk as better and more sustainable, consumers continue to purchase cheaper milk from other brands. The farmer states that it is doubtful that many consumers truly care about sustainable production because he believes consumers often go for the cheapest option and do not care about the sustainability actions taken on the farm.

The farmer expressed dissatisfaction with the climate calculation tool, citing the extensive data reporting requirements that are not customised, the perceived lack of value, and the repetitive and time-consuming nature of the report. This administrative time could have, according to the farmer, been used in farm production instead. However, the significance of accurate reporting in improving the business is acknowledged, and it is suggested that future developments of the tool should aim to simplify the reporting process for farmers. It would also be desirable for Arla to take on a larger role in the process. After all, they are the ones who want to market the products, and it would be good if they could facilitate the reporting and take more responsibility for the results.

4.3 Farmer C

Background

Farmer C runs a conventional dairy farm with around 310 cows. They have a 2x12 milking parlour and prioritise the self-sufficiency of forage and grain production. The climate calculation tool was adopted in early 2020 to estimate their farm's carbon footprint. The primary reason for implementing the climate calculation tool was the financial incentive to receive additional payment for their milk. Farmer C also expressed a genuine interest in understanding their farm's operations and the broader sustainability aspect.

Areas of Usage

The farmer highlights that the tool enables them to accurately calculate their carbon dioxide emissions and identify areas where they could make improvements to reduce those emissions, which they believe can lead to cost savings. The farmer states that “if we do not have an economy, we cannot continue our business”. The tool has made them understand that by using the right inputs and actions, fewer resources will be spent, they will be more profitable, and they will improve their business.

The farmer worked towards the potential areas of improvement before implementing the tool but only had control over the separate areas without a direct overview. The tool has made this more clear, provided a clear overview of the data, and given the ability to see different scores within different key areas. By following these scores and numbers throughout the year, they have been able to improve these areas. For example, they significantly reduced carcass cows, controlled the urea in the tank, and improved feed efficiency. This was done through preventive work and continuous follow-ups. The farmer has acknowledged that feed efficiency gives a high yield in terms of the direct correlation between milk production and feed input. By using the tool, the farmer has been able to get a receipt on what actions are correct and what needs to be adjusted.

The main impact of using the tool is stated to be the insights gained, particularly regarding land use and fertiliser levels. As a result, they are transforming their crop cultivation practices where the results and data from the tool have been instrumental in decisions and guiding this process.

The tool may have influenced some of the farm’s decisions, such as purchasing equipment for growing more grain and reducing tillage. However, the farmer states that it is still too early to have a clear understanding of the tool’s impact on their decision-making process. Over time, the tool is expected to contribute to a greater

extent in decision-making at the farm. Additionally, the ability to do comparisons with other farms in the tool has been used but actions according to this information have not been taken. However, the farmer states that if they had been among the lower-performing farms within the tool, they would have behaved differently and used the insights to take action. They use the tool for internal benchmarking instead and follow their own development.

New Community

Collaboration with others has occurred due to the insights gained, mainly within protein efficiency. The farmer has noticed that it is not possible to grow more protein crops at their farm, so they will collaborate with others on contracts and make clear orders. The farm has a great grain plant that will add value to the other part of this collaboration and overall contribute to more Swedish protein crops being produced. They are in the process of investigating this, but the initiative has been enabled by using the climate calculation tool.

The farmer states that the tool is great for strengthening a brand and enabling communication about the efforts made to reduce climate impact when negotiating and strengthening the company's position against competitors. The farmer sees great potential in using the tool to advertise the added value and the implemented sustainability efforts to end consumers when they purchase products in stores. However, the tool is great for communicating with wholesalers, such as Ica, but is limited to reaching end-consumers.

The results of the tool have also been shared within the company and discussed with the employees. It is highlighted by the farmer that increased collaboration can be reached through using the tool and also by celebrating and reflecting on performance and achievements within the company. For example, the possibility to celebrate when they have reached certain goals and results within the tool.

Drawbacks

The farmer highlights the need to be able to connect the tool to other data systems, for example, they collect a large amount of data on the cows, which would be great to automatically incorporate into the climate calculation tool. However, the farmer has spent less time and energy collecting and administrating data by using the tool. It is mentioned that the tool can strengthen their position in various situations as proving something with data is more trustworthy, and the farmer states “If not measuring with data, there is no possibility to be trustworthy as an industry”.

The farmer downloaded their collected data and results and shared them with other stakeholders on their own. The bank was particularly mentioned, but they were not

interested in knowing the data from the report. It is also stated that there is great potential in reducing carbon footprints by using the tool, however, they can not see a clear change in this particular question as they have not used the tool long enough. The farmer states, “But over time, I can clearly see that we will be able to do it, and the tool will facilitate the process”.

4.4 Farmer D

Background

Farmer D oversees 400 hectares of cultivable land and runs a dairy farm with 270 cows that use robotic milking technology. The farm is self-sufficient in forage and grain production, and the farmer started using Arla's climate calculation tool in late 2020. While the farm had already collected data on climate impact, a full overview was lacking. The farmer highlights the dangers of false reporting and cheating, but it is explained that the tool enables data verification, which contributes to credibility and transparency, according to the farmer.

Areas of Usage

This farmer’s agricultural management has benefited from using the climate calculation tool. It allows for reliable measurement and tracking of greenhouse gas emissions, which enables them to make informed decisions about how to reduce environmental impact while preserving production and profitability.

