D3.5 Valorization model for data and digital services

WP3 – Sustainable Collaborative Business Model Innovation

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PLOUTOS

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Definitions, Acronyms and Abbreviations

Acronym/Term	Explanation
CVI	Cost Value of Information
DCF	Discounted Cash Flow
DSS	Decision Support System
EVI	Economic Value of Information
EXPVI	Expected Value of Information
KPI	Key Performance Indicators
MVI	Market value of information
NPV	Net Present Value
ROA	Real Option Analysis
PDO	Protected designation of origin
SIP	Sustainable Innovation Pilot

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Executive summary

Data valorization is becoming more and more relevant, since companies increasingly adopt digital technologies and rely on them to support their business activities for a wide variety of reasons. Research in the field initially concentrated on valorising data to enhance the decision-making processes, but as the phenomenon gained attention, various disciplines began investigating its potential applications in various industries, including marketing, customer engagement, or supply chain and so forth. More generally, the debate shifted from being purely technological to being managerial, with the opportunity to create value through the transformation of data assets being seen as a major challenge. Nonetheless, the enormous quantity of literature regarding the exploitation of data to generate benefits gave rise to several terminologies such as “Big Data Analytics”, “Data Analytics”, and “Business Analytics”, terms that are often improperly used as synonyms, separated elements, or mixed in order to define diverging concepts. Moreover, even if the valorization of data has proven to be a boon to research and a potential engine for businesses to improve their performance and competitive advantage, studies have found that exploiting this phenomenon has both benefits and risks for businesses. In fact, the adoption of Big Data solutions may not always result in tangible benefits for the users. There is a wide range of technologies and techniques for managing and analysing data, but there is still a gap in terms of how to turn extracted data into knowledge that can support effective actions and generate real value. In agriculture and agrifood value chains, as well as in many all industries, businesses and organizations frequently lack a clear vision and a plan for leveraging the data they already have or for acquiring, integrating, and analysing data to change their value proposition. The agricultural sector is often characterised by power disparities that distribute unevenly the value created throughout the supply chain among its participants, now also because of unbalanced data exploitation. For instance, bigger players, especially those downstream such as processors and distributors, are in the position to impose to farmers particular pricing conditions, as well as to shrink their margins thanks to their position of controlling market access (and data access), and can impose different requirements exploiting their market power, which can further limit the value captured by farmers. This uneven distribution might be not only socially unacceptable, but it might also lead to a lower total amount of value created. Besides this, other challenges emerge that pose a threat to farmers and for the entire supply chain, like climate change and rising population. Market power disparities might hinder the ability of the agricultural sector to achieve economic sustainability first of all, and consequently social and environmental sustainability. Data proved to be a key resource to overcome these obstacles, but farmers and agricultural supply chain actors often lack a clear view of the opportunities that data can generate and of the enabling factors behind them and, sometimes, data strategies are devised without assuming a cooperative perspective, further stressing the inequalities between the involved actors.

In this light, a data valorization framework devised to connect the existing elements which have been studied in the literature into an organic structure has been developed, in order to help farmers and agricultural supply chains to understand the actual value of data produced by data-driven sustainable collaborative business models and to provide insights on potential further exploitation of available resources.

The framework (Figure A) is based on four key variables, namely: i) General enablers, the elements that allow farmers and supply chain actors to be aware of the data resources they have available, to devise appropriate strategies and to deploy effective tools to exploit the value of data; ii) Collaborative benefits, the different types of value generated by data throughout the data value chain, which include: traditional benefit; one-step/mutual benefit sharing, two-step benefit sharing; iii) Data value chain, the interrelated processes that allow to extract data’s value throughout its entire lifecycle from data generation to data use and exchange; iv) Scope of the benefits: the impact of the benefit on the companies involved in the value chain: direct monetisation, operational or strategic.

The framework is then applied to all the Sustainable Innovation Pilots (SIPs) to measure the monetary value of data supporting collaborative business models realised thanks to the innovations introduced.

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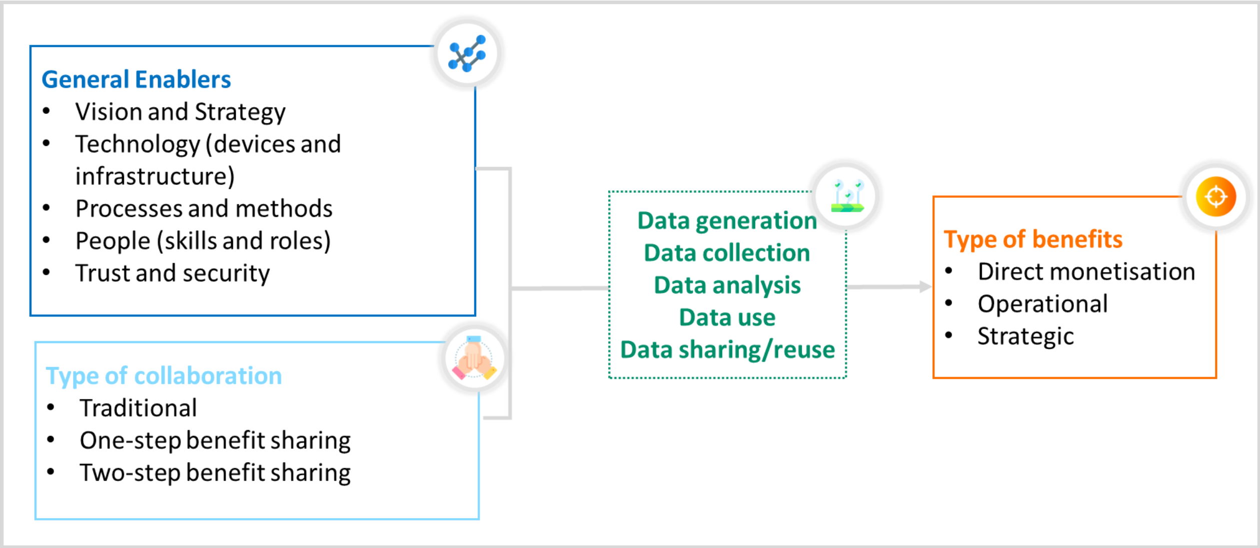

Figure A – Overview of the data valorization framework

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1 Preface

1.1 Project summary

The Ploutos project focuses on rebalancing the value chain for the agri-food system, transforming it into one that works for the benefit of society and the environment. The project has developed a Sustainable Innovation Framework that applies a systemic approach to the agri-food sector, building on three pillars: Behavioural Innovation, Sustainable Collaborative Business Model Innovation and Data-driven Technology Innovation. Exploiting a history of significant agri-food projects and the respective ecosystems around them, the project deploys 11 innovative systemic Sustainable Innovation Pilots (SIPs), where, by adopting a Multi-Actor Approach, innovative solutions and methodologies will be implemented, tested and assessed generating practical learnings. The SIPs cover a large range of agri-food ecosystems, across 13 countries, including arable, horticulture (both open fields and greenhouses), perennials and dairy production among others. In each case, behaviour change, collaborative business modelling and data driven innovation will be integrated to deliver the most environmentally, socially, and economically sustainable solution. Moreover, a Ploutos Innovation Academy has been established as a vehicle for integrating the know-how, best practices and assessments developed across the project and derived from the SIPs. Ploutos includes 33 partners, 22 of them being end-users, representing all relevant actors in the food system, including farmers, food industry companies, scientists, advisors, ICT specialists and policy makers.

1.2 Document scope

The purpose of this task is to quantify and demonstrate the value of data and digital services (ex-ante and ex-post) to support decision making and wider adoption. To that end, we will extend and deploy the POLIMI's Data Valorization[1] Framework to quantify the monetary value generated by data sharing in order to support decision making of digital and data driven services and innovative business models adoption. To do so, key variables such as the number and type of actors involved, as well as the relationships among them, data available, IT instruments used, and the strategy chosen are taken into account to capture the essential characteristics of each case and to enable comparison. Besides this, the main collaborative benefits achieved are measured and assigned a monetary value using common valuation methods like discounted cash flow methodology.

1.3 Document structure

The document is structured as follows:

Chapter 1 presents a summary of the project as well as the document scope and structure.
Chapter 2 introduces the purpose of data valorization and the aim of the task.
Chapter 3 provides an overview of the methodology adopted.
Chapter 4 outlines the data valorization framework.
Chapter 5 presents the analyses of the SIPs.
Chapter 6 contains the conclusions of this report.
Chapter 7 lists the references used throughout this report.

[1] The process of identification and exploitation of information within datasets leading to an effectful creation of value is typically defined as Data Valorization (see section 4.4 for further details).

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2 Introduction

2.1 Context and relevance

The agricultural sector is often characterised by power disparities that distribute unevenly the value created throughout the supply chain among its participants (EC, 2015). For instance, bigger players, especially those downstream such as processors and distributors, can impose to farmers particular pricing conditions, as well as shrink their margins thanks to their position of controlling market access, and are able to impose technological requirements and standards, which can further limit the value captured by farmers (Swinnen, 2020). This uneven distribution might be not only socially unacceptable (Busch and Spiller, 2016), but it might also lead to a lower total amount of value created.

Besides this, other challenges pose a threat to farmers and to the entire supply chain, like climate change and rising population (FAO 2017). Data are one of the instruments that agricultural supply chains can use to generate value and to cope with these challenges. Indeed, data are a key asset for firms and for the supply chain as a whole (e.g., Hartman et al. 2016, Lezoche et al. 2020, Elia et al. 2020) and the farming sector is not an exception (Wolfert et al. 2017). Data can be used to enable a new business model, where revenue generation strategies are fully reliant on data and that would not exist without access to large amounts of data and advanced analytics, or to enhance an existing business, where data are exploited to better coordinate pre-existing business operations, facilitate decision making and introduce new goods and services (Hartman et al. 2016; Ngujen and Paczos, 2020). In either case, social, environmental and economic benefits can be achieved (e.g., Balafoutis et al. 2017; Lezoche et al., 2020; Kamble et al. 2020).

Nonetheless, these benefits might not occur, or might be below their full potential, if, for instance, there is a lack of awareness on data owned and data opportunities or a lack of appropriate technological and organisational elements (Laney 2017). Indeed, farmers, and to a certain extent also other supply chain actors, often do not have a clear vision and strategy on how to leverage the data they have available or knowledge on how to acquire, integrate and analyse data to adapt their value proposition.

Data are, therefore, a part of a more complete process, which can be defined as data value chain (Rayport and Sviokla 1995; Ngujen and Paczos, 2020; Wolfert et al. 2017; Farouki et al. 2020a), where this resource acquires value through different stages and where external factors impact its final outcome. Data valorization models and strategies have been explored in the literature (Hartman et al. 2016; Laney 2017), even for the agricultural sector (Kamble et al. 2020), but a model that captures jointly the drivers of data valorization, the benefits that can be achieved and the realised value in monetary terms looking at data throughout the entire process is still missing.

The value created should be beneficial to the firm pursuing its data strategy. However, if the impact on other supply chain members is not considered, data can be detrimental since the increase in one firm's value might be done at the expenses of others; therefore, data can even lead to an increase of inequality between upstream and downstream actors. For instance, processors might benefit from data coming from the fields for they can better understand the quality of their final products (Lusiantoro et al., 2018) or they can better envision the quantity of raw materials that they will have at disposal and consequently they might act to maximise their profits, like devising procurement strategies that minimise costs and the price paid to the farmers (Lee et al., 2000). The benefits of traceability might be fully reaped by retailers through a data-enhanced product (Cicia and Colantuoni 2010; Violino et al. 2019), while, more broadly, data might enable retailers and processors to further increase their market position and thus their market power with respect to farmers.

One way to cope with this situation is cooperation that has been widely adopted in the agricultural sector. Farmers have joined their forces to cooperatively conduct some tasks, such as storing raw materials and

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transforming them, selling products as a unique entity to increase market power, devising common marketing strategies to have access to a broader set of markets and, finally, sharing the costs of innovation to easily spread it across all participants. Cooperation enables actors to jointly maximise common interests, thus enabling a more even distribution of benefits and costs.

Data too can be part of a collaborative/cooperative process, being collected, pooled and then exploited to maximise the value created for all the actors involved. It can potentially lead to efficiencies related to the abatement of transaction costs, to the establishment of long-term partnerships based on transparency and to an increase in product quality (Lusiantoro et al., 2018). Nonetheless, the evidence on this topic is still limited and uncertain (Kembro and Naslund, 2014), while applications in the agricultural settings are mostly theoretical without practical sound cases.

2.2 Data valorization in Ploutos

Market power disparities might hinder the ability of the agricultural sector to achieve social, environmental and economic sustainability. Data proved to be a key resource to pursue these objectives, nonetheless farmers and agricultural supply chain actors often lack a clear view of the opportunities that data can generate and of the enabling factors behind them and, whenever present, data strategies devised without assuming a cooperative perspective might further stress inequalities (Renga and Bacchetti, 2018).

This is where this task 3.3 steps in. Since Ploutos aims at devising data-driven collaborative business models that can create value not only for the single farm, but for the whole agricultural supply chain, the objective of this task is to create a tool to quantify and demonstrate the value of data and digital services that makes farmers aware that data can be a key resource that can be shared and used to generate value.

This task finds its place within the whole Ploutos project providing insights on how innovative data-driven technologies can enable the generation of value (WP4) and how behavioural change might sustain collaboration (WP2).

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3 Methodology

In order to help farmers and agricultural supply chains as a whole to understand the actual value of data produced by data-driven sustainable collaborative business models and to provide insights on potential further exploitation of available resources, a data valorization framework is devised following these three steps:

- Literature review: to capitalise existing knowledge and propose an original contribution
- Framework development: to devise a framework which can be applied in practice
- Application to pilot cases: to test whether the framework is effective and could be generalised

The analysis of the literature consisted of two phases. First, we searched for papers on “data valorization”, “data monetisation” and “data business model” relying on the Scopus and Google Scholar academic databases. The preliminary exploration highlighted that:

- the theme of data valorization and data monetisation is not only dealt in the academic literature, but also in the grey literature, mainly linked to consultancy firms;
- data monetisation and data valorization entail several dimensions, which deserve vertical inquiries.

Based on the first evidences in literature, the second phase of the literature review is thus a refinement of the first one. On the one hand, the sources have been widened, considering also online queries with common search engines and including in the review also books and professional reports, on the other hand, several specific keywords have been introduced, namely:

- Enablers: (“enablers”, “drivers”; “forces”; “enabling factors”)
- Data value chain: (“data value chain”; “value chain”)
- Benefits: (“benefits”; “outcomes”; “value”)
- Methods: (“Monetary value”; “calculation”; “monetisation”; “quantify”; “quantification”)

Besides this, domain specific keywords have been used relative to Agriculture (“agriculture”; “farming”; “farmers”) and Cooperatives (“supply chain”; “cooperation”; “sharing”).

Through the literature review, each domain which has been analysed, namely enablers, data value chain, benefits and methods, is now characterised by a series of elements that explore the argument. Each group of arguments is connected to each other to form the basic structure of the framework which is devised indeed to connect the existing elements which have already been studied in the literature into an organic framework.

Once the overall structure of the framework is devised, the relevant information for each dominion is integrated and synthetised to draw the main elements which characterise the various parts of the framework.
The focus of the framework is on the agricultural sector, and specifically on farmers, however it includes also supply chain benefits derived from cooperation and coopetition.

The framework defined has been applied to the 11 Sustainable Innovation Pilots (SIPs) both to validate its structure and to measure the monetary value of collaborative benefits based on data valorization obtained thanks to the innovations introduced (see Section 5 for details).

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4 Data valorization framework

In this chapter we present the data valorization framework developed within Ploutos together with literature supporting the different choices. The data valorization framework developed is based on four key variables:

- **General enablers**: the elements that allow farmers and supply chain actors to be aware of the data resources they have available, to devise appropriate strategies and to deploy effective tools to exploit the value of data. In particular, five enablers have been included in the framework: *i)* vision and strategy, *ii)* digital technology, *iii)* processes and methods, *iv)* people, *v)* trust and security (see section 4.1);
- **Collaborative benefits**: the different types of value generated by data throughout the data value chain, which include: *i)* traditional supply-customer interaction, *ii)* one-step benefit sharing, and *iii)* two-step benefit sharing (section 4.2);
- **Data value chain**: the interrelated processes that allow to extract data's value throughout its entire lifecycle from data generation to data use and exchange (section 4.3);
- **Scope of the benefits**: the impact of the benefit on the companies involved in the value chain: direct monetisation, operational or strategic (section 4.4).

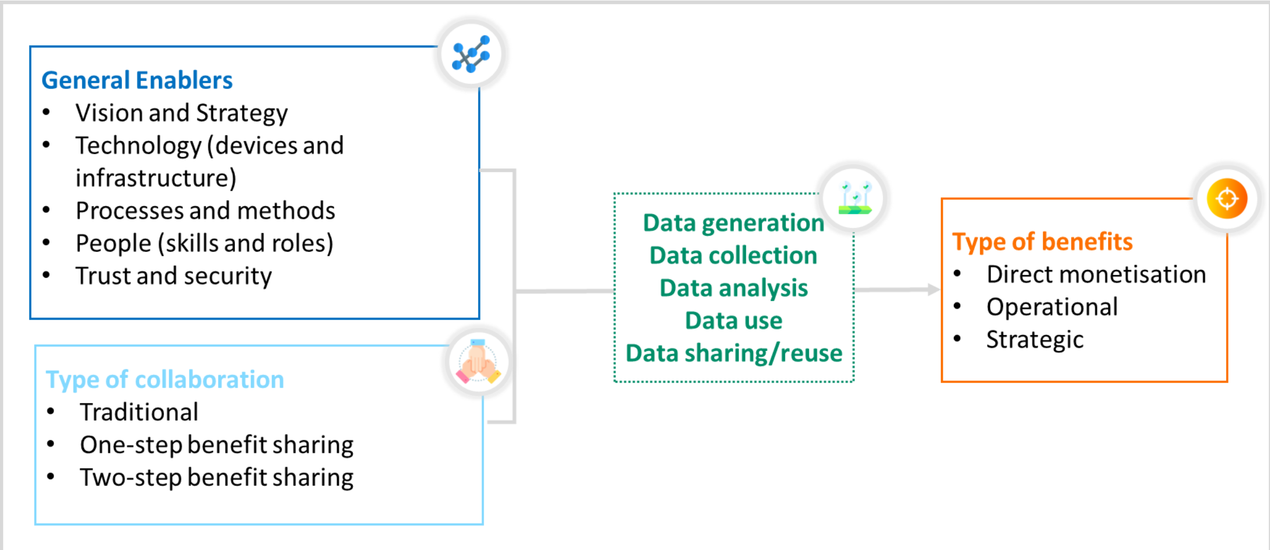

Figure 1 – Overview of the data valorization framework

4.1 General enablers

Data enablers can be considered as the characteristics, besides data, that influence the generation of value in a data value chain. Laney (2017) proposes seven dimensions that influence the management of information as an asset within a company:

- *Vision*: how well the business goals that support the data valorization strategy are defined;
- *Strategy*: the long-term or ongoing plan for realizing this information vision;
- *Metrics*: the way in which the firm expresses benefits and the value of information;
- *Governance*: the way policies are managed and responsibilities are assigned;
- *People*: human resources;
- *Process*: how data are used and are available
- *Infrastructure*: a range of information-related technologies used throughout the organization

Zhang et al. (2019), instead, synthetise several digital maturity models in the academic and professional literature and devise a model specific for the agricultural sector. The dimensions explored are:

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- *Strategy and culture*: priorities towards digitally transforming the business and enabling environment promoted by the agribusiness and its industry;
- *Technology*: digital infrastructures;
- *Data & Analytics*: collection and use of data, analytical tools supporting data-driven decision making and data interoperability across the supply chain;
- *Capability*: knowledge, skills and abilities;
- *Data Rules*: data management and sharing.

Ylijoki and Porras (2018) focus on three main enabling factors in a data value chain:

- *Technology*;
- *Skills and capabilities*;
- *Organisation*.

