Acta Universitatis Agriculturae Sueciae

Doctoral Thesis No. 2023:22
Faculty of Landscape Architecture, Horticulture and Crop Production Science

Knowledge and innovation systems in Swedish horticulture

A study of multi-actor collaboration for impact

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SLU

SWEDISH UNIVERSITY OF AGRICULTURAL SCIENCES

DOCTORAL THESIS

Alnarp 2023

Acta Universitatis Agriculturae Sueciae
2023:22

Cover: Magnolia, Alnarp park
Photo: Lisa Blix Germundsson

ISSN 1652-6880
ISBN (print version) 978-91-8046-096-5
ISBN (electronic version) 978-91-8046-097-2
https://doi.org/10.54612/a.9k7ps0pik7

Swedish University of Agricultural Sciences, Department of People and Society, Alnarp, Sweden

Print: SLU Service/Repro, Alnarp 2023

Errata for Knowledge and innovation systems in Swedish horticulture

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ISBN (print version) 978-91-7760-096-5
ISBN (electronic version) 978-91-7760-097-2
Acta Universitatis Agriculturae Sueciae 2023:22
Alnarp, 2023

Page 27	Location: Figure caption Is now: Adapted from SBA 2020, figure 1. Should be: (SBA 2021a). Add to reference list: SBA, Swedish Board of Agriculture. (2021a). Statistikdatabasen. *Sveriges officiella statistik* (in Swedish). https://www.statistikdatabasen.scb.se/pxweb/sv/ssd/, accessed 2023 02 22.
Page 36-37	The references (Ekelund Axelson pers. comm. 2019) and Carlsson, pers. comm. 2022) should be added to the reference list: Ekelund Axelson, L. (2019). Personal communication 2019 09 10. Carlsson, M. (2022). Personal communication 2022 10 03.
Page 37	Location: "Rather, the articles that helped him understand were mostly within sociology and organisational theory (Carlsson and Johansson 1972)." Is now: (Carlsson and Johansson 1972) Should be: (Carlsson 1976) Add to reference list: Carlsson, M. (1976). Some observations about the interdependence between method development, implementation and the client/consultant relationship from experience with a method for result-analysis and planning of horticultural firms. *Acta Horticulturae* 55, 20.
Page 65	Location: The last box in the column "Data collection methods".

	A sentence should be added: The data from the focus group interviews are accounted for in a paper not included in this thesis; Blix Germundsson et al. in review).
Page 114	Is now: ’Trädgårdsekonomiska utredningen’ Should be:’Trädgårdsekonomiska undersökningen’.

Knowledge and innovation systems in Swedish horticulture. A study of multi-actor collaboration for impact.

Abstract

The background of this thesis is new directions in international and national politics, the challenges of contemporary innovation systems, and the challenges and potentials in Swedish horticulture. The aim is to investigate how the knowledge and innovation system in Swedish horticulture can be reinforced to meet current and future challenges. The research questions focus on how network facilitation, social learning, and impact orientation can contribute to a reinforced knowledge and innovation system. The frame of reference takes in theories of systems of innovation, and, in particular, agricultural knowledge and innovation systems (AKIS). The thesis is also complemented with theories of social processes related to learning and impact. The methods include qualitative case studies in a progression from traditional qualitative research methods towards an action research approach. The results identified processes of network brokering, dialogue, co-agency and inclusion as central to reinforcing the knowledge and innovation system of Swedish horticulture. The findings point to a need to balance a structural interpretation of the horticultural knowledge and innovation system with a process perspective, to actively invite the agency of engaged and entrepreneurial individuals, and to balance the historical 'supply side innovation' perspective with a prioritization on the creation of societal impact. These results provide a contribution to the debate around different systems perspectives of the AKIS. They also highlight how changes in everyday work at the micro-level are a precondition for system level change, and how actions at the micro-level have the potential of improving the ability to meet current and future challenges and contribute to societal impact and change.

Keywords: innovation systems; agricultural innovation systems; agricultural knowledge and innovation systems; AKIS; impact; multi-actor; collaboration; social learning; agency; inclusion; horticulture; Sweden.

Kunskaps- och innovationssystem inom svensk trädgårdsnäring. En studie av aktörssamverkan för nytta.

Sammanfattning

Bakgrunden till denna avhandling är de nya inriktningarna inom internationell och nationell politik, utmaningarna i dagens innovationssystem, samt utmaningarna och potentialerna i svensk trädgårdsnäring. Syftet är att undersöka hur kunskaps- och innovationssystemet inom svensk trädgårdsnäring kan stärkas för att möta nuvarande och framtida utmaningar. Forskningsfrågorna fokuserar på hur nätverksarbete, gemensamt lärande och nytto-orientering kan bidra till ett förstärkt kunskaps- och innovationssystem. Referensramen utgår från teorier om innovationssystem, och specifikt agrara kunskaps- och innovationssystem (AKIS), kompletterat med teorier om sociala processer relaterade till lärande och nytta. Metoderna inkluderar kvalitativa fallstudier, i en progression från traditionella kvalitativa forskningsmetoder till aktionsforskning. I resultaten identifierades nätverksarbete, dialog, co-agency samt inkludering som centrala processer för att stärka kunskaps- och innovationssystemet inom svensk trädgårdsnäring. Resultaten pekar på behovet av att balansera ett strukturellt synsätt på trädgårdsnäringens kunskaps- och innovationssystem med ett processperspektiv, att aktivt arbeta för att bjuda in engagerade och entreprenöriella individer, och att balansera innovationssystemens historiska fokus på uppströms innovation med att prioritera samhällsnytta. Dessa resultat är ett bidrag till debatten kring olika systemperspektiv på AKIS. De belyser också hur förändringar i det vardagliga arbetet på mikronivå är en förutsättning för förändringar på systemnivå, och hur åtgärder på mikronivå har potentialen att förbättra förmågan att möta nuvarande och framtida utmaningar, samt bidra till samhällsnytta och förändring.

Dedication

To all of you who develop and use knowledge and innovation within and in relation to Swedish horticulture, I hope this thesis will inspire and empower you to keep working for a sustainable, competitive and attractive horticultural production and business sector.

Contents

List of publications

This thesis is based on the work contained in the following papers, referred to using Roman numerals in the text:

I. Blix Germundsson*, L., Augustinsson, S. & Lidén, A. (2020). Collaboration in the Making—Towards a Practice-Based Approach to University Innovation Intermediary Organisations. *Sustainability (Basel, Switzerland),* 12**,** 5142.

II. Blix Germundsson, L., Frankelius, P. & Norrman*, C. (2021). The role of innovation intermediary organisations in forming value creating meetings: the agri-food firm perspective. *The international food and agribusiness management review,* 24**,** 993-1004.

III. Sørensen*, L. B., Blix Germundsson, L., Hansen, S. R., Rojas, C. & Kristensen, N. H. (2021). What Skills Do Agricultural Professionals Need in the Transition towards a Sustainable Agriculture? A Qualitative Literature Review. *Sustainability (Basel, Switzerland),* 13**,** 13556.

IV. Blix Germundsson*, L., & Norrman, C. Market formation and the role of the farmer in an emerging micro-level agricultural innovation system. (submitted)

V. Blix Germundsson*, L. & Ljung, M. Leverage points in multi-actor innovation. Two case studies from Swedish horticulture. (submitted)

VI. Blix Germundsson*, L., Dimitrievski, I., Melin, M. & Jönsson, H. Inclusion for impact? A study of how actors reflect on inclusion in the context of agricultural research projects. (submitted)

The contribution of Lisa Blix Germundsson to the papers included in this thesis was as follows:

I. Planned and performed data collection and analysis. Chose study design and wrote paper jointly with co-authors. As the main author, had overall responsibility for writing the paper.

II. Planned and chose study design, performed data collection and analysis, and wrote paper jointly with co-authors.

III. Planned and chose study design, performed data collection and analysis, and wrote paper jointly with co-authors.

IV. Planned and chose study design, and performed data collection and analysis and wrote paper jointly with co-author. As the main author, had overall responsibility for writing the paper.

V. Planned and chose study design, performed data collection and analysis, and wrote paper jointly with co-author. As the main author, had overall responsibility for writing the paper.

VI. Planned and performed data collection. Chose study design, performed data analysis and wrote paper jointly with co-authors. As the main author, had overall responsibility for writing the paper.

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Abbreviations

AKIS	Agricultural Knowledge and Innovation System
EIP-Agri	The European Innovation Partnership for agricultural productivity and sustainability
EU SCAR	The European Standing Committee on Agricultural Research
IFAMA	International Food and Agribusiness Management Association
IFSA	International Farming Systems Association
IMS	Department of People and Society (at SLU).
ISS	Innovation support services
SLU	Swedish University of Agricultural Sciences
SoU	Unit for Collaboration and Development (at SLU)

Prologue

In the spring of 2017, I had been the operating manager of a university-industry intermediary organisation at the university campus Alnarp for four years. I had seen how the collaboration between the university researchers, teachers and students, and the industry and societal actors sometimes worked out just fine, and sometimes seemed difficult. The grand policies of European agriculture and rural areas, the national innovation policies and the brand-new strategy for the domestic agri-food sector, all emphasising cooperation, seemed distant from the everyday reality I encountered.

Even though the intermediary organisation I was heading was a decisive attempt to bridge the divide between academia and practice, I was weary of figuring out how to navigate the landscape. I was ripe for a deeper understanding of what was really going on, in hopes of perhaps seeing more clearly how things might be improved. In May 2017, I attended a conference in Brussels, where I first encountered the concept of AKIS. It was stated that European AKIS' were failing to live up to the demands of new knowledge and innovation for the current and future challenges surrounding food security and sustainability for all. This struck a chord with my experiences and came to be an important input in the thought process of starting this doctorate journey.

Horticulture was one of the subsectors of the intermediary organisation, and a very specific one, as it seemed more market-exposed and entrepreneurially oriented than other subsectors within the agricultural family. It was subject to tough price competition from imported produce and had challenges in economic, environmental and social sustainability. Yet, the increasing consumer interest in healthy food offered an opportunity for skilled growers. It was no doubt an interesting subsector for the kind of investigation I was thinking of. With this direction, a funding proposal was

sent to a regional bank trust. In the fall of that year, an opportunity came up to work with colleagues on a proposal to the H2020 program. Along these lines, the early thoughts of a deeper understanding of what really goes on in multi-actor knowledge development and innovation had finally materialised.

In my years of professional work as a sustainability liaison for a farmers' organisation, at a producers' cooperative dairy, and at the university-industry intermediary organisation, I have learned that the work of forming new things is primarily dependent on *people*, what they think, believe, their social connections and their ability to cooperate. And, I have found that people do what they find joyful, meaningful, and rational from their own vantage point.

Somewhere here arises a discrepancy between the grand policies and visions of agricultural and food innovation, and the everyday messy and contradictory, yet often fascinating and magnificent, reality. The overarching issues raised at the policy level need to be addressed at a practical level, or else we will never be able to truly tackle current and future challenges. While policies can help, any real change happens at the practical level of everyday life. This thesis is an invitation to everyone to reflect on such changes, and how they can lead to a more innovative and sustainable horticultural sector.

1. Introduction

Agriculture has become "the world's single largest driver of environmental change, and, at the same time, is most affected by these changes" (Rockström et al. 2017:4). Agriculture and food systems are among the leading sources of greenhouse gas emissions and are, in turn, severely affected by climate change (Vermeulen et al. 2012). These reports are part of the growing ecological and social sustainability awareness on a global scale reflected in the United Nations' Sustainable Development Goals (UN 2015).

On an EU level, the strategies of the European Green Deal for climate neutrality, and the Farm to Fork strategy for a fair, healthy and environmentally friendly food system (EC 2020a; b) has meant renewed policy ambitions. On a national level, Sweden has adopted a list of Environmental objectives (Government offices 1999), and more recently, a Food strategy (Government offices 2017). Due to the international security situation, Sweden is now, for the first time since the second world war, considering re-introducing measures to increase food security and preparedness in case of an emergency crisis (Government offices 2022). Thus, the new directions in international and national politics emphasise the challenges of reaching environmental and social sustainability, while also ensuring viable food production and security.

This is the policy landscape in which this thesis is situated. In addition to the policy landscape, the thesis is founded on the challenges of contemporary innovation systems (presented in section 1.1), and the challenges and potential in the horticultural sector (section 1.2). The thesis aim and research questions are presented in section 1.3, and an overview of the empirical case study and the appended papers is given in 1.4.

The first chapter is an overview, with the concepts introduced below of innovation systems, agricultural knowledge and innovation systems (AKIS),

and social learning being explored at greater depths using previous research in chapter 3.

1.1 The challenges of contemporary innovation systems

The system of innovation approach arose from the 1970's oil crisis, with its focus on economic growth, material welfare, globalisation and increased agricultural production (Schot & Steinmueller 2018). Solutions were found in technological development, improved material standards, and innovations on the supply side.

The innovation systems framework, grounded in the perspectives of its time, is now confronted with an expectation to meet new goals, shaped by societies' needs, values and expectations of sustainability for current and future generations (EC 2020a; b; Government Offices 2017; 2022). These expectations ask for system innovation (innovation of the system itself), the involvement of end users, and transdisciplinary research for learning and negotiating, in order to solve the challenges and demands of today (OECD 2020). It has been argued that the current societal challenges need to lead to radical shifts in how society uses its resources, meaning that changes in the system itself are necessary (Schot & Steinmueller 2018; OECD 2015).

The new demands have been even further emphasised by the recent developments of the global security situation, which are likely to spur new policy developments. Hence, there is a tension between the underlying logic of the systems of innovation framework, and the challenges and demands it is expected to solve today and in the future.

Still, there is strong support from both scientific research and political policymaking for the use of the systems of innovation approach to agricultural knowledge development and innovation (Klerkx et al. 2012; EU SCAR AKIS 2019; see further in section 3.2). In the new agricultural policy for the European Union (Regulation EU 2021/2115), the member states are encouraged use the AKIS concept to improve knowledge flow and strengthen links between research and practice (EU SCAR AKIS 2019).

However, it has been noted at a European level that the agricultural knowledge and innovation system is insufficient for dealing with the urgent challenges of sustainability and competitiveness (EU SCAR 2009; 2012). The increasing privatisation of applied research and advisory services has

created a fragile and fragmented structure to the knowledge and innovation system (Knierim et al. 2015; 2017). It has been argued that the increasing fragmentation of agricultural knowledge and innovation systems (AKIS) emphasises the need for building and maintaining professional networks, and leads to a more central role for innovation brokers and intermediary organisations to strategically connect actors (Klerkx & Leeuwis 2008; 2009). In addition, as new technologies like artificial intelligence and robotics enter the horticultural sector, there is a need to regard the sector in a broader context to utilize existing potentials for development in, for example, digitisation and climate issues. It has been noted that financiers and clients have a difficult time grasping the nature and value of innovation brokering activities (Klerkx & Leeuwis 2009). This means that if there is to be motivation to finance innovation brokering and network facilitation, the black box of what is done by intermediaries must be opened. While there are several macro-level studies on the embedding and functions of intermediary organisations, studies focusing on their micro-level dynamics are much fewer (Kilelu et al. 2014).

Knowledge, skills, and learning are central components of systems of innovation (Lundvall 1992) and are fundamental when tackling complex challenges (Daniels & Walker 2001; Wals 2007). Research and practical experience have shown that learning about complex challenges is more productive when taking place in a rich social context where people have different interests, values and stakes (Daniels & Walker, 2001; Leeuwis & Pyburn 2002; Wals, 2007). This insight has paved the way for the concept of 'social learning', denoting the interactive learning between actors, in which they learn about the problem itself and about the views and stakes of one another. While much has been written about social leaning in agricultural and sustainability settings, there has been less of a focus on how social learning can be used to strengthen small firms' ability to innovate.

According to Joseph Schumpeter (1934; 2008), innovation is fulfilled only when it has been introduced to the market or otherwise put into practical use in society. Any talk of innovation must have a clear impact orientation, ensuring it makes an impact in society in some way or another. This implies a broadening of the role of agricultural innovation from an instrument of knowledge production towards a tool for practical change (Horton 1998). According to the World Bank (2008), agricultural research should increase its efforts to reach societal impact, by focusing beyond the farmers to look at

the interface with farm customers, such as traders and processors, and broader civil society. Heeding these calls, the strategies for increasing the societal impact of agricultural and horticultural research and innovation needs further scientific attention.

1.2 Challenges and potential in Swedish horticulture

Horticulture[1] is a unique branch within the Swedish agricultural family, as it has been historically much less dependent on agricultural subsidies, import tariffs and market regulation. Horticultural farmers have been more market-exposed, making them immediately aware of fluctuations in consumer demand, in contrast to agricultural farmers, who operated in a regulated market (Ekelund Axelson 1992). This implies that customer and consumer demands have been important drivers of new knowledge and innovation for horticultural farmers.

The total consumption of vegetables, fruits and berries in Sweden has doubled over the last 20 years, and the value growth at the consumer level is now 5-10% annually for horticultural products (Lööv et al. 2015; Fernqvist & Göransson 2021). The import of fruits and vegetables has increased rapidly in recent years, amounting to SEK 12.4 billion in 2015 (Johansson 2016). Yet, consumer demand for locally produced foods (Fernqvist & Göransson 2021) creates potential for Swedish growers, both preexisting and new ventures.

The Swedish horticultural sector is currently in a growth trend, with the total turnover at the farm gate was 6.5 billion SEK in 2020. Approximately 60% of the total turnover at the farm gate is derived from open field cultivation of nearly 14,000 hectares, see figure 1 (the green sections). Greenhouse production on nearly 300 hectares accounts for 40% of the turnover (blue sections).

[1] Horticulture is defined as the art and science of growing fruits, vegetables, flowers and ornamental plants. Definition retrieved from Merriam Webster Dictionary, https://www.merriam-webster.com/dictionary/horticulture, accessed 2019 04 04.

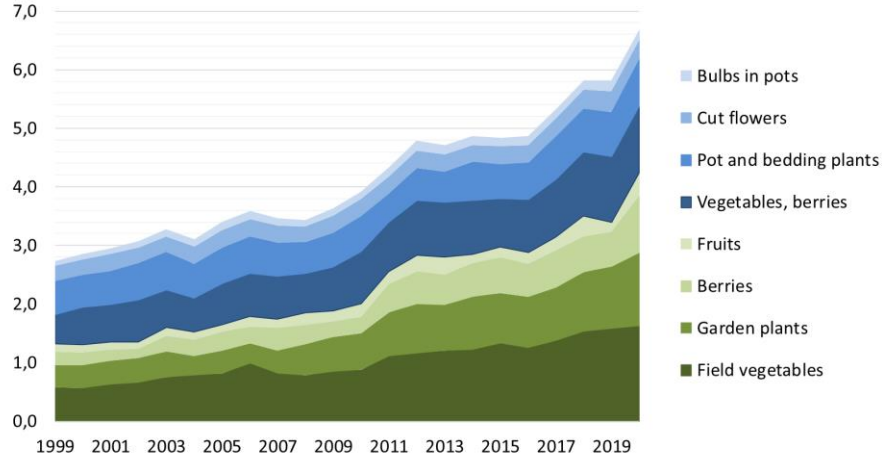

Figure 1. Total turnover in billion SEK of horticultural production at farm gate. Adapted from SBA 2020, figure A.

However, the number of firms shows a rapid structural rationalisation towards fewer and larger companies. Since the top rating of 5,296 firms in 1984, the declining rate of horticultural firms has been close to 100 firms per year, down to 1,818 firms in 2020 (SBA 2003; 2021)[2]. If this decline continues, there will be no horticultural firms left in 18 years. While this is unlikely to happen, it shows the strong profitability pressure and rapid structural rationalisation among horticultural firms, see figure 2.

[2] Firms with less than 0.25 hectares of open field or 200 m^2 of greenhouse area are not included in the official statistics. These are "relatively many, but their total production volume is very small in comparison" (SBA 2021:1).

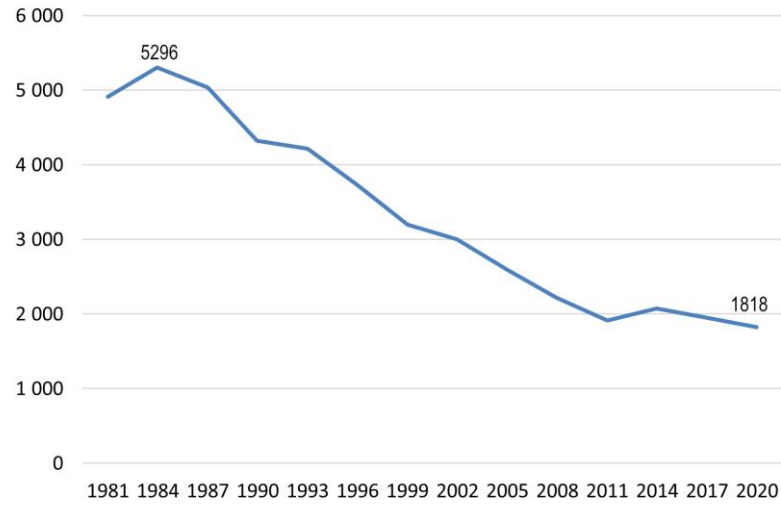

Figure 2. The number of horticultural firms in Sweden (SBA 2003; 2021)[2].

The research and extension for Swedish horticulture has seen a rapid decline, from being state-funded and structured well, to a predominantly privately funded existence with much fewer resources for applied research and advisory services (Ekelund Axelson et al. 2017; von Bothmer et al. 2022; see further in section 2). At the same time, international horticultural innovation in production technology is developing quickly, with a number of new technologies, like AI and robotics, being put to use (HortiBiz News 2022).

The parliamentary agreement on a national Food strategy aims to realise the potential of the entire food supply chain through increased food production and new job opportunities throughout the country, and increased market shares for local and organic food, while simultaneously achieving economic, environmental and social goals (Government Offices 2017). One of the three strategic measures is to "support the knowledge and innovation system so as to contribute to increased productivity and innovation" (ibid:14). The ambition to innovate, learn and adapt quicker than others has been highlighted as the main competitive advantage for Swedish agri-food (ibid; OECD 2018). In the context of the horticultural sector, this thesis takes an interest in how this potential can be harnessed and realised.

In summary, the horticultural firms in Sweden are facing market growth while in fierce competition, a cool climate, high national environmental and labour standards, an anorectic research and advisory system, and with rapid technology development in an international environment. In order to survive,

the sector will need to muster the supportive powers of an agile knowledge and innovation system. This makes Swedish horticulture an interesting case to employ when investigating the main premise of the thesis: how knowledge and innovation systems can be made fit to deliver to the challenges of today and tomorrow.

This section has provided an introduction and overview to Swedish horticulture, the sector will be presented in greater depth in chapter 2.

1.3 Aim and research questions

The aim denotes the overall intent and central direction of this dissertation. With a background in the tension between the original motives of the system of innovation approach and the need to deliver on today's challenges as expressed by contemporary policies, it is valid to ask how knowledge and innovation systems can be made to work better, in order to deal with the current and future challenges and demands of society. The aim of this dissertation is as follows:

> The aim is to investigate how the knowledge and innovation system of Swedish horticulture can be reinforced in order to meet current and future challenges.

The aim has been broken down into three research questions in order to facilitate the reaching of the aim. Firstly, in response to the practical need to bridge a fragile and fragmented innovation system, and to connect to other specialised sectors, the first research question is:

> RQ1. How can network facilitation contribute to a reinforced knowledge and innovation system?

The facilitation of networks alone, however, is not enough to provide a basis for innovation. The second research question takes its starting point in the emphasis on innovation systems as learning systems, and specifically how social learning can be used to strengthen small firms' ability to innovate.

RQ2. How can social learning contribute to a reinforced knowledge and innovation system?

It is not a given that network facilitation or social learning will automatically lead to innovation. Viewing agricultural knowledge development and innovation as a tool for practical change implies a steady orientation towards impact. Hence, the third research question is:

RQ3. How can impact orientation contribute to a reinforced knowledge and innovation system?

The relationship between the background of this study, as presented in the introduction, and the aim and the research questions are illustrated in figure 3.

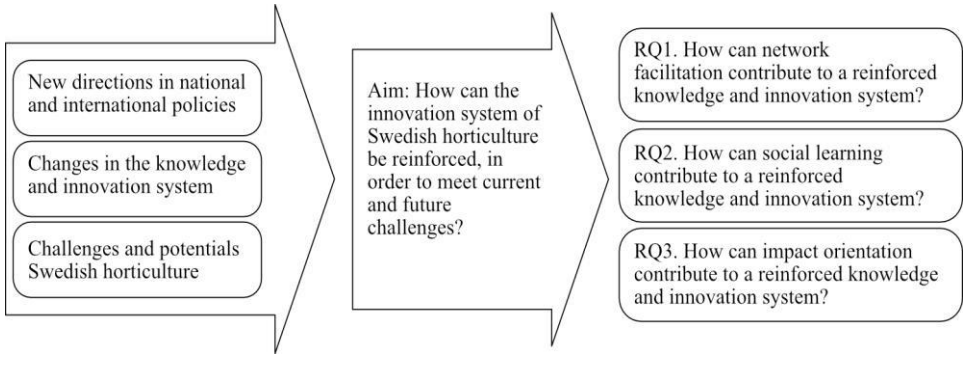

Figure 3. The relation between the introduction, aim and research questions

The three research questions above are addressed by the collective results of six papers appended to this dissertation, stemming from an empirical study of Swedish horticulture, as described in the next section.

1.4 Overview of the empirical work and appended papers

The three research questions above are addressed using the Swedish horticultural sector as the empirical base. The motive for this was the sector having a long-held emphasis on market competitiveness, being under

profitability stress, and having limited resources for applied research and advisory services (Ekelund Axelson et al. 2017). It is thus a sector with a high demand for new knowledge and innovation, yet with little resources to deploy, making it an interesting case to employ when investigating the main premise of the thesis.

This thesis has been funded in two parts. The investigation of the horticultural knowledge and innovation system, with a national focus, was funded by Sparbanken Skåne/Sparbanksstiftelsen, SLU Partnership Alnarp, SLU RådNu and the Royal Swedish Agricultural Academy. The other section, focusing on the societal impact of applied research, was funded by the NextFood project of the Horizon 2020 program, an international consortium providing a cross-border exchange of ideas. NextFood was created from the belief that current and future professionals need new skills and competencies to handle current and future challenges. The dual funding base has given the thesis its unique position in the overlap between horticultural innovation at a national level, and the societal impact of research in an international context.

The first empirical study, on intermediary organisations, stemmed from the increasing fragmentation of the Swedish horticultural knowledge and innovation system. This has emphasised the need for building and maintaining professional networks, and the role of intermediary organisations to facilitate connections between actors for the furthering of innovations. The study involves three intermediary organisations and collaborative cases within them, resulting in papers I and II (see figure 4 below).

The second empirical study, of multi-actor collaborations, encompassed an investigation of how new knowledge and innovation is regarded and developed within the Swedish horticultural sector. This study resulted in a literature review on the skills needed for the future, a case study of an emerging micro-level agri-food system, and an investigation of two long-term collaborations related to weed control in field production and the storing of fresh produce. This study resulted in the papers III, IV and V.

The third empirical study, of societal impacts, involved four already existing research projects at SLU Alnarp. An action research approach was used for staging an evaluation and impact assessment process, involving the researchers and societal stakeholders connected to the four research projects.

This study provided the empirical basis for an investigation into the inclusion of actors and the relation to societal impacts, and resulted in paper VI.

While the three empirical studies provided the factual basis for the papers, there was also an ongoing cross-fertilization of ideas between them, see figure 4.

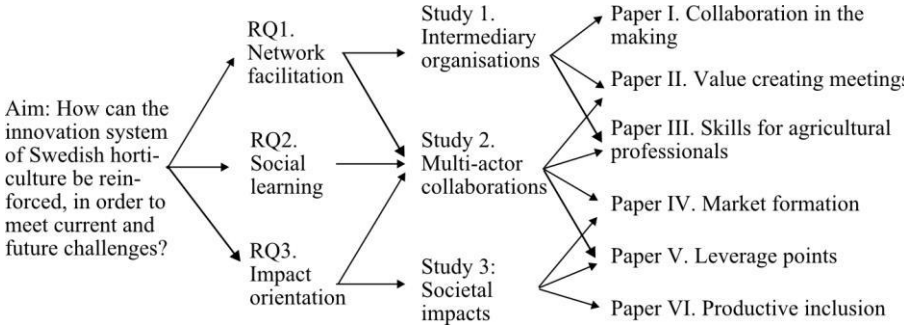

Figure 4. The relations between the aim, research questions, empirical studies, and appended papers.

The appended papers are summarised in section 5, focussing on their history and contribution to the thesis, along with a reflection on the paper process.

2. The Swedish horticultural sector

To complement the brief introduction of the case study given in section 1, this chapter provides a historical review of the Swedish horticultural sector. It is characterised by value chain competition, decreasing state-funding of research and extension, and the birth of a benchmark tool for multi-actor learning. The section closes with an outline of challenges ahead, with emphasis on factors of relevance to knowledge and innovation.

2.1 A story of market competition

The Swedish agri-food market was subject to heavy regulations from 1930 to 1990. The political goals at the time were national food security and falling food prices, while still allowing farmers a reasonable income. The reason for this political direction was the recent memories of starvation and food rationing during the two world wars (Hedlund & Lundahl 1985). The policy for the horticultural sector was separate from the agricultural sector; there were no politically negotiated fixed prices for horticultural products. This made horticulture a unique branch within the agricultural family, as it was much less dependent on agricultural subsidies, import tariffs and market regulation. In the international trade agreements, created after the Second World War, Sweden prioritized export opportunities for its large industries (mining, forestry, mechanical manufacturing), and thereby, to create balance, had to ease imports on other products, among those were the horticultural products (Ahrland & Olauson 2011). This prompted tough competition from imported goods, which, in combination with the fact that the products were fresh and perishable, forced horticultural firms to become very efficient and market-oriented in order to survive (Ekelund Axelson 1991).

Long after the system of politically regulated food prices was abandoned in the 1990s, actors in the Swedish food system were still influenced by the ideas of the regulated era. This caused the actors to have little or no understanding of other levels in the system, with some actors feeling no solidarity with actors in other levels (Frykfors & Jönsson 2010). According to Frykfors and Jönsson (2010) and Beckeman et al. (2013), this was a great hinderance for the type of innovation that requires cooperation and collaboration between market actors and their suppliers. While the price regulations applied mainly to agricultural products, the attitudes spilled over to horticultural products (Carlsson 1979).

Horticultural firms have historically been, and still are, market exposed and sensitive to customer and consumer demand, which is a main driver of knowledge development and innovation in the case studies of this thesis.

2.2 From state funded research and extension to a knowledge market

An important role in the earlier political strategy was carried out by the Swedish university of agricultural sciences (SLU). Its aim was to support increased productivity by pursuing research and putting the new findings into practice through extension services. Built on the model of U.S. land grant colleges, the university conducted applied research and field trials. This was complemented with 40 horticultural extension specialists deployed in regional authorities across the nation (von Bothmer et al. 2018). While it was well resourced, the efficiency of this system was severely questioned in a study by Renborg (2010). Based on agricultural research projects carried out between 1944 and 1987, Renborg estimated an average of 16-18 years from a projects' start until the results had any practical implications at farm level. In the deregulation of the 1990s, the state-funded research and extension model was terminated.

Today, applied research in horticulture has developed towards multi-actor, project-based, partly industry financed knowledge development (Ekelund Axelson et al. 2017; von Bothmer et al. 2022). This has led to an overall reduction in the volume of applied research (von Bothmer et al. 2022), as well as a dependency on external research funding (Ekelund Axelson et al. 2017). The remaining horticultural research in Sweden is

struggling to encompass the wide range of topics in horticulture, with limited resources (ibid).