Using the tool has resulted in numerous changes, making the farm more efficient and precise. It has improved knowledge of feed and waste management, stimulated investments in better equipment, and optimised field operations like fertilisers and insecticides. Using the tool also gave an overview of the farm business and enabled climate footprint reductions through meticulous production practises and the use of appropriate machines and equipment

The farmer emphasises that sustainability leads to profitability, and by using the tool, they have improved the business by being more precise and have started using more precision agriculture. By understanding the whole farm, they were able to make more informed decisions, for example, to optimise production by analysing cow-related data and feed composition. The farmer explains that a productive cow translates into a profitable farm.

Furthermore, the farmer highlights the beneficial value the tool brings to Arla, as they can prove the climate efforts taken at their farms. The farmer believes more consumers will recognise the positive impact of dairy farming when this is

communicated, which may increase sales. This can also lead to increased milk prices and better revenues for Arla farmers, according to the farmer.

New Community

By using the tool, the farmer has acknowledged areas where collaboration with other farmers can be beneficial, for example, sharing machinery with neighbours, and getting satellite wells installed to reduce the distances that the machines need to travel and thus save money and the climate. These are things the farm did not consider before using the tool. The farmer emphasises the tool's potential to improve internal collaboration within the farm because if the employees are on board with the desired outcome of using the tool, efficiency will be achieved and enable higher salaries for the employees.

The ability to do comparisons between other farmers in the tool has been used by the farmer as it is assumed to be a great way to improve the whole industry. However, the farmer has not taken any decisions or actions based on the comparisons other than just acknowledging how the farm is performing. Further, the farmer has used the insights from the tool for decision-making. For example, it was acknowledged that there were possibilities to improve energy efficiency, which made them consider implementing solar panels and biogas. They are currently evaluating the costs and benefits associated with these options to determine the best course of action.

Drawbacks

It is stated that there is no way of communicating to society the specific actions taken to reduce the climate impact of the specific farm. Other stakeholders have not been interested in their climate impact or data, but in this context, they have mainly been used to satisfy customers' demands to know their climate footprint. However, the farm highlights that by reporting and sharing data through the tool, they can reach out to customers regarding their climate impact and therefore use the tool to communicate.

5. Analysis & Discussion

In this chapter, the empirical data is analysed and discussed based on the conceptual framework developed in Chapter 3, which builds on the triple bottom line framework, sustainability reporting, and benchmarking. The analysis is categorised into three different empirical themes that commonly emerged during the case study. Followed by a discussion that reflects on the findings related to previous research. The chapter ends with a discussion summary. *Table 5* presents these themes and the key insights they are based on.

Table 3. Empirical themes based on key insights from empirical data.

Empirical Theme	Key Insights from Empirical Aata
Improved sustainability performance and awareness.	• **Social** Increased collaboration externally and internally. • **Environmental** Improved feed efficiency, manure management, crop rotation strategies, and precision agriculture. Implementing solar cells, hygiene plans, and biogas. • **Economic** Nudged in the direction of where to make investments. Reducing energy consumption and increasing overall production efficiency.
The use of data to communicate sustainability responsibility and efforts.	• **Measuring** The tool calculates the climate impact and shows the efforts taken to reduce it. • **Disclosing** Stakeholders outside Arla are not interested in the farmers' climate impacts or sustainability data. • **Communicating** Data and tangible evidence in numbers strengthen the farmer's position. It is easier to communicate efforts and responsibilities based on real and reliable data.

Business improvements made by using Arla's climate calculation tool.	• **Identifying** Increased overall understanding and insights into the whole farm. Detected where resources must be placed. • **Evaluating** Understanding of which areas need to be improved and how to take action. • **Implementing** The possibility of making more informed decisions about business and sustainability improvements.

5.1 Increased Sustainability Performance and Awareness

According to Elkington (1999), TBL strives to address the complexities of sustainability, instead of only having an economic responsibility, it expands organisations' environmental and social responsibilities so they must account for all three dimensions. According to the empirical findings, all farms implement the TBL concept's responsibilities in different ways by gaining an increased understanding of their own farm's sustainability performance by using the tool.

Based on the insights they gained from using the tool, the farms have evaluated their areas for improvement and been able to make more informed decisions. This was enabled by collecting data in a comprehensive system that gave a clear overview of the farm's data and by acknowledging other farms' performance through benchmarking (Freytag & Hollensen 2001). The farmers gained an understanding of how their management decisions regarding, for example, the use of resources impact economic sustainability. Enabling the farms to incorporate actions within the people, planet, and profit aspects of their business strategies, aligned with the sustainability literature (Kleindorfer et al. 2005). Hence, systems thinking emerged, and they act to meet their responsibilities in the social, environmental, and economic dimensions.

5.1.1 Social

Miller (2020) sees collaboration within and outside of businesses as an important factor in achieving high social values. The case study shows that some collaboration within the farms has emerged by using the tool. It is shown that the gained insights create the possibility to reflect on achievements, collaborate, motivate common strategies, and celebrate with the employees when reaching goals. According to Dentre & Gunderson (2011), the social dimension of TBL includes the effect farming practises have on the employees, where some new social practises on the farms have been generated and indicate a positive effect on the employees.

Strengthening the corporate culture and sense of community within the farms is also possible by using the tool, but it is too early to draw conclusions based on the empirical results. However, a social responsibility taken by the farms is indicated when using the tool.

