CROP UP!

Adoption and value chain organisation in crop diversification transitions

Chiara Sophia Weituschat

Propositions

1. Simplistic framing of farmers' choices ignores the systemic barriers to sustainable agricultural transitions.
(this thesis)

2. Value chain formation is a crucial obstacle in the diffusion of crop diversification that needs institutional support.
(this thesis)

3. We can accelerate knowledge creation on farmer behaviour by learning from cases in different institutional contexts, regardless whether these are in the Global North or Global South.

4. The process of selecting research questions is not objective.

5. Discrimination in academia wastes talent and weakens the entire scientific system.

6. If you haven't cried at your desk, you haven't done your PhD.

7. The different PhD categories in the Dutch educational system create unequal opportunities.

Propositions belonging to the PhD thesis, entitled:

Crop up!
Adoption and value chain organisation in crop diversification transitions

Chiara Sophia Weituschat

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Dedicated to my family, the one I was born into and the one I gained along the way.
You give me hope that we can do better.

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It feels wholly inadequate that solely my name appears on the cover of this book as it was the support I have received that made it possible.

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CHAPTER 1

Introduction

1.1 The role of crop diversification in sustainable agriculture and soil health

The dominant paradigm in European agriculture is characterised by highly specialised and industrialised production. It is based on intensive use of agrochemicals, monocultures and few crops and varieties, and contributes to greenhouse gas emissions, water pollution, soil degradation and loss of biodiversity (Davies, 2017; Kleijn et al., 2019; Rockström et al., 2017). Specifically in monocultures, the ecosystem services usually provided by (rotating through) diverse crops are artificially (and only partially) replaced by agrochemicals (Ditzler et al., 2021). For example, legumes in rotation, or as intercrops, fixate nitrogen to the soil which is then available for subsequent crops (Bedoussac et al., 2015; Ditzler et al., 2021). In a monocultural system, this function is often fulfilled by mineral fertilizers which can lead to pollution of waterways and eutrophication (Nemecek et al., 2015). Similarly, pests and diseases are kept at bay as diverse crops lead to a balance in pests and their natural enemies, and diseases have sufficient time to die out before the vulnerable crop returns (Gurr et al., 2016). Without diversity in crops, chemicals such as pesticides are needed to protect them (Gurr et al., 2016). The (over-) use of agrochemicals has serious consequences for soil health and biodiversity (Plaas et al., 2019; Virginia et al., 2018). As chemicals threaten both insects and microbes, above and below the ground, natural cycles of soil restoration are disrupted, threatening several essential functions of healthy soils, from food production, carbon sequestration and climate regulation, to regulating water cycles (Arshad & Martin, 2002; Borrelli et al., 2017; Panagos et al., 2020). Given these challenges, fundamental changes in the agri-food system are needed urgently. Yet, they are happening far too slowly (Pretty et al., 2020; Rockström et al., 2020).

Diversifying cropping systems is known to improve soil health and fertility, reduce erosion, and contribute to increased (agro-)biodiversity, reversing or reducing many of the effects of industrial agriculture and agrochemicals (Bedoussac et al., 2015; Ditzler et al., 2021; Gurr et al., 2016). Therefore, crop diversification practices[1] are an integral part of improving the sustainability of the agri-food system (Therond et al., 2017). It is a central element of a range of overarching concepts for sustainable agriculture, such as organic agriculture (Migliorini & Wezel, 2017), conservation agriculture (Lahmar, 2010), and agroecology (Duru et al., 2015), as well as ecological and sustainable intensification (Garibaldi et al., 2019; Therond et al., 2017).

Crop diversification in arable farming, the focus of this thesis, can come in different forms, such as extending crop rotations with more diverse crops, intercropping different species in the same field at the same time, or planting different species around the edges of a plot, e.g. in the form of flower strips (Bedoussac et al., 2015; Gurr et al.,

1 While this thesis speaks of crop diversification more generally, the research chapters treat different aspects of it. Specifically, we consider legume adoption and extended rotations, as well as a combination of practices under the umbrella term of sustainable intensification, using terms adequate for each chapter.

2016; Meynard et al., 2018). Consequently, we define crop diversification practices as agricultural practices that increase the number of different crops and species grown on a plot of land in a given timeframe, possibly in combination with other environmentally beneficial practices such as reduced agrochemical use[2]. The arable crops dominating the European cropping system are cereals (particularly wheat, rye, triticale, barley, maize and rice), oil crops (namely rapeseed, sunflowers and soy[3]), and root crops (specifically potatoes and sugar beet) (Eurostat, 2021a). When considering crop diversification practices we particularly focus on introducing crops other than those just mentioned. The one exception to this rule is soy which, as a legume, can still carry the benefits associated with this crop type and is thus still considered a diversification crop in this thesis.

Crop diversification is also receiving increasing attention from European policy makers. For instance, diversification practices form part of the EU's strategy for soil health, local plant protein production and agriculture more generally (European Commission, 2018, 2021b, 2022b). Firstly, the EU has set the target that by 2030 at least 75% of all European soils are in a healthy state (European Commission, 2022a). Considering their role in restoring and preserving soils, diversification practices will be needed to achieve that target. Secondly, looking at local plant protein production, Europe is currently meeting a significant share of its plant protein needs through imports of soy, mostly from Brazil, Argentina and the US, with only 5% of soy being produced locally (European Commission, 2018). This implies a rather low degree of self-sufficiency when it comes to plant proteins, as well as underrepresentation of plant proteins in European cropping systems (Watson et al., 2017). Finally, crop diversification conditions in the new Common Agricultural Policy have also been strengthened (European Commission, 2022b), showing an increased recognition of its relevance in European agriculture.

Yet, while the environmental benefits of crop diversification are rather clear, adoption mechanisms for and barriers to crop diversification practices have so far received relatively little attention of researchers, especially in the European context (Morel et al., 2020). This thesis contributes to the investigation of crop diversification adoption and scaling among European farmers. To do so, we investigate the process of adoption and scaling as a major element of *sustainability transitions*. Sustainability transitions are fundamental and purposive changes to increase the sustainability of *socio-technical systems,* i.e. the system of actors, institutions and technologies necessary to fulfil societal functions (Geels, 2004, 2019; Vermunt et al., 2020). We analyse adoption and scaling of crop diversification practices within the European agri-food system as the relevant socio-technical system. This perspective implies that, on the one hand, we need to consider

2 Economic diversification, such as agro-tourism or care farming, is therefore out of scope for this thesis.

3 While being a legume, Eurostat considers soy a dual purpose crop, both rich in oil and protein, and officially classifies it as an oil crop (Eurostat 2020).

farmers as pivotal actors in the adoption and scaling of agricultural practices such as crop diversification, including their motivations and cognitive processes (e.g. Brown et al., 2021; Louah et al., 2017). On the other hand, we recognise that farmers are embedded in specific institutional contexts, and we thus need to analyse the socio-technical system that surrounds them, including their value chains and policy environments all of which have been found to be relevant in the adoption of sustainable agricultural practices (e.g. Dessart et al., 2019; Magrini et al., 2016; Mawois et al., 2019; Vermunt et al., 2020).

Thus, based on this approach, we consider three separate but interconnected themes analysing farmers' adoption and scaling of crop diversification within the socio-technical system of the European agri-food system. First, we assess the role of the individual farmers' motivations and goals in relation to their institutional and regional setting (chapter 2). We do so in order to determine the conditions under which farmers even want to adopt crop diversification practices. Then, we assess the (attempted) scaling process to examine institutional tensions and potential obstacles to scaling of crop diversification arising over time (chapter 3). Finally, we consider a specific element of the institutional context, namely the value chain, in more detail to investigate contract farming as a potential enabling mechanism to the adoption of crop diversification (chapter 4).

The remainder of this chapter first briefly describes extant literature on crop diversification in Europe (section 1.2). Then it lays out the specific research questions addressed in the individual chapters (section 1.3), followed by the conceptual and methodological approach that was taken (section 1.4 and 1.5, respectively). Section 1.6 describes aims for practical and policy applications of this thesis. Then in chapters 2 to 4, each individual research question is addressed according to its specific methodological and conceptual needs. Chapter 5 discusses the results provided by each chapter in the broader context of transitions in the agri-food system and concludes.

1.2 Crop diversification in European agriculture

From a historical perspective, diversity in cropping systems in Europe varied over time (Jepsen et al., 2015). Before the introduction of mineral fertilisation and chemical pest and disease management, crop diversification as well as crop-livestock integration, were common by necessity in European cropping systems (Jepsen et al., 2015; Voisin et al., 2014). With the wider industrialisation of agriculture starting in the 1950s, alongside the increase in mechanisation and use of mineral fertilisers, and induced by supportive policies, specialisation on European farms increased (Jepsen et al., 2015; Magrini et al., 2016). This specialisation brought with it, on the one hand, the separation of crop and livestock farming (Jepsen et al., 2015). On the other hand, farmers specialised in a smaller number of crops, focussing more and more on cereal production, which received extensive policy support at the time (Magrini et al., 2016; Watson et al., 2017). These simultaneous developments not only led to high levels of productivity, but also to a dependence on monocultures and agrochemicals (Meynard et al., 2018; Pretty et al., 2018). As a result, from the approximately 100 million hectares of arable land in use in the EU in 2020, 52.5 million hectares were planted with cereals alone (Eurostat, 2021b, 2022). An additional 12.9 million hectares were planted with root crops, sunflower or rapeseed (Eurostat, 2021a). This highlights the high level of crop specialisation in European cropping systems. Finally, starting in the 1990s, even though environmental awareness, as well as agri-environmental policies, were on the rise, the trend of specialisation and decreasing diversity, though slowing, has not yet been reversed (Jepsen et al., 2015; Voisin et al., 2014; Watson et al., 2017).

Given this marginalisation of diversified cropping systems over time, this thesis is focussed on their rehabilitation. Extant literature has already begun to unravel the complexities of reintroducing crop diversification in Europe, and a range of obstacles have been identified. Starting with crop varieties, and thus upstream in farmers' value chains, plant breeding is largely focussed on developing varieties for the most common crops. Less common crops suitable for diversification often lack adequate varieties adapted to local agro-ecological conditions (Magrini et al., 2016; Meynard et al., 2018). Equally, research on crop management also tends to be limited to the most commonly planted crops in conventional systems, leading to less attention being paid to crop interactions (Vanloqueren & Baret, 2009). As a consequence, advice is often provided per crop, instead of encompassing entire farm and cropping systems which could take the benefits of increased crop diversity into account (Berrueta et al., 2021). This lack of attention to crop diversification and crop interactions decreases the availability of adequate scientific knowledge and locally adapted varieties, and consequently increases the risk of adoption for farmers. Downstream from farmers, standardised, industrial processing in both the feed and food industry also leads to buyers' preference for dealing with the most commonly grown crops (Magrini et al., 2016; Mawois et al., 2019; Meynard et al., 2018). Finally, today's European consumers' dietary preferences for processed foods and animal protein also contribute to low demand for diversification crops, including legumes such as lentils and beans, leaving little room for such crops in the more lucrative food market (Boer & Aiking, 2011; Springmann et al., 2018; Willett et al., 2019). Finally, implementing crop diversification has also been associated with increased cost, both for farmers (Bonke & Musshoff, 2020; Rosa-Schleich et al., 2019), as well as for other actors in the value chain (Magrini et al., 2016). For farmers, while diversification likely leads to higher and more stable yields, reduced input and labour costs, reduced risk and higher quality, prices and profits in the long run, short term costs can outweigh the benefits due to temporarily reduced crop yields and possible initial investments in knowledge and machineries (Lemken et al., 2017; Rosa-Schleich et al., 2019; Zimmer et al., 2016). At the value chain level, increased costs are primarily linked to fixed costs per crop, as well as storage and logistics when dealing with smaller quantities (Magrini et al., 2016). We can thus assume that, given these obstacles, crop diversification is facing an uphill battle. Yet, open questions remain particularly with regard to how exactly farmers are embedded in this unfavourable institutional context in the European agri-food system, how it shapes their decisions and behaviour, and what can be done to enable farmers to adopt crop diversification on their farms. This thesis thus focuses on farmers' institutional embeddedness in the transition towards diversified cropping systems. How exactly this issue is tackled is presented in the following section.

1.3 Research questions

This thesis aims to complement and expand the extant literature on crop diversification in Europe by adding a farmer-centred perspective to the discussion. Particularly, it contributes to the literature by exploring barriers and drivers for crop diversification at value chain and policy level, with a more explicit farmer-based view and line of inquiry. Hereby, we focus first on how farmers' *decision-making on adoption* is embedded within their regional agri-food system. Then, we consider the diffusion of crop diversification by observing actors' behaviour in the process of *scaling* up diversification practices. Finally, we consider the effects of one specific *governance mechanism* in the value chain, namely contract farming, and how that influences farmers' considerations on adoption of crop diversification. As such, we thus assess the potential of contract farming as an institutional vehicle for diffusing the practice among European farmers. This section provides an overview of each research chapter (see table 1.1 for a summary), while the following sections will provide more details on conceptual (1.4), methodological (1.5) and policy implications (1.6).

Table 1.1 Overview of research chapters

	Research question	Conceptual lens	Methodology	Results
2	How is farmers' *decision-making on adoption* of crop diversification shaped by cognitive processes and how does that relate to the institutional setting in sustainability transitions?	Goal framing theory in the context of transition theory	Qualitative analysis of farmer interviews in two regional case studies	Institutional setting creates cognitive lock-ins around gain goals, locally specific value chain arrangements needed to overcome barriers
3	What are the institutional dynamics that obstruct or promote the *scaling* process of crop diversification in sustainability transitions?	Institutional logics and their dimensions in the context of transition theory	Process analysis of two innovation niches attempting to scale	Tensions among dimensions of institutional logics stall the scaling process, value chain formation needed for realignment
4	How can *governance mechanisms* in the value chain, specifically contract farming, promote the adoption of crop diversification and low-input practices in sustainability transitions?	Empirical analysis inspired by economic organisation studies and contract design theory	Quantitative analysis of survey data and hypothetical choice experiment	Contract farming is a potential tool to induce adoption, but only for farmers that are generally open to contracting

Firstly, while we know that the institutional context, both in terms of value chains and policies, is not favourable to adoption, as presented in section 1.2, we are yet to analyse how exactly this institutional setting shapes farmers' *decision-making on adoption* of crop diversification. Farmers are pivotal actors when it comes to the implementation of more sustainable practices (Vermunt et al., 2020). This is also true for crop diversification as it is farmers who ultimately choose which crops will be planted on their farms. While extensive research has been done on determinants of farmers' adoption of sustainable agricultural practices more broadly (see e.g. Bartkowski & Bartke, 2018; Brown et al., 2021; Dessart et al., 2019 for reviews), investigations on farmers' decision-making on crop diversification specifically are still missing. Additionally, such decisions are not made in a vacuum and farmers face pressures and limitations in their decision-making, depending on their institutional context in sustainability transitions. Given that cognitive factors have been identified as relevant when it comes to practice adoption (Dessart et al., 2019; Louah et al., 2017; Morel et al., 2020) and within sustainability transitions (Geels, 2019, 2020), we focus on these cognitive processes in particular to analyse in more detail how exactly adoption decisions are shaped by the institutional context. We do so by drawing on goal framing theory for environmental behaviour (Lindenberg, 2017; Lindenberg & Steg, 2007) in conjunction with transition theory. This approach is applied to a qualitative analysis of in-depth interviews with farmers in two regional case studies, one in the Netherlands and one in the UK. We find that farmers' institutional settings strongly shape their decision-making, creating a cognitive lock-in around dominant gain goals. Yet, focussing purely on gain goals to induce adoption may be counterproductive as it may undermine the normative goals supporting the adoption of crop diversification. To overcome barriers in their institutional setting, farmers aim to find value chain arrangements suitable to their regional context. The inquiry as to what motivates farmers to diversify, the cognitive processes they go through in their decision-making, and how that relates to their particular settings, helps us improve our understanding of farmers' decision-making in transitions processes, as well as inform us how farmers can best be addressed and supported in the adoption of crop diversification.

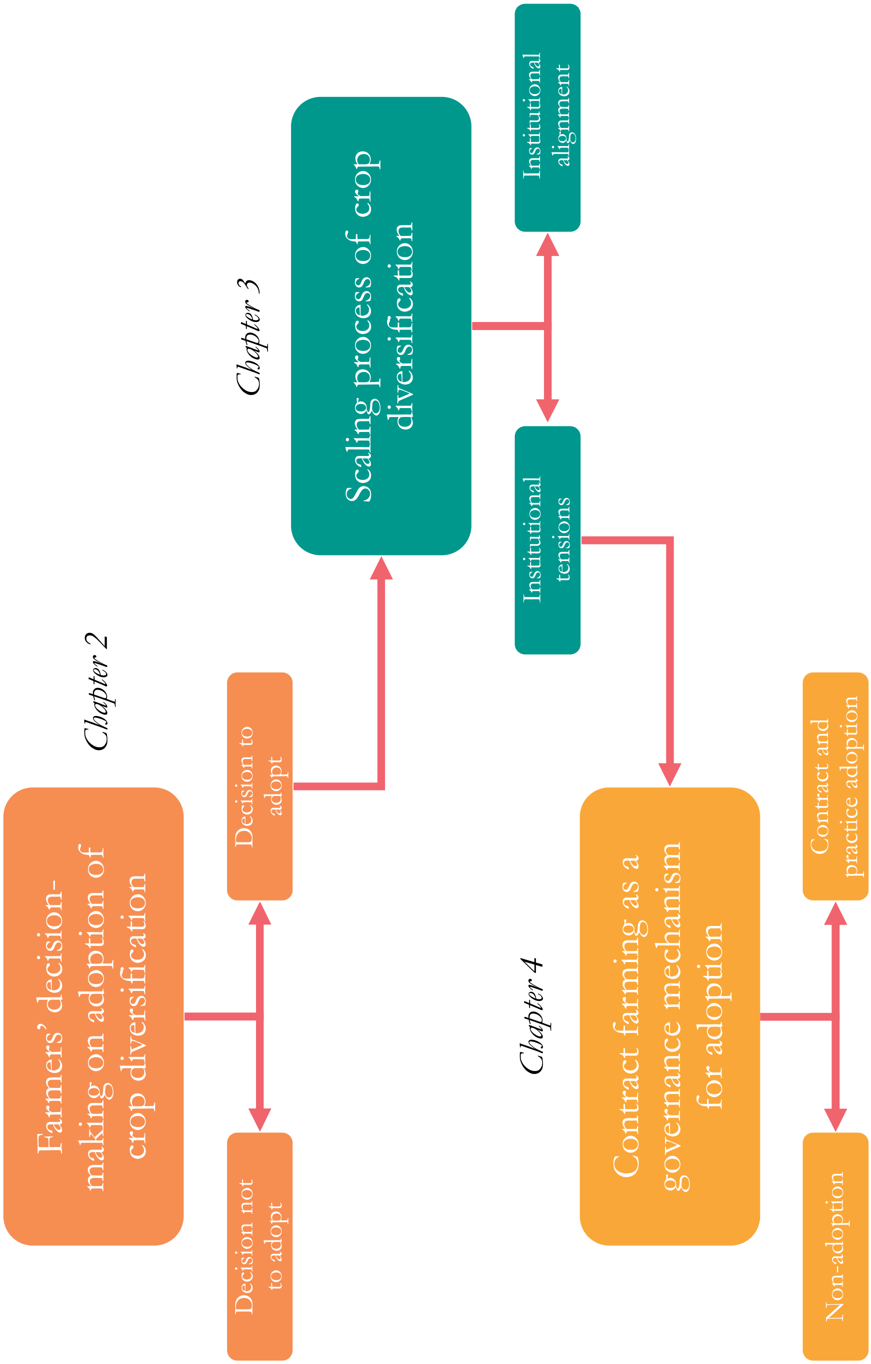
Secondly, when considering diversification practices from the perspective of sustainability transitions, we need to look beyond the adoption of crop diversification by individuals, and also consider the process of *scaling*. In order for the dominant agricultural system to be challenged by a sustainability transition, crop diversification being practiced in small, more sustainable niches, is unlikely to be sufficient. These niches need to scale up in order to bring about change in conventional agricultural systems (Belmin et al., 2018; Geels et al., 2016; Vermunt et al., 2020). Yet, what enables or blocks these niches to scale is not yet fully understood (Ingram, 2015; Magrini et al., 2016; Meynard et al., 2018; Morel et al., 2020). We thus look at the scaling process of diversification in two case studies in Italy and the Netherlands, taking a longitudinal perspective to observe both the emergence of obstacles over time, as well as the conditions of their resolution, focussing particularly on institutional dynamics. For that we use a process analysis approach (Langley, 1999) in which we analyse the institutional logics and their dimensions (Fuenfschilling & Truffer, 2014; Thornton & Ocasio, 1999) and how they change over time, based on a wealth of primary (interviews, observations, focus groups) and secondary data (such as company documents and reports). We find that, despite rather distinct starting conditions, niches in the scaling process seem to go through similar stages in which we observe tensions and realignment of dimensions within their institutional logics. Scaling processes are stalled when dimensions of institutional logics are in conflict, which in the analysed cases happened particularly around the issue of organisational forms in value chains. Value chain formation thus emerged as a crucial obstacle to the scaling of crop diversification practices.

Thirdly, while value chains specifically have been established as obstructions to adoption and scaling of crop diversification, insufficiently is known about which *governance mechanisms* can be employed to overcome these barriers and support sustainability transitions. The relationship between value chain organisation and practice adoption has been extensively argued (see e.g. Swinnen & Kuijpers, 2019) and contract farming has been identified as an effective governance mechanism to support farmers' practice adoption (e.g. Bonjean, 2019; Mazhar et al., 2021; Mulwa et al., 2021), which makes it a promising candidate to support crop diversification. However, contract farming has not yet been tested in relation to crop diversification, and there is no blue print when it comes to designing governance mechanisms for practice adoption (Meynard et al., 2017; Pancino et al., 2019; Swinnen & Kuijpers, 2019). Therefore, closer attention needs to be paid to not only the potential of contract farming to induce the adoption and diffusion of diversification but also the more specific contract design to achieve that. Inspired by economic organisation studies (Ménard, 2018), and contract design theory (Grandori, 1991; Grandori & Furlotti, 2019), we empirically test the potential and design of contract farming for crop diversification and related practices. A survey and hypothetical choice experiment with Italian farmers was performed, supported by qualitative and secondary data. We find that contract farming has the potential to induce adoption, and thus support sustainability transitions, for some but not all farmers, depending on their preferences for contracting in general and cooperative membership status.

In summary, we consider farmers' *decision-making on adoption* of crop diversification, shaped by cognitive processes within their contextual setting (see chapter 2). Secondly, once a decision is made to diversify at niche level, we are led to investigate the process of *scaling* (chapter 3). Here, we observe attempts to bring crop diversification from a niche practice to broader scale uptake in the mainstream of agricultural production, and analyse the dynamics that obstruct or promote the scaling process. Finally, in chapter 4 we discuss and test the potential of contract farming as a *governance mechanism* to induce and support the adoption and scaling of diversification. We address the following research questions. Figure 1.1 illustrates the coherence among these questions from an empirical perspective.

1. How is farmers' *decision-making on the adoption* of crop diversification shaped by cognitive processes and how does that relate to the institutional context in sustainability transitions? (Chapter 2)
2. What are the institutional dynamics that obstruct or promote the *scaling* process of crop diversification in sustainability transitions? (Chapter 3)
3. How can *governance mechanisms* in the value chain, specifically contract farming, promote the adoption of crop diversification and low-input practices in sustainability transitions? (Chapter 4)

Figure 1.1 Internal logic of empirical investigations in the research chapters



Source: The author

1.4 Conceptual framework

Overall, though empirically-focussed, this thesis aims to contribute to the conceptualisation of sustainability transitions by adding a perspective of farmers' institutional embeddedness within socio-technical systems by using complementary frameworks (Geels, 2020; Hassink et al., 2018; Vermunt et al., 2020). In order to answer the diversity of empirical research questions posed in this thesis, several theoretical lenses were needed to address them. While our conceptual choices are motivated extensively in each chapter separately, this section provides an overview of concepts used, and explains their connection and complementarity.

The underlying concept for all chapters is that of sustainability transitions. *Transitions* are complex and non-linear processes of change in so-called socio-technical systems (Geels, 2011). *Socio-technical systems* encompass actors, institutions and technologies, as well as all other aspects necessary to fulfil specific societal functions, such as transport, nutrition, or energy (Geels, 2004; Vermunt et al., 2020). Within this field and the focus of this thesis, *sustainability transitions* are defined as fundamental and purposive changes to socio-technical systems with the aim to fulfil societal functions more sustainably (Geels, 2019; Vermunt et al., 2020). Transitions of this type are further complicated by the characteristic of having diffuse benefits to society rather than having obvious benefits to the specific actors implementing changes (Geels, 2019; Vermunt et al., 2020). In the case of agriculture, for example, this means that while farmers largely bear the cost of adjusting their practices, many of the environmental benefits are enjoyed by society as a whole, not the farmers themselves (Vermunt et al., 2020). Additionally, there is a temporal aspect to this dilemma. Investments need to be made in the short-term, while the benefits, whether to farmers or society, only become visible over time (Vermunt et al., 2020). This implies that such transitions, away from the dominant agricultural paradigm[4], are unlikely to occur without collective coordination and support (Vermunt et al., 2020). This dilemma further highlights the importance of the interactions between actors and their institutional context. In order to analyse these change processes towards sustainability in more detail, each chapter complements the concept of sustainability transitions with other perspectives adequate for each specific analysis.

In chapter 2, the concept of sustainability transitions is combined with goal framing theory for environmental behaviour (Lindenberg & Steg, 2007). This combination allows us to analyse the cognitive processes of decision-makers, in this case farmers, when it comes to the *decision-making on adoption* of crop diversification, and to build

4 While the transition literature often refers to the dominant paradigm in a socio-technical system as the 'regime' and/or 'landscape', this thesis consciously avoids these terms for two reasons. One, 'regime' and 'landscape' are empirically challenging to distinguish (Geels , 2011; Fuenfschilling and Truffer , 2014), and two, their distinction does not contribute to the investigation conducted in this thesis, since it is rather the niche practice, namely crop diversification, that is the focus in this study.

the connection to their local institutional context within the socio-technical system of the European agri-food system (Geels, 2020; Lindenberg, 2017). Conceptually, the perspective on decision-making is particularly important for sustainability transitions as the benefits of crop diversification do not exclusively lie with the farmers adopting them. While they may well benefit e.g. from improved soil health and decreased cost for agrochemicals, the benefits of reduced pollution and emissions are much more diffused. Therefore, we investigate farmers' goal frames in adoption decisions and how their institutional settings can trigger "lock-ins". Lock-ins are settings in which the status quo is reinforced (Geels, 2019), and we show how cognitive lock-ins, specifically, may prevent farmers from adopting crop diversification (Louah et al., 2017). Thus, understanding what guides farmers' decisions around crop diversification, and the cognitive processes and lock-ins that shape them, can improve our understanding of transitions themselves.

In chapter 3, we complement transition theory with an institutional theory perspective. Specifically, we use an analysis of dimensions of institutional logics (Fuenfschilling & Truffer, 2014; Thornton & Ocasio, 1999), proposing that the underlying logics of innovation niches in agri-food systems influence and shape their *scaling* process. This conceptual lens allows us to observe dynamic changes in dimensions of institutional logics over time, relating internal tensions and their realignment to the scaling up of niches in the context of sustainability transitions. With this perspective, we can show how tensions among dimensions obstruct scaling, while their realignment actually allows for progress in transitions. It also points us to the specific dimension not in alignment and thus stalling the scaling process, namely organisational forms within the value chain. This further highlights the role of value chain arrangements in the governance of transitions.