The advisory services of today are dominated by authorities procuring environment-oriented advice, while production-oriented advisory services are private and limited to certain regions and types of cultivation (ibid). Instead, advice from suppliers regarding their products has become more important for farmers (Yngwe 2013). Private laboratories provide soil and crop analyses, and a small number of the farmers' customers provide production advice (Ekelund Axelson et al. 2017).

The deregulation in the 1990s caused a dismantling of the cooperation between SLU and the industry (von Bothmer et al. 2018). In response to this, and as a consequence of a re-organisation of SLU, the intermediary organisations of SLU Partnership Alnarp and SLU Partnership Horticulture [Swe. Tillväxt Trädgård] were formed in 2004 and 2007, respectively (von Bothmer et al. 2022; Blix Germundsson 2020). These two became notable intermediary organisations for horticulture (Ekelund Axelson 2015), contributing to a rebuilding of the tradition of research and education in cooperation with the horticultural industry.

In its first years, SLU Partnership Horticulture developed a novel approach to handling the knowledge needs of horticultural firms: the Idea and Project Workshop. It had two steps: 1) The network facilitator participated in field excursions, farmers' meetings and events, taking notes of problems and ideas. 2) These were brought to a group of experienced researchers and discussed. Some were easily answered using existing knowledge, others were found suitable for a seminar, a students' thesis, a popular science article in industry media, or even a research project. The Idea and Project Workshop was a structure for identifying problems, and either providing an answer or suggesting an action plan around each issue. Through financial "seed money" support in the SLU Partnerships, many research projects were born.

Internationally, innovation in horticultural production technology is developing fast. Many innovations in Agriculture 4.0, where devices and machinery are web-linked together and with artificial intelligence (Zambon et al. 2019), will likely take their first steps within horticulture. New policy ambitions, e.g. towards a bio-based economy, sustainable intensification and multifunctional agriculture, call for both technological innovation and social innovations, with a need for new ways of organizing multi-stakeholder

communication and collaboration. In this context, it may be valuable to look at a historic case of social innovation in Swedish horticulture.

2.3 An early multi-actor learning model for revival?

In 1964, the newly appointed lecturer in horticultural economy at Alnarp, Mårten Carlsson, proposed the idea of collecting and analysing data from individual horticultural farms at a much more detailed level than had been done before. The point was to provide researchers, teachers, extension providers and horticultural farmers with a basis for financial analysis and production planning.

Starting in 1965, Stig Johansson was hired to visit the farmers to collect data concerning work hours, fuel, water, input materials, areas under glass or open field, yield, and several financial measures. The data was processed, and certain measures calculated, giving the farmers individual feedback through a comparison between cultures and years, as well as a comparison between the mean values of a group of peers. The model was named the Horticultural Economic Survey [Swe. Trädgårdsekonomiska Undersökningen] (Carlsson & Johansson 1972).

Initially, Carlsson and Johansson had difficulties finding farmers willing to share their data, so they had to offer monetary compensation. Soon, however, the farmers realised the value of the detailed analysis. The interest spread through word of mouth. Small groups of farmers, students and advisers were formed, to discuss the findings, compare with each other, and exchange experiences. According to the farmers in one of the first groups, the group discussions were very valuable and led to significantly improved results in the following years. This, in turn, led to more groups being formed (Carlsson et al. 1975). By now, the Horticultural Economic Survey had a commercial basis, and was transferred to the horticultural farmers' organisation (Ottosson 1982).

There were no similar models within agriculture at the time; on the contrary, the idea was puzzling to agricultural farmers and advisors. Firstly, the idea to buy advice commercially was seen as odd, as the current extension service was state-financed and free for farmers. Secondly, the model required farmers to share detailed production data, which they were not used to, and therefore reluctant to do (Ekelund Axelson pers. comm. 2019).

The scientific community of horticultural economics was likewise puzzled. When Carlsson presented his research at the International Society for Horticultural Sciences' (ISHS) symposium in 1972, the reaction was "interesting - but is this research?" (Carlsson, pers. comm. 2022). Carlsson had looked for theoretical explanations for the concept and why it was successful, and the search was summarised in the ISHS article. He did not find any good explanatory models in agricultural economic literature or in any economic literature. Rather, the articles that helped him understand were mostly found within sociology and organisational theory (Carlsson & Johansson 1972).

The Horticultural Economic Survey from 1965 may have been one of the very first multi-actor learning models where researchers, advisers, students, and farmers worked together, bilaterally and in groups (ibid). While the Horticultural Economic Survey today is dissolved, it contained many features that later research has found invaluable. For example, taking the starting point of everyday challenges of horticultural firms; using detailed data from such firms to provide insight for the farmers' themselves and benchmarking with others; matching with knowledge from research and advisors; and facilitation and co-learning in small multi-actor groups, including students.

While the model from 1965 focused on production management and profitability, the challenges for today's horticultural firms include a broader sustainability spectrum. In light of the challenges currently facing the horticultural sector, it is relevant to ask if an updated version of this model could be of inspiration and use today.

2.4 Challenges ahead

As noted in section 1, the challenges ahead for the horticultural sector include the accommodation of policies aimed towards environmental and social sustainability goals, and towards viable production and food security. Sustainability and sustainable production methods have been topical in Swedish horticulture for a long time, being felt in all parts of business. For example, a major transition from fossil oil to renewable fuel for greenhouse heating has taken place. Currently, solar panels are being installed to supply energy to cold storage during the summer. LRF Horticulture's sustainability goals focus on sustainable plant protection methods, increased biodiversity,

and a transition towards fossil-free production (LRF Horticulture 2022). This entails the use of, for example, field robots for weed control. The use of plant protection chemicals has decreased over the past 20 years, in favour of mechanical weed control and biological pest control. Even so, the lack of such products in Sweden today may favour imports, often treated with the very same chemicals that are forbidden here (Johansson 2016). Other current topics relate to carbon storage in soils with cover crops and other measures, how to reduce plastics in packaging, and the prevention of quarantine pests. In the long term, the need to reduce manual labour is a matter of survival for the horticulture sector. All of these issues will require new knowledge and innovation.

The horticultural sector in Sweden is in a production and turnover growth, while the number of firms is declining (see figures 1 and 2). The exposure to strong competitive forces from imported goods, in combination with a cool climate and high national environmental and labour standards are putting great pressure on the horticultural sector (Government offices 2015; Johansson 2016; OECD 2018). The sector needs to innovate towards increased efficiency and quality, and for the expansion of existing production and entry of new growers (LRF 2018).

3. Theoretical frameworks

In order to address the thesis aim, theories are needed that are able to address innovation at both the system-level and at the micro-level. Therefore, the theoretical framework is a collection, starting out with the theories of systems of innovation, which provide the wider frame (section 3.1), and the literature of agricultural knowledge and innovation systems (AKIS), to provide a sectoral setting relevant to horticulture (section 3.2). The system theories are complemented with theories of social processes related to learning (section 3.3) and impact orientation (section 3.4), in order to inform investigations of practical, micro-level innovation processes. The chapter closes with an attempt towards a meta-perspective of the theories, which I have found useful in shedding light on underlying aspects of the horticultural innovation system (section 3.5).

3.1 Systems of innovation

In the early 20th century, the Austrian scholar Joseph Schumpeter highlighted the importance of innovation and entrepreneurship for the societal economy (1934; 2008). Schumpeter established that economic development is characterised by innovation in terms of new combinations of resources, new products or new production methods, which are put into commercial use by entrepreneurs. The systems of innovation framework emerged as a complement to incumbent technology transfer logic, in the aftermath of the 1970s oil crisis and global economic recession (Godin 2006; Freeman 1987; 1995; Berman 2012). The framework was originally conceived of for technological innovation on the supply side, for the sake of economic growth and material welfare (Freeman 1987; Edquist 1997). It was seen as a promising tool for getting ahead in the global competition between nations

and increasing economic power (Schot & Steinmueller 2018). It focused on building links and clusters between triple helix actors, i.e., government bodies, universities/research institutes, and entrepreneurial firms; enabling cooperation and learning between these actors, and stimulating entrepreneurship through favourable institutional environments (Lundvall 1992; Berman 2012).

In this dissertation, a *system of innovation* is defined as a network of entities for the furthering of innovation (based on Havelock 1986; Edquist 1997). *Systems* are defined as networks of connected entities by Havelock (1986:77), who stated that "all systems, from the most rudimentary to the most complex, are composed fundamentally of networks of connected entities." The strengths of a systems perspective lie in the emphasis on the interdependence of the entities in a system, their interdependence within their surrounding environment, and the fact that the whole can be more than the sum of its parts. The term *innovation* is defined as new combinations of resources, or new methods of production that are put into commercial use (Schumpeter 1934; 2008); this is true in terms of both inventions (Frankelius et al. 2017) and adaptations (OECD 2005).

The system of innovation approach implies seeing innovation as a mainly collective, interactive process between multiple actors, shaped by institutions, and emphasising learning (Lundvall 1992; Edquist 1997). An innovation system consists of "all important determinants of the innovation process" (Edquist & Johnson 1997:60); this is further detailed by Malerba (2002) as knowledge and technologies, actors and their networks, and institutions. *Actors* can be individuals, such as entrepreneurs, or organisations, such as private firms, universities, financial institutions and authorities (Malerba 2005). *Networks* include the actors and their connections. The interactions between the actors are ruled by *institutions*, defined as 'the rules of the game' (Edquist & Johnson 1997). Institutions can be divided into hard institutions, such as legislation and rules, and soft institutions, such as values, beliefs and expectations (ibid). Actors and their networks are embedded in the social norms, beliefs and routines of the human individuals who work within the system, shaping its development, and such institutions therefore affect the development path (ibid).

As the systems of innovation framework was originally conceived for technological innovation on the supply side (Freeman 1987; Edquist 1997), it has been criticised for its tendency of regarding markets as a matter of

diffusion. For example, in the concept of sectoral innovation systems (Malerba 2002; 2005), markets are posed as an institution generating demand feed-back, that is, in a rather passive role. Bergek et al. (2008) note that, in regards to new technologies or services, the market may not exist yet or may be just emerging. In this way, the innovation system approach gives centre stage to the production and use of scientific and technical knowledge, and tends to underestimate the co-creational aspects of market formation (Randelli & Rocchi 2017). Yet, von Hippel (1988) found that customers and end-users had a direct influence on the innovative direction of firms, leading to many user-driven innovations. This indicates that the perspective of the end-user could be underrepresented when using an innovation system framework.

In summary, the system of innovation theories provide the wider framework of the thesis, and the historical roots of the innovation system perspective. The strength of the innovation systems framework lie in its focus on building networks and cooperation between different actors, to enable collaboration and learning in order to stimulate new knowledge, innovation and entrepreneurship. A weakness is the perceived emphasis on a supply chain perspective, at the expense of an end-user perspective.

3.2 Agricultural knowledge and innovation systems

The notion of an 'agricultural knowledge and innovation system', AKIS, can be seen as a sectoral version of the above-described innovation system approach (Malerba 2002; Hall et al. 2006). It is considered as having two roots, one in the above-described systems of innovation approach, and one in 'agricultural knowledge system' research, based on an extension perspective (Blix Germundsson 2021). Derived from the innovation system definition in section 3.1, an agricultural knowledge and innovation system can be defined as a network of entities for the furthering of agricultural knowledge and innovation.

This thesis takes its empirical base in a subsector of agriculture, the horticultural knowledge and innovation system. Some of the first descriptions of a horticultural knowledge and innovation system, at least to my knowledge, were made by Carlsson, in Swedish (1979) and at an OECD conference in Paris (Carlsson 1995). From here on, the notion of AKIS will

be used to provide a sectoral setting for this study of the Swedish horticultural knowledge and innovation system.

In 2009, the European Standing Committee on Agricultural Research, EU SCAR, concluded that the current knowledge and innovation system was *not* fit to cater for the needs of modern agriculture (EU SCAR 2009). The committee noted that there was a need to strengthen the connection between research and practice (EU SCAR 2009; 2012). This resulted in a set of new policies calling for an improved societal impact of applied research through a vital AKIS (EC 2022; EU SCAR AKIS 2019). For example, EU member states are encouraged to map their AKIS' and work to improve knowledge flow and strengthen links between research and practice by, for example, connecting farmers, researchers and advisors through the EIP-Agri program (ibid).

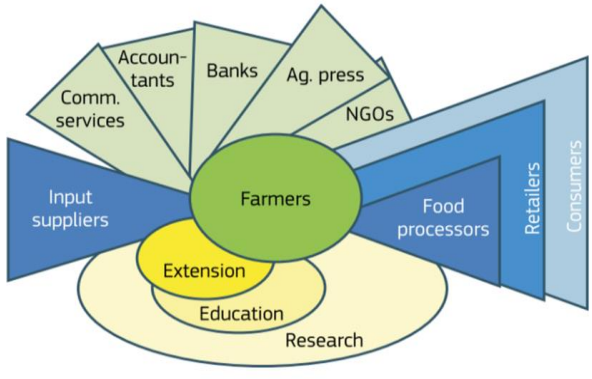

Figure 5. A model of AKIS according to the EU SCAR report (2012:9)

Scholarly studies of AKIS have often taken different perspectives, for example, a structural view, a process view, or a functions view (Klerkx et al. 2012). The structural approach typically focuses on the actors, networks and institutions influencing innovation to examine the enabling environment for innovation. The processual approach focuses on the agency of individuals and the interactions between innovators and their socio-institutional and technological context (ibid). The functions view has similarities with the process view, in that functions can be defined as the emerging sub-processes of the overall innovation process (Bergek et al. 2008).

Investigating the structures of AKIS actors and networks in the EU member states, Knierim et al. (2015) found that these vary greatly, as the organisational set-up was highly dependent on the historical and administrative context of each country. Such mapping of AKIS actors and their networks provides an illustration of the multitude of actors and linkages at the time of the analysis (ibid). While such an overview may be useful for policymakers, the diversity was too great to allow for any comparison between countries, or forming any general advice for AKIS structures (ibid).

The processual and functional approaches have often been used in studies related to innovation brokers and intermediary organisations (cf. Klerkx & Leeuwis 2008). According to Smits and Kuhlman (2004), intermediary organisations can be seen as systemic instruments, arrangements that create interfaces between different actors. Howells (2006:720) introduced the term "innovation intermediary" and listed a set of functions performed by such intermediaries to enhance innovations. According to Klerkx and Leeuwis (2008), important functions of an agricultural innovation intermediary organisation were demand articulation, network brokerage and innovation process management.

However, despite the perception that innovation brokers have a catalysing effect on innovation, their financiers and clients have a difficult time grasping the nature and value of their brokering activities (Klerkx & Leeuwis 2009). The result can be too little or too short-time funding, impeding the innovation broker from becoming established and embedded. The difficulties in properly evaluating the activities of such a broker contribute to the struggles of motivating funding (ibid).

The importance of network facilitation has been emphasised by several authors. The notion of 'facilitation' can be understood both as a structure, for example in providing strategic structures to enable meetings and networking, and as a process, as in facilitating processes between actors. According to Beers and Geerling-Eiff (2014), facilitated networks are the most effective and cost-efficient type of innovation support in early phases, regardless of whether they are formal or informal. In a study across 10 European nations, Faure et al. (2019:155) found that the function of "networking, facilitation, and brokerage" was by far the most commonly occurring activity in an innovation support context. They even noted that "'networking, facilitation, and brokerage' and 'demand articulation' appear to be crucial across all phases of the innovation process" (ibid:161). The authors suggest that this

indicates a gradual shift from technology transfer logic towards a multi-actor approach. Even so, they found the function of "knowledge transfer" to be commonly prevalent (ibid:155).

Investigating innovation support services, a number of activities or functions were found, ranging from problem identification, network brokering, facilitation of dialogue and learning processes, to dissemination and scaling up and out (Faure et al. 2019; Proietti & Cristiano 2022). The concept of an 'innovation support service' has been defined as "an activity based on the service relationship between the supplier of a service and the client" (Faure et al. 2019:149). A wide diversity of actors have been found to perform innovation support services of varying kinds (Proietti & Cristiano 2022).

In summary, the scholarly analyses of the structures of AKIS, such as actors and their networks (cf. Knierim et al. 2015), has over time been complemented by a focus on the functions provided by AKIS actors, i.e. the processes performed (cf. Faure et al. 2019; Proietti & Cristiano 2022). This implies a shift in focus from organisational structures to the performance of actual activities, processes and functions, which in turn can be provided by many different types of actors.

The next section deepens the analysis of a specific, and for this thesis especially important, part of innovation processes: learning.

3.3 Social learning

One of the early and influential scholars of systems of innovation, Bengt-Åke Lundvall, introduced the notion of 'the learning economy', by noting that "knowledge is the most fundamental resource in our contemporary economy and that learning is therefore the most important process" (Lundvall & Johnson, 1994:23). He established that the system of innovation is a social system, that learning is fundamentally a social activity, involving interaction between people (Lundvall 1992). Learning was also central to the Hawkesbury school of thought, which launched a new paradigm of thinking about, learning and doing agricultural research (Bawden 1992). They developed a systemic and participatory approach to agricultural research, built on multi-actor experiential learning (Sriskandaraja et al. 1991; Bawden 1992; Checkland 1981).

According to Glasser (2007:46), learning is defined as "the process of acquiring knowledge, skills, norms, values, or understanding through experience, imitation, observation, modelling, practice, or study; by being taught; or as a result of collaboration." Learning is fundamental, he continues, especially for those who wish to create change; "Any planned, directed change by individuals or collectives is built on learning" (ibid).

The concept of experiential learning is a process of reflective observation of experiences, which leads to abstract conceptualisation, pattern recognition or generalisation, from which new actions are tried out (Kolb 1984). The phase of reflection on the observations is vital, as it provides for 'double loop learning', i.e., a change of underlying values and norms, requiring reflection on assumptions which have been taken for granted (Argyris & Schön 1995). Single loop learning implies instrumental learning and problem solving, which can change strategies but leaves values and norms unchanged (ibid). These theories of experiential learning (Kolb 1984) and single/double loop learning (Argyris & Schön 1995) have been incorporated as cornerstones of 'soft systems methodology', first described by Checkland (1981). The concept of soft systems methodology stipulates a method for a facilitated learning process between different actors to for concerted action and further mutual learning, introducing the term social learning (Checkland 1981; 1999).

According to Loeber et al. (2007), a social setting helps us to learn better. It is through social learning, when farmers come together and learn from other's experiences, like colleagues, advisers and researchers, that most learning occurs (Millar & Curtis 1997). There is a strong preference for farmers to learn in interactions with other farmers and experts, thus farmers' groups can be used to identify and work with current training needs (Kilpatrick & Johns 2003). Šūmane et al. (2018:232) state that "farmers greatly value local experiential knowledge as they see it as having practical, personal and local relevance". In relation to innovation support services, Kilelu et al. (2014) studied learning in an on-going innovation process and found it to take the form of a dynamic learning agenda ensuing in co-creation between demand and supply actors, facilitated by several innovation support service providers.

In a similar vein, Schäfer and Kröger (2016) argue for the importance of shared problem understanding between actors involved in multi-actor endeavours, as individuals have their own knowledge and perspective. A

shared problem understanding is seen as the only way to negotiate actors' diverging outcome expectations (Jahn et al. 2012). The establishment of a 'common language' is essential for this process (Jahn et al. 2012; Akpo et al. 2015). Stakeholder knowledge can contribute to building system knowledge, awareness of conflicting perspectives and to the design of possible future strategies (Schäfer & Kröger 2016).

According to Daniels and Walker (2001:36), the dialogue underpinning social learning should focus on three dimensions: the *relationships* between the actors, the *procedure* (the process between the actors over time), and the *substance* (the subject matter). According to Isaacs (1999), something can be created between people in a genuine dialogue that cannot be created by any one actor alone. The dialogue is "an art of not just talking together but of thinking together" (Isaacs 1999:6). Individual perspectives have limitations, but meeting others' perspectives aids an understanding that things can be seen in a different light, facilitating new insights to emerge.

Guijt and Proost (2002) highlight the importance of monitoring for social learning. The feedback of results from monitoring and evaluation of, for example, field trials, makes the learning process more reliable and robust by providing quality input (ibid).

Despite the above, social learning is no panacea. Learning in itself is neutral; it does not automatically lead to better outcomes (Sterling 2007). Even an active process of social learning does not guarantee beneficial outcomes (Glasser 2007). The success of active social learning depends on capacity building, such as institutional support, maturity and the openness of the engaged individuals. A good process and positive outcomes still depend on the potential of new ideas and actions to be embraced by others in society (ibid).

Despite the fact that several approaches fostering multi-actor learning and co-innovation have been developed and implemented (cf. Cerf et al. 2000; Fieldsend et al. 2021), it still seems difficult to find a robust and generic model proven to be effectively scaled up and out (Wigboldus & Leeuwis 2013). According to Macken-Walsh (2019), the context dependency and distinctly relational aspects of multi-actor approaches are responsible for the lack of successful and uniform implementation models. This leaves the social learning process with a set of basic principles to adjust to the local context and specific case. This perspective has been of great importance for understanding how innovation and social learning are connected.

The crux of working with social learning in multi-actor collaboration is to make the process lead to more than mere niceties, but to real and lasting change. For instance, Arkesteijn et al. (2015) cautions that there is an overconfidence that multi-actor collaborative projects will lead to system innovation. This reflects the challenge to create impact, and to this we turn next.

3.4 Impact and the role of agency

It is not a given that social learning for innovation will lead to the desired changes in society. According to the definition of innovation as established by Schumpeter (1934; 2008), innovation is fulfilled only when it has been put into commercial use or gained a similar practical outlet in society. Schumpeter even denoted entrepreneurs as his heroes; they were the ones who brought inventions into the economic system. Hence, any talk of innovation must have a clear impact orientation, of reaching an impact in society in some way.

This implies a broadening of the role of agricultural research, from an instrument of knowledge production towards a tool for practical change (Horton 1998). According to the World Bank (2008), agricultural research should increase its efforts to reach societal impact by focusing beyond the farmers to the interface between farmers' customers, such as traders and processors, and broader civil society.

One of the strategies used to work towards creating societal impact is making individual agency into a collective endeavour. According to Pelenc et al. (2015:227), *agency* is "the ability of a person to pursue goals and act in order to reach them in accordance with his/her values". Similarly, Giddens (1984:14) defines agency as an individual's ability to "make a difference" with regard to the current state of affairs. The sharing of individual agency can lead to the creation of collective agency (Pelenc et al. 2015). Pahl-Wostl (2006) emphasises that collective agency emerges in a social learning process and cannot be imposed on anyone unwillingly. Thus, social interactions between actors are essential for collective agency to arise. Such a set of more or less shared ideas facilitate communication in the group, and act as a "specific resource for individual members in terms of orienting and coordinating their actions" and can lead to the adoption of joint goals for

action (Pelenc et al. 2015:228). This is the reason collective agency can be a strong source of action.

In a similar vein, Dolinska and d'Aquino (2016) found that farmers are empowered in groups rather than individually. The authors argue that farmers' knowledge and learning among themselves enable their agency for innovation, while the linear technology transfer model subdues farmers' agency for innovation. Active farmers' groups and communities of practice (Wenger 1998) contribute to recognising and stimulating farmers' agency in innovation processes (Dolinska & d'Aquino 2016). According to Coutts et al. (2005), farmers' groups provide motivation and a structural base for farmers to identify and deal with their own needs for new knowledge and innovation. Hence, such groups can provide a basis for researchers' engagement with farmers around meaningful research projects (ibid).

Another strategy to stimulate agency is accounted for in the scientific literature on impact evaluation of practice-oriented agricultural research. It looks at the inclusion of stakeholders in ex-ante monitoring and evaluation, the inclusion of the actors needed for making the changes happen, and how the actors themselves are expected to change (Alvarez et al. 2010; Douthwaite & Hoffecker 2017). The participants design a plan for monitoring and impact evaluation of an agricultural research project, and the subsequent follow-up on the plan turns the participants into action-researchers for the research project itself and its impacts. Douthwaite and Hoffecker (2017) argue that research models which include key stakeholders in ex-ante monitoring and evaluation contribute to the building of system capacities to innovate, such as knowledge, skills and trust, which in turn leads to generating new ideas and knowledge in a self-reinforcing loop. Ideally, this leaves system actors better able to tackle technical and complex challenges through enhanced capacities for technical, adaptive and local development (ibid).

Evaluating 13 research projects, Faure et al. (2018) found that vibrant interactions between researchers and stakeholders constituted a major contribution to successful outputs and outcomes. Douthwaite and Hoffecker (2017) and Faure et al. (2018) found that such interactions led to the capacity building of all actors in the local context, which was essential to produce positive outcomes and generate social impacts, such as technical and managerial capacities, the capacity to experiment and learn, and to interact with others and participate in policy dialogues.

In summary, an impact approach is crucial in relation to innovations, as the concept of innovation presupposes a market introduction or other kind of practical use in society. In the context of horticultural innovation, a shared problem understanding, the creation of collective agency, and the inclusion of relevant actors in relation to agricultural research projects have been central perspectives in this thesis for understanding how knowledge and innovation can lead to impact.

3.5 Connecting the theories - a meta perspective approach to innovation in the horticultural sector

This section is an attempt to create a meta-perspective of the theories presented in 3.1-3.4, which I have found useful in shedding light on underlying aspects of the horticultural innovation system.

The notion of systems, as in innovation systems and the AKIS, highlights the interdependence of the entities in a system, and their dependence on their surroundings and their natural environment. It also emphasises the possibility that the whole can be more than the sum of its parts (von Bertalanffy 1950). The roots of system thinking about society can be traced back to the French sociologist Emile Durkheim (1858-1917), who introduced a functional metaphor of society as a biological organism. For instance, organisations in society were seen to have different functions just like the organs in a human body. While Durkheims functional theory of society won many followers, it was also criticised, with critics pointing to two major issues with the concept (Guneriussen 1997).

Firstly, the functionalist systems view risks slipping into an assumption of a purpose, a common goal of the system. Durkheim focused on the purposes and needs of society, similar to the metaphor of all the organs in a human body contributing to the main goal of keeping the body alive (ibid). The problem is that human individuals rarely have the same goals. Secondly, the functional view of society as a biological organism was criticised for not taking the individual into account, instead focusing on abstractions such as roles, structures and functions (Guneriussen 1997). This implies a risk that humans are reduced to rational, goal-seeking beings.

One of the early critics of applying natural science metaphors to various parts of society was Edith Penrose (1952). She objected to the wide-spread biological analogy of the firm, in which the firm is supposed to be born,

grow, mature, and then decline and die. She underlined how firms have a choice of creating their own future and are not doomed to follow the lifecycle path of organisms, as the metaphor suggests. She warned that this view would unintentionally lead to neglect of important aspects of the firm (ibid).

There seems to have been a preference, at least historically, to consider 'systems' through a biological metaphor lens. This in turn leads to a preference for a structural-institutional view of innovation systems, which risks overlooking the relations between system dynamics and processes of individual actors, and the critical role of agency (Loeber et al. 2007).

While there are several system metaphors (Morgan 1986; Leeuwis 2004), two perspectives on innovation systems have been especially salient in my studies, related to two of the main constituents of an innovation system; structures and processes. While structures and processes are basic components of a system, these components are often separated for analytical purposes. Scholarly work on AKIS has often taken a single perspective, for example, a structural view or a process view (Klerkx et al. 2012). The structural view has been criticised for having some affinity with hard systems thinking (ibid), and for essentially looking back at existing structures. By highlighting a systemic perspective, Bawden (1992) and others emphasise the learning processes of agricultural research and development.

In reality, structures and processes are closely intertwined and often inseparable. For example, networks are structures, but the establishment, maintenance, development and change of networks is a continuous process. This interrelationship is illustrated in figure 3.

Structures are here defined as stable entities, and can be actors, networks and institutions. Institutions are social structures, and can be divided into hard institutions, such as legislation and rules, and soft institutions, such as values, beliefs and expectations. Giddens (1984) regards social structures as containing the rules and resources that guide human behaviour. Structures range from physical infrastructures to more ethereal social structures.

Processes are here defined as actions, flow, change, and becoming. A process view sees entities like organisations, individuals and roles as continuously formed and reformed by the various processes that shape them on a daily basis (Czarniawska 2014).

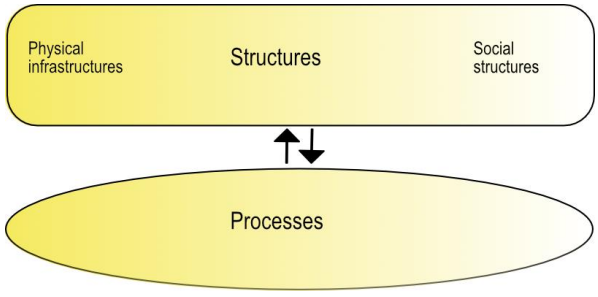

Figure 6. The mutual relationship between structures and processes.

One of the early advocates of a process view was Weick (1979), who argued that social scientists should focus on actions and processes, instead of entities like organisations, roles, and hierarchies. He held that social scientist should focus on 'the verbs' of a societal phenomenon, instead of 'the nouns'. He even argued that social scientists should "stamp out the nouns" and replace them with verbs (Weick 1979:44). A process perspective of a social system is increasingly used in management and organisation studies, as it is believed that phenomena like knowledge and decision-making are better understood as processes of becoming, rather than stable entities (Sandberg et al. 2015).

Czarniawska (2014) argues that the faiblesse for illustrating societal phenomena such as organisational schemes and networks, as boxes with arrows between them (as is common in organisational overviews of AKIS), partly misses the point. It is not only about filling the boxes with entities, nouns, or organisational units, but also finding the verbs to make such models meaningful. There is a need to specify the processes actually happening in such models. This means that the study of AKIS should not stop at conventional organisation models, but focus the inquiry into the practices and processes that keep evolving a focal system (Czarniawska 2014).

The dichotomy between structure and action is dissected in Giddens' theory of structuration (1984). The resolution, according to Giddens, lies in the idea that social structures are both input to and output of human actions. Human actions form social structures, and structures in turn affect human actions. This means that agency is central for the study of innovation, as human agency is the capability for individuals to "make a difference" compared to the usual state of affairs, according to Giddens (1984.)

The idea of the mutually created relation between structures and processes provides the basis for the concept of social practices applied in the

first paper. Social practices acts as an intermediate step, a ‘translator’, between structures and processes. Social practices are seen as the recurrent and routinized activities influenced by structures. Simultaneously, they provide space for new initiatives and creative processes (Nicolini 2012), which in turn affects the social structures.

Morgan (1986), Leeuwis (2004), and Klerkx et al. (2012) all argue that the different systems perspectives, such as the structural and process perspectives, are important. These underlying perspectives influence how systems are viewed and affect our beliefs of how systems work and change occurs. Becoming aware of the various perspectives used in a certain situation can help recognise different viewpoints, and facilitate scrutiny of underlying assumptions (Morgan 1986). Klerkx et al. (2012) suggest that the different systems perspectives should be systematically compared and debated to formulate a common basis for a coherent perspective for understanding AKIS. The reflections in this thesis are intended as a contribution to such a debate.

4. Research methodology and materials

This chapter starts by positioning the research and the researcher, as influenced by my personal and professional background. This is followed by the motivation for the overall research design and the development of the research methods over time. After that, the sampling, data collection and analysis methods are explained. The chapter ends with a reflection on the scientific rigour and limitations of the study, data management, and concluding remarks on the methodology.

4.1. Positioning the research and the researcher

As a trained agronomist, specialising in soil and plant science, my outlook was formed in a natural science worldview. However, after having worked for a farmers' organisation, a dairy cooperative, and as operating manager of an intermediary organisation, I started to reflect on my philosophical outlook. Through years of life experience, I have learned that the work of forming new things is primarily dependent on *people*, what they think, believe, their social connections and their ability to cooperate.

