DIVERFARMING

Crop diversification and low-input farming across Europe: from practitioners' engagement and ecosystems services to increased revenues and value chain organisation

RESEARCH PROTOCOLS ON HOW TO ANALYSE THE ROLE OF VALUE CHAIN CONDITIONS ON ADOPTION AND DIFFUSION MECHANISM

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Executive summary

In this report we present a **brief overview of the research strategy and related protocols** that will be used in WP6 activities in connection to the topic of how to analyse the role of value chain conditions on adoption and diffusion mechanism. The research strategy is organised in three lines of inquiry: **the first line of inquiry** is represented by a case-study analysis in which we will compare and contrast empirical evidence from the 14 so-called short term case studies and the literature review in order to make sense of the key value chain conditions related to process of adoption and diffusion of CDPs. The **second line of inquiry** is represented by an in-depth case study analysis (or deep-dive) which will aim at understanding how specific mechanisms of value chain coordination can be designed and assessed to facilitate the adoption and diffusion of CDPs. The **third line of inquiry** refers to thematic analysis developed by consortium partners on topics related to the adoption and diffusion of CDPs in various contexts. This thematic analysis will be managed and implemented by partners under the supervision of the WP coordination team.

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1. Introduction

In this document we present and discuss the research strategy and protocols that will be used during the activities related to WP6. The aim of the document is to create a joint and shared **methodological framework** which will help researchers of the Diverfarming consortium to work together on common tasks, in order to collect data and information aligned with the project, WP and tasks objectives.

We start by presenting the overarching research strategy of the WP6 related activities (figure 1.1). We discuss how this strategy intends to tackle the key methodological challenges of this project and more specifically 'how to analyse the role of value chain (VC) conditions on adoption and diffusion mechanism'. As presented and discussed in Deliverable report 6.1. investigating and analysing the conditions leading farmers to the adoption and diffusion of crop diversification practices (CDPs) is a complex task which deals with multifaceted economic, social and environmental aspects.

Therefore we have identified a research strategy approach that takes this complexity into account and designed three key methodological approaches that form our overarching research strategy. We have organised these approaches through **three lines of inquiry**.

The **first line of inquiry** is represented by a **qualitative case-study analysis** in which we will compare and contrast empirical evidence from the 14 so-called short term case studies and the literature review in order to make sense of the key value chain conditions related to process of adoption and diffusion of CDPs. The case study methodology will develop three interconnected data collection activities:

1) In each case study we will reconstruct inductively and retrospectively the longitudinal process of adoption and diffusion of CDPs, its barriers and support factors. Qualitative process data will be collected and then compared and contrasted between and among cases.
2) Starting from the analysis of the different phases of the value chain and the respective actors, the focal points of the VC will be identified, focusing the attention on the power relations and the exchange of value, through the aid of a matrix-based approach[1].
3) Based on the process data collected we will develop an overarching conceptual model to identify "pathways" of adoption and diffusion. Pathways will inform a scenario-building analysis which will be conducted with key informants and stakeholders to define the "futures of CDPs" in the European and international agri-food value chains.

The **second line of inquiry** is represented by an **in-depth quantitative case study analysis** (or deep-dive) which will aim at understanding how specific mechanisms of value chain coordination can be designed and assessed to facilitate the adoption and diffusion of CDPs. This line of inquiry will be developed with a selected set of consortium partners and will engage directly with the case studies related to the diversification of annual crops and particularly cereals and tomatoes in the Mediterranean pedo-climatic area and involving Barilla and Casalasco cooperative as key stakeholder partners. The line of inquiry is developed in interconnected data collection activities:

- A preparatory phase with qualitative data collection through focus groups, observational data and interviews with key informants related to stakeholder partners.

[1] Further guidelines for the case study managers will be delivered during the implementation stage of this research.

- A supply chain contract co-design and piloting phase, in which Design Thinking will be used to define contractual arrangements which will be subsequently tested in pilots with a small group of farmers.
- A field work-based experimental study to test adoption and diffusion of CDPs through innovative contracts with a sample of farmers operating in the Barilla and Casalasco supply chains.

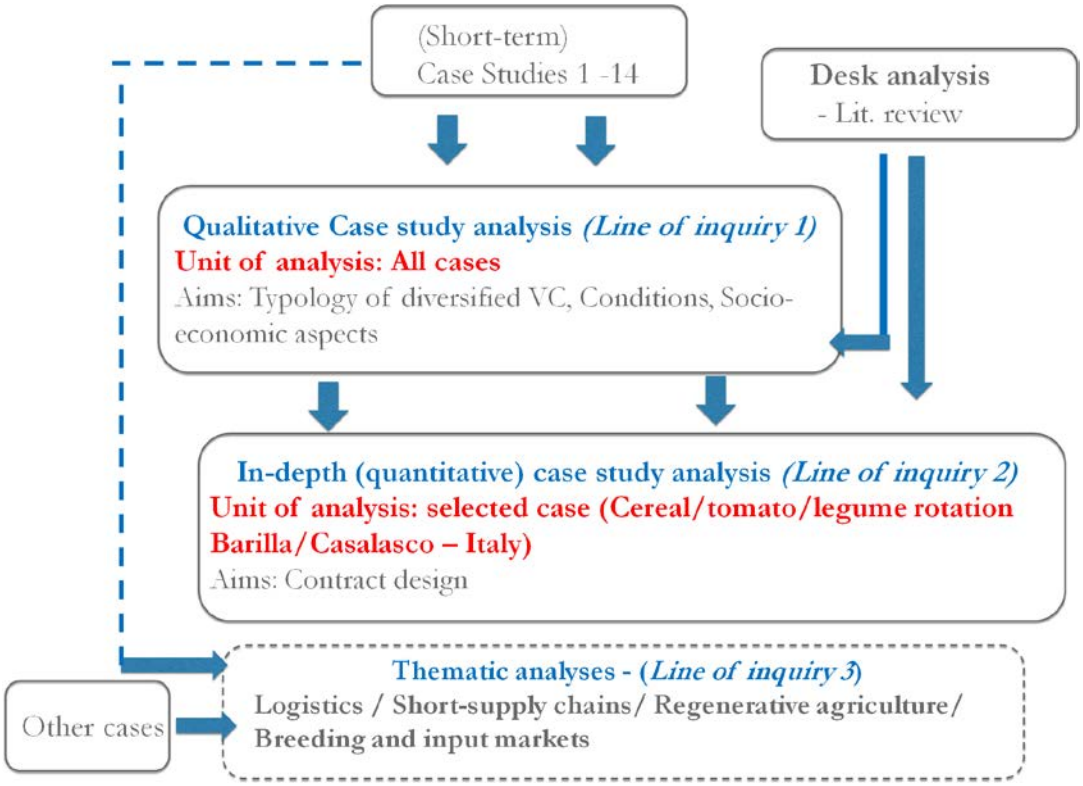
The **third line of inquiry** refers to **thematic analyses** developed by consortium partners on topics related to the adoption and diffusion of CDPs in various contexts. The thematic analyses will be managed and implemented by partners under the supervision of the WP coordination team. Pre-selected thematic areas of inquiry are:

- Plant breeding and diversification strategies
- IT, big data and logistics
- Short supply chains
- Regenerative practices
- Circular food systems

In order to ensure flexibility, consistency and scientific rigor, the detailed methodological approaches used in the thematic analyses will be discussed between the partners and WP coordinator and Diverfarming Project coordinator.

In the next section we present the research protocols related to the different activities of the first line of inquiry (Qualitative case study analysis), while in chapter 3 we present the research protocols related to the second line of inquiry. We conclude with an overview related to the third line of inquiry and its expected contribution to the WP and the project.