The potential benefits of partnering and collaborating with other farms are another social component shown in the case study. This is demonstrated by Miller (2020), which states that sharing best practises with other organisations and developing strategic partnerships and collaborations are important factors for taking social responsibility. Sharing machinery with neighbours, developing satellite wells to minimise travel distance, and implementing contracts about protein crops are examples of collaborations that were not considered before using the tool. This is a synergy between the TBL dimensions, as environmental responsibility and economic savings arise when such collaborations are implemented (Elkington 1999).

It is not evident that the tool has significantly helped the farms prove increased involvement in local communities or that it affects fair working conditions, which Elkington (1999) means is an important part of the social dimension. However, one farmer highlights that when the farm is performing well, which the tool enables and even improves, economic values and profitability increase, which enables higher salaries for employees which is a social value.

5.1.2 Environmental

The environmental dimension of the triple bottom line covers an organisation's obligation to decrease its environmental impact and do as little harm to the planet as possible (Elkington 1999). Initiatives and methods that can be taken to decrease environmental impact are further described by Singh & Srivastava (2022), and the case study demonstrates that such initiatives have been implemented. The farmers have taken action to reduce their environmental impact and implemented several new sustainability practises by using the tool. These are described below:
All farmers started managing machines more efficiently to use less diesel, and one farmer started operating some machines with electricity. Generally, they are all trying to use less diesel in production after acknowledging their climate impact, which also brings economic benefits.

Some farmers detected opportunities for improvements in their crop cultivation practises, and based on information about land use and fertiliser levels, new practises were developed. For example, strategies for improving protein efficiency, different crop rotation strategies, precision farming techniques, manure management, and optimisation within these areas. The farmers acknowledge that increased efficiency in the fields contributed to several benefits, such as resource

efficiency, feed efficiency, healthier animals, reduced waste, reduced climate impact, and increased profitability. The farms gained increased awareness about how their strategies and methods in these areas impact the business. Synergies between the TBL dimensions were achieved and demonstrate that the farmers are considering the three Ps when conducting business (Elkington 1999).

This is further in line with the literature by Singh & Srivastava (2022), which states that farmers need to consider how their methods affect the resources they rely on, like soil, water, healthy animals, and biodiversity, and how they would contribute to lowering greenhouse gas emissions and tackling climate change. Consequently, the tool has enabled farmers to calculate their environmental bottom line, and thus take action on how to manage their practises and resources, which therefore demonstrates increased environmental responsibility by using the tool (Amaladoss & Manohar 2013).

Collaboration regarding growing protein crops has been developed after sharing data and understanding areas for improvement based on benchmarking against other farms' performance. Whereas Kneipp et al. (2019) and Smith (2008) state that collaboration contributes to a win-win situation and is of high importance when incorporating sustainability practises, it is also a way of taking responsibility for the social bottom line (Miller 2020).

It is demonstrated that the implementation of solar cells and the use of solar energy have emerged as a result of acknowledging their farm’s climate impact. Practises regarding biogas have also been developed to decrease methane emissions and reduce climate impacts. Indicating improvements in the farms’ sustainability work based on using the tool and the consideration of both environmental and economic sustainability when doing business (Elkington 1999).

Singh & Srivastava (2022) highlight the importance of healthy animals, where two of the farmers have implemented hygiene plans on how to reduce mortality among the cows and how to prevent diseases. These strategies are stated to be both production and sustainability strategies, as the cows’ health is directly correlated with environmental impact. Consequently, the tool enables the farms to take responsibility for actions and sustainable development, as well as move towards a regenerative and more sustainable future (Amaladoss & Manohar 2013; Painter-Morland et al. 2006). The statements “It is profitable to be sustainable”, and “It is profitable not to waste” were mentioned in the case study, which indicates a strong connection for developing their business according to the TBL framework (Elkington 1999).

5.1.3 Economic

Agricultural businesses are often dependent on cost-savings and investments that help them compete more effectively (O'Sullivan et al. 2019). According to the case study, the farms have been able to reduce their costs by taking action in areas of improvement. For example, by reducing energy consumption, starting collaborations instead of investing on their own, using resources more efficiently, optimising feed, and being more efficient in the fields.

The economic bottom line focuses on financial performance and the ability to add value to the market (Elkington 1999). It is demonstrated that a low climate impact is equivalent to profitability, hence, the farms want to improve their sustainability performance to also gain economic value, which consequently brings value to society. Aligned with the benchmarking theory, the farmers compare themselves against other farms to become among the best, which is stated to potentially improve the whole industry (Doorasamy 2015). Thus, the tool has the possibility to improve environmental and economic performance while adding value to the whole market. It is evident that the "race to the top" dynamic within benchmarking has been beneficial when developing sustainability practises (Iseal Alliance 2019).

O´Sullivan et al. (2019) highlight the importance of maintaining a profitable farm business. According to the empirical evidence, there are possibilities for the farms to maintain profitability by marketing their collected data and initiatives to reduce climate impact. The case study shows that Arla can use the collected data to prove and market the whole corporation's sustainability initiatives and performance by collecting data through the tool. This is described by the sustainability reporting literature as a way for corporations to communicate sustainability activities and provide a transparent picture of a company's sustainability performance (Deegan & Unerman 2011). Such communication by Arla can encourage and promote consumers to purchase from them and generate increased milk prices. Enabling the farmers to maintain a profitable farm business (O´Sullivan et al. 2019). According to the case study, the farmers were not aware of their data and climate impact to this extent before using the tool, and thus Arla could not communicate the whole cooperative's sustainability performance.

