D2.7 REPORT OF COPRODUCTION OF ENVISION SERVICES

Project: Monitoring of Environmental Practices for Sustainable Agriculture Supported by Earth Observation

Acronym: ENVISION

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List of Abbreviations

BiHOCS - Bosnia & Herzegovina Organic Control System
CAP - Common Agricultural Policy
CAPO - Cyprus Agricultural Payments Organisation
CB - Certification Bodies'(CBs)
DRXS – Draxis Environmental SA
DOA - Description of Action
DT – Design Thinking
ELMs – Environmental Land Management scheme
EO - Earth Observation
ILVO - Flemish Research Institute for Agriculture, Fisheries and Food
INOS – INOSENS doo Novi Sad
IT - Information Technology
LPIS - Land Parcel Identification System
LV - Flemish Region Payments Organisation
NPA - National Paying Agency of Lithuania
OCS - Doo Organic Control System Subotica
PA - Paying Agencies (PAs)
PAR - Participatory Action Research
RRI - Responsible Research and Innovation
URDG - University of Reading
UCD - User Centre Design
XP – Extreme Programming

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Executive Summary

This report presents the implementation of the coproduction processes. Thus, it outlines the outcomes of the series of consultations with the ENVISION end users in regard to their views and comments on the development of the ENVISION services. Coproduction can support uptake by end users by addressing issues such as ease of use, trust (evidence-based tool), habit and relevance to user, and potentially mitigate issues around lack of expertise in using EO data and remote sensing technologies, supporting the development of a platform accessible to all users and leading them through areas requiring new skills or technical expertise.

- The report follows the work presented in Deliverable 2.2. "Report of customer requirements from ENVISION services" that had produced qualitative information stored in the form of User Stories which have been analysed to identify common themes and patterns in stakeholder responses.
- A brief discussion of the importance of coproduction of services and products in the agri-food sector is presented followed by an outline of the potential stakeholders and challenges to consider in order to safeguard and undertake effective coproduction.
- Moreover, the key principles and considerations for effective coproduction are discussed and the need for a standardised framework of coproduction is described.
- A coproduction framework was implemented that considered the generation and advancement of overall knowledge, stakeholder experiences and networks, and future collaborations as equally important as final outputs and/or products.
- Coproduction within ENVISION has followed the integration of Design Thinking (DT) into Extreme Programming (XP). This approach aims to involve different stakeholders in a continuous, active, and iterative collaboration through five phases. This was integrated with the approach outlined by the e-shape project.
- Our goals were to: improve our knowledge of the main challenges in coproduction, inform the agri-food sector stakeholders about their possible roles and benefits in coproducing digital innovation, increase active participation by stakeholders, and share our insights with other large EU consortia that use coproduction methods.
- A set of specific themes have been evaluated by the software developers, consumers and end users in a series of interactive hybrid workshops. Results from the workshops guided the ENVISION product development and coproduction processes. User Stories we had created previously were updated, and ways to overcome coproduction difficulties (such as improving communication, defining partner roles and responsibilities) were found.
- We have demonstrated that coproduction is a valuable approach for developing innovative products and services for sustainable agriculture that can address complex and wicked problems(problems with multiple interdependent factors).
- A number of challenges and opportunities for improving coproduction practice and research are also highlighted.
- The key considerations for successful coproduction focussed on effective communication between stakeholders and facilitators, ensuring the process of coproduction was iterative, took account of stakeholder feedback and was adaptable, and ensuring active participation of stakeholders and facilitators in the process.

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1. Introduction and Background

This deliverable summarises the coproduction approach that WP2 has applied for the design and delivery of the ENVISION services and platform. We explain the methodological steps that we followed and showcase the final outcomes in relation to the current state-of-the-art in the relevant scientific literature. The coproduction and delivery of ENVISION is a process that lasts beyond the project lifespan. The findings presented with the proviso that the interpretation of these results may change when these are considered in scientific publications and hence reflecting the input of other academics and researchers in the area. This report also sets out the tasks for a successful completion of the coproduction process and provides an insight into the outputs produced.

1.1 What is coproduction?

> "*Coproduction rejects the idea of service delivery to passive users, proposing instead they be treated as active participants in the production of outcomes*." (Ryan, 2012)

The term "coproduction" was coined in the 1970's by Ostrom et al., (1978) with a focus on developing public services (Police services) through bringing together government officials and the public to coproduce services. This notion of service coproduction was further developed by Bovaird (2007) "*we define user and community coproduction as the provision of services through regular, long-term relationships between professionalised service providers (in any sector) and service users or other members of the community, where all parties make substantial resource contributions*" and later by Alford (2014) to include the coproduction of both products and services and expands on the importance of relationships within the development process.

Coproduction emphasises the need for feedback loops and the use of feedback as part of an ongoing process. The iterative process of collecting and responding to feedback is highlighted as a vital part of effective coproduction and can lead to substantial changes in the project outcomes (Knowles et al., 2021).

The process of coproduction can bring a range of stakeholders together for a range of different reasons. Within the sustainability sector, there are several key reasons why this is an important project management approach which can be characterised into six "*modes of coproduction*" (Chambers et al., 2021):

1. Researching solutions
2. Empowering voices
3. Brokering power
4. Reframing power
5. Navigating differences
6. Reframing agency

Chambers et al. (2021) also highlight two main motivations for the use of coproduction approaches;

1. to more effectively solve predefined problems
2. to reframe problems

Coproduction is a versatile term that can be employed to elucidate the intricacies of the manufacturing process. However, this flexibility in usage can sometimes give rise to confusion, especially when juxtaposed with other terms like "cocreation" and "codevelopment." In the realm of manufacturing

and production, the terminology surrounding collaborative efforts can be somewhat interchangeable, leading to potential misinterpretation.

When we delve into the concept of coproduction, it signifies a joint effort wherein multiple parties contribute to the creation or manufacturing of a product or service. This collaborative approach emphasizes shared responsibilities, resources, and expertise. The confusion arises when similar terms such as "cocreation" and "codevelopment" enter the discourse.

"Cocreation" suggests a collaborative effort that goes beyond the traditional confines of manufacturing, emphasizing a joint creative process involving not only production but also ideation, design, and innovation. This term often implies a more holistic and inclusive approach to the entire product lifecycle.

"Codevelopment," on the other hand, focuses specifically on the joint development of a product or technology. It underscores collaboration in the design and creation phases, highlighting shared input and mutual investment in research and development.

The challenge lies in the subtle nuances that differentiate these terms, making it imperative for stakeholders to clarify their usage to avoid confusion. While coproduction may encapsulate elements of both cocreation and codevelopment, each term carries its own distinct connotations. Precision in language becomes crucial in ensuring effective communication and a clear understanding of the collaborative dynamics at play in the intricate landscape of manufacturing processes.

In conclusion, the terminology surrounding collaborative manufacturing processes is rich and multifaceted. Navigating the intricacies of coproduction, cocreation, and codevelopment requires a nuanced understanding of each term's implications to foster effective communication and collaboration in the ever-evolving world of production.

1.2 Why use coproduction?

Why use coproduction as a process? Involving end-users in the development of decision support systems can support their uptake and use. Rose et al. (2016) propose a checklist for the production of agricultural decision support tools, to encourage uptake by farmers, the list includes: Ease of use; Trust (is the tool evidence based and do we have user's trust?); Habit (does the tool fit with the existing habits of the farmer?) and; Relevance to user. Coproduction can support these aspects of production and potentially mitigate issues around lack of expertise in using EO data and remote sensing technologies, supporting the development of a platform accessible to all users and leading them through areas requiring technical expertise they do not yet have.

1.3 What are the drivers of coproduction?

There are drivers from the EU in utilising coproduction and cocreation. End-users and practitioners are to be involved, not as a "study-object", but in view of using their entrepreneurial skills for developing solutions and creating "co-ownership" of results. This speeds up the acceptance and dissemination of new approaches." (European Commission, 2019).

The European Innovation Partnership for Agricultural Productivity and Sustainability (EIP-AGRI), an initiative based on collaboration between groups such as farmers, advisors and researchers and

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identifying the needs of end-users in order to cocreate and disseminate solutions to agri-environmental issues (European Commission, 2019). Two examples of these projects are:

- EuroDairy - https://eurodairy.co.uk/
- Inno4Grass - https://www.inno4grass.eu/en/project

In the UK the Environmental Land Management scheme (ELMs), intended to replace the CAP following the UK leaving the EU, has used aspects of coproduction with farmers and land managers involved in designing and testing the systems put in place (see, for example, Peak District National Park Authority, 2020). Drivers for coproduction should also consider the impact, benefits and value of using coproduction.

1.4 How can coproduction enhance the impact of the solution?

The product developed or research outcomes may be more likely to be used or implemented by stakeholders, leading to a greater impact than a solution "imposed" on stakeholders. Involving stakeholders in the development of policies, support systems or research can support their uptake, use and legitimacy (Armitage et al., 2011; Mann and Schäfer, 2018; Prokopy et al., 2017; Lemos and Morehouse, 2005). Resources produced through coproduction processes are more likely to be used by stakeholder groups (Ryschawy et al., 2019). Kenny and Regan (2018) highlight farmers' increased likelihood of using a geotagging app on their farms if User Centre Design (UCD) had been used both pre- and post- design. Coproduction and working with stakeholders to better ensure they understand the capabilities and potential of a system (or app) can also support the process (Kumar et al., 2020).

This increased uptake and potential impact could be due to a variety of reasons:

- Increased uptake of a coproduced solution could be due to the technology addressing the specific needs the stakeholders themselves defined at the beginning of the development process, and the tailoring of the application interface around the capacity of end-users to use such tools.
- The solution deals with issues raised by stakeholders, not perceived problems.
- Future proofing and sustainability – coproduced solutions may be more likely to be forward looking as they take into account concerns and issues "on the ground".
- Further reach – input from those who know the issues can be a selling point to others in same or similar situations. Fry and Thieme (2019) highlight how, although extensive guidance or instructions for use can be provided, including first-hand experiences and arguments from those who have implemented or changed practices can hold more sway.
- Social cohesion – awareness of the issues other stakeholders face can lead to acceptance of trade-offs that may not have been accepted if imposed (Ryschawy et al., 2019).
- Additional, originally unconsidered, issues or problems can be considered.