Figure 1.1: Overarching research strategy



2. Qualitative case study analysis (line of inquiry 1)

2.1. Inductive qualitative case study analysis

Our analysis takes a grounded theoretical approach based on an inductive cross-case study methodology, analysing 14 cases of crop diversification in the different pedo-climatic areas included in Diverfarming project. This methodological protocol is based on an **iterative and inductive process of data collection and analysis**:

(i) to map and identify the supply chain configuration, their features changes over time in each case study,
(ii) to identify value chain dimensions/characteristics per crop/flow;
(iii) to identify value chain conditions to adopt and diffuse diversification;
(iv) to assess the economic increase of the economic value added.

The use of a **case study methodology** is justified by the lack of theorising about mechanism of adoption and diffusion of CDPs in both the practitioner-oriented and academic-oriented literature.

Therefore, a theory development is considered an appropriate approach to support development of conceptual and empirical models and frameworks to understand and explain new phenomena, in this case, adoption and diffusion of CDPs (Eisenhardt et al., 2016). Given the nature of inductive research, **this methodology entailed an iterative process from data to theory** and purposively selected cases to provide evidence of the conceptual categories emerging from the research questions, and as presented in the deliverable 6.1 (Yin, 2014).

The results of the analysis will be generated by researchers' interpretation of **emerging themes and patterns**, which will lead inductively to the choice of suitable theoretical lenses (Eisenhardt, 1989; Langley, 1999). More specifically, our research protocol is based on the idea of **theory-building form cases** where different source of information could be used (Eisenhardt et al., 2016), compared and contrasted both within each individual case and between cases (Gioia et al., 2013) in order to reconstruct the process data related to emergence and diffusion of CDPs (Langley, 1999).

Primary data for each case will be mainly collected by **in-depth interviews** with one or more key informants, who will be asked individually to describe the origin of the value chain, its key features and activities, and how these changed over time. Interviewees will be asked to focus on adoption and diffusion of CDPs and to reflect on the role of value chain conditions, particularly looking at contractual arrangements. This research protocol entails an **engagement with the case study manager** (please see draft questionnaire in appendix 2) which will be leading to the definition of interviews that will be semi-structured in design, with the option of follow-up discussions when needed. The structure and key elements of the interviews with key informants will be adjusted, as necessary, to the context. Moreover to enrich our primary data, interviews with other stakeholders and observational data can be collected in all cases.

Finally, we will integrate information from the cases according to the specific needs suggested by evidence from the field (Gioia et al., 2013). More specifically, in order to ensure triangulation of sources, in each community we will be mapping and using all the secondary sources already available. All the studied cases will have an inventory of documents and information related to their activities, as well as a website and/or social media page. All the material collected from primary and secondary data will be transcribed, where necessary,

The 14 Diverfarming short-term cases offer the WP6 research team access to rich primary and secondary sources enabling them to reconstruct the history and key developmental stages of the supply chain, particularly looking at processes of crop diversification. In each case study a filed survey will be used to gather data from key value chain actors and stakeholders. The survey will be organised in two phases:

Phase 1 – Mapping the configuration / structure of the diversified value chain (please see figure 2.2), through the following steps:

Step 1 – Identify the focal farmer(s) F1

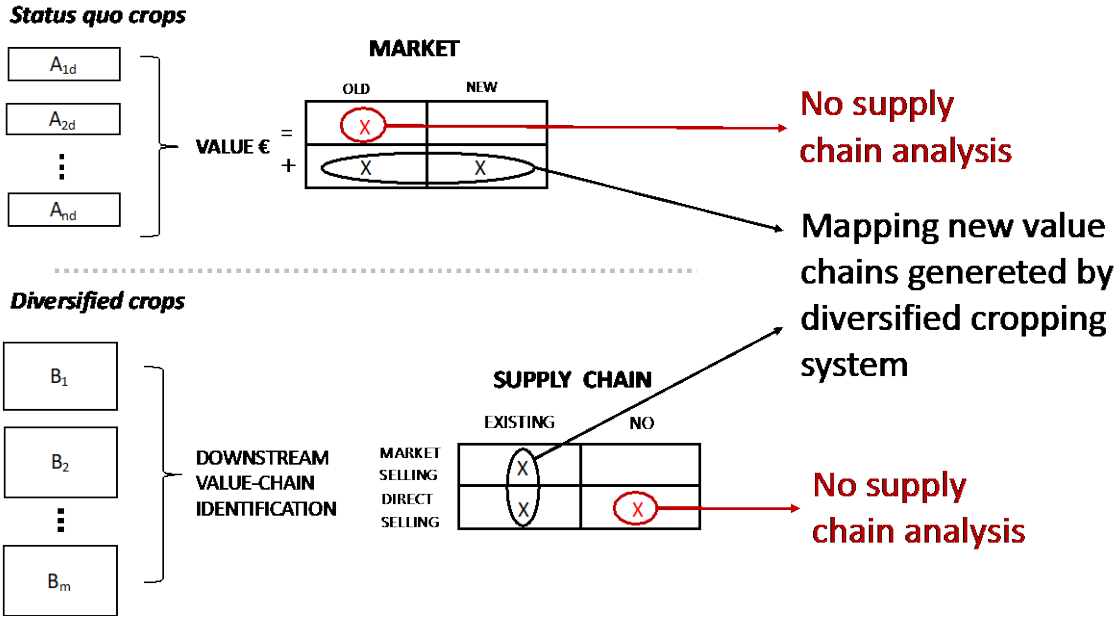
Step 2 – Identify the different crops/product flows at farm level

Step 3 – For each crop/product flow identify the upstream and downstream matrix

In this phase the case manager of each case study will collect data, and interview involved stakeholders to map the value chain and to reconstruct the main changes between and after the diversification process.

The following scheme represents the approach to use in analysing and mapping the different value chains. The analysis will be done for the main products (from A_{1d} to A_{nd}) as well as for the ones deriving from the diversification processes (from B_1 to B_m).

Figure 1.2: Example of matrix to map value chains



Then, only for the products for which there will be an expected increase of value or a different market, the following matrix should be filled.

Figure 1.3: Example of matrix to identify phases and actors in the value chain mapping

ACTORS	PHASES															
	LP		Seeding		Crop cult.		Harvest		Log. 1		1st process.		Log. 2		--------	
Farmers	X		X		X		X	€								
Input supplier																
Trader									X	€						
Transport company							X	€	X	€						

Legend

- **X**: presence of the actor
- Power level of the actors
  Yellow: low power Red:
  Strong power
- **€**: exchange of value

In order to complete the matrix[2], the case manager should be able to:

- define who do the activities related to each process/chain phases;
- identify who addresses the decisions about the different activities;
- identify several level of power;
- identify when different actors exchange each others products and services with money.

The final filled matrix will then guide the selection process of the VCs to be considered for the in-depth analysis.

The second phase will look into the specific features and conditions that may be associated to diversification processes and particularly to adoption and diffusion of CDPs in the given case study.