In line with my reflections, Röling and Wagemakers (1998:15) noted that a positivist outlook, "which most agricultural professionals have drilled into them", is increasingly incompatible with the search for a sustainable society. They note that "extension is a means for socially (re-)constructing agrarian reality through communication", implying that the natural science knowledge of extension specialists and farmers is used as a basis for socially constructing the "agrarian reality". Similarly, Douthwaite et al. (2003) noted that innovation is a social process where users socially construct new knowledge. My background in natural sciences has forced me to think through my beliefs and worldview in this regard. Especially doing social

science at a predominantly natural science university, I find this to be worthwhile. To know the philosophical standpoint of a researcher, "is to know our conversational partner" (Miles et al. 2020:5), and it is therefore valuable to make one's philosophical orientation clear.

There seems to be no 1:1 relationship between theory and practice in social sciences, as there is in natural sciences. In general, people do not want to behave rationally and predictably, governed by strict laws of nature or society. Rather, they do as they please, as they find rational from their vantage point, or as they find joyful and meaningful. Yet, I believe that social phenomena exist not only in the interpretations of people's minds but can be discovered in empirical phenomena in the social world. These social phenomena may consist of regularities, sequences, patterns or relations that can be detected through scientific methods and presented as explanations, as theories, that underlie the social world (Miles et al. 2020).

However, I do not think it is possible to describe the world by entirely separating it from our perceptions of it (Silverman 2005). Anyone who tries to describe the world and how it works is embedded in their own way of perceiving the world through experience, ideas and feelings (Alvesson and Sköldberg 2018). This reflects a certain degree of epistemological relativism, which facilitates the exploration of the constructed nature of the field, and acknowledges the ways in which the researcher is an active part of the research process (Mir & Watson 2000). There is a need to be aware of human subjectivity, acknowledging that all data is theory laden and subject to interpretation by the researcher (Alvesson & Kärreman 2007).

In summary, my philosophical orientation includes the need to find a balance between findings of empirical phenomena and an awareness that people experience and interpret the world and specific situations differently, and the fact that the researcher likewise is a subjective perceiver of the world.

Ison (2010) offers a framework for thinking about the researchers' positionality when doing research. Research can be described as a researcher using a framework of ideas, and certain methods, to engage with a certain situation. In using a reflexive approach, the researcher can reflect on what is happening in the situation, seeing themself as included in the system, see figure 7.

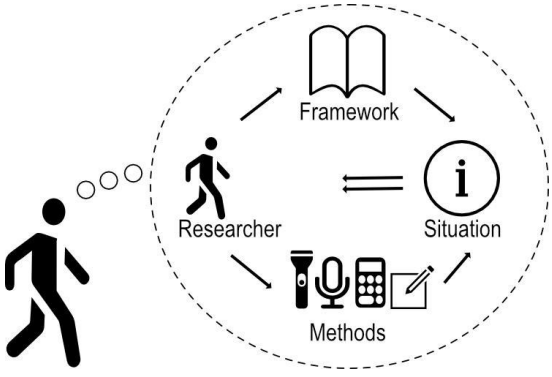

Figure 7. A researcher using a framework of ideas and certain methods to engage with a situation. Adapted from Ison (2010:48).

This implies that, as a researcher, I see myself as part of the "system", and that the choices of framework of ideas, methods, and particular case situation all affect the study. The researcher above is reflecting on the whole system, the researcher included, i.e., I am reflecting on my own thinking and doing. Reflexivity is the practice of moving beyond the first-order practices of reflection and interpretation, to the second-order practice of reflecting on your first-order thinking, and involves seeing yourself as part of the situation (Ison 2010; Alvesson & Sköldberg 2018).

The notion of being familiar with a research context, has been elaborated in the philosophical theory of pragmatism by Peirce (1990/2020). Pragmatism is about using familiarity, i.e., previous practical experiences, as a sounding board for related theories. Peirce (1990/2020) argues that owning both practical and theoretical experiences and insights about a certain topic will enable the researcher to gain a deeper understanding than if the insights were merely theoretical. This implies that a researcher with both kinds of knowledge could have an advantage in, for example, asking questions and interpreting answers in a way that can offer deeper insights into the subject area (ibid).

An important aspect is striking a balance between being familiar with the setting and becoming a 'professional stranger' and 'detached participant'. Since being 'objective' is unrealistic, the researcher must realise their privileged role, and that all accounts are partial constructions and interpretations (Brannan & Oultram 2012:302); they must be transparent

about it. Self-reflection and reflexivity is an important part of the process; an example of this would be asking oneself if the data could be interpreted in another way (Alvesson & Kärreman 2007).

Tietze (2012) reflects on the relationship between the researcher and the researched, in terms of finding an equilibrium between maintaining good relationships and getting access to information, in a way that focuses on addressing research concerns. This implies reflections from the researcher about one's own position, purpose and power in relation to the researched, especially when the relationships are meant to last after the study is finished. Tietze (2012) concludes that such relationships are part of meaning-making and future research accounts.

As an educated agronomist with several years of work experience in the sector and from running a farm, I carry experiences and relations from "the inside", which I need to be aware of in the process of this thesis. In addition, my position as employee at the university may colour interview responses when asking about knowledge and innovation, in which the university has a role (Alvesson 2011). The advice from the scholars above emphasise being aware, careful, and reflexive in the research process.

4.2 Research design

Starting with the aim of the thesis viewed through my philosophical orientation and theoretical lens, I found the underlying questions of *how* and *why* things happen as they do interesting, and a major motivation for writing this thesis. As the research problem and how we address it should decide the research design (Silverman 2005), it should cater for an explorative investigation of social processes in an innovation system context.

The overall research design of the thesis can be described as starting from the aim, examining relevant literature, finding relevant areas for empirical studies, and applying a developing set of methods to the studies. The work developed step by step, both in terms of deeper insights into literature and theories, and empirical observations from fieldwork. Since my aim was to capture the social processes of knowledge development and innovation, this influenced the methods, progressing from traditional research methods toward an action research approach. I have adopted an abductive approach, in the sense that the research process has been characterized by an alternation between empirical observations and theories in an iterative fashion,

successively deepening the understanding of both (Alvesson & Sköldberg 2018).

4.2.1 Qualitative research

According to Yin (2009), a qualitative approach is appropriate for exploring phenomena or situations in all of their detailed complexity; it is suitable when determining the how and why. The flexibility of qualitative research allows for the recognition of the evolving and dynamic nature of social events and processes over time, which appeals to my curiosity and desire to discover what is really going on. Qualitative data is often collected over a period of time, facilitating a chronological flow, ideal for studying social processes (Yin 2009). My connection to the focal sector of horticulture and the ambition to learn more about it, allowed for the collection of rich empirical data. Following Miles et al. (2020), such a "rich picture" of a social phenomenon allows researchers to reveal profound insights into complexity. It helps discover interrelationships beyond those at the surface that first meet the eye, such as the subtle processes of multi-actor collaborations. Miles and Huberman (1994:5) note that the dependency of context can provide an opportunity to discover and understand "latent, underlying or non-obvious issues".

4.2.2 Case studies

Case studies are among the most widely adopted research strategies in qualitative research, as they are well suited for collecting the kind of rich data described above. The idea behind a case study approach is to choose one or several cases, and study them in such detail that a deep and multi-faceted understanding of the cases can be developed (Silverman 2005). Case studies are well-suited for investigating "a contemporary phenomenon within its real-life context" (Yin 2009:11). While the overall aim is to preserve the wholeness of the case, the study can lean towards certain aspects, for reasons of research focus (Eisenhardt 1989; Yin 2009). As I have gone from seeing innovation as mainly a natural science phenomenon to viewing it predominantly as a social process including social learning, my ambition was to capture the social processes of learning and networking which lead to knowledge development and innovation.

Flyvbjerg (2006) notes that it is through experiences with case studies that we can move from beginners to experts in any field. Context-

independent theories and rules in textbooks need to be complemented with concrete and context-dependent experiences for a novice to become an expert. Hence, case studies are important for researchers' own learning processes to enable them to become skilled researchers (ibid).

Case studies can be used as instrumental cases, in which the case is examined in order to provide basis for a generalisation. This means that although the case is studied in depth, the focus is on aspects that can be generalised to other cases (Silverman 2005). According to Eisenhardt (1989), case studies are well suited for theory building, as they can generate theory that is testable, measurable and empirically valid, i.e., closely linked to empirical data. However, the use of case studies can lead to theories that are overly complex or too narrow and idiosyncratic, due to the detailed nature of a specific case (ibid). Yin (2009) points out that theories resulting from case studies are not squarely generalizable to other populations, but rather to theoretical propositions.

4.3 The sampling

The sampling for a research study is not necessarily random; it may be guided by the search for settings that allow for a study of the phenomena or processes of interest, in a theoretical or purposive sampling (Denzin & Lincoln 2005). It means that cases may be selected on the basis of their relevance to the research question (Bryman 2014). This is not a pass to choose any case at hand, rather "purposive sampling demand that we think critically about the parameters of the population we are studying and choose our sample case carefully on this basis" (Silverman 2005:129). In this way, a certain sample is constructed, in order to meaningfully develop and test certain theories and explanations (Eisenhardt 1989). In this study, Swedish horticulture was an interesting sector to employ when investigating the main premise of the thesis (see section 1.2), and the further sampling was guided by the search for cases that would allow for the study of networks, multi-actor collaboration, and impact orientation (figure 4).

In the first empirical study (figure 4), the system delineation was the focal intermediary organisations and their partners. The unit of analysis was specific situations of collaboration between different actors. In paper I, a single case study was chosen because of its unique access to intermediary organisation, both from personal experience, and through a qualitative

evaluation of the organisation. Paper II was a triple case study of three intermediary organisations, with specific situations of collaboration related to each.

The second empirical study started with a semi-systematic literature review of the skills needed for sustainable agriculture (including horticulture). The results acknowledged the learning processes underpinning sustainable development, alongside the usual focus on the subject content. Then, the study deepened into a more detailed investigation of how new knowledge and innovation is regarded and developed within the Swedish horticultural sector, beyond the existence of intermediary organisations. The unit of analysis was collaboration between different actors seen as a process over a longer time, rather than specific situations of collaboration as above. The three cases were domestic sweet potato, weed control in field vegetables, and the storing of fresh produce. There were two major points of access to these case studies, through the people involved in the study and through the documents related to the research projects connected to the cases. Longitudinal cases are often a rationale for pursuing single cases, as it allows one to follow the development over time, contributing to the theories of interest (Yin 2009).

The third empirical study involved four pre-existing research projects at campus SLU Alnarp, and the researchers and stakeholders connected to it. The four projects were selected based on the following criteria: i) practice-oriented agri- or horticultural research projects that include stakeholders in the working group and/or reference group, and ii) projects that were either ongoing or completed within the period of 2018-2022. The system delineations included the actors directly or indirectly involved in the focal cases. The unit of analysis was the respondents' perceptions and dialogues over the projects, their impacts and impact assessments.

In section 6, the knowledge gained from all papers (I-VI) is drawn upon in order to discuss the research questions and the aim, making the thesis a study of multiple cases.

4.4 Data collection

The use of data from multiple sources contributes to a rich and more robust pool of data (Denzin & Lincoln 2005; Bryman 2014). The three empirical studies provided ample opportunities for triangulated data collection, using

multiple sources for data collection: funders' database searches, documents, personal experience, interviews, focus groups and participatory observation (see table 1 for an overview).

Funders' database searches. The second empirical study (see figure 4) started with a funders' database search, revealing the number and nature of applied and practice-oriented research projects related to Swedish horticulture, especially vegetable and fruit production.

Semi-systematic literature review. A qualitative semi-systematic literature review was done in paper III. This approach allows for the study of a topic that has been investigated and conceptualised in various ways by several groups of researchers within different disciplines. A three-step methodology was used: the generation of key words, semi-systematic search, and the extraction of skills.

Documents. All three empirical studies started by gathering relevant documents in order to provide a basis for the following fieldwork. All studies provided ample material in the form of research project documentations, such as applications, final reports, research publications and articles in industry media. Historical documentation, such as government reports and investigations, were used to gain a historical overview.

Personal experience. The first empirical study partly drew on my own and co-authors' experiences as insider accounts. According to Humphreys (2005), the strength of this method is that it offers in-depth access to naturally occurring data in the form of informative situations, along with short- and long-term processes connected to the cases. The researcher gains a rich picture of the operations in their broader context and detailed access to events as they happen. This familiarity and personal involvement naturally differs in comparison to a distant researcher, and can cause bias and inappropriate considerations in the interpretation of the studied phenomena. This can be ameliorated if the researcher consciously strives to view the studied phenomena reflexively from a variety of angles and interpretative stances (Alvesson & Sköldberg 2018).

Interviews. Interviews are an important source of qualitative data, as they may be the most common data source in qualitative research. However, it is worthwhile to consider why an interview is necessary, as they are a time-consuming way of collecting data (Kvale & Brinkmann 2014). Physical interview opportunities were sometimes extended to include more than just the recorded interview, for example, short walks to see fields, facilities and

machinery, providing opportunity for a more relaxed conversation. After the outbreak of the Covid 19 pandemic, the interviews were conducted as digital meetings or by telephone. All interviews were carefully transcribed or meticulously note-taken. For paper I, the notes were focused on the narratives collected. Transcribing the interviews myself involved becoming closely familiar with the data material, and evaluating myself as an interviewer (Karlsson 2002).

Focus groups. The usefulness of focus groups lies in the interaction between group participants, complementing the individual interviews (Morgan 1996). The participants' dialogue with each other provides insights into consensus and possible disagreements, as well as how the participants learn from each other, develop and perhaps change their positions (Morgan 1996; Wibeck et al. 2007). Our work with focus groups was guided by the four research cases and the research aim to develop and test a framework for impact assessment. The role of the moderator can be both a problem and an opportunity in work with focus groups (Wibeck et al. 2007). After an introduction, my co-moderator and I tried to keep the role of the moderator to a minimum.

Participatory observation. According to Fangen (2005), participatory observation allows the researchers to "immerse" themselves in the research field to gain hands-on experience of what is going on. With an underlying view of society as individuals doing things together, it follows that getting first-hand experience of societal life is important, hence is the rationale for participatory observation (ibid). Due to the outbreak of the pandemic, occasions for participatory observations were reduced to five meetings, one ordinary meeting, one field visit and three web-meetings. The meetings I observed gave insights into the dialogue and reasoning between the actors around their projects, and were valuable for understanding the context.

4.5 Data analysis

According to Miles et al. (2020:5), "research is actually more a creative craft than a slavish adherence to methodological rules". Agreeing with this, I believe it is important to share more of how this craft is done. There are numerous ways of working with data analysis in qualitative research (Rennstam & Wästerfors 2018). To start with, the often large amounts of data collected in a qualitative approach must be condensed, i.e., selected,

focused, and simplified (Miles et al. 2020). The purpose of this is not to dilute or lose data, but to make data stronger by, for example, developing themes and generating categories in order to sort and focus data. I have worked with this in several ways. I think it starts early in the researcher's head and continues throughout the entire data collection phase. I have sorted data manually, by writing analytic memos and notes, by using colour pens on interview transcripts, and by cutting interview transcripts into excerpts and sorting them in various ways (Rennstam & Wästerfors 2018). I have also done this on the computer, using excel sheets (which tend to get very large), and the coding software NVivo (Saldaña 2021). I find there are pros and cons with either method; there is often a better overview with manual methods, and better detail control when using computerised methods.

In the next step, I tried to make a data display to facilitate further analysis. This may be in the form of a simple matrix, a network display of boxes and arrows, or the development of a series of figures. For example, in papers IV and V, I have worked with creating timelines of unfolding events, mapping the actors and their actions and interactions over time. For paper IV, software which created digital murals was used, enabling digital co-working with my co-author while in different physical locations. These exercises provided opportunities to cross-check data from, for example, interviews with other sources such as project reports and industry media articles. The timelines, murals, and series of figures served as maps of the cases, facilitating the sorting of the data and further steps in the analysis.

The final step is the sorting of patterns, explanations and causality into findings, and drawing conclusions. This has been an iterative process, where I have needed to go back and forth between the original data, interpretations of the data (such as matrixes, network displays or timelines) and an iterative re-visiting and re-formulation of the findings. Discussions with co-authors is valuable in this step. Working with displays can facilitate the iterative process and examples of such displays can be seen in the figures in papers I and IV, and the matrix table in paper VI.

Table 1. Overview of the three empirical studies, research approach, data collection and analytical methods.

Study	**Research approach**	**Data collection methods**	**Analysis methods**	**Paper**
Study 1. Networks and intermediary organisations	The study starts with the first research question (RQ1) around facilitated networks. It focuses on professional networks and the role of intermediary organisations to facilitate the connection of actors for the furthering of innovations. The study builds on three intermediary organisations, with one of these studied in greater depth.	The data built on a recent evaluation of the organisation, the experiences of the authors as operating manager and evaluators of the intermediary organisation, and three narratives used as illustrations of the empirical material.	The analysis began with a "thick description" of the intermediary organisation (zooming out). Then, zooming in, three narratives were used as illustrative cases for the collaboration in the extensive empirical material. Using a practice-based approach and process theories, the analysis method can be described as a dialogue between practice and theory, between an insider and two outsiders (the three authors), zooming in and zooming out on the empirical material, using figures as data displays.	I.
		The data comprised documents, interviews and insider accounts from the three authors, who all had multiple years of work life experience connected to the three intermediary organisations. Three examples of value creating meetings, one for each organisation, were used as cases of the role played by the intermediary organisations in connecting actors for innovations.	The analysis method began with a "rich picture" of the three intermediary organisations, focusing on how they worked to form value creating meetings. Three examples of value creating meetings, one for each organisation, were analysed and compared for similarities and differences.	II.

Study 2. Multi-actor social learning	This study arose from the second research question (RQ2) of social learning. It started with a semi-systematic literature review of the skills needed for sustainable agriculture (including horticulture). Then, the study deepened into a more detailed investigation of how new knowledge and innovation is regarded and developed within the Swedish horticultural sector, beyond intermediary organisations. The empirical data collection started with 1) funders' database searches, mapping the applied horticultural research funding from the four main funding bodies of applied agricultural research, and in 2) interviews with actors in the horticultural innovation system, with the aim of taking a closer view on these actors. The interview studies revealed the importance of farmers' customers for horticultural innovations to reach the market, prompting a case study of the market introduction of a new crop, sweet potato. The database searches revealed two long-term collaborations between various actors: weed control in field	The data was derived from a semi-structured literature review of papers published during the ten-year period of 2010-2019. A three-step methodology was adopted to capture relevant sources and ensure a rigorous and repeatable method: (i) the generation of keywords and search strings, (ii) a semi-systematic search, and (iii) extraction of skills. Based on a keyword generation process among the Nextfood project consortium partners, 21 keywords were grouped into clusters, and developed into three search strings.	The large number of articles produced by the search strings were scanned for relevance using their title and keywords, then reviewed by abstract and read in full in the following two steps. The analysis was performed by identifying from each of the remaining articles any mentioned skill or phrase that might emphasise a skill, competence, and/or knowledge required. This initial list identified a total of 164 skills. A mapping process grouped them stepwise until finally condensed into five categories of skills.	III.
		The primary data sources were project documents and interviews with 20 individuals connected to the introduction of sweet potato cultivation in Sweden. Secondary data was collected, such as articles in industry magazines, trade regulations, authority reports and terms of innovation support measures.	The analysis was carried out through a careful reading and comparison of interview transcripts, notes and documents. The secondary data was used to validate and triangulate the primary data. Firstly, the actors and their relations were mapped on a timeline of the unfolding events, from the start in 2013 until 2020. Secondly, the analysis focused on the functions performed in the emerging innovation system. Thirdly, the data concerning the market function was analysed in depth, revealing a variety of pathways to market formation, and the interaction of the market function with the other functions. The work included using digital murals and a series of figures for data display.	IV.

	vegetables and the storing of fresh produce for year-round retail supply.	The data built on two long-term innovation collaborations. Numerous project documentation over approximately a ten-year period for each case was collected. Interviews were carried out with 14 individuals involved in the two cases; farmers, producer organisations, researchers, advisers, and others.	The method used is comparative process ethnography, as suggested by Leeuwis (2004), entailing a reconstruction of the unfolding of events over time. Through triangulation of different data sources, a timeline was built up, and the nature of the interactions was reflected upon in the interviews. The close reconstruction of the cases over time, and the comparison between them, was aided through the use of manual coding, excel sheets and coding software NVivo.	V.
Study 3. Societal impacts of research	This study sets out from the third research question (RQ3) around impact orientation. Four pre-existing research projects at SLU, and the researchers and stakeholders connected to it, were included. An action research approach was adopted in to create an impact assessment process for each of the four existing research projects, with the aim of developing and testing a framework for the assessment of research quality and societal impact, alternative to the dominant scientometric model. (The results of the framework testing is accounted for in a paper not included in this thesis; Blix Germundsson et al. in review)	The data built on documents and individual interviews with the researchers and stakeholders involved in four agricultural research projects, with a total of 20 respondents. Focus group interviews were carried out for each project, and project meetings were followed through participatory observations.	The analysis focused on the social orientations of inclusion as enacted in the interviewees' accounts. Data analysis was done through careful examination of interview transcripts, notes and documents to locate the sections that explicitly addressed inclusion or aspects of inclusion. Each section was analysed individually, focusing on uncovering the social organisation underlying the informants' claims about the inclusion of stakeholders. The team of authors used transparency and reflexivity in the interpretation of the empirical material.	VI.

4.6 Reflections on the methodology

4.6.1 Scientific rigour and the limitations of the study

For this thesis, I have chosen a qualitative path with a case study approach. While qualitative methods can be criticised for being interpretative, they can offer a glimpse into complex social realities that other methods cannot easily give (Alvesson & Sköldberg 2018). In addition, as the thesis builds on a collection of theories and approaches reflecting my learning process in the PhD journey, some readers may find it too eclectic and shallow in parts. My hope is that the reader will be able to see the collection of pieces as forming a whole quilt, useful for anyone who wishes to study knowledge and innovation in horticulture. Below, I refer to the main limitations of this study, and reflect on the measures taken to ensure the validity of the study, see table 1.

The first empirical study builds on three intermediary organisations, one of which is viewed in greater depth. There are a few other regional intermediary organisations in the country, working with horticultural innovation from time to time. The inclusion of these would have widened the empirical base and provided more cases to the study.

The second empirical study, of multi-actor collaborations, builds on a literature review and three cases of long-term collaborations; the domestic production of sweet potato, weed control in organic field vegetables, and storing of fresh produce. These three cases were chosen as they were unique in comparison to others; they illustrated the introduction of a new crop and stood out as long-term in the funders' database searches. While the cases were purposefully sampled in order to inform the research focus, others may argue that a random sampling would have been more appropriate to explore the phenomenon of multi-actor collaboration in Swedish horticulture.

The third study included four existing research projects at the university campus, and the researchers and stakeholders connected to it. The four projects were followed for more than two years, starting in early 2020. However, it would have been valuable to follow the projects for another two years, in order to follow up on at least some of the actual impacts.

To ensure the validity of the research in this thesis, there has been an attempt to achieve four types of validity, in accordance with Yin (2009) and Bryman (2014): construct validity, internal validity, external validity, and

reliability. As the validity of a study is best described by the concrete research actions taken to ensure validity (Gibbert & Ruigrok 2010), a summary of the research actions is given below (see also table 1).

Construct validity is the extent to which a study investigates what it claims to investigate. It is the "data collection logic" that answers whether the set of actions that the researcher undertakes to collect data leads to accurate observations of reality (Denzin & Lincoln 2005). Some authors, like Silverman (2005) and Alvesson and Sköldberg (2018), argue that a "true" reflection of "reality" cannot be separated from "particular ways of looking at it" (Silverman 2005:212). Still, strategies have been suggested to ensure construct validity, the two most significant being triangulation of data from various sources (Denzin & Lincoln 2005), and explication of a clear chain of evidence from research question to conclusion (Yin 2009). As shown in table 1, all of the studies and papers build on data from various sources (except for the literature review in paper III) and are intended to clearly explain a chain of evidence from observation to conclusion.

Internal validity refers to the "data analysis logic", answering to the logic between variables and results. It is the extent to which the researcher manages to build arguments to ensure the results and conclusions can be convincingly drawn from the observations made. The analysis of these studies has been done using data triangulation, pattern matching, data displays and building logical chains of explanation (Miles et al. 2020; Yin 2009). Due to on-going data collection and the unfolding of my understanding of the field, I had ample opportunity to reflect on my own thinking (Haynes 2012), looking at the collected data from different angles, and asking if the data could be interpreted in other ways (Alvesson & Kärreman 2007). This experience was especially salient in connection to paper V, where the data underwent several rounds of analysis.

External validity refers to the "generalizability" of the results. According to Yin (2009), theories resulting from case studies are not statistically generalizable to other populations, but are instead analytically generalizable to theoretical propositions. Eisenhardt (1989) warns that the use of single case studies can lead to theories that are overly complex or too narrow and idiosyncratic, due to the detailed nature of specific cases. Flyvbjerg (2006) nuances this stance by noting that case studies primarily are instruments of learning, and not necessarily to 'prove' things. He emphasises the 'force of example', rather than formal generalisation, as a source of scientific

development. Social science essentially has only context-dependent knowledge, Flyvbjerg (2006) argues, and solid proofs for context-independent theories regarding human affairs are hard to come by. In a similar vein, Kärreman and Alvesson (2001:61) propose that a detailed study of micro-events can be seen as the organisation in miniature, or "written small", which can open a window to a broader understanding of the setting if combined with sufficient context knowledge. This is to say that, although the nature of a specific innovation process is context specific, it is possible to learn from the experiences in similar settings.

Reliability refers to the "repeatability" or replication of the study, i.e., the possibility of arriving at the same results if the study was done again by other researchers (Denzin & Lincoln 2005). In this regard, Silverman (2005) highlights the need for transparency in the analysis, so that readers can judge whether the observations lead to the conclusions drawn. He recommends that data should be presented with a minimum of author inference. However, to achieve this in practice is challenging, as journals will often have word limits and high requirements for accounting for previous related research. Yet, attempts to fulfil this requirement were done with papers V and VI, starting out with a large number of data excerpts in the manuscripts.

4.6.2 Data management

The research has followed "Good research practice 2017" from the Swedish Research Council. The NextFood research was conducted under the ethics requirements and guidelines of the NextFood project (Deliverables 8.1, 8.2, 8.3), which complies with regulation (EU) no 1291/2013 of the European Parliament and the European Council.

A data management plan was developed to ensure that data collection and processing was performed in accordance with good research practice and GDPR legislation. The collected data has been systematically organised in order to maintain a chain of evidence for each study (Yin 2009). Written informed consent forms to publish qualitative data were collected from all interview respondents.

The choice of case study method can be a challenge for the aim of complete anonymization of respondents, as the number of organisations and actors are limited within the case study field. This risk was mitigated by sharing excerpts of manuscripts with the respondents for their comments, which is also an acknowledged way to validate interview results. The

confidentiality of interview participants was assured through the anonymization of their information in articles and manuscripts.

4.6.3 Concluding remarks on the methodology

The aim of the thesis, concerned with the knowledge and innovation system of Swedish horticulture, and the recognition that I am part of this system, has given the thesis its specific character. As described above, being familiar with the research area can be both a strength, as in field access and familiarity (Peirce 1990/2020), and a challenge, as in finding the detached and analytical eye of the 'professional stranger' (Brannan & Oultram 2012). This awareness has permeated the research approach, design, data collection, data analysis and ethical considerations. It has facilitated access to the field cases, respondents, and documentation. It has prompted thorough analysis of the data, using the tools described above, and careful ethical considerations.

Summarising the methods, and how they have evolved over time, the thesis started with cases and methods that were close to me in terms of familiarity. Gradually, the thesis work opened up new cases and methods, to arrive at an action research approach with focus groups. As I believe research methods are at the core of the scientific craft, this has been a fascinating learning journey for me, underlining the educational aspect of a doctorate thesis.

The investigation of the knowledge and innovation system of Swedish horticulture could have been done using different approaches. Quantitative methods could have been incorporated into the study, for example, to survey specific issues. Using an action research and participatory approach from the start would have invited relevant actors to be the co-creators of the study, its results and impacts. My hope is that this thesis can provide a starting point for such a multi-actor process with a broad palette of methods.

5. Main findings of the papers

This section presents the history and main findings of each of the appended papers. The brief history provides an overview of the motivation for each of the papers and contributes to the overview of the research process of the dissertation. The main findings of each paper are presented, focusing on their contribution to the thesis aim and research questions. The chapter closes with a reflection on the paper process.

5.1 Paper I. Collaboration in the Making - Towards a Practice-Based Approach to University Innovation Intermediary Organisations

The paper investigates an intermediary organisation central to Swedish horticulture, SLU Partnership Alnarp. What affected the actions of the intermediary organisation, and why had it been supported for more than 15 years, in spite of the constant budget constraints? The paper drew from a qualitative evaluation carried out by Augustinsson and Lidén (2019), and additional data was collected for three narratives of collaborative situations. The paper also drew from my personal experiences from almost six years as operating manager of the intermediary organisation.

The data collection, analysis and writing was done in the second half of 2019 and the first half of 2020. It was intended as a paper for the IFSA conference in March 2020, which was postponed due to the pandemic. The theme convenors sent information that a journal was offering to do a special issue for the conference, which we submitted to. After revisions, the manuscript was accepted.

The study aimed to explore and understand how the intermediary organisation facilitates collaboration in the making. The theoretical

perspective included using a practice-based approach and process theories, and the methods included narratives of three multi-actor collaborative situations.

In the analysis, the three narratives were examined in relation to the theoretical model, where the structures of the intermediary organisation are translated into social practices as the participants adapt to these structures, and in turn, the practices provide a background against which processes between people may emerge and continue to evolve. A fixed structure (the board meeting narrative) implied a tighter interpretational frame, as the participants knew what to expect and what was expected of them. This allowed for continuity but, most importantly, made trust, commitment and action possible. A looser structure (the seminar narrative) implied a more flexible interpretational frame, which allows for a larger degree of spontaneity, creativity and unexpected acts, altering the practice and structure of the seminar or excursion in sometimes unpredictable ways.

The different structures within the intermediary organisation contributed to a creative tension between the orderly structures and the spontaneous, looser structures. This enabled people to use the different structures and practices, according to their individual intentions, motives and relational processes, to set new collaboration processes in motion, and continue to evolve them.

The findings highlighted how, while the intermediary organisation provided various kinds of meeting spaces, it was up to the participants to take advantage of these opportunities. In fact, the intermediary organisation was dependent on individuals using this opportunity to take initiatives and create collaboration. Resources of different kinds, e.g., financial, infrastructural, knowledge and social, are embedded in structures, which in turn provide for social practices and processes. Reciprocally, the practices and processes maintain and recreate the structures. It is when these practices and processes are carried out, as in the narratives, that meaning is created, keeping the intermediary organisation going. It was concluded that the organising of collaboration should focus its attention not only on structures but also on the practices and processes formed between the individuals.

5.2 Paper II. The role of innovation intermediary organisations in forming value-creating meetings: the agri-food firm perspective

Paper I prompted an interest in digging deeper into the workings of innovation intermediary organisations. How could such organisations increase their efficiency and deliver better value to their owners and target groups? Starting out from the concept of value-creating meetings, as presented by Frankelius and Vogel (2009), we expanded the empirical base into three innovation intermediary organisations.

The data collection, analysis and writing were done in the second half of 2019 and in 2020. Intended for the IFAMA physical conference in May 2020, it was presented at the digital version of the conference in September 2020. The conference held a "Best paper competition", and our contribution was placed in the Top Ten final. It was then offered to be published in a special issue of the IFAMR Journal. After further revisions, it was accepted in the end of 2020.