1.5 Benefits of coproduction

The process of coproduction, can itself benefit stakeholders.

- Stakeholder gain knowledge and experience of working with and between different communities and groups (Armitage et al., 2011).
- Bringing together stakeholders to work together on an outcome can foster a sense of belonging, leading to groups can remaining in contact after project completion. This echoed

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in, for example, Communities of Practice, where groups of individuals interested in topic form a group to share and exchange knowledge.

- “Ownership” of outcomes.
- Peer-to-peer learning and peer recommendations, leading to stakeholders sharing knowledge and experiences, see (for example) Rose et al., (2018).
- The end product or solution is more likely to be accepted and utilised by stakeholders (Lemos and Morehouse, 2005)
- There can be more rapid uptake of a product or solution by end-users.

1.6 Where has coproduction been used?

Coproduction has been used in a range of settings and sectors to bring together groups of stakeholders to develop a range of outcomes.

- Healthcare – healthcare providers / professionals and patients (for example, Coalition for Personalised Care, 2023)
- Sustainability and Environmental research (Galende-Sanchez and Sorman, 2021)
- Public policy and administration (Alford, 2014)
- Education

A variety of EU funded projects, have also used coproduction in a range of settings, brief examples are given in Table 1:

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Table 1: Example of coproduction projects

Project Title	Brief Description	URL
CONFER Coproduction of Climate Services for East Africa	"Focusing on climate adaptation through coproduction of Climate Services in East Africa. Our main objective is to codevelop dedicated climate services for the water, energy and food security sectors with stakeholders and end-users, to enhance their ability to plan for and adapt to seasonal climate fluctuations. With the help of statistical and machine learning tools, we want to improve the accuracy of weather forecasting in the region, in order to reduce impact associated with extreme weather."	https://confer-h2020.eu/
ENABLE	"... partners work together in a co-productive way to test and promote coproduction as a new participatory way to provide services for people with intellectual disability. The coproduction approach on which the ENABLE project has been developed is fundamentally rooted in addressing social injustice and inequity. Training and focus groups were approached from the standpoint of collaboration and partnerships that regard diversity and inclusion in training environments as vital assets that contribute to the richness, accessibility and effectiveness of learning and training activities."	https://coproduction.eu/project-3/
AGORA - A Gathering place to coproduction and cocreate Adaptation	"The project will focus on the coproduction and cocreation of innovative, problem-oriented climate-adaptation solutions. These cooperative processes will tap the insights of a wide variety of people: citizens, academics, experts, policymakers, entrepreneurs, representatives of civil society organizations, and other relevant actors. The aim is to generate solutions that can be widely adopted in Europe, and that can be tailored to specific contexts and needs to address ongoing socioeconomic change."	https://www.sei.org/projects-and-tools/projects/co design-and-cocreate-adaptation/

Coproduction has also been used widely within e-shape (https://e-shape.eu), an initiative that aims to foster the development of EO data and services for a wide range of stakeholders, including decision-makers, citizens, industry and researchers. e-shape has characterised, developed and utilised a wide range of coproduction processes. Coproduction methods were adapted to overcome the challenges relating to the effective use of EO data, such as the high levels of technical expertise needed and the diverse range of stakeholders involved. The e-shape coproduction framework was used within the ENVISION project following a self-assessment process and adaptation to fit the needs and scope of ENVISION (see Section 2).

1.7 Coproduction methodological frameworks

Coproduction can involve the use of a variety of research methods and approaches. For example, Participatory Action Research (PAR) aims to bring together researchers and communities / groups in order to develop solutions and knowledge in response to community needs. Working on the principle that communities have the expertise and understanding of their "local" needs it aims to give control to those experiencing problems and engage them in finding solutions, leading to more relevant, sustainable solutions and solutions that are more often adopted and utilised (Institute of Development Studies, 2023).

Figure 1 illustrates the stages of PAR (Lloyd-Evans et al., 2023) and highlights how PAR can be a circular / looped process, where sharing findings with stakeholders and taking action based on these findings is not necessarily the end point but can lead back into the research or development process.

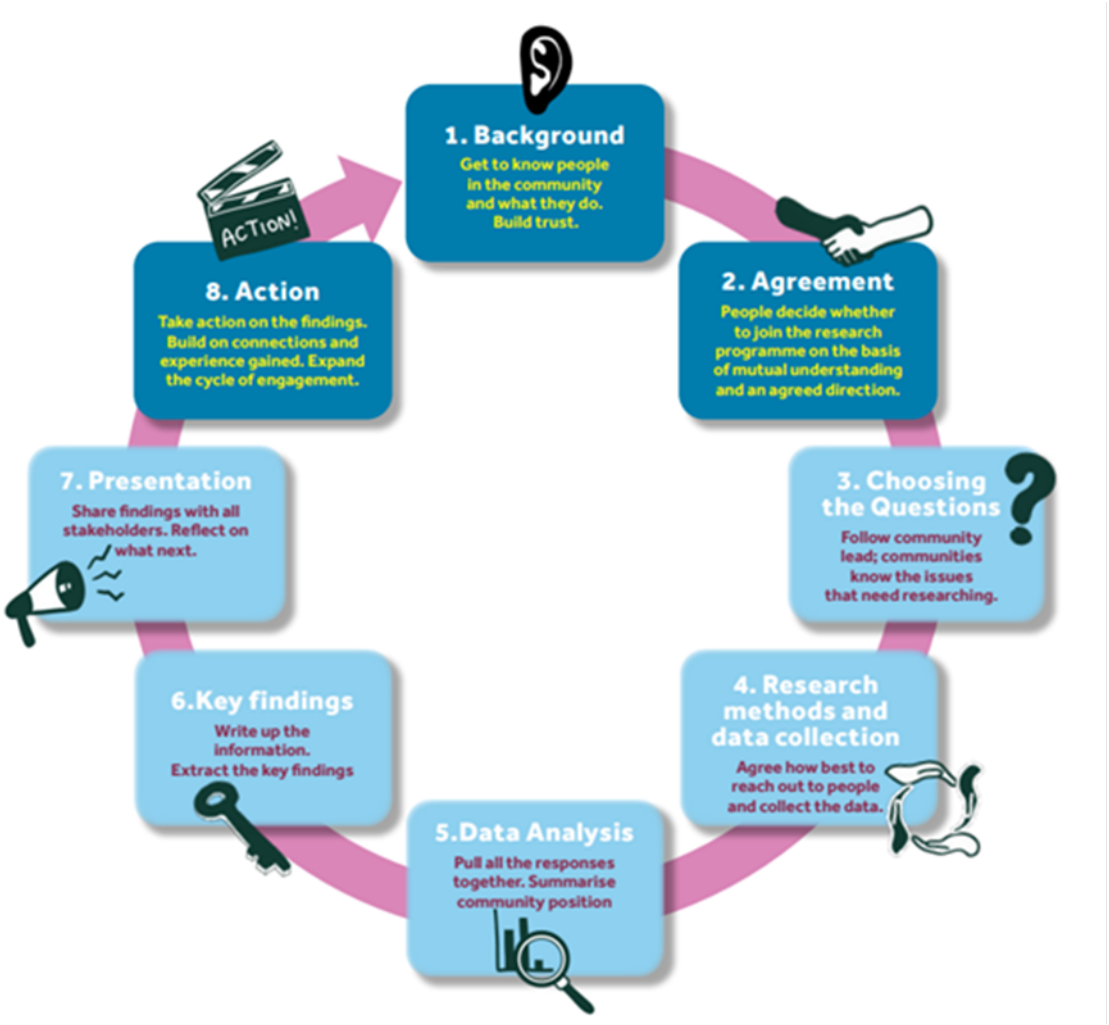

Figure 1. The 8 Stages of Participatory Action Research (Lloyd-Evans et al., 2023)

Design Thinking originated within engineering and technical product design and has now been adopted as a design process across various disciplines (Olsen, 2015). It has been defined as "an analytic and creative process that engages a person in opportunities to experiment, create and prototype models, gather feedback, and redesign" (Razzouk and Shute, 2012), and emphasises the need for engagement with the process of design (from both the designer and the people whose needs are being considered)

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through feedback and re-design processes. Design Thinking will also take into consideration technical feasibility and commercial viability.

Design Thinking incorporates five phases (Fig. 2): 1. Empathise; 2. Define; 3. Ideate; 4. Prototype and 5. Test (Kenny et al. 2021) which encourage understanding stakeholders and their needs and engaging with stakeholder feedback at all points.