Phase 2 – Interviews with key value chain actors:

Step 1 - Identify value chain dimensions/characteristics per crop/flow

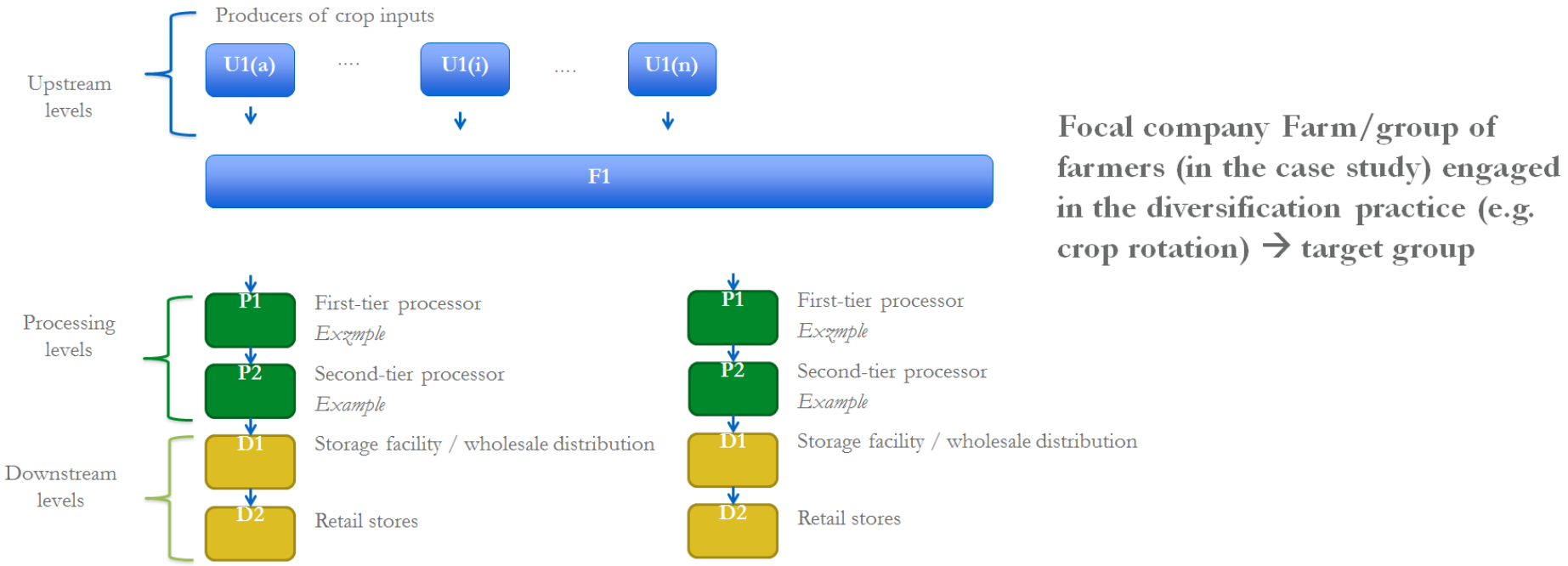
Step 2 - Identify value chain conditions to adopt and diffuse diversification

Step 3 - Assess the economic increase of the economic value added

An example of the draft questionnaire which will be used by case study managers in their interviews is presented in Appendix 1. Before the data collection will take place, the WP 6 leader and task coordinators will organise a preparatory meeting with the case study manger in order to ensure that the protocol for the data collection is shared and adapted to the specific conditions of the case study.

[2] A guideline explaining how to fill in the matrix for each case study will be discussed within the specific workgroups and then the WP leader will made it available.

Figure 2.1: Value chain standardised structure

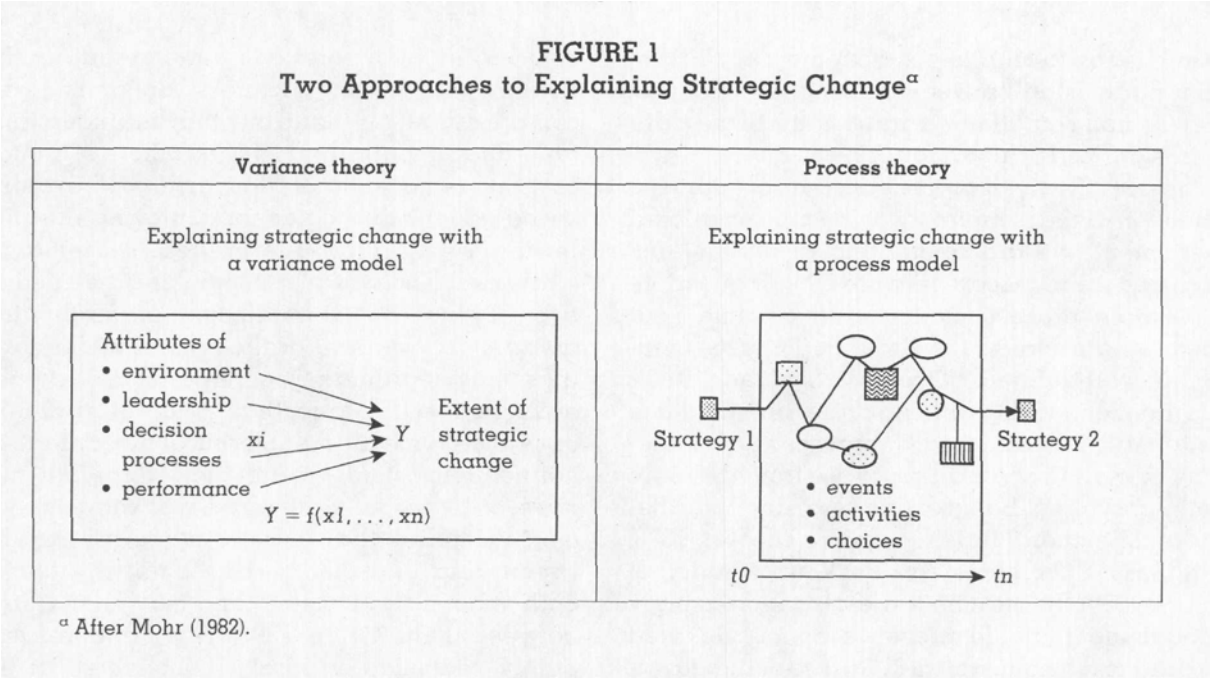


2.2. Process data methodology

Besides the inductive case study analysis we will develop a **process data methodology** in order to be able to identify and further specify **patterns of diversification** and derive **generalizable conceptual models of adoption and diffusion of CDPs**. We will use this analysis also to create scenarios to make sense of future changes of diversification patters. In this section we briefly present the research protocol associate to the process data analysis.

Our process data approach will be based on a consolidated set of practices in the field of organizational and institutional change. In a process data methodology researchers focus on reconstructing sequences of key events that shape a given process (Langley, 1999; figure 2.2). Events, like strategies, become the unit of analysis and in a process methodology approach they are the primary focus of a data collection strategy. Process methodology is qualitative in nature as as oppose to variance theory based approaches aims at reconstructing "logics", "narratives" and "themes" rather than quantify indicators or variables associated to strategic changes (please see figure 2.2. for a comparison between variance and process theory based approaches).

Figure 2.2: Process methodology as research approach to identify organisational changes



Source: Langley, 1999

In our case we will focus on conditions that have determined adoption and diffusion of CDPs, the emergence of patterns in these sequences and any kind of barriers or bottlenecked. The unit of analysis will be the farm decision making process and farmers' strategizing around value chain relations, farming activities and their interconnections in terms of decisions of adopting CDPs. Particularly we will focus on three theoretical aspects as discussed in the deliverable 6.1. report, and namely: proximity, quality, and relations. The process data collection protocol is divided in 5 distinct but interconnected steps, as briefly presented below.

Step 1: Narrative Construction (chronological)

The first step of the data analysis we aim derive a chronological reconstruction of the events which have characterized the emergence of CDPs particularly in relation to the farming activities, value chain conditions.

Step 2: Visual Mapping

The second step of the analysis will be based on a visual mapping approach to present the sequence of events and "phases" for the development and verification of our conceptualization (Langley, 1999). In this way we have been able to show how the parallel processes and events characterizing the adoption and diffusion of CDPs in the different cases took place, and how conditions might have been translated in different "phases".

Step 3: Temporal Bracketing

The third step of our analysis will be using temporal bracketing to identify patterns between phases in relation to the development of key conceptual issues.

Step 4: Open Coding

In this step of the analysis researchers will code meanings, themes, and emerging narratives to define a conceptual framework related to patterns of changes or phases in the adoption and diffusion of CDPs.

Step 5: Reliability Checks and Interviewee Validation

The last round of analysis relates to reliability check and validation. This is performed by triangulating the first four steps between researchers in the team and with a new round of engagement between the researchers and the stakeholders (farmers and value chain actors).