The aim of the study was to explore the concept of value creating meetings and examine the role of intermediary organisations in the forming of such meetings. The definition of a value-creating meeting includes a meeting between two or more actors that creates an innovative process which results in economic value, either in the short or long term, for at least one of the actors. The study investigated and compared the practices of three intermediary organisations and how they work to form cross-sectoral value-creating meetings.

The findings revealed staff from all three intermediary organisation had an active role in connecting actors with relevant expertise and facilitating a learning dialogue between the actors. This happened in various ways, although the matchmaking function was strongly tied to one or very few individuals. While this can provide an agile and efficient process, the drawback is that the operations become vulnerable as they are dependent on a small number of individuals.

5.3 Paper III. What Skills Do Agricultural Professionals Need in the Transition towards a Sustainable Agriculture? A Qualitative Literature Review

The Nextfood project started in 2018 through a literature review of the skills needed for the future in agriculture (including horticulture), relevant for any professionals in the sector. After a time lag due to personnel changes, the work was taken up again in 2020, and finished in 2021.

The purpose of the paper was to identify and analyse the skills needed for professionals in the agricultural system to engage in the transition towards sustainable agriculture. It would also elaborate on the implications of this for a transition towards sustainable agriculture. The paper built on the notion that, most often, agricultural education for sustainable production is focused on the subject content, while it is also important to acknowledge the learning processes that underpin sustainability. 'Professionals in the agricultural system' are broadly delineated as all groups working directly or indirectly with agriculture as well as researchers, teachers, and students. They are all seen as potential 'change agents' in the sustainable transition of agricultural and food systems in society.

The review is based on a qualitative semi-systematic literature search. We adopted a three-step methodology to ensure a rigorous and repeatable method: i) the generation of keywords and search strings, ii) a semi-systematic search, and iii) the extraction of skills. The step-by-step procedure resulted in a list of 20 peer-reviewed articles concerned with sustainability, skills, and agriculture. From these papers, 164 skills were extracted, which were grouped thematically into five categories of skills representing the most emphasised topics.

The five categories of skills identified were: 1) Systems perspective, 2) Lifelong learning, 3) Knowledge integration, 4) Building and maintaining networks and learning communities, and 5) Technical and subject-specific knowledge and technology. The reviewed articles illustrated a turn from classical learning theories based on positivist images of scientific inquiry as an objective activity, towards subjective and contextual perspectives. While the dominant learning model within agricultural studies remains a linear process from scientist to student or farmer, the identified shift requires further exploration of learner-centric educational approaches based in real-

life practices and contexts. Hence, the review offers an understanding of agricultural 'sustainability skills' as being relational and context-dependent.

The review highlighted how agricultural education and life-long learning today should not only encompass technical knowledge but also social skills and competencies within a systems perspective, continuous learning, integration of knowledge and networking, and motivation and openness to engage in a dynamic and changing world.

5.4 Paper IV. Market formation and the role of the farmer in a micro-level agricultural innovation system.

The 2019 interviews of actors in Swedish horticulture revealed the importance of customers and suppliers for innovation in horticultural firms. This sparked the interest in a case study focusing on the market function of an innovation system. The recent introduction of a new crop, domestically grown sweet potato, was seen as an interesting case for investigating this premise. We gained access to the case both through interviews with involved individuals and documentation from the related research and development projects. The empirical work took place in late 2020 and the first half of 2021. The analysis and writing process continued into 2022.

The aim was to analyse an emerging micro-level agricultural innovation system and the market instep of its product, focusing on the role of the entrepreneurial farmer. The theories used build on the technological innovation systems approach of functional dynamics, in combination with entrepreneurship theories (the latter are not further elaborated in this thesis).

The data consisted of documentation and interviews with 20 individuals. Firstly, the actors were mapped on a timeline of the unfolding events. Secondly, the analysis focused on the functions performed in the emerging innovation system. Thirdly, the data concerning the market function was analysed in depth, revealing a variety of pathways to market formation, and the interaction of the market function with the other functions.

Entrepreneurial experimentation of the farmers was found to be the core of the new innovation system, lending emphasis to the role of individual agency. The analysis showed that the driving force for continuous development was market interest, prompted by customer and consumer demand, which energised the other system functions. The early market formation was supported by the knowledge actors providing entrepreneurial

farmers with knowledge and contacts to start experimenting with sweet potato cultivation.

Two strategies were found in the new value chain: a cost-leadership strategy and a focus strategy, the latter profiling the domestic produce as a premium product, competing based on quality and local proximity rather than on price. However, to develop the latter strategy would require more investment than the early project funding covered, which the farmers alone could not bear. In order to support this, agricultural innovation policy measures would need to be developed towards more long-term support and pre-market related activities.

The study points to a lack of dialogue contexts that include both market actors and innovation support actors for joint problem solving and co-innovation. The results showed that the farmers were the connecting link between the market actors and innovation support actors, leaving farmers and rural entrepreneurs in the nexus of the technical development and the market formation. Hence, farmer entrepreneurship, building on generations of experiences of adapting the use of the farmland to changing market conditions, can be a crucial driver of innovation in agricultural innovation systems. A combination of innovation system theories and entrepreneurship theories were suggested to provide a framework for understanding of the driving forces of agricultural knowledge development and innovation.

5.5 Paper V. Leverage points in multi-actor innovation. Two micro-level case studies from Swedish horticulture

This paper started out broadly, aiming to conceptually model and analyse the Swedish horticultural innovation system in order to identify opportunities for enhancing innovation and improving policy. The data collection consisted of database searches, historical document studies and field interviews. The first findings were included in a paper presented at the ESEE conference in Sicily in June 2019. The database searches where updated, and a second round of interviews was performed in the second half of 2019 and early 2020. The new findings were presented at the digital ESEE conference in June 2021, and a further revised version was presented at the IFSA 2022 in Évora, Portugal.

The paper takes its starting point in Swedish horticultural firms' need to innovate to stay competitive. The aim was to investigate factors that can leverage the innovation system for the sustainable business development and growth of horticultural firms. Based on extensive database searches, two cases of long-term (exceeding 10 years) multi-actor collaborations for sustainable business development were identified.

The theoretical approach of innovation systems and leverage points were used. The research design followed a 'comparative process ethnography' approach, meaning an ex-post reconstruction of events and interactions, as well as the gathering of the participants' reflections on these.

The findings from the two case studies were analysed and compared, and three factors were identified as crucial for leveraging the innovation system and for the longevity of the collaborations. Firstly, both cases had a strong sense of agency (i.e., a need to solve a specific problem), and a network approach, viewing the collaboration with others as the preferred path for moving forward. By combining these, it was possible to transform their agency into a collective agency, or co-agency, for all involved. The co-agency became a joint resource for them to draw upon, facilitating communication, idea-generation and action planning.

The second factor was the learning dialogue established within both cases, underpinned by the ongoing evaluation of research trials. The two elements of a genuine dialogue and monitoring/evaluation in combination provided the basis for the quality of the learning process. Thirdly, several types of resource were frequently mentioned as valuable assets in the case studies, such as networks of skilled individuals, successful funding proposals for spin-off ideas, and infrastructure and competence for field and laboratory research.

The use of the leverage point approach provided insights into how seemingly small and insignificant processes result in changes in social structures, which in turn contributed to the desired effects in the long run. This research illustrated the dialectic and systemic relationship between structures and processes. The challenge for the innovative actors was to balance the creative process with the appropriate support structures; a process that in turn affected social and institutional structures.

5.6 Paper VI. Inclusion for impact? How actors reflect on inclusion in the context of practice-oriented agricultural research projects

This paper stems from the four existing research projects recruited as pilots in the NextFood project. In my earlier experience as the operating manager of an innovation intermediary platform, I often found myself facilitating actor dialogues around potential collaborations. Hence, I was interested in how the four projects had worked to involve stakeholders in their projects. The data collection in the Swedish pilots started in the summer of 2020, and continued into early 2022. The analysis and writing of this paper took place in 2021 and 2022. An early conference version of the paper was presented at the digital ESEE conference in June 2021.

The benefits of engaging stakeholders in agricultural innovation have been highlighted in research over past decades, based on arguments for a systemic view and a participatory approach. Yet, less is known about how the benefits of inclusion on impact are learned and negotiated in actual research project settings, and the relationship between inclusion and the perceived impacts of research efforts and outcomes. The article asks:

- What are actors' social orientations in the process of stakeholder inclusion in practice-oriented agricultural research projects?
- What are the perceived benefits and impacts of inclusion, in what sense, and for whom?

The empirical basis is a qualitative case study of four agricultural research projects involving researchers, advisers, farmers, and other actors. A detailed account is presented of how the actors reflected on inclusion in these projects. The findings illuminate the social orientations reflected by the respondents as: i) acquaintance and the hard work of building relations, ii) uncertainty and risk taking due to the nature of knowledge production close to practice, and iii) the potentials of achieving meaningful societal impacts. The perceived benefits of the inclusion were summarised as framing and funding, complementary resources, and enabling future impact.

The theoretical implications include how actors elaborate the benefits and impacts of inclusion, and contributes to a better understanding of the social orientations and dynamics of inclusion in the context of agricultural research projects. The reasons for inclusion can be shifted from merely adapting to

funders' requirements, towards providing inspiration and a sense of contributing to meaningful societal impacts with and through others.

5.7 Reflections on the paper process

With the aim of investigating how the knowledge and innovation system of Swedish horticulture could be reinforced, I started with the intermediary organisation and networks I had recent experiences of, resulting in papers I and II. About the same time, the work with the literature review in paper III started. From these experiences, the interviews began for paper V.

The first papers' use of the concepts of structure and process, and relating it to a practice-based approach, sparked a resonance with a level of interpretation in me, causing me to question what systems were made of and how they work. This became a theme for the rest of the thesis work and is accounted for in section 3.5.

Then, the Covid 19 pandemic hit the world. The final interviews were mostly carried out through web meetings or phone, with a few being done in person. While a digital meeting is never the same as a physical one, I still felt able to perform most of the interviews for papers IV and VI as planned. The disadvantages of the pandemic was felt mostly in the lack of physical meetings in the NextFood international consortium, and the scientific conferences, which were postponed or turned into digital events.

The two sources of funding, the horticultural study and the NextFood project, required a lot of work on two tracks at the beginning, before a joint track became visible. It gave the opportunity to combine a sectoral specific (horticultural) innovation approach with a focus on the societal impact of research in an international context.

6. Discussion

This section discusses the findings in relation to the three research questions in sections 6.1-3, and in relation to the aim in section 6.4.

6.1 Network facilitation

The first research question was: "How can network facilitation contribute to a reinforced knowledge and innovation system?" It has been noted that financiers and clients have a difficult time grasping the nature and value of innovation brokering activities (Klerkx & Leeuwis 2009). This means that if there is to be motivation to finance innovation brokering, including network facilitation, the black box of what is done must be opened. At the same time, it has been found that network facilitation was by far the most often occurring activity (Faure et al. 2019), and the most effective and cost-efficient type of innovation support in early phases (Beers & Geerling-Eiff 2014). While there are several macro-level studies of the embedding and functions of innovation intermediaries, micro-level dynamics have been studied less (Kilelu et al. 2014). Below, two points are highlighted.

6.1.1 Creative tension and the reciprocity of intermediaries and actors

A number of activities or functions have been found to be performed by innovation support services, ranging from problem identification, network brokering, facilitation of dialogue and learning processes, to dissemination and scaling up and out (e.g., Faure et al. 2019; Proietti & Cristiano 2022). In relation to this, paper I outlines the use of a "creative tension" within a specific intermediary organisation for the development of collaborations between actors. The use of a practice based approach made this visible. The results illustrate how the different structures of the intermediary, ranging

from flexible to more fixed structures, provide for the enabling of different social practices and processes between people. For example, flexible network facilitation and loosely structured meeting-places allows for starting dialogues, while the firmer structures of handling project proposals gives access to seed-money. In this way, paper I claims that the 'creative tension' between the spontaneous and the orderly is used by the actors to set new collaboration processes in motion and continue to evolve them, according to the actors' motives.

The notion of a creative tension further elaborates on the concept proposed by Faure et al. (2019), who stated that the network support function was more informal in the early phases of innovation and more formal in the later stages. As an innovation process can iterate between various phases, the actors can use the creative tension between informal and formal practices according to their needs.

Furthermore, the results of paper I illustrate the reciprocity of the intermediary – actor relation; it is through the meetings and interactions between the actors, their practices and processes, that the intermediary gains results and recognition, and hence, provides arguments for keeping the intermediary going. Kilelu et al. (2014) and Faure et al. (2019) note that there are competing interests and power relations between various service providers, making the system complex to navigate. The results of reciprocity found in paper I, contributes to the understanding of the motives of such competition and power play between service providers.

6.1.2 Value-creating meetings

The results of paper II contribute to the unravelling of the specific competencies and actions of an innovation intermediary as an active network facilitator in arranging value-creating meetings, especially across sectoral borders. This in line with Klerkx and Leeuwis (2008) who identify network brokering as a central role of innovation intermediaries, and with Faure et al. (2019) who note that the 'network facilitation' and 'demand articulation' functions were present in all phases of an innovation process.

The ambition to span across sectoral borders puts even greater demands on the intermediary in terms of access to a range of networks and capability to arrange value-creating meetings across the 'usual' borders. Paper II found that dialogue facilitation was not merely a question of linear matching of demand and supply, instead it is a dialogue of on-going learning and co-

creation between the actors. This supports the findings of Kilelu et al. (2014) and puts the co-creational and dynamic aspects of the dialogue at the centre, emphasising the facilitating role of the intermediary, as this matching does not happen automatically or inevitably.

While Faure et al. (2019) note that the network facilitation function in a broad sense was the most often occurring function among ISS functions, Proietti and Cristiano (2022) note that the networking facilitation functions, including guidance of the learning process, were performed to a lower extent than other ISS functions by all of the actors performing innovation support services. Both Faure et al. (2019) and Proietti and Cristiano (2022) relate this function to the transition from traditional advisory services towards innovation support provision of new and more complex functions. It indicates that active network facilitation, matchmaking and dialogue competencies are critical yet still challenging functions.

6.2 Social learning

The second research question was: "How can social learning contribute to a reinforced innovation system?". While much has been written about social leaning in agricultural and sustainability settings (Leeuwis & Pyburn 2002; Wals, 2007), this research highlights how social learning can be used to strengthen small firms' ability to innovate. Below, two points are discussed.

6.2.1 Social learning and co-agency

One of the five skills needed for the future identified in the literature review in paper III, was lifelong learning. A change in perspectives could be discerned in the reviewed papers, from learning being understood as an institutional and formalised practice associated with learning institutions and formal education, towards a view of learning as a part of everyday practices and a mind-set of being proactive. The reviewed papers argued for learning ability to adapt to an uncertain and complex future, to challenge one's own knowledge and understanding, and to be proactive through experimentation. The literature review in paper III also highlighted networking and learning communities, pointing to the importance of social learning.

Social learning is noted as a central part of the value-creating meetings in paper II, in the inclusion processes in paper VI, and is especially dealt with

in the long-term collaborations in paper V. Paper V introduces the notion of co-agency to denote a small group of individuals sharing a specific agency within (horticultural) innovation. This is a set of shared ideas guiding the members' communication and decision-making, a resource for orienting and coordinating their actions. While the individuals were of heterogeneous backgrounds and knowledge traditions, similar to the notion of collective agency in Fernandez-Wulff (2019) and Pelenc et al. (2015), they were a smaller group with a more focused aim. In the two cases in paper V, the forming of co-agency enabled the resources of a small group with complementary skills to be drawn on to deal with certain issues. This is to say that horticultural firms can gain innovative strength by forming co-agency with key individuals in order to access competence and resources.

The value of feedback from monitoring and evaluation was illustrated in papers IV and V. The results of experiments and field trials provided valuable input to the on-going social learning processes in the studied cases (Guijt & Proost 2002). This is akin to what Freeman (1987:41) noted from Japanese factories, where the concept of "using the factory floor as the laboratory" was coined. It meant that expert engineers and production operators worked together on the factory floor to find solutions, often "raking in the suppliers" as well (ibid). This mode of working created a collective agency around solving certain issues (Pelenc et al. 2015), where joint experimentation provided feedback on possible solutions (Guijt & Proost 2002).

The leverage point approach in paper V provided insights into how seemingly small and insignificant processes can result in changes in social structures, which in turn may act as steppingstones in the process towards the desired outcomes. It illustrated the dialectic and systemic relationship between structures and processes, and their co-evolvement in innovation processes.

6.2.2 Dialogue skills

Examples were noted in paper V of the three dimensions of learning necessary in multi-actor collaborations; relations, process and substance (Daniels & Walker 2001), where the relations and process dimensions lay the foundation for the substance work. The examples illustrate how the learning process between actors can be reinforced through conscious

reflection on the types of learning that need to happen and pursuing these levels of learning actively as ‘dialogue skills’.

Paper V also illustrated how new ideas were born through dialogue with others. This is, in a simple way, the art of “thinking together”, which adds a dimension to the dialogue (Isaacs 1999). As individuals have various perspectives and knowledge traditions, they will add different things to the original idea in an exploratory dialogue, making new things visible. This further elaborates on the findings of Millar and Curtis (1997) and Šūmane et al. (2018), who stated that most learning occurs when expert and local knowledge meet.

In summary, the results of paper V illustrate and elaborate on how dialogue skills can be learned and used to create social learning in order to support innovation in horticultural firms.

6.3 Impact orientation

The third research question was: “How can impact orientation contribute to a reinforced innovation system?” According to the definition of innovation established by Schumpeter (1934; 2008), innovation is fulfilled only when it has been put into commercial use or gained similar practical use in society. This implies a broadening of the role of agricultural knowledge and innovation towards an instrument for practical change (Horton 1998). Two points of interest will be raised here.

6.3.1 The role of the entrepreneurial individual

Paper IV is a case study of an innovation being introduced to the market in the form of a new domestic crop. Even if the volumes were initially limited, there was an immediate impact on the farmers and consumers. The entrepreneurial experimentation of the farmers was found to be the core of establishing the new crop and micro-level innovation system. This lends emphasis to the role of the agency of the individual, as noted by Loeber et al. (2007).

Furthermore, the analysis showed that the driving force for continuous development was market interest. The farmers acted to meet demand from their customers, indicating the strong force exerted by customers and consumers on their suppliers (Randelli & Rocchi 2017).

Early market formation was supported by the innovation support actors, providing the farmers with knowledge and contacts to start experimentation with the new cultivation. If the innovation support had not existed, the farmers could still have tried the new crop but would likely have had to do most of the experimentation themselves, which would come with considerable risk and cost. Some, who perhaps had less clear signals from their customers, may have refrained from trying the new crop. Hence, in this case, the innovation support services played a supportive role in the development of innovations at farm level, but the entrepreneurial farmers and their customers had the last call. This illustrates and concretizes the findings of Fieldsend et al. (2019), who noted that the role of customers and suppliers for agricultural innovation was likely underestimated in the European AKIS policy discourse.

6.3.2 Impact with and through others

The findings of paper VI illuminate the social orientations of inclusion of stakeholders in agricultural research projects. These were reflected by the respondents as: i) acquaintance and the hard work of building relations, ii) uncertainty and risk taking due to the nature of knowledge production close to practice, and iii) the potential of achieving meaningful societal impacts. These results reflect the emphasis on the relational and procedural aspects of multi-actor work (Daniels & Walker 2001), which can be difficult and cumbersome. At the same time, it can be very rewarding, as reflected by the three main ways in which the participants framed the importance of inclusion as beneficial and impactful: framing and funding, complementing resources, and enabling future impact. The results highlight the respondents' views of the inclusive approach as having several advantages, having a real impact on the involved individuals, and enabling the creation of future impact.

The results imply that networking and trust-building are necessary for enabling inclusion and forming collaborative practice-oriented research projects. Researchers, advisors, farmers and others have reasons to be cautious of getting involved with each other in research projects (Collins 1987). Hence, the provision of training opportunities in transdisciplinary approaches for researchers, professionals and students, such as experiential learning in university programs, may contribute to the building of cross-border networks and fostering the skills needed to work effectively in multi-stakeholder settings. The literature review in paper III highlights the

proactive effect of creating networks and learning communities and how social relationships are shown to foster collective action.

Moving from a positivist to a constructivist approach, impact assessment and evaluation practices become a vital part of the process of making change happen, as there is less of an underlying assumption that people and the world can be controlled and influenced rationally. Thus, the inclusion of actors in ongoing evaluation and learning becomes a central part of the work itself (van Mierlo et al. 2010; Douthwaite & Hoffecker 2017; Faure et al. 2018). This emphasises the experiences of the people involved and their mutual learning to create an impact with and through others.

6.4 Concluding reflections on the results in relation to the aim

With the tension between the original motives of the system of innovation approach and the need to deliver on today's challenges as expressed by contemporary policies (section 1.1), it is valid to ask how knowledge and innovation systems can be made fit to deliver to the challenges of today and tomorrow. The aim of the thesis was to investigate how the knowledge and innovation system of Swedish horticulture can be reinforced to meet current and future challenges. With the results of the research questions above, the following three reflections are made in relation to the aim.

6.4.1 Balancing structure with process

As noted in section 3.5, the systems concept in itself, illustrated in the definition of systems as "networks of connected entities" (Havelock 1986:77), brings a structural mode of explanation that risks obscuring the critical role of processes between individual actors (Loeber et al. 2007). While structures are necessary and indispensable in innovation systems because, among other things, they carry rules and resources, the results of this research emphasise how people perceive knowledge and innovation primarily as processes (cf. Sandberg et al. 2015).

While the actors make use of structures as resources and steppingstones, their focus is on advancing their own processes. In papers I and II, individuals use the structures of the intermediary organisations to initiate and further their ideas. In papers IV and V, the entrepreneurial farmers and the producers' organisations make use of the innovation support actors, such as

advisors and researchers, in order to solve issues and improve their operations. Likewise, in paper VI, the actors in the four research projects further their innovation processes by making use of existing structures.

While existing structures, such as actors, networks and institutions, are important as a starting point, in an emerging or developing innovation system, the relevant structures may not exist yet or may just be forming (Bergek et al. 2008). The results of paper I show how the structures of an innovation intermediary are continuously shaped and re-shaped by the actors that use them, and paper V notes that the forming of social structures between actors plays a vital role. This implies a view of AKIS as being continuously formed and re-formed by the actors that work in it to further their ideas (cf. Czarniawska 2014; Weick 1979).

Recent developments around a more functionalist view on innovation support services (Faure et al. 2019; Proietti & Cristiano 2022) are clear steps in this direction, as functions can be seen as sub-processes of the overall innovation process (Bergek et al. 2008). This view suggests that it is the processes underlying innovation which should be the focus of policy interventions, not necessarily the structural components (ibid).

6.4.2 Balancing a systems view with acknowledging dynamic individuals

This reflection takes its starting point in the use of the biological-functional systems metaphor, which gives priority to roles, functions and structures of an innovation system, and risks overlooking dynamic and creative individuals (see section 3.5.) (Loeber et al. 2007; Guneriussen 1997). In such a systems view, humans risk being reduced to rational goal-seeking beings, when in fact, most of the time, people do as they please. They do what they find joyful and meaningful from their own vantage point. The empirical results of this study have emphasised the importance of the agency of engaged and entrepreneurial individuals, and how such individuals can create change by working with and through others.

In papers I and II, the agency of actors forms the basis for the value creating-meetings and provides results and recognition for the intermediary organisations. In papers IV and V, the agency of the entrepreneurial farmers, advisors, researchers and producer organisations leads to engagement with others in order to make progress regarding the identified issues and potentials. In paper VI, the projects were created together with included

parties, reflecting the various agencies of the involved individuals. In line with this, Faure et al. (2019), noted that the 'demand articulation' function was present in all phases of the innovation process.

Edith Penrose (1952) highlighted the potential in the agency of engaged and entrepreneurial individuals when she argued that firms are not doomed to follow others' expectations; rather, they have a choice of creating their own future. This emphasis on entrepreneurial individuals bears some resemblance to the 'innovation ecosystems' strand of literature, which is generally more focused on the entrepreneur (Pigford et al. 2018).

If we wish to advocate for a progressive AKIS policy, it may require the active invitation of engaged individuals and their ideas, as well as providing a conducive environment for innovation. The notion in paper I, that an intermediary organisation gains recognition through the interactions with and between the actors, adds to the motive of any innovation support actor to work actively to identify such agency.

6.4.3 Balancing supply side innovation with prioritizing impact

This point refers to the origin of the systems of innovation frameworks, conceived for technological innovation in the supply side for the sake of economic growth and material welfare (Freeman 1987; Edquist 1997; Schot & Steinmueller 2018). In regards to new technologies or services, the market may not exist yet or may just be emerging (Bergek et al. 2008). This reflects a tendency to regard the market as a matter of diffusion, despite the fact that customer demand is often an important driver of innovation (cf. von Hippel 1988). For example, in papers IV and V, the entrepreneurial farmers of sweet potato, field vegetables and the producer organisation, were responding to customers' demands, as they got involved in knowledge and innovation efforts.

This illustrates the strong role of end users and customers as crucial drives of innovation in horticulture. The policy discourse on AKIS, hitherto focused mainly on research-centred innovations (Fieldsend et al. 2019), may need to acknowledge the strong influence of customers and end-users as crucial drivers of innovation. This lends emphasis to the responsibility of customers and consumers as drivers of societal change.

As illustrated in paper VI, the inclusion of relevant actors in agricultural research projects was perceived as a vital part of the process to create impact. The multi-actor approach of the research projects provided a sense of

relevance and significance, and emphasised mutual learning as a means to create impact with and through others.

These results imply that while system changes may happen through a "trickledown effect" from the policy level, it is also suggested that systemic changes in the Swedish horticultural sector is more related to the actors at the micro level start working towards it. Thus, system innovation in the horticultural knowledge and innovation system is dependent on individual actors at the micro level. While current policies may have an aim of achieving this already, this research provides reflections on the conditions and needs for change to occur at the micro level.

7. Conclusions and implications

This chapter concludes the contributions to research, outlines the implications for policy and practice, and ends with suggestions for future work.

7.1 Contributions to research

This thesis contributes to the unravelling of multi-actor collaborations for knowledge and innovation. It is placed mainly within the scientific literature stream of agricultural knowledge and innovation systems.

To the functioning of innovation intermediary organisations, the notion of a creative tension was introduced. This signifies how the different structures of an intermediary organisation, ranging from flexible to more fixed structures, enabled different social practices and processes. The creative tension between the spontaneous and the orderly is used by the actors to set new collaboration processes in motion and continue to evolve them according to their individual needs. This elaborates on the view of different kinds of support in various phases of innovation (cf. Faure et al. 2019), and adds to the view of an enabling environment for innovation (cf. Klerkx et al. 2012).

The notion of value-creating meetings (Frankelius & Vogel 2009) was deepened with regard to intermediary organisations and their role in strategic and practical matchmaking, especially across sectoral borders. The dialogue facilitation in such meetings was found to be not merely a question of linear matching of demand and supply but also an on-going learning and co-creation between the involved actors and the intermediary, nuancing the findings of Frankelius (2009) and Kilelu et al. (2014).

Dialogue skills and social learning were emphasised as central for a genuine meeting between actors to happen. In this context, the notion of co-agency was introduced, derived from the concept of collective agency (Pelenc et al. 2015; Fernandez-Wulff 2019). It denotes a set of shared ideas guiding the communication and decision-making between members, orienting and coordinating their actions in horticultural innovation. The forming of co-agency enabled horticultural firms to draw on a group of individuals with complementary skills and resources. In this context, the interplay between social processes and structures was detailed, as an underlying layer of the innovation process, adding to e.g. Labarthe et al. (2018).

The introduction of a new domestic crop enabled the study of the interplay between market actors and an emerging micro-level innovation system. The role of entrepreneurial individuals and their customers was emphasised. This complements the work of Fieldsend et al. (2019), suggesting that the policy discourse on AKIS, hitherto focused mainly on research-centred innovations, needs to acknowledge the strong force of customers and end-users as crucial drivers of innovation. It also suggests the responsibility of customers and consumers as drivers of societal change.

Studying the concept of inclusion in agricultural research projects, it was found that the social orientations as reflected by the respondent were i) acquaintance and the hard work of building relations, ii) uncertainty and risk-taking due to the nature of knowledge production close to practice, and iii) the potentials of achieving meaningful societal impacts. The three main ways in which the participants framed the importance of inclusion as beneficial and impactful were found to be framing and funding, complementing resources, and enabling future impact. These results deepen and nuance the relational and procedural aspects of multi-actor work in general (cf. Daniels and Walker 2001), and add to the work on impact assessment and evaluation practices as vital for making change happen (Douthwaite & Hoffecker 2017; Faure et al. 2018).

Taking a helicopter view of the knowledge and innovation system of Swedish horticulture, this study points to a need to balance a structural interpretation of the system with a process perspective (cf. Klerkx et al 2012; Labarthe et al. 2018). While the systems concept in itself brings a structural mode of explanation, the results of this research emphasise how people

perceive knowledge and innovation primarily as processes, and that certain processes are vital for the development of new knowledge and innovation. The leverage point approach in paper V provided insights into how seemingly insignificant processes can result in changes in social structures, which in turn constitute steppingstones in the process towards the desired outcomes. Likewise, the introduction of a practice-based approach to studying the daily work of an intermediary organisation in paper I untangled the relation between structures, practices and processes in this context.

These studies illustrate the dialectic and systemic relationship between structures and processes, where transformation is dependent on the ability to create new social structures and spaces for creative action. In this way, processes affect both their own future and their structural context. This research emphasises the processes of network facilitation and brokerage, dialogue skills and social learning, agency and co-agency, inclusion and impact orientation as central to the Swedish horticultural innovation system. It adds to and nuances recent scholarly findings regarding the functions of AKIS and agricultural innovation support services (cf. Kilelu et al. 2014; Faure et al. 2019; Proietti & Cristiano 2022).

Furthermore, this study emphasises a need to balance a systems view of AKIS while acknowledging the agency of dynamic individuals. While the historical view of innovation systems focused on abstractions such as roles and functions, the results of this research instead emphasise the importance of the agency of engaged and entrepreneurial individuals, and how such individuals can create change by working with and through others. It is suggested that the systems view could be balanced through the recognition of individual agency, connecting it with systems actors in forming co-agency in order to further the innovation process. This adds to the findings of Loeber et al. (2007) of the need to recognise the agency of dynamic individuals.

Finally, this research suggests that the ‘supply side innovation’ perspective in general (Freeman 1987; Edquist 1997) and for AKIS in particular (Klerkx et al. 2012) would gain from being balanced with societal impact prioritizing. The importance of horticultural customers and end-users as drivers of innovation was emphasised through, for example, illustrating the co-evolution of a micro-level market and innovation system in paper IV. The long-term collaborations in paper V were motivated by responses to customers’ demands. Paper VI illustrates how the inclusion of relevant actors in research and development efforts becomes a vital part of the process to

make change happen, as perceived by the participants. This adds to and nuances the findings of Douthwaite and Hoffecker (2017) and Faure et al. (2018).

In paper III, five skills were identified for professionals in the agricultural system for engaging in the transition towards sustainable agriculture (including horticulture). These were: systems perspective; lifelong learning; knowledge integration; building and maintaining networks and learning communities; and technical and subject-specific knowledge and technology. These findings reflect the responsibility of all individuals involved in the agri- and horticultural sectors to develop and make use of such skills, and not just be represented at a system level. This brings the attention to the role of micro level actors in creating societal impact.