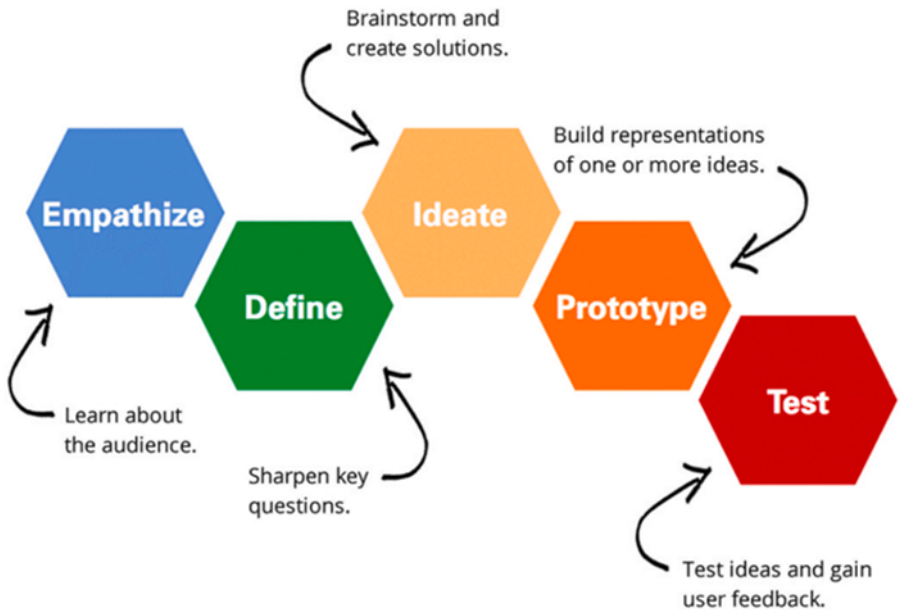

Figure 2. Five phases of design thinking used by Kenny and Regan (2021) in co-designing a smartphone app for, and with, farmers

1.8 Coproduction tools

Coproduction can utilise a range of methods and techniques, these could include interviews, workshops, focus groups and surveys. One example of the types of survey used is the Delphi style, where the systematic, interactive and iterative process fits with the "feedback loops" which support the process of coproduction. Himanen, (2016) describe the use of the Delphi system in coproducing resilient food systems, whereby the iterations and feedback within the Delphi process supported coproduction. "Feedback and re-evaluation based on accumulating knowledge should be assistive in coproducing solutions toward developing food system resilience."

Consideration also needs to be given to how these methods are used. For example, are workshops and interviews held in person, or online? Or is a combination of delivery modes used? Medema et al. (2014) discuss the benefits of using Virtual Learning Platforms, whereby an online space "... fosters equal access and a democratic environment for all actors carrying a diversity of views and opinions. It also provides a safer and more accessible environment to the wider public for more easer and open engagement and expressions of views and opinions.". However, stakeholders need to be able to effectively access the technology required for online participation which could require software or accessible and good quality internet access, which may be an issue for some.

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1.9 Coproduction stakeholders

Who are the specific stakeholders within the agri-food sector we need to consider within ENVISION? The stakeholders who need to be involved in a successful coproduction process will depend on the focus and end-point.

Within ENVISION there are a broad range of potential stakeholders, for example:

- Farmers, landowners, agricultural workers
- Paying Agencies and Certification Bodies
- Retail sector
- Consumers
- Scientists and Researchers
- Decision Makers
- Other software developers

When considering the involvement of each stakeholder, their role within sector needs to be identified, relationship dynamics need to be understood, and what influences stakeholders have on decision making and technologies. The ENVISION project brings in relevant stakeholders as outlined in the methodology section (

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3. Methods).

The selection of stakeholders may also have to take into account the constraints stakeholders can face in being involved in the process. For example, Agricultural Advisers could take on the role of end users on behalf of farmers if they have fewer time constraints and are able to disseminate knowledge or research wider due to their access to larger numbers of groups or individuals (Prokopy et al, 2017).

1.10 Challenges of coproduction

Establishing and bringing together groups of stakeholders for coproduction can be challenging. Cultural differences can cause difficulties in discussions and enabling all stakeholders to have the opportunity to both speak and be heard. Time constraints may also be an issue. The coproduction process can be time consuming and, stakeholders may have limited time available to contribute to the process. Accessing a physical or online space in which stakeholders can meet may also be problematic. Physical meetings may require travel time and incur costs, online or virtual meetings (for example via Zoom or MS Teams) requires stakeholders to have access to technology and an internet connection that enables them to participate in full.

Ensuring all stakeholders can contribute is important. Communication needs to be enabled between all stakeholders. There could, for example be language constraints, both in terms of stakeholders having to communicate in their non-native language and the use of “discipline-based” or “expert” language. Hierarchies could also form and it is important to emphasise that coproduction aims to give all those involved in the process a voice. Norstrom et al. (2020) highlight the need for frequent interactions between all participants in the coproduction process and the need to avoid token participation. Galende-Sanchez and Sorman (2021) undertook a review of the coproduction of sustainability policy focussed projects that used coproduction. They highlight that many of the projects (60%) although described as coproduction, did not go beyond a consultation model, and note that in these instances it is often experts that were the focus, not the diverse range of stakeholders. The roles and responsibilities of stakeholders in the process need to be clarified and communication between different groups enabled.

1.11 Principles and key considerations for effective coproduction

What needs to be considered when designing and implementing coproduction? Beier et al. (2016) developed a series of recommendations for coproduction which included a set of guiding principles and recommended practice. Emphasis was placed on sharing of both knowledge and the constraints faced by different groups of stakeholders, for example with scientists this could involve discussing uncertainty around research results. Flexibility was also highlighted; for example, adapting the outcomes of the coproduction process to range of different scenarios or contexts. Using evaluation to feedback on the process of coproduction as well as the outcomes in order to improve following iterations was also highlighted as an important step in the process of coproduction. Barbier et al. (2021) explore four “types of co-design actions”, to link different stakeholders in the co-design process. Different actions could be relevant at different stages in the process or with different groups of stakeholders, potentially leading to a dynamic process where actions could be changed depending on progress and issues within the project.

2. ENVISION Coproduction framework

In this section, we present the methodological frameworks that describes the ENVISION coproduction approach for the development of a platform, mobile application, EO-based monitoring services, and data products to facilitate sustainable agriculture through compliance with the EU CAP. While ENVISION, as an EU H2020 Innovation project, primarily aims to produce a commercially viable and desirable toolbox to address specific needs of the agri-food sector, we implemented a coproduction framework that considered the generation and advancement of knowledge overall, stakeholder experiences and networks, and future collaborations as equally important outputs/products. Through the specific activities described in the following sections, WP2 ultimately aimed to enhance our understanding of key coproduction challenges, raise awareness in stakeholders of the agri-food sector regarding their potential involvement and benefits of coproduction for digital innovation, maximise stakeholder active engagement, and share the lessons learnt with other large EU consortia that employ coproduction approaches.

2.1 ENVISION coproduction stakeholders

Identifying and engaging with all potential stakeholders is among the most critical and challenging aspects of developing an effective coproduction approach, particularly when considering such complex concepts as sustainable agriculture and ambitious targets as the commercial implementation of innovative digital technologies, as ENVISION does. ENVISION identified the following main groups of stakeholders that would play a key role in the development of commercially desirable and viable EO-based monitoring technologies addressing CAP requirements for sustainable agriculture:

- Business cases – here we identified members of the three Paying Agencies (CAPO, NPA, LV), one Certification Body (OCS), and one Farm Assurance Scheme (LEAF) pilots. This diverse group consisted of a range of experts including senior governmental officers, administrative officers, field inspectors, IT experts, and associated farmers.
- Developers – this group involved platform, service (i.e., model), and mobile application developers from AgroApps, DRAXIS, NOA, and EV ILVO, consisting primarily of IT experts and project managers.
- Coproduction facilitators- – this group included academics (URDG) as the lead coproduction facilitators, and involves a collaboration with researchers and service developers (EV ILVO) for the monitoring of business case implementation, as well as with communications managers (ITC) and project managers (DRAXIS) to address specific coproduction challenges such as potential issues with dissemination of information and materials, lack of resources and time, etc.
- Lighthouse customers, advisory board members, and other external stakeholders – here we identified potential users of the ENVISION platform, services, and mobile application that were external to the project consortium, but expressed an interest to be actively involved in aspects of the coproduction process (e.g., design, testing). The group involved among others Paying Agencies, Certification Bodies, farmers, academics, and IT developers.

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2.2 Design Thinking into Extreme Programming (DT-XP)

As set out in the DOA, in order to improve the quality and usability of the ENVISION software interface for customers and end users, Design Thinking (DT) practices were integrated into Extreme Programming (XP) development processes. The DT-XP coproduction approach that describes the ENVISION product development journey, attempted to engage the groups of stakeholders described in Section 2.1 in a continuous, active, and iterative collaboration through 5 phases, formulating specific objectives and using appropriate engagement methods as presented in Section 2.3.

2.2.1 Extreme Programming

Extreme Programming (XP) is an agile software development methodology that focuses on user centricity. It improves software development in five ways; communication, simplicity, feedback, respect and courage (Erikson et al., 2005). This methodology considers customer satisfaction at its core and aims to involve all partners in a collaborative team as equals and empowers developers to respond to changing customer requirements (Wells, 2013).

2.2.2 Design Thinking

Similar to XP, Design Thinking (DT) describes an iterative, interactive, human-centred development process that involves collaboration, and interactive visualisation and testing of prototypes and business plans (Lockwood, 2009). Further to XP, DT proposes 5 distinct phases in the innovation process through which users can define problems collaboratively, identify potential solutions, develop and test those, and develop plans for their commercial implementation and viability. The implementation of these phases in the context of ENVISION is described in more detail in the section "The 5 phases of Design Thinking in ENVISION" below and summarised in Fig.3.