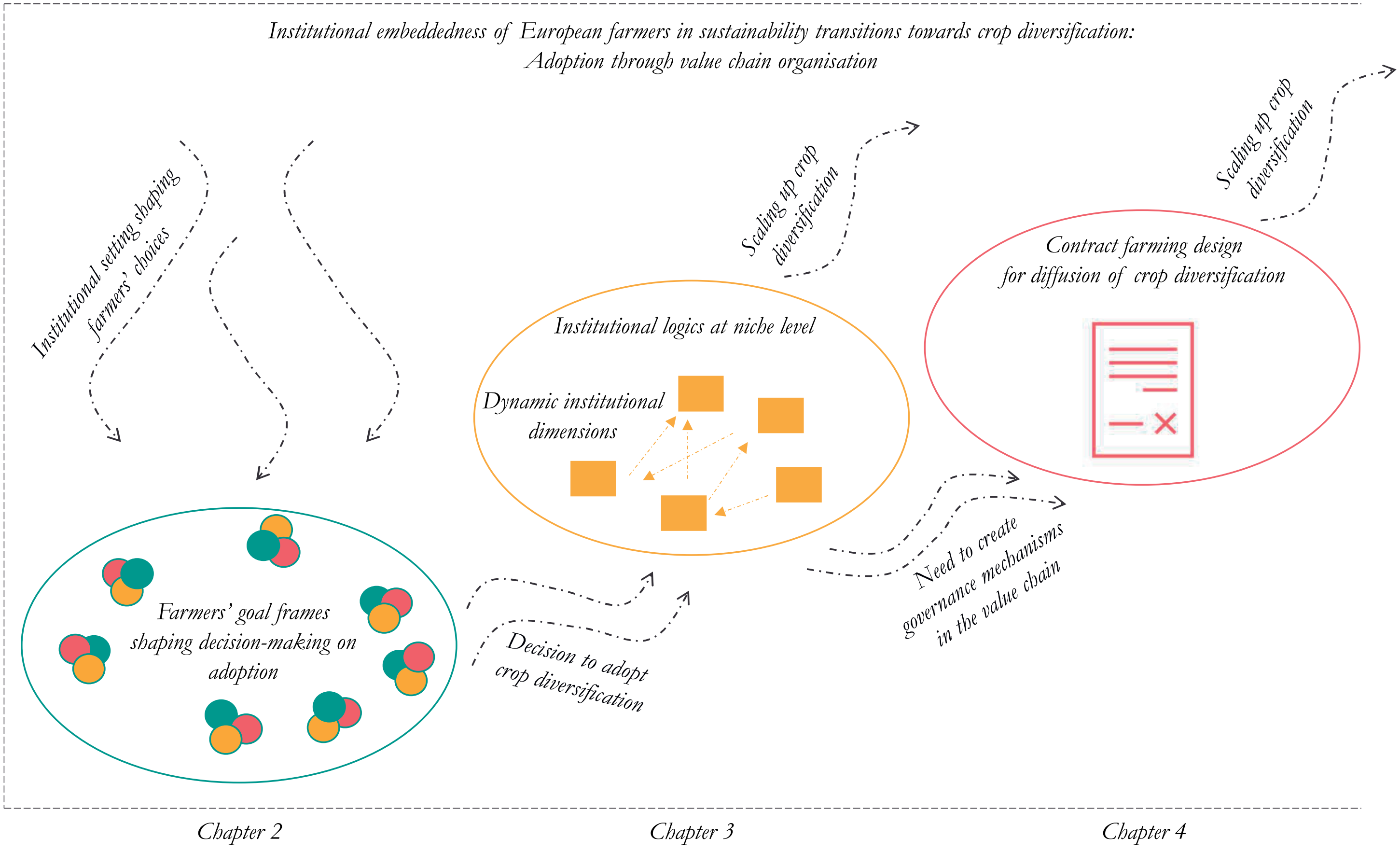
Finally, chapter 4 analyses contract farming as a *governance mechanism* to facilitate the diffusion of crop diversification. While the study itself is limited to the empirical testing of contract farming, the approach is implicitly inspired by the tradition of economic organisation studies which consider governance as the organisational forms that coordinate economic activities, interactions and exchanges (Ménard, 2018), as well as theories on contract design (Grandori, 1991; Grandori & Furlotti, 2019; Mamine et al., 2020).

In summary, we provide a framework to analyse cognitive processes in the *decision-making on adoption* drawing on goal-framing theory (chapter 2). We argue how the analysis of the dimensions of institutional logics helps us understand (the absence of) *scaling* processes in sustainability transitions (chapter 3). Finally, we empirically assess contract farming as a facilitating *governance mechanism* in the value chain (chapter 4). Doing so allows us to demonstrate both the interconnectedness of these simultaneous processes, as well as their distinctiveness. Table 1.2 provides a brief overview of the conceptual lenses applied in each chapter and figure 1.2 illustrates the overall approach visually.

Table 1.2 Overview of the conceptual lenses

Chapter	Conceptual lens	Conceptual contribution to transition theory
2	Goal framing theory in the context of transition theory	Cognitive lock-ins create barriers to the adoption of and transition towards crop diversification
3	Institutional logics and their dimensions in the context of transition theory	Tensions in dimensions of institutional logics obstruct scaling processes of crop diversification niches
4	Empirical analysis inspired by economic organisation studies and contract design theory	Contract farming as an institutional vehicle supporting the transition towards crop diversification

Figure 1.2 Overview of conceptual framework



Source: The author

1.5 Methodological approach

The methodological strategy for this thesis is a complementary, mixed method approach with both qualitative and quantitative, and primary and secondary data used to analyse different aspects of the subject matter. This approach was chosen since while each individual method has its benefits and short-comings, collectively the diversity of methods and data types strengthens the insight we can gain (Dahler-Larsen, 2022; Glaser & Strauss, 2017). Therefore, each chapter of this thesis has a distinct methodology for data collection and analysis, each contributing to the overall approach, and argued to be adequate for its purpose within the separate methodology sections of each chapter. In brief, in chapter 1 we use an inductive comparative case study approach (Eisenhardt & Graebner, 2007) based on semi-structured interviews with farmers to gain understanding of their decision-making processes on the adoption of crop rotation, and complemented these interviews with secondary data on their institutional setting. In chapter 3, in order to reconstruct the different stages of the scaling process in the two innovation niche case studies, we employed a process analysis (Langley, 1999), collecting different types of data from different stakeholders over time, complemented by secondary data. This data collection was done iteratively in order to abductively move from data to analysis to further data collection (Philipsen, 2018), allowing us to understand and conceptualise the innovation niches' scaling processes and their institutional dynamics. Finally, in chapter 4, we used a quantitative approach, collecting survey data from 319 Italian farmers. As part of the survey we performed a hypothetical choice experiment to assess the potential of contract farming for the adoption of crop diversification and low input practices, and to gain insight into contract design. Complementary qualitative data and secondary data was used to support both the research and instrument design, as well as the interpretation of results. The methodological approach for the research chapters is summarised in table 1.3.

Table 1.3 Overview of methodological approach per chapter

Chapter	Methodology	Approach	Data types
2	Qualitative analysis of farmer interviews in two regional case studies	Inductive comparative case study approach using qualitative analysis	Semi-structured interviews, complementary secondary data
3	Process analysis of two innovation niches attempting to scale	Abductive comparative case study approach using qualitative data analysis	Semi-structured interviews, observations, focus groups, complementary secondary data
4	Quantitative analysis of survey data and hypothetical choice experiment	In-depth, quantitative approach using econometric analysis	Survey, complemented by semi-structured interviews and secondary data

A range of data sources was consulted for this study. Overall, more than thirty in-depth, semi-structured interviews were held across three countries, the Netherlands (NL), the United Kingdom (UK), and Italy. We performed focus groups and a number of farm visits, and participated in several meetings and events. Further, we conducted a large scale survey of farm households in Italy. Finally, several sources of secondary data were consulted. We considered company documents, such as public sustainability reports, as well as internal presentations, and websites, e.g. reporting on companies' sustainability initiatives. Further, we used research papers published on the cases, and industry reports, for example covering local market conditions by regional farmer organisations. Finally, we covered policy documents, such as reports from the European parliament or the European commission on agricultural policies, as well documents from local councils on regionally specific policy measures. These secondary sources are meant to complement, contextualise and triangulate the primary data collected. While most of both primary and secondary data directly fed the analyses, some elements were used to inform research and instrument design. All primary data was collected between 2017 and 2021. Starting with the different focus group discussions in 2017/2018, alongside which interviews and farm visits were conducted mainly in 2017-2019, with few interviews and one farm visit in 2020 and 2021. The survey data collection started in late 2019 and continued until early 2021 due to disruptions by the COVID-19 pandemic. The research team collected secondary data throughout the duration of the project starting in 2016 to 2021. Table 1.4 gives an overview of all data sources consulted in this study.

Table 1.4 Overview of data sources

Category	Data source	Chapters
Interviews	Farmer interviews, NL and UK (21)	2, 3, 4
	Expert interviews, UK (3)	
	Value chain actors, NL (2)	
	Company executives Barilla, Italy (7)	
Observations	Farm visits, NL (5)	3
	Lupine supply chain event, NL (1)	
Focus groups	Focus groups with farmers and first buyers, Italy (2)	3, 4
	Group discussion with experts (Jeffersonian dinner), Italy and NL (2)	
Survey	Pilot interviews, Italy (4)	4
	Farmer survey, Italy (319)	
Policy documents and governmental databases	Netherlands (11)	2, 3
	United Kingdom (10)	
	European Union (7)	
Private sector documents and websites	Industry reports (3)	3, 4
	Company reports (or report series), including internal documents (7)	
	Company websites (2)	
Research reports and grey literature	Research reports (9)	3
	MSc thesis reports (4)	

1.6 Policy and practice-oriented implications

This thesis aims to contribute to the identification of barriers and enablers of crop diversification in the European context. Its research has been conducted as part of the Horizon 2020 project Diverfarming (Diverfarming, 2017b). As such, the Diverfarming project has already published and disseminated a range of results assessing the feasibility, design and implementation of crop diversification practices from agronomic and socio-economic perspectives (Diverfarming, 2021). At the same time, activities were actively aligned with the Crop Diversification Cluster, a cluster of six Horizon 2020 projects on crop diversification, through meetings and working groups (Crop Diversification Cluster, 2021). All projects in the cluster aim to encourage uptake of crop diversification practices among European farmers and associated innovations along value chains. They, individually and jointly, report directly to officers of the European Commission. Thus, this research, in conjunction with these broader projects aims to inform policy design on crop diversification for the European Commission, for instance in relation to the EU Soil Strategy (European Commission, 2021b), the Common Agricultural Policy (European Commission, 2022b), or rural development plans. It further also aims to provide information to farmers and other actors in the value chain on possible challenges and benefits of the adoption of crop diversification practices. As businesses and value chains in the agri-food system are increasingly recognising soil health as being among the sustainability issues central to their functioning (Davies, 2017), such research will likely be of increasing interest.

CHAPTER 2

Goal frames and sustainability transitions: How cognitive lock-ins can impede crop diversification

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Abstract
Transitions towards more sustainable agricultural systems are often characterised by 'lock-ins', understood as self-reinforcing mechanisms that reproduce the status quo and impede change. While socio-economic, technological and institutional lock-ins have been widely used to understand processes of sustainable transitions in agri-food systems, the role of so-called cognitive lock-ins is still under-investigated. In this study we focus on how institutional settings create cognitive lock-ins in farmers' decision-making related to the adoption of sustainable agricultural practices. We apply goal-framing for environmental behaviour and transition theory in explaining how socio-technical conditions may shape farmer's decision-making. Empirically, we focus on the example of diversifying crop rotations with legumes as an established strategy to increase biodiversity and soil health, and reduce agrochemical use, emissions and pollution, which still remains rare in European agriculture. We use two cases in the Atlantic pedo-climatic region, Cornwall, UK, and Gelderland, Netherlands. Using in-depth interview data with farmers and extensive supplementary secondary data, we explore how context-specific socio-technical settings interact with farmers' normative, gain-oriented and hedonic goal frames to shape the (un-)desirability of crop diversification with legumes. This creates conditions recognizable as cognitive lock-ins: the context of farmers' decision-making creates cognitive processes that drastically reduce the perceived viability of alternative agricultural practices. Our findings in this case suggest the framework developed for this study may help to identify regionally-specific, as well as common, barriers and solutions to crop diversification and comparable practices, that are relevant to transitions towards sustainability in agri-food systems.

2.1 Introduction

Agricultural practices in contemporary agri-food systems are now recognised as major drivers of climate change, biodiversity loss, soil erosion, and pollution, requiring fundamental and urgent shifts to more sustainable production, distribution and consumption (Campbell et al., 2017; Davies, 2017; Rockström et al., 2020). Changing agricultural practices to enhance soil health and agro-ecological diversity, while mitigating and combating climate change and ensuring fair access to affordable and nutritious diets, are only a few of the transitions widely accepted as necessary (Böhm et al., 2020; Springmann et al., 2018). Despite agreement on the need for and nature of required transitions, change is happening far too slowly (Pretty et al., 2018; Rockström et al., 2020). Self-reinforcing mechanisms that reproduce the status quo and impede change, so-called lock ins, have been found to delay needed changes (Geels, 2019; Magrini et al., 2016; Meynard et al., 2018). While extant literature has explored factors relevant to lock-ins, such as technologies, economic mechanisms, institutional rules, and political dynamics, the role of cognitive processes as impediments, recognised as relevant to sustainability transitions, has only partially been explored (Geels, 2019; Louah et al., 2017). Given that transitions in agri-food systems are complex and non-linear processes (Geels, 2011), it is relevant to also consider potential cognitive mechanisms impeding change.

The context in which we have studied cognitive lock-ins is that of crop diversification in Europe. The focus on major, high-productivity crops, large-scale production, specialization and monocropping is known to contribute to the damaging ecological conditions in agricultural systems, and diversifying cropping systems is an essential step in achieving sustainability in the agri-food system (Davies, 2017; Gurr et al., 2016; Hammond & Dubé, 2012). Introducing legumes[5] in extended crop rotations, particularly, is well known to increase agro-biodiversity, reduce pests and diseases, improve soil structure and increase soil fertility through nitrogen fixation, which is known to reduce the impacts of chemical fertilisation, pollution and eutrophication associated with intensive monocultural farming (Bedoussac et al., 2015; Magrini et al., 2016; Voisin et al., 2014; Watson et al., 2017). Also the emergent debate on “protein transitions” has added to calls for their re-introduction, in order to support the necessary shift to more plant-based diets which reduces the substantial greenhouse gas emissions from meat production (Manners et al., 2020; Springmann et al., 2018; Willett et al., 2019). On a policy level, the EU strategy on climate and biodiversity has increasingly focused on stimulating crop diversification and increasing the production of plant proteins (European Commission, 2018, 2021b). Despite these well-known benefits and

5 Legumes refer to a group of plants, including crops such as beans, peas and lentils, which have broad applications in both human consumption and animal feed due to their high protein content. They also fix nitrogen into the soil from the air through biological processes, reducing the need for nitrogen fertilisation for the next crop in rotation. For further discussion of legume benefits see e.g. Watson et al. (2017) and Bedoussac et al. (2015).

support, the use of extended crop rotations with legumes remains limited (Voisin et al., 2014; Zander et al., 2016), and factors relevant to crop diversification, also within conventional farming systems, are less studied than other sustainable practices such as organic farming, especially in the European context (Morel et al., 2020).

In this study we explore the role of cognitive lock-ins within two parallel case studies of crop diversification, informed by literature that attempts to explain cognitive processes relevant to the adoption of pro-environmental behaviour (Lindenberg & Steg, 2007). The identification of cognitive lock-ins requires understanding of how those queried make sense of their environment. We, therefore, used in-depth interviews supported by secondary data to investigate farmers' decision-making processes related to the introduction of legumes in rotations in two farming communities, one located in Gelderland in the Netherlands, and the other located in Cornwall (UK). We then used an abductive methodological strategy to support iteration between evidence and theory (Gioia et al., 2013).

In the following, section 2 presents a brief discussion of the literature that frames our conceptual approach (section 3). Then, we describe the methodology used for this study, followed by the related findings. We then discuss our results and the concept of cognitive lock-ins within the context of transition research. Finally, we conclude and suggest avenues for further research.

2.2 Sustainability transitions and lock-ins

Sustainability transitions are fundamental, purposive changes to fulfil societally necessary functions more sustainably (Geels et al., 2016; Vermunt et al., 2020). Transition processes include, but are not limited to, technical, political, market and cognitive dimensions (Dumont et al., 2020; Geels, 2019), and literature discussing them often focusses on meso- and macro-level processes (e.g. Bui et al., 2016; Ingram, 2015, 2018; Meynard et al., 2017). When one or more of these dimensions intersect and reinforce the status quo, "lock-ins" may emerge which constrain actors' choices (Magrini et al., 2016). Boonstra and colleagues (2016) call these "social-ecological traps": a situation in which circumstances trigger a decision-maker's behavioural response that leads to the reproduction of the structural conditions within which that decision makes sense: the status quo. Several dimensions of lock-ins have been previously considered (Geels, 2019), as reported in table 2.1 below.

Table 2.1 Overview of lock-ins

Dimensions of lock-in	Description
Technological	Infrastructure and (applied) know-how organised around existing technologies and practices
Economic	Existing economies of scale, sunk investments creating costs and benefits biased towards current technologies and practices
Institutional	Existing regulations, standards, and policy networks create an uneven playing field biased towards the status quo
Political	Vested interests and power relations that favour the status quo
Social	Existing alignments, relations and social capital between social groups
Cognitive	Routines and mindsets that "blind" actors to (the benefits of) other alternatives

Source: Adapted from Geels (2019)

The literature on sustainability transitions, particularly that examining agri-food systems, makes frequent use of the concept of "lock-ins", particularly when examining institutional, technical and economic dimensions (e.g. Magrini et al., 2016; Plumecocq et al., 2018; Vanloqueren & Baret, 2009). Studies discuss, for example, actors' technical knowledge and experience being limited to monocultural production systems (Kuokkanen et al., 2018; Morel et al., 2020), as well as the monoculture focus in public policies and research (Magrini et al., 2016; Meynard et al., 2018; Vanloqueren & Baret, 2009). Sunk cost and economies of scale related to existing technologies have also been explored (Magrini et al., 2016; Meynard et al., 2018). Kuokkanen et al. (2018) and Morel et al. (2020) discuss power imbalances in agricultural value chains with their economic and political implications.

While less prominent so far, cognitive processes are also starting to be recognized as relevant in the transition literature. For instance, Vanloqueren and Baret (2009) describe the "cognitive routines" keeping agricultural scientists focussed on using monocultures and agro-chemicals. Morel et al. (2020, p. 11) briefly mention lock-in resulting from farmers' inability "to develop systemic thinking" in their decision-making, thus preventing complex changes in practices. Similarly, Louah et al. (2017) explicitly describe cognitive lock-ins when exploring the necessity for "holistic thinking patterns" for the adoption of agro-forestry. While highlighting the relevance of cognitive processes in lock-ins, these studies do not provide a clear framework adequate to analyse cognitive lock-ins. Given that cognitive processes and their related behavioural responses in decision-makers are central to lock-ins (Boonstra et al., 2016), more attention needs to be paid to the conceptualisation of cognitive lock-ins, in order to complement our understanding of the role of structural and institutional conditions in transitions (Geels, 2020; Hassink et al., 2018).

Outside of transition literature, and confirming the relevance of cognitive lock-in, farmers' decision-making has long been discussed as part of adoption processes. Here, farmers' adoption of, for example, sustainable practices is commonly linked to farm-level economic, socio-demographic and farm structure factors, such as costs and benefits, age and education, and land size and tenure, respectively (Brown et al., 2021; Jones-Garcia & Krishna, 2021). Additionally, there is a growing body of studies that takes farmers' attitudinal, behavioural and (to a certain degree) cognitive variables into account (see e.g. Bartkowski & Bartke, 2018; Brown et al., 2021; Dessart et al., 2019 for reviews). It has been pointed out that the different motivations driving farmers' decision-making should be considered (Han et al., 2021). We build on these streams of literature on lock-ins and farmer decision-making by providing a first conceptualisation of cognitive lock-ins within sustainability transitions.

2.3 Conceptual framework

2.3.1 Cognitive processes and decision-making: Goal framing theory

In order to connect context-specific cognitive processes to behavioural change within sustainability transitions, we draw on goal framing theory (GFT) (Etienne, 2011; Lindenberg & Steg, 2007). GFT is often used to study pro-environmental behaviour in the agri-food sector (e.g. Djenontin et al., 2020; Lemken et al., 2017; Thøgersen & Alfinito, 2020; Veisi et al., 2017). Since GFT fits our purposes of investigating and theorizing the role of cognitive processes in transitions, and since it has been used in similar conditions, we found it appropriate for our study.

GFT starts from decision-makers' consideration of multiple relevant goals in their decision-making. While the *focal goal* receives most attention, decision makers continue to attend to other goals, and the rise and fall of the importance of these *background goals* alter the salience of the focal goal (Etienne, 2011; Lindenberg & Steg, 2007). Background goals may reinforce or contradict the focal goal and change the order of preference among options that satisfy the focal goal (Lindenberg & Steg, 2007). For example, a farmer's main goal in farm management may be to make a living, thus he or she may be guided by *gain-oriented goals*. Gain goals focus on preserving and improving one's personal resources (Etienne, 2011; Lindenberg & Steg, 2007). So, in the situation of buying new machinery, budget and effectiveness considerations are likely guiding. Yet, within the set of suitable options, one may select the more environmentally-friendly option, thus being swayed by a normative background goal. Following *normative goals* means doing what is appropriate and contributing to collective goals (Lindenberg, 2017). Farmers may also be motivated to get more enjoyment out of the everyday job activities, such that a farmer might opt for manual over mechanical weeding to create a more social work environment (a *hedonic goal*). When hedonic goals are in focus, we pursue immediate pleasure, try to avoid negative emotions and seek to feel better in the current moment (Etienne, 2011; Lindenberg & Steg, 2007).

Goals need not conflict. If the most environmentally sound option is also the most profitable, gain and normative goals can strengthen each other (Lindenberg & Steg, 2007). Yet, only providing financial incentives, such as subsidising an ecological focus area on a farm, can undermine the subsidy-independent sustainability of that initiative by reinforcing the salience of the gain goal frame and crowding out intrinsic motivation based on hedonic or normative frames (Steg et al., 2014). The salience and contents of goal frames are, in part, contextually determined (Foss & Lindenberg, 2013; Gkargkavouzi et al., 2019; Steg et al., 2014). For example, as a farmer nears retirement their goal frame may switch from making a living (gain-oriented) to transferring something worthwhile to their heir (normative). The possibility to influence goal frames brings us to the next aspect: the relationship between an individual decision-maker's goal frames and the contextual conditions of sustainability transitions.

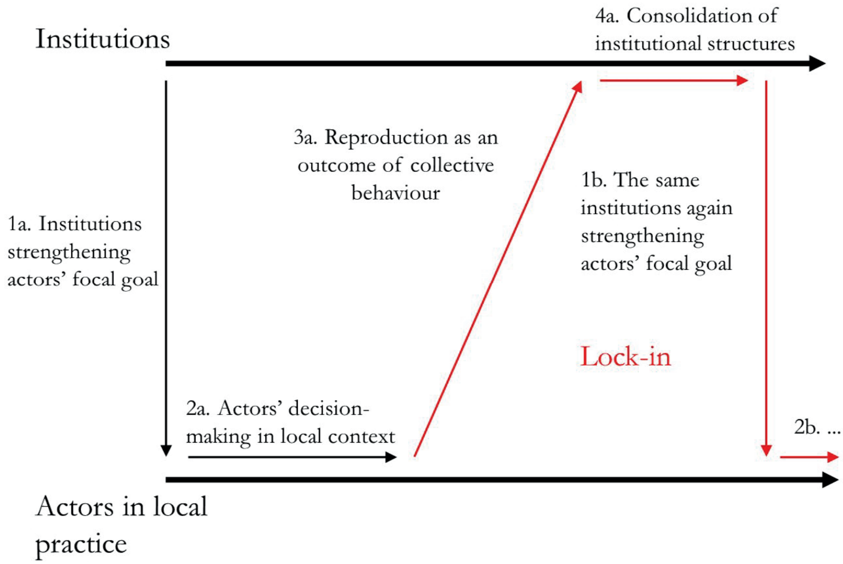
2.3.2 Goal framing in the context of sustainability transitions

Decision-making in transitions entails a constant (re-)negotiation between goals. Once taken, decisions, then, contribute to either the reproduction or transformation of the overall system which creates interdependence between individuals' goals, the decisions they make and the institutional context to which these decisions in part contribute (Geels, 2004, 2020). Institutions interact with individuals' goal frames, create incentives and disincentives for certain behaviours, and delimit decision-makers' autonomy (Lindenberg, 2017; Steg et al., 2014).

These interactions between institutions and actors are shaped by power. Transitions are contested processes in which not all actors have compatible goals or the same amount of control over their actions (Geels et al., 2016; Hinrichs, 2014). Relations of power mediate between institutions and individuals' goal frames and decisions. We, thus, assume that the more power an individual has, the lesser the degree to which their decisions are determined by contextual factors and the higher the degree of influence over the institutions that surround them and others. While an in-depth investigation of the effects of different degrees of power is beyond the scope of this paper, we assume that, given market concentration in processing and retail (Morel et al., 2020), farmers tend to be relatively less powerful actors in the agri-food system, and their business-related decisions are thus assumed to be highly influenced by their institutional context. Moreover, actors' definition of goals, and their hierarchical salience, is influenced by these power relations, often embedded in the social and institutionalised norms of the given context (Lindenberg, 2017).

Promotion of environmentally-friendly decisions often requires hedonic and gain goals to be restrained and normative goals to be supported (Steg et al., 2014). When actors operate in institutional contexts where hedonic or gain-oriented goals are dominant, normative goals will be less relevant and achievable (Lindenberg, 2017). The interplay between institutional conditions (e.g. rules systems and regimes) and actors' goal frames is key to understanding cognitive lock-ins (Geels, 2004; Hassink et al., 2018). When barriers in the institutional context are stronger than drivers promoting change, the current focal goal of decision-makers will be strengthened, their actions will gravitate around the status quo, and the institutional setting will be reproduced, creating a **lock-in**, as shown in figure 2.1.

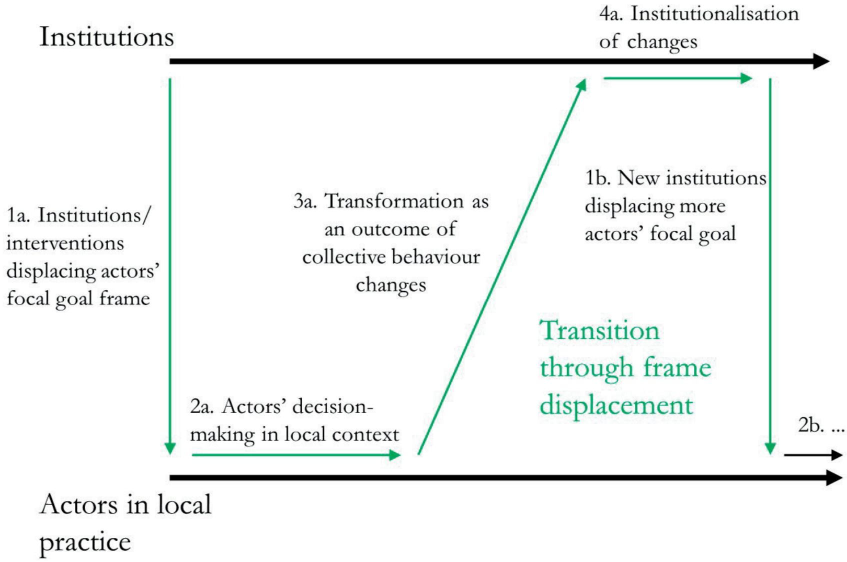
Figure 2.1 Institutions, goal frames and lock-ins



Source: Adapted from Geels (2020), Lindenberg (2017) and Steg et al. (2014)

However, Steg et al. (2014) explain how interventions that alter the institutional context can trigger or displace focal goal frames. Such a 'frame displacement' involves shifting the relative salience of goal frames (Etienne, 2011; Lindenberg & Foss, 2011). Changes at institutional and societal level can lead to changes in the wider decision-making setting in which the salience of goals that support environmental transitions increases (Steg et al., 2014) which, in turn, can lead to different outcomes that then may provoke institutional transformations. These dynamics of reproduction and transformation imply that, while individuals may adopt different practices, despite unfavourable conditions and due to their own personal goals, broader transition processes require the alignment of the institutional context and the dominant goal frame of a substantial share of decision-makers (Geels et al., 2016; Geels, 2020; Kuokkanen et al., 2018). Figure 2.2 illustrates this process.

Figure 2.2 Institutions, goal frames and transitions



Source: Adapted from Geels (2020), Lindenberg (2017) and Steg et al. (2014)

2.4 Data and methodology

2.4.1 Research context and methodological strategy

The context in which we investigated cognitive lock-ins is that of crop diversification with legumes. While once commonly part of farmers' rotations, legume production in Europe is low and decreasing (Watson et al., 2017; Zander et al., 2016). According to the latest available data, legumes covered only about 1.3% of agricultural land in the EU in 2016 (DG Agriculture and Rural Development, 2018, 2021). In Europe, farmers are reported to be reluctant to re-introduce legumes due to the pressure to stick to monoculture-oriented practices, now embedded in established policy, subsidy and regulatory regimes, indicating the presence of lock-ins (Magrini et al., 2016; Meynard et al., 2018; Voisin et al., 2014; Zander et al., 2016). Additionally, the adoption of legumes broaches several dimensions of the agri-food system such as climate, agronomy, markets and value chains, as well as policies and trade (Magrini et al., 2016; Morel et al., 2020). This inserts complexity into a farmer's decision-making process, which makes it a useful case within which to investigate cognitive lock-ins.

Our efforts to conceptualise cognitive lock-ins is based on rich case studies (Eisenhardt & Graebner, 2007). The research team had the opportunity to conduct field work in two farming communities located in the Atlantic pedo-climatic region, both affected by low adoption rates of legumes despite the presence of public support for their adoption. However, these communities also differ on few significant characteristics, such as regional and local social norms and institutional setting, as well as structures and dynamics in the agricultural and market systems. The farming community located in the region of Gelderland in the Netherlands is embedded in an export-oriented agricultural sector, is well-connected to domestic urban centres, and supported by very active agricultural research and innovation organizations (CBS, 2016; European Commission, 2020; Food Valley, 2021). The farming community in Cornwall, UK, on the other hand, is more socio-economically disadvantaged, more remote, has poorer infrastructure, and a far more domestically-oriented agricultural sector (Cornwall Council, 2017; DEFRA, 2018a). Both areas were easy to access and data sources required for triangulation were readily available which provided extensive opportunities for our efforts to build sound empirical cases. At the time of primary data collection, the purpose was to understand what explained the low adoption of legumes in crop rotation in farmers' own terms. Once data was collected, the research team developed an interpretive framework by iteratively moving between our initial frames (presented in section 3) and the evidence found in our cases. In our analysis we started from transition literature (e.g. Geels, 2004, 2011) and, guided by our empirical data, extended our framework with coding informed by GFT[6].