The analysis demonstrates that it is too early to determine whether the tool has contributed to a calculated decrease in climate impact at the farms. At the same time, the farmers have implemented sustainability practises to reduce their climate impact in areas they were not aware of before using the tool. This is a way of responding to the increased pressure from stakeholders on corporations to become more sustainable and take responsibility for their actions (Amaladoss & Manohar 2013). Demonstrating that the tool has contributed to farmers taking responsibility for sustainability and climate impact, not only focusing on profit maximisation.

This is supported by previous literature by Garnett (2013) that highlights the increasing need to produce food with less environmental impact while meeting the needs of the growing population, which the farms have taken action on. However, it is revealed that social responsibility and implemented practises were not as apparent. In the context where agriculture is facing criticism about being unsustainable, previous literature demonstrates that being sustainable and having a low climate impact are the most important factors (Crippa et al. 2021; Liljeström et al. 2023), and the tool has enabled improvements mainly in the environmental dimension.

Previous research demonstrates that using digital technologies has the potential to significantly change how agriculture functions by implementing new practises and tools and using data to drive business efficiency (McFadden et al. 2022; MacPherson 2022). The analysis shows that the farms have become more efficient in both their practises and within the overall business, which indicates that using data-sharing technology has contributed to several improvements in the way their farm business functions. Additionally, data-sharing technology has enabled Arla to understand the whole cooperative's climate impact, which makes it possible to set strategies, improve sustainability on a larger scale, and bring value to its owners and society.

5.2 Using Data to Communicate Sustainability Responsibility and Activities

5.2.1 Measuring

The case study demonstrates that the tool provides an overview of the farm's sustainability performance, a calculated climate impact, and how the actions taken to reduce it have affected the farm's operations, strategies and sustainability performance. The tool can be seen as a way to support sustainability reporting as it measures climate impact by collecting data and disclosing environmental impact in numbers. Sustainability reporting is the practise of measuring, disclosing, and communicating an organisation's sustainability responsibilities and efforts toward stakeholders (Deegan & Unerman 2011), which is enabled by the tool.

The outcome of sustainability reporting is a sustainability report that presents the organisation's environmental, social, and economic efforts (GRI 2017; Cerin 2002). In this context, farmers have been unable to do a report with the tool. However, the tool is a way of sharing data to measure, disclose, and communicate climate impact, sustainability performance, and activities taken in the TBL dimensions (Deegan & Unerman 2011; Elkington 1999). It is indicated that farmers are making efforts to

present their sustainability efforts and show a transparent picture of their corporate sustainability performance by using the tool. According to Hrebicek et al. (2015), there are limited possibilities for agriculture to communicate sustainability responsibility. Even though a report is not generated, the collected and shared data have the possibility of being used in a report if desired.

Sustainability reporting can be used by an organisation in different ways, and the content of interest varies depending on the type of company and its stakeholders (Manetti & Toccafondi 2012). It can be used to manage risk, demonstrate sustainability commitment, engage stakeholders, or make informed decisions. The empirical evidence demonstrates that the tool has been used to demonstrate sustainability commitment and make informed decisions. Turzo et al. (2022) state that corporations can improve sustainability performance by measuring, managing, and reporting on it, whereas the case study shows that farm businesses have benefited from the tool due to farmers gaining an increased understanding of their farm's data and performance, and the implementation of actions to reduce climate impact.

There is no standardised and commonly used framework for sustainability reporting, which makes published information difficult to interpret and compare. (Turzo et al. 2022). It also leads to problems with corporations not providing reliable data, hindering transparency and comparability among farms. The case study demonstrates that the tool contributes to standardisation, comparability, and transparency in calculations and reporting, as well as facilitating complex calculations. The tool collects the same data from every farm as they report on the same questions and receives a calculated climate impact based on a standardised calculation method. Additionally, real production data is provided, and verification of submitted data is required by prompting farmers to submit evidence. This facilitates interpretations and reliable comparisons among farm businesses.

By sharing data in this instance, reliable and accurate benchmarking is enabled, as the farms benchmark against the same set of verified datasets. According to Freytag & Hollensen (2001), this enables farmers to develop improved business strategies. Snoo (2006) implies that benchmarking improves transparency between the benchmarked entities, which is essential to making sustainability reporting trustworthy (Turzo et al. 2022). Contributing to standardisation and developing the sustainability field in the food and agricultural sectors.

According to the analysis, the tool has enabled farms to communicate sustainability data, climate impact, and commitments, while making sure real and trustworthy data is provided. Contributing to standardising sustainability reporting in agriculture and increasing transparency between farms and other corporations

interested in farm data and sustainability impact. Previous research states that there is currently no standardised way of measuring, reporting on, or calculating climate impact in agriculture (Spanaik et al. 2021; Lynch et al. 2021). Different sustainability reports and data are demanded from various stakeholders, and such data are usually collected in reports based on templates and estimated data (Liljeström et al. 2023). This results in several different ways of calculating climate impact and a lack of transparency when communicating to stakeholders. According to the analysis, the tool has the potential to solve this situation by providing a transparent and standardised way of communicating and measuring farm sustainability. It can also be used to develop branch standards for sustainability reporting in agriculture.