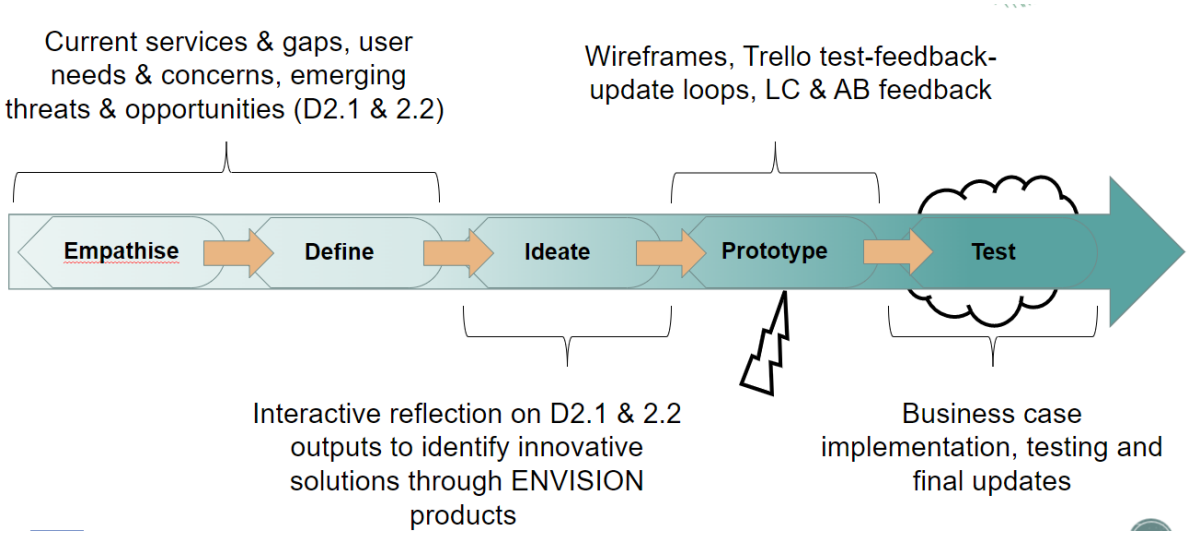

Figure 3. Summary of DT phases in ENVISION

2.3 e-shape coproduction framework

In addition to integrating DT into XP methods, the coproduction methods used in ENVISION were aligned with the coproduction framework that was being developed concurrently by colleagues in the e-shape project (Barbier et al., 2019a; Barbier et al., 2019b). This e-shape coproduction framework is

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specific to the EO context in recognition that developing services based on EO data must be able to cope with specific challenges, namely;

- A high level of technical expertise is needed - combining both knowledge on data processing and knowledge on the domain of the final usage;
- There is a heterogeneity of actors that might contribute to the successful development of user-centric services - not only users and researchers but potentially all other actors of the ecosystem - related to legislation, platform owners, technical developers etc.

The finalised e-shape coproduction method, based on recent advances in design theory has two phases (Barbier et al., 2019a and refined in Barbier et al., 2019b)

- Phase 1: a diagnosis process to identify the coproduction needs and the actors to be involved;
- Phase 2: the implementation of coproduction actions based on this diagnosis.

In this e-shape framework, the coproduction of EO-based services is described as a toolbox to support building relationships between data, information and usages with a long-term perspective. In order to develop resilient solutions, the constitutive elements of the coproduction process should be designed to guarantee the sustainability of the developed services by ensuring:

1. information is “use-generative” (that is having the power of generating multiple usages)
2. data-information relationships are able to adapt to future advances
3. information-usage relationships are able to cope with multiple usages.

Through consultation with e-shape colleagues regarding their coproduction methodology (see Supplementary materials S1), ENVISION followed the broad outline steps for Phase 1 in Task 2.2 (reported in Deliverable D2.2) and implemented Phase 2 in Task 2.3. Here we summarise how the DT stages were aligned with the six-step e-shape process in Phase 1 (that was adapted to serve the needs of the activities and objectives in ENVISION Task 2.2) and how this led to coproduction actions in Phase 2 (Task 2.3).

2.4 The 5 phases of Design Thinking in ENVISION (integrated with the e-shape phases)

2.4.1 e-shape Phase 1

As in the more classic DT approaches, the ENVISION DT-XP began with the “**Empathise**” phase, which aimed to help developers better understand user requirements and concerns that need to be addressed by the end products (i.e., services, data products, knowledge, experience, networks). In this phase, the stakeholders explored potential challenges that could have made development and adoption of the end products difficult, as well as opportunities and threats to their implementation and viability at large or commercial scales. This phase was facilitated through questionnaire-based surveys, semi-structured interviews, and workshops that involved all potential stakeholders (i.e. ENVISION coproduction facilitators, developers, business cases). The qualitative information was stored in the form of User Stories, as described in detail in Deliverable 2.2. “Report of customer requirements from ENVISION services” and analysed to identify common themes and patterns in stakeholder responses.

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2.4.2 e-shape Phase 2 (short term goals)

Next in DT was the "**Define**" phase, where ENVISION business cases and developers reflected on previously identified User Stories (requirements, concerns, and challenges) in order to prioritise and redefine the most concerning issues that need to be addressed. ENVISION business cases used the "importance of requirement/concern/challenge to stakeholder" and "urgency to address" criteria to prioritise User Stories, while ENVISION developers considered the "Effort to address" and "Data intensity" criteria.

In the "**Ideate**" phase that followed, stakeholders used the prioritised User Stories to identify and design innovative solutions, as well as to adapt and improve existing ones. To facilitate this, we held technical workshops where ENVISION developers presented wireframes and mock-ups of the proposed platform, services, and mobile application, and business cases provided detailed feedback considering the previously established User Stories and the following characteristics / functionalities:

i. Layer and data visualisation – this explored what type of information that is relevant to the demographics of monitored parcels do business cases want to visualise (e.g., location, ID), which alerts and graphs from services relevant to the declaration (e.g., baseline NDVI values for crop growth monitoring), and at what temporal and spatial resolutions
ii. Data and information uploading – this explored the purposes service users would want to be able to upload data and information for (e.g., training / improvement / updating of services), which specific file formats they would want to be able to upload, which potential users would need access to such features (e.g., inspectors, farmers, IT experts), and at what frequency
iii. Data requests and acquisition – similar to above regarding requested file formats, frequency of data and information downloading, and users that would have access to this functionality, as well as issues of interoperability i.e., would service users need to transfer data and information from the ENVISION platform and services to their own existing systems
iv. Integration with existing systems of the business cases – here we identified service users' existing systems and asked them to describe the systems' architecture, workflow, and uses to identify potential connection points, as well as to better understand how business cases envisioned the ENVISION platform and services working through their systems.

The identified solutions (i.e., ENVISION services) were then developed into artifacts ("**Prototyping**") around the specific pilot cases through a coproduction phase that involved frequent (i.e. biweekly) bilateral technical meetings led by the ENVISION developers (i.e., developer – business case meetings). A detailed log of the development process (e.g., progress of specific tasks, issues that emerged and how they were overcome) was kept on the Trello platform (software development management platform), which was accessible for information purposes and for reflection on pilot progress by all ENVISION partners.

2.4.3 e-shape Phase 2 (long term goals)

The final coproduction phase described by our DT approach, involved the "**Testing**" of services by all business cases regardless of whether they were involved actively in the development of a specific service, plus potential customers, developers, and farmers external to the consortium (e.g., Lighthouse Customers). To facilitate this, we structured coproduction workshops for external stakeholders to test

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and reflect on the ENVISION platform, services, and mobile application, and engage in a feedback and update / improve iterative process with ENVISION developers. Within the context of this phase, a coproduction workshop was held for software developers external to ENVISION and with multidisciplinary backgrounds in May 2023; specific emphasis was given on the features and functionalities of the ENVISION Add-on Development Tools. As potential end users of the ENVISION mobile app, farmers were consulted through another coproduction workshop in June 2023. In order to make a 'resilient' solution, specific questions were included that asked all stakeholders to consider the use of the ENVISION data products in future iterations of the CAP and future policy demands. Table 1 shows the adaptations made and the steps taken in the ENVISION approach.

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Table 1: Adaptations of the e-shape coproduction method for ENVISION

Phase 1 (Sept 2020 – February 2021)		
	e-shape steps	Steps adapted for ENVISION
Step 1	The data-information-usage framework is used as a tool to represent the situation of each e-shape pilot. Based on the framework, the conditions needed for a sustainable development of services are examined and blocking or unclear elements are identified.	The current workflow for inspections was used as a framework to explore the current data sources and collection processes [data], the data synthesis and analysis steps [usage] and the requirements for checks and reporting [information].
Steps 2 & 3	Through confluence, this framework is then shared with each pilot. Specific questions are raised based on the identified blocking or unclear elements. These questions are expected to be answered by the pilot on Confluence as far as possible	The developers of the ENVISION platform (Draxis) and services (NOA, ILVO, AgroApps) discussed with each business case the blocks or unclear elements within their current workflow for development and delivery through the ENVISION platform and services. The interactive discussions were hosted in a virtual environment designed by URDG, on the Miro platform (https://miro.com/).
Step 4	A tele conference discussion is then organized with the pilot leader to clarify the elements remaining unclear and further expand on the characterization of the future users' ecosystem, through a story-telling exercise where the pilot leader is asked to take the user's point of view and imagine the sequence of actions conducted by the user to implement the service provided by its pilot.	A workshop for each business case then explored whether the ENVISION platform would; cover the requirements, whether any additional requirements could be fulfilled, what other functions could be added and whether the proposed models and data products meet the needs for; monitoring agricultural practices, whether other practices could be monitored, whether the accuracy of the models could be improved and what other data products could be provided. The outputs from these discussions were captured in the form of User Stories. [Exploration of problem space]. Potential problems within and external to the organisation were discussed to identify ways to mitigate any problems with adoption.
Step 5	Thanks to these clarifications, the pilot framework is updated and divided into two distinct frameworks - one for the initial state and one for the targeted state and each framework is accompanied with a comparison of the users' characterization and the "design environment" provided by the pilot's members.	A second workshop was convened with the same participants to further clarify the user requirements and data sources needed for the developers (as these have been expressed in the User Stories). The developers were encouraged to ask specific questions about data requirements and possible solutions to each user requirement [Exploration of solutions space].
Step 6	Coproduction needs are then identified based on these considerations. For this last step, the method used to identify coproduction needs can be better described thanks to the enrichment of our coproduction model.	The updated list of User Stories (derived from Step 5) was distributed to all participants and developers for the weighting process (D2.2 February 2021).
ENVISION coproduction self-diagnosis in collaboration with e-shape (April 2021) See full diagnosis in Supplementary Materials S2		