2.4.2 Data collection and analysis

Our primary data comes from semi-structured interviews held with farmers in 2019[7]. We decided that it was appropriate to interview farmers since, while some in our sample may be bound by production agreements for certain crops, they declared considerable freedom when it came to crop selection. Farmers in the two farming communities were identified through co-authors' professional networks and snowball sampling, in which we deliberately sampled for heterogeneity as is appropriate in exploratory research (Eisenhardt & Graebner, 2007). We conducted ten interviews with farmers from Gelderland and seven interviews with farmers in Cornwall. As less supplementary data was available for the Cornish case, three additional expert interviews were conducted, two of which were also former farmers. Additional interviews in the Dutch case were used to support the design of our data collection instruments. Secondary data, such as official statistics, government reports, and scientific literature were used to situate the farmers' responses in the context of local agriculture in general and grain legume production in particular. All interviews were held in the farmer's native language, recorded and analysed in Atlas.ti[8]. First, in-vivo coding highlighted all relevant information related to inclusion of legumes in rotation. In-vivo codes were then summarised into descriptive categories. Finally, these descriptive categories were matched with goal frames.

6 An attempt to apply the transitions theory's own institutional theory base (Geels, 2004, 2020) based on Scott (1995) as the analytical framework for this study failed due to the difficulty to empirically distinguish between cultural-cognitive and normative rules. Additionally, the overarching dominance of financial motivation that emerged from the empirical data could not be sufficiently captured in the three categories offered by this approach.

7 This means that at the time of the interviews the UK had not yet left the European Union.

8 Analysis was also done in the native language to avoid the data losses associated with translation prior to analysis.

2.4.3 Data sources

In this section we briefly describe the sample of farmers and list the additional sources of data consulted. To support comparability, we imposed restrictions on our interviewee selection. Firstly, arable farming had to be a core activity of the farm business. On the included mixed crop-livestock farms, at least 30% of land had to be used for arable farming. Secondly, to exclude hobby farmers, we determined that income had to be drawn from the farming business. All but one interviewee were full-time farmers and fully depended on their farming income. The one exception is a Cornish farmer who draws income from his arable crops, but has other additional sources of income.

The Gelderland sample included eight strictly arable farms and two mixed farms who also reared livestock. Farm sizes ranged between 35 and 200 hectares. The most commonly grown crops in the sample were sugar beet, maize, summer grain and potatoes, of which sugar beet, grains and potatoes are also the most common crops in Dutch arable farming (Voskuilen, 2020). Currently or previously grown legumes included field beans, peas, green beans, soybeans and broad beans.

In the Cornwall sample, three farmers were strictly arable and four were mixed farms, ranging between 53 and 560 ha. The most common crops among the interviewed Cornish farmers were: barley, wheat, oats, forage maize and oil seed rape. This is in line with the most common crops in in the UK and Cornwall, where 66% of arable land is used to grow cereals (DEFRA, 2018b; National Farmers Union, 2014). The only legume that appeared in this part of the sample were beans, though others such as lupines were also discussed.

All but one interviewee sold their arable crops off-farm. The exception was one Cornish farmer who uses his arable production on-farm as livestock feed, and only sells in case of overproduction. In both cases, we made sure to include farmers that are currently using legumes in their rotation, farmers that previously used legumes but stopped, as well as farmers that never grew legumes on their farm. All interviewed farmers were male. Table 2.2 below shows an overview of all data sources consulted. The appendix provides an overview of farmers.

Table 2.2 Overview of data sources

Category	Gelderland, NL	Cornwall, UK
Farmer interviews	Current legume production (2) Previous legume production (5) No legume production (3)	Current legume production (2) Previous legume production (2) No legume production (3)
Expert interviews and supplementary material	Exploratory interviews with legume-growing farmer CEO of organic vegetable and legume food processing company Participatory observation at lupin supply chain event	Farm advisor on diversification[9] Expert on Cornish agriculture and rural development[3] Expert on Cornish rural resource management and farm household behaviour
Policy documents and government sources	Policy documents (5) Central Statistics Bureau Netherlands (6)	Department for Environment, Food and Rural Affairs (6) Cornwall Council (4)
	EU policy documents and data (7)	
Other secondary data	Academic papers (8) Research reports (9)	Industry reports (3)

2.5 Findings

In this section we start by presenting the main goal frames identified . We then discuss how these different goal frames relate to the institutional setting to create cognitive lock-ins.

2.5.1 Goal frames in decision-making processes for farm diversification

Within the themes consistently nominated by farmers as important, we identified normative, gain-oriented and hedonic goals, as emerging from farmers' expressed motivations and decision-making relevant to the introduction of crop diversification. The first set of findings revolves around *normative goals* (table 2.3), summarised into three emerging themes: providing soil health and environmental benefits (theme 1), supporting the local economy (theme 2), and preserving traditions and social relations (theme 3). These demonstrate recognition of collective goals that go beyond the farmers' personal benefit. Farmers link their motivations to adopt legumes in crop rotation to the recognition of potential collective benefits. This *process of recognition* extends to the social and economic dimensions of how they make sense of their practices.

9 This expert was previously a farmer himself and thus added his own experience of farming in the region.

Table 2.3 Normative goals - Overview of emerging themes

First order codes	Exemplary quotes
Theme 1: Providing soil health and environmental benefits	
First order codes	Exemplary quotes
Preserving/promoting soil health (NL/UK)	We can't carry on farming the way we are farming, traditionally, the soils are knackered. – UK Farmer g
	I strive to get as much balance into the soil as possible. Then peas, beans, grass and spelt fit a lot better. – NL Farmer A
Provide environmental benefits (NL/UK)	[It] is the environmentally right thing to be doing, is growing pollinators. – UK Farmer c
	You had a crop that produced pollen in an open flowering way that was attractive to pollinators such as bees – UK Farmer d
Theme 2: Supporting the local/place-based economy	
First order codes	Exemplary quotes
Improve non-GMO varieties for local conditions (NL)	It is interesting to help bring non-GMO soy to another level – NL Farmer I
Local production more environmentally friendly (UK)	I think we should look also to the environment instead of getting all the stuff from South America. – UK Farmer b
	With all the protein beans imported from the amazon and rain forest […] I do think we should be encouraged as an industry to grow our own protein. – UK Farmer b
Theme 3: Preserving traditions and social relations	
First order codes	Exemplary quotes
Trust in the buyer that proposes crop (NL)	I was getting along with him well and you just think, let's try it. – NL Farmer H
Legumes not an "established" crop (UK)	I think it's an element of education. In the last 50, 60 years, which is all of my generation, probably most of my father's generation, who will remember the old school way of farming. – UK Farmer f

The second set of findings relate to *gain-oriented goals* (see table 2.4 below). This set of goals emphasises farmers' frames that are directly associated with benefits for their farm business and themselves. Our findings highlight five main conceptual themes. First, a set of farmers' gain-related goals emerges in association with the mitigation and avoidance of risks related to agro-ecological and climate-related conditions (theme 4). This socio-ecological dimension captures the struggles to diversify in an uncertain environment, where a lack of socio-technical solutions is coupled with increased uncertainty due to climate change. The second set of themes associated with gain-oriented goals refers to costs and benefits derived from policy and regulatory instruments and support systems (theme 5). Finally, three sets of themes directly relate to market conditions, namely avoiding import competition in the feed market (theme 6), creating opportunities from local cooperation in the feed market (theme 7), and creating economic advantages by integrating into food/seed supply chains (theme 8). While legumes have the potential to add economic benefits by increasing soil fertility and reducing costs of fertilization, they also come with what this frame recognizes as the salient risk of not being easily and profitably marketable. Despite these conditions, farmers still saw opportunities to overcome these challenges using entrepreneurial logics specific to their local circumstance. For instance, in more isolated Cornwall, where almost all grown legumes enter the feed market, farmers were inclined to cooperate directly with local livestock farmers. In Gelderland, instead, increased integration into food supply chains, along with the associated support measures, was perceived as a prospective solution.

Table 2.4 Gain-oriented goals - Overview of emerging themes

Theme 4: Dealing with agro-ecological and climate-related risks	
First order codes	Exemplary quotes
Vulnerability to wet climate conditions (NL/UK)	You got to be cuckoo to grow combining peas in Cornwall because we're just too wet. – UK Farmer d
	The dependency on the weather makes the pea harvest very risky. – NL Farmer E
Lack of adequate seed varieties for local climate (NL/UK)	I know they have tried to grow soya in the UK […] but I think the problem is having the right varieties. – UK Expert h
	[The growing period of] the variety was way too short. […] if the pulses are ripe and you touch them, they fall […] and the harvest is lost. – NL Farmer C
	You actually have to harvest in August, this [growing period] lasts till October. With the rain and the cold, it does not work. – NL Farmer I
Pest and disease management (UK)	[Y]ou got a massive weed problem then, and you got real chocolate spot diseases around here so […] that was useless. – UK Farmer b
Machinery (NL/UK)	Then you got the damage that you do to your combine because peas in Cornwall in a wet climate are as flat as that table. – UK Farmer d
	If you have your own machinery, you're not going to experiment with something else so quickly. – NL Farmer G
	Technically, it would be easy since I can use my own combine – NL Farmer I
Theme 5: Optimising use of subsidies and policy/regulatory support systems	
First order codes	Exemplary quotes
Subsidies were strong motivation while they lasted (NL/UK)	After the subsidy period it was better to grow grain, because in the end it is about money. – NL Farmer B
	We were growing it for the subsidy that was on it at the time. – UK Farmer d
Regulations banning planting of GMO soy (NL)	Because we are not allowed to plant GMO here, it takes more time and effort in weed management compared to abroad. – NL Farmer J
Regulations on pest and disease control limit access to subsidies (UK)	So, the political masters said: 'you take that away because we believe the NGOs are all good people and will stop you horrible farmers putting sprays on your pulses. – UK Farmer d (sarcastically)
Theme 6: Avoiding threats from import competition in the feed market	
First order codes	Exemplary quotes
Low prices due to global competition (NL/UK)	Certainly in western Europe, we are not going to be able to compete with the cost and production of soya that is coming in from the States and South America. – UK Farmer d
	[Legumes] disappeared 20 years ago from the farm because they could get it cheaper from abroad. So there were no more buyers. – NL Farmer D
Low demand due to lack of continuous supply (UK)	The truth is, the mills, […] they don't want 2 or 300 tonnes of beans, cause they can't just keep changing things over and over. […] It is easier for them to take soya. – UK Farmer b

Market uncertainty (NL)	I don't want to be dependent on the whims of the world market. – NL Farmer A
Value distribution along the chain (UK)	You sell to a middle [who] will use the excuse of logistics. This is me being a little bit cynical. There is a problem in the system, not the logistics. […] There is a big bit in the middle going missing. – UK Farmer f
Theme 7: Creating opportunities for local cooperation in the feed market	
First order codes	Exemplary quotes
Protein crop for on-farm livestock (NL/UK)	[With the beans] we hence got a regular source of protein that we know. We haven't got to rely on the world market or what the price of soya is. – UK Farmer c
Direct cooperation with livestock farmers (NL/UK)	[…] it is increasingly happening I think, where your arable producers have discussions with local livestock producers. To ask what feed they need, rather than the market for their crops being global, they are thinking more local. – UK Expert i
Create local brands (UK)	You don't have to compete with [imports]. If the public will pay the price for identity preserved, GMO free, European produced soya. – UK Farmer d
	"[I]f consumers are saying, I want to know where my food is coming from, I want my food to help pollinators or I want my food to have a positive effect on the environment […] as a result that is […] what the farmer grows." – UK Farmer g
Theme 8: Creating economic advantages by integrating food/seed supply chains	
First order codes	Exemplary quotes
Demand and good prices but with high standards (NL)	Vegetable crops, where quality is very important, a dry period can be a real problem. – NL Farmer E
	Niche markets pay more but they also ask more of you. – NL Farmer A
Low risk, labour input and investment, secure outlet (NL)	[With this contract] I have not invested anything besides my land lease, a bit of weeding and making a seedbed. – NL Farmer A
Timely payments (NL)	As soon as the peas are gone, 6 weeks later I have my money, that is very fast. – NL Farmer A
Geographic distance to buyers in can be prohibitive (NL)	The buyers do not come here, it is too far away. I would like to grow products for the canned industry, but all buyers are located below the big rivers and the polder [region in NL]. – NL Farmer C

The last set of themes relates to *hedonic* goals. Farmers demonstrated a direct association between their sense of well-being and the adoption of legumes. A more diversified farm was, at times, associated with a change in lifestyle perceived either as a discomfort (theme 9), or with the joy of experimentation, the excitement it brings, as well as the aesthetic value of a diversified farm landscape (theme 10). Table 2.5 provides the overview of hedonic goals.

Table 2.5 Hedonic goals - Overview of emerging themes

Theme 9: Dealing with the struggles of changing lifestyles	
First order codes	Exemplary quotes
Change/taking risks is uncomfortable (NL/UK)	I like a simple life, I like to be able to block crop things […] [Growing beans], it's making life difficult. It's making life hard work." – UK Farmer d
	Technically I would participate in such trials […] but on the other hand it costs a whole lot of effort. […] Not much is known, it is like pioneering. – NL Farmer J
Theme 10: Enjoying experimentation	
First order codes	Exemplary quotes
Joy of experimentation (NL)	It was a nice crop, a different crop, simply less boring. – UK Farmer B
	I always particularly enjoy trying new things, even if it just brings the same money. – NL Farmer H
Beauty of crop and its attraction to insects (NL)	Just the joy to look at it, walking through the field, the humming of all the insects. – NL Farmer A

2.5.2 Situating goal frames and cognitive lock-ins

We used secondary data to triangulate our primary findings, identifying systemic and contextual factors in each institutional setting relevant to each goal type. We then identified where misalignments between salient goal frames and the institutional context were consistent with the production of cognitive lock-in.

Overall, normative goals seem to align with expressed collective goals in the institutional context, as indicated in policy documents for both regions, the national and European context. However, the exception is the preservation of traditions which aligns, rather, with historical prioritisation of food security as a collective goal, resulting in policies focussed on industrialised production of cereals which marginalised legumes (Magrini et al., 2016; Zander et al., 2016). While policies change, individuals' perceptions and practices may do so more slowly, leading to a *'historic misalignment trap'* in which current and historically rooted normative goals are in conflict. For gain-oriented goals, the institutional context does not appear to be aligned with the adoption of legumes. Farmers reported underinvestment in seed development, resulting in a lack of locally adapted varieties. This, in turn, produced low demand for seeds justifying continued underinvestment. Despite policy makers' expressed support for local protein production, their policies support imports. As for entrepreneurial solutions, partially adequate institutional support was reported in the form of labelling options and changes in consumer demand. In the end, these *misaligned incentives* reinforce gain goals that discourage adoption. For hedonic goals, there appears to be a lack of risk management instruments to overcome the *discomfort of change* and enable the desired level of experimentation for the given circumstances. While this discomfort persists, adoption is not attractive.

However, hedonic goals were not particularly prominent in farmers' deliberations in interviews so they may be less relevant in decision-making. An overview of the identified lock-ins per goal type and the associated conditions in the institutional context is given in table 2.6.

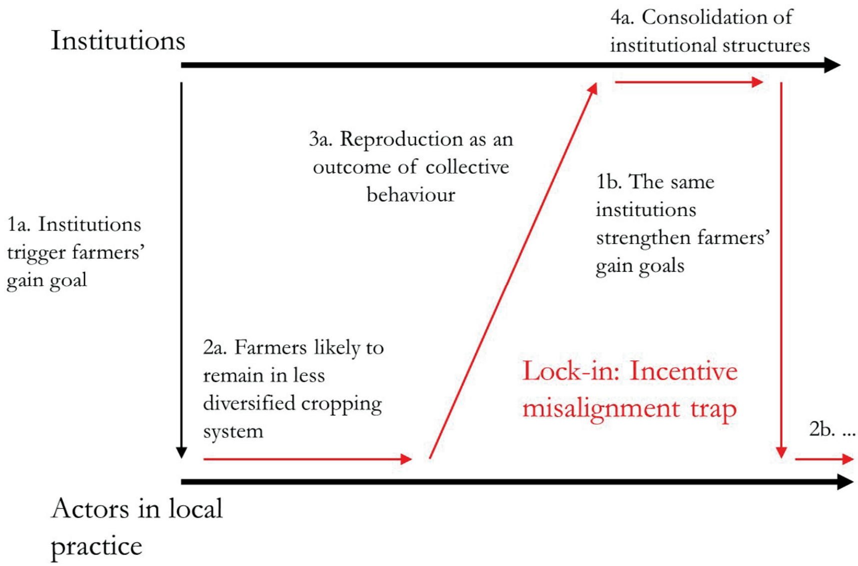
Table 2.6 Types of goals and related lock-ins

	Systemic or contextual conditions	**Exemplary secondary data support**
Normative goals: **Historic misalignment trap**	Normative goals align with public recognition of soil health and environmental issues, as well as support for local economy Misalignment on preserving traditions: goals align with historic focus on mass production for food security, not the current promotion of sustainable production	*Dutch national protein strategy is motivated by both environmental reasons, as well as to support the local economy and to move away from legume imports (Schouten, 2020)* *The Cornwall Council (2019) acknowledges the region's issues with soil management and carbon emissions.* *There is an overall European push to tackle the plant protein deficiency in European agriculture (European Commission, 2018; Häusling, 2011).* *Historic prioritisation of cereals in EU policies lead to the marginalisation of legumes (Magrini et al., 2016; Zander et al., 2016)*
Gain-oriented goals: **Incentive misalignment trap**	Incentives reinforce misaligned gain goals Underinvestment in local breeding programmes leads to low adoption which leads to underinvestment Lack of (previously effective) subsidies, subsidies strengthen gain goals Unfavourable import policies Possibility to label local production at EU level, but lack of collective action for implementation in Cornwall Consumer demand is changing in the Netherlands but as of yet insufficient	*History of low investment into research on seed varieties a EU level (Magrini et al., 2016). Available varieties were not sufficiently adapted to the Dutch cold (Nederlandse Akkerbouw Vakbond, 2019; Prins et al.)* *Adoption rates were substantially higher during periods of subsidies (Voskuilen, 2020; Watson et al., 2017)* *International trade agreements set by the EU, (e.g. the GATT and the Blair House Agreement), allow the import of protein crops on a duty-free basis (Häusling, 2011)* *Added value for local production is supported through labelling options (European Commission, 2021a) but local cooperation in Cornwall is still lacking and not actively encouraged (expert interviews)* *Consumer demand for plant proteins and meat replacements in on the rise in the Netherlands (Aiking & Boer, 2020; Tziva et al., 2020), protein production in Cornwall is almost exclusively for the feed market (expert interviews)*
Hedonic goals: **Disregard of discomfort trap**	Discomfort of behavioural change not recognised or compensated which leads to continued discomfort	*40% of English farmers indicated a lack of appropriate risk management tools (DEFRA, 2019).* *More transparent legume markets are needed to develop risk management tools (European Commission, 2018).*

2.6 Discussion

In this section we reflect on the potential role of cognitive lock-ins in sustainability transitions. While previous work has established the role of lock-ins generally (Geels, 2019; Magrini et al., 2016), results of our study show the relevance of cognitive lock-ins, specifically, for our understanding of sustainability transitions. By integrating GFT to conceptualise cognitive lock-ins as an interplay between individual-level behaviours and contextual factors, particularly societal norms, regulations, policies and standards, we have been able to identify key relations between cognitive lock-ins and transition pathways. First, confirming existing findings, *dominant gain-oriented pathways* appear to hamper transition opportunities, keeping farmers in what we defined as the 'incentive misalignment trap' (see table 6 above). While normative goals, related to environmental protection, and hedonic ones, related to enjoying experimentation, are favouring transitions, they are outmatched by goals formed in the gain frame, which seems to be embedded in and re-enforced by current institutional conditions. As indicated, crop rotation with legumes is known to enhance soil health, increase fertility, and reduce crop losses from pests and diseases, and thus may actually reduce long-term costs. Paradoxically, the dominance of a gain-oriented goal frame, in combination with adoption of legumes being associated with normative background goals, may in fact impede farmers' recognition of crop diversification practices as a potential financial gain. Figure 2.3 shows this cognitive lock-in, reinforcing the dominant gain frame and reproducing current practices. This implies that if we fail to recognise the dynamic of this cognitive lock-in, possible efforts to only target normative frames to encourage legume adoption, e.g. by emphasising positive environmental effects without further changes, is unlikely to have an effect, and may even further entrench the incentive misalignment trap.

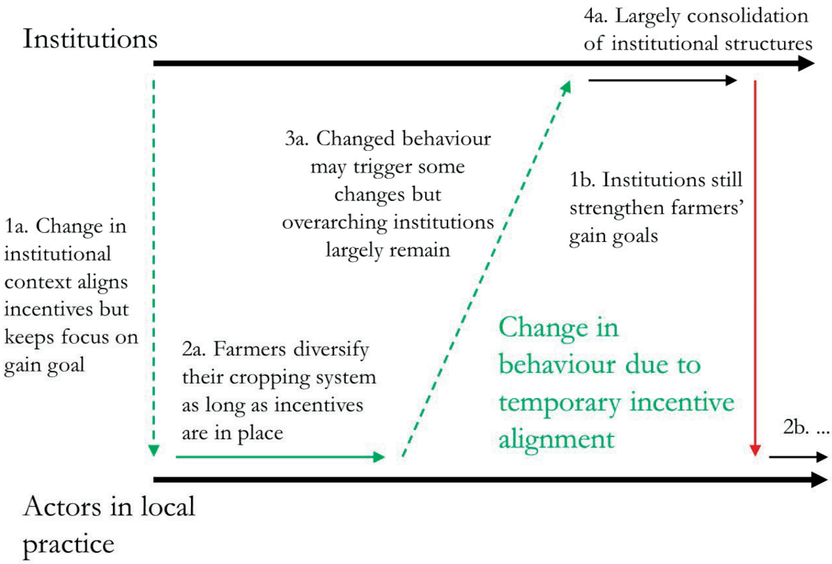
Figure 2.3 Cognitive lock-in on gain goals: The incentive misalignment trap



Source: Inspired by Geels (2020), Lindenberg (2017) and Steg et al. (2014)

Our analysis also identified two alternative mechanisms for inducing transition using the concept of cognitive lock-ins. For instance, a re-alignment of financial incentives with adoption of legumes, through a reintroduction of subsidies, may compensate for low prices or the extra effort required finding suitable outlets. Historically, subsidies were found to shift practice indicating improved alignment of gain, normative (and hedonic) goals. However, the framework also explains why subsidies only work while in place: their use triggers and strengthens the gain-oriented goal frame, as illustrated in figure 2.4, and they do little to address the underlying relations of power that delimit farmers' options (Morel et al., 2020). Our results on farmers' responses to subsidies and their current experimentation with other crops are consistent with that of flexible optimisation: they grow what makes financial sense, with a bias in favour of normative and hedonic goals as long as impacts on gain goals are negligible. Still, analysing the dynamics of cognitive lock-ins indicates that, by buying into the immediate response of farmers to non-sustainable financial incentives, policy makers may reinforce the short-term gain goal frame whose priority suppresses the relevance of the normative goals needed for long-term adoption without subsidies. This could actually hamper long-term sustainability transitions. The naturalisation of gain motivations and the 'crowding out' of normative motivations has been discussed in relation to several environmental behaviours such as energy conservation and deposit refunds for reusable packaging (Baum & Gross, 2017).

Figure 2.4 Transition pathway on gain goals: Incentive alignment

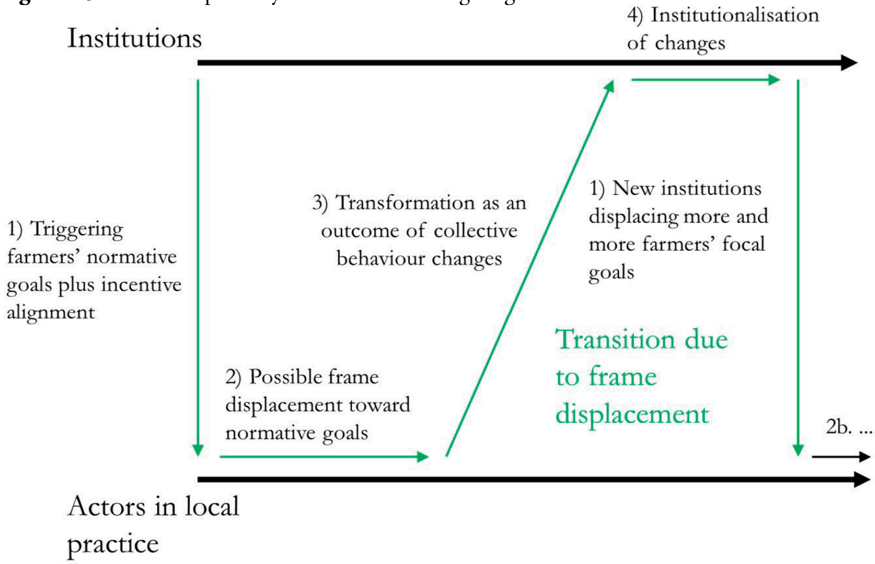


Source: Inspired by Geels (2020), Lindenberg (2017) and Steg et al. (2014)

In the absence of a permanent shift of financial incentives, a long-term, lasting adoption of legumes without continued financial support would need a shift away from the gain-oriented goal frame towards a normative goal frame. Clear societal recognition of ecological values, in this case for legumes, and related shifts in markets and consumers preferences may be essential to increase the salience of normative goal frames in farmers' decision-making. In certain innovation niches pushing for change, these alternative goals are usually the guiding ones (Feola, 2020; Koretskaya & Feola, 2020). Such broader considerations of normative goals would also support the quest for soil health and soil life, as Krzywoszynska (2019) discusses for English farming. Baum and Gross (2017) also point to the importance of maintaining normative motivations in policy making, e.g. by reminding actors of past environmental behaviour and strengthening self-identification as environmentally motivated, as essential to trigger sustained changes in behaviour. While not as prominent in our study, emphasising hedonic goals, and reducing emphasis on economic ones, could also be an additional strategy to foster adoption by farmers, as suggested by Walder et al. (2019).

Placing normative values at the centre has been argued to be a necessary condition for fundamental sustainability transitions (Nightingale et al., 2020). Yet, as we have illustrated using cognitive lock-ins, if the starting point is the incentive misalignment trap, only focussing on the normative frame will likely be ineffective. To counter this, Steg et al. (2014) suggest explicitly linking financial interventions, such as subsidies, to normative goals, e.g. by stressing their environmental benefits, in order to trigger a frame displacement. Such an approach would target other goal frames supporting the adoption of legumes, as well as making their adoption painless for farmers' gain goals. If a frame displacement takes place for a sufficient share of actors, and thus changes what most actors consider pertinent to their decision-making, it may even shift some of the relevant power relations and allow for a transformation of the institutional setting. As illustrated in figure 2.5, it could turn a vicious cycle into a virtuous one. Thus, while our findings support previous calls for public investments, for example in legume research or subsidies (e.g. Magrini et al., 2016; Zander et al., 2016), they also point to the need for a further consideration of individuals' goal frames and decision-making which was revealed by the cognitive lock-in analysis.

Figure 2.5 Transition pathway on normative and gain goals



Source: Inspired by Geels (2020), Lindenberg (2017) and Steg et al. (2014)

Farmers' decision-making on adopting practices, and thus supporting sustainability transitions, is known to be driven by a variety of factors and motivations (Brown et al., 2021; Dessart et al., 2019; Jones-Garcia & Krishna, 2021), and scholars have come to recognize the complexity of farmers' motivations (e.g. Marr & Howley, 2019). Thus, cognitive processes do not singularly determine the outcome of farmers' decision-making. Nonetheless, the study of cognitive lock-ins adds to our understanding of sustainability transitions and enables us to more carefully consider the role of individuals in transitions processes. Further, it is widely recognised that lock-ins can be multi-dimensional and interrelated (e.g. Kuokkanen et al., 2018; Meynard et al., 2018; Voisin et al., 2014). We must thus assume that, while the relative salience of different lock-in mechanisms may be context-specific, cognitive lock-ins likely play a role in maintaining the status quo.

2.7 Conclusions

The approach presented in this study starts from the well-accepted position that farmers' decisions are driven by a wide range of factors (e.g. Bartkowski & Bartke, 2018; Dessart et al., 2019; Sok et al., 2021). Using GFT permitted us to find that these different drivers and motivations can interact to create cognitive lock-ins that reproduce the status quo. Recognition of this complexity is necessary for understanding farmers' behaviour (Baum & Gross, 2017; Baur, 2020), and thus sustainability transitions in agriculture. Broader approaches to the study of decision-making that go beyond simple economic incentives have already been strongly recommended (Bartkowski & Bartke, 2018; Baum & Gross, 2017; Brown et al., 2021). More generally, this study supports the advice that policies' interactions with farmers' goals need to be taken into account when designing interventions, in order to maintain internal drivers that support desirables behaviours (Baum & Gross, 2017; Brown et al., 2021). The analysis of cognitive lock-ins can be instrumental in such an approach as it allows for the recognition of local specificities and may avoid some of the de-contextualization of farmers' decisions that has been cautioned in studies on practice adoption (Jones-Garcia & Krishna, 2021). This local contextualisation is particularly important as separate policies with singular objectives in the same locale can trigger different, competing goals in the same decision-making process, despite the best intentions of farmers and policy-makers (Baur, 2020).