In summary, the reflections emphasise the importance of how researchers, policymakers, and practitioners regard the system and its actors. Morgan (1986), Leeuwis (2004), and Klerkx et al. (2012) all argue that different systems perspectives are important. Underlying perspectives influence our expectations and goals of what is possible, and affect our beliefs around how this area of society ultimately works. Klerkx et al. (2012) suggest that the different systems perspectives should be systematically compared and debated again to formulate a common basis for a coherent perspective for understanding AKIS. The reflections above, of balancing a structural view of the AKIS with a process perspective, balancing a systems view with acknowledging dynamic individuals, and balancing supply side innovation view with prioritizing impact, are a contribution to such a debate.

7.2 Implications for policymaking and practice

The aim of the thesis was to investigate how the knowledge and innovation system of Swedish horticulture can be reinforced in order to meet current and future challenges. With background in the tension between the original motives of the system of innovation approach and the need to deliver on today's challenges as expressed by contemporary policies (section 1.1), it is a valid question. With the results of this thesis, the following reflections can be made in relation to policymaking and practice.

While structures are necessary and indispensable in innovation systems because, among other things, they carry rules and resources, the results of this research emphasise how people perceive knowledge and innovation

primarily as a process (cf. Sandberg et al. 2015). Giving preference to the processes of AKIS implies that the processes underlying innovation should be the focus of policy interventions, not necessarily the structural components. While existing structures, such as actors, networks and institutions, are important as a starting point, in an emerging or developing innovation system, the relevant structures may not exist yet or may just be forming (Bergek et al. 2008). The processes of network facilitation and brokerage, dialogue skills and social learning, agency and co-agency, inclusion and impact orientation have been identified as central to the Swedish horticultural innovation system.

Furthermore, this research has found that individual agency in combination with a network approach can act as a crucial driver of knowledge development and innovation in the horticultural knowledge and innovation system. This implies that policy interventions and innovation support actors could actively work to invite the agency of engaged and entrepreneurial individuals, including horticultural farmers and entrepreneurial individuals of all kinds of competences of relevance to horticultural knowledge and innovation. By promoting and facilitating social learning, horticultural firms and others can gain innovative strength through forming co-agency with key individuals to access competence and resources. Dialogue skills can be learned and used deliberately, for example, the three dimensions of learning between actors (relations, process, and substance), and how to foster genuine dialogues of 'thinking together' (Daniels & Walker 2001; Isaacs 1999).

The concept of "using the factory floor as the laboratory" (Freeman 1987:41) meant that experts and production engineers worked together on the factory floor to find solutions, often "raking in the suppliers" as well (ibid). This mode of working creates a shared agency around solving certain issues, which can be used as a resource for communication, goal setting and actions, and where the joint experimentation provided feedback on possible solutions. Whereas this was an example from a manufacturing industry, the horticultural sector could take as a model the innovative way of working that was started in the 1960s with the Horticultural Economic Survey (see section 2.3.). Through a close collaboration between researchers, advisors and growers, new knowledge was created for everyone, not least among the growers who had their production and economics analysed, enabling them to see how they could develop their operations. Another useful model was the

Idea and Project Workshop of the years 2008-2010 (see section 2.2.). It aimed to identify problems and either provide an answer or suggest an action plan around each issue. These models took their starting point at the everyday challenges of horticultural firms. By adding matching knowledge from the university and advisors, relevant solutions were developed with and for the firms. While the Horticultural Economic Survey focused on production management and profitability, the challenges from today's horticultural firms are of a broader spectrum, and an updated model may include a range of issues.

Furthermore, this thesis suggests that the horticultural knowledge and innovation system should give priority to the creation of societal impact. This is a call for applied research to plan for impact along the entire research process and include relevant actors in achieving long-term impact. This implies that the inclusion of relevant actors in ongoing learning and monitoring becomes a central part of the work itself in research and innovation efforts. In this way, policymakers could encourage the active learning of actors to be impactful with and through others.

Prioritizing societal impact also suggests that the policy discourse on AKIS, hitherto focused mainly on research-centred innovation, needs to pay more attention to customer and end-user driven innovation. This implies that policymakers and market actors need take the potential and responsibility of customers and end-users as driving forces of innovation, into account. It has been suggested to address the lack of space for dialogues and joint problem-solving between farmers' customers and innovation support actors (see paper IV).

This implies, in turn, that network facilitation and brokering must go beyond intermediary organisations and innovation support actors, and encourage cross-actor meeting and learning. For example, providing training opportunities in transdisciplinary approaches for students, teachers, researchers and professionals, such as experiential learning in formal education programs and life-long learning opportunities.

The literature review in paper III identified five skills for professionals in the agricultural system engaging in the transition toward sustainable agriculture (including horticulture): i) systems perspective, ii) lifelong learning, iii) knowledge integration, iv) building and maintaining networks and learning communities, and v) technical and subject-specific knowledge and technology. These findings reflect the responsibility of all individuals

involved within the agri- and horticultural sectors to develop and make use of such skills. These skills are not just to be represented at a system level, everyone involved at all levels can develop these skills in relation to their own every-day practices for change to occur. This is something for universities and other actors to consider in relation to formal education and lifelong learning.

This thesis highlights how change in the everyday work at the micro-level is a precondition for system level change. There is no single Alexander's sword thrust to reinforce the knowledge and innovation system of Swedish horticulture, rather, it is the many small actions at the micro-level that will improve the ability to meet current and future challenges, and contribute to societal impact and change.

The concept of AKIS is primarily an analytical construct, it is not automatically or inherently a tool for system change. If the phenomenon of AKIS, i.e., a focal system such as the horticultural knowledge and innovation system, is to be developed in some direction, it needs not only the concept of AKIS as a theoretical model, but a framework for working with that change. The reflections in this thesis are a contribution towards such a framework of change.

7.3 Future work

This work has identified several concepts and methods that are worth further investigations, both on a general and detailed level.

On the general level, the three concluding reflections on the results in relation to the aim in section 6.4 were: i) balancing structure with process, ii) balancing a systems view with acknowledging dynamic individuals, and iii) balancing supply side innovation with prioritizing impact. Such views colour interpretations and expectations, and therefore deserve further scholarly attention and hands-on investigation by researchers, policymakers and practitioners. For example, as noted in section 4.6.3, an action research and participatory approach could be used to invite relevant actors to further concretize how to strengthen the central innovation processes, actively invite entrepreneurial individuals, and prioritize impact of the horticultural knowledge and innovation system.

On a detailed level, the first empirical study (see figure 4) builds on three intermediary organisations. As there is a set of variegated actors providing

innovation support services, the dynamics of service provision in such a set of actors could be a relevant avenue for future investigations.

The second empirical study, of multi-actor collaborations, revealed how small firms can gain innovative strength by, for example, sharing their agency with key individuals through dialogue skills and social learning processes. As there are risks associated with such processes, it might be worthwhile investigating their place as drivers or disablers of innovation in further detail. More empirical case studies would enable a greater understanding of patterns and be able to provide guidance in this part of the innovation process.

The third empirical study included four existing research projects at the university campus, which were followed for more than two years, starting in early 2020. It would be valuable to follow such projects for another two years in order to follow up on at least some of the actual impacts and provide the opportunity to study long-term impact at the systemic level.

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Popular science summary

The total consumption of vegetables, fruits and berries in Sweden has doubled over the last 20 years. While the import of fruits and vegetables has increased rapidly, so has the consumer interest in locally produced foods. This creates potential for Swedish growers, and the Swedish horticultural sector is currently in a growth trend. At the same time, the applied research and advisory services for horticultural farmers has been severely cut back since the deregulations in the 1990s, and the sector is facing several challenges related to economic, environmental, and social sustainability. Hence, the aim of this thesis is to investigate how the knowledge and innovation system in Swedish horticulture can be reinforced to meet current and future challenges. The research questions focus on how peoples' networks, joint learning and the creation of impact can contribute to a reinforced knowledge and innovation system.

The terms innovation systems, and specifically agricultural knowledge and innovation systems (AKIS), are used to describe a network of actors developing and using new knowledge and innovation. The research methods include several case studies, investigated through database studies, document studies, interviews, participatory observation and focus group interviews. The thesis is made up of three empirical studies, presented in six papers.

The first empirical study focused on intermediary organisations. The intermediary organisations worked with strategic and practical match-making. The results illustrate how they arranged so-called value-creating meetings across sectoral borders, and the way in which actors use the 'creative tension' between the spontaneous and more orderly structures within an innovation intermediary organisation to set their collaboration processes in motion and continue to evolve them.

In the second empirical study, a literature review identified five skills needed for professionals working towards sustainable agriculture and horticulture, among those cooperation and learning. Case studies showed how horticultural firms used cooperation and joint learning to access the competencies and resources of others, such as researchers and advisers. Furthermore, a case study of the introduction of a new crop illustrated the role of farmers, their customers, and innovation support actors in the formation of the market sales and the emerging micro-level innovation system.

The third empirical study investigated how actors were included in agri- and horticultural research projects. It showed the social orientations of inclusion, and that the inclusion of actors was regarded as helping to define the research aims, find funding, provide complementing resources, and enable future impact.

In summary, the results showed that the processes of network brokering, dialogue, co-agency and inclusion were central for the knowledge and innovation system in Swedish horticulture. The findings point to a need to strengthen the central processes of innovation, actively invite entrepreneurial individuals, and prioritize impact of the horticultural knowledge and innovation system. These results are a contribution to the debate around different systems perspectives of the AKIS.

It is suggested that the earlier initiatives of the Horticultural Economic Survey and the Idea and Project Workshop could be used as inspirational models to reinforce the knowledge and innovation system in Swedish horticulture. These models took their starting point in the everyday challenges of horticultural firms, matching with research and advisory knowledge, to develop relevant solutions with and for the firms.

The results highlight how changes in the everyday work at the micro-level are a precondition for system level change, and how actions at the micro-level bears the potential to improve the ability to meet current and future challenges, and contribute to societal impact and change.

Populärvetenskaplig sammanfattning

Den totala konsumtionen av grönsaker, frukt och bär i Sverige har fördubblats under de senaste 20 åren. Importen av frukt och grönsaker har ökat snabbt, men det har även konsumentintresset för närproducerade livsmedel. Detta skapar möjligheter för svenska odlare och den svenska trädgårdssektorn befinner sig just nu i en tillväxttrend. Samtidigt har den tillämpade forskningen och rådgivningen för trädgårdsföretag dragits ned kraftigt sedan avregleringen på 1990-talet, och sektorn står inför flera utmaningar relaterade till ekonomisk, miljömässig och social hållbarhet. Därför är syftet med denna avhandling att undersöka hur kunskaps- och innovationssystemet inom svensk trädgårdsodling kan stärkas för att möta nuvarande och framtida utmaningar. Forskningsfrågorna fokuserar på hur människors nätverk, gemensamt lärande och fokus på att skapa nytta kan bidra till ett förstärkt kunskaps- och innovationssystem.

Begreppen innovationssystem, och specifikt agrara kunskaps- och innovationssystem (AKIS), används för att beskriva ett nätverk av aktörer som utvecklar och använder ny kunskap och innovation. Forskningsmetoderna omfattar flera fallstudier, undersökta genom databasstudier, dokumentstudier, intervjuer, deltagande observation och fokusgruppsintervjuer. Avhandlingen bygger på tre empiriska studier, presenterade i sex uppsatser.

Den första empiriska studien fokuserade på så kallade samverkansplattformar. Dessa arbetade med strategisk och praktisk match-making mellan aktörer. Resultaten illustrerar hur de arrangerar ”värdeskapande möten”, framför allt över branschgränserna, samt hur aktörer använder den ”kreativa spänningen” mellan de spontana och mer ordnade strukturerna inom en samverkansplattform för att sätta igång sina samarbetsprocesser och fortsätta att utveckla dem.

I den andra empiriska studien identifierade en litteraturöversikt fem färdigheter som behövs i arbetet mot ett hållbart jordbruk och trädgårdsföretagande, bland dem samarbete och lärande. Fallstudier visade hur trädgårdsföretag använde samarbete och gemensamt lärande för att få tillgång till andras kompetens och resurser, såsom forskare och rådgivare. Dessutom illustrerade en fallstudie av en marknadsintroduktion av en ny gröda vilka roller odlare, deras kunder och innovationsstödjande aktörer spelade i det framväxande innovationssystemet.

Den tredje empiriska studien undersökte hur aktörer inkluderades i tillämpade forskningsprojekt och hur deltagarna såg på inkludering som fördelaktig eller effektfull. Den visade de sociala aspekterna av inkludering, samt att inkludering av aktörer ansågs hjälpa till att definiera forskningsmålen, hitta finansiering, tillhandahålla kompletterande resurser och möjliggöra framtida effekter.

Sammanfattningsvis visade resultaten att några specifika processer; nätverkande, dialog och gemensamt lärande, samt inkludering av aktörer i gemensam problemformulering och skapande av nytta, var centrala för kunskaps- och innovationssystemet inom svensk trädgårdsnäring. Resultaten pekar på behovet av att stärka de centrala innovationsprocesserna, aktivt bjuda in entreprenöriella individer, samt prioritera nytta i trädgårdsnäringens kunskaps- och innovationssystem. Dessa resultat är ett bidrag till debatten om olika systemperspektiv inom AKIS.

De tidigare initiativen ’Trädgårdsekonomiska utredningen’ och ’Idé- och projektverkstaden’ föreslås kunna användas som inspirationsmodeller för att stärka kunskaps- och innovationssystemet inom svensk trädgårdsnäring. Dessa modeller tog sin utgångspunkt i trädgårdsföretagens vardagliga utmaningar, matchade med forskning och rådgivning, för att utveckla relevanta lösningar med och för företagen.

Dessa resultat belyser hur förändringar i det vardagliga arbetet på mikronivå är en förutsättning för förändringar på systemnivå, och hur åtgärder på mikronivå har potentialen att förbättra förmågan att möta nuvarande och framtida utmaningar, samt bidra till samhällsnytta och förändring.

Acknowledgements

First of all, I would like to thank the study participants. This study could not have been carried out without you. Thank you for sharing your views, opinions and insights generously and thoroughly. The interviews and meetings with you were the best part of doing this thesis. I wish you all the best for the future and I hope we meet again soon.

Next, I would like to thank Kristina Santén, head of the Unit for Collaboration and Development (SoU), and Christina Lunner Kolstrup, former head of the Department of People and Society (IMS). Without your firm support, this thesis journey would not even have started.

By offering to be main supervisor, Lena Ekelund Axelson, you were brave enough to dive into this with me, and for that, I will be ever grateful. I am also deeply indebted to my co-supervisors. Magnus Ljung, you guided me through the lively waters of multi-actor collaboration, always anchoring me in the practical issues, thank you for sharing your wealth of insights. Charlotte Norrman, the energy you have shared is contagious, thank you for the good advice and fresh perspectives. Martin Melin, thank you for introducing me to the international consortium of the NextFood project and being part of that process. Lastly, as Lena became professor emeritus in the last year of this study, Håkan Jönsson stepped into the role of new main supervisor. Your new eyes on the material enabled a fresh start at the narrative writing, and you have made important contributions to the shaping of the final product – thank you.

A special thanks to the co-authors of papers, for inspiring cooperation and discussions. Sören Augustinsson, Alina Lidén, Per Frankelius, Laura Brandt Sørensen, Stine Rosenlund Hansen, Claudia Rojas, Niels Heine Kristensen and Ivanche Dimitrievski (in order of appended papers), it has been very rewarding to work with you all.

I would like to extend my gratitude to Thomas Magnusson and Rebecka Milestad for insightful observations and comments on earlier drafts of this dissertation in the half-time and final seminars. It has been invaluable to get your experienced views on the on-going work.

I am also thankful to the many scholarly friends and colleagues at the department and other places, for insightful conversations and exchanges on a range of topics related to the dissertation. Many thanks should also go to the librarians at the SLU Library for helping me with my questions.

A very special thanks to the funders of this study, Sparbanken Skåne/Sparbanksstiftelsen, SLU Partnership Alnarp, SLU RådNu, the Royal Swedish Agricultural Academy, the NextFood project of the Horizon 2020 program, SoU and IMS. Without your support, the study would not have been possible.

A heartfelt thank you to my family, my family-in-law, my friends and neighbours for illuminating life outside of work, and for celebrating this journey with me. Finally, my deepest gratitude to Per, Nils and Carl, who have encouraged and supported me throughout this journey, especially at challenging times - I love you.

Lisa Blix Germundsson, Alnarp, February 2023.

Appendix

I

sustainability

MDPI

Article

Collaboration in the Making—Towards a Practice-Based Approach to University Innovation Intermediary Organisations

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Received: 28 April 2020; Accepted: 18 June 2020; Published: 24 June 2020

Abstract: The study aims to understand and explore situations of collaboration between various actors in connection with a university-driven innovation intermediary organisation, and how the intermediary organisation facilitates collaboration in the making. To this end, we employ a case of a university-driven long-lasting intermediary organisation within the agricultural and forestry sectors. We examine three collaborative situations, using practice-based research and process theories as theoretical perspectives. A narrative approach is adopted as the method of investigation. The findings are presented in a conceptual model where the structures of the intermediary organisation are translated into practices, against which individuals can develop their collaboration processes. It is concluded that collaboration in the making is formed in the interplay between structures, practices and processes in relations between people. This implies that the organising of collaboration should focus its attention not only on structures but also on the practices and processes formed between people. The study contributes to the understanding of the organising of university innovation intermediary organisations by untangling the relations between structures, practices and processes in situations of collaboration between people.

Keywords: agricultural innovation systems; university industry collaboration; interactive innovation; intermediation; sustainability transitions; transdisciplinarity; multi-stakeholder processes; learning; open innovation

1. Introduction

The study aims to understand and explore collaborative situations involving various actors in connection with a university-driven innovation intermediary organisation and how the intermediary organisation facilitates collaboration in the making.

1.1. Univeristy Innovation Intermediary Organisations

In the current era of climate change and pressing global sustainability challenges, university collaboration with industry and societal actors could significantly contribute to the necessary transition to a more sustainable society [1]. Collaboration between universities and industry has increased dramatically in recent decades [2,3], along with an increase in the number of various intermediary

organisations [4,5]. New and better ways to collaborate and share knowledge, as well as best practices, are crucial for keeping agriculture and food production competitive, ecologically viable and socially equitable [6,7].

University–industry collaboration has been conceptualised as a higher-level process that encompasses cooperation, teamwork and coordination [8,9]. The literature on university–industry collaboration has largely focused on how interaction is carried out by identifying categories of links or on who interacts and why, cf. [10]. Actors from different domains are motivated to enter into collaboration by, for example, new knowledge, inspiration, new methods and the expectation of or need for innovative solutions [11]. Traditionally, collaboration between universities and industry has been discussed in terms of partnerships, where the business practitioner initiates the collaboration with a researcher by proposing a research problem that requires an innovative solution and new knowledge [9]. The literature addressing these types of collaborations often focuses on dyadic partnership, grounded in a problem to be solved and generally terminated when the problem is solved [12].

However, in the last decade, collaboration has started to emerge in other forms as different types of university–industry intermediaries have been investigated (e.g., [13]) as well as the role of intermediaries as facilitators [14]. Such examples are arenas or platforms for collaboration, often initiated by the university, and with numerous members (such as the case study of this paper). Such arenas or platforms are initiated based on an assumed reciprocal commitment, rather than concrete projects. The aim of the arena is often formulated by the initiator, i.e., the university, and the members commit themselves to hoped-for potential value or a hoped-for potential concrete partnership.

The focus of this paper is collaboration within a university-driven innovation intermediary organisation in the agricultural and forestry sectors. An innovation intermediary is defined as "an organisation or body that acts as agent or broker in any aspect of the innovation process between two or more parties" [4] (p. 721). An increasing body of literature, not least in agricultural research, is raising the importance of innovation intermediary organisations as important drivers for innovation and change towards more sustainable socio-technical systems [4,5,15]. Innovation intermediaries are assumed to perform a relatively large variety of activities; for example, information and knowledge processing and combination/recombination, gatekeeping and brokering, commercialisation, evaluation and outcome monitoring [4,5]. In agriculture, the main functions are demand articulation, network brokerage and innovation process management [15].

This implies that innovation intermediaries are seen not only as mere facilitators of innovation but also as a source and carrier of innovation [15,16]. Recently, a multi-faceted view of the interaction of innovation intermediaries in collaborative projects has been suggested: "more complex, enriched and involved roles as they/ . . . /engage in co-creative innovative activity with collaborators, in a process of wider co-creation and co-development" [17] (p. 70). This brings the attention to the micro-level of collaboration, which is less well investigated and understood [2,9,16,18]. Hence, the analysis must be performed in specific situations, times and contexts. This enables actions and interactions between individuals to be studied, as well as the implications for the shaping of intermediary organisations.

1.2. The Micro-Level of Collaboration

The interest in the micro-level perspective has also recently been highlighted in the literature streams of university knowledge transfer and exchange [2,18,19]. Nevertheless, the understanding of the micro-level processes of collaboration between universities and other actors is still in its infancy [2]. The research on university collaborations frequently takes a macro-structure perspective, such as through the triple and quadruple helix models [19]. However, these models and system-level perspectives fail to address the social processes in the making [18,20], i.e., the "processes of forming, developing and coordinating UI [university–industry] collaboration" [10] (p. 159). Collaboration studies that take a system perspective have the system as the primary concern, and micro-processes between humans become secondary [21]. Within the structural perspectives, people are assumed to be rational and goal-seeking beings [22]. According to Patriotta [23], the structure is often seen as an effect of rational

individuals, and it is added that "This 'alienation' of theory from practice underscores the need to engage with the study of processes, streams, flows, and flux" [23] (p. 9).

If we instead see collaboration as knowledge creation processes, it includes the ability to interpret and make sense of conversations and interactions with others, at a specific time and in a specific context. This process of working together at the micro-level is recognised to be rather poorly understood, i.e., [24]. With the help of narratives, the analysis can be taken down to specific situations, times and contexts—actors and interactions between individuals—that at the same time lets us understand the relation to the structure of the intermediary organisation.

In this study, we argue that to understand and explain the collaboration between actors, the analysis needs to take its starting point as what happens in specific situations. A practice-based approach enables the exploration of the building blocks of the collaboration process, such as actions, situations and relationships [25]. By adopting a practice-based and process approach in exploring the challenges of collaboration between academia and industry, attention is re-directed from structure and the systemic settings to the concrete activities of collaboration, what people do and the practices they perform. Furthermore, it sees the individual action as always embedded within a network of social practices [26] and processes in relations between people [21]. However, there are a limited number of scientific contributions with a practice-based perspective of collaboration [20].

1.3. Aim of this Study

Hence, this study aims to understand and explore situations of collaboration between various actors in connection with a university-driven innovation intermediary organisation, and how the intermediary organisation facilitates collaboration in the making. We do this by taking the actions of people in specific situations as the starting point for the analysis. More concretely, we address the two following research questions:

(1) How can we understand and explore collaboration in the making within the intermediary organization?
(2) How does the intermediary organisation facilitate collaboration in the making?

The empirical backdrop of the study is a university-driven innovation intermediary organisation within the agricultural and forestry sectors. Started in 2004, the intermediary organisation currently has around 90 partner organisations, ranging from small firms and producer organisations with numerous members to large businesses, along with local, regional and national authorities. We examine three collaborative situations, and a narrative approach is adopted as the method of investigation. The intermediary organisation involves both industry and societal stakeholders and focuses on creating meeting places [27], and seed-funding new collaborative research and development (R&D) initiatives and student projects.

The remainder of this paper is structured as follows: the next section outlines the theoretical background to practice-based approach and process theories, the methodology is detailed in Section 3, narratives are presented in Section 4, and Section 5 contains analysis and discussion, followed by conclusions in Section 6.

2. Frame of Reference

This section outlines the frame of reference of this study—practice-based approaches and process theories. These two perspectives are not entirely separate but melt into each other with a focus on what happens in practice [28]. However, below, they are presented separately for clarity. In both perspectives, the questions are how, what and why do things happen.

2.1. Practice-Based Approach

In order to understand collaborative situations in intermediary organisations, we start from the practice-oriented turn within organisational and collaboration research [29], the core of which consists of participants' practice and what is actually done [30]. For the purpose of this study, we focus on the

relationship between structure and practice mutually created. In this way, we keep a focus both on what people do and the social and formal structures where collaboration takes place.

In the previous century, works by writers such as Heidegger, Wittgenstein and even Aristotle were influential in forming the background to practice-based research [31]. Representatives of practice theories [32] emphasise that there is no single uniform practice theory but rather a practice turn in social and organisational studies. The core of the plurality of practice theories is that it puts recurrent activities, interactions and practices in focus and uses this as the unit of analysis. Practice-based research takes a starting point where seemingly mundane activities play the lead role [33]. Practice-based researchers see the world as a seamless assemblage of practices in continuous relation to each other. The queries of what, how and why are the theoretical questions that permeate practice theories [31].

Practice-based research states that social structures only exist as long as practices are performed that keep them in place. This highlights the two-way relationship between practices and structures, and the fact that social structures are temporal and can be torn down or changed if they are no longer supported by practices. As the aspects of power, politics and conflict are always present, practices are constantly open to contestation, and this keeps them continuously in a state of tension and flux [31,32]. Organisations, as formal structures, are part of this perspective. Organisations are governed by formal structures that organise what people are doing [34]. Therefore, one way to approach collaboration is through maps of structures. This perspective can be applied to the intermediary organisation focused on by this study.

Practice is described as routinised activities and postures, as in the roles we play in certain contexts, e.g., the teacher–student relationship. Thus, the human is a carrier and performer of social practices. However, in doing so, there is normally space for initiative, creativity, individual performance and adaption [31]. This is where new processes and collaborations between people can start.

However, as Chia and Holt [22] note, a challenge in practice-based research is avoiding ending up with mere descriptions of organisational practices but rather, following Schatzki et al. [32], seeing knowledge and meaning residing in a nexus of practices. The affordance of a practice-based approach is not only that it describes the world in terms of what is being done and redone but that these practices shape the meaning given to activities and contribute to the formation of the identity of the people involved [22,35]. Nicolini [31] (p. 7) notes that "Practices are, in fact, meaning-making, identity forming, and order-producing activities.".

2.2. Process Theories

In our view, collaboration in the making has a focus on what is done, how and why. The practice-based approach addresses collaboration as a system that limits the individual but acknowledges that the system can be formed and re-formed by the individuals [32]. Process theories, on the other hand, focus on the interplay between individuals and formal and social structures. Process theories understand the world as " ... in flux, in perpetual motion, as continually in the process of becoming." [36] (p. 1). Order is emergent, hence spontaneous, without intention or control, but through individuals interacting with each other [21].

While a practice-based approach has the individual action, situation, material conditions and, in some way, systems as a starting point, it does not take adequate account of processes. Therefore, we combine the practice-based approach with process theories [36,37]. Supplementing the concept of practice with the concept of process allows for "structures" to take various shapes, ranging from firmer to looser. Hence, it allows for the better interpretation and understanding of contexts that are differently structured and organized. Thus, we shift the focus towards actions and relations between people within the frame of various structures. Consequently, we reduce and move beyond the criticism of Stacey and Mowles [21], that Nicolini [31] has an overly dominant view of structures, systems and individuals. Practice-based research, together with process theories, offers a tool that helps us focus on collaboration in the making. The processes of interaction between people can be generalised, but the results of these processes are unique and cannot be predicted beforehand [21].

When applying structural and cognitive perspectives, there is an adherent risk that people are assumed to be rational and goal-seeking beings [22]. The structure is often seen as an effect of rational individuals, and this view contributes to an alienation of theory from practice [23]. This underscores the need to focus on processes and what is happening [23].

Starting the process turn in organisational studies, Weick [38] argues that social scientists should focus on actions and processes instead of entities like organisations, roles and hierarchies. Thus, we should use verbs more frequently instead of nouns, such as in "organising" rather than "organisation". Weick [38] even argues that we should "stamp out the nouns" (p. 44) and replace them with verbs. He describes process as the interaction between actions and meaning-making, and refers to this as sense-making [39]. He continues: "The language of sensemaking captures the realities of agency, flow, equivocality, transience, reaccomplishment, unfolding, and emergence, realities that are often obscured by the language of variables, nouns, quantities, and structures" [40] (p. 410).

In this study, we take the issue of nouns and verbs one step further and see the need to deal with both at the same time. As noun-making is necessary for human sense-making, we are incapable of thinking purely in terms of processes [41]. Hence, noun-making is an indispensable ingredient for coming to grips with processes [41]. Czarniawska [42] sees the current focus on nouns in models of organisational change as a reminder of the influence of natural sciences on social science. She argues that social sciences missed the point of the models in natural sciences; it is not only about filling the boxes of the models with nouns but also about finding the verbs to make the model meaningful.

In summary, processes of collaboration can be seen as a continuous motion between interacting people and structures. In a collaboration situation, there is a dialectic reciprocal relationship between structures on the one hand, and practices and processes on the other. It includes knowledge creation processes in relations between people, in a specific context and time period.

3. Case and Method

This section presents the case study of an intermediary organisation and outlines the methods in which a narrative approach is adopted to understand and explain collaboration between various actors.

3.1. Case

The studied case is an intermediary organisation, SLU Partnership Alnarp, started in 2004 as a collaborative platform at the Swedish University of Agricultural Sciences. Today, the intermediary organisation has around 90 partner organisations, ranging from small firms and producer organisations with numerous members to large businesses and local, regional and national authorities. The intermediary organisation consists of a board, a working committee with an operating manager, and six subject groups [43]. The activities are R&D projects, funded together by both university and partner organisations; meeting places such as seminars, workshops and field excursions; and student projects and a mentorship program, along with regular meetings of the board, working committee and subject groups. Researchers at the university can apply for R&D funding from the intermediary organisation, provided that the applications include 50% funding from partner organisations. The applications are first discussed in the relevant subject group and then decided upon by the board. The working committee, which meets every month, decides on funding for meeting places and student projects [43].

Thus, the model of the intermediary organisation facilitates the meeting between the university, authorities, industry and civil society to discuss current issues, and offers tools for starting to deal with them. The intermediary organization involves both industry and societal stakeholders and focuses on creating meeting places [27] and seed-funding new collaborative R&D initiatives and student projects. It views everyone's knowledge as legitimate, allows for multiple value propositions, and stimulates the co-creation of new ways forward [27].

As this is a single case study, our aim is not to generalize but rather to explore certain aspects that can enrich our understanding of this specific phenomenon.

3.2. Method

This is a qualitative single case study. The first author of this article was the operating manager of the intermediary organisation from 2013 to 2018, while the two other authors evaluated the organisation in 2018–2019. Thus, we used a dialogue between the "insider" (first author) and "outsiders" (second and third authors) to understand processes in an organisation [44]. The two outsiders gained empirical understanding through the evaluation. The analysis begins in a thick description of the intermediary organisation as detailed interpretations of collaboration in the making. Nicolini [45] argues for a combination of zooming in on and zooming out from the immediate operation and the empirical material. In summary, the method used in this study can be described as a dialogue between practice and theory, between an insider and outsiders, and zooming in and zooming out. The interpretive dialogue has the advantage of providing insights into more in-depth details of the backstage, experience-oriented knowledge that goes beyond interviews [46]. The discussions between the three authors through critical questions resulted in new insights, challenging the theoretical and methodological framework.

As the aim of this study was to understand and explore situations of collaboration between various actors, the question we posed to our empirical material was "how can we interpret and understand collaboration processes in the empirical material, viewed through the theoretical lenses of practice-based approach and process theories?". According to Kärreman and Alvesson [47] (p. 59), " . . . some situations in organisations may be seen as the organisation 'written small' and the close and detailed interpretation of these may, if combined with sufficient background and context knowledge, open up a window for a broader understanding of organisations." Hence, we adopted a narrative approach and identified three narratives to illustrate the empirical material.