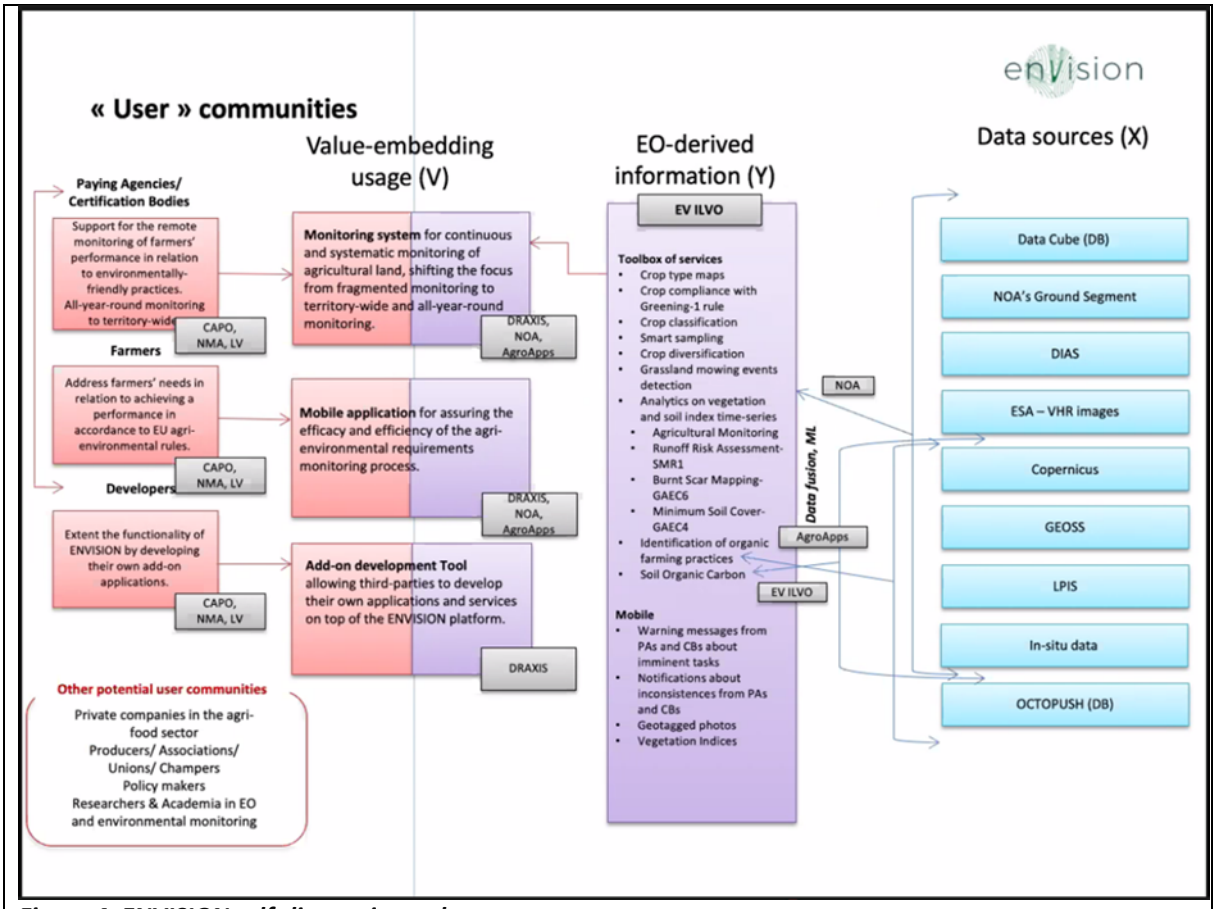

Figure 4. ENVISION self-diagnosis results

ENVISION self-diagnosis actions		
e-shape Coproduction types and descriptors	**Short-term for ENVISION**	**Long-term for ENVISION**
Coproduction Type 1 **(1) Some knowledge on the user community** **(2) An existing contact point** **(3) Some interest of the user** **(4) A sufficient level of engagement on the user side** **(5) Unformalized cooperation modalities** **(6) Feedback loops to be improved** (7) Lists of requirements to be further clarified	"With CAPO, NMA, LV, OCS (1) + (2) + (3) The platform and services' developers have well-established relationships and communications with the business case partners who are also end-users of the ENVISION tools. (4) All ENVISION partners, particularly the platform and service developers together with the business case partners, have been involved and actively engaged to several coproduction workshops, where user requirements and potential problems for	-

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	adoption of ENVISION tools were identified. (6) **While a preliminary timeline for feedback / progress reports has been agreed, its implementation needs to monitored and the schedule could potentially improve."**	
Coproduction Type 2	-	-
Coproduction Type 3 **(1) Lists of requirements clearly defined** **(2) Some knowledge on the user community** **(3) An existing contact point** **(4) A clear interest of the user** **(5) A sufficient level of engagement on the user side** **(6) Upscaling challenges to meet** **(7) Operationalization resources unclearly defined** **(8) Cooperation modalities between R&D and operationalization teams to be improved** 9) Cooperation modalities between pilot partners to be improved	With CAPO, NMA, LV, OCS (1) + (2) + (3) + (4) + (5) All ENVISION partners, particularly the platform and service developers together with the business case partners, have been involved and actively engaged to several coproduction workshops, where user requirements and potential problems for adoption of ENVISION tools were identified.	-
Coproduction Type 4 **(1) A well-established relationship with a long history and a perspective of long-term cooperation** **(2) A first functional service** **(3) A clear interest of the user** **(4) Your common objective is the exploration of new uses on the basis of an existing service** (5) The new service might trigger new operations for the user to be explored	-	With CAPO, NMA, LV, OCS (1) DRAXIS, AgroApps and NOA have previously collaborated with CAPO and NMA in multiple projects and have a well-established relationship, as have ILVO and LV. (4) Exploring new uses of existing services (e.g. crop growth as a proxy to monitor malpractices), improving on current services and exploring the inclusion of new users (e.g, farm managers), are common objectives for all ENVISION partners.
The diagnosis of coproduction needs identified in the table above in (Barbier et. al, 2020) was used to form an action plan Phase 2 coproduction within ENVISION: - Short term: Implementation of the timeline needs to monitored (Type 1 workshops) - Long term: Exploring new uses of existing services (e.g. crop growth as a proxy to monitor malpractices), improving on current services and exploring the inclusion of new users (e.g., farm managers), are common objectives for all ENVISION partners (Type 4 workshops)		
Phase 2 following e-shape diagnosis (March 2021 – October 2023)		
The prioritised list of user stories, resulting from Phase 1 Step 6, fed into Task 2.3 (Phase 2) where the same stakeholders, plus a wider group of potential end-users of ENVISION (Lighthouse Customers), were engaged		

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to continuously using a series of interactive workshops and survey tools to refine the ENVISION platform and services to produce products that meet current and future remote monitoring needs of PAs and CBs.
The e-shape team were working concurrently with ENVISION at this stage. The e-shape website **https://e-shape.eu/index.php/co-design** now outlines the kinds of workshops they propose that would be suitable in Phase 2 (Barbier et al, 2023): • Codesign type 1 workshops organize the dialogue between the pilot and the users in a specific way in order to establish adapted relationships with these specific users and to overcome fixation effects • Codesign type 2 workshops consist in confronting the service to different contexts (decided by the pilot in the preliminary phase) with users. The topic of each workshop can be formulated as follows: exploring the range of usefulness of the pilot's service and related actors of the ecosystem by leveraging the knowledge & experience of the participants to the workshop. • Codesign type 3 action is a sequence of workshop sessions with pilot partners to progressively refine and update a common understanding of the service structure (modules to be operationalized/to be further explored), and the related cooperation modalities on each type of modules. • Codesign type 4 action should be a cycle of workshops with users that consist in a joint exploration with the help of existing users to explore a range of perspectives for the development of future usages - either new usages for existing users or for others (supporting the evolution of the usage ecosystem in certain directions).
Phase 2 of ENVISION proceeded with Codesign Type 1 workshops as outlined in the Methods section to meet the short-term goals of monitoring the implementation of the timeline. As the guidelines for Codesign type 4 workshops weren't available from e-shape at the time, ENVISION implemented a series of future-looking activities to meet the long-term goals of exploring new uses of existing services, improving existing services, and including new users.

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3. Methods

This section outlines the methodological steps undertaken throughout the coproduction processes in ENVISION. Figure 4 shows the activities in Phase 1 (and reported in D2.2) and Figure 5 shows the activities in Phase 2 (reported here in the Results Section).

Figure 5. Flow diagram of Phase 1 (September 2022 - February 2021 Reported in D2.2)

Start Date	Key Coproduction Activities	Ongoing/regular activities		
March 21	Business case implementation – start of regular coproduction monitoring activities (see section 3.1)	Opportunistic interactions with LHCs (see section 3.2)	Monthly feedback on engagement in coproduction (see section 3.6)	Daily activity log (on Trello) of specific tasks, progress on user story implementation, data needs and progress in WP4 (see section 3.5)
Nov 21	Lighthouse Customer Kick Off meeting (see section 3.2)			
May 22	User Story reflections by BCs and developers (see section 3.3)			
June 22	Panta Rhei engagement with PAs (see Deliverable 2.1)			
Oct 22	Lighthouse Customer webinar (see section 3.2)			
Nov 22	Delphi process on successful coproduction (see section 3.6)			
March 23	LHC workshop at Reading (see section 3.2)			
May 23	Developers workshop (see section 3.4)			
June 23	Farmers workshop (see section 3.4)			
June 23	Panta Rhei engagement with PAs (see Deliverable 2.1)			
Sept 23	Repeat of user story evaluation and reflections on coproduction by key BCs and developers (see section 3.3)			

Figure 6. Flow diagram of Phase 2 (March 2021 – October 2023)

3.1 Business case implementation (monitoring of coproduction activities)

In the context of the DT-XP ENVISION coproduction approach described above, the "business case implementation" process largely involved activities that took place during the "Prototyping" and "Testing" phases. During these, WP5 led the monitoring and evaluation of relevant activities and progress made, specifically working through an Operational and an Evaluation period.