Finally, Berndtsson et al. (2018) identifies five dimensions that influence the generation of values:

- *Management;*
- *Data;*
- *Tools;*
- *Organisation;*
- *Decision process.*

There are some common elements among these views: for instance, technology, skills and organisation are shared in all three souces. Organisation can encompass also strategy and vision, however it is more useful to keep them separated and highlight each single enabler in the data value chain. Digital technology can be further divided to capture the more operational part directly interacting with data (Zhang et al., 2019) - and the digital infrastructure can be understood as the physical resources – such as broadband and mobile communications – that are needed to enable the use of data and computerised devices/systems. Finally, metrics is for sure a crucial element to valorise data, however the framework itself can be used as a metric by the farm or the supply chain to assess the value generated by data.

Enabling factors are crucial both as a key element that influences the outcomes of a data value chain and as an important background information to identify the potential for actual data valorization, as well as to provide guidelines to interpret the current situation and the future development direction. Following the categorisation introduced in this Chapter and reported in the literature (Table 1 - List of enabling factors used in the framework and their link to referenced models), the enablers included in the framework are:

- **Vision & Strategy**;
- **Digital technology**;
- **Processes and methods**;
- **People;**
- **Trust & Security.**

Laney 2017	Zhang et al. 2019	Ylijoki and Porras 2018	Berndtsson et al. 2018	Ploutos's Data valorization model
Vision	---	Organisation	Management	Vision
Strategy	Strategy and culture	Organisation	Decision Process	Strategy
Metrics	Data & Analytics	---	Data	---

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Governance	Data rules	Organisation	Organisation	Processes and methods
People	Capability	Skills and capabilities	Management / Change management	People
Process	Data rules		Data	Processes and methods
Infrastructure	Technology	Technology	Tools	Digital technology
Infrastructure	Data & Analytics	Technology	Tools	Data value chain stage specific technologies

Table 1 - List of enabling factors used in the framework and their link to referenced models

4.1.1 Vision & Strategy

With the term vision we refer to the way in which the farmers, or the supply chain actors, think about the role of data in their environment, in other terms how they envision the potential of the information they deal with to generate economic, environmental and social value. This element is crucial, and it is the first element to be considered within the framework. In fact, a farm will not implement any strategy to create value from data if it does not think that data is useful and part of its business environment.

In the agricultural sector, farmers are progressively aware that data will be more and more fundamental for their activities since they can produce huge benefits both from an economic and environmental perspective, for instance by optimising production inputs (Renga and Bacchetti, 2018). Nonetheless, farmers might not be aware that data might also help their food processing company partner to better plan their production schedules and thus gain efficiencies, which in turn will result in higher prices or long-term purchasing contracts for the farmers themselves. Clearly, farmers will not share his data with the rest of the supply chain if the role of data is not recognised along the whole supply chain, or they will not collect relevant data. Similarly, they will not gather data that can be sold if they do not think that there is an interesting market opportunity to exploit. Of course, vision is not fixed and immutable, but it might change with proper behavioural interventions. Moreover, both the farm-specific vision and the supply chain vision must be considered to make sure there are no misalignments.

Once the vision is defined, farmers and supply chain actors must define a clear strategy to pursue their objectives, i.e., they have to define the actions that will be taken to pursue their vision and how data will be used. A well-defined strategy allows to determine which data will be exploited by either direct use or exchange with other actors, as well as to identify the resources around the firm and within the supply chain that can support data valorization in the long term. Examples of resources are infrastructures, people with their skills and their roles, and the culture that permeates their action. Strategy can be defined at the farm level and at the supply chain level as well, therefore both types of information should be gathered. Strategy is fundamental to turn what has been indicated in the vision into actionable activities and to actually transform data and information into value. Without a clear data strategy which is aligned with the business strategy all the actors risk to miss opportunities and underuse actual resources.

4.1.2 Digital technology

Digital technologies are a crucial factor that enables data to support the interaction among the component of the value chain. This enabler can be further decomposed into two elements:

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- Devices/systems: a combination of software and hardware components that allows to data generate, collect, analyse, exchange and use data (e.g. Internet of Things or Data analytics);
- Infrastructure: the physical and software resources that are needed to support the functionality of digital systems (e.g., connectivity and interoperability or blockchain and distributed ledgers).

Technologies vary based on the specific stage of the data value chain. For instance, technologies like sensors are specifically designed to collect and record data in the field, while RFId[2] tags are used to track data during distribution and storage. Examples of technologies available for each stage of the value chain are reported in Table 3 - Components of a data value chain based on the categorisation from the Smart AgriFood Observatory (2021) and Balafoutis et al. (2017).

Data generation	Data collection	Data analysis	Data use	Data exchange
Global navigation satellite system (GNSS)	Farm Management Information Systems (FMIS)	Decision Support Systems (DSS)	Actuators (for instance, variable rate technologies)	Farm Management Information Systems (FMIS)
Sensors (weather stations, soil moisture sensors, thermal, multi and hyperspectral cameras, …)	Cloud	Data mining and analytics		Cloud
Satellite images	Sensors			External physical devices (like USB sticks)
	Blockchain			Blockchain

Table 2 - Examples of technologies available for each stage of the data value chain.

To fully deploy the potential of digital technologies in agriculture (and data, consequently), some conditions based on the paradigm of Agriculture 4.0 solutions (Sponchioni et al., 2019) should be met. For instance, connectivity is crucial to enable the correct flow of data towards the parts where they are most needed. In fact, if there is no connectivity, data cannot be collected from external sources, or it becomes harder and more costly to acquire, register and then use data. For instance, a network infrastructure in a field that enables data from IoT devices to flow seamlessly to a Decision Support System available to the farmer and then to a precision irrigation system that bases its actions on the data collected would be impossible, or at least difficult, without a proper connectivity, implying manual registration and transfer.

Interoperability, which can be defined as the ability of ITC systems to share data, information and services, is another key supporting tool: it enables data synergies and thus an increase in the value of data available thanks to the possibility of using data in different environments and for different purposes. This reduces the costs of data transfer and make data monetisation easier.

4.1.3 Processes and methods

One of the elements which can help farmers and supply chain actors to effectively gather and manage data is the definition of appropriate processes and methods. This also includes the definition of standards for

[2] Radio-frequency identification.

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managing and using data, which can ease the costs needed to interpret, clean and adjust data to make them usable in another way.

Procedures also avoid mistakes and funnel efforts and competencies towards those activities which might better support the role of data, either by making data suitable to processes that are involved or by providing insights to other business lines.

Processes and methods should be devised as to fit into the firm's activities to ease the process of data monetisation rather than providing obstacles and difficulties.

Procedures and mechanisms might also influence the outcome of data monetisation, as they might be imposed by the data provider, being therefore more aligned to their goals, or they can be devised jointly to maximise a common goal. Procedure setting is thus crucial to drive the results and opportunities of data monetisation.

Finally, the quality of the processes and methods, the features and quality of data sources, the data analytics capacity and capabilities of the actors involved in collecting and processing data, and the availability of the data infrastructure are all factors that influence the data monetisation outcomes.

4.1.4 People

Data monetisation cannot be solely pursued by technologies, in fact people are needed to set priorities and translate instruments and results into actionable activities which can be useful for the business and for the society.

People should have the appropriate skills to manage the whole data value chain to cover each link by competent people. Skills are evolving and companies need to clearly assess what are the skills that they need and fill the gap to derive the best out of data monetisation.

The importance of top-level management in adopting a plan for establishing a data-driven culture cannot be overstated, otherwise the project will become mired in the organization's mind. It can be particularly difficult for middle management to adopt a data-driven decision-making methodology. Management could develop resistance to advanced analytics (since the results achieved by the algorithmic approach could challenge the skills, and hence the salaries, of the employees) and have excessive high expectations of analytics results. For this reason, top management must actively participate in talks about why establishing a data-driven culture is critical for the organization.

Berndtsson (2018) states that a supporting factor in the journey to help people adopt a data-driven culture is change management: this element can be defined as the use of structured methods and concepts to encourage people, organizations, and companies to accept change. Implementing a data-driven culture necessitates cultural change, which is difficult because even if all the necessary components are in place, there is no assurance that employees will adopt a data-driven culture. This is because individuals are complicated beings with a variety of requirements, desires, and incitements. People's actions and thoughts are influenced by their cultural heritage and experiences, as well as the corporate culture in which they work. It is critical that employees (including management) understand how a data-driven culture may enhance their working conditions, contribute to higher performance, and possibly increase their pay. As a result, change management encompasses all the previously mentioned enablers (as analysed in Work Package 2). Finally, adequate roles might enable processes to run smoothly and thus to run data monetisation to obtain valuable results.

4.1.5 Trust & Security

The benefits of data monetisation within enterprises are frequently hampered by privacy concerns. The data utilised frequently involve personal data, or information that was obtained with an individual's agreement

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for a certain reason but was ultimately used for another. Combining personal data with other sources of data can pose several ethical and legal challenges, including the risk of disclosing or leaking private information about the person (such as their medical records, financial condition, embarrassing behaviour, and familial relationships). The fact that many organizations are not transparent about how they use their customer data makes the issue considerably more complicated. To prevent ethical or legal disputes and to guarantee customer support for data valorization projects, privacy protection is essential as personal and sensitive information becomes more exposed in the age of big data. To help people maintain control over their data and prevent privacy and security mishaps, several behavioural solutions are put forth. The ability of individuals to define data expiration dates, the right to remove their historical data, and the right to own information about their social connections are some examples of proposed solutions in this area. The development and acceptance of laws that formalize these concepts may be necessary to consolidate these procedures. These laws and regulations will not only safeguard consumer privacy but also encourage people to share their personal data in a way that benefits both customers and the businesses that will use it to enhance performance.

4.2 Collaborative Benefits

The value generated by data can be identified in several forms. First of all, data can be turned into information. Information is data with relevance and purpose, can be articulated and easily transmitted across parties (Lusiantoro, 2018). The value of information can be determined by assessing its contribution to decision making. Lezoche et al. (2020) focus on the distinction between economic, social, and environmental benefits. Kamble et al. (2020) introduce a category called "business impact", which captures the elements that affect the business of the single farm. Some authors, like Balafoutis et al. (2017), focus specifically on the economic benefits that the application of data driven technologies to agriculture can yield. Other categorisations which stress the way in which the final outcome is produced rather than the benefit itself have been proposed too. For instance, according to Elia et al. (2020), the value generated by data, which they call "directions of value creation", can be divided into: *i)* informational value, where data turn into information supporting decision making and knowledge discovery; *ii)* transactional value, where value influence firm's transactions determining revenue growth and cost reduction; *iii)* transformational value, where data influence the transformation of the whole company structure; *iv)* strategic value, where data influence strategic actions related to market positioning and competitive advantage, and finally *v)* infrastructural value, where, thanks to data, infrastructures are improved and optimised (for instance, decentralized certifications exploiting blockchain).

The value generated can benefit a single entity or many actors within the supply chain (e.g., Lusiantoro et al. 2018). Moreover, the data value chain can be established entirely within a single firm or can benefit from the presence of collaborative activities, therefore extending the scope of the generated advantages. In the Ploutos Data Valorization Framework, collaborative benefits can be achieved through the collaboration of two or more companies in three different ways:

- traditional supply-customer interaction;
- one-step benefit sharing;
- two-step benefit sharing.

In the case of *"traditional supply-customer interaction"* (see Figure 2), Actor 1 shares data with Actor 2 willingly or as a result of a legal obligation and the transaction is made for free or entails some remuneration or compensation. Both Actor 1 and Actor 2 have individual benefits from this interaction/transaction (Benefit 1 and Benefit 2), but the collaboration is limited to the two (or more) actors and the exchange can be occasional.

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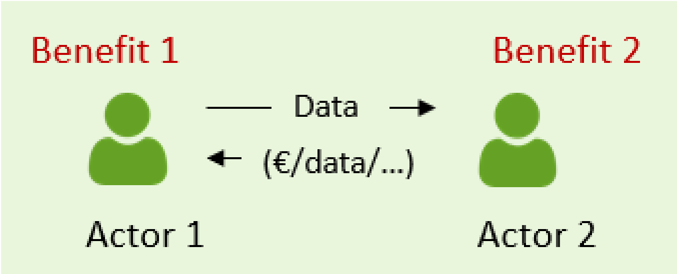

Figure 2 - Traditional supply-customer interaction

For example, a scenario where farmers generate carbon credits and proceed to sell them to third parties can be considered a traditional supply-customer interaction. In this way, farmers receive an individual economic benefit (i.e., additional revenues from the sale of carbon credits), while the other party also benefit from balancing its carbon footprint. A second example is provided by the scenario in which farmers improve their efficiency thanks to the use of a Decision Support System (DSS) developed by a technology provider. The technology provider receives revenues from the use of its software (for example through subscription or sale) and is able to refine the latter thanks to the data collected by the farmers. Farmers, on the other side, can become more efficient by reducing their inputs (thereby improving their sustainable practices) and increase their output. Finally, the same type of interaction occurs when farmers' collected data is used to subscribe a parametric insurance with an insurance company to cover their losses caused by unmanageable events which, for example, might prevent them from meeting the requirements agreed in their contracts with their customers. While it is true that the benefits are only achieved thanks to the sharing of data with the insurance company, the actors enjoy different and individual benefits, the interaction is occasional and thus no collaboration is in place. For this reason, the benefits are achieved through a traditional supply-customer interaction.

The second type of collaboration, namely "*one-step benefit sharing*" (mutual), is shown in Figure 3. Actor 1 and Actor 2 share data with each other creating at least a pair of benefits for both actors (αBenefit 1 and γBenefit 1) that are equal in nature for the two actors even though the magnitude (not the benefit nor the actor) might be different depending on the resources and competences of each actor. A collaboration needs to be in place for the benefits to be generated.

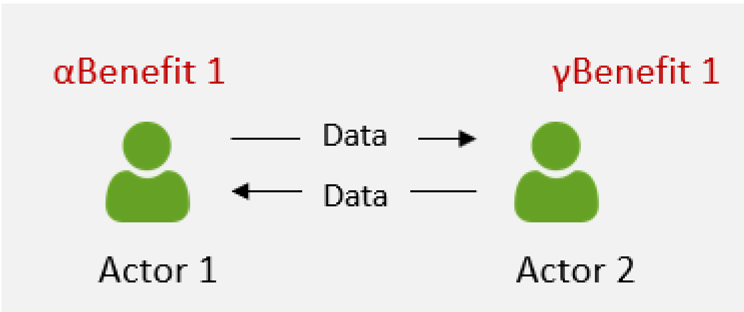

Figure 3 - One-step benefit sharing

An example of "*one-step benefit sharing*" is represented by the scenario in which there are two main parties involved: the farmers and the farmers' cooperative. Farmers' collected data is shared between the two parties so that the cooperative can produces KPIs to benchmark the farmers and lead them to adopt more virtuous practices. Additionally, the higher the number of collaborating farmers, the greater the amount of data will be collected, which will further improve the optimization of farming practices through KPIs benchmarking. A second example is the case in which farmers share their harvest data to align more efficiently the logistics with the procedures of the intermediaries involved in the transfer, storage, and distribution of the farmers' products to the end user. In these examples, a collaboration needs to be in place to exploit the benefits that are mostly (if not entirely) achieved through the sharing of data between actors.

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Two real examples already in place have been presented during the Ploutos plenary meeting held on 4th and 5th of October 2022: Grana Padano and GS1.

In the case "*two-step benefit sharing"* (Figure 4), Actor 1 shares data with Actor 2 willingly or as a result of a *de jure* or *de facto* obligation. Both Actor 1 and Actor 2 have immediate benefits (Benefit 1 and Benefit 2) that are diverse in nature. This situation might look like the normal data sharing except that Actor 2 has some legal, contractual or factual obligation to share part of the additional benefit (αBenefit 3) they generate over the years with Actor 1. Collaboration is a key element of this type of data sharing.

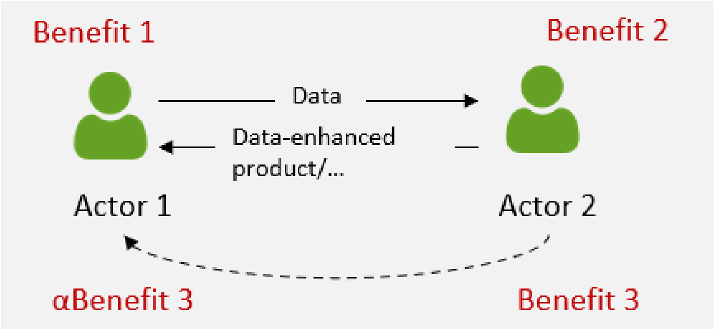

Figure 4 - Two-step benefit sharing

An example of "*two-step benefit sharing*" is represented by the scenario in which the farmers and the end costumers collaborate through one or more intermediaries (for example, an e-platform provided by a third party). Customers co-design products by sharing their preferred characteristics with the farmers, that in return will deliver an enhanced product for the end users. This could not be achieved without the trust developed through the sharing of data with the customers that guarantees complete transparency on the processes, practices and methodologies adopted by farmers from farm to fork. In this way, thanks to the sharing of data, customers are completely informed about the realization process and the characteristics of the products. A final example is provided by the case in which farmers collect and share data across the various actors in the supply chain (through, for example, a traceability service) to prove the quality of their products to secure certifications and sustainability related labels. In this way, farmers can certify the superior quality of their enhanced products to the certification body, hence making them able to charge a premium price to the end users. The benefits from the sharing of data are not limited to the farmers but distributed across the supply chain: a retailer could use the enhanced quality of the product to penetrate new markets or increase customers' satisfaction.

4.3 Data value chain

The Data Value Chain is a model that describes the series of processes needed to generate value and useful insights from data, which are seen as a raw material and a major resource in the business (Faroukhi et al., 2020). Several categorisations of the data value chain are found in the literature, for instance, Rayport and Sviokla (1995) divide its phases into five steps, that are *gather*, *organise*, *select*, *synthetise and distribute*; Ngujen and Paczos (2020) focus instead on four stages, that is *data collection*, *data aggregation*, *data analysis* and *data use and monetisation*, where data storage underlies all of them. Wolfert et al. (2017) increase the granularity of the analysis introducing six dimensions, namely *data capture*, *data storage*, *data transfer*, *data transformation*, *data analytics* and *data marketing*. Finally, Faroukhi et al. (2020a) along the same lines define six dimensions, that are *data generation*, *data acquisition*, *data pre-processing*, *data analysis*, *data visualisation* and *data exposition*, where data storage, in this case too, underlies all of them.

Some common aspects emerge from this review: first of all, data should be created and therefore come into existence; then, the value from data should be somehow *captured* by any of the actors within the value chain. Once data have been captured, they should be processed and refined and finally it can be used or transferred.

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The distinction between data analysis and data collection is blurred, however, following Faroukhi et al. (2020b), the latter precedes data analysis as it comprises all the necessary activities, like organisation, selection and pre-processing, to prepare data for their analysis. Finally, since the focus of the framework is not only the single farm, but also on supply chain benefits, data use and data exchange are separated to highlight their different role in creating value. For instance, a farmer might *generate* and *collect* data from their fields, then these data are *given* to a Cooperative that *analyses* them and *use* them to better plan the production or to provide traceability-enhanced products to consumers. The Cooperative might also *analyse* data to produce a benchmark that is then *given* back to farmers who use it to guide and optimise their activities.

The data value chain dimensions that are used in the model are thus:

- *Data generation*: data come into existence.
- *Data collection*: data are collected validated and stored.
- *Data analysis*: data are analysed to extract valuable insights, which can support the decision-making process and, more broadly, yield some results.
- *Data exchange*: data are given to some third parties either just after data collection (in this case it is the receiver who analyses data), or after data analysis. Data can be used solely by the receiver or can be given back, analysed, to the sender.
- *Data use*: data is used to generate value.