A narrative approach is in line with practice-based and process research, where the focus is also on aspects like heterogeneity and unpredictable events that may shine forth [48,49]. Narratives provide the opportunity to describe some aspects of life as it is [50]. The narrative approach also connects to process theories where processes can be generalized, while the results are seen as local and specific [21].

Since we cannot recount the results of numerous long narratives, we use small narratives, what Boje [51] calls ante-narratives or micro-stories. Such stories "are told without the proper plot sequence and mediated coherence preferred in narrative theory" [51] (p. 3). Boje further writes "the micro-stories want to think, feel and see the world the way it was seen in that time and place" and "to see the world through the eyes and mind-set of the Other" [51] (p. 48).

Being aware of the bias risk, we used several observations to support any claims and tried to use different interpretative lenses throughout the study [52]. We recognise the role of the researcher as shaped by previous experiences, by the social and cultural environment to which he or she belongs, not only theoretical points of view [52]. Thus, we acknowledge the risk of different interpretations depending on individual experiences and backgrounds. Therefore, we were careful in interviews to constantly ask questions like "What do/did you think? Can you develop? Are there other similar situations?".

In short, we present three narratives, like interviews, to represent the extensive empirical material. It should be noted that while it has not been possible to explore all the practices of the intermediary organisation, the narratives should be regarded as illustrative cases for the analysis of collaboration in the making.

4. The Case Study

This section contains three collaborative situations in the form of narratives. These narratives are examples illustrating the empirical material.

4.1. Narrative (1): A Board Meeting—Strategy Discussion

The board of the intermediary organisation consists of the chairpersons of the subject groups, coming from non-university actors, and the two deans of the two faculties involved [43]. The board

makes decisions on grants for R&D projects and handles strategic issues for the intermediary organisation. The board mostly consists of long-term members, which ensures continuity and stability.

A part of the board meeting is spent on the board members' reports from their perspective and sense of what is going on in their wider context that could be of relevance to the operations of the intermediary organisation. Examples of the issues discussed were trends in the industry and sectors, the financing of applied research, concerns of keeping and building applied research competence, policies affecting the industries and the university, education, and the need for skilled labour at every level of the industry. Christine (we use fictive names throughout the paper) is one of the board members, and Lars is one of the deans.

Christine: "Right from the start, I was very impressed with the competencies that existed in the group. They were genuinely interested in the intermediary organisation as a phenomenon. And there was a genuine driving force that this would be something good. Every time, new thoughts and ideas came up on how this could be improved and changed. And everyone did not agree from the start. The atmosphere in the group was that everyone spoke their mind, which made things happen. Perhaps we didn't follow through on some of the strategic discussions quite like we could have. Then, of course, the project discussions took a pretty big part of the meetings, but that was quite OK; we wanted many applications. On some occasions, different external events put our industries in more or less difficult situations. Then the reasoning in the group was how to handle it and support each other.".

Lars: "The board meetings have a very important function in getting perspectives from different parts of the sectors, what is going on and what is around the corner. Then there is the legitimacy; it confirms the commitment of the involved actors, and that the operations are effective and efficient. The board has a quality assurance function in that we ensure that the granted projects are relevant and of good quality. And most importantly, future issues and development of the intermediary organisation at a strategic level are discussed. How can such a tool keep up, adapt and develop continuously? There is a wide range of important functions to the board.".

4.2. Narrative (2): A Subject Group Meeting—Aphids in Root Crops

The intermediary organisation has six subject groups, e.g., animal husbandry, horticulture, and agricultural crop production [43]. The partner organisations are members of these groups according to their interests. The subject groups meet twice a year to discuss the current situation within their field of interest and any activities needed. They also read and discuss the applications for R&D funding coming in to the intermediary organisation. When Victoria, working for the root crop industry, attended the meeting of the crop production subject group, she read a project application from university researcher Felipe about aphids in grains and apples.

Victoria: "I read Felipe's application to the subject group, about new methods against aphids in grains and apples, and thought we should try this in our root crops. One of my co-workers is sometimes at the department, so with his help, a meeting with Felipe was arranged. Felipe presented his research, and I presented what we do in root crops. Together, we worked out a simple field trial plan. It has worked out great; Felipe has the knowledge and methods for academic work. If it had not been for the intermediary organisation, we would have never met.".

Felipe: "For me, it started when a guy I know from the department said to me, "you should talk to Victoria, I think you could do some interesting things together". So, we met, and we found each other on the same page, since she works for growers and I like to work with growers as well. The next step was to do a pilot field trial, just a small one, but the results were interesting, and we will be continuing.".

Further dialogue between the involved organisations followed, where both had an interest in developing these issues further. New plans were made, and additional resources applied for from the intermediary organisation and elsewhere.

4.3. Narrative (3): A Seminar—Soil Carbon Storage by Subsidiary Crops

The intermediary organisation arranges a large number of seminars, workshops and excursions every year. These events are vital meeting places for academia, industry, and society, and they provide opportunities to discuss and deliberate on current topics across organisational borders [43].

There has been an increasing interest in subsidiary crops over the last few years in both agricultural and horticultural crop rotations, for reasons such as nutrient retention, soil conservation and biodiversity. The university has had a few applied research projects about this, some of which were partly financed by the intermediary organisation and its partners. The research projects have been presented at yearly seminars and field excursions, organised by the researchers and the intermediary organisation. At these events, farmers, advisors, the agri-business industry and authorities have presented their views and reflections on subsidiary crops. Niels is one of the researchers working with the projects on subsidiary crops and has met Sophie, who is as an expert advisor at a national authority.

Niels: "The seminars and field excursions are valuable as they open up new perspectives on things you realise you have to keep track of, and perhaps include for the future. You get to hear what kind of questions the farmers have, and the advisors. The authorities for instance, are interested in soil carbon, which is the area of my own research. After making contact at these seminars, I have been invited to meetings about developing tools for evaluating the contribution of subsidiary crops to soil carbon storage. Now we are working on a project funded by the authorities, on the impact of the time of establishment of the subsidiary crop.".

Sophie: "For those of us who are located here, it is great to be close to the university, as there are Niels and his colleagues, so we can benefit from each other. I have met Niels at various workshops and seminars. My contacts with Niels and his colleagues are certainly part of a general knowledge build-up on subsidiary crops for, for example, biogas, reducing nitrogen loss, and soil carbon storage. Our collaboration might not be super organised, but it feels like we benefit from each other.".

5. Analysis and Discussion

This study aims to understand and explore situations of collaboration between various actors in connection with a university-driven innovation intermediary organisation, and how the intermediary organisation facilitates collaboration in the making. With the help of the narratives above, the analysis is taken down to specific situations of interactions between individuals in time and context, that at the same time lets us understand the relation to the structure of the intermediary organisation. It is shown how the actors in the three narratives use structures for their sensemaking, identity-forming and order-producing, in a reciprocal dance between structure, practices and processes.

5.1. Structures

To start, the intermediary organisation can be described as different structures. The structures constitute a map [34], a sort of context in which to understand the collaboration in the three narratives. The three narratives each represent different structures of the intermediary organisation, from a board meeting with a fixed structure, to a seminar with a loose structure (see Section 3.1). Therefore, the structures within the intermediary organisation can be depicted along a continuum from fixed to fluid.

Furthermore, the narratives illustrate how the structures of the intermediary organisation constitute arenas for practices, where people meet and engage in a board meeting, subject group meeting or a seminar. These practices, in turn, present possibilities for processes to take place in relations between people. Thus, the different structures of the intermediary organisation give shape to varying practices, which in turn allow for multiple ways of action and performance by people. An attempt to graphically illustrate the dynamics between the varying structures, practices and processes is made in Figure 1.

The top left side of Figure 1 are shown the fixed structures of the procedures of the board and working committee. While the fixed structures contribute to the frame of the meetings, they do not determine the content. A firm structure implies a tighter interpretational frame, influencing the practices

and processes that are formed between people. The board, which consists of mainly long-term members, makes formal decisions on the funding of R&D projects in a tradition since 2004, ensuring continuity and stability. These meetings have a similar agenda each time, and participants know, fairly well, what to expect of it and what is expected of them. This allows for continuity but, most importantly, makes commitment and action possible. Primarily, the commitment is made to the structure and not necessarily to the participants in the meeting. However, with time [37], trust and commitment between the participants start to grow, as in the narrative in Section 4.1.

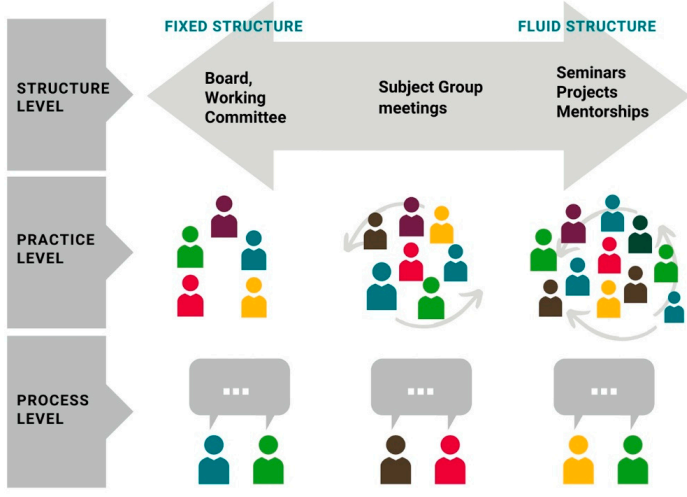

Figure 1. Model of structures, practices and processes of the university intermediary organisation. The structures range on a continuum from fixed to more fluid structures. The top left side of the figure shows the fixed structures, i.e., procedures of the board and working committee. The top right side of the figure shows fluid structures, such as seminars and projects, where informal elements, unexpected meetings and conversations, can be more apparent. The different structures enable various kinds of practices for people to engage in, which in turn allows for processes between people. The arrows in the practice level indicate that the participants and group size can vary. On the process level, only two persons are depicted for graphical reasons; there can naturally be multiple relations and persons.

The top right side of Figure 1 shows the fluid structures, such as seminars, workshops, excursions, R&D projects and student projects and a mentorship programme. Meeting places, such as seminars, can be organised flexibly by decisions in the monthly working committee and thus respond to upcoming needs of, for example, industry or academia. A looser structure implies a more flexible interpretational frame, which allows for a larger span of spontaneity, creativity and unexpected acts in the processes between people, which can alter the practice and the structure at hand, in sometimes-unpredictable ways [39]. The participants in these activities can vary between different occasions.

The subject group meetings take an intermediary position along the fixed–fluid continuum in Figure 1, as they have both fixed and fluid items on the agenda, e.g., reviewing applications and discussing current trends and needs for activities. The participants are mostly well known to each other, but occasionally, new partners join the group.

These different structures within the intermediary organisation contribute to a creative tension between the orderly structures and the spontaneous, looser structures [53]. When this is aligned with individual intentions, motives and relational processes that make sense of collaboration, actors use the different structures and practices to set their collaboration processes in motion. The three narratives illustrate how actors use the structures and practices to develop their collaborations; for example, from ideas

that start in seminars (looser structures), they can apply for funding from the board (firm structure), enabling projects to start. The project results can be presented and discussed in a field excursion (looser structure), arranged by the project co-workers and the working committee (firm structure).

5.2. Practices

The scientific literature stream of university knowledge transfer and exchange research often takes a static macro perspective [19] or a helicopter view [54] of collaboration. Hence, the focus is on the structures and the elements of the system. When adopting a practice perspective, the focus shifts to recurrent activities.

Practices are described as routinised activities and postures, as in the roles we play in certain contexts. As the intermediary organisation facilitates meetings between different actors from the university, industry, authorities and civil society, it contributes to the creation of a common understanding of each other's practice. This means that getting to know each other is important, and it involves the shaping of the roles and identities of the people involved. How do I play my role in the meeting with others in this context? How do they play their role? What is expected from me? This could be learned by the actors by participating in meeting places arranged by the intermediary organisation, such as subject group meetings, seminars and workshops.

In the above narratives, people interact and form their understanding of each other. For example, Lars learns about issues perceived by different parts of the sector, and Victoria discovers Felipe's research. Niels learns what kind of questions and experiences farmers, advisors and authorities have, concerning the use of subsidiary crops.

However, practices are constantly in a state of tension, due to the continual presence of power, politics and conflict aspects [31]. While perhaps not directly present, this element is inherent in the narrative of the board meeting. Both Christine and Lars refer to discussions on strategic issues and the future development of the intermediary organisation. Strategic discussions in the board could end in decisions to alter the structures of the intermediary organisation and, thereby, the practices.

5.3. Processes

Practice-based research states that while the individual is a carrier and performer of social practices, there is normally space for initiative, creativity, individual performance and adaption [31]. These are the processes that take place in relations between people. In the narratives above, the actors take initiatives against the stable background of the intermediary's practices. For example, Victoria contacts Felipe about trying the new method against aphids in root crops, starting a process of developing new knowledge about this topic.

While the intermediary organisation provides various kinds of meeting spaces and facilitation by the operating manager, it is up to the participants to take advantage of these opportunities. In fact, the intermediary organisation is dependent on individuals using the possibility of taking initiatives and creating collaborations. Resources of different kinds, e.g., financial, infrastructural, knowledge and social networks, are embedded in structures, which in turn make practices and processes possible. Reciprocally, the practices and processes maintain and reinforce the structures [31]. It is when the practices and processes are carried out, as in, for example, the narratives, that meaning is created which keeps the intermediary organisation going. Thus, the structures provide resources and give legitimacy to the intermediary organisation, but it is through the meetings and the interplay between its members, the practices and processes, that it gains results and recognition.

Practice-based research and process theories highlight the fact that practices are meaning-making, are identity-forming and, at same time, produce the structure [22,31] of the intermediary organisation. While this study has touched upon these aspects, they each constitute interesting areas for further research in connection to collaboration between multiple actors in innovation intermediary organisations.

6. Conclusions

The aim of this study was to understand and explore situations of collaboration between various actors in connection with a university-driven innovation intermediary organisation and how the intermediary organisation facilitates collaboration in the making, and we have reached the following conclusions.

To answer the first research question of how collaboration in the making within the intermediary organization can be understood, we conclude that collaboration in the making is formed in the interplay between structures, practices, and processes between people. While the structures provide legitimacy and resources, the intermediary organisation may be perceived as being constituted by the practices and interactions among its members. The three narratives are examples of unique results emerging from relational processes between people, performed against the background of practices and structures provided by the intermediary organisation.

To answer the second research question of how the intermediary organisation facilitates collaboration in the making, we conclude that the presence of a continuum from fixed to fluid structures enables people to use the different kinds of structures to set their collaboration processes in motion. The fixed structures of the board and working committee allocate the financial resources used for meeting places and projects. The looser structures of, for example, meeting places imply a more flexible interpretational frame, which allows for a larger span of spontaneity and creativity in the processes between people, which in turn can alter the practice and the structure at hand, in sometimes-unpredictable ways [39]. This contributes to a creative tension between activities with firmer and looser interpretational frames [53], which along with the presence of resources allows for people to set their collaboration processes in motion.

Based on the frame of reference and the analysis of the empirical material, we developed a conceptual model where the structures of the intermediary organisation are translated into practices, against which individuals can develop their collaboration processes; see Figure 2. This implies that the organising of collaboration should focus its attention not only on structures but also on the practices and processes formed between people. It is in the practices that individuals can make meaning of what they do, learn about each other, shape identities, take initiatives, find collaboration partners and develop collaboration processes.

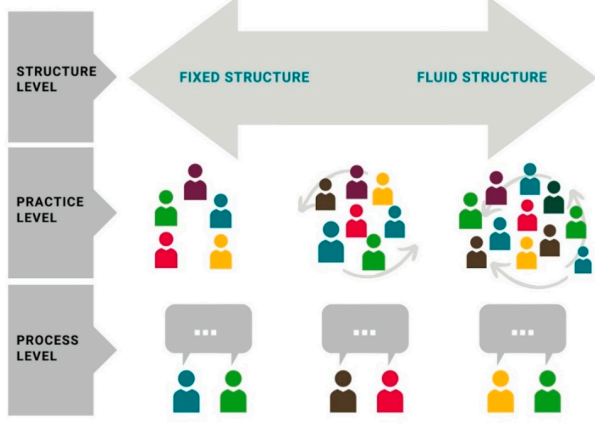

Figure 2. A conceptual model of the structures, practices and processes of an innovation intermediary organisation. The structures are translated into practices, against which individuals can develop their collaboration processes. This implies that while the structures provide resources, the organising of collaboration should focus its attention not only on structures but also on the practices and processes formed between people.

The results of this study further emphasise the key role of intermediary work, as in, for example, [2,4,15,27]. We propose that the presented conceptual model can help practitioners to understand and model their intermediary work, as well as inspire further research on how to understand the micro-level of collaboration. If we want to understand and develop collaboration, we must have an understanding of collaboration in the making.

Author Contributions: Conceptualisation, L.B.G. and S.A. with contributions from A.L.; methodology, S.A. with contributions from L.B.G. and A.L.; investigation, L.B.G., S.A. and A.L.; resources, L.B.G.; writing—original draft preparation, L.B.G., S.A. and A.L.; writing—review and editing, L.B.G., S.A. and A.L.; visualisation, L.B.G.; project administration, L.B.G.; funding acquisition, L.B.G. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by Sparbanksstiftelsen Färs & Frosta/Sparbanken Skåne, SLU Partnership Alnarp, and SLU RådNu—thank you to all.

Acknowledgments: We thank anonymous reviewers of the IFSA Conference and this journal for comments. We thank H. Weiber-Post for help with the graphics.

Conflicts of Interest: The authors declare no conflict of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

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International Food and Agribusiness Management Review
Volume 24, Issue 6, 2021; DOI: 10.22434/IFAMR2020.0167

Received: 21 September 2020 / Accepted: 3 November 2020

Special Issue: IFAMA 2020 symposium

The role of innovation intermediary organisations in forming value creating meetings: the agri-food firm perspective

RESEARCH ARTICLE

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Abstract

The aim of this study is to explore the concept of value creating meetings that connect agri-food firms with other crucial actors with whom they can collaborate or co-innovate, and related to this, examine the role of innovation intermediary organisations in the forming of such value creating meetings. The research design involves three case studies of intermediary organisations, within the agri-food sector in Sweden, each with an adherent case of a value creating meeting. The method comprises data collected through documents, interviews and insider accounts. The findings include the notion that three factors – problem, professionals and platform – are important to combine in order to facilitate value creation. We also show that intermediaries play an important role in the value creation process and that this process could be summarised into four steps: problem recognition, contact creation, dialogue facilitation and value creation. We elaborate on the role of innovation intermediaries, give examples of how value creating meetings could be arranged and what such meetings can lead to in case of outcome. Practical implications for policy makers and agri-food business firms include that intermediary organisations can play an important bridging role in a complex and fragmented context, offering contacts, networks and value creating meetings for targeted actors. Intermediary organisations need to focus on forming value creating meetings, work actively across sectoral boundaries, and allocate adequate resources for mediating efforts.

Keywords: agriculture, food, innovation brokering, agricultural innovation system, VUCA
JEL code: O30, Q10

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1. Introduction

Operating on a competitive global market, the agri-food sector faces considerable challenges to the agri-food business actors. Besides price competition, there has been a steady increase in the demands for food safety, product quality, sustainability, animal welfare and data/information accompanying products. This, in turn, has resulted in reinforced laws and regulations around agriculture and food in many countries. Handling these challenges have put the sector in an astonishingly complex context (cf. Hertel, 2015; Reinert, 2015).

To meet these challenges, the development of new knowledge and innovation is seen as crucial (OECD, 2019). However, the ambition to gain new knowledge and work efficiently with innovation poses several problems, especially for the many small and medium-sized business firms of the agri-food sector. In this regard, supportive knowledge and innovation systems have been put forward as vital (OECD, 2019). Also the European Commission encourages enhanced knowledge flows and boosted links between research and practice to strengthen the agricultural knowledge and innovation system, AKIS (EU SCAR, 2019). The scientific literature on agricultural innovation systems brings forward the role of innovation intermediary organisations and innovation support services as bridging elements for enhancing innovation and knowledge flows between multiple actors in the agri-food sector (Klerkx and Leeuwis, 2008).

Consequently, the OECD and the European Commission are discussing three kinds of central actors in the agri-food system. The first kind is actors comprising 'knowledge resources' that can be useful for development of food production. The second kind is actors that can implement new knowledge and concepts for improved food production; 'firms in the agri-food sector'. However, firms in other sectors seem to be equally important, as agronomy and food science needs to increase their efforts to join forces with technology, engineering and other relevant expertise. The third kind is actors that can bridge the assumed gap between knowledge resource actors and the implementing actors. These bridging actors are called 'innovation intermediaries, innovation support services', or similar names. Bridging actors are extra important for brokering networks with other sectors of expertise (Curran *et al.*, 2010).

To succeed in innovation, awareness of other actors in the innovation system is important (Adner, 2006). This implies that innovating firms have to see beyond their own execution and regard the processes of the actors between themselves and their end customers. In the case of converging industries – such as agtech, which is a convergence of agriculture and technology, it becomes even more complicated as the actors need to understand the uncertainties and risks of other sectors and areas of expertise (Curran *et al.*, 2010).

Today's multiple challenges, as described above, creates a context of highly complex and uncertain systems, which can be summarised as having entered the 'VUCA world'. According to Bennet and Lemoine (2014), this acronym stands for Volatility, Uncertainty, Complexity and Ambiguity. VUCA is one proposed paradigm that follows upon the previous linear industrial paradigm, which in turn replaced the local circular paradigm (*ibid.*). These paradigms could also be related to the steps of industrial development, where the first (mechanisation), second (the assembly line) and third (automation, PLC), industrial revolutions made society leave the local circular paradigm and move into the linear paradigm, that have been present during the last century (Zambon, 2019). Now entering the fourth (digitalisation, Internet of Things) and fifth (robotisation and autonomous systems) industry paradigm, coincides with entering the VUCA-paradigm that is described by Bennet and Lemoine (2014).

This situation calls for collaboration and the core of collaboration between various actors is the meetings between individuals from different organisations and backgrounds. The start of a dialogue between two such actors, initiates a process between them, where intentions, ideas, needs and competencies can be exchanged. If the dialogue is successful, 'value' in case of new thoughts and ideas that could form a base for inventive actions are formed. For such actions to occur, a relational process needs to evolve over time between the actors.

Not all value creating meetings result in innovations; imitation and incremental steps as well as enlarged networks, new affairs, new business constellations or new knowledge, could also be valuable results of meetings. Besides, not all meetings result in anything valuable at all and to avoid this kind of waste, it is of interest to investigate how intermediary organisations operate to form meetings that they believe have potential to be valuable for the invited actors.

The aim of this study is therefore to explore the concept of value creating meetings that connect agri-food firms with other crucial actors with whom they can collaborate or co-innovate, and related to this, examine the role of innovation intermediary organisations in the forming of such value creating meetings.

An innovation intermediary organisation is, in the context of this paper, 'an organisation or body that acts as an agent or broker in any aspect of the innovation process between two or more parties' (Howells, 2006: 720). Being aware of the existence of innovation intermediaries without formal organisations, e.g. advisors and mentors that can act as facilitators of innovation; this study focuses on innovation intermediaries that are and act like formal organisations. A value creating meeting is defined as a meeting between two or more actors that creates an innovative process that results in an economic value, either in short or long term, for at least one of the actors.

To fulfil this aim, this study investigates the practices of three intermediary organisations in the agri-food industry, based in the two largest agri-food production areas in Sweden. The three cases are compared to elicit how they work to form value creating meetings. In addition, three examples of value creating meetings are included, where the intermediary organisations have played an important role and pinpoint the connection between these and the mentioned intermediary organisations. The research method comprises data collected through documents, interviews and insider accounts.

This paper is structured as follows. After the introduction (Section 1) follows a theoretical framework (Section 2), the method of the study (Section 3), and a presentation of the three case studies (Section 4). These are analysed and discussed (Section 5), and finally the conclusions are presented (Section 6).

2. Theoretical framework

If we depart from the theories of innovation systems (e.g. Edquist, 1997; Freeman, 1987; Lundvall, 1992), and view innovation as recombination (Schumpeter, 1934), meetings among actors in the system become essential (Howells, 2006). Innovation intermediaries are known to perform several activities, such as foresights, brokering between actors, mediating in collaborations, transferring of knowledge, helping with commercialisation, evaluation and validation of results (Howells, 2006; Winch and Courtney, 2007). Because they are perceived neutral, they are also regarded as able to contribute to systemic interaction (Klerkx and Leeuwis, 2009).

For the agri-food sector specifically, three functions of innovation intermediaries have been highlighted as important: demand articulation, network brokerage and innovation process management (Klerkx and Leeuwis, 2008). Demand articulation is explained as 'establishing a dialogue between users and producers' (*ibid.*: 262) to clarify both demand and supply, through analysing problems and facilitating the arrival at innovation strategies/plans (*ibid.*). Network brokerage is understood as helping SME's connect with external actors and resources such as financing (*ibid.*). Innovation process management comprises several activities such as managing relations to new and existing actors, knowledge brokerage, implementation and commercialisation (*ibid.*; Howells, 2006).

Ungureanu *et al.* (2018) link intermediary organisations to the turbulent development that in the introduction above were described as VUCA and concludes that intermediaries facilitate cooperation and hence could be means for organisations to be successful in a complex and uncertain world. According to Bennet and Lemoine (2014), the VUCA-world could be survived and its factors could be handled. 'Volatility' could be

conquered by agility and flexibility, along with quality information to reduce 'uncertainty'. Internal company operations will need to be restructured to handle 'complexity', and the 'ambiguity' could be remedied by intelligent experimentation. Ability to cooperate across disciplinary borders will hence be essential. This is supported by Fleming and Waguespack (2007), who argues that the social capital of brokers and border spanning roles can unite open innovation communities and facilitate collaboration between organisations. Based upon these new conditions, collaboration among actors is put forward as the new logic (Ungureanu *et al.*, 2018), since few actors will survive the battle in the VUCA world on their own. To foster collaboration, intermediary organisations play an important role by means of connecting actors with matching resources and competences. Thereby they can contribute to creation of collaboration-based business models (Norrman *et al.*, 2020).

However, as argued by Frankelius (2009), meetings need to 'create value' if firms shall invest lots of time in them. Firms need to create value to be successful, thus they need to meet with other actors for knowledge, competencies, cooperation and innovation that creates value for the firm. It is proposed here to define value creation meeting in this context as a result from a meeting between two or more actors that creates an innovative process that results in an economic value, either in short or long term, for at least one of the actors. Direct results can be a business deal fulfilled in direct connection with the meeting. Indirect results can be new: (a) knowledge; (b) ideas; or (c) information about opportunities or risks in the external environment – that later contribute to the economic performance for some organisation involved in or related to the meeting. Empirically it is often easier to define value *ex post* than *ex ante*.

According to Frankelius (2009), actors that could combine, merge or fuse their knowledge, ideas and technologies into new combinations first need to be 'aware' of each other and the possible interesting resources of the actors, then 'reach' each other and 'start interacting'. Being part of networks created by e.g. intermediary organisations is a way to become aware of other actors. However, merely being aware of other actors is not enough; a fairly detailed knowledge of the actor and its resources and competencies is needed, to know whether a valuable collaboration could ensue. However, the next step 'reaching' is nothing to be taken for granted as the reason for this might not be obvious for the actors because there is no reason putting them together. Even in a situation where the actors have a 'true reason' to meet this may not be obvious for them as they lack this information and therefore cannot make a rational choice (Simon, 1945). Hence, some kind of 'substance' needs to create attention enough to start an action. It could be a problem, a need or some kind of opportunity and it has to be captured by an actor that knows who can create a solution. This third part actor, which could be labelled innovation intermediary, 'recognises the problem' and also has the motivation and capacity to promote and organise the meeting – and to persuade the actors to attend and thereby facilitate the 'contact creation'. If credibility is an issue, the intermediary also can take the role as credibility generator (Sanner, 1997), alternatively involve someone else to take this role.

Getting into contact is necessary but not enough for value to be created. With or without help from an innovation intermediary, it is needed for the actors involved to understand their 'offers' and 'needs' and here the intermediary could be instrumental in 'facilitating the dialogue' between the meeting actors that leads to such understanding. Sometimes this actor needs to overcome problems such as the involved actors represent different cultures, styles, assumptions and attitudes (Duarte and Snyder, 2001; Hofstede, 1996; Neff, 1995). It could also be needed (for the actors) to overcome cultural[1] and disciplinary boundaries (Haslam, 2001).

Facilitating the dialogue may include to ease the actors' mutual learning about each other. In a successful dialogue, social learning is key (Blackmore *et al.*, 2018). The learning between the actors should focus on four dimensions: (a) about the subject matter; (b) about the process; (c) about the other and the others' perspective; and (d) about oneself and one's own perspective (Daniels and Walker, 2001). This learning is necessary for successful meetings, in order to manage the complexity of the self-organising process

[1] In this, culture could be defined as a body of learned behaviour, a collection of beliefs, habits and traditions shared by a group of people and successively learned by people who enter society (Mead, 1951).

that ensues between the actors (*ibid*). A person that acts as a facilitator can also aid in handling any power elements that are present (Purdy, 2012).

3. Methods

The empirical material in this study consists of three intermediary organisations, each with an adherent case of a selected value creating meeting. The three intermediary organisations in the agri-food industry were chosen due to their presence in two of the largest agri-food production areas in Sweden. The adherent cases of value creating meetings were chosen as they embody several aspects relevant to value creating meetings.

The data is obtained through documents, interviews and insider accounts. Firstly, we build upon documents gathered from the three intermediary organisations, such as reports, evaluations and policy documents. Secondly, to gain deeper knowledge about the adherent value creating meetings, interviews were conducted with the persons involved. The interviews were performed as semi-structured interviews with in total six persons, in January through March 2020. Each interview took 30-60 minutes and was carefully note-taken.

Thirdly, as all three authors have been directly and indirectly engaged in the intermediary organisations used as cases, over the past ten years, we use these experiences as insider accounts. The first author of this study was operating manager of the intermediary organisation presented in Section 4.1, during the years of 2013-2018, and was present at the meeting in Section 4.1. The second author was a member of the board of one of the founding organisations for the intermediary organisation described in Section 4.2 and has since had a lot of contact with them. The third author has collaborated with the same intermediary for a long time, and together with the second author founded the intermediary organisation presented in Section 4.3.

Due to the authors' engagement in the intermediary organisations, this study has at least partly an autoethnographic method (Hayano, 1979). This was originally defined as a research approach where anthropologists conduct research on their own people rather than other peoples. The method describes building scientific knowledge based on self-perceived experiences. Thus, kinship exists with action research (Lewin, 1946). According to Humphreys (2005) autoethnographic vignettes aim to connect the researcher both as a writer and subject with the reader through an autobiographical account that allows readers to engage with the events narrated. The strength of this method is that it offers in-depth access to naturally occurring data in the form of informative situations, along with short- and long-term processes connected to the cases. The researcher gains a rich picture of the operations in its broader context, and detailed access to events as they happen (Gummesson, 1991). This familiarity and personal involvement naturally has drawbacks in comparison to a distant researcher, as it can cause bias and inappropriate considerations in the interpretation of the studied phenomena. This can be ameliorated if the researchers consciously strive to view the studied phenomena reflexively from a variety of angles and interpretative stances (Alvesson and Sköldberg, 2018). We are aware of the bias risk and have tried to keep our minds as open as possible.

4. Results

The intermediary organisations are situated in two of the largest agricultural production areas in Sweden; Skåne and Östergötland. The three cases differ in setup, operating level and regional context.