3. In-depth quantitative case study analysis (line of inquiry 2)

3.1. Introduction to the experimental design approach

In this section we present the research protocols associated to the second line of inquiry and namely the in-depth quantitative case study analysis. In this analysis we will be focusing on the role of value chain conditions, particular looking at how participations and contractual arrangements may be used to facilitate the take up of CDPs and thus their adoption and diffusion. This is calling for a rather **experimental design approach** since there is limited evidence in this field of inquiry on the relation between contractual arrangements and farmers' strategic responses in terms of farming practices and therefore likelihood to adopt and diffuse CDPs.

To the best of our knowledge, there are currently only few studies reporting on the effect of contractual arrangement on crop diversification practices, or technology and practice adoption in general, using experimental or quasi-experimental designs in a farm decision making environment. Our desk analysis has highlighted that so far, quasi-experimental studies focused on income effects rather than effects on technology or practice adoption. In fact, a recent systematic review of contract farming arrangements in developing countries did not find a single study using an experimental design (Ton, Vellema, Desiere, Weituschat, & D'Haese, 2018).

This is a significant gap in the literature. In current strides to make agriculture more sustainable, globally, contract farming could be a tool to improve the adoption of more sustainable practices or technologies. Yet, this aspect has yet not been investigated.

Based on this consideration we have defined a research protocol which aims at using new contractual arrangements mimicking the approach used by stakeholders in contract farming strategies to tackle barriers to adoption and diffusion of CDPs. The **experimental design** presented here will be applied to the case of the supply chains of Barilla S.p.A., a pasta manufacturer with global reach and Casalasco, a farmer cooperative in Italy. The cooperative has branches across different regions in Italy and focusses on processing of tomato. The two parties have been cooperating for the past years under the Barilla Sustainable Farming (BSF) contract to supply durum wheat to Barilla. This contract contains specifications of quantity, quality, price (incl. quality premium scale) and timing of delivery, as well as access to a decision support tool surrounding agronomic advice for durum wheat. The BSF contract builds the status quo option for farmers in the sample. This means that any alternative contract offered to farmers in the treatment groups would be offered alongside this status quo contract so that farmers can choose between them. The new alternative sample would include a requirement of crop diversification. The sample is comprised of members of the Casalasco cooperative.

In the following sections we present the activities which form the research protocol steps.

3.2. Preparatory steps

The research protocol used for this approach requires **extensive preparation**. Firstly, qualitative data will be used to identify the major barriers to the adoption of crop rotations in this case and options for contracting mechanisms. Secondly, baseline survey data will be collected to observe stated preferences of farmers with regard to crop diversification and perceived obstacles and needs. Thirdly, new contractual arrangements will be co-designed between the cooperative Casalasco and Barilla. Only then alternative contracts can be offered to farmers based on randomization and contract adoption be observed. This section deals with the first steps as a preparation to the experimental approach.

3.2.1 Qualitative data collection

Key informant interviews with farmers, cooperative managers, intermediate traders and Barilla and Casalasco employees will help to understand the context and processes currently involved in the negotiation and contracting procedure between the main actors in this case (see appendix 3). Further, interviews should also offer a first insight into barriers and enablers of crop rotation as identified by the actors involved. Possible issues that may arise are soil health awareness, climate change awareness, risk and uncertainty, agronomic knowledge gaps or marketing of minor crops in rotation. Focus groups with farmers and traders provide an additional tool to validate interview outcomes. The information provided will inform the development of a survey tool.

3.2.2 Contract co-design

The aim of this stage of the preparatory phase is the creation of testable, legally binding and commercially oriented contracts for crop diversification between Barilla and Casalasco. In the process Barilla's '**Design Thinking**'[3] team, alongside Casalasco representatives, intermediaries, farmers and researchers will work together to identify and negotiate promising contract mechanisms based on the previously collected data (appendix 3 and 4). Due to the extensive consideration and inclusion of farmers' perceptions and needs, the new contractual arrangements should connect well with farmers and have a relatively high adoption rate.

3.2.3 Baseline survey

Alongside the contract co-design, baseline survey data of the Casalasco farmers for the experimental sample will be collected. This survey observes the status quo of farmers before any new contract is introduced and allows for the measurement of changes in farming practices and socio-economic outcomes when compared to an end-line survey implemented after contract offer. The survey will focus on farming practices, attitudes, risk preferences, perceptions on value chain governance and business relationships, knowledge and experience with alternative practices (in their network), as well as some socio-economic data and farm characteristics.

3.2.4 End-line survey

Two years after the contract offer, farmers will again be asked to fill in the survey. Now we can observe changes in farm management, practices and other outcomes, such as farming income, yields and environmental effects and relate them to the contract implementation.

[3] Please see appendix 4 for an overview of key steps of the Design Thinking methodology

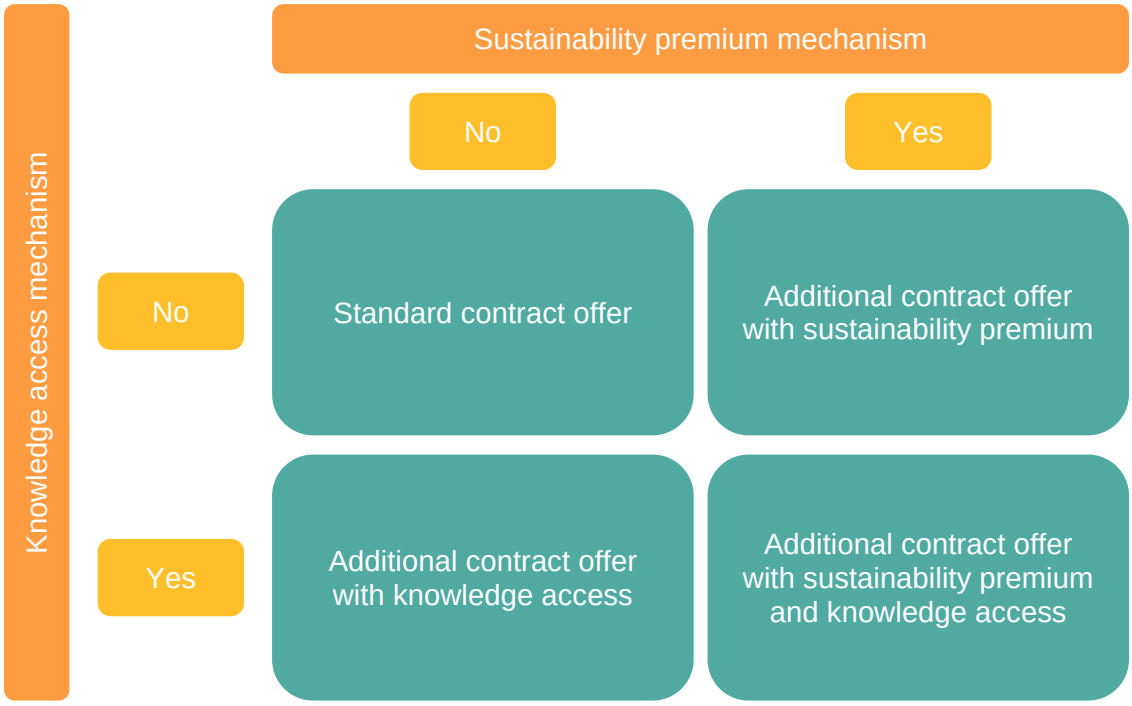
3.3. The experimental protocol: Field experiment

3.3.1 Experimental set up

The experiment is set up as a 2x2 between subject comparison completely conducted in the field. It will be conducted among Casalasco members in Italy. The process of contract offer will be conducted exactly according to current contract offer procedures in Casalasco and will be performed by the same people (Casalasco employees) that already perform the contract negotiations within Casalasco. The aim of this is to keep the procedure as familiar to farmers as possible in order to avoid introducing additional barriers to adoption due to process issues. While farmers are already used to this type of contract negotiation their understanding of the differences will be ensured through explanations and questions during the contract offer procedure.