Components	Reference	Data valorization model
Data generation	Faroukhi et al., 2020a	Data generation
Data collection / Data gathering	Rayport And Sviokla, 1995; Ngujen and Paczos, 2020; Wolfert et al., 2017; Faroukhi et al., 2020a	Data collection
Data organisation	Rayport And Sviokla, 1995	Data collection
Data selection	Rayport And Sviokla, 1995	Data collection
Data pre-processing	Faroukhi et al., 2020a; Miller et al., 2013	Data collection
Data aggregation	Ngujen and Paczos, 2020; Miller et al., 2013	Data collection
Data storage	Ngujen and Paczos, 2020; Wolfert et al., 2017; Faroukhi et al., 2020a; Miller et al., 2013	Data collection
Data transformation	Wolfert et al., 2017; Miller et al., 2013	Data Analysis
Data synthesis / Data analysis	Rayport And Sviokla, 1995; Ngujen and Paczos, 2020; Wolfert et al., 2017; Faroukhi et al., 2020a; Miller et al., 2013	Data Analysis
Data distribution / Data transfer	Rayport And Sviokla, 1995; Wolfert et al., 2017; Faroukhi et al., 2020a; Miller et al., 2013	Data use / exchange
Data monetisation	Ngujen and Paczos, 2020	Data use / exchange
Data marketing	Wolfert et al., 2017; Miller et al., 2013	Data use / exchange

Table 3 - Components of a data value chain

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4.4 Scope of the Benefits

The analysis has been focused on the benefits obtained, mainly economic. To evaluate the benefits are further divided into direct, operational and strategic. The direct and operational benefits capture more immediate and short-term benefits, while strategic benefits are more complex and long-term in nature. Some examples of operational benefits are the increase of the income channelled towards the poorest farmers or the reduction in injuries at work, the reduction in the emissions of pollutants and the increase in the quantity produced. Strategic benefits are instead those benefits that influence the strategy of the actor of the value chain, for instance, a better market positioning in the long term or the creation of a new business model.

All benefits are clearly intertwined. For instance, reducing the use of agrochemicals has both economic and environmental impacts. It leads to an economic impact because fewer resources are used, and costs are saved, and an environmental impact because fewer pollutants are released into the environment. However, since environmental and social benefits might be difficult to express in economic terms, or are lagging effects, as well as in terms of their impact on profits, and thus be hard to compare to the costs necessary to obtain these results, since these benefits might influence other stakeholders, external to the farm and its supply chain, then focusing only on the economic benefits allows to achieve a higher level of detail and to better help decision making in comparing the pros and cons on investing in digital solutions and reframing the business model. Social and environmental benefits must be considered to fully account for sustainability, however reducing them to an economic value is beyond the scope of this activity and this framework. Direct and operational benefits are therefore analysed through the lens of the data monetisation approach where economic benefits generated by a data value chain are given a monetary value. This enables a more effective comparison with the costs needed to pursue the valorization activities as well as the impact on the income.

According to Najjar and Kettinger (2013), data monetisation is when the intangible value of data is converted into real value for instance by selling raw data to a third party or by bartering them to achieve a non-monetary benefit. According to Laney (2017) this can be also defined as a process of direct data monetisation, leading to our definition of direct benefits. Where operational benefits are considered, data are used to improve internally a process or a product in a way that results in measurable monetary outcomes, such as income growth or cost savings. This is sometimes referred in the literature as indirect data monetisation (Laney 2017).

The transformation of data into profit can take place in two ways consistent with the definition of profit: (i) increase in revenues and / or (ii) optimization of costs. In the first case, the data enable the creation of new products and services aimed at satisfying the needs of consumers that Big Data managed to intercept. In the second case, data increases the level of transparency of internal business processes, favouring cost optimization and reducing frictions that undermine the level of efficiency of business activities.

Data valorization, however, consists in transforming data into value. This does not mean that the use of data is limited to economic benefits, but also, for example, to discover new knowledge (Elia et al. 2020), enable new value proposition (Lezoche et al. 2020) and competitive differentiation (Mikalef 2018). Finally, from the review of the literature, data valorization can be defined as the transformation process of data through which techniques, technologies, systems, practices, methodologies, and applications are employed to collect, store, retrieve, and analyse complex and unstructured huge amount of several varieties of high–velocity data to generate different businesses' benefits such as operations optimization, forecasting outcomes, improving efficiency, making better decisions, innovating new products and services, capturing new market opportunities and gain strategic competitive advantage against competitors.

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The remainder of the sections explains in detail all the benefits considered. These are not only derived from the literature, but also from the interactions of the Smart AgriFood Observatory[3] with farmers, processing companies, technology providers and farmers' associations during its research activities.

As an example, Table 4 provides and overview of some of the different contributions in literature regarding the type of the benefits obtained though data valorization.

Type of benefit	Detailed benefit	Reference
Market positioning	Enable competitive differentiation	Laney 2017; La Valle et al., 2011; Kiron and Shockley 2011
	Enable new value proposition	Lezoche et al. 2020; Elia et al. 2020; A. Urbinati, et al. 2017
	Favour new products/services/markets	Laney 2017; Lezoche et al. 2020; Furtado et al., 2017
	Increase Market responsiveness	Lusiantoro et al. 2018; Elia et al. 2020; Braganza et al. 2017; Wang & Hajli, 2017
Customer relationship	Increase customer acquisition/retention	Laney 2017; Manyika, Chui, and Brown 2011
	Increase customer loyalty & satisfaction	Lusiantoro et al. 2018; Elia et al. 2020; Lezoche et al. 2020
Information and capabilities	Knowledge discovery	Elia et al. 2020
	Skills development	Elia et al. 2020
	Decision making support	Lusiantoro et al. 2018; Elia et al. 2020
Supply chain	Shifts in roles and power relationships	Lezoche et al. 2020
	Build and solidify partner relationships	Lusiantoro et al. 2018; Laney 2017
	Reduce information asymmetries among stakeholders	Lezoche et al. 2020
	Increase trust	Lusiantoro et al. 2018
	Increase visibility	Lusiantoro et al. 2018
	Increase flexibility	Rialti et al. 2019

Table 4 - Synoptical view of benefits in literature obtained though data valorization

4.4.1 Direct benefits

Data (or access- to data-stream) can be directly sold to a third party, which in turn can then use them to provide a service. An example is provided by companies selling locally-collected climatic data which are used to optimise algorithms, or data on yields.

Data can also be directly monetised without the exchange of money through bartering. This form of data monetisation applies in supply chain relationships where one party might take advantage of the data produced by another party offering a non-monetary reward in exchange. For instance, farmers share data on

[3] https://www.osservatori.net/en/research/active-observatories/smart-agrifood

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traceability, quality and the extension of actual and future fields devoted to cultivation with retailers or processors who can better schedule their production, promotions or stocks and they receive in return more stability, better contractual conditions and access to new markets, otherwise inaccessible or too costly.

4.4.2 Operational benefits

Operational benefits refer to improvements in the daily activities that businesses carry out to generate profits and are related to the concepts of efficiency and effectiveness. Efficiency may be defined as the quantity of resources used per result unit, and effectiveness as the degree to which the organization is successful in producing a desired result.

In this case, efficiency and effectiveness can be divided in the following broad categories: efficiency gains, where the farm or other supply chain actors obtain a reduction in costs, or effectiveness gain, where an increase in revenues thanks to product's characteristics is realised.

One of the aspects of efficiency are the savings in production costs:

- Water: farmers can optimise the amount of water they use in their fields thanks to data collected through in-field sensors and weather stations and elaborated by a decision support system. Besides this, they can even use automatic systems that, exploiting these data, choose and use the recommended amount of water.
- Fertilisers: similar to water, sensors and decision support systems help define the exact amount of fertilisers needed, while variable rate application can actually help farmers differentiate their applications according to the specific crop needs, thus optimising fertilisers applications.
- Agro-chemicals: just like fertilisers, farmers can save also on agro-chemicals thanks to insights into the right moment and the right quantity to be applied derived from data.
- Energy: Thanks to data, non-necessary activities are not done, therefore, for instance, farmers might save on the amount of fuel necessary to make the tractor execute in field activities exploiting satellite guidance which avoids passing on the same plot more than one time.
- Labour: Some tasks can be replaced by machines, for instance robots on fields that collect fruits or eradicate weeds or sensors that collect relevant data, like soil humidity, or cameras and thus do not require the actual presence of a labourer to acquire these data or pursue these kinds of activities. At the same time, a better planning enabled by data reduces the time a worker needs to be in the fields to make their activities done.
- Other inputs: more broadly, data allow farmers to optimise any kind of input, even those not previously mentioned, like seeds, exploiting, for instance, precision sowing based on prescription maps.

Another aspect of efficiency is the reduction in waste thanks to data. Two examples are: *i)* the ability to optimise production parameters or transportation characteristics, such as humidity, light, and temperature, and to provide alerts to promptly reply and fix the harming conditions can lead to a reduction in the number of products that need to be thrown away or to a reduction in the value at which they could have been sold before the damage; *ii)* the alignment of demand and supply can, on the one hand, help farmers to better set their production in order to maximise the probability that their product will be sold at the best market conditions while, at the same time, enables food processing companies or retailers to have a clear view of the raw materials or products they will have at disposal, thus devising a strategy to minimise waste. Also, in this case the outcome is a reduction in the products unsold or sold below the maximum level they could have achieved.

A better alignment between demand and supply as well as a higher visibility on the stock enable farmers, or other actors in the supply chain, to reduce the amount of produces held in warehouses and therefore their costs.

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Data can also make farmers and supply chain actors save time on their administrative tasks. For instance, data collected automatically by sensors, of whichever type, or retrieved by external sources do not have to be collected by a person, who is thus freed to spend its time in another activity. Besides this, data correctly stored in a digital ledger might be more easily set to comply to information requests for bureaucratic reasons, such as requirements to keep track of all the activities done and the chemicals used, as well as to keep track of traceability information. Similarly, data can be used to fulfil certifiers' requests to obtain certifications or to comply to production schemes necessary to obtain PDO (Protected Designation of Origin) quality marks. Therefore, farmers might save time on searching and preparing documentation to satisfy certifiers' needs. More broadly, in all those supply chain activities that require administrative information to be collected, effective data collection and data sharing reduce the time needed to insert several times the same data and reduce the probability of data inconsistencies along the supply chain.

Data proves to be key also in risk management. Losses due to adverse effects, such as weather damages or pests, can be reduced when farmers take prompt actions thanks to more precise forecasts of hail/frost events or pests' infestations that cannot be obtained without site-specific data. To reduce the risk associated with uncontrollable circumstances, farmers can also rely on parametric insurance, which, again, requires data to be applied. Another example related to risk management, is the reduction in recall costs for food security issues, as well as costs related to reimbursements or sales decrease owing to a reduced brand reputation. A complete and traceable supply chain enable all the actors to quickly identify the whole story of a product and the potential source of non-compliance, therefore limiting the number of products to recall, compared to a less documented situation, and limiting the potential damage to consumers that can be produced. At the same time, even if less quantifiable, data enable farmers to avoid such products to enter the market thanks to more accurate analyses.

Finally, data can also lead to a reduction in transaction costs, that are costs needed to conclude an agreement between two or more parties in the supply chain. The time to reach an agreement can be reduced, for instance, thanks to transparency, which enhances trust. More data available might provide a clearer picture of the business situation and, therefore better align expectancies used to make a decision. The time to find and match a supplier can also be reduced by increasing the information available and exploiting algorithms, which can address the search in a more efficient way leveraging on available data. Finally, assurance costs to finalise a transaction can be reduced or avoided thanks to an increase in trust. Guarantees assured by data, for instance tamper proof records or real-time tracking, reduce the probability of a free-riding behaviour and thus the need to mitigate this risk through an insurance.

As previously mentioned, data can also act on efficacy, for instance increasing the quantity and the quality of a product which in turn might translate into higher revenues.

A more efficient use of fertilisers and water based on actual needs of plants might – other factors being equal - increase the production.

Besides this, an accurate use of inputs might also lead to an increase in intrinsic product quality characteristics such as shape, colour and texture, or nutrients, like proteins, or the lack of preservatives or residues. Also, an effective collection of data might support the decision of the farmer to pick the products only when actually ready or to separate products according to their quality in order to serve different markets and exploit the best available market prices.

Clearly, these characteristics may or may not turn into higher revenues according to several market variables which might not always be fully under farmer control.

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4.4.3 Strategic benefits

The term "strategic benefits" describes those advantages that have a significant impact on an organization's likelihood of success [4] in the long term. These benefits frequently serve as the foundation for an organization's present and future competitive success in comparison to other manufacturers of comparable goods and services. Core competencies, which concentrate on enhancing and extending an organization's internal capabilities, and strategically significant external resources, which are shaped and leveraged through important external relationships and partnerships, are the two sources from which strategic advantages are typically derived.

This type of benefit can be divided into four main categories: supply chain benefits, information and capabilities benefits, customer relationship benefits and market positioning benefits. The category of **supply chain benefits** comprises:

- Shift in roles and power relationships, that is the possibility to rebalance power unbalances. For instance, farmers having more data might be better in negotiating conditions with processors or distributors and therefore might acquire a higher share of value. Moreover, sharing of data among members of the same supply chain might foster relationship and increase, also in this case, the market power of the whole group with respect to distributors and retailers owing to, for instance, a better coordination and collective action.
- Data might also help in building and solidifying partnerships by creating data sharing mechanisms that enhance trust or by devising a data value chain that makes it convenient to maintain the relationship and fully exploit the benefits of data, such as learning economies and habits. Moreover, stability in partner relationships might reduce future uncertainty and therefore enable farmers, and the supply chain as a whole, to better plan their actions on a long term basis.
- Data can reduce information asymmetries thanks to an increased amount of data and transparency which can be used to better assess the situation of each party in the supply chain. Reducing asymmetries, for instance, reduces the chance of certain members of the supply chain to conduct free riding activities useful for themselves but detrimental for the supply chain; reducing asymmetries might also better channel resources towards those who can really bring benefits to the whole supply chain revealing their actual contribution.

In the category of **information and capabilities** lie all the benefits related to the increase of knowledge and awareness among the members of the farm or of the supply chain. They might not be strictly related to a specific economic benefit. However, increased knowledge can be useful for the actors of the supply chain and it can be useful as well to support decision making and foster creativity to come up with new ideas and ways to exploit data. They can be mainly:

- Knowledge discovery, that is knowing something that was previously unknown, as certain dynamics behind the functioning of the farm or certain supply chain characteristics or bottlenecks.
- Skills development, that is acquiring new skills thanks to data, and also data sharing. For instance, the availability of data might be used to better train employees, learning from previous mistakes and gaining useful insights to build new skills in an efficient way.
- Decision making support, that is the ability to leverage data to improve the decision-making process, for instance having a broader and more accurate set of information.

The category of **consumer relationship** comprises all the benefits related to an improvement of the way in which the farm - or the supply chain as a whole if we are considering, for instance, processed foods - respond to consumers' needs. Those benefits can be an increase in customer acquisition or retention and an increase

[4] The definition of success is connected to the objectives of the organization, either for profit or not-profit.

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in customer loyalty and satisfaction. All these elements are leveraged by data. As an example, data generated by sales might provide hints for consumption patterns, therefore the company can better tailor promotions and advertising campaigns to anticipate customers' needs and to customise the offer on what they might be interested in.

Finally, data can be used to foster **market positioning**:

- Enabling competitive differentiation: meaning that thanks to data the farm is able to offer a product that differentiates it from competitors: customers or other actors down the supply chain are more willing to engage in business relationship with the firm thanks to its use of data.
- New value proposition: which refers to the ability of the farm to innovate its business model by leveraging on data.
- New products / services / markets: referring to the fact that thanks to data, farmers can offer new products and services. Moreover, the data collected might provide insights as to devise new products which can be more in line with market requests, or it can enable faster and more accurate tests which reduce the time needed to place a new product on the market. Finally, more and better data available might provide insights on how to better penetrate a new market, reducing failure.
- Market flexibility: data insights allow to anticipate and promptly shift business activity in order to respond to market stimuli.

4.5 Data valuation methods

As explained in paragraph 4.1, data should be considered an asset embedded in a data value chain. One of the main categories of methods used to assess whether an investment in an asset will yield sufficient financial results to cover the initial and recursive expenditures are the Discounted Cash Flow (DCF) methodologies. In this context, the Net Present Value should compare all the future cash flows generated by data exchange and data use with an initial investment, to set up the system to collect and analyse data, and recursive costs and operatively make this system work, discounted by a certain factor.

This approach, however, shows some limits:

- firms over time have the chance to pursue other investments or cease the investment to avoid additional costs;
- the benefits generated by data might not yield actual cash flows.

To cope with the first of these limits, the Real Option Analysis (ROA) method has been considered. In this case, the firm has the chance to decide how to act in each time period, for instance to keep investing or to give up, and some potential outcomes, with their probability, are considered. Moreover, this method includes also the uncertainty in the future values of data, while in the DCF methods the cash flows are deterministic. However, how to calculate the "input" of the cash flow is unclear also in the ROA approach.

The monetary value of data can be computed using simplified approaches that capture the value of data and express it within a financial framework even in the absence of a direct production of a cash flow. In this framework, three approaches proposed by Laney (2017) are used, which differ based on the point of view and how the benefits are computed:

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- Income approach: where the monetary value of data is the stream of revenues that is generated or the cost savings that are achieved, therefore it is the marginal contribution to the increase of the income of the farm or of the supply chain as a whole.
- Cost approach: where the monetary value of data is the cost of replacing them in case it would be stolen or severely damaged or the revenues not realised and the costs non reduced owing to data not used or data being lost or damaged.
- Market approach**:** where the monetary value of data is the market price paid for them either in direct markets or in comparable markets.

These three methods yield the formulae in the following sections. Moreover, as examples, Table 5 provides a view of suggested methodologies in literature for data valorization of some benefits.

Type of benefit	Sub-type of benefit	Detailed benefit	Reference	Suggested measurement
Direct	Selling raw data or analytics solutions using data	Products linked to ecosystem services (e.g. carbon sequestration)	Faroukhi et al., 2020	MVI; EVI
	Information-enhanced products or services	Traceability enhanced products - farm to fork	Cicia and Colantuoni 2010; Violino et al. 2019	EVI
	Bartering or trading with information	Better contractual conditions/higher prices for raw product/discounts	Laney 2017; Fawcett, 2013	EVI
Operational	Efficiency (cost reduction)	Waste reduction (losses during production, better alignment demand and supply)	Lezoche et al. 2020; Kamble et al. 2020; Lusiantoro et al. 2018	EVI
		Production costs savings (water, fertilizers, pesticides, energy, labour, other inputs)	Balafoutis et al. 2017	EVI
		Inventory costs savings	Lusiantoro et al. 2018; Lee et al. 2000	EVI
		Admin time savings (Bureaucratic requirements, Certification acquisition / IG)	Laney 2017	EVI
		Risk reduction (Losses due to adverse-effects, Costs for recalls, reimbursements; brand image damages)	Lezoche et al. 2020; Purgat and Mrozek, 2018	CVI; EXPVI
		Transaction costs savings	Lezoche et al. 2020; Lusiantoro et al. 2018; Lee et al. 2000	CVI; EVI

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	Effectiveness (Revenue growth)	Product quantity	Lezoche et al. 2020; Elia et al. 2020; Balafoutis et al. 2017; Kamble et al. 2020	EVI
		Product quality (shape, colour, texture, nutritional composition, preservatives, agrochemical residues...)	Elia et al. 2020; Balafoutis et al. 2017; Lusiantoro et al. 2018; A. Urbinati, et al. 2017	EVI

Table 5 –Synoptical view of suggested methodologies in literature for data valorization in literature

4.5.1 Economic value of information (EVI)

The exploitation of data within a data value chain can lead to an increase in the revenues achieved. One way to capture this phenomenon is to compare the stream of revenues generated before data are exploited and after their usage. However, the costs necessary to structure the data value chain must be accounted for; therefore the costs of acquiring data, the costs of managing data and the costs of analysing and using data are subtracted to capture the net value generated by data. Finally, the formula can be further refined by taking not account the reduction in the costs borne by the involved actors in carrying out their activities not strictly related to the acquisition, management and analysis of data.

$$EVI = [(Revenue_i - Revenue_c) - (AcqExp + AdmExp + AppExp)] * \frac{T}{t}$$

Eq. 1.1 – Economic Value of Information, main formula

Where:

$Revenue_i$ = The revenue generated using data (informed group)

$Revenue_c$ = The revenue generated without using data (control group)

T = The average expected life span of any given information instance or record

t = The period of time during which the EVI experiment or trial was executed

$AcqExp$ = The costs required to acquire the data

$AdmExp$ = The costs required to manage data

$AppExp$ = The costs required to analyse and use data

A more generalised version of EVI can be nonetheless derived as the variation in the contribution to income generation obtained thanks to data. Therefore, the generalised formula can be rewritten as:

$$EVI' = [(Income_i - Income_c) - (AcqExp + AdmExp + AppExp)] * \frac{T}{t}$$

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$$EVI' = [((Revenue_i - Cost_i) - (Revenue_c - Cost_c)) - (AcqExp + AdmExp + AppExp)] * \frac{T}{t}$$

$$EVI' = [((Revenue_i - Revenue_c) + (Cost_c - Cost_i)) - (AcqExp + AdmExp + AppExp)] * \frac{T}{t}$$

Eq. 1.2 – Economic Value of Information, generalised formula

Where $Cost_i$ and $Cost_c$ refer to the costs that are influenced by data in the various business activities and which fall under the category of benefits labelled as "efficiency".