The Operational period, included three "activity groups":
i. Use and testing of the ENVISION products and services within the business case – involving the development of the business flow (business logic) within the specific requirements of each business case, the testing of the products under different conditions and scenarios, and the integration of the products within the business case workflow and existing systems whenever necessary.
ii. Communication and collaboration between the consumers, the providers, and the end users – involving technical meetings, webinars, and workshops at business case and consortium levels to

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support the implementation phase (e.g., ensuring that the desired and correct data formats were accessible via the platform and services)

iii. Gathering and reporting of feedback – this was performed through frequent workshops, questionnaire-based surveys (e.g., regarding user-friendliness and user acceptance), and ENVISION product demonstration events (both internal and external to the business case)

The Evaluation period included a single activity group "Evaluation of business cases and their added value in collaboration with WP2", which involved the definition first of evaluation criteria through consultations with stakeholders within the ENVISION consortium, identification of baseline standards and information (for benchmarking purposes), and finally the validation of ENVISION products and services. For reference, the final ENVISION data products are shown in Table 2. The Evaluation of these data products were conducted as part of the activities of WP5 and reported in D5.7.

Table 2: ENVISION data products and their relation to the user requirements, business cases in WP5, the services tested and the service provider

ID	Related Task	Data Product	User Requirements	Business Case	Services	Service Provider
DP1	Task 3.3	Analytics on Vegetation and Soil Index Time-series	UR5/UR7/UR13/UR16/UR17/UR18	NMA	Harvest events detection	NOA
				NMA & CAPO	Stubble burning identification on arable land	
				CAPO	Detection of illegal land clearing in Natura2000 protection areas	
				NMA & CAPO	Minimum soil cover for soil erosion	
				NMA & CAPO	Runoff risk assessment for the reduction of water pollution in nitrate vulnerable areas	
DP2	Task 3.4	Cultivated crop type maps	UR1/UR3/UR5/UR7/UR13/UR17/UR18/UR19	NMA & CAPO	Confirmation of GSAA	NOA
					Smart sampling for OTSC inspections	
					Crops diversification compliance	
DP3	Task 3.5	Grassland mowing events detection	UR2/UR3/UR5/UR13/UR17/UR18	NMA	Grassland activity monitoring and management	NOA
DP4	Task 3.6	Soil condition monitoring	UR19/UR20	LV	Top-soil qualitative soil organic carbon estimations	EV ILVO
DP5	Task 3.7	Crop growth Monitoring and identification of organic farming practices	UR6/UR11	OCS	Distinction of organic farming practices	AgroApps
					Crop growth monitoring/ Crop phenology monitoring	

3.2 Lighthouse customer engagement in coproduction

External Lighthouse customers were engaged continuously using a series of interactive meetings and workshops to discuss their interest and include their current and future needs from the ENVISION platform and data products. There were online workshops in November 2021, October 2022 and March 2023 and regular one-to-one meetings. The project manager was present at all meetings and their feedback was fed into the regular coproduction communication channels. The LHC interactions are reported in Deliverable 1.7.

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Table 3: ENVISION Lighthouse customers

Lighthouse Customers – interest in products
Rural Payment Agency, DEFRA
Danish Ministry of Food, Agriculture and Fisheries
Serbian Ministry of Agriculture, Forestry and Water Economy
German Central Competence Center, State of Management Academy for Food, Agriculture and Forestry
The Agency For Services and Payment - France
Agtelligence - UK
Lighthouse Customers - input
Greek Paying Agency, OPEKEPE
Inspection Institute for Organic Products "BIO Hellas" (BIO)
Inspection and Certification Organisation TUV Hellas
Agricultural Chamber – Institute Murska Sobota

3.3 User Story reflections

As explained in the DT-XP description above and in D2.2., User Stories have been a core element of the ENVISION product development process and the overall DT-XP coproduction approach. The ENVISION software developers used the identified User Stories as a progress guide throughout the development and business case implementation phases to ensure that the ENVISION platform, services, and mobile application would address the consumers and end users requirements adequately. A log of the specific tasks, progress, and challenges associated to the established User Stories were kept on the Trello management platform, as well as through the detailed feedback and evaluation processes of WP5 (see Section 4.2).

The WP2 coproduction facilitators led a series of interactive, hybrid workshops during the first consortium meeting in Thessaloniki, Greece (May 2022) that aimed to collect feedback from ENVISION stakeholders regarding the progress made in relation to each individual User Story, and to update User Stories through a consensus approach whenever necessary. The workshops included a mixture of quantitative and qualitative data and feedback collection methods through the Mentimeter platform, which then informed group (i.e., group of developers, group of end users) and joint discussions. Some of the specific themes that were evaluated by the software developers, and consumers and end users in relation to User Stories and ENVISION product development were:

- *Considering each of the established User Stories, do ENVISION products and services meet my needs and expectations? (scale from 1-Dissatisfied to 10-Very satisfied)*
- *Are my concerns being addressed throughout the ENVISION product and services development process? (scale from 1-Not at all to 10-Fully addressed)*
- *Do I feel confident that the end product will fit my future strategic planning? (scale from 1-Not at all to 10-Very confident)*

The workshops also involved an exploration of ENVISION stakeholders' perceptions and reflection on coproduction related concepts, including the following:

- *What does successful coproduction mean to me? (Word-cloud exercise)*

- *State your level of agreement regarding the following statements as requirements for a successful coproduction: frequent communications; active collaboration on every objective; active engagement with stakeholders from beginning to end; active and frequent engagement with farmers (end users); active and frequent engagement with developers*
- *I feel that communications in the first half of ENVISION coproduction were 1-Not effective to 10-Very effective*
- *We need to prioritise on improving our communications with: Lighthouse customers and advisory board members; Project management; Coproduction facilitators; Farmers; Developers (Voting exercise)*
- *The specific tasks of other ENVISION partners and stakeholders throughout and till the end of coproduction are clear to me (1-Strongly disagree to 10-Strongly agree)*
- *I understand how other partners' tasks relate to my work within the ENVISION coproduction (1-Not at all to 10-Fully understand)*
- *My worth within the ENVISION coproduction is dependent on other partners delivering objectives in a timely manner (1-Not at all to 10-Absolutely dependent)*
- *All ENVISION partners are equally represented in the ENVISION coproduction (1-Strongly disagree to 10-Strongly agree)*
- *All ENVISION stakeholders are equally represented in the ENVISION coproduction (1-Strongly disagree to 10-Strongly agree)*
- *I feel confident that ENVISION products and services will be delivered on time (1-Strongly disagree to 10-Strongly agree)*
- *I feel confident that ENVISION products and services will meet my needs adequately (1-Strongly disagree to 10-Strongly agree)*

The outcomes of these workshops were used to inform the next steps of the ENVISION product development and coproduction processes, specifically through updating the previously established User Stories and through developing solutions to identified challenges of coproduction (e.g., communication effectiveness, clarification of partner roles and responsibilities).

In September 2023, key use cases were identified and some of the workshop activities described above were repeated to gather feedback on the implementation of the user stories in the final ENVISION data products.

3.4 External stakeholder workshops

3.4.1 Software developers

A capacity building workshop was run online in May 2023 to introduce to 8 software developers external to the ENVISION consortium to the ENVISION Add-on Development Tool and gather expert feedback regarding specific functionalities and features of the ENVISION platform. Developer discussions were recorded for further analysis of transcripts. Further, they were asked to complete an online survey providing scores regarding the importance and usefulness of a range of ENVISION platform functions and features. This was designed to understand the needs of external developers to

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ensure that their needs can be met when building additional services linked to ENVISION. The results and actions taken are reported in Deliverable 5.8.

3.4.2 Farmers (workshop)

Similar to the coproduction activity above that engaged developers that were external to the ENVISION consortium, a capacity building workshop was held online in June 2023 with 15 invited farmers and farm managers affiliated with CAPO. The aim of the workshop was to inform stakeholders about the specific ENVISION products and demonstrate some of the direct benefits farmers would experience if they used the ENVISION mobile application and products as a means to facilitate their applications through CAPO. Furthermore, a detailed presentation and Q&A was held on how CAPO aims to use ENVISION products to assist operations throughout the application period, with participants of different capacities actively engaging (e.g., smallholder producers, larger farming business managers, IT experts of CAPO not previously involved in ENVISION). Following the workshop, a representative of the farmer stakeholder group collected their perspectives and specific responses for a brief online survey regarding specific ENVISION product functionalities and features, as well as other potential uses of such tools.

3.4.2 Farmers (survey)

In addition to our efforts within the ENVISION team of partners (consortium) for a deeper understanding of the potential factors that limit stakeholder engagement, an online questionnaire-based survey was distributed to farmers (potential end users) of several EU Member States (translated to their native language), investigating their level of awareness and involvement in coproduction processes for the development of EO-based monitoring technologies in sustainable agriculture.
The survey was developed and distributed via the Qualtrics XM platform and included questions along the following themes:

- Demographics (e.g., type of production, size of farming business)
- Capacity of farm business to support the development and adoption of novel IT systems (e.g., personnel training, IT infrastructure)
- Current or past participation in coproduction efforts for digital innovation in agriculture
- Access to information regarding developments and innovations for sustainable agriculture
- Access to support or training that would enable them to unlock the potential benefits of novel IT systems for sustainable agriculture
- Impacts of Covid-19 pandemic on their farming operations and potential for novel IT systems to help overcome similar challenges in the future

The survey was open until the end of June 2023.