Who will be offered which of the additional contracts, or none of them, will be determined according to a randomisation procedure. To achieve this, farmers will be randomly assigned to one of the four groups. Figure 3.1 presents an example of how the allocation in the different groups may look like. We will randomise group allocation using the Casalasco member registry.

Figure 3.1: Treatment groups



In order to have every province represented in every group, the sample may be stratified by province. Exact stratification quotas would be determined based on the internal regional organisation and distribution of members of Casalasco. The current status quo contract will be offered to all farmers, either exclusively (control group) or alongside one of the alternative contracts (treatment groups). Depending on the group to which farmers were assigned, they will receive either a contract according to the standard conditions that Barilla and Casalasco have been using in the past years (Barilla Sustainable Farming – BSF contract) or they will additionally receive the

option of a new contractual arrangement. This new contractual arrangement will specify a diversified crop rotation as a requirement to be able to supply under that alternative contract. If they are given the option, farmers will then decide whether to remain in the status quo BSF contract or to accept the new arrangement.

In summary, the differences between the groups will lie: i) in the offer of an additional contract next to the status quo contract (control vs. treatment groups), and ii) in the type of mechanisms that the contract includes (treatment 1 vs. treatment 2 vs. treatment 3) to induce the acceptance of a contract that includes diversification as a requirement. This is also summarized in Table 3.1. These groups form the independent variables of interest. The adoption of CDPs is a concept that has to be further operationalised by defining several outcome variables to be assessed as dependent variables. The outcome variables are likely to include whether or not a nitrogen binding crop or minor crop is included in the rotation at least once every three years on each plot, the extent to which additional CDPs and soil health measures beyond crop rotations are adopted (such as reduced tillage, mulching, use of plant residues), the share of a farm's land on which CDPs are applied, the average length of crop rotations on a farm, or the average number of crops grown on each plot in the last 5 years.

Table 3.1: Overview of example contract types

Contract	Content	Crop diversification	Preliminary
Standard contract	Includes pricing, quality, quantity and timing)	No	No
Contract with sustainability premium	Standard contract plus sustainability premium element	Yes	Yes
Contract with knowledge access	Standard contract plus knowledge access element	Yes	Yes
Contract with sustainability premium and knowledge access	Standard contract with both sustainability premium and knowledge access element	Yes	Yes

The theoretical framework to be used to model this decision, for example an expected utility framework for decision-making under risk, will depend on the identified barrier(s) addressed in the contracts as it will have to model behaviour in relation to that particular issue. It can thus not be determined at this point. All contract offers will take place during the general contract negotiation phase that Casalasco goes through every year, in September and October 2019.

3.3.2 Informed consent

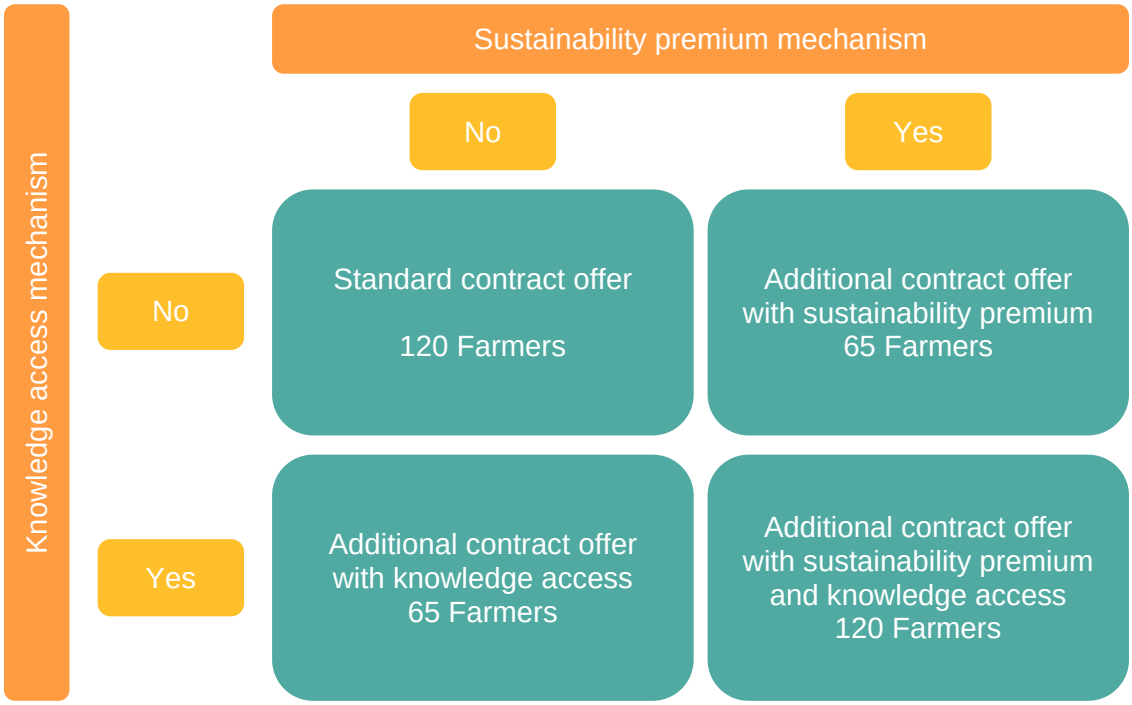
The participants will be informed that they are part of an experiment through the communication channels of Casalasco, e.g. mail or email, before the contract offer. They will also be informed about the existence of a randomisation procedure. Before the contract offer they will have the opportunity to give or deny consent. If farmers do not wish to participate in the experiment, only the status quo contract will be offered. Still, once offered, also all treatment groups will always have the opportunity to reject the additional contract offer and stick to the status quo contract so that experiment participants are in no way disadvantaged over non-participants. Participants will not be rewarded separately for their participation but their payment will be solely through the commercial specifications of the contract chosen. Participants' data will be handled confidentially and according to the guidelines of the Diverfarming project (Appendix 1).

3.3.3 *Treatment effects and sample*

Due to these ethical and feasibility considerations, it will not be possible that farmers only receive the new contract but they will need to have the option to choose to remain within their current arrangement. This means that when comparing average outcomes in control and treatment groups, one measures the average intent-to-treat effect (ITT). When comparing those that accepted a new contract with those that did not from the same or the control group, we estimate the average treatment effect on the treated (ATT). Due to possible self-selection bias in the decision on whether or not to accept a new contractual arrangement and heterogeneous treatment effects, an average treatment effect (ATE) can only be approximated with econometric techniques and under certain assumptions (e.g. selection on observables or parallel trends assumption).

In order to detect a treatment effect, the sample has to be sufficiently large. The sample is limited by the number of members Casalasco has at the time which is approximately 370 farmers. Using the example of including n-fixing crops in the rotation, we can approximate the effect size we will be able to detect given this sample size. Based on a database of BSF farmers, 27% recently used an n-fixing crop as a crop previous to wheat. These crops are often minor crops and we can use this information as a proxy for a diversified rotation. While this variable does not tell us anything about the entire cropping system, it is an indication of the degree to which farmers include minor crops on their fields. Assuming we can include all members of Casalasco in the experiment, a power calculation for a binary outcome variable (diversified crop rotation yes/no) can tell us the size of effect we can expect to detect. Aiming for a statistical power of 80% and a significance level of 5%, and with a sample of 370 farmers, a minimum of approximately an additional 14% of farmers would need to adopt CDPs for that effect to be detectable with statistical significance. Yet, since it is likely that some observations have to be dropped, e.g. due to incomplete data, the effect size will likely need to be somewhat beyond 14% to be detected. An exemplary sample division across treatment groups is shown in Figure 3.2.

Figure 3.2: Exemplary sample division across treatment groups



3.3.4 Challenges and alternatives

While the plan described above is technically feasible, there are some practical challenges that may force changes to the plan to be made. Therefore, this sections outlines alternative approaches in case circumstances do not allow for the above plan to be carried out.