In our empirical context, we found that gain-oriented goal frames seem to be dominant in farmers' reported decision-making. Rooted in the institutional context, the 'incentive misalignment trap' seems to be taken for granted by farmers so, when they exercise the agency so often celebrated in studies of innovation, they turn to local solutions. While legumes are desirable for hedonic and normative reasons, those goal-frames are easily overwhelmed by the perceived risks and lack of profitability found in the gain frame. Similarly, Suvanto et al. (2020) claim that, even if profitable, the riskiness of legumes and similar crops may entice only the most entrepreneurial farmers which is not enough to precipitate the broad uptake that is needed. Institutions aiming to alter practice by reinforcing a gain frame through subsidies may fail to directly produce the sustained changes required. Subsidies may need to be accompanied by normative framings, investments in research on seed development, financial instruments to mitigate risks and the creation of markets in which less subsidized European legumes can actually compete.

Looking ahead, scholars have previously assigned different (salient) goals to different groups of farmers (e.g. Reimer et al., 2012; Thompson et al., 2015). It is thus advisable to investigate whether different cognitive lock-in mechanisms emerge in different categories of farmers, as well as in other agri-food actors more generally. It would, then, be reasonable to conduct studies that attempt to understand the variables relevant to trade-offs between normative and gain goals over short and long-term timeframes, as well as the specific role of power relations within and beyond these trade-offs. Further, while the limited reported salience of hedonic goals may not be surprising, given that the decision to adopt sustainable practices is usually presented as a business decision (Dessart et al., 2019), future applications may want to look at the interactions of institutions with hedonic goals more intensively as hedonic goals may be both more tacit and less easily articulated. Finally, the farmers we interviewed knew the benefits of legumes. Their demonstrated knowledge is not compatible with the knowledge deficit often cited as a barrier to adoption (e.g. Meynard et al., 2018; Zimmer et al., 2016). Further studies should, therefore, test such broadly held assumptions.

Acknowledgements
We would like to thank Mandy van Kemenade for her support during the data collection in the Cornwall case, and the participating farmers and experts for their time.

Appendix 2.1: Farmer overview

The table below provides an overview of the rotation farmers reported for their most important plot, as was indicated in the interview guide for each region. Other crops may have been present on other plots.

Gelderland, Netherlands				
Farmer	Farm size	Experience with legumes	Current rotation	Arable vs. mixed
A	35 ha	Yes	Grass clover, spelled, field bean, partially peas and partially green beans, grass seed	Mixed (Organic)
B	118 ha	No	Sugar beet, wheat, potato, corn	Arable
C	150 ha	Yes	Sugar beet, wheat, winter rapeseed, wheat	Arable
D	200 ha	Yes	Wheat, sugar beet, onion, potato (consumption)	Arable
E	90 ha	No	Corn, barley, potato (starch), sugar beet	Arable
F	120 ha	Yes	Onion, potato (starch), winter wheat, corn, sugar beet	Arable
G	70 ha	No	Sugar beet, corn, potato (experiment), corn	Arable
H	200 ha	No	Lily, gladiolus, potato (consumption), grassland (for 5 years)	Mixed
I	35 ha	Yes	Summer grain (wheat – barley), potato (starch), corn, sugar beet	Arable
J	75 ha	No	Potato (consumption), sugar beet, corn/barley	Arable

Cornwall, UK				
Farmer	Farm size	Experience with legumes	Current rotation	Arable vs. mixed
a	Not given	Yes	Barley, beans, forage maize, oats, wheat, oil seed rape, cover crop	Arable
b	560 ha	Yes	Barley, beans, forage maize, oats, wheat, oil seed rape, grass, stubble turnips	Mixed
c	113 ha	Yes	Barley, forage maize, oats, oil seed rape, wheat	Mixed
d	200 ha	No	Barley, oats, oil seed rape, wheat	Mixed
e	200 ha	Yes	Barley, forage maize, oats, cabbages, potatoes	Mixed
f	400 ha	No	Barley, wheat, potatoes, daffodils, Spanish bluebells	Arable
g	53 ha	No	Hemp, borage, calendula, sunflower, roses	Arable

CHAPTER 3

Understanding the role of value chain formation in the scaling of crop diversification practices

This chapter is under review as:

Weituschat, C.S., Pascucci, S., Materia, V.C., Blasi, E. Understanding the role of value chain formation in the scaling of crop diversification practices. Journal: Agronomy for Sustainable Development

Abstract
Significant detrimental effects of agricultural intensification and specialisation are becoming increasingly evident. Reliance on monocultures, few varieties and intensive use of agrochemicals is a major factor in climate change, biodiversity decline, soil health deterioration and pollution, putting our food system at risk. While more sustainable approaches, such as crop diversification, are practiced at niche level, they are struggling to scale up to induce broader sustainability transitions. Using rich empirical evidence from two in-depth, longitudinal case studies of innovation niches in Italy and the Netherlands, we observe the niches' scaling processes through an institutional lens. Specifically, we analyse the dimensions of their institutional logics, their changes, internal tensions and realignment over time. Doing so, we show for the first time that scaling processes of crop diversification in both corporate-led and community-driven niches converge, showing similar progressions in terms of institutional dimensions, and facing similar obstacles when it comes to value chain formation. While initial experimentation could still be implemented using organisational forms familiar to the lead actors, a systemic lack of adequate value chain arrangements obstructed the scaling process of crop diversification. Thus, despite their differences, we identified value chain formation as a crucial step in the realignment of institutional dimensions which is needed for the scaling of crop diversification in innovation niches.

3.1 Introduction

Despite increasing evidence of detrimental effects for climate and environment, agricultural intensification and specialisation have persisted over the last decades (Kleijn et al., 2019; Rockström et al., 2017). Our reliance on monocultures, few varieties and intensive use of agrochemicals is a major factor in climate change, biodiversity decline, soil health deterioration and pollution, putting our food system at risk (Davies, 2017; Lanz et al., 2018; Rockström et al., 2020). Increasing crop diversity at field, farm and agricultural system level is considered a starting point to support the broader transitions towards sustainable food systems (Bonke & Musshoff, 2020; Gurr et al., 2016; Rodriguez et al., 2021; Struik & Kuyper, 2017; Alexander Wezel et al., 2020) and it plays a role in many approaches targeting more sustainable agriculture, such as organic agriculture, ecological intensification and agroecology (Duru et al., 2015; Garibaldi et al., 2019; Migliorini & Wezel, 2017; Therond et al., 2017). Crop diversification, and especially the introduction of legumes in crop rotations, has the potentials of introducing agri-environmental and economic benefits, including increasing agro-biodiversity, decreasing the incidence of pests and diseases and improving soil health and structure (Bedoussac et al., 2015; Ditzler et al., 2021; Magrini et al., 2016; Watson et al., 2017). Additionally, the nitrogen fixation properties of legumes reduce the need of chemical fertilisation, and thus reduce pollution and eutrophication (Bedoussac et al., 2015). EU strategies on climate and biodiversity vocally support crop diversification, and increased production of legumes in rotations (European Commission, 2018, 2021b).

Nevertheless, in the European context, crop diversification remains a practice confined to so-called “innovation niches”, which refers to protected spaces where innovations, e.g. more sustainable practices, are developed and tested (Duru et al., 2015; Geels, 2019; Ingram, 2015). Yet, the enablers and barriers for bringing these niches to scale at a territorial level are far from being fully understood (Ingram, 2015; Magrini et al., 2016; Meynard et al., 2018; Morel et al., 2020). The implementation and adoption of niche practices at larger scale is a complex endeavour (Boulestreau et al., 2021; Wigboldus et al., 2016; Wojtynia et al., 2021) and in the case of crop diversification touches upon many dimensions, including policies, markets and value chains, and farm management (Magrini et al., 2016; Meynard et al., 2018; Voisin et al., 2014). Accordingly, farmers are not always in full control of their choice to adopt crop diversification (Bonke & Musshoff, 2020), and while they can stimulate change at the innovation niche level (Boulestreau et al., 2021), it is the scaling of these practices that is essential to bring about the sustainability transitions food systems need. Against this background, this study focuses on these scaling processes in order to further unravel the mechanisms that facilitate or obstruct the adoption of crop diversification practices, and their scaling. In our analysis, we look at *how* two sustainable innovation niches in different settings develop *over time*, paying special attention to the barriers and enablers of crop diversification adoption and scaling mechanisms. Hereby we focus our discussion, as indicated by our findings, specifically on the process of value chain formation, which has emerged as a crucial obstacle in bringing practices to scale. Our study draws on rich empirical evidence from two longitudinal case studies: On one hand, we collected data related to the *Barilla Sustainable Farming* (BSF) project in Italy, where crop diversification practices have been introduced in existing industrial value chains, representing a case of a company-led process. On the other hand, we collected data from the *Ekoboerderij de Lingehof* (EDL) initiative in the Netherlands, a farm and community-led approach where diversification practices have stimulated the formation of new value chains (see figure 3.1). Thus, in both cases, we observed actors engaged in the attempt to implement and promote crop diversification practices through extended crop rotations, including those with legumes, but under different institutional and organizational conditions. We developed a longitudinal, abductive analysis, comparing both cases over time in order to reconstruct their scaling processes, considering primary, as well as a wealth of complementary secondary data. Analytically, we use an institutional analytical lens (Fuenfschilling & Truffer, 2014; Thornton & Ocasio, 1999), which helped us to better understand and conceptualize the scaling of niches by means of value chain formation.

The next section briefly introduces the conceptual approach on institutional analysis, particularly on the role of logics in innovation niches, as well as the methodological approach. That is followed by the findings of this study and the discussion of results in relation to scaling opportunities for crop diversification and sustainability transitions. Finally, we present our conclusion.

Figure 3.1 Diverse crops at EDL case study, clockwise: Lupins, potatoes with flower strips, flax.

Source: The authors

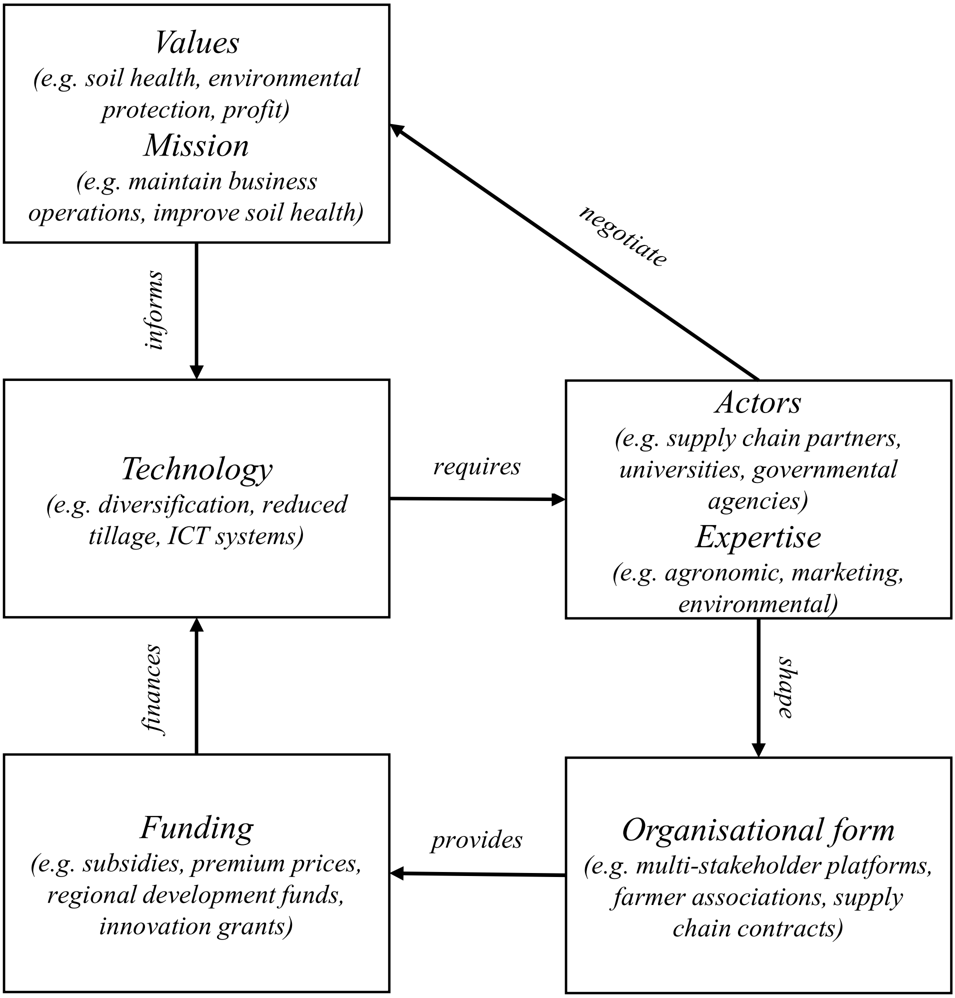
3.2 Conceptual framework

Innovation niches are spaces in which actors experiment and test novel practices, in response to pressures and opportunities, such as socio-ecological crises, in their wider societal context (Hermans et al., 2016; Ingram, 2015). Niches may differ in terms of the degree in which they align with the dominant food system and the degree in which they are supported by mainstream practices (Gaitán-Cremaschi et al., 2019). While in some cases actors operating in the niche do not intend to scale their innovative, more sustainable practices (Belmin et al., 2018), in other cases there is the expressed aim for the actors to move out of the niche, scale up and trigger a broader shift in practices and technologies (Geels et al., 2016; Ingram, 2015; Meynard et al., 2017). Scaling processes are often understood through the lenses of transitions, and when they are concerned with fundamental, purposive changes to fulfil societally necessary functions more sustainably, they are referred to as sustainability transitions (Geels et al., 2016; Vermunt et al., 2020). While niches may scale up and initiate a sustainability transition, there is debate about the conditions that enable these processes (Pigford et al., 2018). Additionally, recent scholarship has highlighted the institutional and organizational dimension of transition processes (Berthet & Hickey, 2018; Hermans et al., 2016; Meynard et al., 2017), indicating the need to better understand these perspectives in relation to niches and their potential to scale (Pigford et al., 2018; Wigboldus et al., 2016).

In order to help us understand these scaling processes, we draw from institutional theory which is firmly rooted in the conceptualisation of sustainability transitions (Geels, 2004, 2020) and has been used extensively to analyse transition processes (e.g. Fuenfschilling & Truffer, 2014; Huxley et al., 2019; Smink et al., 2015). Just like transition processes, the scaling process of niches is non-linear and based on tensions and negotiations (Fuenfschilling & Truffer, 2014; Geels, 2011) and if stakeholders are not aligned, transitions are likely to be blocked (Wojtynia et al., 2021). It is proposed that these tensions and negotiations are guided by the (changing) institutional logics upon which a niche is built (Fuenfschilling & Truffer, 2014; Thornton & Ocasio, 1999). Institutional logics are defined as "the socially constructed, historical patterns of material practices, assumptions, values, beliefs, and rules", both formal and informal, which "guide and constrain decision makers in accomplishing the organization's tasks and in obtaining social status, credits, penalties, and rewards in the process" (Thornton & Ocasio, 1999, p. 804). In order to identify different institutional logics, several dimensions have been proposed, namely *values, mission, technology, actors, expertise, funding,* and *organisational form* (Fuenfschilling & Truffer, 2014). We propose, based on our findings, that these dimensions are interrelated (see figure 3.2) and that they shape the scaling process of sustainable innovation niches. This assumption is inspired by the fact that changing farming practices at scale is complex and has many interrelated determinants (Boulestreau et al., 2021) which we can disentangle by considering these dimensions. For example, actors in an innovation niche are motivated by their *values and mission* to implement and scale up sustainable practices. These values and missions may be focussed on protecting the environment, improving soil health, maintaining productivity, or increasing profits. First they will need to identify which *technologies*, in this case sustainable practices, will achieve their goals, such as crop diversification, reduced tillage, or new machinery or IT systems. To identify and experiment with these practices, additional *expertise* may be needed. This expertise might be in terms of agronomic practices, environmental effects, operational knowledge or even financial considerations. In order to bring in this expertise and engage with the necessary parties for implementation lead actors will need to involve other *actors*, such as research institutes or value chain partners. In this phase the *funding* required for experimenting with these sustainable practices may still come from external parties, such as subsidies or innovation grants from governmental agencies or investors. Yet, in order for both long-term viability and large scale implementation of these practices, funding will need to be internalised, which will require new *organisational forms,* such as new contractual arrangement, new associations or partnerships, that provide the additional funding needed for scaling.

Thus, rather than to identify different sets of institutional logics in a given sector and analysing tensions between niche and regime (Fuenfschilling & Truffer, 2014; Smink et al., 2015), we suggest that by observing these dimensions, their combinations, tensions and changes over time within the niche, we can analytically reconstruct the scaling process and identify barriers to niche formation and scaling. In this study, we add to the extant literature on innovation niches and sustainability transitions by using the lens of institutional logics and related dimensions as an analytical tool to conceptualise the scaling process of crop diversification niches. The advantage of this approach is that it provides analytical categories that can be observed over time and that highlight the missing pieces of scaling processes. The following section describes the methodology that informed this conceptual approach.

Figure 3.2 Proposed relations between key dimensions of institutional logics



Source: The authors, based on Fuenfschilling and Truffer (2014)

3.3 Materials and methods

3.3.1 Research strategy and context

We implemented an abductive research strategy (Philipsen, 2018). Initial data collection and analysis subsequently informed the research team to collect further data while simultaneously engaging with notions and concepts related to institutional aspects in the scaling of diversification practices. This process, including unexpected results, triggered further data collection and analysis, moving from cases to theory (Philipsen, 2018), which helped us gain an in-depth understanding of the ongoing scaling processes in the innovation niches. In order to reconstruct the temporal process, in line with an in-depth case study methodology (Eisenhardt et al., 2016; Eisenhardt & Graebner, 2007), it was necessary to have a long-term engagement and commitment from and to these case studies. The research team had the opportunity to select two in-depth longitudinal case studies, as part of an EU-H2020 funded project, Diverfarming, in which the research team had been involved since its initiation (Diverfarming, 2017a). More specifically, the research team compared and contrasted the case of *Barilla Sustainable Farming* (BSF) initiative and the case of the farm *Ekoboerderij de Lingehof* (EDL). These case studies were selected due to their specific characteristics, both in terms of similarities and differences. Both cases describe the establishment of an innovation niche where crop diversification practices, including the introduction of legumes in rotation, was the key element targeted by the actors in the niche. On the one hand, the BSF case is a corporate initiative led by the Barilla Group, a family-owned, multinational food processing company with its headquarters and majority of operations in Italy (Barilla, 2021c). The BSF case study represents a corporate-led and commercially-driven project introduced in an existing industrial value chain by the key actor Barilla, aiming to promote sustainability for the company's brands and to secure high quality raw materials. With soft and durum wheat as the company's most important raw materials, crop diversification implemented by farmers in Barilla's pre-existing value chains was established to have strategic positive outcomes, both environmentally as well as in terms of product quality (Barilla, 2020, 2021b, 2021a), as illustrated in picture in figure 3.3. EDL, on the other hand, is a farm encompassing approximately 100ha, in the region of Gelderland, Netherlands (Ekoboerderij de Lingehof, 2020). The farm currently carries biodynamic[10] and organic certification and delivers their crops to regional, national and European buyers. Since its establishment, EDL farm managers considered ecological principles and particularly the enhancement of soil health as a defining factor in crop rotation and diversification choices, which eventually extended to approximately 10-15 different crops each year. Hence, while converging in terms of crop diversification practices and scaling processes, they are positioned in different organizational and institutional conditions, thus maximising opportunities for case comparison (Eisenhardt et al., 2016; Eisenhardt & Graebner, 2007). More details on the cases can be found in the appendix.

10 Biodynamic agriculture assumes the farm, soil and ecosystem to be a living organism and diversity in rotations with a focus on soil health is a key factor in biodynamic farming. Sources: Biodynamic Association (2022); Demeter (2021).

Figure 3.3 Farm in the BSF case study, clockwise: Tomato, peas, and wheat straw after harvest

Source: The authors

3.3.2 Data collection

In order to analyse crop diversification and scaling processes over time, and in line with the abductive approach, an iterative process of data collection and analysis was undertaken (Philipsen, 2018). Data was primarily collected using in-depth, semi-structured interviews with farmers (EDL) and company managers (BSF) who were asked to describe the origin of the innovation process, its key features and activities, and how these changed over time. The structure and key elements of the interviews were adjusted, as necessary, to each interviewee and context. Moreover, to enrich our primary data, interviews with actors related to the activities in the innovation niche, e.g. value chain partners, and observational data were collected. All interviews lasted between one and two hours and were conducted within the timeframe of 2016-2020. Interviews were conducted in English since the interviewees were proficient in this language. However, there was always at least one researcher present who spoke the native language of the interviewee (Dutch or Italian), in order to clarify or translate terms if needed. For the BSF case study, we also conducted two focus groups, with farmers and suppliers in Italian. Finally, we integrated and triangulated information from the cases with secondary data according to the specific needs suggested by evidence from the field (Eisenhardt & Graebner, 2007). Both cases had an inventory of documents and information related to their key activities, as well as a website. Table 3.1 reports an overview of all consulted data sources.

Table 3.1 Overview of data sources

Category	Barilla Sustainable Farming	Ekoboerderij de Lingehof
Interviews	Global purchasing manager (GPM) Agronomy R&D manager (ARD) Purchasing director for raw materials (PDM) Sustainable Farming specialist (SFS) Marketing manager (MM) Brand equity manager (BEM) Purchasing soft wheat manager (PSW)	Farm manager (1) (FM1) Farm manager (2) (FM2) Value chain partner 1 (SCP1) Value chain partner 2 (SCP2)
Observations	Internal strategic meetings (ISM)	Farm visit 1 (FV1) Farm visit 2 (FV2)
Focus groups	Farmers focus group Parma (FGP) Suppliers focus group Parma (SFG) Jeffersonian dinner Parma (JDP)	Jeffersonian dinner Wageningen (JDW)
Documents	Barilla Sustainability reporting inventory (BSI) Reports and presentations on sustainable raw material initiatives related to crop diversification (SRMI) Barilla strategic reporting (BSR)	Report – Lupine project (LPR) Presentation – Crop rotation design Diverfarming Wageningen (CRDW)
Secondary data sources	MSc thesis reports Academic papers Barilla corporate website	Farm website repository

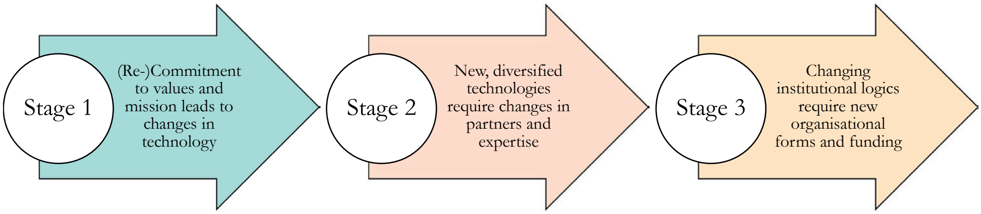
3.3.3 Data analysis

We coded the contents of interview and meeting transcripts for qualitative analysis and triangulated with a comprehensive collection of documentary data (see table 1 above). Through the theoretical lenses of the analytical framework we thematically coded primary and secondary data sources, purposefully sieving through the data for indications of the dimensions of institutional logics (values, mission, technology, actors, expertise, funding, organisational form). We specifically focussed on the implementation and scaling process of crop rotation practices. At the same time we organized these codes and their respective extracts in chronological order, using a process analysis approach, creating a timeline of key events (Langley, 1999) and accounting for coherence, tensions and changes of the identified institutional factors in the two cases. Based on this reconstruction, we identified temporal stages characterising the two niches' scaling process. Based on this approach, we describe the identified institutional logics at play in each of the case studies and discuss how the order of key events creates specific institutional dynamics. The quotes used are marginally adjusted for conciseness and readability.

3.4 Findings

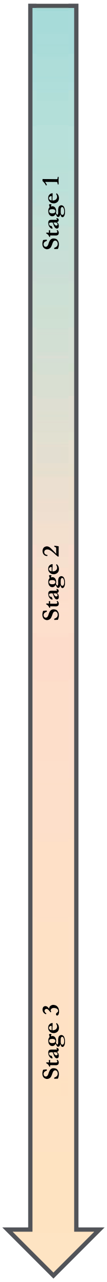
In this section, we present a detailed account of chronological narratives emerging from our data analysis. We have identified common stages characterising the temporal development of both niches, and identified the key 'turning points' of their scaling pathways, from project to value chain level. First, table 3.2 summarises the changes in the institutional dimensions as they occurred across the different stages of the scaling process. Then we discuss each stage of the scaling process, as reported in figure 3.4 below, in more detail, relating them to the different dimensions of institutional logics, according to the conceptual background presented in section 2.

Figure 3.4 Three stages of niche scaling observed in the case studies



Source: The authors

Table 3.2 Overview of changes in dimensions informing each innovation niche



Institutional dimensions	**Barilla Sustainable Farming**	**Ekoboerderij de Lingehof**
Values	"Good for you, good for the planet": While the collection of values remained the same, there was a shift towards more emphasis on environmental sustainability and productivity of its supply base.	"Artisan of the soil": Shift from organic farming and maintaining soil health to focus on restoring and improving soil as a living organism (biodynamic).
Mission	Maintaining or improving business operations remains central, yet there was a shift in recognizing that improving soil fertility and farm productivity is necessary for that mission in the long run.	Shift towards improving on-farm soil health and ecosystem, while maintaining the financial viability of the farming business, recognizing the trade-off when it comes to cash crops.
Technology	Introducing e.g. legumes or oil seeds in an at least 3 to 5-year crop rotation with cereals, supported by decision support system.	Combining cash crops (e.g. potatoes and onions) with rest crops (e.g. legumes) in a long, 6 to 7-year crop rotation, supported by new weeding machinery.
Actors	Shift to closer engagement with and consultation of stakeholders, incl. farmers, associations, storage centres and brokers, other food companies trading complementary crops, enabling actors (e.g. NGOs, universities, extension services).	Shift to closer engagement with other farmers, suppliers, brokers, associations, certification bodies, consumers.
Expertise	Agronomic expertise: shift from internal R&D to cooperation with universities, and expertise of the value chain: based on purchasing department and value chain partners → shift from internal to joint expertise	Agronomic and financial expertise: own experimentation and mutual advice with farmer group, cooperation with university, shift from internal to joint towards sharing of expertise, e.g. on legume production with others
Funding	Initially internal funds are complemented with external funding from e.g. EU research projects, but for scaling funds need to be rooted in the value chain	Experimentation supported by research projects and regional development funds, but for scaling needs premium prices for biodynamic crops
Organisational form	Multi-stakeholder partnerships for consultation and experimentation but for scaling needs value chain formation through contract farming	Long term verbal contracts work for most crops but for scaling needs value chain formation incl. associational/collective contracts

Stage 1 – Commitment to values and mission leads to changes in technologies

We now present each stage in table 2 in more detail, relating it directly to our primary data. In stage 1, in both innovation niches, the process of engaging with crop diversification started through the need of reconsidering and repositioning the set of values of the involved organizations. BSF was launched in the early 2000s with the aim of learning about the environmental footprint of the Barilla Group's sourcing, production and value chains (Blasi et al., 2015). Initially, the company focused on life cycle assessments of its products, which highlighted the need to engage with the supply chains' agricultural production (Blasi et al., 2015). Subsequently, the company engaged in the design of a systemic initiative:

'We looked at our values – good for you and good for the planet [the company's mission statement] – and we thought we were not always consistent. We needed a long term view, and to mobilise ideas and create conversations from the retailing shelves to the farmer's gate, and beyond' [ISM]

BSF was soon defined as a strategy to re-shape the sourcing of the company, connecting it more closely to its core values, and re-embedded in a place and locality.

'Reference to the Mediterranean diet has been always very important in our business values. We recognised that this starts by looking carefully at the sourcing of your raw materials' [PDM]

The BSF initiative had started with a shift in the strategic focus of Barilla, as captured in their corporate motto 'good for you, good for the planet'. When confronted with the need to truly operationalise this vision, the company needed to re-think its value chain governance more profoundly. The company was already confronted with issues of reduced productivity, coupled with increased uncertainty for sourcing raw materials, like cereals, both nationally (from Italian farmers) and globally. The (re-)commitment to the company's stated values and mission led to these institutional dimensions being more firmly implemented as guiding principles. Since these principles were previously not fully aligned with current practices, this re-commitment led not only to the re-shaping of the marketing of the company's products, but also to the introduction of a more 'place-based' sourcing strategy, increasing the sourcing from local/national (Italian) farmers through the BSF initiative. This is evidenced in one of the statements of the supply chain strategist:

'Until the mid-90s we have been operating through a portfolio of sourcing options, from spot markets to international brokers, to support our global brand in the pasta segment. We then realised we needed more diversity in our sourcing, and a more careful, regionalised approach.

We had moved into a 'good for you, good for the planet' approach, and what was good for the planet we needed to figure out and control more carefully' [PDM].

Amongst many pressures, the need to enhance soil health had taken a pivotal role in the introduction of the Barilla Sustainable Farming initiative. The need to improve soil fertility also triggered the idea to engage with a wider set of stakeholders, and to create partnerships, for sharing practices and knowledge, beyond managing value chain relations.