The ratio between T and t can be omitted if time specific measurement can be conducted. This ratio is in fact introduced to insert a time span in the formula, taking into account that cumulatively data should yield results for a period of T years, while we have been already able to compute the difference in revenues and the necessary costs for the trial period t, where actual data realised. In other terms, we are computing the unitary net income effect and then extend it to the cumulative value that will be generated over the time period T.

$$EVI'_t = \left[\left((Revenue_{i,t} - Revenue_{c,t}\right) + (Cost_{c,t} - Cost_{i,t})) - (AcqExp_t + AdmExp_t + AppExp_t)\right]$$

Eq. 1.3 – Economic Value of Information, generalised formula with time reference

Finally, the costs of data acquisition, data administration and data application, that is basically the costs necessary to guide data through the entirety of the data value journey, might not be easy to compute, therefore they can be neglected if the focus is only placed on the benefits that data valorization accrues. Costs can be apprised to gain more insights or can simply be used as a reference point to determine whether an investment can be worth doing.

$$EVI^*_t = \left[\left(Revenue_{i,t} - Revenue_{c,t}\right) + (Cost_{c,t} - Cost_{i,t})\right]$$

Eq. 1.4 – Economic Value of Information, reduced formula with time reference

This formula linked to an income approach might be best suitable in those occasions where it is possible to compute the difference in income generated by the use of data, that is the increase in revenues and the decrease in costs. This might occur, for instance, if the farm or the supply chain have measuring mechanisms in place and can compare these quantities before and after data have been used. Some hints on methods that can be integrated to further refine the data estimates and limit possible errors in the measurement of the actual contribution of data are introduced later in the document. The drawbacks are linked to the fact that this is a trailing indicator, since realised data is needed to compute both the value already obtained and the value that might be obtained in the future; moreover, it might be difficult to have clear estimates of the impact of data on revenues and costs, especially if metrics are not present in the farm or in the supply chain. Finally, it might not be that easy to compute the cost to acquire and use data, which instead might be blurred into other costs and business activities.

4.5.2 Cost Value of Information (CVI)

The value of data can be seen not only on the actual impact on revenues growth and costs reduction, but also on the costs needed to recover this competitive advantage in case data were missing or damaged.

$$CVI = \left[\frac{(ProcExp * Attrib)}{t} * T + \sum_{n}^{N} LostRevenue_n\right]$$

Eq. 2.1 – Cost value of information

Where:

$ProcExp$ = The annualized cost of the process(es) involved in capturing the data

$Attrib$ = The portion (percent) of process expense attributable to capturing the data

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T = The average expected life span of any given information instance or record

t = Time period over which the process expense is measured

N = The number of periods of time until the information is reacquired, or until business continuity is no longer affected by the lost or damaged information

This formula tries to answer the question: what would my losses be if I lose data or if data are stolen or lost? This is done by computing the cost of acquiring data and the losses suffered by not exploiting the data that have been lost; it is used to parametrise the costs to the unit time period while T captures the extent to which data could potentially bring benefits.

In this case too, if sufficient information is available, point estimates of costs and losses can be computed.

The CVI is best suited to estimate data replacement cost and negative business impact if data are lost, stolen or damaged. The costs are already present, however in this way they are specifically attributed to data acquisition. This method is also more conservative with respect to EVI and, albeit heavily reliant on the subjectivity especially of the portion of process expense attributable to capturing data, can provide a rapid and informative indication of the value of data, in particular when the impact on revenues increases or cost savings are not clear or not yet obtained, for instance where the probability of a certain event to occur is assessed, as in food security issues or weather insurances.

4.5.3 Market value of information (MVI)

Finally, the value of data can simply refer to the revenues that can be obtained by selling them, just like any other product. Therefore, the value of data from a market point of view is their price multiplied by the number of times data are actually – or potentially, in a less restrictive way - sold.

$$MVI = \left[\frac{(Exclusive\ Price * Number\ of\ Licenses)}{Premium}\right]$$

Eq. 3.1 – Market value of information

Where:

$Exclusive\ price$ = The price a customer is willing to pay to have access to data

$Numer\ of\ licenses$ = The number of licenses sold to get access to data

$Premium$ = A discount factor which captures the premium that customers are willing to pay to get access exclusively to data.

This formula is most useful for determining the value of a saleable or barterable information asset while it shows some drawbacks for nonmarketable information assets, therefore it should be used with already existing markets, albeit they are not so diffused in the agricultural sector.

4.5.4 Expected value of information (EXPVI)

Finally, another formula that can be exploited to compute the value of information in those circumstances in which it is not clear the actual impact of data on increased realised revenues or reduced costs leverages the contribution of data to the reduction in uncertainty in a decision-making process and therefore in the potential losses one may occur.

The expected value of information (EXPVI) (Hubbard, 2010), is thus computed as the reduction in the expected opportunity losses; in other terms:

$$EXPVI = [EOL_{Before\ information} - EOL_{After\ information}]$$

Eq. 4.1 – Market value of information

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Where:

$$EOL = E(D) = P * C$$

Eq. 4.2 – Expected Opportunity Losses

That is, the expected opportunity loss is the expected damage that might occur if the activity is done: the probability (P) that the negative situation realises multiplied by the harm that will be caused (C).

The ratio behind this measure is that by having a better set of information based on my data, the expected value of my activity should be closer to the actual possible outcome. The expected losses of pursuing an activity and find out that it is not worth doing should be more accurate and more reliable. For instance, if I am valuing an investment in the digitalisation of my farm, then I might end up having a positive expected value, net of the costs, therefore I might be induced to invest, even though I also have a certain chance that a negative scenario occurs. Additional information might reduce uncertainty: on the one hand it might become clearer that the investment is not worth doing, for instance because the expected value is now negative, therefore I have saved on the expected loss I would have gone through if I had accepted to invest before acquiring additional information; on the other hand the potential loss might be lower and thus if I invest now I have a reduced expected loss. In both cases, the difference between the current expected loss after information has been acquired and the previous expected losses is the value of information.

Since this applies especially to uncertain scenarios, this might be used as an alternative to CVI.

4.5.5 Additional methods

Even though DCF and ROA cannot be always directly used to assess the monetary value of data, as outlined in Hubbard (2010), once data have been attributed a monetary value, then further calculations using standard financial methods can be performed.

Discounted Cash Flows can be used to compute the cash flow generated over time by data monetisation (for instance savings or increased revenues) and to compare it to actual expenses (for instance training costs, investments in technology, …). This can potentially be applied to all the mentioned approaches, nonetheless it might suit best the income approach.

In its simplest form, the Net Present Value method, the formula is the following:

$$NPV = \sum_{t}^{T} \frac{Value_t}{(1+i)^t}$$

Eq. 5 – Net Present Value (NPV)

Where:

$Value_t$	=	The value generated by data at time t
i	=	The interest rate one can achieve by investing the money in the financial markets (or in another activity)
T	=	Time span over which data produce value
t	=	Specific time period

The value of data can be thus computed in one of the methods previously outlined. In particular, EVI already encompasses data costs, while these should be added if the monetary value of data is computed using the other methods.

Real Option Analysis can be used where uncertainty is relevant in assessing the future value of information. In this case too the method best fits the income approach. Nonetheless it can be applied also to the remaining approaches.

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The formula is developed as follows:

$$ROA = (Value_{1,g} * p_{1,g} + Value_{1,b} * p_{1,b}) * (\frac{1}{(1+i)}) + (Value_{2,gg} * p_{2,gg} + Value_{2,gb} * p_{2,gb} + Value_{2,bg} * p_{2,bg} + Value_{2,bb} * p_{2,bb}) * (\frac{1}{(1+i)^2})$$

Eq. 6 – Real Option Analysis

In each time period two outcomes might happen: good (g) or bad (b). They can be dependent or independent of the previous state. Moreover, in each time period the firm is able to decide whether to pursue the activity or to give up.

Regression analysis can be exploited to assess more clearly the contribution of data on the increase of revenues or the reduction in costs to increase the accuracy of an income method. Regression analysis can be implemented to isolate the effect of data on the outcomes that need to be measured and imposed a monetary value (for instance, the regression analysis can be used to assess the contribution of the data asset to the increase in the number of customers and consequently in the amount of revenues).

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5 Framework application

The framework presented in Chapter 0 has been applied to the SIPs with a specific focus on the farmers. For each SIP data has been collected within different Ploutos' meetings, workshops and one-to-one interactions to fill the framework in its parts. Technology, processes and methods and people are considered both on a firm level basis and on a supply chain level basis, where applicable.

The analysis has been focused mainly on the evaluation of the collaborative benefit obtained or obtainable in the SIP following the aim of the project. The calculation of the collaborative benefit (or potential collaborative benefit) is gross of the technology costs ("sunk costs" already incurred).

A synthesis per each SIP is reported in the next sections following this structure:

- Sector and value chain stage
- Actors
- Initial situation
- Benefits mapping
- Quantification of collaborative benefit
- Remarks and potential collaborative improvements

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5.1 SIP 1

Context and baseline

Sector and value chain stage: Frozen Fruit (Greece) - Production, Processing Industry

Actors: NP (Neuropublic, SIP Leader, smart farming service provider), ALTERRA (processing industry), PROODOS (farmers union)

Initial situation: Fruit producers in Greece make daily decisions based on intuition or inherited knowledge from their ancestors with the support of limited farming advice (mainly on pest management), making them incapable of overcoming critical challenges such as increased production cost due to higher product quality and the employment of sustainable practices. The lack of transparency across the value chain due to the absence of a traceability system prevents farmers to establish collaborations with new market players (such as other distributors) and certify the quality of their products to their customers (for example through a certificate like e GLOBALG.A.P) hence building up their brand name ripping additional value. Finally, even if they could prove such quality, they would need a way to sustain in a more effective way the increased production costs, which is currently impossible due to the lack of a DSS.

Enablers

Enablers	Description
Vision and Strategy	Main goal is to secure the certification and the sustainability related labels (ex. GGFSA) thanks to the collection and sharing of data through a traceability service. Secondly, the application of inputs (water, fertilisers, pesticides) will be reduced (decreasing production costs) and the fruit quality will be improved (fewer chemical residuals) while, at the same time, the environmental footprint of the production will be reduced. Those objectives will be possible thanks to the development of ICT tools and a DSS to make the recording and sharing of the farmer's activities easier.
Technology (hardware, software and infrastructure)	• **IoT Stations and mobile proximity sensors** collecting data about agro-environmental and soil parameters • **Remote sensing platforms** • **DSS and cloud computing** infrastructure that enable digital record keeping and real time access to weather conditions at the farm, provides weather forecast on a parcel level, visual indications on potential future pest infestations, current irrigation needs, recommendations on pest management and irrigation actions thus supporting decision making with regards to farming practices. • **Traceability system that collects and provides on-the-spot data** from different sources that are related with the farming and processing practices of the fruit product to help farmers provide evidence and secure subsidies through the exchange of data with the authorized actors. • **Data interoperability - Data management platform** that facilitates a uniform way for collecting, maintaining and providing data.
Processes and methods	Firstly, data is collected from a network of stations, from a digital farm calendar which is inputted manually and other data sources. This data is then processed by the DSS that sends messages to the farmers in an automated way. Messages are tailored to the needs of each farm/crop

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	and focus on pest management, irrigation, and fertilisation. Data is also shared with Alterra's system through the traceability solution, which will aid in the collection of the necessary data/proof to secure certification and sustainability-related labels, such as GGFSA and the Central Macedonia Region's "Macedonian Land Products" label (policy maker). The certification process is based on an auditing process of the applied farming practices and the selected recordings from the digital farm calendar. Finally, the collected data will be shared with the regional data collection services that are part of the Integrated Administration and Control System (IACS) and utilised as secondary evidence in the context of the new monitoring of the Future CAP (Common Agricultural Policy).
People (skills and roles)	Small farmers with no data skills and that have no advanced equipment, but they are supported by NP that offer advice on how to use the technology provided.
Trust and Security	The farmers remain in control of the shared data.

Table 6 - SIP1: Enablers

Benefits mapping

ID	Benefit description	Beneficiary	Benefit type	Data value chain step	Type of collaboration
1	Premium price thanks to increased product quality granted by certifications (consumers are willing to pay more because they perceive a higher quality)	Farmers and Alterra	Operational	Data exchange	Traditional
2	Access to different markets thanks to quality certifications acquired through data	Farmers and Alterra	Strategic	Data exchange	Two-step benefit
3	Reduce bureaucracy using the DSS	Farmers	Operational	Data use	Traditional
4	Less water consumption	Farmers	Operational	Data use	Traditional
5	Reduction of pesticides	Farmers	Operational	Data use	Traditional
6	Improved fertilisation efficiency to avoid soil health degradation due to nutrition loss	Farmers	Operational	Data use	Traditional
7	Decreased fuel input	Farmers	Operational	Data use	Traditional

Table 7 - SIP1: Benefits mapping

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Quantification of collaborative benefits

ID	Description	Beneficiary	Valuation method	Benefit value (yearly)	Notes
1	Additional revenue due to higher price achieved from certification and labels	Farmers	EVI	10.533 € × 10% = 1,053 € (or for Alterra from frozen peaches 36.233 € x 10% = € 3.623)	• Increased final product value from enhanced quality and visibility: 10%[5] • The annual revenues of Poodos producers for the cultivation of "industrial" clingstone peaches is: 10.533 €/year/farmer* or 6.585 €/year/ha*.[6] • Alterra's turnover for frozen peaches from Proodos producers is: 1.5 million: 36.233€/year/farmer* or 22.645€/year/ha*.[7] (*in average)
Total monetary value: 1,053 €/year/f (or					Gross of technology cost

Table 8 - SIP1: Quantification of collaborative benefits

Remarks and potential collaborative improvements

This SIP highlights how the exchange of data can guarantee the quality of the farmers' product to the various actors in the supply chain, which is critical to enable new profitable collaborations. The achievement of the certification and other sustainability-related labels through the collaboration within the supply chain generates additional value that ultimately benefits all the actors involved and the environment: farmers are now incentivised to follow sustainable practices because they share this information across the supply chain, hence certifying the superior quality of their product. This will not only favour the environment, but will attract new collaborations with actors in downstream stages of the supply chain that are willing to penetrate new markets or enhance their brand's image by selling higher quality and sustainable products. Customers will also benefit from the sharing of information because they will have guaranteed that the product is healthier while respecting the environment. For this reason, customers may be willing to pay a premium price, which has to be fairly distributed across the supply chain between the different actors. Moreover, it is possible to improve the efficiency of logistic and production processes due to the fact that farmers can share data about whether they are ready to harvest and deliver the products to the downstream actors in the supply chain.

[5] Source: PROODOS; Product quality influences positively its price (Voros J., 2019; Steenkamp J., 1988); it is not possible to quantify how much premium the customers are willing to pay, but a recent survey by Akeneo (a French product information manager) in 2021 saw that 3,500 customers in 7 different countries are willing to pay at least 10% more if product information includes certifications and quality labels and environmental support/sustainability.

[6] Source: PROODOS 2023 (remark: average of the last three years. It is worth noting that in recent years peach cultivation, like other crops, has been damaged by extreme weather events such as frost, rain and hail. This means that productivity has been significantly affected (reduced harvest quantities) and therefore the data recorded do not represent the average yields of the crop under normal conditions. Nevertheless, this is the best our partners can provide in terms of data).

[7] Source: PROODOS 2023 (same remark as the above note).

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5.2 SIP 2

Sector and value chain stage: Arable crop / durum wheat (Italy) - Field Production

Actors: Università Cattolica del Sacro Cuore (UCSC / CETIF), HORTA (technology provider), CON.CER (wheat producers), Barilla (processing company)

Initial situation: Farmers currently have multi-annual contracts with the processing company for the supply of high-quality durum wheat, which foresee premium price for the use of a specific decision support system. However, they are currently not covered for risks linked to unmanageable events (e.g., extreme weather conditions), which might prevent them from meeting the safety and quality requirements agreed in the contract.

Enablers

Enablers	Description
Vision and Strategy	Guarantee that the requirements agreed in the contract with Barilla are met thanks to the collection and sharing of data regarding the safety (mycotoxin contamination) and the high quality of the product (e.g., grain weight and protein content), and the sustainability of the farmers' crop management. Secondly, use multiple data collected on the field to enable a parametric insurance to protect the durum wheat producers from risks linked to the unmanageable events that can happen during the cropping stage, which would prevent them to meet the safety and quality requirements agreed in the contract.
Technology (hardware, software and infrastructure)	• **Weather stations and sensors** that provide real time access to weather and soil conditions at the farm level. • **Decision Support System (DSS)** that leads to input optimization thanks to the collected data. The DSS is composed of two main parts: 1. an integrated system for real-time monitoring of the durum wheat crop components (air, soil, plants, pests, and diseases); 2. a web-based tool that analyses data by using advanced modelling techniques and then provides up-to date information for managing the durum wheat crop in the form of alerts and decision supports on the tactical management of treatments and other cultural practices. The DSS provides outputs for pest and diseases, crop development, and various management aspects. • **Traceability Service** that records all field operations and share them across the value chain. • **Parametric Insurance platform** that through an online is able to provide service capable of providing parametric insurance, managing the contracting and subsequent liquidation phases. It will interface with the DSS in order to define the insurance parameters. The mechanism requires the following elements to certify information for all the actors in the system: o Advanced analytics o IoT o Blockchain technology

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	The insurance platform provides a subscription mechanism, the insurance policies, and a liquidation mechanism. • **Data sharing platform that** provides evidence of added value towards the valorization of the carbon credits and allow the development of a new parametric insurance mechanisms through the exchange of data.
Processes and methods	Farmers use the "Register of Field Operation" functionality in the DSS to collect all the data on the operations they perform, which are then tracked through the traceability service. Data on grain yield and quality (e.g., protein content, specific weight, and mycotoxin contamination) is also controlled at the grain delivery by Barilla (at plot level). Once data has been collected on the field, the DSS transfers advice to farmers and computes sustainability indicators from the acquired data and valorise the carbon credits generated through the data sharing platform. The DSS also works as an oracle by using the weather station data, disease model outputs, and the register of farm operations to support the parametric insurance platform. Data from different sources and locations is continuously shared from the farmers to the DSS to test and refine the proposed innovation in multiple conditions.
People (skills and roles)	Farmers are trained for the use of the Decision Support System (DSS).
Trust and Security	High security levels in the technical mechanisms used for sharing data.