Firstly, it may be challenging to achieve the necessary sample size with Casalasco's members alone. This implies that we may not be able to detect a change in the adoption of CDPs with statistical significance even though the change does exist. In that case, the best alternative would be to increase the sample size by adding another cooperative from Barilla's BSF supply chain. If this is not possible, there is a risk that effects could be too small to measure.

Secondly, as the contract offer will take place in mid-2019 and time needs to be allocated for effects to take place, the endline survey would ideally be three to four years after the contract offer in order to be able to observe a full rotation cycle. Due to the length of the project and delivery dates, this is not possible. While the feasible aim is to observe changes in mid-2021, two years after implementation, when a large part of the rotation and planning for the remainder of the rotation has been completed, this planning also leaves limited time for the collected data to be analysed before the project has to be completed. Should it become clear that the analysis cannot be completed in time, endline data may have to be collected in 2020 instead which would imply that less and less definitive changes may be observed. The clear disadvantage of such an approach is that results may have to be considered more preliminary than if they had been collected after two years.

Lastly, it could happen that participating parties can only agree on one type of contract as the outcome of the contract design phase. This contract could then also draw on several mechanisms rather than just one. As this contract has to be commercially viable, it is in the hands of the negotiating parties to develop contracts they can agree to. Such a combined contract may even have a higher chance of adoption as drawing on different mechanisms may allow for more farmers to accept the contract if farmers face different barriers addressed by different mechanisms. From a scientific perspective, this would mean that no definitive conclusions can be drawn on individual contracting mechanisms but only on the combination of mechanisms included in the contract. Conclusions on the effectiveness of 'contracting for sustainability' in general would still be possible. Indications for the relative effectiveness of different mechanisms could then only be based on farmer's perceptions and opinions on what was most important to them in their decision to adopt CDPs. This approach also implies a higher risk of not finding significant effects of the contract offer as there would only be one possible effect to test.

4. Thematic analysis (line of inquiry 3)

As mentioned new thematic analyses will be encouraged during the duration of the project. The intention is to stimulate researchers involved in WP6 activities to further investigate what are the barriers and potential drivers of diversification, looking at aspects that belong to the local/regional context, or related to a specific stage of the value chain or farming system. Interdisciplinary research activities and case studies will be particularly supported and welcomed. The WP6 coordinator and research team will discuss with Divefarming project coordinator and the involved stakeholder how to support researchers to contribute to thematic analyses from a methodological stand point.

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REFERENCES

Bachev, H. (2012). *Farm diversification and market inclusion in East Europe and Central Asia* (MPRA Paper No. 38683). Retrieved from Munich Personal RePEc Archive website: https://mpra.ub.uni-muenchen.de/38683/

Basch, G., Friedrich, T., Kassam, A., & Gonzalez-Sanchez, E. (2015). Conservation agriculture in Europe. In *Conservation Agriculture* (pp. 357–389). https://doi.org/10.1007/978-3-319-11620-4_15

Bernstein, H. (2014). Food sovereignty via the 'peasant way': A sceptical view. *Journal of Peasant Studies*, *41*(6), 1031–1063.

Blasi, E., Ruini, L., & Monotti, C. (2017). Technologies and new business models to increase sustainability in agro-food value chain: Promote quality and reduce environmental footprint in durum wheat cultivation processes. *Agro Food Industry Hi-Tech*, *28*(6), 52–55.

Borremans, L., Marchand, F., Visser, M., & Wauters, E. (2018). Nurturing agroforestry systems in Flanders: Analysis from an agricultural innovation systems perspective. *Agricultural Systems*, *162*, 205–219. https://doi.org/10.1016/j.agsy.2018.01.004

Carlisle, L. (2016). Factors influencing farmer adoption of soil health practices in the United States: a narrative review. *Agroecology and Sustainable Food Systems*, *40*(6), 583–613. https://doi.org/10.1080/21683565.2016.1156596

Castaneda-Vera, A., & Garrido, A. (2017). Evaluation of risk management tools for stabilising farm income under CAP 2014-2020. *Economia Agraria Y Recursos Naturales*, *17*(1), 3–23. https://doi.org/10.7201/earn.2017.01.01

Di Falco, S., Adinolfi, F., Bozzola, M., & Capitanio, F. (2014). Crop Insurance as a Strategy for Adapting to Climate Change. *Journal of Agricultural Economics*, *65*(2), 485–504. https://doi.org/10.1111/1477-9552.12053

Duru, M., Therond, O., & Fares, M. (2015). Designing agroecological transitions: A review. *Agronomy for Sustainable Development*, *35*(4), 1237–1257.

Eisenhardt, K. M. (1989). Building theories from case study research. Academy of management review, 14(4), 532-550.

Eisenhardt, K. M., & Graebner, M. E. (2007). Theory building from cases: Opportunities and challenges. The Academy of Management Journal, 50(1), 25-32.

FAO. (2018). *CATALYSING DIALOGUE AND COOPERATION TO SCALE UP AGROECOLOGY: OUTCOMES OF THE FAO REGIONAL SEMINARS ON AGROECOLOGY*. Rome.

Gioia, Dennis A., Kevin G. Corley, and Aimee L. Hamilton. "Seeking qualitative rigor in inductive research: Notes on the Gioia methodology." *Organizational research methods* 16.1 (2013): 15-31.

Kassam, A., Friedrich, T., Derpsch, R., & Kienzle, J. (2015). Overview of the Worldwide Spread of Conservation Agriculture. *Field Actions Science Reports [Online]*, *8*. Retrieved from http://factsreports.revues.org/3966

Knowler, D., & Bradshaw, B. (2007). Farmers' adoption of conservation agriculture: A review and synthesis of recent research. *Food Policy*, *32*(1), 25–48. https://doi.org/10.1016/j.foodpol.2006.01.003

Kremen, C., Iles, A., & Bacon, C. (2012). Diversified Farming Systems: An Agroecological, Systems-based Alternative to Modern Industrial Agriculture. *Ecology and Society*, *17*(4). https://doi.org/10.5751/ES-05103-170444

Lahmar, R. (2010). Adoption of conservation agriculture in Europe Lessons of the KASSA project. *Land Use Policy*, *27*(1), 4–10. https://doi.org/10.1016/j.landusepol.2008.02.001

Langley, A. (1999). Strategies for theorizing from process data. *Academy of Management review*, 24(4), 691-710

Le Bail, M., Magrini, M. B., Fares, M., Messean, A., Charlier, A., Charrier, F., & Meynard, J. M. (2014). How to break out the lock-in on crop diversification in France? *11th European IFSA Symposium, Farming Systems Facing Global Challenges: Capacities and Strategies, Proceedings, Berlin, Germany*.

Louah, L., Visser, M., Blaimont, A., & Canniere, C. de. (2017). Barriers to the development of temperate agroforestry as an example of agroecological innovation: Mainly a matter of cognitive lock-in? *Land Use Policy*, *67*, 86–97. https://doi.org/10.1016/j.landusepol.2017.05.001

Magrini, M. B., Anton, M., Cholez, C., Corre-Hellou, G., Duc, G., Jeuffroy, M. H., . . . Walrand, S. (2016). Why are grain-legumes rarely present in cropping systems despite their environmental and nutritional benefits? Analyzing lock-in in the French agrifood system. *Ecological Economics*, *126*, 152–162. https://doi.org/10.1016/j.ecolecon.2016.03.024

Meynard, J.M., Messéan, A., Charlier, A., Charrier, F., Farès, M., Le Bail, M., . . . Réchauchère, O. (2013). *Crop diversification: obstacles and levers. Study of farms and supply chains: Synopsis of the study report*. INRA.