'We needed to design and implement guidelines and procedures, rapidly learning from farmers and practitioners, but trying to still govern a complex and dispersed supply chain' [ARD]

'I remember the agronomist from Barilla mentioning a new decision system and guidelines to be used in our farm. I thought, here we go again; they're coming to squeeze us. But instead, we started discussing best practises, reducing fertilization, crop rotation. I felt engaged to be honest, perhaps for the first time' [SFG]

Therefore, while maintaining business operations remained first priority, the commitment to environmental values and the associated mission changed *how* that aim was to be achieved.

In the other case, our findings indicate a similar shift, although from a different perspective. Arable farming is the core activity for EDL, a farm located in the Gelderland region, in the Netherlands. When taking over the farm in 2005, the founder of the Ekoboerderij de Lingehof immediately initiated the transition to organic farming. In subsequent years, however, the farm managers wanted to move beyond organic and embraced biodynamic farming.

'I was looking for a way of making the soil come back to life, to experiment with new crops, to embrace nature in my daily farming decisions' [FM1]

'Learning how to manage multiple crops was my initial challenge, but there was no alternative, we needed to go back to the basics and see this as a new project' [FM2].

Becoming an active member of the biodynamic movement, EDL started its innovation journey by recognising the need to engage with crop rotation as part of a shared ecological worldview and value system. Becoming an "artisan of the soil" meant focussing on restoring and improving the soil and thus further diversifying the crop rotation. However, the mission to remain a functional farm meant aligning rotations with financial and marketing considerations. Which crop to introduce in the rotation, its duration, and adaptation to the agro-ecological conditions of the farm had to be combined with the need to ensure the presence of a few cash crops, for example potatoes and onions:

'We were following a strict biodynamic calendar and planning for our rotations. You have to treat tuber crops that are heavy for the soil very carefully, but we needed some more to make the long rotation [economically] viable' [CRDW]

Both innovation processes started with a (re-)commitment to the core actor's values and mission, which had consequences for the technologies to be applied. In stage 1, the tension of values and mission being inconsistent with current practices led to the identification of new technologies, including the adoption of diversified crop rotations, that more closely adhere to these values and missions.

Stage 2 – New, diversified technologies require changes in partners and expertise
In the BSF initiative, the need to combine soil fertility with productivity triggered the mobilisation of a wider network of actors such as value chain partners, knowledge institutions, farmer associations, and NGOs.

'We had considered several agronomic practices, but we needed a wider understanding of how these practices could be introduced and implemented, which incentives to use and where to apply them. We needed to start collecting data and partners who knew how to do it. That's when we opened to collaboration with universities and [farmer] associations' [SFS]

In 2008-2009, BSF took the shape of a multi-stakeholder platform based on formal rules and procedures to improve the sustainability of the durum wheat supply chain. This move was due to the need of scaling extended crop rotations and sustainable practices among Barilla's supply base, and to identify drivers for their adoption and diffusion. As part of this platform and related interactions, actors negotiated the interpretation and operationalisation of the values and mission put forward by Barilla. As an outcome of these consultations, the Barilla Sustainable Farming Handbook was officially launched. The Handbook represented the first moment where Barilla and its value chain partners codified practices, including crop rotation, into a form that could be shared more easily (Blasi et al., 2015). The final BSF Handbook organised rules and best practices to support farmers in making the production of durum wheat more sustainable:

'Durum wheat has always been a very strategic crop for our company. [To set-up and develop the Handbook] We focused on small scale and territorial clusters where quality programmes to improve the protein content in durum were already in place. We needed an infrastructure and methodology to emerge, to be tested and used. We needed data, not only stories." [GPM]

To facilitate the implementation of the Handbook, a decision support system was developed and farmers were encouraged to use it free of charge. The Barilla Group had already developed a network of extension services and strong value chain contract relations in various regions in Italy.

'Before crop-rotation and contracts were considered, we had experimented with various partners we could trust. We started in Emilia-Romagna and Lombardy, where associations could help us to unpack the complexity of what we wanted to achieve. Then we looked for universities, labs and NGOs who could support a regionally-based multi-actor platform… that's were all this started' [JDP]

Thus, in order to identify the necessary changes in practices, agronomic expertise was needed first, collected from internal R&D, as well as consulting university resources. For implementation among the supply base, extensive knowledge on farmers and operations from different value chain partners was needed.

In the same period, EDL had re-organised its management by introducing a shared farm management strategy and entrepreneurial ideas, mostly by focusing on new crops with the intention of having long and diverse rotations. After few trials, crops were selected that could be harvested in one go, then stored on-farm or delivered directly to the customer, often with a short value chain approach. The company moved more decisively towards biodynamic practices.

'Experimenting with new crops, looking for new marketing channels and going to work with my machines has been challenging and exciting at the same time' [FM1]

'Consumers are interested in where their food comes from, but it also needs to work for the farmers and it has to be part of a supply chain approach. That's what we do at [EDL]' [JDW]

Additionally, the farm began to design and experiment with new machinery for manual and mechanical weeding to reduce the increased labour cost associated with their soil health approach. On-farm experimentation and agronomic expertise was complemented by mutual advice with a group of farmers, as stipulated in the biodynamic approach. Alongside that, the farm entered research projects with a local university and research centre for mutual learning. These collaborations included, for example, on-farm experimentation to support variety development for legumes, and the development of financial expertise connected to the profitability of different rotations. This was necessary so that the soil health focussed rotations would still maintain farm operations. Thus, EDL simultaneously engaged new actors and new expertise, and then moved to share this expertise with other farmers. Sharing this expertise also enabled the attempt to reshape marketing conditions. For example, sweet lupins were introduced due to their benefits for soil health. Yet, in order to improve the viability and profitability of this crop, engagement with other farmers and the sharing of agronomic knowledge on production was needed to create critical mass of local lupin production, with the aim to sell under better (bargaining) conditions. Overall, the engagement and consultation with their partners, including other actors in the value chain, led to a continuous re-design of rotations to balance the co-existence of profitable cash crops with soil health enhancing crops. In summary, in stage 2, the companies moved to experimenting with the identified technologies, and in this experimentation realised the need for new partnerships and expertise for their intended activities.

Stage 3 – Changing institutional logics require new organisational forms and funding
From 2013 onwards, the BSF approach was extended and further scaled up. To scale up and reach more farmers in the supply base, the company's sourcing strategy had to be adapted. In order to extend support to farmers, more intensive coordination along the value chain was needed, and BSF aimed for implementing (at times multi-year) contractual arrangements with farmers and value chain partners. Since 2015, BSF has become one of the flagship initiatives for introducing sustainable practices in the Barilla sourcing strategy, involving value chain stakeholders in different countries and with the prospect to become the leading approach for the company's global sourcing strategies (Pancino et al., 2019; United Nations Global Compact Network Italy, 2015).

'We realised we also needed a strategy for mobilising different departments, but without jeopardizing our core operations – we needed to reach a different scale too, without scaring anyone.' [JDP]

'We work with farmers to improve decision-making. Partners are engaged to support the change process too, since farmers struggle to change crop practices and engage with supply chain contracts' [ARD].

However, with the scaling of operations and the diffusion of guidelines across the value chain also came tensions related to the governance of this process, as BSF met resistance from its partners with regard to the contractual arrangements.

'Farmers aren't sure on how to go about these practices, and the data monitoring… it's tricky, they want stability but they seem to avoid long-term commitments […] they dislike multi-year contracts' [SFG]

The scaling process of BSF stimulated a period of intense governance experimentation, as the changes in the other institutional dimensions were no longer aligned with the organisational forms in use at the time. From the early 2010s, the BSF initiative moved from experimenting with groups of associated farmers and dispersed regional projects, into a more ambitious approach to redesign contracts at value chain level, and across crops and commodities.

'We wanted crop rotation introduced across borders, as a way of increasing our brand value and reduce costs, stabilising sourcing, and making a strategic alignment possible between marketing and supply chain governance' [PDM]

In the end, contractual arrangements that prescribe agronomic practices were needed in order to reap marketing benefits from sustainability activities and thus integrate consistent flows of funding into the value chain. Thus, while limited internal and external funds, e.g. for research projects, was sufficient for experimentation, in order to scale up, finding adequate agreements on organisational form obstructed the continuous flow of funds along the value chain.

A surprisingly similar process was observed in the scaling of the EDL case. Starting in 2013, farm management at EDL became particularly concerned with ensuring financial viability for the farm business operation while keeping a focus on soil health and fertility, combining biodynamic practices with the use of technology and precision agriculture for balanced plant growth and efficient business operations (Ekoboerderij de Lingehof, 2020). While initial experimentation was externally funded through regional development funds, research projects and innovation grants, in order to continuously keep rotations focussed on soil health-promoting crops, funding needed to be integrated into the value chain. Therefore, EDL relies on an extended network of collaborations, with place-based communities and value chain networks working with the farm. EDL experimented with value chain partners and consumers for many of their crops, for example by shortening the value chain and opening the farm gates to consumers and partnerships with other farm managers and buyers.

'When you operate in a niche you either need to create margins by getting closer to the consumers or by protecting your bargaining power with buyers' [JDW].

Building partnerships with local farmers for managing organic manure, and with various value chain partners, including a local mill for grains, EDL also continuously engaged with Demeter certification (Ekoboerderij de Lingehof, 2020). The farm also created collective marketing agreements for crops such as potatoes and red beets, and contracts with processors or retailers for others, such as red cabbage or pumpkins. Particularly to enable other farmers to follow in their footsteps and diversify with legumes such as lupines, a completely new initiative was needed to not only enable joint marketing, but also create demand in the market place. Thus, similarly to BSF, EDL has been commercialising crops increasingly using value chain agreements and creating alliances with certification bodies and retailers.

'The demand for eco-friendly food products is booming, they [retailers] have to look into projects like our farm more often than before' [JDW]

However the increased complexity of the value chain relations had put some pressure on the farm managers too:

'We should invest in an inventory and data collection, as well as partnership contracts [...] but we do not have the resources to do that. Also, quality standards from retailers are tricky, we do not know if they're paying premiums or not. We need to invest in storage facilities and improve our bargaining power… this is sometimes nerve-wracking' [FM2]

Despite the increasing evidence that crop rotations could create the conditions to combine ecological benefits with economic gains, both the BSF and EDL initiatives quickly faced a set of challenges, interfering with, if not blocking, any scaling process. The Barilla Group was interested in defining contract templates which could be used in various contexts and with different types of farmers (Blasi et al, 2015), while questions remained on how one governs this approach in absence of clear legal and institutional frameworks.

'If you make a statement that the farmer will be able to sell all the crops in a rotation, then you need to offer them a contract and some forms of guarantee… but how you go about it if you are not the buyer of the crop but another company?' [MM]

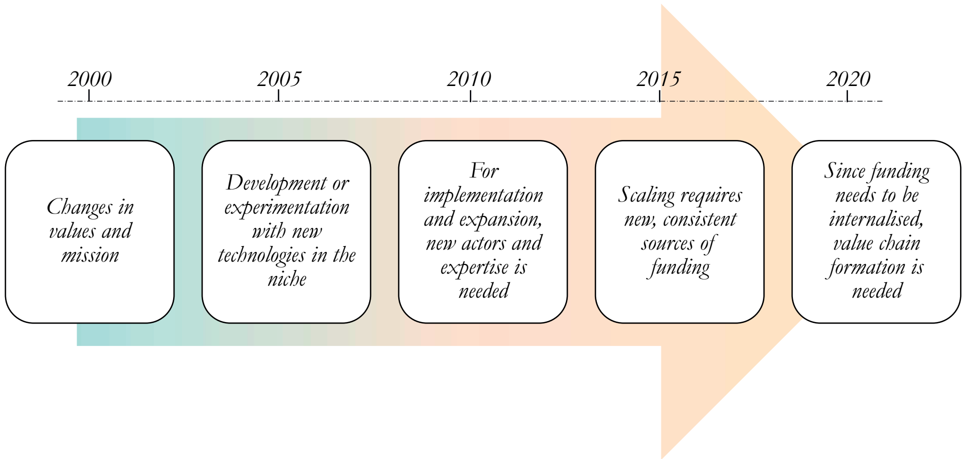
EDL needed to maintain some flexibility to continue to experiment with crops and a long-term rotation while experiencing the pressure of using more formalised partnerships and contracts. Lack of standards, labels and policy support also created concerns on how scalable and viable both innovation trajectories could be. In short, both organizations were confronted with the absence of organisational mechanisms to which to anchor their practices.

In summation, as the required agricultural practices crystallised following the commitment to values and mission, also the required expertise and the interactions between value chain partners and other actors changed, becoming more complex and in need of novel organisational solutions. Our findings indicate a convergence of both innovation pathways towards tensions related to organisational forms, where the innovation practices and processes seem to be challenged and blocked. Despite different institutional settings otherwise, these tensions currently seem to converge towards similar organisational solutions such as novel contract farming and value chain arrangements. However, developing these solutions requires substantial efforts by the lead actors involved. We further reflect on these processes in the discussion.

3.5 Discussion

Based on our findings, we are able to further discuss the scaling process of innovation niches through an institutional lens, by looking at the dimensions of institutional logics and their internal coherence throughout changes over time. Our findings add to extant scholarship emphasising the role of alignment of logics between the niche and the wider institutional context (Fuenfschilling & Truffer, 2014; Smink et al., 2015; Turner et al., 2017). What our study highlights in addition is the relevant role of how these logics are formed, negotiated and defined through processes involving actors in the niche. Particularly, we looked at how the internal coherence of these logics affects the scaling process of innovation niches, in the case of adoption and diffusion of crop diversification practices. For instance, the importance of coherence for niche stability has been previously emphasised (Belmin et al., 2018), indicating that the more internally coherent the dimensions of institutional logics are, the more stable the niche. Nonetheless, stability of a niche does not necessarily mean that a niche is scaling up (Geels et al., 2016), and rigidity itself can be a barrier to the scaling of a niche and associated transition processes (Smink et al., 2015). Our results show that changes and re-alignment in the dimensions of institutional logics may be necessary in order to enable scaling of a niche. Specifically, in our cases, changes in the lead actors (priorities of) values and mission, lead to the quest for new technologies and practices. For experimentation and initial implementation, the lead actors engaged with researchers and value chain partners to gain the needed expertise, while relying on innovation funding and grants. Yet, when it came to further expanding the niche, and scaling up, these funding sources were no longer sufficient. In order to support the scaling, long-term, continuous funding sources were needed. Therefore, the focus of the lead actors shifted to their value chains. In negotiation with their partners, new value chain agreements needed to be formed to internalise funding for new practices. Figure 3.5 shows this process over time.

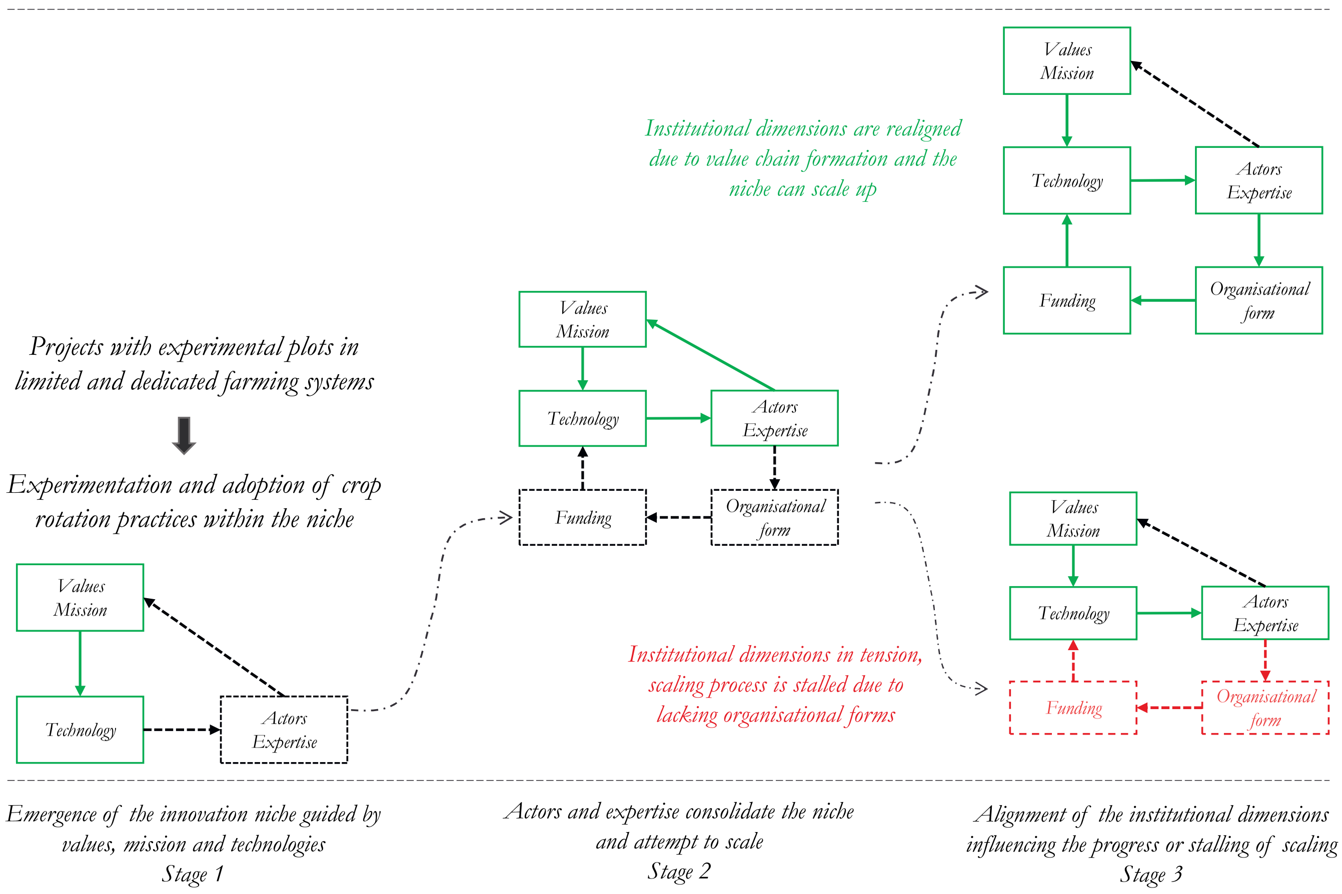
Figure 3.5 Adjustment process of dimensions of institutional logics over time



Source: The authors

Our findings also indicate that even niches for the same new practice, namely crop diversification, but with rather different conditions may follow a rather similar process of scaling, and face similar issues of value chain formation. Both a multinational company and an individual farm went through a process of realignment of the dimensions of institutional logics under which they operate, and thus analysing these dimensions helps us to better understand the scaling process of innovation niches. We observed that when these dimensions are not aligned, the scaling process is stalled (see figure 3.6). When logics start to be reframed around a novel set of values and mission, then a continuous need for reconfiguration becomes conducive for a wider redesign and repositioning of niche technologies, involving novel actors and expertise, and the need for new sources of funding. This need results in emerging organisational tensions which creates the space for imagining, discussing and negotiating solutions between actors in the niche (Berthet et al., 2016; Berthet et al., 2018). Therefore, in order to overcome these tensions, actors in both niches are aiming to form new value chain arrangements, as suitable arrangements were lacking, showing that such organisational innovations are essential in the scaling process (Meynard et al., 2017).

Figure 3.6 Institutional dimensions and scaling processes



Source: Authors' adaptation inspired by Fuenfschilling and Truffer (2014)

Despite the two cases in this study concerning rather different settings, namely a multinational company and a farm as lead actors, our data shows surprisingly similar scaling trajectories. Looking specifically at the scaling of crop diversification practices, we see that *value chain formation* is an essential step to reap the environmental benefits of diversification practices at scale. This finding is of particular interest by adding to extant literature where farmers' agronomic knowledge is considered the key factor in the adoption of crop diversification (Morel et al., 2020; Zimmer et al., 2016). Our analysis shows that agronomic knowledge and technological innovation, while necessary, is not a sufficient condition for scaling. In both our niches, the lead actors aiming to implement crop diversification managed to get sufficient agronomic expertise by experimenting and collaborating with other actors. However, building value chain relationships that can sustain and scale crop diversification, may be even more challenging. While a lack of funding is also often cited as an obstacle of scaling (Bonke & Musshoff, 2020; Rosa-Schleich et al., 2019), our approach allowed us to identify that the absence of clear and effective organisational forms to manage relations in the niche, and to maintain funding over time, is also a significant barrier. We find that value chain formation is necessary to finance a scaling process from experimentation with crop diversification at niche level, to diversification occurring at a wider value chain and food system level. Current organisational forms seem to be supporting innovation pathways for productivity and agricultural intensification (Dicecca et al., 2016; Duncan & Pascucci, 2017; Seifu et al., 2020; Virginia et al., 2018), rather than diversification. Our research indicates that the emergence of tensions in relation to organisational forms is crucial to understanding pathways to transitions. Without adequate governance, the innovation niche may struggle to operate, to scale or even to survive. This echoes Meynard et al. (2017) who also highlight the necessity of organisational forms changing alongside the adoption of crop diversification.

Looking at our case studies, actors operating in the two niches have been struggling to find adequate organisational forms, and to deal with this limitation, they have adaptively and creatively adopted novel value chain arrangements to keep supporting the adoption and diffusion of diversification practices. In the BSF case, organisational tensions were mostly generated by the mismatch of new values, practices and relationships with pre-existing organisational forms, predominantly shaped towards economically driven and market-oriented solutions, while more cooperative forms were needed, predominantly oriented towards sustainability. These tensions pushed actors to look into new organisational solutions, such as standardised sourcing of 'sustainable wheat' through contract faming, while also considering more radically new options such as building partnerships with buyers of other crops in rotation. The BSF innovation niche is following a pathway of transition starting from a corporate-driven logic, thus considering agricultural systems from a perspective of commodification and through transactional relations, moving towards a more collaborative and sustainability-inspired coalition of supply chain partners.

The EDL innovation niche, similarly, was struggling to couple intensifying socio-ecological ambitions with a more market-driven approach. The demands of sustaining business operations under these conditions required novel value chain arrangements. EDL shifted from operating at an individual farm level towards what seems to be a community or pool of partners with shared values, cooperating in value chain activities. Despite their differences, in their realignment processes, these two innovation niches seem to be facing the same type of tension, the systemic lack of organisational solutions. The two alternative pathways, originating from different logics and settings, seem to converge towards similar pivotal organisational tensions, expanding our understanding of scaling processes.

The extant literature has investigated scaling processes through diverse socio-technological and governance perspectives (Meynard et al., 2017; Meynard et al., 2018; Seifu et al., 2020), often looking at how actors operating in innovation niches are engaged in developing logics and their dimensions aligned with actors operating outside the niche, in order to mobilise key institutional, technological and financial resources, and to facilitate the scaling process (Hounkonnou et al., 2018; Seifu et al., 2020). The assumption is made that organisational forms emerge separately or because of the 'success' of the innovation niche. Our findings suggest that identifying governance solutions at value chain level is part of development of innovation niches, and, as pointed out by Pigford and colleagues (2018) and Meynard et al. (2017), they should be considered more organically and systemically part of the niche scaling process. Value chain partnerships and networks emerge as a response to tensions among institutional dimensions in the innovation niche, and they are necessary to push diversification practices beyond the niche. To the best of our knowledge, this study is the first to show how these tensions unfold similarly in both in corporate-led, industrial innovation niches, as well as in ecologically-focussed ones aiming to scale crop diversification. Understanding the 'temporality' of this process, in relation to key dimensions in institutional logics is a key factor for explaining (a lack of) scaling processes, and therefore sustainability transitions (Fuenfschilling & Truffer, 2014; Pigford et al., 2018).

3.6 Conclusions

The contributions of this study are twofold. Firstly, we demonstrate how the lens of institutional logics and their dimensions enhances our understanding of the scaling process of innovation niches. Our approach has relevance in terms of expanding existing conceptualisation of institutional logics and their role in stimulating or impeding sustainability transitions from innovation niches. By analysing the niches' values, missions, technologies and practices, actors and expertise, organisational forms and funding sources, we gain insight into the niches' institutional logics. When observing these dimensions and their development over time, we can detect how tensions between the dimensions can lead to changes and realignment which facilitates the scaling process, and how the absence of this realignment stalls it. Secondly, we contribute to the literature on the adoption and diffusion of crop diversification practices by analysing the scaling process of diversification niches. For the first time it has been shown that scaling processes of crop diversification can progress similarly in different niches, whether the lead actor is a multinational company, or an individual farm. We indicate that struggles to find governance solutions at value chain level are connected to scaling mechanisms, but originate from *tensions* internal to the innovation niche. These tensions are indeed part of the innovation process, and, to be better understood, can be investigated through an institutional lens (Fuenfschilling & Truffer, 2014).

In this analysis, we have shown that there is currently a lack of adequate governance mechanisms that allows actors to compensate the higher cost of diversified practices that they are currently experiencing, from within the value chain. This lack of organisational forms blocks the scaling of diversification practices, as it prohibits the trade-off between environmental benefits and economic costs to balance out long-term and at scale (Meynard et al., 2017; Rosa-Schleich et al., 2019). Based on our findings, we can conclude that supporting only the experimentation phase of the scaling process, e.g. with innovation grants and subsidies, is not sufficient to induce a sustainability transition at scale. Scaling requires the internalisation of funding into the value chain. This part of the scaling process is currently lacking adequate support.

This study is limited to two case studies, and while their similarities in process despite differences in characteristics gives us confidence, our results remain exploratory. Similar longitudinal studies should be conducted to draw conclusions from a wider variety of case studies. Further, our findings are limited to the European context and may not hold in different institutional setting where other limitations may outweigh value chain formation as a crucial barrier curtailing the scaling process. We therefore suggest that future research should further investigate the role of institutional logics exploring multiple settings and indeed integrating evidence from other cases. Moreover we suggest to further explore what measures are effective to support actors finding suitable, locally-adapted organisational forms that allow for the adequate compensation of diversified agricultural and food systems.

Acknowledgements

The authors would like to thank both the Barilla Sustainable Farming initiative and the Ekoboerderij de Lingehof for their time and continued dedication to this study. We would also like to thank Eleonora Sofia Rossi for her valued contributions during the data collection phase in Italy.

Appendix 3.1: Case study descriptions

Barilla Sustainable Farming (BSF) – Barilla Group

Barilla is a family-owned company founded in Italy in 1877, and nowadays owns 18 different brands of food products, from pasta, to baked goods and sauces (Barilla, 2021b). Barilla currently purchases and processes raw materials in 30 production districts, owns 15 factories in different countries other than Italy, and sells their products in 100 countries across the world (Barilla, 2021b).

In 2009, Barilla established the Barilla Centre for Food and Nutrition Foundation (BCFN), whose objective is to understand the complexity of agri-food systems and promote dialogue between scientists, institutions, private sector, and civil society (Barilla, 2020). The theoretical approaches developed by the BCFN also contributed to the company's new vision around the sustainability of food, looking at both the consumption side, in terms of sustainable diets, and the production side. Considering specifically sustainable agricultural production, Barilla launched different sustainability initiatives for selected supply chains and raw materials.

For example, in 2009, for durum wheat, one of Barilla's key raw materials, Barilla introduced a sustainable durum wheat project in collaboration with academic partners, specialized in agronomy and innovation in cropping systems. Two tools were introduced to support the development of more sustainable agronomic practices: the Handbook for the sustainable farming of durum wheat and a decision support software (granoduro.net®,) which provides support to farmers in making technical decisions on e.g. field fertilization and crop disease treatments. Multi-year agreements with suppliers, which require compliance with specific guidelines concerning product quality and (sustainable) farming practices have been launched at limited scale (Barilla, 2021b). For its soft wheat supply chain for the brand Mulino Bianco, Barilla launched a similar project, in collaboration with universities, an NGO and value chain partners (Barilla, 2020). This focusses on product quality, crop diversity, controlled use of chemicals, and protection for pollinating insects. It further aims to ensure the traceability of soft wheat during all stages of the supply chain, in combination with third-party certification and a price premium for wheat flour produced according to the given rules (Barilla, 2021a).

Using the same approach, the company also initiated sustainability programs for the procurement of other raw materials and for other brands, for value chains in Italy and abroad, largely based on crop diversification, carbon neutral and regenerative practices. These include the Harris Paper, for French grains in bakery products, a protocol for the wheat-pasta supply chain in Greece, Turkey and the United States. Further there is an initiative related to rye production for the Wasa brand in northern Europe, and a project focussed on cocoa procurement in Ivory Coast for the Pan di Stelle brand (Barilla, 2021b).

Ekoboerderij de Lingenhof (EDL)

This arable farm of about 100ha with organic and biodynamic certification is located in the central Dutch region of Gelderland. This farm illustrates some of the consequences to value chains when soil health is the guiding premise of crop rotation design. Promoting soil health sets the limits of crop choice for each plot. Rotations are six to seven years long with a total of about ten to fifteen different crops on the farm each year, including onions, potatoes, grain, and lupines. Such diversity in crops requires creativity in value chain relationships. This is illustrated by the variety of marketing arrangements in just one year:

For some crops, rather straight-forward contract farming arrangements, using both written and verbal contracts are used. In these cases the aim is to build, and build on, long-lasting relationships with buyers both nationally and at a European scale. For other crops. the Ekoboerderij farm uses more complex arrangements cooperating with other farmers. In these, the farmers group pools their production and sells the crop jointly and thus reaching different markets than they would have been able to as a single producer. For example, companies processing red beets, a crop regularly grown on the farm, often need a particular range in size of beets. By pooling production, beets can be sorted by size and yet each category will reach a quantity sufficient for the farmer group to be an attractive trading partner for these processors.