Table 9 - SIP2: Enablers

Benefits mapping

ID	Benefit description	Beneficiary	Benefit type	Data value chain step	Type of collaboration
1	Improved DSS performances thanks to the sharing of data between the farmers, resulting in better decisions and better insurance policies	Horta and Farmers	Operational	Data exchange	Two-step benefit sharing
2	Higher revenues due to improved production thanks to the DSS	Farmers	Operational	Data Use	Traditional
3	Premium price for higher quality durum wheat	Farmers	Operational	Data exchange	Traditional
4	Higher quality products	Barilla and Consumers	Strategic	Data Use	Traditional

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	because producers no longer need to import wheat from other countries (increased customer satisfaction due to higher quality)				
5	Coverage for potential revenue losses thanks to the parametric insurance	Farmers	Operational	Data exchange	Traditional
6	Less nutrients in cropping phase	Farmers	Operational	Data use	Traditional
7	Less water consumption	Farmers	Operational	Data use	Traditional
8	Less greenhouse emissions	Farmers	Operational	Data use	Traditional
9	Less fuel used	Farmers	Operational	Data use	Traditional

Table 10 - SIP2: Benefits mapping

Quantification of collaborative benefits

ID	Description	Beneficiary	Valuation method	Benefit value (yearly)	Notes
1	Coverage for potential revenue losses thanks to the parametric insurance	Farmers	EXPVI	Firstly, revenues per hectares are computed: 3 t/ha × 447 €/t = 1,341 €/ha Then, hectares per farmer: 1,230,000 ha ÷ 135,000 f = 9,1 ha/f Finally, revenues per farmer: 9,1 ha/f × 1,341 €/ha = 12,200 €/f Insurance premium is then:	• Between 5% and 10% of the farmers' revenue losses could be covered by the parametric insurance (insurance coverage is at average durum wheat price) [8] • Durum wheat production in Italy in 2021: 4M tons [9] • Price of durum wheat in 2021: 447 €/t [2] • Durum wheat hectare yield in 2021: 3 t/ha [2]

[8] Source: CON.CER

[9] Source: ismeamercati (https://www.ismeamercati.it/flex/cm/pages/ServeBLOB.php/L/IT/IDPagina/855#MenuV)

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				5% × 12,200 €/f = 610 €/f	• Total durum wheat hectares in Italy in 2021: 1,230,000 ha [2] • Number of durum wheat farmers in Italy: 135,000 f in 2021 [10]
2	Higher revenues thanks to premium price paid by Barilla	Farmers	EVI	Additional revenues per farmer in case 5% of the production is lost: (12,200 – 610) €/f × 20% × 95% = 1,700 €/f Additional revenues per farmer in case 0% of the production is lost: 12,200 €/f × 20% = 2,440 €/f	• 20% increase of price paid by Barilla if the requirements are met[1] • Revenues per farmer (previously computed): 12,200 €/f • 5% of the production is lost by unmanageable events (previous assumption)
Total monetary value in case 5% of the production is lost: 2,310 €/f Total monetary value in case 0% of the production is lost: 2,440 €/f					The value is gross of the technology costs

Table 11 - SIP2: Quantification of collaborative benefits

Remarks and potential collaborative improvements

The main distinctive and collaborative benefit of this SIP is that, thanks to the sharing of data between the farmers and Horta, the system is continuously improved and refined, resulting in better decisions transferred to the farmers (hence increasing their efficiency and sustainability) and better tailored policies for each different scenarios to cover their losses caused by unmanageable events which might prevent them from meeting the requirements agreed in the contracts with Barilla. Those benefits are then distributed across the whole supply chain since farmers improve the quality of their production (due to the adoption of more sustainable practices) and thus their revenues (increased efficiency and premium price paid by Barilla). Hence, Barilla enhances its products by using raw materials from local farmers (that have a superior quality guaranteed through the traceability system) and customers are more satisfied due to higher quality and the origin of the product purchased. Barilla will have an economic benefit too because they could charge a premium price to the costumers, hence increasing their revenues.

[10] Source: ISTAT, 7° Censimento generale dell'agricoltura

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5.3 SIP 3

Context and baseline

Sector and value chain stage: Cross-sector - Production, Processing Industry, Consumers

Actors: CQLP (SIP leader, Brand and platform creator & farmers representative in France), PETA (Brand owner & farmers representative in Greece)

Initial situation: CQLP is a French brand where any consumer can contribute to co-design one of its new products by completing an online questionnaire (no registration or fee required) on a crowdsourcing platform voting against a variety of characteristics, such as the remuneration of the producers, deciding how much they are willing to pay for the given product. Information on what product customers would like next are available through the crowdsourcing platform where they can express their preferences. For 1€ the consumers can become members and be part of the cooperative governance, participate to further votes and do on-field visits to witness with their own eyes how the products are realized.

The model currently employed by CQLP shares some common aspects with an e-ethnography approach, where companies employ user data to design their core products or services and develop their relationship with their customers. Companies exploiting that user-generated data allows them to form a different kind of connection with customers, one that is built on a deeper, continuing interaction (Trabucchi et al., 2017).

In Greece, however, no collaboration across the supply chain is put in place due to the absence of data sharing between the different actors (farmers, processing industry, exporting companies, …). Decisions made by farmers are neither data-driven due to the absence of a Decision Support System (DSS) nor aligned with customer preferences because they do not know the preferences of potential customers. Moreover, enhancing certain products' characteristics without knowing the actual customers' preferences would be a risk, likely resulting in higher production costs and lower margins (farmers might improve characteristics that are not important for the customers). Finally, there is a strong need for technological improvements to collect data across the value chain and from the customers through a crowdsourcing platform to understand their preferences, and a way to share the information with the costumers to prove that their requirements are met.

Enablers

Enablers	Description
Vision and Strategy	Replicate the existing French business model in Greece to collect key information to validate the use of this business model in other countries and design a Business Model Canvas for the employment in other 5 countries. The first step consists in the replication of CQLP in Greece where data is collected from the customers through a questionnaire in a new developed web/mobile app, allowing them to co-design with the farmers different products by collecting their preferences on the product's characteristics, showing how their decisions will affect the final product's recommended price. To overcome information asymmetries (Mishra D. et al., 1998), it is necessary to improve the current controls in place to ensure that a product has been manufactured in accordance with what the customers decided (for example, if the product has been manufactured through sustainable practices) and share this information with the customers. Data sharing will make it possible to create systems to improve collaboration and communication across all value chain operator: the collection of data and the sharing of information on

	products' specifications enables another brand to use CQLP products as a component of its final product, enabling new profitable collaborations (Waller and Fawcett, 2013).
Technology (hardware, software and infrastructure)	• **IoT Stations and mobile proximity sensors** • **Remote sensing platforms** • **DSS and cloud computing infrastructure** that enable access to real time weather conditions at the farm, provide weather forecast on a parcel level, visual indications on potential future pest infestations and current irrigation needs, recommendations on pest management and irrigation actions. • **Traceability service** enables the transparent and distributed storing of heterogeneous information about the provenance of the various ingredients (such as milk, flour, and eggs) used in the final food product (e.g. bread, cookies, cakes). This procedure will aid in the certification of "CQLP ingredient items.". • **Distributed ledger database** to support the collaborative, transparent and distributed storage/retrieval of information of heterogeneous origins and formats. • **Data interoperability - Data management platform** that supports the openness of the systems involved and make data sharing with authorized parties easier. The data management platform, when combined with the appropriate data translation mechanism, enables a standardized approach to data collection, maintenance, and distribution. • **Mobile and Website app**: the "Survey" tool is a CQLP-developed questionnaire generation system that intends to co-create goods by allowing customers to vote on their choices. The tool's key features are a display of a list of questions/answers, as well as the insertion of help bubbles with explanatory text for each question, and a calculating functionality, which allows the user to see the pricing of the product they developed. Three more features are being implemented: increased use of media formats, highlight the CO2 impact of the product and a custom page for each country.
Processes and methods	Questionnaires are available through a new web survey app and a mobile app that collect data from the customers through their preferred product characteristics (type of farming, use of smart farming-enabled practices, product packaging, remuneration of the farmer, type of processing). The system shows the correspondent production cost reflected on the final product to help customers make the most appropriate choice. Thanks to this system and the collected data, farmers and customers can co-design the product. To guarantee the total transparency on the value chain, Ploutos traceability solution helps in collecting all the needed data/proof to make sure that the producers follow the defined specifications of the product that are related to application of agricultural inputs on the field through the support of a fully operational network of IoT stations that is interconnected with the cloud computing infrastructure of NP, which is properly parameterized to accommodate the data. To further guarantee the trustworthiness of the collected data, a number of volunteers will directly visit the fields to make sure the specifications are followed.

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	Finally, thanks to the sharing of data on the products' characteristics with other brands through the traceability system, CQLP products can be used as a component of other players' final products.
People (skills and roles)	Small farmers with no data skills or appropriate equipment, but the situation is addressed by the technology provider that will support not only in data collection, but also in data analysis and interpretation.
Trust and Security	The trust along all the supply chain is granted by the sharing of data among all actors involved. The preferences of the customers will be collected in a way to grant anonymity.

Table 12 - SIP3: Enablers

Benefits mapping

ID	Benefit description	Beneficiary	Benefit type	Data value chain step	Type of collaboration
1	Increased consumer satisfaction since the product is co-designed and its characteristics are aligned with consumers' preferences (increased customer loyalty, fidelization)	Farmers and Consumers	Strategic	Data use	Two-step benefit
2	Increased consumer acquisition and retention because the consumer can co-design the product, developing a sense of belonging to the brand	Farmers and CQLP	Strategic	Data use	One-step benefit
3	New collaboration opportunities thanks to exchange of data leading to reduction of Information asymmetries	Farmers and other brands	Strategic	Data exchange	One-step benefit sharing
4	Competitive differentiation because consumers are certain that products are sustainable and up to standards (increased transparency thanks to data sharing and on-field visits)	Farmers and CQLP	Strategic	Data exchange	One-step benefit sharing
5	Increased revenues thanks to monetization of data to other players (other brands might want to know about the customers' preferences)	CQLP	Direct monetisation	Data use	Traditional
6	All actors in the value chain receive additional value: the premium price paid by the	Value chain	Operational	Data use	One-step benefit sharing

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	customers is distributed fairly in the value chain, while the customers are happy to support and pay a premium price to the farmers that follow sustainable practices				
7	Reduction of pesticides	Farmers	Operational	Data use	Traditional
8	Reduction of water consumption	Farmers	Operational	Data use	Traditional
9	Improved fertilisation efficiency to avoid soil health degradation due to nutrition loss	Farmers	Operational	Data use	Traditional
10	Decreased fuel input	Farmers	Operational	Data use	Traditional

Table 13 - SIP3: Benefits mapping

Quantification of collaborative benefits

ID	Description	Beneficiary	Valuation method	Benefit value (yearly)	Notes
4	Competitive differentiation because consumers are certain that products are sustainable and up to standards (increased transparency thanks to data sharing and on-field visits)	Farmers	EVI	Initially, total units sold attributable to a single farmer are computed: 2,000,000 u ÷ 300 f = 6,500 u/f Secondly, revenues generated from the sale of the products (from the units produced by a single farmer): 6500 u/f × 0.72 €/u = 4,680 €/f Then, it is necessary to find the percentage of the revenues that the farmer actually	• Estimated yearly increase of average quantity sold by the 300 involved farmers: 2,000,000 units (potatoes and tomato sauce) [11] • Assuming that 50% of products sold are potatoes and 50% tomato sauce, the average price would be 0.72 €/u • 20% average increase in farmers' income per unit of product [12] • Farmers earn approximately the 40% from the price paid by the customers [13] • 1 kg of potatoes in Greece is approximately 0,5 €/kg, so 1 product would be 1 €/u (CQLP package is 2kg/u) [14]

[11] Source: CQLP

[12] Source: CQLP

[13] Source: CQLP

[14] Source: Selina Wamucii (https://www.selinawamucii.com/insights/prices/greece/potatoes/#:~:text=Producer%20prices&text=One%20kilo%2

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				receives: 4,680 €/f × 40% = 1,872 €/f Finally, the premium price is applied: 1,872 €/f × (1+20%) = 2,246 €/f	• 1 kg of tomato sauce in Greece is approximately 1,09€/kg, so 0.44 €/u (CQLP package is 0.4 kg/u) [2] Other information: • 1 package of potatoes consists in 2kg of product and is sold by CQLP for 2.78€/u (1.39€/kg) [1] • 1 package of tomato sauce is approximately 0.4kg and is sold by CQLP for 1.07€/u [1]
Total monetary value: 2,146 € increase for each farmer, yearly					

Table 14 - SIP3: Quantification of collaborative benefits

Remarks and potential collaborative improvements

Thanks to the sharing of data, it is possible to generate additional value that can be distributed more equally across the supply chain, enabling new collaborations to penetrate new markets, improving the efficiency of the farmers and building a strong relationship with the customers. The main differentiator of this SIP is given by the sense of belonging that the customers develop with the farmers thanks to the complete transparency on the processes, practices and methodologies enabled by the sharing of information from farm to fork. In fact, other players could replicate the co-design business model but would ultimately fail to achieve the customers' trust due to the lack of the degree of transparency provided by CQLP which is enabled by data. In conclusion, the real competitive differentiator of this pilot is that the customers are completely informed about the realization process and the characteristics of the products thanks to the SIP's unmatched transparency.

It might be interesting to understand if farmers from different countries require the same enablers and face the same challenges, for this reason it is important to keep track of the information that could be used to facilitate the development of this business model in other nations.

0of%20Potatoes%20in,in%20EUR%20currency%20is%203.3985826.&text=The%20prices%20of%20potatoes%20in,US%24%20583.71%20in%20that%20order.)

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5.4 SIP 4

Context and baseline

Sector and value chain stage: Horticulture under greenhouses (Spain) - Pre and Post-harvest

Actors: HISPATEC (IT solution and service provider), UNICA Group (2nd Degree Farmers Cooperative)

Initial situation: Without a traceability solution in place to link the data between the preharvest and postharvest stages, it is impossible to automatically track all the data controlled throughout the value chain. Paper forms are used to manually collect data, which makes it hard to manage and use for beneficial purposes. Not enough data is available to support the decisions to improve farmers' pre- and post-harvest practices. Furthermore, the inability to produce additional benefits is aggravated by the lack of an appropriate methodology and set of procedures for managing data along the value chain. Due to a lack of integrated control across the value chain, customers are unaware of environmental protection, social impacts, and eco-friendly management.

Enablers

Enablers	Description
Vision and Strategy	Improve farmers' performances by developing a collaborative system where the farmers can share their data with the farmers' cooperative to enable the application of a benchmarking approach. Through this method, it will be possible to develop farmer-specific KPIs on their crop management and produce advices to maximize the economic yield and minimise the environmental impact. Thanks to the sharing of data between the farmers and hence their collaboration, it will be possible to identify the best KPIs and benefit from their use as indicators for each crop season. To fully exploit the system put in place, a traceability system will share information regarding the social impacts, healthy products, and eco-friendly farm management with the customers.
Technology (hardware, software and infrastructure)	• **Agroclimatic stations** that collect data on temperature, humidity, precipitation, solar radiation, photosynthetic solar radiation, wind speed and direction. Also, sensors will provide real-time access to greenhouse and soil conditions (soil moisture, Electrical conductivity and soil temperature) • **Thales architecture** (Traceability service) that contains an analytical engine which operates with the data obtained from the different data sources and runs the agronomic models. It also includes a layer to make the data available to the rest of systems. This service will collect and combine**:** o *pre-harvest data*: information of the applied farming practices, species and varieties per each crop, plot location, soil type, planting pattern, climate conditions, irrigation strategies, fertilization strategies, phytosanitary applications, managing strategies (bio, conventional), agronomic labours done, person involved (costs for social impacts), results of the different quality controls s performed, productivity. Water consumption and energy consumption will be also collected.

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	◦ *post-harvest data:* source crop (linking with preharvest area for traceability across the entire value chain), quality control to segment the type of product to handle in the industry, product storage conditions, people involved in each process (costs for social impacts), social footprint (linked to the corresponding one in preharvest area), environmental footprint (linked to the corresponding one in preharvest area). • **ETL service** (Extraction, Transformation and Loading) that supports the traceability service by processes that extract and obtain data from the fields, transform them into a standard format and load or send them to a Data lake. In detail, it collects data from multiple sources (structured or not), formatting them, and removing those that generate inconsistencies in the data structure (i.e., "cleaning" them). • **Data lake** that massively stores data and provides the analytical engine with the necessary information to build the agronomic models. • **General Dashboard** that elaborates the data collected in the data lake, providing end users with the information obtained on the fields processed through the GD algorithms to generate advice for their daily management. The KPIs resulting from the analysis will be displayed here.
Processes and methods	Data is collected from the agroclimatic stations and (regarding crop management and consumption) manually during periodic visits of the farmer. The collected data is processed and loaded in the data lake through a ETL service. The Thales architecture then utilizes the data in the storage to run the agronomic models in order to elaborate recommendations that leads to sustainable agricultural processes and the protection of the environment and shares the available data to the rest of the IT systems. Unica presents results to farmers twice a year + individual technical visits are organized every other week to the greenhouses where personalized advice is provided to the farmer, based on these results. Information regarding sustainability is shared with the customers through the traceability service. From the data that has been collected in the data lake, KPIs are then computed and displayed through the general dashboard: those KPIs support farmers' cooperative to identify those that could improve their KPI, in comparison with the rest of farmers members of UNICA (the cooperative), to generate recommendations for daily management of the fields and that are accessible through the internet (web and mobile app). Farmers do not have access to other farmers data, they do but anonymously.
People (skills and roles)	Farmers are supported by UNICA advisors and experts; the dashboard will be user friendly (no data skills required) and the infrastructure is automated. Manual data is collected by UNICA farmers and uploaded to the data lake by the IT company (Hispatec). Meetings for the farmers will be organised to share their experiences and help them improve their data skills.

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Trust and Security	It is crucial to have human contact and to build trust and understand the side of the farmer to increase their positiveness on the project. Elderly farmers are those that are less willing to adopt data driven decisions.

Table 15 - SIP4: Enablers

Benefits mapping

ID	Benefit description	Beneficiary	Benefit type	Data value chain step	Type of collaboration
1	Maximized economic yield thanks to the recommendations generated from the benchmarking of KPIs	Farmers and Unica	Operational	Data exchange	Two-step benefit
2	Higher price due to increased product quality (more qualitative and sustainable products)	Farmers and Unica	Operational	Data use	Two-step benefit
3	Increased consumers' retention and satisfaction thanks to enhanced sustainability guaranteed by data	Unica and Customers	Strategic	Data exchange	One-step benefit
4	Reducing water consumption	Farmer	Operational	Data use	One-step benefit
5	Reduce energy related to irrigation	Farmer	Operational	Data use	One-step benefit
6	Reduce phytosanitary use	Farmer	Operational	Data use	One-step benefit
7	Waste reduction	Farmer	Operational	Data use	One-step benefit
8	Increase labour productivity	Farmer	Operational	Data use	One-step benefit
9	Decreased fuel usage	Farmer	Operational	Data use	One-step benefit

Table 16 - SIP4: Benefits mapping

Quantification of collaborative benefits

ID	Description	Beneficiary	Valuation method	Benefit value (yearly, per single farmer)	Notes
1	Reducing water consumption (l/m^2)	Farmers	EVI	Savings thanks to reduced water consumption per farmer: 58 l/m^2 × 18,000 m^2 × 0.000115 €/l = 120 €	• Water consumption is reduced by 58 l/m^2 [15] • Unica Group has 9,000 ha (18,000 m^2) and

[15] Source: Unica Group

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					5,000 farmers[16]; assumption: each farmer owns 18,000 m^2 • Average price of water per liter in Spain is 0.000115 €/l[17]
2	Energy related irrigation (kWh/t)	Farmers	EVI	First, energy consumption saving is computed: 3.35 kWh/t × 100 t = 335 kWh Finally, energy cost savings are computed: 335 kWh × 0.15 €/kWh = 50.25 €	• Energy related to irrigation is reduced by 3.35 kWh/t [1] • Energy price per kWh: 0.15 €/kWh[18] • Unica Group realizes 500,000,000 kg of fresh produce each year [2] (100,000 kg/f or 100 t/f)
3	Phytosanitary use (kg/ha)	Farmers	EVI	Savings thanks to reduced phytosanitary use per farmer 39.3 kg/ha × 1.8 ha × 40 €/kg = 2,829 €	• Phytosanitary use is reduced by 39.3 kg/ha[1] • On average, phytosanitary in horticulture costs 40 €/kg [19] • It is assumed that each farmer owns 1.8 ha (from previous data)
4	Production increase (kg/m^2)	Farmers	EVI	Production increase per farmer: 6.2 kg/m^2 × 18,000 m^2 = 111,600 kg Additional revenues generated, assuming that	• Production increase of 6.2 kg/m^2 [1] • Assuming an average price of 1.96 €/kg from Italian market computed on various

16 Source: Interview with Enrique de los Ríos, Agro-Food Marketing & International Consultant at Unica Group (https://www.hortidaily.com/article/9252398/thanks-to-the-data-management-system-we-were-able-to-increase-production-by-at-least-10/)

17 Source: Carles et al., 2001a, b; García et al., 2004

18 Source: Eurostat, non-household consumers in 2021 (https://ec.europa.eu/eurostat/statistics-explained/index.php?title=File:Electricity_prices_for_non-household_consumers,_second_half_2021_v2.png)

19 Source: Confagricoltura (https://www.confagricoltura.org/ferrara/wp-content/uploads/sites/5/2016/03/prezzi-indicativi-fitofarmaci.pdf)

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				only 30% [20] of them are received by the farmer: 1.96 €/kg × 111,600 kg × 30% = 65,500 €	horticulture products[21]
Total monetary value: 68,500 €					Gross of the technology

Table 17 - SIP4: Quantification of collaborative benefits

Remarks and potential collaborative improvements

It can be argued that the innovation of this SIP is limited to an implementation of a DSS. While the DSS plays an important role, the main difference between this SIP and other DSS adopters is that the sharing of data is not only limited within the farmer and the technology provider (DSS), but between all the farmers and Unica. In fact, the benefits of this SIP can only be fully exploited if all the farmers share their data between them and Unica, which produces KPIs to benchmark the farmers and lead them to adopt more virtuous practices. Moreover, the higher the number of collaborating farmers, the higher is the quantity of data acquired, hence leading to better optimization through the benchmarking of the aforementioned KPIs.