Pretty, J., & Bharucha, Z. P. (2014). Sustainable intensification in agricultural systems. *Annals of Botany*, *114*(8), 1571–1596. https://doi.org/10.1093/aob/mcu205

Reckling, M., Bergkvist, G., Watson, C. A., Stoddard, F. L., Zander, P. M., Walker, R. L., . . . Bachinger, J. (2016). Trade-Offs between Economic and Environmental Impacts of Introducing Legumes into Cropping Systems. *Frontiers in Plant Science*, *7*, 523. https://doi.org/10.3389/fpls.2016.00669

Roest, K. de, Ferrari, P., & Knickel, K. (2018). Specialisation and economies of scale or diversification and economies of scope? Assessing different agricultural development pathways. *Journal of Rural Studies*, *59*, 222–231. https://doi.org/10.1016/j.jrurstud.2017.04.013

Tilman, D., Fargione, J., Wolff, B., D'Antonio, C., Dobson, A., Howarth, R., . . . Swackhamer, D. (2001). Forecasting agriculturally driven global environmental change. *SCIENCE*, *292*(5515), 281–284.

Ton, G., Vellema, W., Desiere, S., Weituschat, S., & D'Haese, M. (2018). Contract farming for improving smallholder incomes: What can we learn from effectiveness studies? *World Development*, *104*, 46–64. https://doi.org/10.1016/j.worlddev.2017.11.015

Van den Broeck, G., Grovas, R. R. P., Maertens, M., Deckers, J., Verhulst, N., & Govaerts, B. (2013). Adoption of Conservation Agriculture in the Mexican Bajío. *Outlook on Agriculture*, *42*(3), 171–178. https://doi.org/10.5367/oa.2013.0136

Vankeerberghen, A., & Stassart, P. M. (2016). The transition to conservation agriculture: an insularization process towards sustainability. *International Journal of Agricultural Sustainability*, *14*(4), 392–407. https://doi.org/10.1080/14735903.2016.1141561

Watson, C. A., Reckling, M., Preissel, S., Bachinger, J., Bergkvist, G., Kuhlman, T., . . . Stoddard, F. L. (2017). Grain Legume Production and Use in European Agricultural Systems. In D. L. Sparks (Ed.), *Advances in Agronomy. Advances in Agronomy, Vol 144* (Vol. 144, pp. 235–303). https://doi.org/10.1016/bs.agron.2017.03.003

APPENDICES

Appendix 1: Data privacy guidelines

This research protocol will follow the data privacy guidelines as specified by the Diverfarming project. The individuals whose personal data is being collected and processed have the right to: i) obtain a copy of their Personal Data being stored by the Participant without undue delay; ii) request that any Personal Data relating to them which is shown to be incomplete or inaccurate be rectified; iii) request that on compelling legitimate grounds processing of their Personal Data should cease; and iv) know the contact details of the Project Coordinator to which the individual should direct requests in relation to their rights above. All Diverfarming participants dealing with personnel data derived from interviews, questionnaires or surveys will record the following elements, which will be always confidential: name and contact details of the Participant Processing Personal Data; description of Personal Data being Processed; and purpose or purposes of Processing of Personal Data. Personal Data shall never be transferred to individuals or organisations outside Diverfarming consortium unless there is an appropriately enforced legal request.

Appendix 2: Draft template of the filed survey for case manager in the qualitative case study analysis

QUESTIONNAIRE FOR FARM LEVEL

TO BE FILLED OUT PREVIOUS TO INTERVIEW	
Date	
Place	
Case study n◦	
Interviewee	
Organisation	
Position/Title	
Interviewer	
Type of diversification applies in case study	

INSTRUCTIONS	1) Please be as specific and detailed as possible when recording an answer. 2) For questions for which no answer options are given, please record the respondent's answer. 3) For questions for which answer options are given, read out all options before the respondent answers. Additional information to explain the answer can be given. 4) Record all answers in this form. If interview is conducted in a language other than English, please provide a translated version to the WP leaders. 5) Text in *cursive* is for the information of the interviewer.

Section 1: Farm characteristics	
Questions	Answers
What crops/products do you produce? *List all products/crops produced on the farm, not just those related to the diversification project.*	
Which crops/products are affected by the new diversification strategy related to the Diverfarming project?	
Do you pursue any other crop diversification strategies not related to Diverfarming? If, so which?	
How much land for crop production do you own? *Indicate unit used.*	
How much additional land do you rent for crop production? *Indicate unit used.*	
How many people work on the farm on average throughout the year?	
Does your farm hold any certifications? If so, for which crops?	
Section 2: Sales and marketing	

Please list every buyer category to whom you have sold in the last year for each crop. Please also categorize the relationship you have with that buyer. *One crop may have more than one buyer. You may add rows if needed.*	Buyer categories: Own sale (e.g. on farmers markets, on-farm store) Cooperative Local buyer (i.e. within region of province) - trader Local buyer - processor National buyer - trader National buyer - processor International buyer - trader International buyer - processor
Crop/product	Buyer(s)
Are there any crops that will become available due to the diversification strategy? Please name them and any plans you may have with regard to their sale.	

	What changes do you observe, expect or plan due to the diversification strategy? *Please specify if changes are observed, expected or planned.*	
	What challenges do you observe or expect in selling your crops/products due to the diversification strategy? *Please specify if changes are observed or expected*.	
	What solutions to these challenges have you considered?	
	Do you know where your buyers in turn intend to sell the (processed) product? If so, please add this information.	Even if no details can be given, information such as "For national retail market" or "Supermarkets" is already helpful. Other examples: Food market (local, national, international) Feed market (local, national, international) Industrial market (local, national, international)
	Crop/Buyer	Intended market

Do you expect or observe any changes to this due to diversification? *Please specify if changes are observed or expected.*	
Section 3: Standards	
This section only concerns the crops affected by diversification, for main and diversification crops (if already known).	
For each buyer, please specify what kind of standards and quality criteria are required and/or desired by this buyer. Please provide this information in detail.	*Examples: certifications, specifications on shape or colour, protein content, particular production processes, seed or variety selection, determination of technologies or machinery, determination of timing (e.g. for seeding or harvesting), provision of information, use of a decision support system, use or avoidance of certain agrochemicals, etc.*
Crop/Buyer	Standards and quality specifications

Do you expect or observe any changes to this due to diversification? Please be specific to which crops these changes apply. *Please specify if changes are observed or expected.*	
Section 4: Input purchases and advice	
What type of inputs did you buy before the implementation of the diversification strategy?	
Where did you purchase these inputs?	
Input	Seller
What changes do you observe, expect or plan due to the diversification strategy? *Please specify if changes are observed, expected or planned.*	
What challenges do you observe or expect in purchasing inputs due to the diversification strategy? *Please specify if changes are observed or expected.*	
What solutions to these challenges have you considered?	

From whom do you receive agronomic advice? Please specify whether advice is received per crop or for the farm as a whole.		
Section 5: Networks and associations		
Are you member of a cooperative or farmer group that sells output?	1 2 - No	- Yes
If yes, please describe all the activities the cooperative/farmer group offers.		
Are you member of a cooperative or farmer group to purchase inputs?	1 2 - No	- Yes
Please describe all the activities the cooperative/farmer group offers.		
Are you member of any farmer group/association to represent farmer interests?	1 2 - No	- Yes
If yes, please describe all the activities the group/association offers.		
Are you member of any farmer group/association to share or distribute knowledge?	1 2 - No	- Yes
If yes, please describe all the activities the group/association offers.		
Are you member of any farmer group/association for any other reason?		

If yes, please describe the reason and all the activities the group/association offers.	
Section 6: Innovation	
Please indicate to which degree you agree with the following statements?	1 - I totally disagree 2 - I somewhat disagree 3 - I somewhat agree 4 - I totally agree
Soil is a living ecosystem that needs to be considered in its entirety.	
Agrochemicals are an essential aspect of my production process that cannot be replaced.	
I need to feel very well informed about a crop before I start growing it.	
Whatever a crop takes from the soil, I can replenish by adding these elements, for example with agrochemicals.	
The benefits of diversification are recognized by my buyers.	
Diversification means I have to change to whom I sell the crops I already grow.	
Diversification means I have to find new buyers for the diversification crop since I cannot sell it to my current buyers.	