5.2.2 Disclosing

Research has identified that corporations can respond to stakeholders' increased demand for corporations to take sustainability responsibility by conducting sustainability reporting (Manetti & Toccafundi, 2012; Cerin 2002). The case study demonstrates that the farmers want to take responsibility for their climate impact and communicate the efforts taken to reduce it. By using the tool, farmers have been able to respond to increased demand by communicating sustainability data and performance. Whereas Elkington (1999), states that satisfying the needs and demands of relevant parties is a social responsibility. Additionally, it is argued that the main reason for conducting sustainability reporting is to improve corporate legitimacy and generate stakeholder value (Manetti & Toccafondi 2012). However, farmers used the tool and shared their data with Arla mainly to receive the additional payment for the milk. Indicating that economic values are the main incentives for sharing data and using the tool, not social responsibility.

Further, Fortanier et al. (2011) highlight the importance of considering the relevant stakeholder's interest in sustainability reporting because they have an essential role that can affect the corporation's business operations. According to the case study, the farms' data and results have been shared with the bank and other stakeholders, but they were not interested in knowing such data. Hubbard (2009) emphasises that sustainability reports usually focus on descriptive outcomes, which make performance information invaluable to other stakeholders. According to Prado-Lorenzo et al. (2009), Spanaki et al. (2021), and Georgios (2022), this is caused by the fact that sustainability reporting is not mandatory in the agricultural sector and reporting on climate impact is limited and biassed. Hence, stakeholders are not interested in or relying on such farm data yet. However, this lack of interest did not affect the farms' business operations, as they were aware that sharing sustainability-related data is emerging and not desired by every stakeholder yet.

The analysis indicates improvements in disclosing and communicating farm sustainability performance and increased responsibility for sustainability work by using the tool. However, the incentive for using the tool has mainly been the economic compensation from Arla, indicating a need for increased support from the agricultural sector, the food industry, and actors in supply chains to continue improving sustainability at farms. This is further highlighted in previous research, where agriculture is especially exposed to the increased pressure on corporations to become more sustainable and account for transparency of sustainability throughout the whole supply chain (Amaladoss & Manohor 2013; Garnett 2013; Wognum et al. 2011). The increased demand for sustainability reporting requires farmers to keep track of their sustainability data and practises, as other corporations in the supply chain must collect such data.

As farmers mainly reported data to receive economic compensation, it is evident that the economic bottom line and profit maximisation were the main drivers for engaging in this sustainability initiative developed by Arla. However, the farms have benefited from using the tool, but if they are to continue their sustainability work while under high pressure from other corporations to reduce their environmental impact, farm businesses need more support from the whole industry. Arla, as a major actor in the food industry, plays a crucial role in increased sustainability, and it is evident that the tool has helped the farms in their sustainability work.

Previous research shows that stakeholders' demand for farms to show their sustainability results through reports have increased, and it is especially important for banks that need to verify real, accurate data to finance sustainability initiatives (Amran & Keat Ooi 2014; CSRD 2022; Liljeström et al 2023), but the analysis contradicts this. Other stakeholders than Arla were not interested in the farms' sustainability data or climate impact. However, as mentioned in the analysis, the relevant stakeholder's interest is of high importance, which indicates that this tool might be more suitable for working with sustainability at a farm level rather than using it to collect data to disclose sustainability performance to other stakeholders.

5.2.3 Communicating

The tool has enabled farmers to show the farm's sustainability work and communicate efforts and improvements made to reduce climate impact. According to the case study, data and tangible evidence in numbers have been the enablers, which have also strengthened their position against competitors and stakeholders. The sustainability literature indicates that providing such information makes it possible for stakeholders to assess how sustainable a corporation is over time by benchmarking against other organisations (Deegan & Unerman 2011; Maas et al.

2016; Hrebicek et al. 2015), which would not have been possible if not collecting and sharing data through the tool. The farms were not able to disclose or communicate sustainability data and efforts before using the tool. Thus, it is easier to demonstrate responsibilities in the TBL dimensions when farmers can provide real and reliable data (Elkington 1999).

The benchmarking theory implies that farms can use benchmarking as an analytical process for continuously comparing and improving business processes (Zairi 1996). Data-sharing technology has enabled comparisons and benchmarks and made it possible for the farmers to collect, communicate and provide tangible evidence of sustainability efforts and performance compared to other farmers in the Arla cooperative. This was not possible for the farmers before using the tool.

Based on the analysis, data-sharing has enabled beneficial values and improvements in farms' sustainability work, as there are clear benefits to using the tool. However, there is not enough evidence to determine whether it is specifically data-sharing technology that has been the enabler. According to previous research, data-sharing is considered crucial for developing sustainable practises and profitability in agriculture (Sundberg et al. 2021; Nordin 2021). The achieved improvements are mainly caused by the possibility of collecting and storing data in one system that offers a clear overall understanding of the farm and its sustainability performance, not particularly by sharing data. Consequently, the tool brings beneficial values for small firms working with sustainability.

It is also important to emphasise that farmers do not identify that data-sharing is the main activity when using the tool. Data-sharing technology is used within the tool to make it work and for Arla to collect sustainability data. Previous research on data-sharing explains that most farmers share their data without knowing it (Ault et al. 2022). Data-sharing can therefore be seen as passive data-sharing where farms disclose sensitive data sacrificing a lot of administrative time, data ownership, data privacy and accuracy. The case study demonstrates that farmers passively share data, but receive several benefits in return, such as the possibility to benchmark against and analyse other farms' performance, prove their sustainability work with data, share knowledge and best practise, foster collaboration and enable Arla to increase sustainability in the whole cooperative. Consequently, data-sharing technology brings beneficial values to farm businesses' sustainability work but most of the achieved improvements are caused by the effects of using the climate calculation tool. Such as the collection of data in one comprehensive system that offer farmers an overall understanding of their farms and facilitated informed decision-making.