4.1 SLU Partnership Alnarp

SLU Partnership Alnarp started in 2004 as an intermediary organisation for collaboration between the Swedish University of Agricultural Sciences (SLU), and the agricultural, horticultural and forestry sectors in the south Sweden region (Blix Germundsson, 2020). Currently, the intermediary has around 90 partner organisations, ranging from small firms to large businesses and authorities. The main activities are threefold: (a) R&D projects, jointly financed by the university and the intermediary partners; (b) meeting places such as subject groups, seminars, workshops and field excursions; and (c) students' thesis projects and a mentorship program.

As the idea behind the intermediary was to connect the university with industry and society, the creation of meeting places between different actors is a core activity. The intermediary's organisational structure with a board and seven subject groups, provide for regular meetings between the university and the intermediary partners in seminars, workshops and field excursions. These meetings facilitate networking and individual contacts, and often give rise to new ideas (Blix Germundsson *et al.*, 2020). The possibility of applying for seed funding for R&D projects within the intermediary is valuable, as it enables financial support to develop ideas one step further for ideas that emanate from these meetings.

■ *The biochar seminar*

In 2015 a seminar was initiated about the potentials of using biochar as an additive in soils. The seminar contained presentations by five researchers and two firms, and in the audience were an additional twelve firms, a nearby municipality administration, a research institute and ten university staff. The seminar ended with a workshop where concrete ideas and initiatives were discussed in smaller groups.

One of the firms had for some time entertained the idea of using husks from their seed production for producing biochar. They had made some trials in using agricultural soils and now found interesting results presented by a researcher studying biochar use in plant beds for urban trees and green areas in cities. Facilitated by the intermediary organisation, a dialogue between the firm and the researcher ensued in the workshop discussion after the seminar. Their dialogue grew into collaborative applications for external funding, to develop new knowledge and techniques regarding the production and use of biochar. Today a substantial research project is running and the firm has built a production of certified biochar of seed husks.

4.2 Vreta Kluster

Vreta Kluster is located outside Linköping in Östergötland county in east Sweden and was incepted in 2010 by the region, a number of prime-moving individuals and organisations, e.g. agricultural societies, an agricultural high school, a local property firm and the regional public authorities that wanted to see an increased collaboration and progress. Vreta Kluster has three pillars: firm park, meeting arena and arena for business development – in short, a physical place and a collaborative and innovative environment.

It offers business development, technology and product development, innovation management, innovation events, conference facilities, education, network and contact mediation, localities and flex-offices. The approach is open and inclusive and the main aim of Vreta Kluster is to be the natural node in the region for everything and everyone that has an interest in green industries, including farming, forestry, food, animal breeding, renewable energy, aquaculture and horticulture. Due to this Vreta Kluster becomes a natural hub for actors from green industries that seek contact with e.g. academia or trade and industry in general and for those outside the green industry that aims to reach this sector. Organising meetings has been at the core of the Vreta Kluster functioning since the inauguration and the meetings range from those organised between two or a few more individuals to big meetings (up to 150 persons), commonly organised in the form of seminars and conferences.

■ *The rooster egg project*

In today's egg production, rooster chickens are sorted out and destroyed immediately after that they are hatched, while female chickens are saved to become egg producing hens. This is a waste of life and does not go along with the goals on animal welfare. The trade organisation of Swedish egg producers, Svenska Ägg, has long been aware of this issue but have not seen any obvious solution. In June 2018, the manager of Svenska Ägg, contacted Vreta Kluster to start solving the problem. As it was suspected that the problem could be solved by researchers at Linköping University, Vreta Kluster contacted its liaison office, which in turn facilitated a contact with researchers at the university. A meeting took place shortly after, attended by the three actors, where the issue was discussed. The researchers ended up in the idea to attack the problem

with gas sensors. Vreta Kluster also connected the project to the innovation initiative Agtech 2030 that supported the idea with some finance at a critical phase of the project.

This first meeting started a process that included several meetings and communications between the actors, that have enabled the researchers to understand the market fit of their invention and made the poultry industry aware of the emerging solution. Hopefully this collaboration could facilitate also the commercialisation of the upcoming product. What remains now is refinement of the method into a commercial prototype and then commercialisation. The role of Vreta Kluster in this project was to intermediate between Svenska Ägg, Linköping University and Agtech 2030.

4.3 Agtech 2030

Agtech 2030 is a 10-year development initiative, granted by the Swedish innovation agency Vinnova in November 2018. Its mission is to create a sustainability-oriented innovation environment that is inclusive and generates significant technology-, business- and competence development, as well as new knowledge within the area of agricultural technology. Agtech 2030 draws upon resources and competencies that mirror their regional areas of strengths and focus on creation of new concepts based on, for example, sensors, digital technology and mechanics but also on new collaborations and ways of doing business. Agtech 2030 strives to become one of the world's most prominent innovation environments in agricultural technology, with the reputation of meeting key sustainability challenges through collaboration and innovation.

The initiative is built upon a regional partnership of about 20 actors, representing farmers, agtech firms, tech firms, public organisations (regional authorities and weather service) and academic research (sensor technology, sustainable development, innovation management, marketing and entrepreneurship). This partnership will grow over time as the initiative develops. Agtech 2030 is run by a process management team, a board, where the main triple helix partners are represented. Agtech 2030 is hosted by Linköping University.

Agtech 2030 operates through identification and initiation of different types of collaboration-based development projects which are co-financed by the initiative. In this work, the process management team has a crucial mediating role in facilitating the composition of the project constellations and most projects so far have sprung out of dialogues between the management team and the partners. Hence, most projects run by Agtech 2030 could be regarded as 'inhouse' by means that they are initiated and run within the partnership constellation.

- *The digital platform project*

The digital platform was originally developed as a solution to protect African rhinos in the wild-life park of Ngulia in Kenya. The back-end solutions were developed in the form of an app and dashboard for the rhino project. The Agtech 2030 management team saw a potential in this technology for use by farmers. Through the mediation of Agtech 2030, the rhino technology development team, that consists of researchers in sensor informatics and IT-experts, met with farmers from different farming sectors, such as livestock breeders, horse breeding and equestrian sports, and beekeepers. In the case of beekeeping, Agtech 2030 has connected the tech developing professionals with a network of people working with bee farming, and among them a professional beekeeper with a strong interest in technology. A process of developing Internet of Things solutions for beekeeping has started.

The new direction of the project strives to develop an open standard for cost efficient and robust field data collection and visualisation, tailored for farmers to keep track of both animals and equipment. This cooperation between technology developers and farmers will enable the technology applications fit to the needs of farmers. The role of Agtech 2030 in this has been to facilitate contacts between these groups of people.

5. Analysis and discussion

The intermediary organisations in our three cases are built differently, as described above. While SLU Partnership Alnarp and Agtech 2030 are university-based with strong research foundations, Vreta Kluster is a regional cooperation initiative and a physical place for agri-food firm locations. Their different backgrounds affect the activities and possibilities offered by the intermediary organisations. Following the development stages described by Ungureanu *et al.* (2018) one can say that Agtech 2030 acts similar to the emergent model, while Vreta Kluster has more in common with the brokering model. SLU Partnership Alnarp has been around since 2004, therefore being more mature and has similarities with the platform model. However, all three organisations are engaged in: (1) forming meeting places with several actors such as seminars; and (2) specific matchmaking meetings between two or few actors. As argued by Winch and Courtney (2007) intermediary organisations should be organised on a non-for-profit basis and preferably in case of private-public partnerships and their reason is that this creates independence of stakeholders. Furthermore, good contacts with sources of innovative ideas are essential, and so is also their positioning in the innovation network. This holds also for the intermediary organisations studied in this paper.

Meetings with several actors, such as seminars, coffee meetings and subject groups or industry council meetings, serve the purpose of supporting agri-food firms and other actors in navigating in a complex VUCA world. Gaining information of opportunities and for reducing risks and uncertainties is important, along with building networks and making oneself known to others. These meetings also aid actors in getting to know the intermediary organisation, to build personal relations, trust and get familiar with the environment of the intermediary organisation. Besides providing subject information, this helps to lower the cultural barriers and start the social learning mentioned in Section 2 and prepare the ground for eventual value creating meetings. While Partnership Alnarp invited firms and researchers with an interest in biochar so that they could get to know each other, it could not foresee the value creating meeting that occurred between the firm and the researcher in the following workshop.

On a matchmaking level, the intermediary organisations described in Section 4, provide meetings for actors with a specific aim, i.e. trying to form value creating meetings. This was the case with the rooster egg and the digital platform projects, where the intermediary organisations brought together actors who would not have met otherwise, to meetings that resulted in substantial innovative ideas for future commercialisation. While Vreta Kluster and SLU Partnership Alnarp arrange events where information is shared among the participants, Agtech 2030 is already more focused in its set-up and scope, which allows for more directed efforts in matchmaking.

All three intermediary organisations devote efforts into forming and if needed facilitating value creating meetings. For this, a wide network is needed, and a familiarity with both agriculture and other areas that can cross fertilise the agricultural industry, such as food industry and digital technology. While SLU Partnership Alnarp and Vreta Kluster over the years have built strong reputations of trustworthiness within the agricultural sector in Sweden, partly due to familiarity and legitimacy within the industry, intermediary organisations are perhaps extra important in making connections across sectoral boundaries. Agtech 2030 makes an explicit effort to connect the agricultural industry with technological sectors and thus spanning sectoral boundaries. Agricultural intermediary organisations need to be constantly aware of and working with other areas of expertise to open up for new combinations, competence and collaborations.

Taking a closer look upon how the organisations studied have worked in the example cases, some comments could be made; regarding SLU Partnership Alnarp, it was a seminar on a specific topic that led to a contact between actors that contributed to value creation. In this chain of meetings, staff from the intermediary organisation had an active role in facilitating the dialogue. In the Vreta Kluster case, it was an organisation in the house that turned to Vreta Kluster to get a problem solved. Vreta Kluster then mediated contact with the university that started to work on the solution. Vreta Kluster also mediated contact to a financier. Both these processes could be described as generated by a market need. In the Agtech 2030 case, the digital platform

collaborations were formed to push the technology out to new areas – i.e. from rhinos to cattle, horses and beehives. In all the three cases mediation has been crucial. Another crucial factor is, as put forward by Curran *et al.* (2010), knowledge – in all the three development cases the people involved have deep professional knowledge within their areas respectively. Hence it is when this knowledge is combined that 'value' is created.

Regarding how the matchmaking is conducted, our empirical examples reveal that it can take different forms. In the case of SLU Partnership Alnarp an open activity – a seminar – for knowledge exchange led to a match. In the Vreta Kluster case, it was an active search through a large network that led to a match and in the case of Agtech 2030 the matchmaking has been dependent on personal contacts of closely involved individuals. The Agtech 2030 approach could be seen as highly efficient, however, it is also the most vulnerable since it is highly dependent on sole individuals. In all three intermediary organisations the matchmaking function has, at least from time to time, been strongly tied to one or very few individuals. The advantage of this is that the processes become agile and also conducted with high precision, provided that the individual is skilled. The drawback is that the operations become vulnerable as they are dependent on very few individuals. Furthermore, the role of mediating is difficult to pinpoint and evaluate (Klerkx and Leeuwis, 2008), hence it is hard to get adequate resources allocated for this.

To summarise this analysis, we can conclude that to create value through meetings three factors seem to be important. 'Problem recognition' is essential for starting the process. We also showed that the right 'professionals', e.g. individuals from firms, farms and academia, need to meet and that someone, i.e. the intermediary organisation has to bring them together. The third factor is the 'platform' where the meeting can take place. A well-known place and a beneficial physical environment can help not only to attract professionals to attend a meeting. Inspiring environments can also make professionals feel good when the meeting has started. Frankelius and Vogel (2009) also mention meals such as lunches and dinners as strategic tools for value-creating meetings. The three crucial factors that need to be combined to create value are illustrated in Figure 1.

Based on our empirical examples, we can conclude that value created through combining these three factors can be of various type. It can lead to new constellation-based business models, innovative concepts, methods and products, increased knowledge and learning, new areas of research, identification of new market opportunities, co-branding and increased sector collaboration.

The analysis also gives ahead that value creation could be described as a four-step process (Figure 2), which includes: (1) problem recognition; (2) contact creation; (3) dialogue facilitation; and (4) value creation. The role of the innovation intermediary as facilitator is crucial in all the steps of this process.

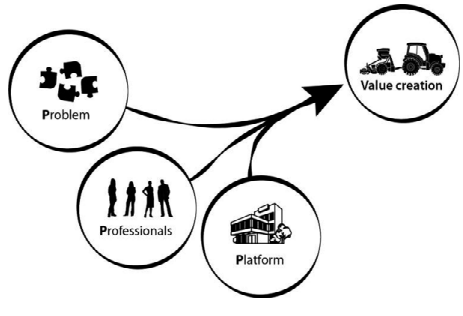

Figure 1. Problem, professionals and platform are essential value creating factors.

Figure 2. Facilitating value-creating meetings as a four-step process.

Finally, even though intermediaries are regarded as catalysts and facilitators of value – including or not including innovation dimensions – there are also dilemmas (Klerkx and Leeuwis, 2009). For example, quality aspects such as adequate knowledge of the intermediary could be questioned and also the mandate of the intermediary organisation. Furthermore, they could be feared to act like 'hidden messengers' of policy actors, which in turn may affect their credibility. Ungureanu *et al.* (2018) show that cooperation can increase complexity and uncertainty, as in VUCA, and they therefore recommend that attention also is put upon the unintended consequences of partnerships. But even if most meetings won't lead to direct value creation, it is still an important striving as meetings provide information and network expansion for the participants, which can lead further.

6. Conclusions

The aim of this study was to explore the concept of value creating meetings that connect agri-food firms with other crucial actors with whom they can collaborate or co-innovate, and related to this, examine the role of innovation intermediary organisations in the forming of such value creating meetings and we have reached the following conclusions:

- Value creation meetings emerge from the fusion of three important factors: problem, professionals and platform.
- Value creation is a four-step process starting with problem recognition, contact creation and dialogue facilitation and, if successful, ends with value creation.
- Collaboration between actors is a way to handle the complex world of VUCA.

In general, there is an untapped potential in professionals not meeting enough today. In a VUCA world, collaboration among actors is the new logic (Ungureanu *et al.,* 2018) to survive and prosper. However, to be useful to agri-food firms, meetings and intermediary efforts need to be created with the aim to form value creating meetings, defined as a meeting between two or more actors that creates an innovative process that results in an economic value, either in short or long term, for at least one of the actors. Here, intermediary organisations can play an important role by building relations, trust, lower cultural barriers and starting social learning processes, that in turn opens for connecting actors with matching resources and competences.

Intermediary organisations in agri-food context have an important role in making connections across sectoral borders, e.g. with technology, digital solutions and new business models, as sectors converge (Curran *et al.,*2010). This, however, requires that the staff of the intermediary organisation have a border spanning competence and network. If this is the case, the agricultural industry can be connected with technological sectors and thus spanning sectoral boundaries. This implies though that agricultural intermediary organisations constantly work with other areas of expertise to open up for new combinations, competence and collaborations.

Arranging meetings, both large and small, with some intellectual investment behind, naturally requires resources. All the three intermediary organisations are led by groups of devoted, inclusive individuals with large networks of contacts. While this is an asset, it is also vulnerable to be dependent on few individuals. As the intermediary role is sometimes difficult to pinpoint, evaluate and correctly attribute (Klerkx and Leeuwis, 2008), it is hard to get adequate resources allocated for this.

Implications for policy makers and agri-food business firms include the suggestion that intermediary organisations can play important bridging roles in a complex and fragmented context, offering contacts, networks and value creating meetings for actors. EU policy on agricultural knowledge and innovation systems brings forward the role of innovation brokering and support (EU SCAR, 2019). However, for this to work out well, intermediary organisations need to be responsive to their network and focus on forming value creating meetings, work actively across sectoral boundaries, and allocate adequate resources for mediating efforts. This, however, is not to say that all intermediary organisations play this role. In fact, there are reasons to believe that not all activities conducted by intermediary organisations promote value creation. Thus, there is a need for further research in order to bring forward more knowledge about the connection between different actions in intermediary organisations and value creation.

Acknowledgements

We are grateful to the three intermediary case studies and persons involved in the value creating meeting case studies, without whom this could not have been made. We are also grateful to Sparbanksstiftelsen Färs & Frosta/Sparbanken Skåne, SLU Partnership Alnarp, SLU RådNu, Stiftelsen Lantbruksforskning and Vinnova who have financed this research.

Conflict of interest

The authors declare no conflict of interest. The funders had no role in the design of the study or in the decision to publish the results.

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III

sustainability

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Article

What Skills Do Agricultural Professionals Need in the Transition towards a Sustainable Agriculture? A Qualitative Literature Review

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Abstract: Agriculture is facing mounting challenges across the globe and must move towards more sustainable practices to combat climate change and meet changed production requirements. Education has been acknowledged as highly important in a sustainable transition, but there is no clear agreement about what skills are needed for professionals in the agricultural system. The purpose of this paper is to identify and analyse skills needed for professionals in the agricultural system to engage in the transition towards sustainable agriculture and elaborate on the implications of this for a transition towards sustainable agriculture. The review is based on a qualitative semi-systematic literature review of 20 peer-reviewed articles concerned with sustainability, skills, and agriculture. Five categories of skills were identified and analysed, including systems perspective, lifelong learning, knowledge integration, building and maintaining networks and learning communities, and technical and subject-specific knowledge and technology. As the identified categories of skills have emerged from different contextual settings and a diverse group of actors, these five categories encourage a broad and inclusive understanding of skills that can be translated into different contextual settings, scales, and professions within the agricultural system. The article concludes that professionals engaged in the transition towards sustainable agriculture need skills that encourage a perspective that moves beyond generic discipline-based skills and instead builds on heterogeneity, inclusion, and use of different actors' knowledge, practices, and experiences, and the ability to respond and be proactive in a constantly changing world.

Keywords: sustainability; agricultural professionals; sustainable agricultural systems; sustainable education; skills

Citation: Sørensen, L.B.; Germundsson, L.B.; Hansen, S.R.; Rojas, C.; Kristensen, N.H. What Skills Do Agricultural Professionals Need in the Transition towards a Sustainable Agriculture? A Qualitative Literature Review. *Sustainability* **2021**, *13*, 13556. https://doi.org/10.3390/su132413556

Academic Editors: Hamid El Bilali, Carola Strassner and Tarek Ben Hassen

Received: 3 November 2021
Accepted: 4 December 2021
Published: 8 December 2021

1. Introduction

What skills are needed for professionals in the agricultural system to engage in sustainable agriculture, and how are these skills represented in the scientific literature today? Agriculture and food production are facing mounting challenges across the globe and must move towards more sustainable practices to combat climate change, environmental degradation, hunger and malnutrition, food safety and security, and a still-growing population [1–3]. Sustainable agriculture and our future food production play an important role and need to be perceived within a broad and integrated perspective that accommodates the three pillars; the environmental, economic, and social dimension, while at the same time keeping within a safe operating space of the planetary boundaries [1]. This insight has resulted in various policy documents and strategies in the past decade, e.g., the EU Commission's 2020 Target, FAO, and the United Nations 17's sustainable developments

goals (SDG's), all acknowledging the key role played by agriculture in global sustainable transition and development [4,5]. While agriculture is the prime target of the United Nations' Sustainable Development Goal of 'zero hunger', it indirectly affects most of the other goals, as food security and food safety are implicit prerequisites for a '*world free of hunger*' [5], a vision of the United Nations General Assembly and the 2030 Agenda for Sustainable Development 2015. To achieve these goals, several scientific and political reports have emphasised the need for agricultural professionals who can deal with the pressing sustainability challenge, and acknowledge education as an important tool in transforming the future of the planet [5–7].

There is a common agreement that moving towards a sustainable future requires a shift in perspective. It is, therefore, critical for sustainability scholars to understand this paradigm shift and orient their work in line with advanced theory and practice from fields relevant to sustainable agriculture and food systems [8]. However, education for sustainable agriculture is a vast research field that holds many discussions about theory, practice, and the educational outputs, as the conceptualisation of sustainability, problems, and the degree of change required in the transition differ significantly depending on different learning institutions and individual people [6]. Most often, education for more sustainable futures, especially within the agricultural sector, is identified by its subject content, while it is also important to acknowledge the learning processes that underpin sustainability [9]. It is, therefore, suggested that some of the key processes promoting learning for sustainable transitions and developments are, among others, collaboration, engaging with whole systems, innovation in the curriculum, teacher and learning experiences, and active and participatory learning [9–11]. Furthermore, the literature highlights the importance of a broad understanding of different kinds of knowledge in a sustainable transition, such as farmers' own experiences and knowledge [12–16]. Even though this is beginning to be well acknowledged, a recent study by Charatsari and Lioutas [17] found that the agronomists in their study were lacking some skills to promote sustainable agriculture and support farmers in making the transition towards more sustainable practices [17]. It is likewise recognised that education for sustainability and agriculture must move beyond dichotomies of objective true and false, and view practices as diverse, subjective, and contextual [18]. These recent examples highlight the need to step up efforts in education for sustainability and environmental and agricultural programs and challenge the normative skill-based course approaches [18,19]. However, there are many different definitions and terminologies regarding what constitutes skills for sustainable agriculture, and scientific research demands a more comprehensive description of skills and the implication in terms of developing the curriculum and future educational programmes [20]. Furthermore, the need to cultivate students' skills in higher education for sustainable agriculture (and food systems) has also motivated discussions about how teachers and students can be competent 'change agents' in the sustainable transition of the society [3,6,21]. Professionals in the agricultural system included in this paper are mainly people working directly with agriculture such as farmers, advisors, mentors, etc., or people involved in sustainable food production strategies, education, and/or research.

The definition and operationalisation of skills, competencies, and knowledge have been dealt with by different theories of knowledge and in educational literature. These definitions often concern differences between the concepts of knowledge, skills and competencies; simplifying knowledge as relating to theory, whereas skills relate to practice, with the link between the two being competencies. However, in the scientific literature, the terms become blurred in practice, and there is no consistent theoretical (or practical) use of skills, competencies or knowledge. We have decided to apply the definition of skills in this review as an interrelated complex of knowledge, competencies, and attitudes that enable positive and collaborative action and problem solving [22]. Furthermore, skills are primarily used in this paper in an educational context. This means that the categories of skills identified are skills that can be integrated into an educational context.

Besides skills, sustainability is a complex concept that is sometimes considered ambiguous because it means different things for different people in different situations. Regarding agriculture, many definitions can be found, but most of them, including those in the articles reviewed here, are connected to the three pillars of sustainability: society, economy, and environment. In this paper, we employ sustainability as a concept that includes a broad perspective, the three pillars of sustainability, and resonates with the definition stated in the report of the world commission on environment and development in 1987 by Brundtland: 'meeting the needs of the present generation without compromising the ability of future generations to meet their needs' [23], and with the definition of feeding the world population while at the same time keeping within a safe operating space of the planetary boundaries [1]. Sustainability in the Brundtland sense means different things in different contexts and the knowledge needed to tackle the UNSDGs is therefore complex and local and must be negotiated in its context. This requires transdisciplinary and interactive work by farmers, advisers, suppliers, researchers, policymakers, and/or other experts—whoever influences or has a stake in the situation. Hence, sustainability in the Brundtland sense is more of an overall direction given by, e.g., the UNSDGs, and then dealing with the social processes of getting there.

Moving towards a sustainable agricultural system, however, is a highly complicated process [24,25], and several articles in the past decade have discussed and argued for different strategies. One of the consistent conclusions is that there needs to be a more holistic approach to addressing the complexity in which an agricultural system is embedded [20,26]. This paper aims to synthesise and discuss the current scientific discussion about the skills that are required to engage with a changing world and move towards sustainable agriculture.

2. Materials and Methods

The purpose of this review was to undertake a thorough identification and analysis of the skills needed for professionals in the agricultural system, represented in the scientific literature. To this end, we developed a semi-systematic and qualitative literature search inspired by Wong et al. [27]. This approach was employed as it allows for the study of a topic that has been investigated and conceptualised in various ways by several groups of researchers within different disciplines [27]. A semi-systematic literature search is particularly relevant when undertaking a qualitative analysis to map themes and other different perspectives (e.g., theoretical, philosophical, and practical) represented in the scientific literature [27]. As sustainable agriculture is a vast research field and we aim to cut across disciplines and professions within this field to identify broad represented skills, such an exploratory approach was selected. One potential contribution of this analysis, using a semi-systematic literature search approach, could be the ability to map out a relatively new research field and identify skills needed in more sustainable agriculture, synthesise the state of knowledge, needs and demands, and create an agenda for future research.

This literature review was carried out as part of the EU Horizon 2020 Nextfood project as part of a mixed-method report on the skills required in the context of the agri-food and forestry system [28]. For a successful literature search, a three-step methodology was adopted to capture relevant sources and ensure a rigorous and repeatable method: (i) the generation of keywords and search strings, (ii) a semi-systematic search, and (iii) extraction of skills.

2.1. Generation of Keywords and Search Strings

Based on a keyword generation process among the Nextfood project consortium partners, a group of interdisciplinary and international researchers, 21 keywords associated with sustainability, agrifood systems, and education were identified, grouped into clusters, and developed into three search strings. These searches were conducted between December 2018 and March 2019 in different scientific databases for a broad subject coverage: Web

of Science, Scopus, EBSCO, and PROQUEST. This search was followed up by a literature search in July 2020 to provide an updated literature review.

The search strings created were: (1) (skill* OR competenc* OR knowledge) AND (agricult* OR agroecolog* OR agri-food*) AND (sustainab* OR resilien* OR environment*), (2) (skill* OR competenc*) AND (agricult* OR agroecolog* OR agri-food*) AND (sustainab*), and (3) (Skill* OR competenc OR learning*) AND (Sustainab*) AND (Farmer* OR Agronomist*).

2.2. Semi-Systematic Literature Search

The literature search was undertaken by adopting a qualitative and semi-systematic approach. This strategy is used to identify phenomena, concepts, or knowledge gaps within the literature [29]. In this case, our research question required the qualitative collection of data. An integrative review approach was useful, as the purpose of the review was not to cover all the articles ever published on the topic, but rather to combine perspectives to create new connections [29]. The inclusion criteria for the initial search included peer-reviewed articles written in English and published in the ten years between 1 January 2010 and 31 December 2019. The three search strings produced (1) 1238, (2) 522, and (3) 514 results. These articles were scanned for relevance by three researchers, who have different scientific backgrounds and nationalities, by their title and keywords and had to include a relevant number of the selected keywords. This step produced a list of 60 articles reviewed for eligibility from their abstract. This step resulted in a list of 27 studies split between the researchers and read in full, leading to the exclusion of a further seven studies that were not relevant for the final research purpose of identifying the skills necessary for actors in the agricultural system. The majority of the relevant selected peer-reviewed articles had a context within agriculture, and some of the articles were concerned with the broader food system perspective. Through this review process, a final list of 20 relevant articles was produced and is shown in Table 1.

Table 1. The 20 peer-reviewed articles that this literature review built upon.

1. Cerf, M., Guillot, M.N., Olry, P., 2011. Acting as a change agent in supporting sustainable agriculture: How to cope with new professional situations? Journal of Agricultural Education and Extension, Volume 17, Issue 1, Pages 7–19
2. Cerutti, Alessandro, et al., 2017. On the use of Life Cycle Assessment to improve agronomists' knowledge and skills toward sustainable agricultural systems. Visions for Sustainability, Volume 7, June 2017, pages 38–53
3. Charatsari, C., Lioutas, E.D., 2019. Is current agronomy ready to promote sustainable agriculture? Identifying key skills and competencies needed. International Journal of Sustainable Development and World Ecology, Volume 26, Issue 3, 232–241
4. Darnhofer, I., Bellon, S. Dedieu, B., Milestad, R., 2010. Adaptiveness to enhance the sustainability of farming systems. A review. Agronomy for Sustainable Development, 30(3), 545–555
5. Davidson, E., 2015. More Food Low Pollution (Mo Fo Lo Po): A Challenge for the 21st Century. Journal of Environmental Quality, 44, pp.305–311
6. Duru, M., Therond, O., Martin, G., (. . .), Bergez, J.-E., Sarthou, J.P., 2015. How to implement biodiversity-based agriculture to enhance ecosystem services: a review. Agronomy for Sustainable Development, 35(4), pp. 1259–1281
7. Dwyer, J; Berriet-Solliec, M; Lataste, FG; Short, C; Marechal, A; Hart, K., 2018. A Social-Ecological Systems Approach to Enhance Sustainable Farming and Forestry in the EU. EUROCHOICES Volume: 17 Issue: 3 Pages: 4–10
8. Francis, C.A., Jensen, E.S., Lieblein, G., Breland, T.A., 2017. Agroecologist education for sustainable development of farming and food systems. Agronomy Journal, Volume 109, Issue 1, Pages 23–32
9. Herrera-Reyes, Ana; Martínez-Almela, J., 2018. Project-Based Governance Framework for an Agri-Food Cooperative. Sustainability, Vol.10(6), p.1881

Table 1. *Cont.*

10. Hilimire, Kathleen., 2016. Theory and Practice of an Interdisciplinary Food Systems Curriculum. NACTA Journal, Vol.60(2), pp. 227–233
11. Ilieva, R. T. and Hernandez, A., 2018 Scaling-Up Sustainable Development Initiatives: A Comparative Case Study of Agri-Food System Innovations in Brazil, New York, and Senegal. SUSTAINABILITY Volume: 10 Issue: 11 Article Number: 4057
12. Kerry, J; Pruneau, D; Blain, S; Langis, J; Barbier, PY; Mallet, MA; Vichnevetski, E; Therrien, J; Deguire, P; Freiman, V; Lang, M; Laroche, AM., 2012. Human competencies that facilitate adaptation to climate change: a research in progress. International journal of climate change strategies and management Volume: 4 Issue: 3 Pages: 246–259
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14. Lankester, A.J., 2013. Conceptual and operational understanding of learning for sustainability: A case of the beef industry in north-eastern Australia. Journal of Environmental Management., 119, pp. 182–193
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2.3. Extraction of Skills Identified in the Literature Search

The analytical formation of categories of skills was performed by identifying from each article any mentioned skill or phrase that might emphasise a skill, competence, and/or knowledge required. Every necessary potential skill identified was compiled in an initial list. For example, '*understanding complexities in agricultural systems*' [30] is identified as a need for a systems perspective, and includes skills to navigate in a broad agricultural system.

This list identified a total of 164 skills. A mapping process was performed to group them into tentative themes. Therefore, words and phrases pointing to similar concepts and/or meanings were categorised into the same theme. This process led to the 164 skills identified from the peer-reviewed literature being condensed into five categories of skills, which are listed in Table 2.

3. Results

It became clear that the skills emphasised in the scientific literature selected for this review are more about directing the perspective in order to succeed in making a transition towards sustainable agriculture, rather than training professionals in specific skills. What stood out in the literature is that sustainability is associated with managing the present and future agriculture, and that this requires a broad and holistic approach in learning and practising sustainable agriculture. The categories of skills identified and listed in Table 2 are not necessarily in the order of those most emphasised in the literature; instead, they provide a thematic categorisation of most emphasised topics. Accepting that the following categories of skills should not be perceived as fixed categories, it is important

to make clear that no single category pre-exists any other; rather, they are interdependent and overlapping. Table 2 presents the primary contribution of the 20 articles in the five identified categories of skills. Some of the articles may have inspired other categories without being referenced in the specific category.

Table 2. Table 2 presents the five identified categories of skills and the primary contribution of the 20 articles.