	Diversifying the crops I grow will affect my existing sales relationships negatively.	
	I consider crop diversification an innovative practice.	
	I consider the diversification strategy proposed by the Diverfarming project an innovative practice.	
	Crop diversification requires a complete rethinking of my farm management.	
	Crop diversification is just another step towards the farm management that I aim for.	
	I consider crop diversification as a big risk.	
	Ecosystem services are very important to the functioning of my farm.	
	My farm is an ecosystem.	
	Diversification can be a solution to soil degradation.	
	Farmers in my neighbourhood also grow diverse crops.	
	Farmers in my neighbourhood recognise the benefits of crop diversification.	
	Farmers in my neighbourhood believe in the use of agrochemicals.	
	The buyers for my crops are usually found by me, my family or employees.	

	The logistics around the sale of my crops have to change when I implement crop diversification.	
	Not enough research has been done on seed varieties for diversification crops.	
	Not enough research has been done on crop protection for diversification crops.	
	I find it difficult to access information on how to produce diversification crops.	

Appendix 3: Guideline for the co-design engagement with Barilla and Casalasco decision-makers

Job sector interviewed	Typology of information
Representative of the cooperative's farmers	1) Understand how Casalasco deals with the sustainability theme and how farmers are affected by this demand for sustainable productions
	2) What kind of obstacles and opportunities do farmers encounter with diversification (on the farmer's side)
	3) Understand how the crop diversification products could be managed by farmers
Technical field agronomist	1) Understand the strategy / means used to engage with farmers to undertake pursue sustainability
	2) To initiate sustainability (and crop diversification) processes, in your opinion, what are the technical and training obstacles for farmers? (to Cooperative's side)
	3) Understand if and how the crop diversification has modified / can modify the current planning of the "fields"
Marketing & Communication	1) Understand if and why sustainability is a fundamental aspect for large-scale agricultural products
	2) Understand if and how crop diversification can give added value to raw materials (to customers) and to final products (to consumers)
	3) Understand if Casalasco see opportunities for "expansion" in the new products resulting from diversification
Director and other representative figures (manager)	1) Understand the importance and demand of sustainability claims of products to customers and how that is expressed (certification, declaration, traceability ...)
	2) Personal perception of the path of sustainability in the company in a long-term logic and the role crop diversification therein
	3) Understand if Casalasco see opportunities for "expansion" in the new products resulting from diversification
Operations manager/ procurement	1) Understand how Casalasco works with farmers and the influence that Casalasco has on the farmer
	2) Understand how Casalasco organises its procurement process and how that would be affected by farmers' crop diversification
	3) Understand if and how Casalasco supports farmers in the different stages of production of diversification products other than tomatoes

Job sector interviewed	Typology of information
R&D manager (Agronomic side)	1) understand how the path to sustainability, and crop diversification specifically, requires new approaches to company research
	2) understand the issues in transferring new concepts / practices along the supply chain (internally-externally)
Durum wheat, tomato and other raw material for arable crops buyers (only for Italian territory)	1) Understand how the transition to "sustainability" has affected the management of relationships with suppliers and what are the modalities with which this theme is respected (quality standard, traceability, certification..)
	2) Understand how the obtainment of sustainable raw materials can be combined with the qualitative and quantitative needs of the company
	3) Understand Barilla's relationship with its intermediaries and the intermediaries' role in communicating sustainability goals to producers
	4) What are the expected changes to supply chain relationships if crop diversification was implemented?
Marketing & communication	1) Understand what role sustainability plays in Barilla's vision, in terms of marketing, and in specifically for everyday products (such as pasta)
	2) What goals is Barilla pursuing when engaging with the theme of sustainability and engaging in sustainability projects from the marketing perspective? What role does crop diversification play in achieving these goals?
	3) Personal opinion about the market / consumer that will continue to "enhance" the sustainability attribute on the product / company
Other key people involved in sustainability projects	1) The launch of the "challenge" of sustainability as a vision in Barilla and the effects on the pasta supply chain
	2) Understand when and why crop diversification has become central to the path of sustainability
	3) Personal opinion about the sustainability path in Barilla on long term period
Product design manager	1) understand plans on future projects for sustainable products
	2) Understand if Barilla is interested to develop new products from raw materials deriving from crop diversification or using them for existing products

Appendix 4: Example of Design Thinking protocol

1. Introduction

This document synthesizes the activities, the organization and planning regarding the "Design Thinking" – project. The research team is going to coordinate the entire project and all the actors involved in the project itself. In particular the profiles involved in the project are going to be:

- 1 coach, available one day a week for team meetings
- interns and young professionals

Roles: coach

The coach will help the team to develop the projects suggesting the proper tools and methods to use, defining the activities for each meeting, supporting the team in the different phases and helping the team for everything that concerns the methodology.

Roles: 4 interns and/or young professionals

The team of 4 interns/young professionals will work **full time** on the project, in collaboration with the research team and the coach. Their time will be completely dedicated to the development of the challenge using the **Design Thinking** approach. They will be working inside Barilla workspace and they will be available anytime for formal and informal meeting with the research team.

2. Objectives

The main objectives of the DT project and its activities are:

- Develop an innovative product departing from the challenge detected by research team;
- Experiment the application of Design Thinking in the development of a new set of contracts;
- Experiment the methods and the tools of Design Thinking through the collaboration with the interns and the coaches;
- Deliver an innovative set of contracts developed through the experimentation of Design Thinking.

3. Planned activities

In this section are present the main activities that typically are delivered in a Design Thinking approach.

4.1 Activity 1: Definition of the challenge

A) Identification of the project challenge departing from the inputs coming from the stakeholders

B) Formalisation of the challenge in a document defining the following elements: the document will be used as a guidance for the team in the primary phase.

- Background
- Intent Scope
- Target Users
- Research Plan
- Exploration Questions
- Expected Outcome
- Success Metrics
- Project Planning

4.2 Activity 2: Project kick-off

In this activity the enlarged research team will meet to discuss on the challenge and define the following elements:

- Understanding of the challenge;
- Understanding and knowledge of the challenge themes;
- Presentation of the project scheduling and milestones;
- Definition of the modality of interaction among the team members;

4.3 Activity 3: Phase I Need-finding (4 weeks)

This activity has the aim to understand the user and the design space: thanks to a deep dive into the users' world the team will start to frame and reframe the challenge through the eyes of the user itself. These research phase will be characterized by the following activities:

- Review the team's knowledge around the issue;
- collect examples of other attempts to aim the same challenge;

- Identify users needs, desires, problems and frustrations;
- Identify all the stakeholders involved in the space of the challenge.
- Testing of the first assumptions.

4.4 Activity 4: Phase II Abstraction (1 week)

This set of activities aims at synthesizing the previous need-finding phase and identify and abstract which are the learning and the insights discovered during the research. Abstraction phase helps the team to identify the right questions in order to innovate and focus in the most interesting and promising issues.

This abstraction phase will be characterized by the following activities:

- Insights and learnings identifications;
- Personas identification.

4.5 Activity 5: Phase III Prototyping

This activity has the aim to understand more and more the user and the design space through iterative prototyping, in order to get closer and closer to the final solution testing concepts and initial ideas from the first phases of the ideation phase. Through multiple iterations the team will produce a high number of low fidelity to high fidelity prototypes to test and validate the project's assumptions in order to reach the final solution.

This prototyping phase will be characterized by the following activities:

- Ideation and brainstorming;
- Multiple iteration of prototyping and testing.

4.6 Activity 6: Phase IV Solution

In this phase the team will develop the end result as a detailed design solution that integrates desirability, viability and feasibility thanks to the contribution of the different prototypes and user testing activities performed during the process. This phase will be characterized by the following activities:

- Prototyping and testing of the final solution;
- Identification of the final solutions specs.