The farms have been affected in different ways by using the tool and have taken different actions and decisions. This can be derived from their attitude toward sustainability as a lack of interest in working with sustainability has been equivalent to less commitment to using the tool and developing the business in a sustainable way. Whereas interest in sustainability has been equivalent to a strong commitment to using the tool to its full potential and improving sustainability at the farm.

5.3 Business Improvements Made by Using the Tool

5.3.1 Identifying

Doorasamy (2015) states that benchmarking is a way to improve company performance by seeing and learning from what others are doing. By evaluating performance against other farms, the case study demonstrates that farmers have been able to determine where they are performing well and where they have deficiencies and opportunities to improve. According to Freytag & Hollensen (2001), benchmarking is a process that involves comparing a company's performance with best practises in the industry, where the farms have compared themselves with competitors in the same industry.

The main business improvement achieved by using the tool is the collection and storage of data in one comprehensive system, which gives farmers an overall understanding of and insights into their farm’s performance and sustainability impact. Enabling farmers to understand and identify areas for improvement, aligning with benchmarking theory (Doorasamy 2015). The tool helped farmers understand how their management decisions impact their farm’s sustainability performance and detect where resources must be placed. Additionally, they were able to analyse how using the right inputs and actions, led to spending fewer resources, which made the farms produce more milk in the same area and improve production processes.

Improved efficiency was achieved, as demonstrated by benchmarking, where efficiency can be enhanced through the “race to the top” dynamic (Iseal Alliance 2019). This is highlighted in the case study, where the farmers want to be among the best-performing farms and have made sure they are when developing their businesses in that direction.

The case study indicates improvements in efficiency and profitability as it is recognised that a well-performing farm in terms of low climate impact is also a profitable farm. The tool has contributed to finding a balance between the three sustainability dimensions when operating a farm, which is important to achieve

long-term sustainability (Elkington 1999). Several benefits were gained by using the tool, and it became easier for the farmers to understand how to take action to reduce their climate impact and how to improve their practises within the triple bottom line dimensions (Elkington 1999).

Previous research highlights the fragmented data landscape and interoperability of systems as problematic because they make it challenging for farmers to make sustainable decisions and communicate sustainability work to society (Liljeström et al. 2023). Nordin (2021) emphasises that in deriving beneficial value from using digital tools, it is essential to have access to the collected data to be able to use it for management and decision-making. The analysis demonstrates that the tool has contributed to standardising the fragmented data landscape by collecting data in a comprehensive system and making it accessible, which enables informed decision-making at farms. Improved sustainability work is correlated to the possibility of making informed decisions.

5.3.2 Evaluating

According to Petuskiene & Glinskiene (2011), benchmarking is an appropriate technique for implementing innovative and proven procedures or methodologies in a company. By evaluating an organisation's strengths and limitations, development areas can be recognised and resources can be focused more effectively. According to the case study, farmers have evaluated strengths and limitations in their businesses, which has improved their sustainability activities. These are improved resource and feed efficiency, increased efficiency in the fields, implemented collaborations, increased animal health, reduced mortality, increased precision in the whole production, and an understanding of where investments must be made. Consequently, the tool has contributed to the implementation of innovative and proven procedures at the farms. This is further demonstrated by Zhu & Li (2021) as an advantage gained by sharing data. It is stated that increased efficiency in agricultural production, management, and operations can be achieved and contribute to sustainable development.

5.3.3 Implementing

Benchmarking involves identifying and evaluating areas for improvement and implementing those improvements into actions to enhance business operations and overall performance (Freytag & Hollensen 2001). The case study demonstrates that there is not enough evidence that the farms have taken action and implemented sustainability practises based on conducting benchmarking and acknowledging how other farms are performing. The reason is that the farms were already performing well compared to other farms' shared data and results. However, benchmarking has been used to make sure the farm is performing well and to

determine whether improvements can be made, thus benchmarking has contributed to beneficial values for the farms. This has helped the farms understand which areas they need to improve to reduce their climate impact. Additionally, the case study shows that if the farms had performed worse, actions would have been taken in order to benefit the business. These insights, together with the overall understanding of the farm, have therefore formed the basis for decision-making and enabled improvements. Consequently, improvements in the TBL dimensions are mainly based on the possibility of collecting, measuring, and disclosing data through the tool and not particularly by disclosing data (Elkington 1999; Deegan & Unerman 2011).

According to Zairi (1996), benchmarking is also a concept that creates change, and it is evident that farmers have implemented and improved some of their business practises. Thus, change has been created by using the tool. To be able to interpret comparisons and be receptive to the changes benchmarking can imply, it is essential to understand strategies and processes within the organisation (Anton & Gustin 2000). The overall understanding and awareness of farm performance, how strategies impact the business, and how to use resources efficiently enabled such acknowledgement. An increased possibility of making more informed decisions about how to improve the business was realised, which was not possible before using the tool. Consequently, reporting data has been crucial for enabling farmers to be receptive to changes and implement improvements.