3.5 Activity log of coproduction activities

During the coproduction of these data products (Table 2), the ENVISION developers kept a log of the specific tasks, progress, and challenges associated with the established User Stories on the Trello management platform. These interactions are reported in the deliverables D4.2 and D4.3, as well as through the detailed feedback and evaluation processes of WP5.

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3.6 Analysis of successful coproduction

In addition, the business case monitoring and evaluation process led by WP5, the coproduction facilitators of WP2 structured a group of activities to gather continuous feedback on specific aspects of the coproduction framework (e-shape Type 1 workshops), and reflect on coproduction stakeholders' perspectives, expectations, and experiences.

3.6.1 Monthly feedback on coproduction

The coproduction facilitators structured and ran a brief questionnaire-based survey to collect feedback on coproduction activities that the different ENVISION stakeholders undertake, on a monthly basis. The survey was initially developed around open-ended questions, with the aim to collect detailed information on success stories and challenges of coproduction as suggested by the progress made in the individual work packages. However, due to low completion rates during its piloting phase, it was then modified and structured around questions using Likert scales (e.g., disagreement – agreement statements) to maximise engagement. The specific themes the survey questions are (Strongly Disagree to Strongly Agree scales):

- *I have been able to express my needs, concerns, and opinions freely within the ENVISION coproduction framework*
- *The ENVISION coproduction framework has been key in keeping track and updating user requirements throughout the different stages of the ENVISION product development process*
- *Discussions, debates, and disagreements between partners have been amiable and respectful*
- *My opinions have been heard and valued equally as everyone else's*
- *Contributions of other partners have been useful, accurate, and without bias*
- *There have not been any conflicts of interest between partners, and if yes, they were addressed and resolved in a collegial and respectful manner*

The stakeholders were then asked about the level of priority they considered regarding aspects of coproduction that need to be improved before the next reporting period (i.e., monthly). Priority was defined as a consideration of the urgency and importance to work on the specific aspects.

- Communications between partners and stakeholders
- Relationship dynamics between partners and stakeholders
- Allocation of tasks, action points, and duties
- Ways to follow-up and reflect on progress
- Expanding ENVISION's networks to achieve higher stakeholder diversity, knowledge exchange, and future collaborations

The survey aimed to collect relevant information over a 12-month period, from October 2022 to October 2023. A link to the survey was distributed to the ENVISION partners at the beginning of every monthly project meeting (virtually). The survey remained open and accessible for completion throughout the 12-month reporting period, and reminders were sent to every partner for timely completion to maintain a more accurate reflection on their monthly activities.

3.6.2 Analysis of factors for successful coproduction

A Delphi consensus approach is a research method used to help arrive at a decision regarding a complex issue under investigation, by consulting the opinions of stakeholders and experts through a

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series of survey and discussion rounds. In the context of the ENVISION coproduction approach, we structured a three-round Delphi consensus framework that consisted of two sequential online questionnaire-based surveys (i.e., one informed based on the outcomes of the other) and a concluding consensus hybrid workshop involving an open joint discussion. The surveys were distributed to all ENVISION partners and stakeholders within the ENVISION consortium boundaries. The follow-up, concluding, consensus hybrid workshop took place in November 2022 during the second formal consortium meeting in Athens, Greece.

The foundations for the construction of the first Delphi survey round, were laid through an extensive literature review we performed on the main challenges of coproduction in agri-environmental sciences and beyond (e.g., health sciences, education, business and management). We supported and further supplemented the findings of the literature review with consultations with coproduction facilitators in other large EU consortia (e.g., e-shape). In the end, we identified six main themes / aspects of coproduction and a list of potential challenges / barriers relevant to each of those that could disrupt coproduction, and invited participants in a score allocation exercise to identify the most important coproduction challenges according to their opinion.

The six main coproduction themes / aspects we investigated were:

- Communication and Dissemination – which included communication between stakeholders, language barriers in information dissemination, format and type of disseminated information, communication and dissemination strategies and channels, frequency of communication and dissemination activities, and identification of appropriate audiences
- Culture – which included cultural differences regarding working hours, work ethos, gender equality, inclusivity, diversity, collaboration, and different priorities regarding sustainable development in the agri-food sector
- Project management – which referred to potential issues related to the delegation of tasks, time management, deliverables, stakeholder roles and responsibilities, opportunities and mechanisms for feedback provision, and specific management styles
- Technology- – which mainly considered issues related to stakeholder access to technologies used within the coproduction framework (e.g., online communication platforms), and accessibility issues
- Stakeholder relationships – which included issues related to inequality, inconsistency, and limitations in stakeholder participation, stakeholder diversity, rotation in roles and responsibilities, understanding of partners and stakeholders responsibilities and interests, and mechanisms for conflict resolution
- Knowledge and experience sharing – which referred to issues regarding the understanding and appreciation of partners and stakeholders knowledge and experiences, and engagement with stakeholders beyond ones immediate roles and responsibilities to generate broader knowledge and network opportunities for the consortium

The stakeholder perspectives that we obtained from the Delphi survey on the themes above, were used to structure the second Delphi round. Specifically, we selected the overall Top 20 factors (based on allocated scores) that participants identified as potentially disruptive to coproduction. The second

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survey involved a scoring exercise (0 to 100) of coproduction activities as potential solutions to the disruptive factors they identified, based on how important they believed these would be in improving overall effectiveness and success rate of the coproduction process. The coproduction activities were:

- Frequent progress meeting regardless of specific tasks / action points / KPIs
- Frequent meetings for stakeholder network development and expansion
- Agree on commonly understood and simplified terminology early-on in the project lifetime
- Dissemination strategies should be audience-relevant and summarise information
- Coordinate dissemination activities / channels in line with potential market audiences
- Each WP should have a dedicated communications manager that can summarise information and link with different WPs
- Communication and Dissemination WP should frequently circulate simplified / filtered outputs from each WP to communications managers
- User Stories should be derived from a consolidated list of sustainable development priorities for each stakeholder nation / region to account for potential cultural / geographical differences
- Frequent consensus meetings to consolidate different perspectives on common action points
- Collective framework for decision making within coproduction
- Coordinate dissemination of outputs according to external decision making mechanisms
- Use various tools processes to allow for different voices to be heard
- Inclusive coproduction framework
- Early identification of different abilities and interests of stakeholders for better delegation of roles and tasks
- Roles and responsibilities are revisited very frequently and rotated to avoid staleness and disengagement
- Communication and task delegation / reporting tools are interactive and user friendly
- Early agreement and provision of Information and Communications Technology (ICT) tools to all stakeholders, to facilitate coproduction throughout
- Dedicated knowledge and experience exchange sessions, frequently and from early on
- Multidisciplinary presentations to gain knowledge of different subjects involved in coproduction and exploring of how to best integrate this knowledge

The second Delphi survey was distributed to all ENVISION stakeholders attending the Athens consortium meeting (whether in-person or remotely). As soon as we had received a response from each attendee, we processed the findings (i.e., 0 to 100 scores) and identified a Top 10 of coproduction activities that future approaches should consider to enhance engagement coproduction, effectiveness of participation, and overall success rate.

These Top 10 activities formed the discussion points around which we structured the concluding, consensus workshop. In this final part of the Delphi approach, we held a group discussion for each of the individual coproduction activities; the workshop facilitator would move the discussion to the next point if and only when consensus was reached regarding the clarity of content, importance, and feasibility of the proposed coproduction activity. In cases of participants changing their mind about a specific coproduction activity belonging in the Top 10, this was validated through a group discussion

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(i.e., the majority would request a change), and the activity with the immediately higher score would be selected to complete the Top 10 list.

The outputs of the Delphi consensus approach will be analysed in conjunction with the outcomes of "Continuous feedback on coproduction" related activities. We aim to evaluate these findings also in the context of lessons learnt from other EU projects and consortia that operated within a coproduction framework (e.g., e-shape, RECAP), to synthesise a set of Guiding Principles for the development and implementation of effective and successful, standardised coproduction frameworks in the agri-food sector. Ultimately, these principles could help guide the design and development of Innovation, Research, and Research & Innovation projects, highlighting critical differences in the way these different types of projects should be managed from beginning to end, to best address stakeholder representativeness and equality issues, the mitigation of funding and management related impacts that large EU consortia often face, and the advancement of knowledge, experience, and stakeholder networks among others.

3.7 Future implementation of ENVISION

As part of the coproduction activities, the business cases were asked to consider the future use of the developing products for the 2023-2027 CAP. All ENVISION partners were involved in a series of workshops and consultation activities with the common objective of how specific user stories can be evolved beyond the project time to support their future needs in accordance to policy demands. These were designed as Type 4 workshops (as subsequently described in the e-shape coproduction methodology). The discussions explored new uses of the existing services (e.g. crop growth as a proxy to monitor malpractices). In addition, the discussions were used to identify actions for improving the current services and exploring the inclusion of new users (e.g., farm managers).

4. Results and Discussion

4.1 Identification and engagement of coproduction stakeholders

The first phase involved identifying and engaging stakeholders in the coproduction process. In the period between September 2020 (Month 1) and February 2021 (Month 6), WP2 reviewed scientific and grey literature and engaged with e-shape to identify broad groups of stakeholders for the development of EO-based monitoring tools for sustainable agriculture (see Deliverable 2.1. for literature review findings and Deliverable 2.2. for an outline of relevant e-shape – ENVISION synergies). The identified groups were: i) Business cases, involving PAs and CBs that piloted ENVISION tools, ii) ENVISION tool developers, iii) ENVISION coproduction facilitators, and iv) Lighthouse Customers and Advisory Board members. Within the Business Case group, WP2 further identified the specific roles and responsibilities that individual participants have within their organisations: IT / GIS analysts, field inspectors and members of the control unit, support administration staff, geospatial aid application analysts and administrators, and direct payments officers. The Developers group involved: model developers, IT experts and programmers, and platform developers. Coproduction facilitators largely involved academics and project managers. Finally, Lighthouse Customers and Advisory Board was the most diverse stakeholder group with PA and CB administrators, farmers, external developers, and external academics involved.