[20] Source: CQLP (SIP 3) remunerates farmers with the 40% of the revenues generated by the final price, in this case the percentage is cautiously set at 30%

[21] Source: ismeamercati (https://www.ismeamercati.it/flex/cm/pages/ServeBLOB.php/L/IT/IDPagina/1881)

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5.5 SIP 5

Context and baseline

Sector and value chain stage: agriculture, tourism. Production, processors, consumers

Actors: DCIH (Dingle Creativity and Innovation Hub); Teagasc (National Farming Research body - Scientific input on Smart Farming and Farm Advisory services); IFA (National Farmer's Association); NetFeasa (Technology provider - Smart Farming Service Provider); Kerry Agribusiness

Initial situation: The initial situation poses challenges related to the need of addressing environmental issues in the Dingle Peninsula of Ireland (due to the more stringent regulations regarding greenhouse gas emissions (GHG) and other environmental factors as well as the issue of sustainability in rural farming communities. As a matter of facts, younger generations are generating a phenomenon of abandonment of the career of farming and the rural area in general. This depauperates the region of one of its main scopes. To stop and reverse this phenomenon, farming in the area must become attractive to the younger generations. This implies the need for increasing the profitability of rural farms.

Enablers

Enablers	Description
Vision and Strategy	Focusing on the need for improving the profitability and attractiveness of rural farms to retain young workforce, SMART farming approach is identified as beneficial. This approach is also believed to stimulate the integration between the farming sector and a more wide and diverse value chain including tourism. The proposed solution involves the use of "real-time" data to improve efficiencies in farm management. This is believed to generate positive effects such as the possibility to create an agri-tourism and food tourism value chain. Therefore, data are to be collected, elaborated and used with a twofold purpose: improve environmental sustainability of agriculture through controlling and reducing emissions and wastes; improve social sustainability by creating links between related industries.
Technology (hardware, software and infrastructure)	**Data capturing mechanisms or sensors**: 6 Ambassador farms already subject to a pilot study of the partners DCIH, Teagasc, Kerry Agribusiness and NetFeasa represent the starting point of "real-time" data collecting. The contribution made by the SIP5 consists of analysing data generated by sensors (describing current weather and soil conditions, grass growth rates, and key environmental indicators) to generate tools and prediction models which aim at supporting the decision-making process of farmers. o Type of data collected include: (a) available quantities of grass and the most efficient strategy by which it could be used for grazing animals; (b) the land areas most and least in need of fertilizer; (c) management of slurry application based on soil and weather conditions rather than calendar date; (d) extension of the grazing period in autumn (depending on grass growth rates, temperature, soil); (e) environmental quality parameters in the area. o The Key Performance Indicators used to support decision-making process concern: (a) labour costs (b) input costs (c) profitability • **Smart farming:** Through the use of smart-farming services farmers participating in this SIP are expecting to have real time access to (a)

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	weather conditions at the farm (b) recommendations on grassland management actions • **Traceability:** Through the use of smart-farming technologies the milk (and potentially beef and lamb) will be escorted with information of the applied farming practices. • **Data sharing:** Through enabling data sharing across partners in the supply chain, the SIP can provide evidence of added value towards sustainably produced grass, milk, beef and lamb. (Grass for energy production – Anaerobic Digestion) • **Data driven technology:** Sharing data securely - technology used from SIP to receivers - data traceability
Processes and methods	Underlying the whole process of evaluating performance an aspect not to be overlooked is that of qualitative data to correctly interpret the analyzed quantitative data result. This establishes the necessary knowledge base to identify the benefits of a good Smart Farming/ decision-making approach, and the context within which it works. Examples of such qualitative data are: (a) education level of the farmer (b) level of farm facilities In order to fulfil the initial objective of generating benefits for a wider agri-food community, the data captured and information generated will also provide evidence-based credence attributes that other value chains may use (the farming community and food producers, farm advisory bodies, local tourism providers, restaurant owners, tourism marketing bodies, tourists and consumers). More specifically some examples of how this interconnection may occur are: (i) the use of good environmental parameters in marketing goods from the area; (ii) the possibility to tailor tourist packages optimised for changing weather conditions thanks to localised 'real-time' weather data; (iii) the exploitation of data proving low food miles and low carbon footprint for building a brand for the Dingle Peninsula to secure the region as a destination of choice.

People (skills and roles)	• Dingle Creativity and Innovation Hub (non-profit SME): Community Coordinator | SIP leader, Community Innovation Hub supporting the link between tourism and agri-food to accelerate the innovation processes
	• Teagasc: National Farming Research body | Scientific input on Smart Farming and Farm Advisory services
	• IFA: Farmers | Farmer's Association
	    ○ The identification of the most appropriate local Precision Farming solutions will be conducted by the IFA[22] partner and supported by Teagasc[23], DCIH.
	    ○ The interaction of data generated from the smart farming approach aimed at creating benefits for other subjects of the local tourism industry will be promoted by IFA.
	• Net Feasa (SME): Technology provider | Smart farming service provider (sub-contractor)

[22] IFA: Irish Farmers' Association

[23] Tegasc: the Agriculture and Food Development Authority – is the national body providing integrated research, advisory and training services to the agriculture and food industry and rural communities.

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Trust and Security	To build trust for the farmer it is crucial to have him/her engaged and aware of the obtainable benefits. Therefore, both technical and theoretical training are important for the value perception, the capability to communicate such value and the willingness to integrate their activity to that of other local entrepreneurs. In order to build trust for the final consumer or the agri-tourist and food-tourist value chain, data must be transparent (e.g. adopting certifications). To this end, some dissemination and demonstration activities have been provided for: o Three workshops to facilitate engagement between farmers, technology providers and researchers to explore enterprise diversification ideas and build understanding of the value of the combined data sets o Whatsapp group established o Project Updates, news items, related articles o Local radio interviews o Journal / Conference papers o Four open day visits demonstrating SIP results on participating farms o Local free magazine fortnightly blog o Regional and National newspaper articles o Regular social media updates and Insta Live series promoting businesses implementing short supply chains

Table 18 - SIP5: Enablers

Benefits mapping

ID	Benefit description	Beneficiary	Benefit type	Data value chain step	Type of collaboration
1	Production costs reduction	Farmer; Final consumer	Operational	Data analysis	Traditional
2	Extension in grazing season on farms	Farmer	Operational	Data use	Traditional
3	Reduction of working time on farms	Farmer	Operational	Data use	Traditional
4	Increased productivity of harvest	Farmer; Distributor; IFA	Operational	Data use	Traditional
5	Marketing of goods from the area by using the good environmental parameters associated to the production process	Farmer; Distributor; Final consumer	Strategic	Data sharing	Two-step benefit sharing
6	Increased attractiveness of the area and possibility to tailor tourist packages optimised for changing weather conditions thanks to localised 'real-time' weather data	Tourism actors; Tourist	Strategic	Data sharing	Traditional

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7	Creation of an authentic product/service proposal for the agri-tourism and food tourism traveller	Tourist; Local entrepreneurs; Farmer; Rural population; IFA	Strategic	Data sharing	Two-step benefit sharing
8	Establishment of a Sutainable Food Network involving farmers, food producers, hospitality businesses thanks to the launch of "Bia Dingle" branded products	Farmer; Food producers Hospitality businesses Tourist/Consumer	Strategic	Data sharing	One-step benefit sharing
9	Exploitation of data proving low food miles and low carbon footprint for building a brand for the Dingle Peninsula to secure the region as a destination of choice	Farmer; Tourism actors; Tourist	Strategic	Data sharing	Two-step benefit sharing
10	Increased value of products by enhancing carbon efficiency certified through data	Farmer; Final consumer	Strategic	Data sharing	Two-step benefit sharing
11	Greater social awareness of carbon efficiency in food production and possibility to associate such attributes to the products	IFA; Farmer Distributor; Final consumer	Strategic	Data sharing	Two-step benefit sharing
12	More focused, objective and precision orientated decision-making through the use of data	Farmer; IFA	Operational	Data analysis	Traditional
13	Increased profitability from improved and more efficient management of the farm system using 'real-time' data brings new/enhanced livelihoods in a marginalised rural area thanks to strengthened social networks reduce risk of abandonment	Rural population Farmer; IFA	Operational	Data use	One-step benefit sharing

Table 19 - SIP5: Benefits mapping

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Quantification of collaborative benefits

ID	Description	Beneficiary	Valuation method	Benefit value (yearly, per single farmer)	Notes
1	Increase of labour productivity per farmer	Farmers; Distributors	EVI	Firstly, the increased labour productivity per meter per year is computed: 34.367€/m × 0.025% =0.85 €/m/yr Then Increase of labour productivity is calculated on an average Irish farm size: = 0.85€/m/yr × 3,240,000m =2,783,727 €/yr	• Target + 2.5% • Average farm income in Ireland Ireland: €34.367€/m (Teagasc) • Average hectares per farmer in Ireland: 32.4ha (assets.gov.ie) (CSO)
2	Value per farmer generated from the creation of the new "Bia Dingle" branded products	Farmers;	MVI	Increased revenue per farmer: 0.15 × 34.367€/m/yr × 3,240,000m = 16,702,362 €/yr	• Average farm income in Ireland Ireland: €34.367€/m (Teagasc) • Average hectares per farmer in Ireland: 32.4ha (assets.gov.ie) (CSO) • Assumption: Premium price of the new "Bia Dingle" sustainable branded products: 15% [Price premium for organic beef and lamb is in the range of 15% to 20% (Teagasc)]
Total monetary value: 19,486,089 €/yr					Gross of the technology

Table 20 - SIP5: Quantification of collaborative benefits

Quantification of potential collaborative benefits

Description	Beneficiary	Valuation method	Benefit value (yearly, per single farmer)	Notes
Revenue increase from eCommerce sales of the creation of the new "Bia Dingle"	Farmers	MVI	First Annual Increased Revenue through eCommerce channels is computed: 14,886.2 €/yr × 119% = 1.,771.5€/yr Then Increased revenue from Premium price is applied to	• Assumption based on data: yearly increase of sales by 11.9% through eCommerce channel [Average growth rate of eCommerce sales worldwide 2022-

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branded products			increased revenues expected from eCommerce (1+0.1+0.45) × 1,771.5€/yr = 2,745.8 €/yr	2026: 11.9% (reaching 8,148 billion U.S. dollars in 2026) (Statista)] • Assumption: Premium price of controlled denomination of origin products: 10% • Assumption: Premium price of the new "Bia Dingle" sustainable branded products: 45% [Premium price of organic products ranges from +7% to +82% (ecoandbeyond)]
Increase of tourists and their spend on the "Bio District"	Experience providers; Restaurants; Farmers	MVI	**FOOD** Spend on food in Ireland every summer: 1,200,000 × 224€ × 12weeks =3,225,600,000€ Assuming that total tourism levels in non-summer season in Ireland is half of summer period, total Spend on food in Ireland every year is computed 3,225,600,000€+1,612,800.000€ =4,838,400,000€/yr **ACTIVITIES** Spend on activities in Ireland every summer: 1,200,000 × 105€ × 12weeks =1,512,000,000€ Assuming that total tourism levels in non-summer season in Ireland is half of summer period, total Spend on activities in Ireland every year is computed 1,512,000,000€+756,000,000€ =2,268,000,000€/yr	• 1.2 million tourists visit the Dingle Peninsula every summer • Average spend per tourist under the hypothesis of a 1week stay: 7 × 85€=595€ [Average spend per tourist in Ireland in 2019: 74-96€/day (mean:85€) (statista)] • Average spend on food per tourist in Ireland under the hypothesis of a 1week stay: 224€ [Average spend on food per tourist in Ireland: 32€/day (budgetyourtrip)] • Assumption: total tourism levels in non-summer season in Ireland is half of summer period • Average spend on activities per tourist in Ireland under the hypothesis of a 1week stay: 105€

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			Then total value venerated form the Bio District is computed: 4,838,400,000€/yr+2,268,000,000€/yr =7,106,400,000€/yr	[Average spend on activities per tourist in Ireland: 15€/day (budgetyourtrip)] •
Total monetary value: 7,106,402,745.8 €/yr				Gross of the technology

Table 21 - SIP5: Quantification of potential collaborative benefits

Remarks and potential collaborative improvements

Considering the main purposes of the project of i) retaining young generations in the area, avoiding depauperation of the region by generating incentives for the farmer profession ii) generating an agri-food and tourism-food economy.

Type of data shared within the project concern: distance from sensors, milk tank measurements hour, slurry tank measurement every hour, reporting every 24 hours, wind speed and direction, rainfall, air temperature, relative humidity, atmospheric pressure, soil nutrient requirement of lime. These real-time measurements could be integrated with meteorological information in the future.

This is possible through traceability methods which escort information of the applied farming practices.

Through this information it is possible to show the sustainability of the farming and breeding process. To be effective, the information must be simplified (perhaps into high, medium, low sustainability categories).

As for the first objective of retaining young generation by increasing the economic incentive of working as a farmer on the peninsula, higher revenue is possible thanks to the enhanced decision making by eventually sharing data on a common platform that all farmers involved in the SIP can access. Information on the platform can help farmers make better decisions, therefore increasing quantity and quality of the final product.

Some outcomes related to the second objective related to the creation of an agri-food and tourism-food economy are:

Experience

1. Creation of a Bio District where tourist can not only try and buy the products, but also participate in activities related to the production process (e.g. pasturing, milking, transformation of feedstock in its derivates). These activities can be enhanced by the complementarity of the offer from the network of farmers and tourism actors which is being generated. The prerequisite for this to be marketed properly is in the sharing of data that can certify the sustainability of the product and its production process. Currently, 1.2 million tourists visit the Dingle Peninsula every summer. The food tourism industry value is growing at a rate of 17.4%[24].
   Today, the term "Sustainable Community Destination" is used to provide a pathway to a bio district as this will engage a wider group of farmers. The Bio District could then be developed over a larger region than just the Dingle Peninsula.
2. Proposition of activities thanks to real-time data sharing. As an example, information from farm data on the herd displacements could be used to market tourist activities (e.g. related to the blossom of a specific plant or the herd movements). This contributes to strengthen the relationship instituted

[24] Report: Culinary Tourism Market: Global Industry Trends, Share, Size, Growth, Opportunity and Forecast 2022-2027

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between farms and experience providers (tourism actors) thanks to the sharing of data. Nevertheless, the attractiveness of this type of activity is yet to be assessed.

Data from platform showing sustainability

3. Generation of additional revenue streams through an eCommerce platform. The value generated can also be used to market products from the region (branded under the “Bia Dingle” name). The product is also integrated with the platform providing information about the sustainable production process, strengthening the association of the brand with sustainable attributes. Such platform could broaden the radius of sale capability, therefore improving revenue for the farmers (which is one of the leverages identified as crucial for retaining young generation, together with the modernization and digitalization of the production process).
4. Generation of certifications of the sustainable products. EvenKeel Platform contains all the information to assess the sustainability of the production process - thanks to the sharing of data between farmers and the technology providers - and can share them to provide information about the sustainability of the final product. For instance, QRcodes applied to restaurant menus can lead to information about the production process.

The remainder of the project will focus on developing and embedding those relationships and addressing the processing challenges to provide end to end proofs of concept, reducing the main barriers still in place: 1) lack of relationships between the tourism and hospitality providers and the farmers and 2) lack of processing facilities and skills to further develop signature products such as beef and lamb.

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5.6 SIP 6

Context and baseline

Sector and value chain stage: Agrifood **-** Soil preparation, production, harvesting.

Actors: ITC (Innovation Technology Cluster, SIP leader, DIH and technology provider), KGZS (public advisory service provider), Termodron (SME technology provider).

Initial situation: Only traditional farming techniques are used; fragmented data is available but difficult to track and find by all actors. Farming practices such as fertilisation and pest treatment are not optimized since farmers are not taking decisions based on actual data, resulting in irrational use of fertilizers and phytosanitary products that can have negative impact to environment, health and also production cost. Moreover, since data is not shared with the actors of the supply chain, farmers cannot guarantee the characteristics of their soil. For this reason, they are not incentivized to commit to maintaining or improving the soil's health.

Enablers

Enablers	Description
Vision and Strategy	Define a soil-passport approach for Slovenian farmers thanks to the data collected from the combination of different technologies and data sources and the sharing of such data with ITC and KGZS that will evaluate the treating of soil and give advice to farmers on how to treat the soil more efficiently and in an environmentally friendly way. Finally, data will enable a rewarding system for farmers adopting such practices.
Technology (hardware, software and infrastructure)	• **Platforms and sensors that** collect data about agro-environmental and soil parameters • **Remote sensing platforms** (satellite and drone imagery) **that detect** the crop status • **E-service platform** that stores central data to provide the farmers and other actors one entry point for performing smart farming practices. The platform produces accurate fertilisation plans and keeps the history of such plans for each field. The fertilisation plans can be downloaded by farmers, imported in their machinery, and used for smart farming practices
Processes and methods	Satellite imagery with the support of drones is used to gather data to produce maps with 2 or 3 different levels of NDVI values, identify different plant growth and stress areas as result of potential disease or pest occurrences, and identify different areas of growth for potential harvesting. On the basis of this data, targeted soil sampling is used to perform analysis of actual soil. That information is shared with the e-service platform to produce fertilization or spraying maps that are then prepared for farmers to perform targeted spraying of fields. The data can also be used to take harvesting decisions. Historical data is also integrated with the newly collected one to produce more accurate fertilisation plans and also to keep the history of such plans for each field. All the data related to used time, type and quantity of fertilisers, pesticides and harvesting quantity used can be tracked to have a comparison basis with the data without any optimisation. In other words, the adoption of a new data collection infrastructure that feeds a DSS can

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	support optimised targeted fertilisation by farmers, selective spraying with the goal to reduce the use of pesticides and define readiness for harvest and collect harvesting quantity for specific field areas. The previous processes are part of a soil-passport centred system, where collected data can rewards farmers that improve soil health treat by adopting more efficient and environmentally friendly practices.
People (skills and roles)	Small farmers with no data skills but supported by the technology provider.
Trust and Security	Technology providers can access the data; each farmer can access only their own data through user code and password. Data is stored on servers or cloud storage owned by the SIP partners.