The Ekoboerderij farm also uses more "experimental" approaches to value chain organization in order to maintain or increase crop diversity on the farm. They entered an agreement with a local art college to grow flax for sustainable fibres for the college's fashion program. Further, the farm experiments with hemp production for a newly established CBD factory, as well as using apple tree adoption by consumers for producing apples and apple juice.

In order to establish a crop that is good for the soil but not established in the local market, namely lupines, a more extensive approach was chosen. It includes the establishment of a company for marketing and communication to consumers cooperation with other farmers in order to breed suitable varieties and increase production capacities, and building relationships with the processing industry. This case study illustrates the entrepreneurial skills farmers may need in order to diversify their crops with a focus on soil health.

CHAPTER 4

Can contract farming support sustainable intensification in agri-food value chains?

This chapter is under review as:

Weituschat, C.S., Pascucci, S., Materia, V.C., Caracciolo, F. Can contract farming support sustainable intensification in agri-food value chains? Journal: Ecological Economics

Abstract
Sustainable intensification aims to minimise the negative impacts of the current agricultural system while maintaining productivity and economic outputs. This study demonstrates that contract farming is a potential mechanism to support many, but not all, farmers in adopting sustainable intensification practices. A discrete choice experiment on a hypothetical value chain contract introducing three sustainable intensification practices, namely extended crop rotation, reducing agrochemicals and planting flower strips, was conducted with a sample of 314 north-Italian wheat farmers. The results show that permanently eliminating glyphosate from the plot under contract is strongly resisted by farmers, while farmers have less strong preferences between introducing legumes or oilseeds in rotation, and between temporary or permanent flower strips. Findings also indicate that farmers who are more educated, are not members of cooperatives and who generally have a preference for more flexible sales arrangements are unlikely to be triggered to adopt sustainable intensification practices through contract farming. Overall, this study indicates that while voluntary contract arrangements can be a potential tool to increase uptake of sustainable intensification practices, they will likely need to be complemented with more regulatory approaches in order to bring sustainable intensification practices to scale.

4.1 Introduction

In the last two decades, agricultural intensification and specialization have persisted, supported by market incentives and policy interventions and despite the mounting evidence of their negative impacts on environment and climate (Kleijn et al., 2019; Rockström et al., 2017). Combined with a decline in soil health and increasing erosion, the threat to our food systems is growing (Davies, 2017). Among other factors, these impacts are due to reliance on monocultural systems and dependence on external inputs (Kleijn et al., 2019; Lanz et al., 2018), while economic profitability is often prioritized over social and ecological considerations (Struik & Kuyper, 2017). In European agricultural systems, increased agricultural intensification has also been observed in association with declining crop productivity and growing environmental costs (Antonini & Argilés-Bosch, 2017), and with higher economic vulnerability of farmers (Roest et al., 2018).

Sustainable intensification (SI) has become one of the leading approaches to transform these highly specialised and input-dependent agricultural systems (Garnett et al., 2013; Petersen & Snapp, 2015; Pretty, 1997). SI generally refers to practices that maintain or increase yields, productivity and economic outputs, while minimising environmental impacts and use of land (Pretty, 1997; Pretty & Bharucha, 2014; Tittonell, 2014). It broadly includes approaches and practices such as precision and climate-smart agriculture, integrated crop-pest management, and crop diversification, with a focus on adapting the use of agrochemicals and (bio-)technology to specific agro-ecological conditions (Garnett et al., 2013; Tittonell, 2014; Uphoff, 2014). The adoption of these practices often ask for incremental changes in practices by farmers, and thus may have the potential for a wider up-take, potentially affecting the agricultural system as a whole, and agricultural value chains in particular (Duru et al., 2015; Pretty & Bharucha, 2014; Swinnen & Kuijpers, 2019).

Despite its potential, so far, the adoption of SI practices is relatively low, as only 9% of global agricultural land is estimate to operate under some form of SI (Pretty et al., 2018), and especially low in countries generally characterised by industrialised agricultural systems. Despite their benefits, implementing such practices often implies (initial) increased costs for farmers (Rosa-Schleich et al., 2019), who struggle to reduce agrochemical use (Bakker et al., 2021; Chèze et al., 2020; Mann, 2018), diversify their crop rotations (Jouan et al., 2020; Lemken et al., 2017), or improve on-farm biodiversity (Kirchweger et al., 2020; Mazé et al., 2021; Plaas et al., 2019). Additionally, a change in practices often requires the reorganisation of relations with downstream partners at value chain level, for example in the case of crop diversification and mixed cropping (Meynard et al., 2017). Yet, while understanding the interplay between the adoption of SI practices and value chain (re-)organisation mechanisms is key, it is as of yet still fairly under-researched (Ricome et al., 2016; Swinnen & Kuijpers, 2019).

Extant literature, in fact, mostly discusses forms of value chain organisation, including contract farming (CF), that have enable farmers to adopt new practices aiming to improve product quality, or comply with food safety standards (e.g. Kumar et al., 2018; Mulwa et al., 2021; Wossen et al., 2017). Only few studies address sustainable practices (see Banterle & Stranieri, 2013; Mazhar et al., 2021; Ricome et al., 2016 for singular examples). Further, only Ricome et al. (2016) and Banterle and Stranieri (2013) have focussed on the European context from a value chain perspective, while the majority of studies assessing (potential) adoption of sustainable practices in Europe usually consider government-led agri-environmental schemes (AES) (e.g. Bougherara et al., 2021; Kuhfuss & Subervie, 2018; Santos et al., 2016). Value chain and commercial private sector initiatives, such as CF, have found only limited space in the literature on adoption of sustainable practices, against the evidence that private actors play a significant role, e.g. by creating incentives, setting standards or exchanging knowledge (Banterle & Stranieri, 2013; Cholez et al., 2020).

Against this background, this study aims to assess the potential of CF to support and incentivise the adoption of SI practices among farmers in Europe. Particularly, we draw on the case of a large scale value chain-based initiative that has been implemented by a multi-national food manufacturer. More specifically, we have engaged with the Barilla Group and its recently launched sustainability-focussed Carta del Mulino initiative (CDM) (Barilla, 2021a). Through this programme, Barilla aims to reconfigure its value chain, including storage centres and millers, in order to incentivise farmers to adopt sustainable practices in line with an SI approach, focussing first on Europe (e.g. Italy, France and Germany). The design of a contract farming scheme has been key to Barilla's strategy (Barilla, 2018a, 2021b; Pancino et al., 2019). Through continuous interaction with this case and its actors, starting in 2013, we have been able to engage with wheat producers located in northern Italy, the area designated for initial pilot studies and the launch of the CDM initiative. Based on an extensive survey of 314 north-Italian farmers, the design of which was informed by intense previous engagement with the case through interviews, focus groups and company documents, we have analysed farmers' willingness to participate in a value chain-based contract farming scheme for SI. More specifically, this study pivots around three key questions: What is the potential of contract farming to incentivise the adoption of SI practices? Which practices can be effectively supported by contract farming? And, which types of farmers are most likely to participate? To answer these questions, we implemented a hypothetical choice experiment to assess three SI practices (crop diversification, flower strips, and limiting glyphosate use) as contract attributes, and relate them to farmer characteristics and attitudes as determinants of contract acceptance and attribute preferences. We have organised this paper as follows:

We first give a brief overview of the concept of SI and then review relevant literature on the role of contract farming in the adoption of SI practices. Then, we present the context and methodology of this study, followed by the results of the choice experiment. Finally, we discuss the results and conclude.

4.2 The role of contract farming in the adoption of sustainable intensification practices

4.2.1 Mapping sustainable intensification practices

In this section, we will briefly discuss the concept of sustainable intensification (SI), as well as its related practices. SI has the overall aim to ensure food security for a growing population while minimising the negative environmental effects of industrial agriculture (Pretty, 1997; Rockström et al., 2017). It emphasizes the importance of adapting practices to local agroecological conditions when balancing production, productivity, and environmental costs and benefits (Pretty & Bharucha, 2014). However, due to this localised approach, many different practices have been discussed under the umbrella of SI (Tittonell, 2014; A. Wezel et al., 2015). This has led to confusion with regard to the actual meaning of the term and to what extent it actually differs from the status quo of industrialised agriculture (Petersen & Snapp, 2015). Some practices such as increasing the use of agrochemicals in previously low-input systems, which one might consider simply intensification, have also been described as SI (e.g. Mulwa et al., 2021; Struik & Kuyper, 2017). Its critics state that SI does not embody the paradigm shift necessary to mitigate and cope with the negative externalities of the current industrialised agricultural system (Levidow, 2015; Petersen & Snapp, 2015; Tittonell, 2014). However, while incremental, practices generally mentioned under this umbrella term, such as reduced and more precise use of agrochemicals, diversifying cropping systems, and improved seed varieties (A. Wezel et al., 2015), may still be a viable, or even necessary pathway towards more comprehensive and transformational approaches, such as agroecology (Garibaldi et al., 2019). Despite the breadth of approaches classified as SI, several common characteristics of SI practices have been defined (Pretty & Bharucha, 2014):

"(1) utilize crop varieties and livestock breeds with a high ratio of productivity to use of externally and internally derived inputs;
(2) avoid the unnecessary use of external inputs;
(3) harness agroecological processes such as nutrient cycling, biological nitrogen fixation, allelopathy, predation and parasitism;
(4) minimize use of technologies or practices that have adverse impacts on the environment and human health;
(5) make productive use of human capital in the form of knowledge and capacity to adapt and innovate and of social capital to resolve common landscape-scale or system-wide problems […]; and

(6) minimize the impacts of system management on externalities such as GHG emissions, clean water, carbon sequestration, biodiversity, and dispersal of pests, pathogens and weeds" (Pretty & Bharucha, 2014, p. 1577).

Some of these practices are becoming increasingly relevant in the European context, with potential for broad uptake at scale. For example, *diversifying crop rotations*, particularly with legumes or oil crops, reduces pests and thus the use of pesticides (Pretty & Bharucha, 2014), increases biodiversity (Garibaldi et al., 2019) and, when introducing legumes, employs biological nitrogen fixation (Bedoussac et al., 2015; Lemken et al., 2017; Pretty & Bharucha, 2014). *Planting flower strips* increases on-farm biodiversity, reduces pests and creates habitats for pollinators (Gurr et al., 2016; Kirchweger et al., 2020). Finally, reducing use of agrochemicals, including glyphosate, can reduce their adverse effects on the environment and human health (Bakker et al., 2021; Chèze et al., 2020). Jointly, these practices thus reduce external inputs, make use of nitrogen fixation, reduce impacts on environment and human health, and improve biodiversity and reduce pests, all of which are SI principles (Pretty & Bharucha, 2014).

4.2.2 Contract farming and the adoption of SI practices

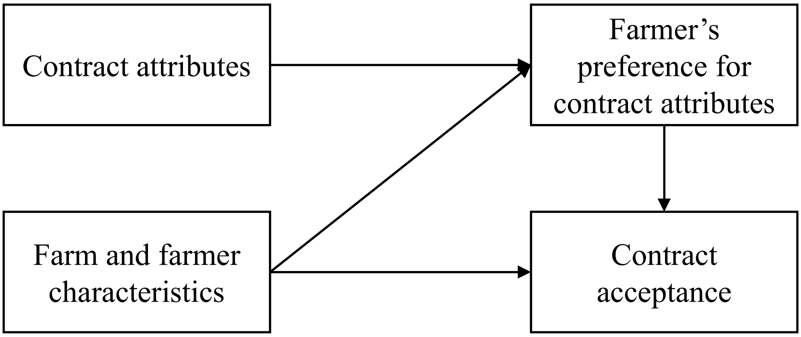
There is increasing evidence on the relationship between of forms of value chain participation and the adoption of agricultural practices (Swinnen & Kuijpers, 2019). Often contractual arrangements are needed to provide premium prices to farmers in order to incentivise the adoption of practices and the implementation of (quality) standards (Banterle & Stranieri, 2013). Nonetheless, studies suggest that there is no blueprint contract to encourage adoption (Meynard et al., 2017; Swinnen & Kuijpers, 2019), and designing adequate contracts and value chain configurations to support the adoption of sustainable practices can be a complex process (Pancino et al., 2019).

Empirically, several examples have started to illustrate the complex relationship, particularly between CF and farmers' adoption of new practices (e.g. Bonjean, 2019; Mazhar et al., 2021; Mulwa et al., 2021). However, these studies largely focus on cases in emerging economies. Studies on the European context are still rather scarce and are mostly centred on the French context. Ricome et al. (2016) find a connection between marketing contracts and adoption of more sustainable practices. They argue that the risk-reduction of marketing contracts might allow for more risk-taking when it comes to French grain farmers' adoption of low-input practices. Several studies analyse value chain organisation with regard to diversifying French cropping systems, such as Meynard et al. (2017) who analysed several case studies in France to show how diversifying cropping systems with minor crops requires a range of changes in the organisation of value chains. That analysis is complemented by Meynard et al. (2018) explaining how these required changes impede the uptake of such minor crops. Jouan et al. (2020) modelled how horizontal cooperation between crop and livestock farmers could diversify cropping systems by introducing legumes on French farms. Cholez et al. (2020) point to the importance of contract farming in the development and transfer of knowledge in legume production when building new value chains, using a case study in Britany, France. These studies, while limited to the French context, illustrate that a change in practices at farm level often requires changes in the organistion of the value chain. Beyond France, Banterle and Stranieri (2013) discuss how Italian farmers' adoption of integrated pest management practices for a private label also required a reconfiguration of contracts. Based on this literature, it is reasonable to suggest a relationship between value chain organisation and practice adoption, and there is still a lot of room to investigate the potential of contract farming to induce SI practice adoption, especially beyond the French context.

As studies on contracts for sustainable practices with the value chain partners are still rare, we also draw from studies on public contracts, such as AES, to inform our study design. It is well established in this literature that contract attributes influence farmers' acceptance decisions (e.g. Bougherara et al., 2021; Christensen et al., 2011; Santos et al., 2016). Beyond the contract itself, previous research has shown that participation in AES is also related to farmer and farm characteristics (e.g. Kuhfuss & Subervie, 2018; Mack et al., 2020). For example, several studies have shown that farmers' environmental attitudes influence their willingness to partake in AES (Calvet et al., 2019; Defrancesco et al., 2018; Was et al., 2021), as well as general perceptions of or resistance to contracts (Allen & Colson, 2019). This general resistance to contracts was also shown for marketing contracts, though unrelated to sustainable practices, for Italian cereal farmers, where resistance to the use of written contracts being due to an aversion to restrictions and low trust in contracts generally (Solazzo et al., 2020). Further, more standard control variables have also been linked to the participation in AES, such as gender, age, education, experience, and land size (Calvet et al., 2019; Kuhfuss & Subervie, 2018; Mack et al., 2020).

Figure 4.1 presents the proposed relationships which link the main elements that emerged from the literature presented above. The following section will outline the context and design of this study, and further specify these relationships.

Figure 4.1 Proposed relationships of concepts based on literature review



Source: The authors

4.3 Study context and methods

4.3.1 Research context

This study analyses Barilla's contract design for the Carta del Mulino initiative (CDM) aiming to make its soft wheat products more sustainable (Barilla, 2021a). CDM is in line with the concept of SI as it combines the aim to minimize environmental impact while maintaining or increasing economic value. This initiative followed several previous multi-stakeholder projects on value chain sustainability involving actors within and outside the company's value chains (Barilla, 2018b, 2020; Pancino et al., 2019). Initiated by the marketing department, CDM was developed with input from an NGO, two universities and value chain partners. Based on the CDM initiative and extensive stakeholder engagement through focus group discussions with farmers, elevators and millers, and in continued consultation with researchers and key managers in Barilla, three SI practices were eventually selected for further consideration in this study, namely crop diversification, flower strips, and limits on the agrochemical glyphosate. In essence, the CDM initiative, presents a contract farming arrangement to farmers, based on ten rules specifically designed to increase wheat quality, crop diversity and protection for pollinators, and reduce agrochemical use (Barilla, 2021b, 2021a). In order to signal this to consumers, products from the CDM initiative are traced throughout the value chain, third-party certified and labelled accordingly. Rolled out in 2017, more than1400 farmers currently deliver under the CDM contract (Barilla, 2021b). Despite the participatory approach used by Barilla to design the CDM contracts, and the initial success during the roll-out, the company also experienced some internal and external pressure to further explore opportunities to enhance CDM contracts. The key aspects for further analysis have been the ability of CDM to impose stricter measures and to attract new farmers to deliver under the CDM rules. Specifically, questions remained whether crop diversification is preferred with legumes or oil seeds, the temporary or permanent nature of flower strips and measure of reduction of the chemical glyphosate, amongst others. As part of the stakeholder engagement, our research team has designed the discrete choice experiment to analyse the role of the above mentioned issues. By targeting this case and related farmers, we ensure that the hypothetical contract design tested here is perceived as realistic. Further, Alcon et al. (2020) show that consumers are indeed willing to pay a premium price, for example, for products from more diversified systems, indicating that this is also a potentially attractive option for the companies involved.

4.3.2 Research design, sampling and data collection

The research design and sampling has been strongly informed by the roll-out process of the CDM contracts, and the sample was thus drawn from farmers operating in the areas where the initiative was already in place. We eventually sampled both from selected suppliers in the CDM value chain, as well as among comparable farmers in the same area, based on information provided by the company. This is due to the aim to reach both farmers currently targeted by CDM, as well as those in the same regions potentially targeted in the future. Farmers were located in the northern regions of Italy, namely Emilia-Romagna, Lombardy, Piedmont and Veneto (see figure 4.2). Data was collected between December 2019 and February 2021, using in-person or phone interviews. Due to the COVID-19 pandemic affecting northern Italy at the time, data collection was prolonged and adjustments had to be made to the data collection strategy along the way. Appendix 4.1 presents details of the adjustments to the strategies that were needed to cope with the challenges related to the pandemic. The final sample contains 314 complete observations. The survey itself contained five sections which collected data on farmer and farm characteristics, the farmer's value chain relationships, the discrete choice experiment, information on production and practices, and farmers' attitudes, respectively.

Figure 4.2 Location of data collection

Source: Own elaboration by the authors

4.3.3 Discrete choice experiment

The questionnaire presented to farmers in the sample included a discrete choice experiment (DCE) to understand the potential of CF to incentivise the adoption of SI practices, analysing farmers' willingness to comply with specific restrictions. While initially developed by mathematicians in the 1960s (Luce & Tukey, 1964), DCEs have largely been used by economists to measure preferences and willingness to exchange attributes for a diverse range of products and services. Some examples of DCEs include, among others, health applications (Green & Gerard, 2009), job and food choices (Jaung et al., 2019; Miranda et al., 2012), and contract design (Broeck et al., 2017).

The DCE in this study started with a concise description of a hypothetical contract farming arrangement, framed as a contract with the farmers' current buyer. As mentioned in the previous section, the analysis focused on three strategic aspects of the CDM contract, and namely crop rotation, flower strips and glyphosate restrictions, which were carefully described to farmers in order to enable them to make an informed choice. Following standard procedure to calibrate the modelling approach, the level of the price premium was initially set based on stakeholder consultation, and then refined after the first set of surveys was collected (34 observations). Attributes of contracts and their levels are shown in table 4.1.

Table 4.1 Overview of contract attributes

Attribute	Level A	Level B
Price premium	Market price + 10€ per ton	Market price + 30€ per ton
Crop rotation	At least one legume included in 5 year rotation.	At least one oil crop included in 5 year rotation.
Flower strips	Permanent flower strips of at least 3% of contracted soft wheat area located inside the farm.	Temporary flower strips of at least 3% of contracted soft wheat area located inside or next to the wheat field.
Ban on glyphosate	Temporary ban of glyphosate in the parcel under contract from 60 days prior to sowing until after harvest.	Permanent ban of glyphosate in the parcel under contract.

The DCE investigated farmers' preferences by letting them choose between two contract schemes characterised by the four attributes with varying levels, plus a business-as-usual alternative. Levels of attributes change from one contract scheme to another following the Fedorov algorithm (Carlsson & Martinsson, 2003; Cook & Nachtsheim, 1980) that maximizes the D-efficiency of the design according to the covariance matrix of the conditional logit model. The resulting design identified 24 choice tasks organized in six blocks. Farmers were randomly assigned to one of the six blocks, each one containing four choice tasks. Figure 4.3 shows an example of a choice set. Based on the presented choice set, respondents were asked to choose the preferred contract alternative or the business-as-usual option. This process was repeated for each choice task by each respondent, thus delivering (314 × 4) 1256 overall stated choices from 314 farmers.

Figure 4.3 Example of choice set presented to farmers in Qualtrics

Possible contracts 1

	Contract A	Contract B
Price premium	Market price + **10€ per ton**	Market price + **30€ per ton**
Crop rotation requirement	Rotation includes at least one **legume**.	The rotation includes at least one **oil seed**.
Flower strips	**Temporary flower strips**	**Permanent flower strips**
Use of glyphosate	**Temporary ban**	**Permanent ban**

Keeping in mind all the information provided, do you prefer contract A, contract B or neither? Neither means you stay in your current supply chain arrangement.

○ Contract A

○ Contract B

○ Neither

Source: The authors

4.3.4 Discrete choice model

Once collected, farmers choices were empirically examined by adopting the theoretical framework of the Random Utility Model (McFadden, 2001) and the Conditional Logit Model for estimating model parameters (Train, 2003). Analytically, by showing a set of 'A' contract alternatives to the *i*-th farmers, the farmer's utility associated with the alternative a can be represented as a linear function of all z attributes and levels characterising contract *a*:

$$U^i_a = \boldsymbol{z}_a{}'\boldsymbol{\Omega} + e^i_a \qquad (1)$$

where $\boldsymbol{z}_a$ is the vector of attributes characterizing the contract, **Ω** is a vector of unknown parameters, and e^i_a represents the stochastic error component. The model assumes that the *i*-th farmer chooses the contract alternative *a* rather than *b* since it maximises their 'expected utility': $U^i_a \geq U^i_b$, where *a* and *b* alternatives $\in A$ and $b \neq a$.

Farmers' choices are modelled in terms of probability: the probability that the *i*-th farmers prefers the contract *a* to *b* is due to the probability that the utility associated to the *a* alternative is higher (or equal) than the utility of the other proposed contract alternative: $p(U^i_a) = p\{U^i_a > \max(U^i_b,\ldots,U^i_A)\}$. In that way, the estimate of **Ω** provides the influence of the different contract attributes on the probability that the contract is chosen, allowing a measure of farmers' preferences.

By considering preferences to be individual-specific, **Ω** parameters vector can be assumed as distributed in the sample according to a distribution function defined by a location (μ) and a scale (σ) parameter:

$$U^i_a = \boldsymbol{z}_a{}'\boldsymbol{\Omega}^i + e^i_a \tag{2}$$

with $\boldsymbol{\Omega}^i = \boldsymbol{\Omega} + v^i$. To allow correlation among the parameters, v^i is assumed to be standard multivariate normally distributed $v^i \sim N(0, \Sigma_\Omega)$. Individual model parameters $\boldsymbol{\Omega}^i$ were thus estimated using the maximum likelihood estimator assuming conditional logit random parameter specifications (Train, 2003).

From the estimated parameters, for each farmer, the marginal value of the attribute in monetary terms (MVA) is calculated. It measures the trade-off between the presence of the *s*-th contract attribute and the base price. Analytically, it can be calculated taking the ratio parameter estimated for the non-monetary contract attributes to the price parameter multiplied by minus one, as follows:

4

$$\mathrm{MVA}_s^i = -\Omega_s^i/\Omega_{\mathrm{price}} \tag{3}$$

Similarly, the same procedure has been followed to calculate the marginal value of the business-as usual alternative. With $\mathrm{MVA}_s^i < 0$, it indicates the maximum amount of the base price per ton that the farmer is willing to give up in order to get that attribute in the contract, while with $\mathrm{MVA}_s^i > 0$, it indicates the extra amount on the base price that farmers require to accept that attribute in the contract. Further insights can be gained via inspection of the empirical cumulative distribution function (eCDF) of the MVA_s associating each euro added to the base price with the share of farmers that are willing to accept that attribute in the contract.

4.3.5 Analysis of farmers' preference heterogeneity

In order to deepen the understanding of the heterogeneity of CF attribute preferences among farmers, a set of regressions was applied. In detail, a system of regression equations was set up, where the marginal values assigned to each farmer's MVA_s^i for each non-monetary contract attribute were analysed against farmer and farm characteristics using the seemingly unrelated estimator:

$$\mathrm{MVA}_s^i = \boldsymbol{x}^{i\prime}\beta_s + u_s^i \tag{4}$$

More specifically, based on the literature presented in section 2.2, a range of farmer and farm characteristics were used to populate the $\boldsymbol{x}$ matrix: farmer's gender, age, experience working in agriculture (in years) to proxy a farmer's knowledge and skills, and the farmer's formal education, with the latter coded into three categories: No formal degree, at least a high school degree, and a university degree. The regressions also include among the covariates: whether the farmer was working on the farm full time (equivalent to a 5 day work week) to control for the time spent on the farming business, whether they were a member of a farmer cooperative or association since this influences the farmers' current value chain, and whether the farm held any certification (e.g. GlobalGAP, organic, or similar) to proxy the farmers' familiarity with the administrative burden of such a CF scheme. Finally, three attitudinal scales on farmers' environmental attitudes, preferences for transaction conditions around the sale of wheat, and satisfaction with the current sales arrangement for wheat have been included. These attitudinal scales are each based on a set of statements and 5-point Likert scales asking to what extent the farmer agrees with each statement. Standardised means were used to combine the items into single indicators for each attitudinal scale.

For environmental attitudes, the set of questions is inspired by the idea that environmental action is affected by farmers' beliefs as to whether their own individual actions and production can have an impact on improving the environment, and whether environmental action is better done collectively (Cleveland et al., 2020; Despotović et al., 2021; Poteete & Ostrom, 2004). The attitudinal scale for transaction conditions measured the farmer's preferences for uncertainty and asymmetric information in sales transactions, focussing on price security and comparisons, transparent quality control, and plannability of sales activities (Cembalo et al., 2014; Pascucci et al., 2016). Finally, the scale for satisfaction with the current buyer measures whether the sales prices are perceived as fair and at least cover costs, whether quality requirements from the current buyer are clear and whether the farmer believes this to be a long term sales relationship. This variable was included in order to estimate the role of the current relationship with the buyer in the farmer's decision-making, since the DCE was framed as a contract with this current buyer, and the farmer's satisfaction with this relationship is likely to influence whether the farmer would like to intensify this arrangement. The individual items forming the indicators can be found in appendix 4.2. Descriptive statistics for all variables used can be found in table 4.2 and table 4.3. Figure 4.4 presents the proposed conceptual relationships between variables as indicated in this chapter.

Table 4.2 Descriptive statistics of continuous variables (n=314)

Variable	Mean	Std. Dev.	Min	Max
Age (years)	51.24	12.97	19	84
Experience in agriculture (years)	28.78	13.43	1	75
Farm size, UAA (ha)[11]	77.89	286.67	2.5	3500
Collective environmental attitudes	0	0.61	-1.75	1.55
Transaction preferences	0	0.73	-1.85	1.35
Satisfaction with current buyer	0	0.73	-1.57	1.46

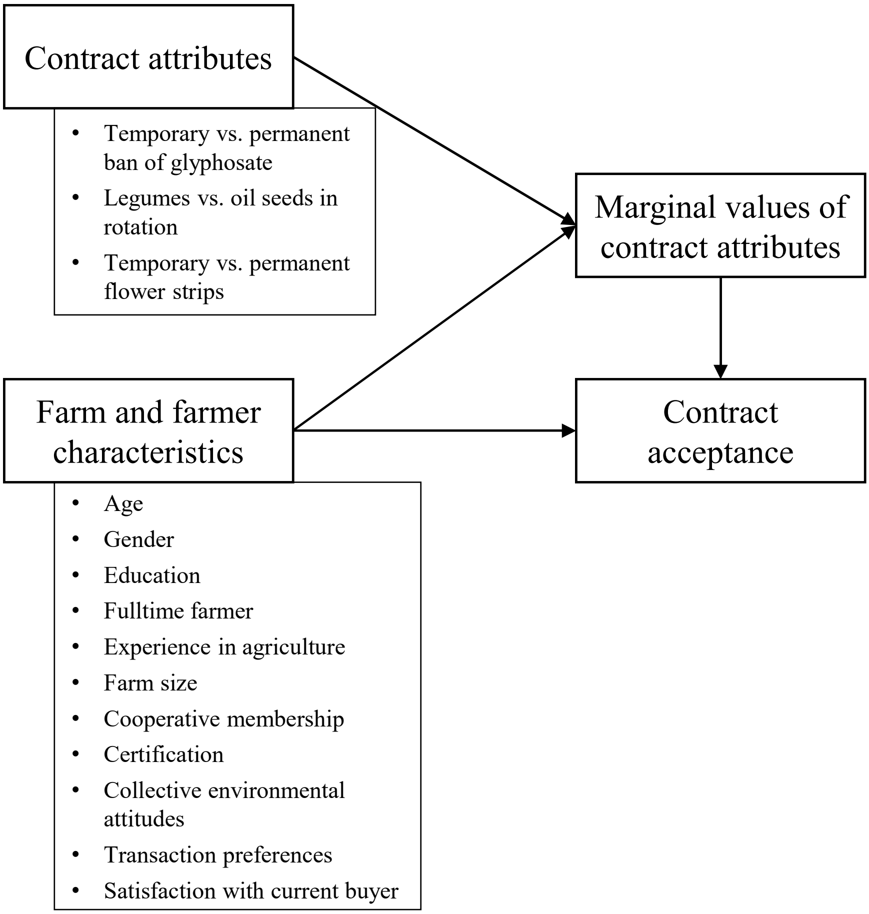
11 Mean and standard deviation of farm size are strongly affected by two outlier observations with large land holdings. Without these observations the mean drops to 55.65ha with a standard deviation of 82.90. The further analysis is not affected by these observations.