Data-sharing technology has enabled benchmarking, which has led to business improvements and improved sustainability work by implementing sustainability practises in the TBL dimensions. According to previous literature, data and digitalisation have great potential to address sustainability, productivity, and resilience challenges in agriculture (MacPherson et al. 2022; Nordin 2021), which Arla's tool provides evidence for.

The analysis shows that benchmarking has not been the main realisation of the farms' sustainability improvements, however, the possibility to benchmark has still made contributions and been beneficial to the farmers' sustainability work. Thus, there is not enough evidence to determine whether sharing data with other farmers has contributed to improved sustainability work. The farmers would have acted differently if they had been among the low-performing farms, which means that data-sharing may be more important when the farms have a high climate impact.

A system to manage a large amount of data and make it accessible is absent in the agricultural sector (Nordin 2021; Poppe et al. 2013; Ritual Amin et al. 2020). This study provides evidence that the tool has enabled farmers to both collect and access a large amount of data. It has provided a clear overview of farm data and

performance, which has been used as a basis for decision-making on how to improve sustainability work and manage the farm. Consequently, the tool's system to collect, manage, and share data has been a clear enabler for the improved sustainability work on the farms. Hence, Arla's climate calculation tool has the potential to function as a data management system, contributing to facilitating the digitalisation and sustainability fields in agriculture.

5.4 Discussion Summary

The discussion highlights the positive effects of the tool, including its ability to improve farm efficiency, increase transparency, and lead the way for standardised sustainability reporting in agriculture. In addition, the importance of stakeholder pressure and financial incentives in driving farm businesses adoption of sustainable practises has been highlighted. The discussion also demonstrate the need for increased support from the agricultural sector and supply chains to continue working on improving sustainability on farms, as well as the importance of making sustainability reporting reliable and transparent. Another aspect that became clear in the discussion is that the tool may be better suited to work on sustainability at the farm level than to disclose sustainability performance to other stakeholders.

Given the theoretical contribution of the study, the findings show that data-sharing technology has a significant impact on small-firms behaviour and sustainability practises. The impact of data sharing includes improved stakeholder engagement, increased transparency in sustainability reporting, increased knowledge exchange, and advances in sustainable business practises. These findings shed insight into the complex dynamics and multiple implications of data-sharing technology in the context of small businesses and their efforts to achieve sustainability.

This is an important contribution to the sustainability literature since it emphasises the importance of data-sharing technology in helping small businesses engage in sustainable practises. It also implies the positive effects of and need for digital solutuions when working with sustainability at a farm level. In contrast, the study only looked at one type of data sharing technology; other types may affect small business behaviour and sustainability in a different way.

6. Conclusions

Chapter six presents the conclusions of this study by addressing the aim and research questions in relation to the main findings.

This study is a case study of Arla Foods, a major actor in the food industry that has introduced a climate calculation tool to reach its sustainability goals of having net zero greenhouse gases in the entire value chain by 2050. The tool is identified as a data-sharing tool used by farmers that are part of the Arla cooperative. This study is aimed at gaining a deeper understanding of how data-sharing technology is affecting small-firms behaviour and sustainability work. The addressed research questions will be answered below.

- *How have farm businesses been affected by using Arla's climate calculation tool?*

- *How does this data-sharing move farm businesses toward implementing new sustainability practises?*

This study finds that farm businesses have become more efficient and improved their sustainability work by using Arla's climate calculation tool. By collecting data in a comprehensive system, farm managers have gained an overall understanding of their farm, its data, operations, sustainability performance, and climate impact. Enabling the possibility of making more informed decisions and developing the business in a sustainable way. Farmers could more easily take responsibility for the farm's climate impact and communicate their efforts taken to reduce it as the tool enables a transparent and standardised way of communicating and measuring sustainability. Making it possible to respond to the increased pressure from stakeholders to become more sustainable.

This data-sharing technology has enabled reliable and accurate benchmarking, and by acknowledging how other farms are performing, improvement areas have been determined. Together with the increased understanding of farm data, sustainability performance and detected areas for improvement, farm businesses implemented new sustainability practises that address social, environmental and economic responsibilities. However, it is concluded that it is not solely data-sharing technology that made farm businesses implement such practises, it is mainly caused

by the tool's function to collect, measure and disclose data in one system. Even though data-sharing technology has not been the main driver for improved sustainability work, it has contributed to several benefits, such as the possibility to benchmark and compare performance against other farms, determine improvement areas, share best practises, foster collaboration, enable Arla to increase its sustainability and provide evidence in numbers for both customers and society.

As the tool uses data-sharing technology, there is insufficient evidence to determine whether it is data-sharing technology or the tool itself that has enabled the achieved business and sustainability improvements, as the tool does not function without farm businesses sharing their data. However, it is evident that digital solutions used by farm businesses contribute to improved sustainability work. It also makes them take responsibility for their climate impact and thus work in line with the TBL dimensions, not only focusing on profit maximisation.

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Popular Science Summary

The Impact of Data-Sharing Technology on Farmers' Sustainability Work: A Study of Arla's Climate Calculation Tool

With the world population on the rise, the food industry and agriculture are under mounting pressure to become more sustainable and reduce their environmental impact. The European Union has introduced a new directive that requires corporations to report on their sustainability efforts, adding to the push for change. The agricultural sector is undergoing a digital revolution that allows businesses to harness the power of data to improve sustainability. However, the use of various digital systems that do not communicate with each other makes it challenging to manage and measure sustainability performance and climate impact. The advancement of digital technology has created new opportunities for businesses to improve their sustainability, and the agricultural sector is no different. Tools for data sharing have emerged as a promising approach for assisting farmers in becoming more sustainable and profitable. While the increased dependence on data and digital solutions in agriculture also implicate various challenges when operating and managing a farm. The purpose of this research has therefore been to understand how data-sharing technology affects farm businesses' sustainability work. This has been done by investigating how farm businesses use data-sharing technology through Arla Food's climate calculation tool.