3.1 Systems perspective	Francis et al., 2017; Hilimire, 2016; Cerf et al., 2011; Cerutti et al., 2017; Duru et al., 2015; Laforge and McLachlan, 2018; Warbach et al., 2012; Dwyer et al., 2018
3.2 Lifelong learning	Davidson et al., 2015; Cerutti, 2017; Francis et al., 2017; Charatsari and Lioutas, 2019; Šūmane et al., 2018; Bennett and Franzel, 2013; Darnhofer et al., 2010; Duru, 2015, Hilimire, 2016
3.3 Knowledge integration	Herrera-Reyes et al., 2018; Triste et al., 2018; Duru et al., 2015; Bennett and Franzel, 2013; Kerry et al., 2012; Cerf et al., 2011; Laforge and McLachlan, 2018; Šūmane et al., 2018; Moschitz and Home, 2014; Nguyen, Seddaiu and Roggero, 2014; Lankester, 2013; Darnhofer et al., 2010
3.4 Building and maintaining networks and learning communities	Laforge and McLachlan, 2018; Šūmane et al., 2018; Herrera-Reyes et al., 2018; Charatsari, 2019; Ilieva et al., 2018
3.5 Technical and subject-specific knowledge and technology	Duru et al., 2015; Cerutti et al., 2017; Cerf et al., 2011; Darnhofer et al., 2010; Herrera-Reyes et al., 2018; Ilieva et al., 2018

3.1. Systems Perspective

There is common agreement that knowledge about systems is crucial to understanding the complexity of sustainable agricultural practices. However, there is no clear nor common understanding of what a system is or how to define it, or what a systems perspective requires from knowledge, awareness, or skills if that potential is to be fulfilled. This section explores the complex and abstract body of 'systems perspectives' highlighted in the scientific literature. Therefore, a systems perspective should not be considered a closed concept. Instead, we want to explore its diversity to understand what a systems perspective is in future sustainable agriculture. When categorising the skills within this category, it became clear that the literature perceives systems and systems perspectives differently and from different scientific positions/paradigms. Overall, we identified the systems perspective as twofold: as a broad and holistic perspective of a system, including different stakeholder groups, sectors, and/or disciplines, and as a micro perspective including a limited disciplinary focus. Our scientific openness to a systems perspective resulted in this perspective being identified in almost all the articles in the literature review in one way or another. The literature represents the systems perspective through concepts such as 'systems thinking' [2,11] or by descriptions that we have condensed and/or interpreted as a systems perspective. A systems perspective is represented in the literature as a tool that supports effective learning to address complex problems in the contemporary food and agricultural system [2] and as an awareness of situations as multi-dimensional which needs to be taken into consideration [31]. Examples of such tools include *embracing the advisory situation as a whole*, or that *advisers need to be aware of the various dimensions of the situation so that they can identify the diversity of situations they encounter, and adjust to it* [31]. Besides these broader representations, a systems perspective is also represented as a system within a more 'closed' system, such as ecological processes, ecosystem services, or agroecological principles (however, this one has many different and contradictive definitions attached that we do not go into here), or as the integration of technical knowledge, which in this context means integrating different disciplines into practice. This involves only including technical

disciplines and thereby excluding social disciplines and society in general [13,30]. This is a common tendency in the literature concerned with the technical and environmental implications of sustainable agriculture.

Furthermore, systems are used as a concept to describe practices, for example, agricultural systems, farming systems, and food production systems—all referring to agricultural practices in a system. This perspective is grounded in traditional conventional agronomy, involving systems that focus on soil systems or ecosystems. These systems are very important for practitioners working on farms, for example, to understand bio-mechanisms in the soil. Nevertheless, the literature also emphasises that there is a need to zoom out from these on-farm knowledge practices and include a broader perspective that includes society, locally and globally, to manage future sustainable agriculture.

From a broad and holistic perspective, the literature highlights, e.g., the need for knowledge institutions and education to incorporate systemic perspectives or 'systems thinking' and experimental approaches that not only include specific technologies or specific disciplines, but also incorporate multiple stakeholder groups, various perspectives, and different institutions [11,32,33]. This emphasises a perspective that crosses disciplines, stakeholders, and institutions. 'Systems thinking' is particularly used as a way of thinking in systems, for example, as a learning strategy for students [11]. In other articles, a 'systems perspective' is not directly demanded, but the importance of being aware of complexities is, for example, the complexities involved in 'real-life' practices [30], including the importance of involving perspectives and knowledge from farmers' own experiences and individual practices [14,31] and being aware of the surrounding society [34]. To 'incorporate awareness of complexities' has been coded as a systems perspective, as it involves the perspective of real-life practices and the inclusion of individuality, context, and society. Individuality, in this case, is important because it represents heterogeneity, which is an unavoidable factor when dealing with sustainable agricultural systems.

Another example of how a system perspective is presented comes in the article by Laforge and McLachlan [32]. They represent systems as not limited or isolated within different sub-systems, but as inclusive and diverse in their existence. Laforge and McLachlan [32] give an example of the situation in which farmers, and their learning communities, are involved about a systemic perspective: *These learning communities are situated within systems of government regulations, international legal frameworks, infrastructure, weather patterns, soil conditions, seed genetics, food traditions, and cultural values, as well as knowledge around growing and eating a wide diversity of foods* [32]. This example shows the complexity and diverse reality of the system in which farmers and other professionals in the agricultural sector are involved, and of which professionals need to be aware to navigate a future sustainable agricultural system. An agricultural system in this review is therefore defined as a broad and inclusive system that can be both contextual and individual as well as structural and global. Most importantly, an agricultural system is dynamic and heterogenic in its representation, and professionals have to be able to navigate through this system to deal with the transition towards more sustainable agriculture.

The concept system is also used as a political argument and as a stepping-stone for talking about alternative vs. conventional food systems. It becomes clear in the literature that there is a contradiction and disciplinary clash between conventional agriculture and alternative agri-food movements. For example, the article by Francis et al. [11] describes agroecology as a discipline with a systemic perspective that addresses criticism of the present agricultural paradigm with arguments such as there being a need to *replace 'Monoculture Mentality' with diverse and creative thinking* [11] and *evolve from a short-term 'Anthropocentric' focus to 'Ecosystems' thinking* [11]. This perspective highlights different scientific paradigms and disciplines, which are negotiated in these articles. Firstly, there is an assumption that a systemic perspective is presenting a change in perspective from what we have done and thought about agricultural practices to what we would like to do and think about them in future.

Nevertheless, the concept of systems and a systems perspective continues to be defined in relation to scientific paradigms and disciplinary traditions, as well as to context. Therefore, a systems perspective needs to be broadened and perceived as situated in individual contexts to include the skills and competencies needed in a transition.

3.2. Lifelong Learning

Lifelong learning in this literature review is identified as an ongoing process of learning and adapting to a changing world on both local and global levels. The need for lifelong learning and continued education has been well-documented in the literature as being important in a transition towards a more sustainable agricultural system, not only for farmers and other practitioners but also for the private sector, retailers, and crop advisers [35]. In particular, the ability to be adaptive is a general competence that is argued for in the literature. This adaptiveness involves different perspectives depending on the context, profession, and/or scale in time and space, which is explored in this section: firstly, being able to enhance and challenge one's knowledge and understanding of sustainability from a long-term perspective, deal with or learn how to adapt to uncertainty and complexities in future, and be proactive through experimenting.

The articles concerned with lifelong learning are also studies about learning, understanding how learning happens, and for whom learning is important to engage in a sustainable agricultural system. Awareness of this learning perspective has particularly increased in studies concerned with stakeholder education and learning within agricultural and food systems. However, lifelong learning is not a new phenomenon but is changing in perspective from only being associated with learning institutions and education to being part of everyday life practices. However, lifelong learning is not perceived in the same way in the literature. Some represent lifelong learning through institutional and formalised practice, while other articles represent it through hands-on practice, real-life practices, network communities, and a mindset of being proactive.

In some of the articles, lifelong learning is characterised as a practice linked to institutionalised settings, in universities or other educational institutions, for professionals in the agricultural system. These articles argue that continued education and lifelong learning are important for students in higher education [11] as well as professionals already engaged in agriculture systems, to continually increase and enhance knowledge about sustainability and qualified sustainable transitions across sectors, professions, and disciplines [30,35]. For example, in the study by Francis et al. [11], they conclude that placing responsibility on students to encourage autonomous learning and prepare them to deal with uncertainties and complexities in future agricultural practices is essential for their future engagement with new knowledge and self-reflection [11]. Another study by Charatsari and Lioutas [17] argues that there is a need to develop lifelong learning programmes for agronomists to enable and motivate them to facilitate farmers' personal and entrepreneurial change, and to facilitate the creation of constellations of actors, such as linking farmers with other producers, institutes, suppliers, and consumers [17]. In this perspective, lifelong learning is directed at agronomists to enhance their own ability to facilitate change for individual farmers. This might be understood as a more practice-oriented focus, while the first example is lifelong learning to facilitate self-reflection and new knowledge at the student level.

The second recognised theme within this category is about being able to deal with, or learn how to adapt to, uncertainty and complexities in the future. The ability to live with change and uncertainty [15] and have the capacity to respond to changing natural and agronomic conditions [36] is greatly emphasised in the articles. Various events are challenging agricultural systems, such as more stringent quality requirements, new environmental regulations, debates on genetically-modified crops, extreme climate events, the revision of the Common Agricultural Policy and consequences of the financial crisis. These all create uncertainty, risks, and opportunities about the future agricultural system [37]. However, living with uncertainty is not a new discipline for farmers, who are used to uncertainty about weather prediction and market prices, for example. However, with globalisation and

issues related to climate change, uncertainty has become more diverse as the categories expand and put pressure on the pace of change [37]. This does not ignore the fact that the agricultural system is and always has been undergoing some sort of change, but the change is no longer just about production and economic development but involves new non-economic interests. Another example of how the need for skills to be able to adapt to constant change has increased is ensuring a flexible farm organisation that increases the options for new activities for the farmer and his or her family [37]. The last theme identified in this category is the ability to be proactive through experimenting. Skills related to lifelong learning for and with a sustainable agricultural system are about reacting to new demands and changes, locally and globally. However, it is as important to learn how to be proactive towards change through skills such as being able to carry out basic experimentation, and problem-solving [2,13,17]. This calls for skills in thinking innovatively and being creative.

Lifelong learning is about adaptiveness and being able to react and respond to changes, as well as being proactive. This requires actors and actor groups to enable an ongoing process of learning and knowledge along the path to transition, including different actors at the local farm level and actors at a global agricultural systemic level, as well as actors in educational programmes. Furthermore, it also requires a willingness to engage in ongoing changes and knowledge developments, which often involve adapting to innovation and new technologies. This perspective will be further elaborated in the results section concerning technical and subject-specific knowledge and technology.

3.3. Knowledge Integration

More and more studies highlight the need to integrate different kinds of knowledge to overcome the challenge and move towards more sustainable agriculture. All the articles in this review are concerned with 'knowledge' in one way or another to describe the needs and potentials to move towards more sustainable agriculture. However, we do not intend to fully present what 'knowledge' covers in these articles, but rather explore the need for knowledge integration. The articles particularly show that it is necessary to integrate farmers' own experiences and knowledge to create more sustainable rural areas and manage a sustainable transition [14,16] or even describe a gap between the theoretical knowledge base and practical, local experienced knowledge [13]. This category of 'knowledge integration' will examine the need for knowledge integration highlighted in the literature and explore the related skills and competencies.

In the literature, 'knowledge' is used to describe what is relevant to know in order to deal with a sustainable transition. Most of the articles relate knowledge to different scientific disciplines, especially agronomy and technical knowledge, or other kind science-based knowledge. This is also referred to as formal knowledge and is related to what is called informal knowledge, which is experienced knowledge, such as hands-on knowledge and know-how. The literature has different ways of expressing these two perspectives of knowledge, and notions such as local knowledge [36,38], farmers' own knowledge [15,31,32], and tacit knowledge [16] are also used in the category of informal knowledge. Then, there is interdisciplinary knowledge [35], however, which still refers to science-based knowledge and knowledge gained in an institutionalised educational setting. The literature expresses a need for these two kinds of knowledge to be integrated, and some articles call this need a necessary change in how knowledge is perceived from a thing that can be transferred to a process of relating and negotiating meaning [12]. Another article describes this integration of knowledge as hybrid knowledge [39]. Besides these two-sided perspectives of knowledge, there is also a theme about knowledge in relation to learning. One article highlights how putting farmers' knowledge back at the centre means that independent and social learning is happening, which can advance a more progressive sustainability agenda in the food system [32]. With this focus, the article also sheds light on and problematises the conventional knowledge represented by most of the institutional venues as something that is not promoting a sustainable agricultural system for the future [32]. Another article emphasises that knowledge can be experimental or about different knowledge systems,

such as systems perspectives, and, for example, that local knowledge can be based on different conceptualisations of the world compared with science-based knowledge about farm management [37]. Another article takes as its starting point a social co-creation process of learning rather than a fixed knowledge transfer [40]. This perspective points towards the integration of informal, local knowledge to achieve a broader and more diverse understanding of the world, in opposition to existing educational institutions.

However, it is not simply about adjusting to new knowledge practices. This is emphasised in the article by Cerf et al. [31] as they investigate and discuss the role of being a change agent in a new professional situation. The study points out that change agents (advisors) need to step out of their historically built professionalism and develop new ways of integrating scientific and technical knowledge with farmers' knowledge to enable farmers to develop a new understanding of their unit of action and how to materialise it in farming practices [31]. Such new approaches are not only based on new forms of verbal interaction but also imply new ways of mobilising the field visit or the experimental data and evaluation criteria [31].

There are different levels of complexity when examining farmers' knowledge versus science-based knowledge. One article by Šūmane et al. [15] focuses on two interrelated kinds of knowledge: local knowledge and farmers' knowledge. Here, local knowledge encompasses dynamic and complex bodies of know-how, practices, and skills, developed and sustained over time based on local people's experiences in their environmental and socio-economic realities. Farmers' knowledge is a sub-set of local knowledge that enables them to farm in specific local conditions. It is based on their practical experience and often linked to a practical skill. As agriculture is highly dependent on the local environment, local farmers' knowledge is of particular importance as it contains an intimate understanding of the particular set of local cultural and natural resources [15].

However, the tendency is that knowledge per se is related to disciplinary or scientific knowledge, and the literature is asking for the integration of the experienced knowledge and know-how with individual, contextual knowledge. Some articles define these two categories of knowledge as formal and informal, while other articles define them as scientific knowledge and experienced or local knowledge. Nevertheless, knowledge is firstly formalised into institutionalised contexts, know-how, and practical experiences, and experimental knowledge is categorised as being outside these institutions. This division challenges the divided relationship between traditional educational practices and real-life practices and advances a need to move beyond this rigid division and present new knowledge paradigms that emphasise a more dynamic, fluid, and inclusive basis where interdisciplinary knowledge, practice and know-how, and proactive and innovative experimentation are included. Nevertheless, it is interesting to ask the question about how knowledge is perceived and what kind of knowledge is accepted in which contexts, as well as what knowledge implies concerning a sustainable agricultural system.

3.4. Building and Maintaining Networks and Learning Communities

The importance of networks and learning communities is frequently highlighted in the literature and includes practices of sharing knowledge and experiences to move towards a more sustainable agricultural system. Networks and learning communities as a category in this review cover the skills for building and maintaining networks, as well as building and maintaining learning communities within these networks. This category builds upon articles which connect learning communities and networks of associated stakeholders, such as farmers, with a positive influence in the transition towards a sustainable agriculture. Furthermore, there is not a coherent linkage between networks and learning communities and sustainable agriculture, but different understandings of the objective and/or effects of these networks. Firstly, the 'network and learning community' phenomenon is grounded in contextual settings, which means that they may look very different from context to context, depending on the profession and the setting or situation. However, there is a common theme within this category, namely the proactive effect of creating networks,

and networks and learning communities in the context of sustainability become activistic and innovative, as social relationships in these networks are shown to foster collective action [14,41]. The literature points out that the potential and need for building and maintaining networks and learning communities provide opportunities for farmers who want to develop an alternative pathway towards a sustainable agricultural system in contrast to conventional farming practices [15,32], as these networks have the potential to cultivate new ideas and voices that have not been listened to before, such as female farmers and those from urban, non-agricultural backgrounds [32]. A consistent trend in the literature is that networks and learning communities within sustainable agricultural do not just contribute to professional knowledge sharing and giving advice to one other but encourage and address a shift towards an alternative (and more) sustainable agricultural system. Furthermore, these networks are not to be understood as an isolated knowledge network, but rather as mutually depending on a broader system. For example, one article highlights the potential of these networks indirectly influencing at a food system level in terms of political issues, such as the policy of seed ownership [32]. In this article, they use a metaphor to describe a network and the inherent potential and responsibility to move knowledge and opportunities to where they are needed. They depict the network as the ecological and mutual symbiosis between fungus and plants called mycorrhiza. This metaphor becomes facilitatory for an exploration of how underground rhizomes support farmers' learning communities in the same way as fungal structures reach out and act in the soil to support vascular plants [32]. The article concludes: *in an era of digital technologies, mycorrhizal connections and associated learning communities need not be situated in place; however, they can be fluid, diversified, and self-organised and may create the impression of unseen, subterranean connections among actors within a global food and farming movement* [32]. Herrera-Reyes et al. [14] explored the relevance of farmers' knowledge and social learning practices in the construction of alternative pathways in sustainable agriculture and the strengthening of project-based governance [14]. In this study, social learning communities include interpersonal relationships, feelings of belonging, trust and commitment, and friendship, all essential for a learning community. Furthermore, actions that lead to learning from collective actions contribute to social cohesion in an organisation, and these actions are linked to the exchange of information, experiences, and mutual help [14]. In addition, another study by Ilieva and Hernandez [41] highlights the effect of grassroots innovations in contrast to top-down governance projects and interventions [41]. In this study, grassroots initiatives have an impact on socioeconomic inequalities by introducing innovations, such as Community Supported Agriculture (CSA), an initiative where the local community financially supports local farms and farmers [41]. Network building is also about building stronger social sustainability that likewise affects the economic and environmental dimensions of sustainability. Another important part of building networks and learning communities is the need to build and grow partnerships by linking participants with different power relations across government and market institutions. This partnership has the potential to translate key values that might be neglected or taken for granted in terms that can be advantageous for mainstream actors in the socio-technical agricultural system [41].

In the literature, learning communities are identified as improving skills, such as the ability to solve internal conflicts and build knowledge capacities [15,17], and thinking across institutions, power hierarchies, and markets. However, building and maintaining networks within the agricultural system is not a single thing or arrangement that can easily be studied or operationalised, and skills related to this category are not univocal but multiple. The skills related to this category are, thus, to possess the ability to integrate networks and learning communities locally in the contextual setting, socially engage with others, and be willing to share experiences and knowledge as a common good.

3.5. Technical and Subject-Specific Knowledge and Technology

In the literature review, technical knowledge is emphasised as fundamental but changing in perspective, and in this section, we explore this transformation of technical knowledge and technology in relation to a sustainable agriculture. It is not within the scope of this article to examine what specific technology or technical skills professionals and farmers need to operate in and manage the sustainable transition at the farm level, but rather to analyse the representation and emphasis this receives in the scientific literature.

The need for more sustainable agriculture is often related to adverse environmental effects such as biodiversity loss, climate change, erosion, and pollution of air and water. This focus often leads to solutions that increase the level of provisions of ecosystem services, such as focusing on solutions such as soil fertilisers or other biological regulations of the soil [13]. Technical knowledge is often associated with a specific practice and is something that students are taught at technical universities [30]. It is shared in local as well as global learning communities, especially by farmers and advisors. Thus, in this literature review, we do not deny that the development of robots and other kinds of software initiatives will have a huge impact on future practices in agriculture, but this is not something that is emphasised in the literature selected for this review and therefore is not examined here. However, technical knowledge is emphasised in the literature as something that changes in perspective in line with the demand for more sustainable agricultural practices. The articles emphasise a shift in perspective, from putting productivity first and sustainability second to focussing on sustainability, in the Brundtland sense, as parallel and inclusive. This builds on the insight that only a sustainable agricultural system can be productive in the long term and meet the UNSDGs. In this change, 'change agents' and advisors find it difficult to navigate a new role and relationship with the farmers, and this uncertainty leads to doubt about their expertise in terms of technical skills and competencies. Previously, advisors and change agents have perceived themselves to be experts at providing technical knowledge to farmers to help them innovate their practices [31]. However, a changing system also requires a changing relationship between actors in the system who rely on each other's practical experiences, experimentations, and scientific research.

Since the 1970s, technology and technical innovation have dominated the agricultural sector and succeeded in increasing income and yields, both in relation to crops and animal production. Thus, in the past decade, more and more critical voices have pointed out the consequences of optimisation and maximisation of income and the need to decrease our environmental footprint [37]. The articles in this literature review present a perspective towards sustainable agriculture that is critical of the previous dominant normative understanding and use of technology and technical solutions at the farm level. This criticism particularly points to the goal of stability, income maximisation, technical fine-tuning, or biological optimisers by controlling processes, reducing the range of natural variation in the farming system, and stabilising farm output to ensure an efficient and stable supply of goods and services [37] as problematic. As well as the 'one-size-fits-all' recommendations and the transfer mode that is mainly a top-down process towards farmers [13], it presupposes that the world is understood as stable and that farmers are a homogenous group. However, this reductionist perspective is encountering many critical voices expressing a need to balance it with concepts such as adaptability, resilience, and flexibility [37]. To do this, the articles by Francis et al. [11] and Ilieva and Hernande [41] highlight the importance of subject-specific knowledge that focuses on alternatives to improve soil health and intensify soil capacity, through agroecological principles with crop rotation, organic inputs, and soil covers [41]. Agroecological principles are here defined within a broad perspective, including both environmental, economic, and social dimensions of managing a farm. The study by Ilieva and Hernande [41] illustrates how environmental conditions are intertwined with social conditions and poverty, as some countries experience Sahara-like conditions where there once was forest, and the effect on the socioeconomic status in that area. Through land and farming managing techniques, such as reforesting and soil restoring techniques, these areas will be improving in all three dimensions [41].

Technical knowledge is acknowledged as a discipline that needs to be discussed and developed in collaboration with companies, practitioners, and scientists. One article expresses the importance of alliances between organisations (for sustainable agriculture) and research centres and universities to promote technological advances related to organic farming, as there is a need to develop new sustainable strategies that do not depend on harmful chemical substances [14]. Specific skills within technical knowledge and technology are not emphasised as the main problem—rather, it is emphasised that technical skills include reducing the ecological footprint of agricultural production, using soils and biomass as carbon sinks, watershed management, enhancing biodiversity on a landscape level, tightening nutrient flows (i.e., nitrogen and phosphorous), and reducing pesticide use. Moreover, technology and technical knowledge likewise tap into the huge developing area of software technologies. For example, one article highlights that there is a potential in focusing on using versions of LCA (life cycle assessment) software to understand the importance of metrics in accounting for environmental sustainability [30]. In this sense, technology is also software and a method for understanding sustainability in higher education.

There is a tendency to mention technical knowledge as an independent and unavoidable factor when dealing with sustainable transition in the agricultural system. However, none of the articles reflect on technical perspectives in a process of redefining technical knowledge in a sustainable agricultural system. It is thus important to raise questions about what technical knowledge, skills, and competencies look like in future sustainable agricultural practices, and whether there is a need to unpack the concept of 'technical' and 'technology' with sustainable agricultural systems to acquire a better understanding of the components, practices, and materialities that make up what they are in relation to the matter of reference.

4. Discussion and Conclusions

This literature review was designed to identify and analyse skills needed for professionals in the agricultural system to move towards, and navigate within, sustainable agricultural practices. We have analysed how skills are represented in the articles, and the implications this may have in practice, as well as in future sustainable practices. In a thorough qualitative reading, we identified five main categories of skills that were given thorough consideration in the literature. The five categories were 'systems perspective', 'lifelong learning', 'knowledge integration', 'building and maintaining networks and learning communities', and 'technical and subject-specific knowledge and technology'.

This review built upon a qualitative semi-systematic literature review, which means that it included a limited and systematic selection of articles. This method was chosen to obtain a more thorough analysis of how skills are represented in relation to sustainable agriculture in the scientific literature. It became clear that this topic of skills needed in sustainable agriculture is still an evolving and developing field of research. This review provided an analysis that not only categorised but also provided insight into how skills and categories are emphasised and represented in the scientific literature in relation to sustainability. This insight is interesting as it sheds light on the manifold usage of complex concepts such as 'system' or 'network' or 'technical knowledge' and what constitutes these concepts.

A systems perspective responds in particular to the required need for a broad and more 'whole-picture' perspective that is generally acknowledged as important in agriculture of the future. We need to move beyond known practices, silo thinking, quick fixes, or best practices as well as the linear learning approach, and integrate the complexities of agricultural practices. The skills that relate to this category are the ability to zoom out from individual practices on the farm level, including different actors and various perspectives, as well as to understand the relatedness of different practices. This also requires a personal willingness and openness to understanding the possibilities of a broader perspective. The category of 'lifelong learning' highlights the importance for actors on different levels to engage in an ongoing process of learning and adapting knowledge along with the transition.

In the review, lifelong learning is emphasised as already relevant in the early years of study as it fosters early self-reflection and attitudes towards a constantly changing practice. It is also relevant for agricultural professionals who have been practising for several years, perhaps especially so for them. The skills embedded are innovative and creative thinking and being able to experiment, but also problem-solving, critical thinking, and the ability to receive and create space for support from employees, family, and/or local society. Besides these, lifelong learning also encourages a discussion about learning as a practice that needs to be reviewed, as studies show that we need to discuss how we educate the future generation of professionals for a transition towards sustainable agriculture. There is growing interest in developing a more iterative and multi-dimensional understanding of learning and educating. Awareness of this perspective has grown in studies (including the articles in this review) concerned with the education and learning of actors within agricultural and food systems. Especially, we see a turn in these studies, from classical learning theories based on positivist imaginaries of knowledge acquisition and scientific inquiry as objective and extractive activities, towards subjective and contextual ones [42]. However, the dominant learning model within agricultural studies has been, and remains, a linear process from scientist to student or farmer [42]. This warrants further exploration of the transition towards a more learner-centric educational approach where real-life practices, context, and subjectivity/heterogeneity are the basis for the understanding and operationalisation of skills and curriculum.

Integration of knowledge, especially formal and informal knowledge, is shown to be essential in the literature. However, knowledge is understood as a broad term that relates to the specific context it is defined in. This category emphasises the need to integrate different kinds of knowledge experienced and obtained by different actors in agriculture. We identified two overall categories of knowledge emphasised in the literature, formal and informal knowledge; however, it is important to make clear that this division does not provide an entirely accurate picture of the different knowledge types that exist among agricultural professionals. Formal knowledge represents scientific and generic knowledge and informal knowledge represents contextual and individual experienced knowledge. Within these two categories, there are many different variations and expressions of knowledge by different actors that can also be placed between or across the here-defined formal/informal division. The skills within this category enable the actors to combine scientific knowledge with experienced and context-specific knowledge, and to understand and operationalise global issues and solutions with individual local and contextual settings. This category of skills is especially important for future agronomists and 'change agents' who need to facilitate change at the farm–society level. Integrating knowledge can be facilitated in networks, and networking and creating and maintaining networks and learning communities is the fourth category identified in this literature review. 'Creating and maintaining networks and learning communities' is a category that particularly covers new farmer networks and learning communities that foster alternative and proactive initiatives through knowledge sharing. In the literature, networks are described as something that has the potential to cultivate new ideas and give voice to a broader and more diverse group of farmers, such as female farmers and farmers from urban, non-agricultural backgrounds. This is particularly important because the transition towards a more sustainable agricultural system requires a shift in perspective and the inclusion of different voices and perspectives. Future agriculture will include a more diverse group of actors, whom not all are familiar with, for example, long farming traditions, but come from diverse scientific backgrounds. Therefore, it is simply not possible to describe different actor groups, such as farmers, as a homogenous group. The articles in the literature review already represent a diverse group of farmers and other actors, as they are placed in different contextual settings. The skills identified in this category are for actors to have the ability to build diverse knowledge capacities, seek out new or existing networks, share knowledge with different actors, and understand the value and potential of these networks.

The fifth category was 'technical and subject-specific knowledge and technology'. This category exists because technical knowledge and subject-specific knowledge, such as theory within agronomy, ecosystems, and economy, are essential when working with and within the network of agriculture. However, we also raise a question about what skills are needed in this category of technical knowledge. This question is relevant as discussions about sustainability often result in a technical solution or future sustainable agriculture that depends on technical and technological solutions. In this review, we do not examine in depth what the technical solutions are and what they should look like. Rather, we highlight the need to learn how to navigate the technical and technological developments that are constantly evolving.

This review highlighted ambivalence to sustainability skills as they do not fit the classical understanding and idea of what skills are, and how these should be integrated into educational settings. Agricultural education today should not only encompass technical knowledge, but also the social skills and competencies within a systems perspective, continuous learning, integration of knowledge and networking, and motivation and openness to engage in a dynamic and changing world. These categories emphasise the need to go beyond skills as something related to subject-specific disciplines and include a broader knowledge capacity. As already mentioned, these categories are not to be understood in isolation, but rather as interdependent. Furthermore, the implications of the results for practice means that these categories are extracted from different contexts and have to be operationalised in other contexts that make sense for that specific case, practice, and context. In this sense, we argue that transdisciplinary development is necessary for our common sustainability agenda.

The particular contribution of this review is to offer an understanding of 'sustainability skills' in the context of agriculture as being relational and context-dependent. Sustainability, and the definition of sustainability in relation to agriculture, is defined within many different perspectives, scientific disciplines, and practical experiences/values in the scientific literature and practice. However, the definition of sustainability is still a relevant debate—especially when discussing 'sustainability skills' in an educational context. Thus, we find it very important to highlight that sustainability is dynamic and inclusive, allowing contextual differences and relationships to exist. The categories of skills identified in this review have the potential to go beyond skills as something static and discipline-specific and push forward a discussion about how skills need to be interpreted and integrated into future educational programs and curricula. Furthermore, we conclude that integrating a fruitful and successful transition requires a diversity of actors with different perspectives, experiences, and scientific knowledge. Another finding was that sustainability as a concept becomes blurred in the review as the articles represent different dimensions of sustainability and highlight examples that relate to their specific cases. That sustainability is not clearly defined in these articles is not a problem in itself; thus, we acknowledge potential in exploring how the scientific literature represents and describes sustainability as a concept. We recommend continued research into future education programmes, Environmental Sustainability Education (ESD), and curriculum development for future programs, and the integration of these perspectives and categories in discussions about how 'sustainability skills' can be assessed, evaluated, and operationalised in education and life-long learning processes.

Author Contributions: Conceptualization, L.B.S., L.B.G., S.R.H. and N.H.K.; Methodology, L.B.S., L.B.G., S.R.H. and C.R.; Supervision, S.R.H. and N.H.K.; Writing—original draft, L.B.S.; Writing—review & editing, L.B.S., L.B.G., S.R.H., C.R. and N.H.K. All authors have read and agreed to the published version of the manuscript.

Funding: This research was funded by the European Union's Horizon 2020 Research and Innovation Programme under grant agreement no. 771738 (Nextfood project).

Acknowledgments: The authors thank the NextFOOD consortium and WP 1 partners for support and review of earlier drafts. We thank Anne Clausen for helpful comments throughout the process and Ane Kirstine Aare for reading and commenting on the final draft.

Conflicts of Interest: The authors declare no conflict of interest.

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Acta Universitatis agriculturae Sueciae
Doctoral Thesis No. 2023:22

This thesis investigates how the knowledge and innovation system in Swedish horticulture can be reinforced in order to meet current and future challenges. The results are a contribution to the debate around different perspectives of knowledge and innovation systems, and highlight how changes in the everyday work at the micro-level are a precondition for system level change.

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ISSN 1652-6880
ISBN (print version) 978-91-8046-096-5
ISBN (electronic version) 978-91-8046-097-2