Table 4.3 Descriptive statistics of categorical variables (n=314)

Variable	Categories		
Gender	Male		Female
	95.54%		4.46%
Education	No degree	High school degree	University degree
	23.25%	70.06%	6.69%
	Yes		No
Full time farmer	86.62%		13.38%
Cooperative membership	71.97%		28.03%
Presence of Certification[a]	36.94%		45.54%

[a]: average given to missing values

Figure 4.4 Conceptual relationships between variables



Source: The authors

4.4 Results

4.4.1 Results of the discrete choice model

This section presents the results of the discrete choice model. Estimates from the random parameter conditional logit analysis show that farmers strongly prefer a temporary restriction on glyphosate use over permanent ones. In fact, on average, to impose a permanent ban on glyphosate covering the entire rotation on the plot under contract would require a price premium of 33€/ton, with 19€/ton necessary to enrol just the most willing 25% of farmers. Further, temporary flower strips are preferred over permanent ones. This preference is less strong, however, if compared to the glyphosate ban. Only approximately 5€/ton would be needed, on average, to switch farmers from temporary to permanent flower strips. Finally, legume production in rotation is preferred over oil seed production. As can be seen in the empirical cumulative density function (see figure 4.6), less than 20% of farmers request any price premium at all to introduce legumes. Finally, the business-as-usual option is less preferred than entering the contract, meaning that overall farmers, on average, see value in contracting in order to implement SI practices for a price premium. Based on this analysis, over 60% of farmers in the sample see an added value in the presented contracts (figure 8). However, figure 8 also shows that of those farmers who demand a price premium, the majority requires one above 50€ per ton. Table 4.4 and 4.5 show the estimates for this analysis. Figure 4.5-4.8 show the empirical cumulative density functions for each contract attribute and the business-as-usual option.

Table 4.4 Random parameter conditional logit estimates

Attribute	Coef. Ω		std.err	p-value
Price Premium	0.053		0.009	<0.001
Use of Glyphosate (*Permanent*)	-1.741	[a]	0.236	<0.001
Flower strips (*Permanent*)	-0.276	[a]	0.155	0.075
Crop Rotation (*Oilseeds*)	-0.29	[a]	0.167	0.083
Business as usual (*opt-out*)	-2.951	[a]	0.708	<0.001
σ(Glyphosate)	1.870		0.257	<0.001
σ(Flower strip)	0.269		0.174	0.123
σ(Rotation)	0.323		0.209	0.123
σ(Business as usual)	7.999		1.041	<0.001

[a]: computed as mean value (μ) of the parameter distribution

Table 4.5 Marginal value of the attribute (€/tons)

Attribute	Mean	std.err	95% conf interval		I quantile	III quantile
Use of Glyphosate (*Permanent*)	33.18	1.22	30.78	35.59	19.04	53.41
Flower strips (*Permanent*)	5.33	0.20	4.93	5.72	1.74	9.46
Crop Rotation (*Oilseeds*)	5.57	0.22	5.14	6.00	2.98	8.24
Business as usual	54.30	7.07	40.39	68.21	-94.07	176.44

Figure 4.5 Empirical cumulative density functions of the marginal value of glyphosate

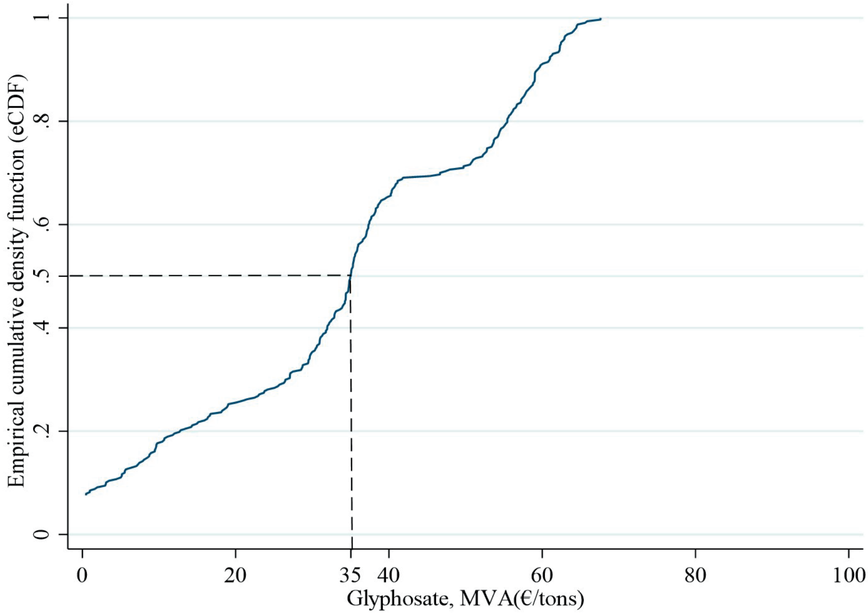


Figure 4.6 Empirical cumulative density functions of the marginal value of crop rotation

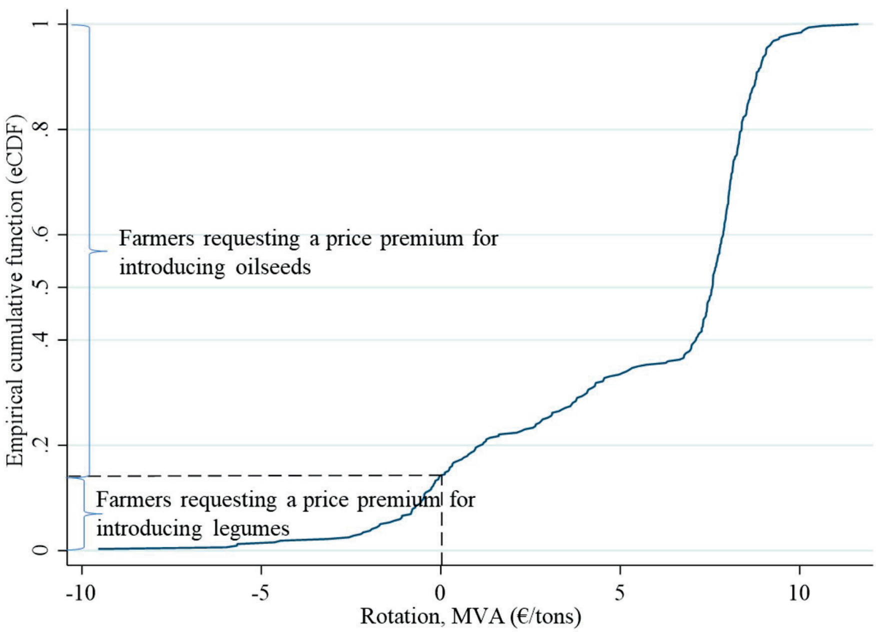


Figure 4.7 Empirical cumulative density functions of the marginal value of flower strips

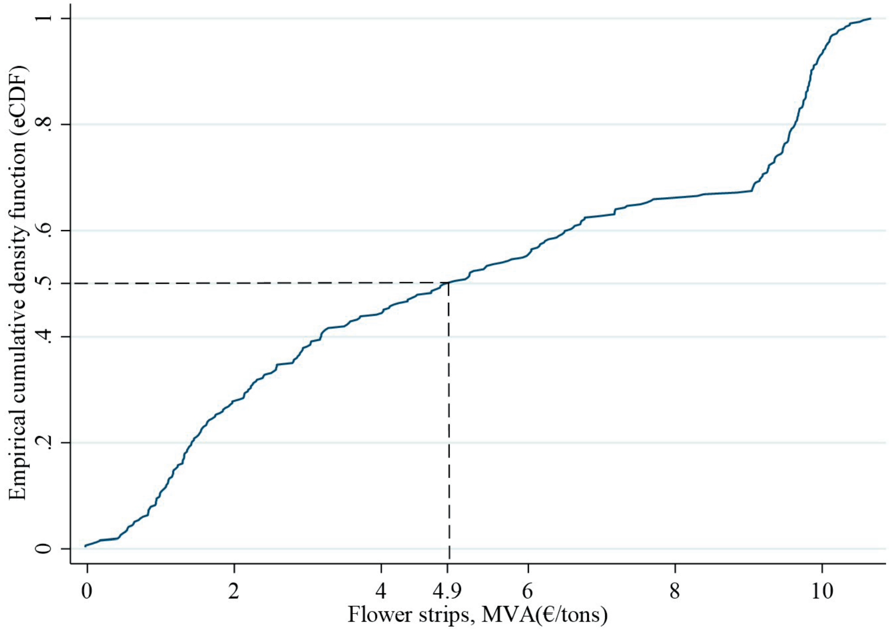
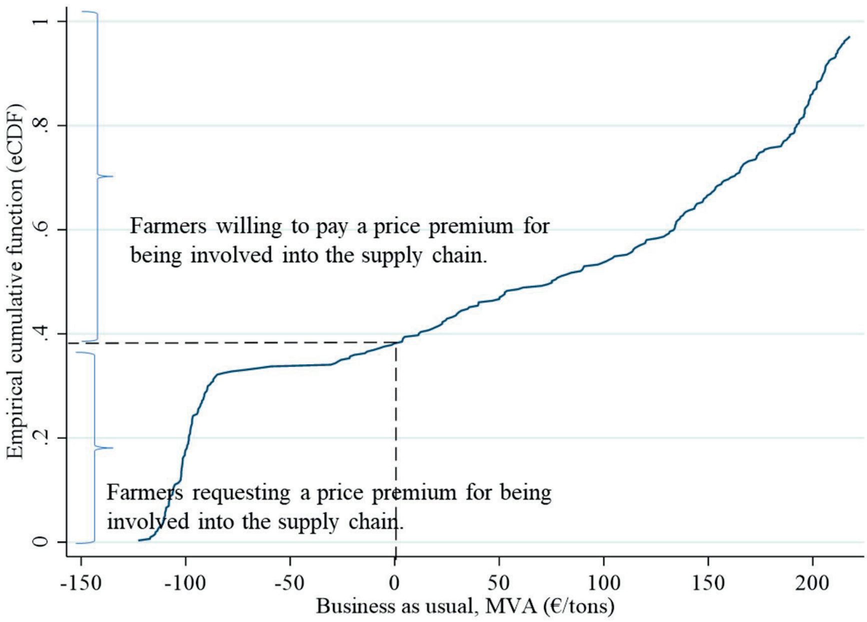


Figure 4.8 Empirical cumulative density functions of the marginal value of business-as-usual



4.4.2 Heterogeneity of farmers preferences

To examine the determinants of the marginal values of contract attributes and the opt-out option, we used seemingly unrelated regression estimates (table 4.6). Results highlight the same statistically significant determinants for permanent glyphosate bans and introduction of oil seeds over legumes, with coefficients higher for glyphosate. All else equal, male farmers are more resistant to both stronger glyphosate restrictions and oil seed introduction in rotation instead of legumes. We find the same effect for full time farmers. Certification holders are less likely to oppose a permanent ban on glyphosate and less likely to prefer legumes. Finally, farmers who believe to have effects on environmental outcomes and are willing to engage with others to improve the environment, and those more satisfied with their current sales arrangement are less resistant to permanent bans on glyphosate and oil seeds in rotation.

For flower strips and the business-as-usual option, we again find the same determinants for both. Coefficients are higher for the business-as-usual option which are generally strongest across the results of all regressions. Here we find those with higher education more likely to oppose permanent flower strips and less likely to want to enter the contract at all, preferring the business-as-usual option. Farmers that are members in a cooperative or farmers association are less likely to oppose permanent flower strips. They also have a strong preference to enter one of the proposed contracts. This is also reflected in farmers' transaction preferences: those preferring more security in their sales arrangements for wheat are also more likely to want to enter the contracting arrangement, and are less likely to resist permanent flower strips.

Table 4.6 Determinants of marginal value of the attribute in monetary terms (MVA), Seemingly unrelated regression estimates

	Glyphosate (permanent)			Flower strips (permanent)			Rotation (oilseeds)			Business as usual		
	Coef	**std.err**	**p-value**	**Coef**	**std.err**	**p-value**	**Coef**	**std.err**	**p-value**	**Coef**	**Std.err**	**p-value**
Age	0.156	0.162	0.335	0.005	0.027	0.856	0.030	0.028	0.279	-0.043	0.963	0.964
Gender (male)	**11.046**	6.075	0.069	0.990	1.031	0.337	**2.415**	1.044	0.021	-33.264	36.178	0.358
Education	-1.688	2.748	0.539	**1.143**	0.466	0.014	0.230	0.472	0.626	**-38.863**	16.368	0.018
Full time	**9.581**	3.727	0.010	0.531	0.632	0.401	**1.922**	0.640	0.003	-19.865	22.196	0.371
Cooperative membership	4.044	2.795	0.148	**-1.581**	0.474	0.001	-0.025	0.480	0.958	**53.890**	16.647	0.001
Experience in agr.	-0.181	0.157	0.249	0.008	0.027	0.773	-0.028	0.027	0.290	-0.318	0.933	0.733
Farm size	0.002	0.004	0.596	0.001	0.001	0.325	0.001	0.001	0.326	-0.024	0.025	0.333
Presence of Certification	**-6.097**	2.856	0.033	-0.044	0.485	0.927	**-1.094**	0.491	0.026	1.378	17.009	0.935
Collective environmental attitudes	**-6.487**	2.151	0.003	-0.251	0.365	0.492	**-1.255**	0.370	0.001	7.826	12.810	0.541
Transaction preferences	-0.001	1.822	0.999	**-0.516**	0.309	0.095	-0.232	0.313	0.459	**20.876**	10.849	0.054
Satisfaction with current buyer	**-3.093**	1.760	0.079	-0.366	0.299	0.221	**-0.716**	0.302	0.018	13.613	10.484	0.194
Cons.	12.937	9.698	0.182	**3.570**	1.645	0.030	1.185	1.666	0.477	**110.408**	57.756	0.056

R^2: 0.159(Glyphosate), 0.096(Flower strips), 0.205(Rotation), 0.099 (Business as usual) #obs 314

Note: Statistically significant coefficients (p<0.10) are reported in bold.

4.5 Discussion

Our research was designed pivoting around three key questions, to (1) analyse the potential of contract farming to incentivise the adoption of SI practices; (2) identify which practices can be effectively supported by contract farming; and, (3) to identify the types of farmers most likely to participate in a sustainability-focussed contract farming scheme, such as the CDM initiative. Our results presented indicate that contract farming indeed has potential to support and incentivise the adoption of SI practices. However, the evidence gathered suggests that some practices seem to be challenging farmers' adoption more than others, and highlight the relevance of designing contract farming arrangements, also taking into account farmers' characteristics. We start by discussing the former and then we move into a commentary on the latter, concluding the section by reconnecting our discussion to key contributions to the extant literature.

Looking at the practices tested in this study, glyphosate limitations seem to be the most difficult for farmers to accept. This indicates that glyphosate is a central element in the cropping system of farmers in this sample which they are rather unwilling to give up. This result is in line with other studies on the adoption of SI practices related to use of agrichemicals (Bakker et al., 2021; Chèze et al., 2020; Mann, 2018), and indicate where a key challenge in sustainability transitions may lay. While the literature on SI practices suggests an incremental approach to the adoption process, some of these practices, for conventional farmers are more disruptive than others. Banning agrochemicals or severe limitations to their use, like in the case of the glyphosate in our study, is indeed perceived as a strong, perhaps unfeasible, constraints to some farmers' operations. Agrochemical management is likely to be a key aspect to consider in further articulation of a contract farming approach to SI practice adoption. Farmers' preference to include legumes in their rotation is encouraging, given the more extensive environmental benefits of legumes. According to some stakeholders' assessment, this may also be due to the regional circumstances of northern Italy, where agro-ecological conditions are fairly suitable for legumes and where there is cultural recognition of legume production.

When it comes to farm and farmer characteristics, gender, education and being a fulltime farmer played a role in farmers' preferences, which has also been found in previous studies (Calvet et al., 2019; Kuhfuss & Subervie, 2018; Mack et al., 2020). While more highly educated farmers have at times been found to be more open to participating in environmental schemes (e.g. Calvet et al., 2019), in this sample we find them to be more likely to resist contracting. Potentially, they may experience higher opportunity cost due to having more options at their disposal. Full-time farmers may be more resistant to stricter measures since their entire professional life is organised around their cropping system, thus making any changes to that system more profound. Certified farmers are possibly less resistant to stricter measures since they may already be used to adjusting to bigger changes in their cropping system, if they have already done so in the past to gain certification. Alternatively, in the case of organic, they may already go without agrochemicals entirely, and a complete removal of glyphosate from the given plot may thus not require any change at all.

Despite often theorised and found to impact adoption of innovative contracts and practices, the farmer's age and agricultural experience played no role in our model (e.g. Calvet et al., 2019; Mack et al., 2020; Murphy et al., 2011). Also, farm size had no effect on preferences for the contract or individual preferences (in contrast to e.g. Kuhfuss & Subervie, 2018; Mack et al., 2020; Murphy et al., 2011). We also confirm the role of environmental attitudes found by e.g. Defrancesco et al. (2018), Was et al. (2021) and Despotović et al. (2021). In this study, however, environmental attitudes only played a role in the acceptance of the more restrictive practices, not in the contract acceptance overall. It is thus advisable to consider this differential effect in future studies. Effects we found for cooperative members and transaction preferences are in line with previous studies in which general attitudes towards contracts shaped farmers' preferences for specific contract offers (Allen & Colson, 2019; Solazzo et al., 2020). Finally, we found that satisfaction with the current buyer relationship makes farmers more likely to accept stricter contract conditions which echoes Calvet et al. (2019), who emphasise the importance of trust in the contracting institutions: trust seems more important the more profound the changes requested from the farmer.

The similarity of determinants for glyphosate restrictions and crop rotations could be explained by the fact that both these practices are rather disruptive to farm management. Whether flower strips are temporary or permanent, their implementation could be considered less disruptive and its determinants may therefore be more connected to whether the farmer is willing to engage in any kind of contracting that restricts choices in farm management. If one is opposed to those contracts in general, one may also be more sensitive to further restrictions, even if they are rather minor. The negative association between wanting to participate in the contract and preferring more flexibility in transactions is further echoed by the fact that, when asked why none of the contracts in the four choice tasks were selected, the most common answer from farmers was that they preferred to maintain more flexibility in their sales arrangement (59% of farmers). The individual practices were also mentioned as reasons to not want to enter the contract at all. Here reasons related to the rotation requirement were most common (42%), followed by glyphosate restrictions (34%) and flower strips (27%)[12].

12 Other answers were that the contract was too risky (7%), the administrative burden too high (5%), preferring direct sales and/or on farm processing (4%), and preferring to sell under the organic label (4%). Multiple answers were possible and the question was only asked to farmers who rejected both contract options in all four choice tasks. 85 farmers answered this question.

The premium being too low was only mentioned by 12% of farmers. These results support the interpretation that farmers that overall prefer more autonomy and flexibility are less inclined to engage in more coordinated value chain mechanisms, whether that is a cooperative or contract farming for SI.

While the nominal price premiums estimated here cannot be directly translated to real prices, they do indicate that a price premium will be necessary to induce farmers' acceptance of contract farming for SI. While Alcon et al. (2019; 2020) estimate that consumers are willing to pay more for products from more sustainable and diversified production, also in Italy, it remains to be seen whether the premium paid by consumers can fully compensate the price increase needed for farmers. This may even be exacerbated given that likely not the entire price increase paid by consumers will reach farmers. Any premium paid by consumers will likely also need to compensate increased coordination costs along the value chain, as well as being subject to effects of imbalance in market power and negotiations among value chain actors.

Yet, looking at our results, we can conclude that indeed a contract farming approach to facilitate adoption of SI practices is not necessarily an option for all farmers, and surely is highly dependent on the type of SI practice under consideration. Almost 40% of farmers in the sample require a likely prohibitive price premium and can thus be considered to be unwilling to engage in contracting for SI. These are mostly farmers that, all else equal, have more formal education, are not members of cooperatives and generally prefer more flexibility in their sales arrangements. This echoes results from Solazzo et al. (2020) who found that Italian wheat farmers in their sample prefer the autonomy granted by foregoing written contracts while at the same time still building on trust-based long-term relationships with their buyer. This seems to imply that a significant share of farmers are unlikely to be attracted by contracts that require written documentation, e.g. in order to provide certification of the practices used in crop production, which may limit the effect contract farming can have on practice adoption. It is still unclear, however, whether the trust in long-term buyers itself, rather than a contract, may be an avenue to reach these farmers and whether that will suffice to induce a change in practices, considering that some farmers may also be principally opposed to certain (agro-ecological) practices (Jaeck & Lifran, 2014). Thus, to maximise uptake of sustainable practices, heterogenous preferences for both contracts and practices need to be taken into account (Mack et al., 2020; Salvo et al., 2018).

This indicates that there are limitations to what a voluntary private sector approach can achieve in terms of improving the uptake of more SI practices. Additionally, if the primary obstacle for farmers to adopt such contracts is maintaining flexibility, similar limitations may apply to voluntary contracting by the public sector through AES, as illustrated by e.g. by Espinosa-Goded et al. (2010) and Christensen et al. (2011), since these contracts may be perceived as equally restrictive. For broad uptake of SI practices, a more regulative approach may thus be necessary to motivate certain farmers to switch practices.

4.6 Conclusion

This study demonstrated that contract farming is a potential mechanism to support farmers in adopting SI practices. Many farmers in the sample see benefits in contracting for SI, and they are likely to accept legumes in their rotations and flower strips in their fields. Completely banning or strongly limiting glyphosate in their cropping system, on the other hand, will require more efforts and likely alternative weed management options. However, almost 40% of farmers in the sample are unlikely to be convinced to adopt SI practices through contract farming. All else equal, it is particularly farmers who are not members of cooperatives, are more educated and who generally have a preference for more flexibility in their sales arrangements that will resist this mechanism to promote practice adoption. For these farmers, other approaches will be needed, such as stricter regulations. Overall, it is likely that no single approach, policy or mechanism can reach all farmers, and that a combination of measures will be necessary to promote SI practices more broadly (Lee et al., 2006).

While the case presented here is exemplary of farmers integrated in industrial value chains, there is most likely regional specificity. As is the case for finding suitable SI practices for each regional cropping system, farmers' preferences for practices and contract attributes are also likely to differ by region. It is thus advised that similar studies will be repeated for other locations. It would also be useful to engage in a direct comparative analysis to investigate whether and which farmers prefer to engage with public or value chain partners when it comes to contracting for more sustainable practices, or if contracts with either of these parties is considered equally restrictive. In addition, as Läpple and Rensburg (2011) suggest, the current degree of diffusion of a practice likely influences who adopts a practice and why. It is therefore advised to observe changes in farmers' preferences overtime, depending on the continued uptake of SI practices. Finally, a large majority of farmers in this sample were men. Further research may thus want to oversample for female farmers and farmers of other marginalised groups in order to assess the specific dynamics they may face in contracting for SI.

Appendix 4.1: Sampling

Initially, in the time frame between December 2019 and February 2020, millers and storage centres in Barilla's value chain, who were willing to participate in the data collection, invited farmers to join sessions of up to 10 farmers. During these sessions farmers willing to participate self-administered the survey on tablets, supervised and supported by trained enumerators. They were discouraged to interact during this time. This initial approach levied responses for 75 farmers. When the COVID-19 pandemic initially reached Italy in the spring of 2020 and several government lockdowns restricted movements and gatherings, the data collection was halted. Due to risk of infection, the initial data collection strategy had to be abandoned. Instead, two different strategies were used between the end of September 2020 and end of February 2021. First, agricultural advisors active in the given value chain and willing to participate were trained as enumerators. The majority of enumerators then used their own network to target farmers participating in the CDM initiative and the Barilla value chain, while one enumerator used the advisory service's data base of clients to target comparable farmers in the same areas. In order to eliminate additional risk of infection, the enumerators targeted farmers in their network whom they were visiting anyway for other activities and then conducted face-to-face interviews. In this manner, 130 farmers were interviewed. Secondly, whenever farmers could not be visited in person, phone interviews were done in order to avoid a possible selection bias based on availability and willingness for an in-person visit. The hypothetical choice experiment in these phone interviews was visually supported by sending the contract options as pdf to the respondent's phone. By phone, we reached 114 farmers. The average response rate of this secondary, one-on-one approach was approximately 91.6%. We assume the achievement of such a response rate was due to the enumerators being known contacts to the farmers and thus increasing their willingness to participate. Five observations were incomplete and dropped from the analysis bringing the total from 319 to 314 farmers.

Appendix 4.2: Attitudinal scales

Below the translated sets of items for the attitudinal scales used in the analysis. Answer options were: "I totally disagree", "I somewhat disagree", "I don't agree or disagree", "I somewhat agree", "I totally agree", or "I don't know".

Environmental and collective attitudes (6 items)
If I do something for the environment just as a single person, it will have no effect.*
Since other farmers already contribute to sustainable crop productions, my contribution is not relevant.*
The best way to solve environmental problems is to act collectively.
Forming an association with other farmers to contribute to environmental improvement is just a waste of time.*
For me, participating in collective actions related to the realization of a sustainable supply chain is important to help the environment.
My family and my friends would be proud of me if I contribute to the realization of a sustainable supply chain.

*reversed in code

Preferences for the sale of soft wheat (4 items)
It is important for my farm to fix a minimum reference price for soft wheat before sowing.
It is important that quality control systems for my soft wheat are clear and transparent
It is important for my farm to compare prices for soft wheat between different buyers before selling it.
For me it is a problem if I cannot plan the sale of my soft wheat in advance.

Satisfaction with usual wheat buyer in the last three years (4 items)
The agreement with my usual buyer gives me a fair price.
The agreement with my usual buyer has clear quality requirements.
The agreement with my usual buyer is a long term relationship.
The agreement with my usual buyer covers at least my cost.

CHAPTER 5

Discussion and conclusion

5.1 Summary of results

In the previous chapters, different perspectives of adoption and scaling of crop diversification practices were discussed. Due to the mixed method approach, this study was able to dive deeply into farmers' motivations and innovation niches' logics, as well as giving a quantitative assessment of the potential of contract farming.

In chapter 2, we combined goal framing theory with transition theory and applied this framework to in-depth, semi-structured farmer interviews, complemented by secondary data, in two regions in the Netherlands and the UK. We found that economic drivers are leading farmers' decision-making on crop diversification with legumes. Concerns of different factors influencing the profitability of legumes in rotation was the most prominent feature. Most of these factors, such as import competition from soy in the feed market, lack of varieties adapted to local agro-ecological conditions, and the discontinuation of subsidies, obstruct the adoption of legumes and create what we have identified as *a cognitive lock-in*. This *incentive misalignment trap* contributes to the obstruction of sustainability transitions towards crop diversification in the local agri-food systems. The institutional setting of regional and European policies creates incentives that are not in alignment with expressed collective goals of local protein production and more sustainable agricultural practices. Particularly agri-environmental and trade policies for agricultural products were shown to shape farmers' decision-making. Easy market access of imported soy, as well as regulation on the use of GMOs and pest and disease control, were reported to reduce the global competitiveness of locally grown legumes. However, farmers' normative goals of improving soil health and environmental conditions and supporting sustainable local production rather favour the adoption of diversification with legumes. Thus, based on interpretations of goal framing theory (Steg et al., 2014), to counter the cognitive lock-in, simply reinforcing farmers' gain frame, e.g. through simple subsidies, could be short-sighted. Doing so could undermine intrinsic motivations, and strengthen the cognitive lock-in triggered by the gain frame. As a result the adoption of legumes is continuously being cognitively linked to financial motivations. Instead, it may be advisable to promote farmers' normative and hedonic goals, while making the adoption of crop diversification financially neutral, e.g. by creating normatively framed financial support. This may be necessary to stimulate a transition towards crop diversification.

Further, results indicate that, while notions of tradition or the discomfort of change may still play a role in farmers' decisions, it does not appear to be dominant. Farmers do experiment with and adopt new crops, but only when it makes financial sense to them. The appearance of crop diversification to be financially unattractive may lead to the feasibility of implementation not even being investigated. At the same time, it was found that local conditions determine what solutions farmers find for themselves to cope with an unfavourable institutional setting. The high level of connectedness of the Gelderland case study to export markets, urban centres, as well as agricultural research and innovation, creates rather different conditions compared to the more socio-economically disadvantaged and geographically and infrastructurally isolated Cornwall. In Cornwall, the domestic orientation of the agricultural market made cooperating with local livestock farmers and creating local brands a promising route to create market outlets. In well-connected Gelderland further integration into food value chains through contract farming was seen as having potential to generate market opportunities. It is thus important to consider this local context and not decontextualise the decision-making process when analysing adoption in sustainability transitions. Conceptually, we have shown that by integrating goal framing theory into a transition framework we can conceptualise the connections between individuals' decisions, their institutional settings and larger transition processes, allowing us to identify cognitive lock-ins without decontextualising decision-making processes.