Table 22 - SIP6: Enablers

Benefits Mapping

ID	Benefit description	Beneficiary	Benefit type	Data value chain step	Type of collaboration
1	Rewards for farmers adopting enhanced farming practices thanks to the soil passport (non-yet in place)	Farmers	Operational	Data exchange	One-step benefit
2	Increased revenue per hectare	Farmers	Operational	Data use	One-step benefit
3	Decreased cost related to soil sampling and treatment	Farmers	Operational	Data use	One-step benefit
4	Reduction of fertilizers and pesticides	Farmers	Operational	Data use	One-step benefit
5	Decreased production costs (spraying)	Farmers	Operational	Data use	One-step benefit

Table 23 - SIP6: Benefits Mapping

Quantification of collaborative benefits

ID	Description	Beneficiary	Valuation method	Benefit value	Notes
1	Increased revenue per hectare	Farmers	EVI	150 €/t × 5,2 t/ha × 5% = 39 €/ha	• Average price on market in 2021 for standard quality crop: 150€/t[25] • Average quantity produced 5,2 t/ha[1] • 5% estimated increase[1]
2	Decreased use of fertilisers[26]	Farmers	EVI	First, cost per kg of fertiliser is computed:	• Average value of fertilizer for complete

[25] Republic of Slovenia, Statistical office (https://www.stat.si/StatWeb/en)

[26] The data utilized is referred to early 2022. It is an example of application of the formulas, the real value of the work.

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				140 €/ha ÷ 500 kg/ha = 0.28 €/kg Then, knowing that farmers will use 25% less of fertiliser per ha, the new cost per ha is computed: 0.28 €/kg × (500 kg/ha × 75%) = 105€/ha In conclusion, the farmer saves 35 €/ha	season estimated to 500kg/ha[1] • Cost per season for fertilisers estimated to 140 €/ha[1] • 25% decreased use of fertilisers per ha[1]
3	Decreased cost of fertilisation process (worktime, materials, operating costs) due to use of precise farming techniques[27]	Farmers	EVI	First, total cost to fertilize 1 ha, excluding the cost of the fertiliser, is computed: 30 €/ha + 120€/h × ¼ h/ha = 60 €/ha Then, the saving per ha is computed: 60 €/ha × 10% = 6 €/ha	• Other production costs 30 €/ha not including fertilisers[1] • Average work and equipment price 120 €/h[1] • ¼ h required to fertilize 1 ha[1] • 10% decrease in cost of fertilisation practices[1]
4	Decreased cost of spraying process (worktime, materials, operating costs) due to use of precise farming techniques	Farmers	EVI	First, total cost to spray 1 ha, excluding the cost of the treatment products, is computed: 40 € + 160 €/h × ¼ h/ha = 80 €/ha Then, the saving per ha is computed: 80 €/ha × 10% = 8 €/ha	• Average work and equipment price 160€/h[1] • ¼ h is required to spray 1 ha[1] • 40 €/ha not including treatment products (not included because the cost can vary too much depending on the product and on the structure/crop/field) [1] • 10% decrease in cost of spraying practices[1]
Total monetary value: 88 €/ha					Gross of technology costs, since SF infrastructure is covered by ITC and the e-platform is free to use

Table 24 - SIP6: Quantification of collaborative benefits

[27] The data utilized is referred to early 2022. It is an example of application of the formulas, the real value of the work.

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Remarks and potential collaborative improvements

Thanks to the SF infrastructure, data can be collected to enable a rewarding system for farmers through a soil passport. The system can exist only if a collaboration is in place between the various actors through the sharing of data (the data collected from the field is shared to Termodron for a first analysis, then to KGZS and finally arriving to farmers ready to be used). Moreover, in the future, the soil passport could potentially re-shape the public subsidy system through the introduction of state subsidies and land lease.

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5.7 SIP 7

Context and baseline

Sector and value chain stage: Wine sector (Cyprus) - Production, post production, industrial processing, retail.

Actors: ARI (Agricultural Research Institute, SIP leader, supporting policy making through research), NEUROPUBLIC (technology provider), Oenou Yi (farmers, agronomists and winery), Filagro Group (exporting company)

Initial situation: Currently no information in terms of quality, location, and applied sustainability practices are collected. Existing technology is unable to collect and share data through the supply chain and decisions are not data-driven due to the absence of a DSS. A monitoring system for pest problems is employed but requires a substantial workforce of agronomists resulting in high operating costs. Moreover, the efforts placed in reducing pesticide application through this monitoring system cannot be conveyed to the consumers.

Enablers

Enablers	Description
Vision and Strategy	The collection and sharing of data related to the wine production process can add value to the final product by informing the consumers about its quality, its provenance and the sustainable farming practices employed. This can be done by combining a monitoring system with a traceability solution and digital labels. The collection and sharing of data will allow the winery to collaborate with Filagro Group, an exporting company, in order to reach new high-price markets, as well as to reposition the wines in the local market to reap additional value. The winery will also be able to minimise the application of fertilisers and pesticides through the support of a DSS; hence reducing the production costs, improving the fruit quality and reducing the environmental footprint of the production. In addition, the winery is willing to share SF data and digital labelling concept with local wineries, farmers and consumers, aiming at the development of a collaborative business model that will help improving market transparency and the sustainability of the wine sector. ARI will support these efforts by providing expertise on marketing recommendations.
Technology (hardware, software and infrastructure)	• **IoT stations and mobile proximity sensors** that collect data about agro-environmental and soil parameters • **Remote sensing platforms** • **DSS** and **cloud computing infrastructure** that enables digital record keeping and real time access to weather conditions at the farm, provides weather forecast on a parcel level, visual indications on potential future pest infestations, current irrigation needs, recommendations on pest management and irrigation actions thus supporting decision making with regard to farming practices. • **Traceability solution** that collects all the needed data/proof to secure digital labelling to guarantee the related product quality and sustainability information to the consumer. The solution could

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	potentially be used for the acquisition of a carbon free label or a similar sustainability-focused label with world recognition. • **Data interoperability - Data management platform** that facilitates uniform collection, maintenance and provision of data, enabling data sharing across partners in the supply chain.
Processes and methods	Data is collected through the SF services and used to produce advice through a DSS which is then followed by the agronomists of the winery. Agronomists can manually enter data in the DSS and share their feedback to further improve the DSS forecasts. Applying the advice as well as monitoring and documenting the results with the help of the appropriate ICT tools, are to be done in close collaboration with the Oenou Yi agronomists and consultants, as well as ARI scientists, which will be trained and supported by the technology provider. This system is connected with the traceability service to support the digital labelling solution (QR codes) through the exchange of data.
People (skills and roles)	Winery staff have no advanced data skills, but they receive support and training by the technology provider. Moreover, ARI will further support the local farmers in adopting new data-driven technology solutions and will act as an innovation push from the policy side.
Trust and Security	Farmers appear reluctant to adopt new technologies and they do not feel that they can trust them. Moreover, they are not familiar with the complex concept of sustainability. It is necessary to involve the ARI to: • Change farmers' way of thinking towards the fact that information sharing is necessary and essential to achieve the SIP vision, since they might be reluctant to share their data. • Help farmers trust the fact that good sustainability performance (environmental, economic, social) is an essential element of success.

Table 25 - SIP7: Enablers

Benefits mapping

ID	Benefit description	Beneficiary	Benefit type	Data value chain step	Type of collaboration
1	Additional revenue due to higher price achieved from the digital labelling approach	Farmers and Winery (and Filagro Group)	Operational	Data exchange	Two-step benefit
2	Enhanced Brand's image due to the superior product quality (resulting in increased customer loyalty and competitive differentiation)	Winery (and Filagro Group)	Strategic	Data exchange	Two-step benefit
3	More visitors in the winery and support locality	Farmers / Winery	Strategic	Data exchange	Traditional
4	Less water consumption	Farmers / Winery	Operational	Data use	Traditional
5	Reduction of pesticides	Farmers / Winery	Operational	Data use	Traditional

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6	Improved fertlisation efficiency to avoid soil health degradation due to nutrition loss	Farmers / Winery	Operational	Data use	Traditional
7	Decreased fuel input	Farmers / Winery	Operational	Data use	Traditional

Table 26 - SIP7: Benefits mapping

Quantification of collaborative benefits

ID	Description	Beneficiary	Valuation method	Benefit value	Notes
1	Revenues increase due to premium price	Winery, farmers, Filagro	EVI	Firstly, average price per ton of wine is computed: 20,981,000 € ÷ 8,585 t = 2,444 €/t Then, average quantity of wine produced by one winery: 8,585 t ÷ 61 w = 141 t/w Finally, the added revenue per each winery generated from the premium price: 141 t/w × 2444 €/t × 5% = 17,230 €/w	• 10% increase in perceived wine quality (assumption: 50% of the increase is reflected on the final price) • Wineries (w) in Cyprus: 61[28] • Market size of wine in Cyprus (last data available): 20,981,000 € [29] • Production of wine in Cyprus (last data available): 8,585 t[30]
Total monetary value: 17,230 €/w					

Table 27 - SIP7: Quantification of collaborative benefits

Remarks and potential collaborative improvements

The use and exchange of data across the supply chain can generate benefits across the various actors, especially the winery. In fact, the employment of sustainable practices and the reduction of harmful inputs thanks to the use of data will substantially improve the wine quality and thus support the development of Oenou Yi, which will potentially increase its brand international recognition and profits thanks to the premium price.

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[28] Source: Republic of Cyprus, Statistical Service. Industrial Survey 2020.

[29] Source: Republic of Cyprus, Statistical Service. Industrial Survey 2020.

[30] Source: Republic of Cyprus, Statistical Service. Sales of industrial commodities of local production by type, 2017–2020.

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5.8 SIP 8

Context and baseline

Sector and value chain stage: Arable, Horticulture - Production, Retail

Actors: Udea (wholesaler of organically and sustainable products), ZLTO (farmer association), FarmHack (technology provider)

Initial situation: A lot of data regarding soil management and soil condition needs to be collected to be able to model and monitor carbon sequestration in the soil. Currently, that data is mostly collected manually on spreadsheets, and no machine data is collected at all. Farmers are not using all the available techniques to optimize carbon sequestration since there are not incentives to do so. There is a problem in ensuring the correctness of measurements regarding carbon sequestrations quantity since farmers use different measures and methods.

Enablers

Enablers	Description
Vision and Strategy	Thanks to the availability and collection of data on farm level linked to carbon sequestration, it is possible to develop a compensation system for farmers. In particular, a data driven support system that analyze the data and quantify the amount of carbon provides input for the compensation model between Udea and farmers.
Technology (hardware, software and infrastructure)	• **Data logging equipment for agricultural machinery**: log data on activity time, coordinates, and technical machine data (ex. fuel consumption, rpm, speed, machine type) • **Data collection infrastructure**: sensors to collect data by national weather institute regarding temperature (real time, day max, day min, day average), humidity, and precipitation • **Carbon monitoring tool**: a tool capable of analysing farm data to monitor soil carbon on farm level and ensure the compliance with carbon standards to compensate the farmer • **API for satellite imagery**: acquire data on normalized difference vegetation index (NDVI) • **Algorithms for detection of measures from the raw data**
Processes and methods	Firstly, data on the actions conducted on the fields, soil and farmland conditions is collected by farmers, while data at farm appliances is collected through sensors. Data is then transferred and analysed by a DSS which provides advice on soil management practices to farmers and to a carbon tool capable of modelling carbon levels in the soil and guaranteeing the compliance with carbon standards.
People (skills and roles)	Farmers' lack of knowledge must be addressed to introduce new techniques and technologies. Farmers need to be aligned with Udea's goals (i.e. reduce CO_2).
Trust and Security	The compensation scheme is reliable and trustworthy to ensure that the farmers are fairly rewarded.

Table 28 - SIP8: Enablers

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Benefits mapping

ID	Benefit description	Beneficiary	Benefit type	Data value chain step	Type of collaboration
1	Increased revenues thanks to the sales of carbon credits	Farmers	Direct monetisation	Data use	One-step benefit sharing
2	Increased income thanks to resilient soils, which results in less fluctuation in yields	Farmers	Operational	Data use	One-step benefit sharing
3	Customers' satisfaction increased because they are supporting a climate neutral business	Udea, Farmers	Strategic	Data use	One-step benefit sharing

Table 29 - SIP8: Benefits mapping

Quantification of collaborative benefits

ID	Description	Beneficiary	Valuation method	Benefit value	Notes
1	Sales of SOC certificates (ex. Positive variation of carbon in soil generate certificates)	Farmers	MVI	45 €-100€/t of CO2[31] in 2021 in Deutschland	
Total monetary value: 45 €/t					

Table 30 - SIP8: Quantification of collaborative benefits

Remarks and potential collaborative improvements

Thanks to the collected data on farm level, it is possible to develop a compensation system for farmers, creating an additional source of income and building resilient soils.

[31] Source: https://carbonmarketwatch.org/2020/12/21/what-can-we-learn-from-the-dutch-national-carbon-tax/#:~:text=Under%20the%20carbon%20tax%20plans,a%20ton%20of%20CO2.

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5.9 SIP 9

Context and baseline

Sector and value chain stage: - Surplus food redistribution and rescue - downstream the agrifood value chain (Serbia).

Actors: Foodscale Hub (FSH, SIP Leader), Green Growth Platform (GGP)

Initial situation: North Macedonia and Serbia do not have an incentive system for food donation. On the contrary almost all surplus food, due to the presence of VAT on donations, is destroyed through expensive processes that harm the environment because it is still the cheaper solution. Nonetheless, due to the absence of collected information on logistics and other waste management processes there are not solid solutions in place to help the farmers and local producers to decrease food destruction costs, or that can estimate the amount of wasted food. Finally, if a donor wants to donate food, they are unable to easily find organisations willing to accept the food due to the absence of contacts information. In this way, finding suitable organisations takes more time and effort than the donors are actually willing to commit.

Enablers

Enablers	Description
Vision and Strategy	Collect data regarding the downstream value chain, especially regarding the surplus food produced, to develop a platform connecting agriculture holdings, supermarkets and other food producers and distributors with food insecure end users to decrease the amount of wasted food. Thanks to the data collected, it will be possible to align the logistics for safe destruction of surplus food and the estimation of the amounts of food that is to be thrown with the procedures of intermediaries involved in the transfer, storage, and distribution of food to the end user.
Technology (hardware, software and infrastructure)	• **Traceability solution:** platform allowing information traceability all the way through the supply chain, from manufacturing to consumption. The food business (retail grocers, farmers, producers, distributors, and foodservice operators) can track their donations and discover who they benefit. • **Data sharing and Data driven technology:** clients (web and/ or mobile ones) need to access to updated data as soon as possible. The backend layer will be able to serve every day a new status of users' data by executing data aggregation flows and algorithms without affecting users' experience. • **E-platform (FoodSHare):** offers a secure and convenient way for food businesses to connect with frontline charities and community groups to streamline surplus food donations
Processes and methods	Data of the food donors, end-user organisations, and volunteers is collected upon registration on the platform including name, address, description and other important information. For example, donors must also register whether they are already donating food and the average quantity donated, their preferred end-user organisation and how many food insecure people will be served. Volunteers will be able to select whether they will be participating on a regular basis or on the one-time basis when available. Moreover, data is shared with the various actors to inform them about upcoming events and donations (ex. donation status, donation start & end date, etc…). Thanks to the traceability service,

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	companies can see exactly where their donation goes and who they are helping. Moreover, based on the FoodSHare dashboard and data collected, it is possible for the companies to unearth key insights, visualise their trends and optimize their surplus management.
People (skills and roles)	To have more companies involved in this SIP, it is necessary to raise awareness around corporate-social responsibility and community building downstream the agri-food value chain
Trust and Security	Public data is shared via "FoodSHare Donations" and "FoodSHare Events" pages, while internal data is only shared with relevant H2020 Ploutos consortium partners for analytics purposes. Data is stored on FoodSHare platform. To use the data on the platform it is necessary to declare to use the data only for non-commercial use. This data will be published in anonymous form. No personal sensitive data will be collected. No personal sensitive data will be collected by the FoodSHare platform.

Table 31 - SIP9: Enablers

Benefits mapping

ID	Benefit description	Beneficiary	Benefit type	Data value chain step	Type of collaboration
1	More surplus food saved from increased number of actors involved in donations	Food insecure end users	Operational	Data use	One-step benefit sharing
2	Increased clients' satisfaction because retail chains support the rebalancing the value chain in favour of farmers and local food producers who introduce sustainability criteria in their practices	Retail chain	Strategic	Data use	One-step benefit sharing
3	Better terms of collaboration from the adoption of environmentally friendly waste disposal	Farmers and local food producers	Operational	Data use	One-step benefit sharing
4	Decreased costs for food waste disposal thanks to optimized processes	Farmers and local food producers	Operational	Data use	One-step benefit sharing
5	Decreased fertilizers use	Farmers	Operational	Data use	Traditional
6	Decreased fertilizers cost	Farmers	Operational	Data use	Traditional

Table 32 - SIP9: Benefits mapping

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Quantification of collaborative benefits

ID	Description	Beneficiary	Valuation method	Benefit value	Notes
1	Decreased cost for food waste disposal	Farmers and local food producers	EVI	First, tons of wasted food per farmer in Serbia is computed: (770,000 t - 1,425 t) ÷ 564,542 f = 1.36 t/f wasted each year Then, tons of wasted food per farmer in North Macedonia is computed: (100,000 t - 320 t) ÷ 454 f = 219 t/f wasted each year Then, waste disposal cost per farmer in Serbia is computed: 1.36 t/f × 100€/t = 136 €/f Finally, the saving per farmer in Serbia is computed: 136 €/f - 136 €/f ÷ 10 = 122.4 €/f	• Food waste disposal for companies in Serbia and North Macedonia is currently 0.1€/kg[32] • 10x decrease in cost of food waste disposal[33] • Annually in Serbia, 1,425 t[34] of 770,000 [35] t is donated, the remaining is wasted or lost. • Annually in North Macedonia, 320t[3] of 100,000 t[36] is donated, the remaining is wasted or lost. • 564,542 farms exist in Serbia[37] • 1781125 farms exist in north Macedonia[38]
Total monetary value: 122.4 €/f each year					

Table 33 - SIP9: Quantification of collaborative benefits

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[32] Source: Research conducted during the preparation stage

[33] Source: SIP's study based on the gathered data regarding the food quantities, types of food that public kitchens in Serbia and N. Macedonia have received through donations

[34] Source: "Food Bank Belgrade" and "Food for all - Food bank MK"

[35] Source: United Nations (Serbia) https://serbia.un.org/en/158555-how-why-and-how-much-do-we-throw-food-away#:~:text=%22Annually%20770%2C000%20tons%20of%20food,households%20struggle%20to%20secure%20meals.

[36] Source: https://borgenproject.org/food-waste-in-macedonia/#:~:text=In%20North%20Macedonia%2C%2040%25%20of,increased%20food%20prices%20for%20consumers.

[37] Source: http://publikacije.stat.gov.rs/G2019/pdf/G20196008.pdf

[38] Source: State Statistical Office of Macedonia (2016). http://makstat.stat.gov.mk

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Remarks and potential collaborative improvements

It is now possible to help food producers and retailers manage their surplus food and food waste by connecting them with organizations that could use that food through the FoodSHare platform and help charities that are in constant need of a food supply that would otherwise be wasted by connecting them with organizations that could use that food. This is made possible by the sharing of data across the supply chain, by boosting collaboration of all the actors involved, from farmers and local food producers to end users. The platform will reduce food waste, streamline donor-mediator communication, establish sustainable food supply infrastructure, link producers to sustainable compost areas, and lead retail chains to incentivize farmers and local food producers in a CSR framework by offering them better terms of collaboration, helping to rebalance the value chain in their favour.

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5.10 SIP 10

Context and baseline

Sector and value chain stage: Grapevine - Field Production

Actors: Horta (SIP leader, Technology provider), UCSC (University)

Initial situation: To comply with the law, farmers mainly record manually all information pertaining to their farms as well as information regarding the vineyard treatments they perform. Only a small number of farms currently use a DSS to support decision-making. There is no additional data gathered, and the data that is currently available is neither used to support the calculation of carbon credits nor for parametric insurance.