Understanding the effects of using data-sharing technology in agriculture is essential as digital technologies have the potential to make farms more sustainable and produce food with less environmental impact while meeting the needs of the growing population. By conducting interviews with farm managers using Arla's climate calculation tool, the study concludes that the tool had a significant impact on farm businesses by providing an overall understanding of the farm, its operations, sustainability performance, and climate impact. Influencing decision-making, contributing to improvements in business performance, and making the farm businesses implement new sustainability practises.

This study contributes to the development of digital solutions and data-sharing technology in agriculture by revealing that data-sharing technology is not the main driver for the achieved improvements. It had a positive impact on small firms' behaviour and their sustainability work but the improvements are mainly caused by the possibility to collect data in a comprehensive system that offers an overall understanding of the farm.

Appendix 1: Interview Guide

Introduktion
Tack för att du tar dig tid att delta i vår studie om datadelning i lantbruk. Intervjun tar ungefär 45 min. Den kommer främst att bestå av öppna frågor, där du får dela med dig av dina tankar och erfarenheter.

Vi heter Annie och Martin och undersöker vilka möjligheter datadelning inom lantbruk bidrar till och dess koppling till cirkulär ekonomi. Tanken är att en klimatberäkningsverktyg kommer att användas för att identifiera hur datadelning inom jordbruket kan bidra till att övervinna barriärer och driva på övergången till ett mer hållbart, effektivt, och cirkulärt lantbruk på gårdsnivå.

Vi spelar gärna in intervjun för att säkerställa att all information kommer med, för att undvika missuppfattningar samt för att underlätta transkribering efter avslutad intervju. Detta kommer inte att delas med någon annan och efter transkribering kommer inspelningen att raderas.

Ni har möjlighet att vara anonyma om det önskas.

Företagsbakgrund
1. Vad har ni för typ av verksamhet och hur omfattande är den?
2. Hur länge har ni använt Arlas klimatberäkningsverktyg?
3. Beräknade ni er klimatpåverkan tidigare? I så fall hur?
4. Vilka aktörer är intresserade av ert klimatavtryck? Vilka intressenter hållbarhetsrapporterar ni till?

Klimatberäkningsverktyget
5. Berätta hur ni använder Arlas klimatberäkningsverktyg och hur fungerar verktyget?
6. Varför använder ni detta verktyg?
7. Har verktyget levt upp till era förväntningar? Har ni kunnat använda verktyget som ni trodde? Är ni nöjda?
8. Vilka för och nackdelar ser ni med verktyget?

9. Hur har användningen av verktyget påverkat ert företag? Vilka mervärden har ni fått genom att använda verktyget?
10. Har verktyget förenklat något i er verksamhet? Hur ni arbetar på gården med till exempel hållbarhet, samarbeten osv. Ge konkreta exempel.
11. Har användning av verktyget påverkat ert beslutsfattande? I så fall, hur?
12. Har användandet medfört kostnaderna eller intäkter? (Kan ses som tid, resurser eller pengar)
13. Kan ni se vilka andra lantbrukare som använt verktyget och deras klimatberäkning? Och i så fall, hur har ni påverkats av att kunna se andras data?
14. OM JA: Jämför du dig med andra företag genom verktyget? I så fall, vad gör du med den datan/ informationen?
15. Har användandet av verktyget lett till att ni spenderar mindre tid, energi och resurser på att sammanställa data? Mindre eller mer administrativ tid?
16. Vilka aktörer får tillgång till datan ni beräknar genom verktyget?
17. Kan ni använda data som används i verktyget/ beräkningen till andra saker? Till exempel ladda ned och dela med andra intressenter.
18. Vad använder ni den insamlade datan till?
19. Vet ni hur eran data används? Alltså den data som rapporteras i klimatberäkningen.
20. Hur känner ni att klimatberäkning når ut till slutkonsumenten? Efterfrågar konsumenten era siffror?
21. Känner ni ett behov av att dela er data med andra intressenter?
22. Har ni med hjälp av datan från verktyget kunnat minska er klimatpåverkan med hjälp av verktyget? I så fall, kan ni ge konkreta exempel
23. Har ni upplevt att datan från verktyget gett dig en säkrare position vid förhandling av kontrakt, försäljning osv? T.ex. påvisa en ställning med data, vilket gör lantbrukaren mindre sårbar för fluktueringar mot dess handelspartner.
24. Har verktyget hjälpt er att påvisa ert hållbarhetsarbete gentemot samhälle/ grannar?

Datadelning

25. Har verktyget lett till nya affärsmöjligheter eller samarbeten med andra intressenter inom jordbruks- och livsmedelssektorn?
26. Har verktyget lett till ökat samarbete i företaget - eller är det bara du som använder verktyget?
27. Hur känner du inför att dela data med extern part?
28. Har verktyget lett till att ni förändrat er syn på data och att dela data? (värde, användningsområden, effektivitet).
29. Har ni upptäckt nya hinder och möjligheter med data/ data delning efter att ha använt verktyget.

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