In chapter 3, two case studies were used to compare the scaling process in two innovation niches for crop diversification. Here, we used interviews, observations and focus groups, as well as a variety of secondary data sources for the two case studies, and applied an abductive process analysis. To identify the different stages of the scaling process in transitions, we analysed the dimensions of institutional logics and their changes over time. We identified three stages in the scaling process in which different dimensions of institutional logics are the drivers of change. In stage 1, the primary actors' values and mission shift, laying more focus on environmental and soil health concerns, thus requiring a change in technologies and practices. Then, in stage 2, the change in technologies and practices, in this case the use of crop diversification practices, demanded new expertise and additional actors to cooperate in the niche. Finally, in stage 3, the scaling up through broad uptake of crop diversification practices showed the need to create new permanent funding sources through the implementation of new organisational forms in the value chain. The analysis pointed to this value chain formation being a potential breaking point for crop diversification transitions. In both niches, the institutional logics under which actors operate, show tensions with regard to organisational forms, and related funding issues. In the presented cases, we observed challenges to balance sustainable, collaborative change processes with transactional value chain relations, creating tensions that can obstruct the scaling process. Actors in the niche did not perceive current value chain arrangements as adequate to solve these tensions. From a conceptual perspective, we show that adjustments in the niche's dimensions of institutional logics are likely necessary to allow a niche to scale. Rigidity in values, mission, technologies, expertise, actors, funding sources and organisational forms may obstruct attempts to further scale crop diversification practices initiated by the innovation niches. This indicates that the analysis of institutional logics and their dimensions can be a useful framework to analyse (the absence of) scaling processes in sustainability transitions. Further, this approach highlights that, next to tensions between the niche and the dominant agricultural paradigm (see e.g. Belmin et al., 2018; Ingram, 2015), also tensions within the niche can create obstacles to scaling.

Just like in chapter 2, actors tried to create new governance mechanisms in order to adapt existing value chains to more diversified cropping systems. We again observed attempts to create both horizontal, community-based arrangements (see Cornwall case study in chapter 2 and EDL case study in chapter 3), as well as vertical contract farming arrangements (see Gelderland case study in chapter 2 and BSF case study in chapter 3). Conceptually, both chapters confirm ideas presented by Pigford et al. (2018) and Meynard et al. (2017) that organising governance mechanisms is systematically part of niche formation and scaling processes, and that governance mechanisms need to be developed alongside changes in practices.

In chapter 4, we then considered one governance mechanism, namely contract farming, more closely. We estimated the potential of contract farming to induce adoption of three different practices in northern Italy, crop rotation with legumes or oil seeds, flower strips and reduced use of glyphosate. To do so, we used data of 314 Italian farmers who participated in a survey including a hypothetical choice experiment with different contract options from which to choose. Findings from the Conditional Logit Model indicate that, contrary to expectations of stakeholders, farmers preferred diversifying with legumes over oil seeds. While temporary flower strips are preferred over permanent ones, neither is a major obstacle to contract adoption. The last attribute tested, the temporary or permanent ban of glyphosate, is a decisive factor in contract adoption. Eliminating glyphosate from the plot under contract entirely is considered a dealbreaker by many farmers in the sample. Still, a large share of approximately 60% of farmers were willing to engage in contract farming for diversification and low input practices. Further, a system of regressions of farm and farmer characteristics on the marginal values of each non-monetary contract attribute was applied to analyse farmers' preference heterogeneity. It was established that it is particularly farmers who are members of cooperatives, and who generally have a preference for more coordination in their sales arrangements, that are open to contract farming for crop diversification. Also, farmers with lower degrees of education were more open to the offered contract options, which runs counter to previous research indicating that more education can increase the likelihood of participation (e.g. Calvet et al., 2019). Additionally, gender and environmental attitudes, certifications, buyer relationships and fulltime dedication to farming also play a role when it comes to preferences between individual contract attributes. We conclude that while contract farming is not a solution for all types of farmers, it can be a step towards further scaling diversification and low input practices. This implies that when it comes to the adoption of sustainable practices, value chain arrangements become more than transactional and can actually function as a vehicle for sustainability transitions.

For crop diversification transitions, the results of these chapters mean that forming new value chain arrangements suited to diversified cropping systems is essential. Yet, how exactly these arrangements need to look is context-dependent. It is also clear that a transition towards more diversified cropping systems requires adequate institutional support, both to support farmers in their adoption of practices, as well as supporting the formation of suitable value chain arrangements.

5.2 Synthesis and conceptual reflections in the context of adoption and transition research

This thesis presents an institutionally embedded perspective on farmers' adoption and scaling of crop diversification practices within sustainability transitions in the European agri-food system. We have shown the role of farmers' goal frames in their *decision-making on adoption*, the role of institutional logics in *scaling* processes, and the potential of contract farming as a *governance mechanism* in the diffusion of crop diversification. In short, from norms and values to regional and European policies, the decisively influential role of institutional conditions in these processes has been emphasized. We have further highlighted the role of value chain organisation in transition processes, in particular. Value chains have played a role in every chapter and were shown to be a central element in transition processes. In fact, in these processes, the role of value chains is not just transactional but value chain arrangements can become vehicles or obstacles of sustainability transitions.

Across all chapters, we find indications that while priorities are shifting towards more sustainable production generally, and more diversification specifically, path dependency in production systems and the logics and mechanisms upon which they are based are hampering transition. Most importantly, we can confirm that while economic drivers are certainly an essential factor in adoption and scaling processes in sustainability transitions, they are not exclusively responsible. Normative factors emerged as drivers of change. The role of values and norms identified in this thesis is in line with previous research such as Elzen et al. (2011), Plumecocq et al. (2018), and Forssell and Lankoski (2018) who also highlight the role of values and norms as drivers in transitions processes. While these studies focus on values and norms in niches challenging the dominant paradigm, we also show how changing values influence behaviour and dynamics within the niche.

The issue of value chain organisation in transitions towards crop diversification has also been previously discussed, particularly by Meynard et al. (2017), Mawois et al. (2019) and Magrini et al. (2016). While these studies all focus on the French context, we not only add analysis in different regions to the literature. We also add further details by specifying how new value chain arrangements are seen as solutions to overcome obstacles in legume adoption (chapter 2), how value chain formation is related to dynamic processes of scaling in the niche (chapter 3), and by assessing the potential of contract farming as a governance mechanism for adoption and diffusion of crop diversification (chapter 4). This research shows that while current value chain organisation seems to obstruct transition processes, finding a suitable arrangement can also catalyse progress.

We also find discrepancies between the chapters in this thesis. While adoption of legumes in particular appeared to be rather difficult in chapters 2 and 3, in chapter 4 we found high current uptake of legumes and willingness to accept contracts compelling their production. This is also in contrast with Suvanto et al. (2020) proposing that legumes are only suitable for more entrepreneurial farmers. Yet, these differences in results across chapters may actually highlight the context-dependency of adoption decisions. We are thus likely seeing regional specificities in the (intensity of) adoption of legumes. In the norther Italian region covered in the survey in chapter 4, legumes are somewhat more common than the EU average (Watson et al., 2017). This indicates that the previous level of adoption of a particular practice in the region may influence farmers' willingness to adopt the practice, as indicated also by Magrini et al. (2016).

Further, there are a few assumptions to be discussed in light of the results of this study and in the context of transition research. In contrast to the expectation of farmers being traditional, i.e. intrinsically reluctant to change (see e.g. Burton, 2004), we found a range of innovation behaviour among the farmers in this study. Even if farmers, including conventional farmers, did not always apply the practices under analysis, which may then appear as if farmers were reluctant to change, they did experiment with other new crops and practices that were in line with their goals. For example, some farmers in chapter 2 experimented with crops new to them, such as flowers, while the farm managers in the Dutch case in chapter 3 experimented with new crops, machinery and new forms of value chain arrangements. Also, additional data from the farm household survey in chapter 4 indicated that some farmers do apply sustainable practices besides the inclusion of legumes and flower strips, such as green manure or reduced tillage. This is in line with several other studies that showcase farmers' innovative behaviour and adaptation capacity, such as Cofré-Bravo et al. (2019) who show how farmers employ different support networks for their on-farm innovation. Also Hermans et al. (2016) describe farmers mobilising different actors in order to support and institutionalise their varying implementation of low-input farming. Thus, while traditions may have a minor influence on decisions (see chapter 2), there may be broader willingness to innovate and change than we expect. This willingness implies that given adequate institutional settings, sustainability transitions are achievable. However, often enough there are systemic barriers and rational reasons that simply limit the attractiveness of adopting certain practices, including crop diversification. Based on these results, it is thus advisable to gain even further insight into barriers to the adoption of sustainable practices farmers may face, be they technical, institutional or governance-related, rather than expecting a general reluctance to change based on farming traditions.

Another often implicit assumption, is that of the profit-maximising, homo economicus farmer as presented in micro economic theory (see e.g. Espinosa-Goded et al., 2013). While this simplification can certainly be useful at times, this study shows, like many others, that farmers are often driven by more than financial motivations (e.g. Dessart et al., 2019; Plumecocq et al., 2018). Economic factors certainly matter and play a central role in farmers' adoption processes, and in transition processes more broadly. Yet they are but one piece of the puzzle. Chapter 2 illustrated the relevance of farmers normative goals in the decision process on crop diversification adoption. Chapter 3 showed that in the Dutch case study, profitability came secondary to ecological values. Even in the Italian case in that chapter, where maintaining or increasing profits and business operations was still the central objective, environmental values were increasingly claiming space. These results are supported by previous studies for practices other than crop diversification, such as Bartkowski and Bartke (2018) highlighting the dominance of economic factors while also emphasising the role of, for example, environmental attitudes when it comes to soil health practices. In their review, Dessart et al. (2019) present a more detailed analysis of this interplay between economic and normative and environmental factors in adoption of sustainable practices in general. On the other hand, Was et al. (2021), for example, show for their sample of Polish farmers that economic interests were decisive and environmental motivations mattered little when adopting practices. This study thus supports the notion that norms and values, in a sense, compete with economic considerations, but additionally points out that they can operate as drivers of change if economic obstacles are removed. For sustainability transitions this means that making sustainable practices less costly, and thus allowing farmers to follow the values they hold at lower cost to themselves, supports transition processes. This is in line with the argument presented by Vermunt et al. (2020) that actors, farmers in particular, need to be compensated to enact more sustainable agricultural practices at broader scale.

Finally, farmers are at times argued to lack the necessary knowledge on or awareness of new practices, including crop diversification (e.g. Meynard et al., 2018; Morel et al., 2020; Zimmer et al., 2016). While this may certainly be the case, it may not always be the primary barrier to adoption. Chapter 2 indicated that systemic barriers and lack of incentives may simply make it unattractive to even look for the knowledge necessary to implement diversified cropping systems, even if it is available. It is thus advisable to address these systemic barriers, alongside creating and distributing technical and agronomic knowledge on crop diversification in order to foster transition processes. Additionally, chapter 3 in particular highlighted that the necessary knowledge for scaling of crop diversification practices likely needs to include practical knowledge on marketing and value chain formation. To the best of our knowledge, this type of knowledge may have been overlooked by the literature so far, but could be a relevant factor in transition processes.

As scientists, we are thus well advised to let go of these assumptions when analysing transitions. While often superficially indicated, and quite possibly true at times, these notions individually are too simplistic, and as Brown et al. (2021) point out could lead to ineffective, or even harmful policies. Sustainability transitions are by definition complex processes (Geels, 2019) and thus need to be considered from diverse perspectives. This implies that identifying barriers to transitions in the agri-food system likely requires a diversity of conceptual and methodological perspectives, as has been demonstrated in this thesis.

In conclusion, there is enough research indicating a great range of farmers' innovative actions and a variety of factors shaping their decision-making. When choosing which practices to apply and adopt, farmers largely act as rational decision-makers driven by a range of normative, economic, and sometimes hedonistic values, and delimited by institutional settings and lack of appropriate governance mechanisms. Change takes a great deal of effort, innovating not only in terms of practices, but also adjusting the governance of relevant relationships. This effort imposes undue economic disadvantage on farmers when adopting crop diversification practices. Given current circumstances, and given the pressure caused by the deterioration of soil health, environment and climate, serious interventions are needed to remove systemic barriers to reduce this burden on farmers. Thus, to achieve a transition to diverse crop production, a more radical redesign of how we organise the agri-food system and its value chains may be indicated. In the absence of such redesign or more fundamental shifts in the economic system under which farmers operate, as discussed by Feola (2020) and Koretskaya and Feola (2020), compensation that makes farmers' adoption of socially desirable practices financially painless, as advised in the policy recommendations, seems like the only option.

5.3 Limitations and further research

This thesis has confirmed the importance of value chains in transition processes. Yet, some issues in this regard deserve further attention. The chapters presented here point towards the potential of several options for governing transitions towards diversified cropping systems. Only one of them, contract farming, could be explored in more detail in this thesis. Others, such as of cooperatives and regional cooperation between livestock and arable farmers, require further attention. Given that there are instances where cooperatives have been found to support practice adoption (e.g. Abebaw & Haile, 2013; Wossen et al., 2017), and that cooperative members were also more likely to be open to contracting for diversification (chapter 4), there seems to be potential for a supportive role of cooperatives in transition processes. We also found indications that farmer cooperation in other forms, such as direct delivery of legumes to livestock farmers in the region (chapter 2), may be useful in transitions. Initial modelling studies on their feasibility have already been conducted in France (Catarino et al., 2021; Jouan et al., 2020) but more exploration on necessary conditions for implementation, also in different regions, is advised. Additionally, chapter 4 explored only the *potential* of contract farming to induce crop diversification practices. While contract farming has been previously shown to support practice adoption (Kuijpers & Swinnen, 2016; Mazhar et al., 2021; Ricome et al., 2016), a study on its empirical effectiveness for diversification specifically is still recommended since practices stipulated in contracts often only concern the contracted crop itself, rather than the entire cropping system. Effects of contract farming on practice adoption have also been mixed at times (Janssen & Swinnen, 2019; Mao et al., 2019) emphasizing the suggested need for further investigation. In addition, as chapter 2 and 3 indicate, suitable value chain arrangements are likely context-dependent. We thus advise further research to explicitly consider the different conditions under which specific value chain arrangements are effective in supporting practice adoption, including and beyond crop diversification. We further suggest to not only assess contextual conditions but also farmer characteristics as these may interact with preferences for value chain arrangements, as stipulated in chapter 4. Finally, effectiveness studies are also advised to estimate the (long-term) effects of different policy instruments to induce diversification, and their framing. While the exploratory study in chapter 2 and theoretical considerations of goal framing theory suggest that normative framing improves long-term effectiveness of such interventions, this still needs to be empirically tested.

In addition, we suggest more in-depth, observational research with regard to farmers' daily practices when it comes to the implementation of crop diversification. While we have addressed barriers related to farmers' decision-making processes, the adoption of new crops on the farm may change farmers' day-to-day lives and habits. Thus, observing these adaptation processes more closely will likely expose additional systemic and practical barriers, that farmers come across when adapting to the new cropping system.

Further, there is an assumption implicitly shared among actors in the agri-food system and researchers, including this thesis, that each crop needs to have its own separate value chain, This is illustrated, for instance, by the issue of buyers being unwilling to purchase intercrops due to the extra step and machinery needed to separate, for example, cereals and legumes grown simultaneously in the same plot (Casagrande et al., 2017; Duru et al., 2015; Magrini et al., 2016). These studies indicated that even if the end product combines different crops, for example in animal feed, processors still prefer separated crops in order to recombine them according to their exact specifications. This implies that value chains are often still thought of in terms of monocrops. Yet, it appears advisable to consider, for example, whether it is worth forgoing the benefits of practices such as intercropping, or bearing the cost of separating crops, in order to enjoy the efficiency gain in livestock production achieved by highly standardised and specialised feed. Such questioning of the level of standardisation we presume and how we evaluate efficiency in our agri-food system, requires a systemic perspective, taking into account an inordinate amount of levers. Such considerations require a more radical rethinking of agricultural value chains and the agri-food system as a whole. We advise to pursue the careful weighing of advantages and disadvantages of standardisation and specialisation of value chains versus the diversification of our cropping systems in future studies.

This thesis has certain methodological limitations. Firstly, particularly chapter 2 and 3 are exploratory studies. While their in-depth exploration allowed us to expand our understanding of the subject matter, sample sizes are too small to draw definitive conclusions. Quantitative studies are advised to confirm or complement results. In chapter 4, we purposefully chose a targeted sampling procedure to specifically look at farmers integrated into industrial value chains. A more representative sampling approach for farmers in different types of value chains is advised to complement our results. We also advise to extend this type of research beyond the regions of western Europe which were the focus of this and most previous studies. Given our discussion of context-specific barriers and solutions, such an expansion is pertinent. Initial attempts for this thesis to include a broader range of case studies, for example in Hungary or Finland, failed. This was due to the difficulties to build and maintain relationships with researchers on the ground, and due the time investment needed to manage even a small number of cases at the intensity needed for this research. Additionally, ambitions of more cases and larger sample sizes were significantly curtailed by the COVID-19 pandemic which limited both the extent of, as well as methodology options for, field work. Furthermore, the principal author of this thesis partially relied on an extended team of researchers for data collection, due to choices in the research design and language barriers. This implies that the principal author in certain situations was not able to be in direct contact with respondents. However, this collaborative approach was efficient and allowed for a lot of mutual questioning and discussion among the research team, and data collection activities were continuously coordinated and overseen by the principal author.

Finally, the sample in chapter 2 involved only men, and also in chapter 4 the share of women in the sample was rather small (4.5%). Given that 29% of farm managers in the

EU in 2016 were women (Eurostat, 2021b), it is strongly advisable to more explicitly investigate gender dynamics in the adoption of crop diversification, and in transitions more broadly, both qualitatively and quantitatively. For our case, the lesson learnt is that adequate gender representation should be specifically targeted in sampling procedures in order to create the ability to investigate such dynamics.

5.4 Policy recommendations

Given the interlinked agronomic, organisational and institutional barriers identified in this thesis, a more coordinated effort by public authorities is needed. As already pointed out by Meynard et al. (2018), private investments are unlikely to be sufficient to overcome the obstacles to crop diversification currently in place. In the current situation, the value added by diversification does not compensate for the extra effort needed to develop and implement suitable governance mechanisms (Meynard et al., 2018). Based on this thesis, a few measures can be suggested. First of all, economic incentives, such as making diversification a condition for existing subsidies or offering additional ones, are likely needed to compensate for the direct cost of transitions. Yet, based on chapter 2, it may be advisable to explicitly connect these subsidies to clear normative objectives to avoid crowding out of intrinsic motivations. This implies that framing payments as enablers to "do the right thing", e.g. restoring environments and soils, may improve the long-term effectiveness of such a measure, compared to framing payments as compensation for "services" provided by the farmer. In the latter case, cognitively, these services are likely to stop once payments do as they are connected to gain goals, while morally motivated actions once implemented may persist even when payments are removed. However, while we find indications for this in this study, the effectiveness of such different framing still requires extensive testing. It is also advised to support variety development of diversification crops and to review current trade and import rules of protein crops, in order to create conditions under which sustainable local protein production can thrive. Further, to support the formation of adequate governance mechanisms, it is advised to create the legal frameworks and/or simplify the establishment of different types of farmer cooperation, for the direct delivery of legumes to livestock farmers or to build cooperatives marketing diversified crops. These mechanisms may require financial support, either directly or through added value from products. This added value from products is likely also necessary to compensate private sector initiatives that involve contract farming, given that chapter 4 indicated that premium prices will be necessary for farmers to accept such contracts. In order to create added value for products from diversified systems, transparent certification and labelling will be needed, in combination with increased awareness by consumers. As Alcon et al. (2020) point out, while consumers are willing to pay more for products from diversified systems, the added value currently recognised by consumers is likely not sufficient to compensate the extra efforts required for a transition.

The principle of increasing returns to adoption identified by Magrini et al. (2016) would justify public investment in early adopters of diversification and sustainable practices more generally, as these practices initially have high costs for implementers with dispersed benefits for society. This implies that once established, subsidies may no longer be necessary. However, as the example of subsidies for legumes in chapter 2 indicates, such establishment may take longer than expected. If withdrawn before systemic changes such as investments in plant breeding and creation of new value chains have occurred, the practice could easily be abandoned again. Still, European agricultural systems need to be diversified to maintain their long-term sustainability and productivity. Therefore, there needs to be a coordinated public effort supporting the adoption of diversified cropping systems.

Finally, for farmers and value chain actors who intend to increase crop diversity in their agricultural production, this thesis recommends to carefully consider and evaluate suitable value chain arrangements early on in the process. The adjustment of value chains' organisation is likely to be an obstacle and building value chains adapted to diversified cropping systems will take considerable effort. Based on this thesis, different contexts will require different types of arrangements. For farmers in rather isolated regions, chapter 2 suggests that building direct relationships with livestock farmers and creating local brands for added value could be an opportunity. In well-connected regions and in industrial value chains, contract farming may be a promising option to explore as a mechanism to provide incentives for crop diversification practices. The EDL case study in chapter 3 also provided indications that cooperating with other arable farmers, for knowledge exchange, joint marketing and possible even variety breeding programmes could be beneficial for certain farmers. But as has been mentioned in the previous section, this option may need further research for confirmation.

Summary

The dominant paradigm in European agriculture is characterised by highly specialised and industrialised production. Its reliance on intensive use of agrochemicals, monocultures and few crops and varieties contributes to greenhouse gas emissions, water pollution, soil degradation and biodiversity loss. The increasing damages caused by this paradigm demand fundamental changes in the agricultural system. Crop diversification is a central element of several alternative approaches to agriculture to promote a transition towards a more sustainable agricultural system, such as organic agriculture, agroecology or ecological intensification. Crop diversification practices, such as extended rotations or intercropping with more diverse crops, are known to improve soil health and fertility, and reduce erosion. These practices contribute to increased (agro-)biodiversity, and reduce fertiliser needs and eutrophication, as well as incidences of pests and diseases. Despite these benefits and expressed EU support, adoption rates of diverse cropping systems in Europe are still low. Yet, adoption mechanisms for and barriers to crop diversification are not yet fully understood.

This thesis contributes to the investigation of adoption and scaling of crop diversification practices among European farmers, by linking interconnected factors across the agricultural system, from farmers' decision-making on adoption, to the institutional context of scaling, to specific governance solutions. We consider this process of adoption and scaling as major elements of *sustainability transitions* within the wider European agri-food system and assume different perspectives thereof in our elaborations. First, we assess the role of the individual farmer's motivations and goals in relation to their institutional and regional setting, within transitions to diversified cropping systems (chapter 2). Then, we assess the (attempted) scaling process to examine institutional tensions and potential obstacles to scaling of crop diversification arising over time (chapter 3). Finally, we consider the value chain more specifically to investigate contract farming as a potential enabling mechanism to the adoption of crop diversification (chapter 4). Conceptually, these analyses draw on transition theory, goal framing theory for environmental behaviour, and institutional theory, as well as inspirations from economic organisation studies and contract design. Empirically, we consider a range of qualitative and quantitative, primary and secondary data, including interviews, field visits and observations, a large scale survey, as well as company and policy documents.

In chapter 2, we combined goal framing theory with transition theory and applied this framework to in-depth, semi-structured farmer interviews, complemented by secondary data in two regions in the Netherlands and the UK. It was found

that gain goals are leading farmers' decision-making on crop diversification with legumes. Farmers' goals can be linked to their institutional setting, both locally and at European level. Particularly local market opportunities and the EU's agri-environmental and trade policies for agricultural products shape farmers' decision-making. Easy market access of imported soy, as well as regulation on use of GMOs and pest and disease control, were reported to reduce the global competitiveness of locally grown legumes. Accordingly, gain goal frames are continuously triggered, creating a cognitive lock-in. Based on goal framing theory, it may be advisable to promote farmers' normative and hedonic goals, e.g. around improving soil health and supporting local production, while making the adoption of crop diversification practices financially neutral, to avoid crowding out intrinsic motivations for crop diversification. At the same time, it also emerged that farmers see context-specific solutions to overcome institutional barriers, particularly in the formation of suitable value chain arrangements, either by cooperating with other local farmers, or creating contracting arrangements with buyers. This indicates the importance to avoid decontextualising decision-making processes. This study illustrated that by integrating goal framing theory into a transition framework, we can conceptualise the connections between individuals' decisions, their institutional settings and larger transition processes, allowing us to identify cognitive lock-ins without decontextualising decision-making processes.

In chapter 3, two case studies were used to compare changes in institutional logics in the scaling process of two innovation niches for crop diversification, one in the Netherlands and one in Italy. Using interviews, observations and focus groups, as well as a variety of secondary data, we performed a process analysis identifying three stages in the scaling process, each driven by changes in different dimensions of institutional logics. We show that adjustments in the niche's values, mission, technologies, expertise, actors, funding sources and organisational forms are likely necessary to allow a niche to scale. The analysis points to organisational forms in the value chain, and related funding sources, being a potential breaking point for transitions to diversified cropping systems. Actors in the niche did not perceive current value chain arrangements as adequate. Thus, both chapters confirm previous research that organising governance mechanisms is systematically part of adoption and scaling processes, as balancing sustainable, collaborative change processes with transactional value chain relations can obstruct change. Conceptually, we show that the (absence of) adjustments in the niche's dimensions of institutional logics are relevant factors in niche scaling processes, usefully complementing transition frameworks.

In chapter 4, we then estimate the potential of contract farming to induce three different crop diversification and low input practices in northern Italy, crop rotation with legumes or oil seeds, flower strips and reduced use of glyphosate. Findings from a survey with 314 farmers and a hypothetical choice experiment, analysed using a conditional logit model, indicate that farmers prefer diversifying with legumes over oil seeds. While temporary flower strips are preferred over permanent ones, neither is a major obstacle to contract adoption. The last attribute tested, the temporary or permanent ban of glyphosate, is a decisive factor in contract adoption. Eliminating glyphosate from the farm is considered a dealbreaker by many farmers in the sample. Overall, 60% of farmers were willing to engage in contract farming for crop diversification, showing significant, but not universal potential of contract farming as an adoption mechanism. A system of regressions of farm and farmer characteristics on the marginal values of non-monetary contract attributes indicates that particularly members of cooperatives, those more open to contracting in general and with lower degrees of education are most open to contracting for crop diversification. When it comes to preferences between individual contract attributes, gender and environmental attitudes, certifications, buyer relationships and fulltime dedication to farming also play a role. We conclude that contract farming has the potential to support the adoption of crop diversification, even if not for all farmers, implying that value chain arrangements can go beyond their transactional function to support sustainability transitions.

Thus, across all chapters, we can confirm that while economic drivers are certainly essential in adoption and scaling processes, they are not exclusively responsible. Values and normative factors emerged as drivers of change, while issues around value chain governance are shown to be clear obstacles which deserve more attention if we are to achieve sustainable transitions to diversified cropping systems. Conceptually, this thesis illustrates the role of farmers' goal frames in their decision-making on adoption, the role of institutional logics in scaling processes, and the potential of contract farming in the diffusion of crop diversification. All these lenses highlight the importance of farmers' institutional context, e.g. in terms of norms and policies, and including the crucial role of value chain organisation as a potential vehicle in sustainability transitions. We thus presented an institutionally embedded perspective on farmers' adoption and scaling of crop diversification practices within sustainability transitions in the European agri-food system.

This study recommends that public institutional support is needed to scale up the adoption of crop diversification practices. It is suggested to target farmers' normative goals while making adoption financially painless in order to support intrinsic motivations. Additionally, in order to make local protein crop production more competitive, it is advised to support variety development for diversification crops and review trade rules on protein crops. Finally, value chain formation for diversified cropping systems is essential for long-term adoption and thus needs to be supported, in terms of knowledge creation and distribution on suitable arrangements, as well as through direct support to value chain actors.

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Training and supervision plan
Chiara Sophia Weituschat
Wageningen School of Social Sciences (WASS)
Completed Training and Supervision Plan

Wageningen School of Social Sciences

Name of the learning activity	Department/ Institute	Year	ECTS*
A) Project related competences			
A1 Managing a research project			
WASS Introduction Course	WASS	2017	1
'Where is the theory: A reflection on empirical studies into the effectiveness of cooperatives in developing countries'	ICA conference, Wageningen	2018	1
Writing of research proposal	BMO, WUR	2018	6
A2 Integrating research in the corresponding discipline			
Food Value Chain Research: Understanding Inter-Organizational Relationships	WASS	2017	1.5
ECH-51306 Behavioural & Experimental Economics	ECH, WUR	2018	6
Systematic approaches to reviewing literature	WASS	2017	4
MAT-50806 Qualitative Data Analysis: Procedures and Strategies	MAT, WUR	2019	6
B) General research related competences			
B1 Placing research in a broader scientific context			
Organisation Theory (A. Grandori)	Bocconi University Milan	2018	4.3
Social Orders, Institutions and Long Term Economic Development	WASS	2018	2
B2 Placing research in a societal context			
Organisation and implementation of workshop on inclusive education at WUR: Workshop for lecturers to create strategies for integration of anti-racism, decolonisation and inclusiveness into study programmes, courses and teaching materials	WUR	2021	1
C) Career related competences/personal development			
C1 Employing transferable skills in different domains/careers			
Supervision and mentoring of 4 MSc students	BMO	2018-2020	2
DARE project committee member (WUR anti-discrimination project)	WUR	2021-2022	2
Total			**36.8**

*One credit according to ECTS is on average equivalent to 28 hours of study load

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