Enablers

Enablers	Description
Vision and Strategy	To calculate the amount (ton) of CO_2 saved and/or stored by winegrowers, convert it into Carbon Credits (CC) that can be sold on the voluntary CC market, and support the introduction of a parametric insurance, data on weather patterns, farming practices, and vineyard characteristics are gathered, integrated, and analyzed through a decision support system.
Technology (hardware, software and infrastructure)	• **Decision Support System (DSS):** enables the access to real time weather conditions at the farm, weather forecast on a parcel level, provides support on the operation to be performed to manage the vineyard (e.g. disease and pest management actions, application of fertilizers etc..), enables the possibility to register field operations and calculates sustainability indicators • **Weather stations and sensors:** automatically record data regarding temperature, relative humidity, precipitation, leaf wetness duration, wind direction and speed and send it to the DSS • **Traceability service**: keeps track of all the field operations
Processes and methods	Data collection procedures are defined together by farmers and the technology provider. Data must be recorded in the DSS to get access to the parametric insurance and to generate carbon credits.
People (skills and roles)	Farmers and agronomists have some basic data skills. Data are mainly recorded by the agronomist/technician that helps the farmer in its tasks or by the farmer himself. Moreover, to help farmers to use the DSS, they received a specific training from the technology provider. The DSS UI is designed to be user friendly.
Trust and Security	Trust must be built between farmers (especially "old-school" farmers) and the technology provider. Farmers need to trust on the DSS solution and on the support provided. It has to be clear for the farmers that it is possible to realize a successful implementation of the DSS, that can be helpful for them to achieve a sustainable management of the vineyard, and at the same time, it can allow them to access to the Carbon credits market and a parametric insurance mechanism.

Table 34 - SIP10: Enablers

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Benefits mapping

ID	Benefit description	Beneficiary	Benefit type	Data value chain step	Type of collaboration
1	Sales of carbon credits	Farmers' association	Direct monetisation	Data sharing	Two-step benefit sharing
2	Coverage for potential revenue losses thanks to the parametric insurance	Farmer	Operational	Data sharing	Traditional
3	Reduction of crop inputs (water, fertilisers, pesticides)	Farmer	Operational	Data use	Traditional
4	Reduction of fuel for crop operations	Farmer	Operational	Data use	Traditional
5	Reduction of labour for cropping activities	Farmer	Operational	Data use	Traditional
86	Reduction of time for administrative tasks	Farmer	Operational	Data use	Traditional
7	Increase of yield	Farmer	Operational	Data use	Traditional
	Increase of product quality	Farmer	Operational	Data use	Traditional

Table 35 - SIP10: Benefits mapping

Quantification of collaborative benefits

ID	Description	Beneficiary	Valuation method	Benefit value	Notes
1	Sales of carbon credits	Framers' association	EVI	Firstly, revenues per ha per single farmer are computed: 2.1 ha/f × 10 t/ha × 510 €/t = 10,710 €/f Finally, revenues increase per ha thanks to sales of carbon credits are computed: 10,710 €/f × 5% = 535.5 €/f	• Average hectares per farmer: 2.1 ha/f[39] • Average tons of grape for wine production per ha: 10 t/ha[40] • Average price per kg of grape: 51 €/100kg[41] = 510 €/t • Revenues increase per ha thanks to sales of carbon credits: 5%
Total monetary value: 535.5 €/f each year					

Table 36 - SIP10: Quantification of collaborative benefits

[39] Source: https://www.ismeamercati.it/flex/cm/pages/ServeBLOB.php/L/IT/IDPagina/4051#MenuV

[40] Source: https://www.ismeamercati.it/flex/cm/pages/ServeBLOB.php/L/IT/IDPagina/2314#MenuV

[41] Source: https://www.bmti.it/uve-vino/ , considering prices in the Piacenza area, where the SIP is located

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Remarks and potential collaborative improvements

Thanks to the collection of data enabled by the technological infrastructure, it is possible to calculate the carbon credits saved during the field phase and sell them in the voluntary market. This will represent a new source of income for farmers. The use of DSS also makes possible a reduction of costs for the management of viticultural operations (e.g., reduction of costs for plant protection interventions). It could be interesting to inform the client on the sustainability of the final product in order to increase the satisfaction of environmentally conscious customers.

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5.11 SIP 11

Context and baseline

Sector and value chain stage: agri-food and tourism. Pre-production, production

Actors: As Partners: ANYSOLUTION: SIP leader, technology provider**;** AGROMALLORCA: Processing Industry**;** COOPBAL: Farmers Union. Other entities involved through letter of support: TURISTEC: Digital Innovation Hub and Tourism cluster; Chamber of Commerce of Mallorca: Industry representative; University of the Balearic Islands: academic and research representative.

Initial situation: The territory is is managed for the most part (85%) by the agricultural sector, but there is also a very vibrant tourism sector which stimulates the economic activity of the area. The project aims at valorising both agricultural and tourist offering by integrating the two.

Enablers

Enablers	Description
Vision and Strategy	The challenge is addressed to increase the digitalization of the agrifood sector based on IoT solution NADIA and to disseminate the notion that agriculture is essential for the tourism and show how tourists are interested in the agricultural part of the Balearic islands. The creation of a system where the agricultural devoted lands also become a place to further stimulate economic gains from tourist activity appears to be a win-win perspective. Nevertheless, some challenges must be taken into consideration in order to correctly develop this synergy between agri-food and tourism. First of all, the islands' economic, social and environmental sustainability depend on balancing the two sectors. Secondly, the agricultural sector lags behind the other sectors in terms of innovation and adoption of the new disruptive technologies. The application of IoT solutions aims at making the agricultural sector more competitive and to generate more synergies with the tourism sector. This will increase its income and positive impact on the area. Data collected and shared between sectors include: • Environmental data/weather data (Temperature (real time, day max, day min, day average), Humidity, PAR radiation, evaporation, atmospheric pressure, wind speed, wind direction) • Cultivation related data (Parcel's coordinates, Cultivation type, irrigation system (water consumption), number of plants per hectare • Farmer's activities calendar data (day of planting, day of harvesting, growth (phenological) stages, blooming period, pesticides applications, performed irrigations, fertilisers)
Technology (hardware, software and infrastructure)	**Smart farming NADIA platform**. A suite of environmental sensing equipment along with data collection and processing mechanisms that support intelligent decision making with regards to farming practices. Through the use of smart-farming NADIA services AGROMA will have access to the following: a.) real time access to weather conditions at the farm b.) weather forecast on a parcel level c.) Soil conditions d.) Production predictions based on the different parameters used, as well as water consumption, pesticides, etc. **Traceability solutions** to share information throughout the whole value chain. This service will allow the "on the fly" collection and provision of data that are related with the applied (farming & processing) practices of the fruit and vegs product.

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	Smart farming technologies allow the detailed collection and digital storage of applied farming practices. Additional data related to the processing of the harvested fruit and vegs are collected and stored through the Ploutos Data management platform. The Ploutos traceability service will be able to collect data from different sources and render them to the authorized actors (e.g., fruit product consumers). **Data interoperability – NADIA Data management platform**. A data management platform designed by Ploutos that (along with the appropriate data translation mechanism) will facilitate a uniform way of collecting, maintaining and providing data. These mechanisms will support the overall realization of this SIP by enabling data sharing across partners in the supply chain. **Real-time multi-device monitoring and Benchmarking tools** to generate a catalogue which improves the information that can be shared with tourist operators. In order to generate synergies related to the identification of joint activities in the tourism and agricultural fields and other activities that complement and improve the farmer's position in agri-food value chains the proposed solution requires the development of new functionalities on the NADIA platform adapted to the agri-food sector.
Processes and methods	The process is structured following 4 main activities: 1) Deployment and operation of IoT infrastructure for data collection and analysis Goal: to deploy and operate an IoT infrastructure for data collection and analysis The activity is focused on the deployment and operation of an infrastructure for data collection and analysis. Sub-activities: • Preparation and analysis of the area and parameters to be monitored: 40 sensors were set up inside and outside of the greenhouse, analysing 35 parameters (and 17 more in the experimental station in lab). Furthermore, weather forecasts and records were used to establish the criteria that will be followed when watering to reduce the use of water. • Deployment and operation of a network of IoT devices: Deployment of the IoT network was fulfilled. Data is being gathered from the sensors and from a lab station. An agreement with the regional government was signed to use the LoraWan network. Virtual sensors have been defined, analysing 35 parameters. • Data collection and analysis: The data collected from the sensors is analysed and it allows for patterns to be established to automate the watering and window opening system to make sure parameters in the production area are optimal. 2) Design, Development and Deployment of the SIP11 technological and non-technological solutions Goal: Development of the crop and climate specific Smart Farming models services on irrigation and fertilisation and link to the tourism sector. Sub-activities: • Data and operational requirements: the optimal operational parameters to increase AGROMA's production, reducing costs and the use of resource were defined. Records are being generated to support decision making in the future.

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	• Development of Smart Agri-food Services: during this activity and as a result of monitoring the data provided by the sensors, AGROMA's experience and the data obtained from external sources, services were developed that will help reduce the use of water and pesticide. These services will provide standards for the different systems with the idea of keeping production parameters optimal. • Connection with Ploutos traceability solution: AGROMA has already in place a traceability solution. It is being checked if PLOUTOS traceability solution brings a new value to AGROMA or if the NADIA platform will be connected to the existing traceability solution instead, following Ploutos' good practices. • Development of Tourism services: First, key stakeholders from the tourism sector who can be related or linked to the agri-food sector were identified and a meeting was organised with some of them. A tourism service has been already identified in which local products from AGROMA will be sold in a well-known hotel in Mallorca as a souvenir. 3) Pilot trials and user testing <u>Goal</u>: Development of a data-based Smart Farming advisory system. Thanks to the data collection, a Smart System will be developed that will automate the processes and help users to understand how to make decisions concerning the production in each of the growing phases. The data will be used to generate synergies with the tourism sector. The agricultural Smart Services developed in activity 2, will not only help to automate certain processes but also carry out complex analysis on which are the next steps to be taken. It will make it possible to know how production is going, based on data, and how the different parameters measured will affect productivity and costs. This together with cross-referenced production, and pesticide and water consumption data and their application will help to offer an overall picture of the production that will help make smart decisions. Furthermore, since the project will cover at least two full production seasons, it will be possible to compare findings with different system configurations. Generate synergies related to the identification of joint activities in the tourism and agricultural fields and other activities that complement and improve the farmer's position in agri-food value chains. The proposed solution requires the development of new functionalities on the NADIA platform adapted to the agri-food sector. The processes traceability will be obtained from two harvests foreseen within the project. 4) Dissemination, demonstration and exploitation <u>Goal</u>: To disseminate and demonstrate the SIP results, aiming to support their exploitation after the end of the project. It also includes internal communication with the Ploutos consortium. <u>Sub-activities:</u> • Dissemination, demonstration and communication: Very active and intense dissemination and communication activities have been developed during this first part of the project., to ensure the extensive impact and long-term sustainability of the SIP outcomes.

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	Channels of communication include: i) online promotion and social media; ii) organization of field visits to the pilot sites in the context of the Ploutos Open Days that will take place in the SIP area within the project duration; iii) workshops and events at local, regional and national level (to spread the SIP's outcomes and reach a wider audience in the smart agri-food sector); iv) production of dissemination material and merchandising (optional); v) establishment of special links with the Tourism sector and organization of joint events will be organized; vi) participation in domain specific fairs (such as Palma Summit, FITUR or the IoTWeeK, as well as in online and offline events and networks that focus on promoting/lobbying Digital Farming solutions, like AIOTI and BDVA). The SIP will take advantage of existing online channels and events of related projects like H2020 SmartAgriHubs, CPS4AGRI as much as possible. Focusing on the replication and exploitation of the SIP results, we will take advantage of the network of DIHBAI-TUR, to have access to potential customers and or business partners. Finally, this activity will also include the connection and exchanges with the Ploutos consortium and the other SIPs. This includes participation in plenary project meetings, the Ploutos Innovation Academy Meetings as well as in the respective Ploutos dissemination and communication activities and events. • Commercial exploitation: This action will focus on the commercial exploitation of the validated solutions and the fair distribution of the created value. The SIP11 partners will try to measure the additional value created in AGROMA but also thanks to the link between the agri-food and the tourism sector. Based on the results of the pilot, a business model will be designed and presented in the form of a Business Model Canvas.
People (skills and roles)	An agri-food cooperative able to provide information and knowledge transfer to the agri-food sector. Link with the tourism sector. It is necessary a Digital Innovation Hub of the Balearic Islands skilled in Artificial Intelligence in Tourism and Agri-food. Supporting the link between tourism and agri-food to accelerate the innovation processes. Mallorca Chamber of Commerce with link with tourism sector. Awareness along the value chian on how to set up a data value chain able to exploit data in different sectors (agrifood and travel).
Trust and Security	The building of trust revolves around various aspects: • **Making farmers understand the importance of sharing data**. The project will start by collecting and sharing data of interest for the farmers (such as pests information). Once the farmers realize the value of sharing this type of data, they will be more inclined to share also other type of data. • **Collaboration who enjoy an excellent reputation**. The collaboration with trusted partners such as Agromallorca is a guarantee of trust, since Agromallorca is very strict about certifications (therefore gives quality assurance). Agromallorca, which was initially sceptical, has now become the one explaining,

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	thus contributing to engage the farmers. This is of the upmost importance for the diffusion of information and for generating commitment of other stakeholders (e.g. farmers) because the company already detains a high level of trust. • **Inclusive attitude towards farmers**. Dashboards has been built together with the farmers (They completely revised the dashboards and made them more customizable). They were very sceptical at first and now they recognize the usefulness of dashboards and the simplicity of obtaining information in the way that they want. The system is working with a high personalised dashboard that allows to follow up all data gathered and analysed, irrigation fertilisers and temperature is completely managed.

Table 37 - SIP11: Enablers

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Benefits mapping

ID	Benefit description	Beneficiary	Benefit type	Data value chain step	Type of collaboration
1	Savings thanks to the reduction of water consumption (-~20%) and pesticide use (-~10%) through intelligent decision making with regards to farming practices thanks to Smart farming NADIA platform.	Farmer AGROMA COOPBAL	Operational	Data use	Traditional
2	Reduction of production costs: ~18,6%	Farmers	Operational	Data use	Traditional
3	Increased final product value from enhanced quality and visibility: ≥ 10%	Farmers Travel operators	Strategic	Data use	Two-step benefit sharing
4	Production increase	Farmer; AGROMA;	Operational	Data use	Traditional
5	Higher level of economic balance promoted thanks to the diversification of the sectors and the collaboration between tourism and agriculture	Inhabitants; Travel operators	Strategic	Data sharing	One-step benefit sharing
6	Higher incomes thanks to data supported decision making (e.g. for irrigation or use of pesticides) will favour attractiveness of the farmer profession for young generations	COOPBAL AGROMA Inhabitants	Strategic	Data use	Traditional
7	Generation of new tourist services related to the agri-food sector: 3 at the end of the project	COOPBAL Travel operators Inhabitants	Strategic	Data sharing	Two-steps benefit sharing
8	Generation of new business models based on the efficient use of data, thanks to synergies between agriculture and tourism. For example information of almond	Fatmers; tourism acotrs	Strategic	Data sharing	One-step benefit sharing

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	blossom, visits to specific agrifood producers, etc., connecting with tourism operators				
9	Repeatability of integration of NADIA with Ploutos Traceability solution and methodology for acquiring certificates and labels in any kind of cultivation system that uses IoT	Farmers ANYSOL, AGROMA, COOPBAL, Processing industry	Operational	Data sharing	Two steps benefits sharing

Table 38 - SIP11: Benefits mapping

Quantification of collaborative benefits

ID	Description	Beneficiary	Valuation method	Benefit value (yearly, per single farmer)	Notes
1	Higher revenue from product sale for Tourism actors selling branded products and receiving a fee and for the farmer due to increased higher quality and visibility of the products and also inclusion of the eCommerce sale channel (€/yr)	Farmers; Tourism Actors	MVI	Increased final product value from enhanced quality and visibility: 232,500,000 € × 0.85 = 197,625,000 €/yr Fee for Tourism operators selling branded products 232,500,000 € × 1.85*0.01 = 4,301,250 €/yr Additional revenues from eCommerce channel 232,500,000 × 0.03 = 6,975,000 €/yr	• Assumption: the target of 80-90% increased value is met • The economic value of agri-food farms in the Balearic Islands was 232.5 million € and they occupied some 225,595 hectares[42] • Assumption: Tourism actor selling the branded product receives a fee of 1% • Assumption: eCommerce generates an increase of 3% in product sale
Total monetary value: 208,901,250 €/yr					Gross of the technology

Table 39 - SIP11: Quantification of collaborative benefits

[42] Source: https://mallorcaglobalmag.es/en/aumento-consumo-producto-local-proximidad-mallorca/#:~:text=According%20to%20the%20data%20analyzed,they%20occupied%20some%20225%2C595%20hectares.

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Quantification of potential collaborative benefits

ID	Description	Beneficiary	Valuation method	Benefit value (yearly, per single farmer)	Notes
1	Increase of total spend from tourists due to a more accurate marketing proposition exploiting almond blossom attractive capacity (€/yr)	Tourism Actors (Tour Operators, Hotels and other accommodations, …)	MVI	Average tourists per month (assuming an even distribution through the months): 16,450,000/12 =1,370,833 First the increased spend of tourists during the flowering months is computed: 0.01 × 1,370,833 × 159€/day × 30days = 65,388,734 €/yr[43]	• 16.45 million arrivals in the Balearic Islands in 2019 (pre-pandemic) (statista) • Average spend of foreign travellers in 2011 in the Balearic Islands: 159€/day Assumption: the spend of domestic tourists is identical to foreign ones' • Assumption: 1%[44] increase arrivals due to almond blossom
Total monetary value: = 65,388,734 €/yr					Gross of the technology

Table 40 - SIP11: Quantification of potential collaborative benefits

Remarks and potential collaborative improvements

Data is being collected uniformly through the NADIA Data management platform, enabling data sharing across partners in the supply chain.
Such data enabled synergies between agriculture and tourism can generate new business models based on the efficient use of data, as for example information of almond blossom, visits to specific agrifood producers, etc., connecting with tourism operators. Data about the state of maturity of the bulbs can be shared between farmers and tourism actors through the NADIA platform and generate a prompter capability to formulate an appealing offer for the potential visitors, therefore a higher number of visitors in the area.
Using a precautionary approach, an increase of 1% of tourists in February (flowering period) is assumed.

[43] The blossoming period lasts about one month each year.

[44] No data are available on the impact of such niche tourism, so a precautionary approach is taken.

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6 Conclusions

According to objective of this deliverable (Section 1.2), the literature review has led to the development of a data valorization framework to quantify and demonstrate the value of data and digital services (ex-ante and ex-post) to support decision making and wider exploitation of data in the agricultural sector. To do so, key variables such as the number and type of actors involved as well as the relationships among them, data available, IT instruments used, and the strategy chosen are taken into account to capture the essential characteristics of each case and to enable comparison. Besides, the main benefits achieved from data sharing/reuse enabled by the collaboration among actors are measured and assigned a monetary value using valuation methods like the Economic Value of Information and Expected Value of Information. In this way, it can be assumed that small farmers and the agricultural supply chain can understand how to exploit the real value of the data through sustainable collaborative business models.

The application of the framework on the SIPs highlighted that the exchange and use of data enabled by the collaboration of the various actors in the supply chain may:

i) guarantee that farmers are enabled to establish new profitable collaborations;
ii) lead to a continuous improvement of a DSS, resulting in better decisions communicated to and implemented by the farmers (hence increasing their efficiency and sustainability) and better tailored policies for a parametric insurance covering potential loss caused by unmanageable events which might negatively affect their revenues;
iii) generate additional value that can be distributed more equally across the supply chain, penetrate new markets, build a strong relationship with the customers and finally develop a sense of belonging that the customers establish with the farmers thanks to the complete transparency on the processes, practices and methodologies;
iv) produce KPIs to benchmark the farmers' performance and lead them to adopt more virtuous practices;
v) increase brand international recognition;
vi) create an additional source of income (e.g., sale of carbon credits);
vii) build more resilient soils;
viii) manage surplus food and food waste by connecting farmers with organizations that could use that food through an 7e-platform;
ix) reduce costs for the management of farming operations.

In conclusion, thanks to the application of the framework to the 11 SIPs, it is shown that data can be part of a collaborative process, being collected, pooled and then exploited to maximize the value created for all the actors involved in the agricultural supply chain.

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