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The following Table 4 presents the demographics of the stakeholders engaged with and actively involved throughout the ENVISION coproduction process. The Table outlines key coproduction and ENVISION development activities through to the end of the project and demonstrates how stakeholders were engaged at repeated points within the iterative design thinking phases of coproduction of the ENVISION platform and services.

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Table 4: Numbers of stakeholders involved in the coproduction activities of ENVISION

Stakeholder group	Organisation	Phases of Design Thinking					Total number of stakeholders
		Empathise	Define	Ideate	Protoype	Test	
Business cases							
	CAPO	Y	Y	Y	Y	Y	12
	NPA	Y	Y	Y	Y	Y	8
	LV	Y	Y	Y	Y	Y	5
	OCS	Y	Y	Y	Y	Y	3
	LEAF		Y	Y			3
Developers							
	AgroApps	Y	Y	Y	Y	Y	3
	DRAXIS	Y	Y	Y	Y	Y	2
	NOA	Y	Y	Y	Y	Y	4
	EV ILVO	Y	Y	Y	Y	Y	3
	INOSENS				Y	Y	3
Coproduction Facilitators							
	URDG	Y	Y	Y	Y	Y	5
	ITC	Y	Y	Y	Y	Y	2
	EV ILVO				Y	Y	2
	DRAXIS				Y	Y	2
LHCs							
	Other PAs				Y	Y	6
	Other CBs				Y	Y	4
External stakeholders							
	Farmers				Y		15
	Academics		Y	Y			46
	Software developers			Y	Y		8

4.2 User Stories

4.2.1 Problem definition and solution identification

Empathise & Define Phases

Phase 1 of the steps in the e-shape framework for coproduction (Barbier et al., 2019, 2022) was implemented by working through the Empathise and Define phases. Thirty one User Requirements for ENVISION were identified at the end of the 'Empathise' phase and were prioritised and redefined in the 'Define' phase (reported on in Deliverable 2.2).

Ideate Phase

ENVISION then moved into Phase 2 of the e-shape framework (implementation of coproduction actions) based on the outputs from the Phase 1 activities. As established in the e-shape framework (Barbier et al., 2019, 2022), the sustainability of the ENVISION services can be achieved by ensuring that the coproduction process delivers:

(1) information which is "use-generative" (that is having the power of generating multiple usages),

(2) data-information relationships that are able to adapt to future advances and

(3) information-usage relationships that are able to cope with multiple usages.

The coproduction approach established repeated involvement of the same end users within the iterative 'Ideate' phase which allowed them to adapt and develop further solutions using these e-shape resilience principles including interoperability of data (LaScala-Gruenewald et al., 2023) and integration with existing systems.

4.2.2 Progress and reflection on User Stories throughout the ENVISION development process

As described in the Materials and Methods section, the Prototyping and Testing phases of the DT-XP coproduction framework were completed in September 2023. To assess the contribution of DT-XP coproduction to enabling development of commercially desirable and viable digital innovations, WP2 facilitated two separate workshops, one for ENVISION Business Cases and one for ENVISION Developers Through these workshops, participants reflected on the level of satisfaction regarding progress on turning the established User Stories into functional features of ENVISION end products. The following Tables present the specific results of the reflection sessions, including a percentage improvement on satisfaction regarding progress from User Story to end-product.

An initial assessment of the ENVISION Business Cases and Developers in relation to their satisfaction regarding progress of User Stories and their integration in the final ENVISION products, shows that overall the ENVISION product development was viewed as a positive and successful process. From an ENVISION Business Case perspective, the online survey showed that the largest overall increase in satisfaction was observed for LEAF (mean score = 42.94%), followed by CAPO (mean score = 34.45%), OCS (mean score = 25.67%), LV (mean score = 22.02%), and finally NMA (mean score = -4.04%). When interpreting these findings it is important that we consider first the absolute scores and also the qualitative information that provides justification for the individual scores both for the May 2022 and October 2023 reflection sessions.

Reviewing this information, we note that NMA reported the highest mean absolute scores across all ENVISION Business Cases and both reflection sessions (May 2022 mean absolute score = 8.61, October

2023 mean absolute score = 7.97). They further explained that in relation to User Stories specific to ENVISION services, any reported decrease in satisfaction was due to specific delays experienced in data collection and provision that however, were overcome through the effective NMA – NOA collaboration in ENVISION coproduction; the largest relevant decrease in satisfaction reported was 10%. Larger reported decreases in NMA satisfaction regarding progress were observed for ENVISION platform related User Stories (up to -50%), due to i) lack of NMA interest in using the ENVISION products through the ENVISION platform – instead, they integrated ENVISION products in their internal systems, and ii) time and resource limitations that did not allow NMA to thoroughly investigate ENVISION platform functionalities and features (e.g., when testing the platform they did not experience any errors and therefore, could not express satisfaction / dissatisfaction regarding aspects such as the ability to receive detailed notifications when specific errors occur). However as before, here we also need to consider that large decreases in satisfaction are a result of a very high scoring in May 2022 (early stages of coproduction) and a lower yet still satisfactory or at least neutral score in October 2023.Considering the above, we conclude that despite an overall observed decrease in satisfaction regarding progress, NMA was perceived in fact as the most satisfactory ENVISION Business Case.

On the other hand, LEAF exhibited the largest overall increase in satisfaction regarding progress (mean score = 42.94%), however had reported the lowest absolute scores in May 2022 together with LV (mean absolute score = 5.13) followed by a relatively high scoring in October 2023 (mean absolute score = 7.29, 3rd highest among business cases). LEAF's scoring throughout can be largely explained by a consortium-level inability to fully comprehend its remit, roles and responsibilities within the agri-food sector as Farm Assurance Scheme, in the early stages of ENVISION coproduction. This created feelings of uncertainty by LEAF partners about the potential benefits of ENVISION products, which reflected in a close to neutral score. However, an intensification of communications and engagement actions in the period between May 2022 and October 2023 significantly helped LEAF and ENVISION Developers, namely AgroApps, gain a deeper understanding of LEAF's action plans towards sustainable agriculture, an insight into their specific workflows, and to synthesise a feasibility study on how ENVISION products could help LEAF future strategic planning and actions as a standard-setter in global agri-food production.

Regarding the responses obtained from ENVISION developers, a decrease in AgroApps scores for satisfaction regarding progress (mean score = -9.98%) between May 2022 and October 2023 could be explained by the identification of specific limitations in data availability for the Serbian ENVISION Business Case and specific difficulties encountered for this case study only, which could not have been identified prior to an in-depth exploration of the User Stories and before the ENVISION product development had started. This contradicts OCS's views (average score = 25.67%), who reported that the knowledge coproduced within the Serbian Business Case was a large enough benefit to counterbalance any disparity between the originally established User Stories and end products, as it greatly enhanced understanding about this CB's capacity to facilitate the development and adopt EO solutions for monitoring of organic crop production practices.
NOA, who was responsible for the development and testing of the bulk of the ENVISION products for the Lithuanian (NMA) and Cypriot (CAPO) business cases, reported an overall 10.72% increase in satisfaction for progress on User Stories throughout ENVISION coproduction. An interpretation of the

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survey outputs (Table 2 above) considering NOA's responses for justification of their scoring, suggests that the actual increase in satisfaction was higher than the 10.72%. This is because 3 out of 4 negative scores estimated by NOA (User Stories #7 = -44.44%, #9 = -44.44%, #28 = -50.00%) in fact represent that the specific activities / responsibilities were not relevant for this developer (i.e., "not satisfied nor dissatisfied), however when they first investigated them in May 2022 they gave a high satisfaction regarding progress score due to early discussions through which they assisted development led by other ENVISION partners (e.g., AgroApps).

Considering the individual User Stories, we observed the highest satisfaction regarding progress for efforts about the interoperability of ENVISION products with PA and CB existing, internal systems (mean score = 166.67%), followed by a 100% increase in satisfaction about progress regarding a number of requirements for the i) ability to intersect ENVISION outputs with externally sourced or existing data and layers, ii) efficient and quick processing of geospatial data in bulk through the ENVISION products, and iii) ability to upload in-situ information to inform and improve ENVISION products.

The largest decrease in satisfaction of progress (mean score = -50%) was noted for a number of User Stories, namely the identification of organic from conventional crop production, the interoperability of ENVISION products with DIAS systems, and several specific requirements for notification of errors by the ENVISION platform. This scoring can be largely explained by a neutral approach in responses of most partners in October 2023 (i.e., absolute score = 5) for User Stories that they originally planned to test and did not due to resource limitations (e.g., not enough time to experience notifications of errors first-hand) or because eventually they found specific requirements to not be relevant with their intended use of ENVISION products.

4.3 Coproduction activities with developers and farmers outside the ENVISION consortium

Here we present the outcomes of two coproduction workshops held for software developers and farmers outside the ENVISION consortium. The aim of the workshops was to receive feedback and insight into potential issues of the ENVISION platform and services, and identify potential ways to improve those.

4.3.1 Developers

External developers reported that from their perspective, the ability to visualise data and information on the platform in various ways (5% score disparity between groups), as well as the ability to connect with external data and information sources (10% score disparity between groups) are the most important features of the ENVISION platform. User-friendliness was also reported as a key feature that should characterise the ENVISION platform. However, here we observed a 15% disparity in scoring between the two developer groups, potentially because some of the developers considered PA and CB staff and specifically IT experts and GIS analysts as the intended end-users, while others considered farmers as the primary target audience.

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4.3.2 Farmers

From their perspective, farmers external to the ENVISION consortium stated that the most important feature is the ability to view detailed information on the platform so that novice users can navigate it with relative ease and address issues of distrust regarding the processes followed to generate the various ENVISION products, together with the ability to filter such information and adjust the content according to the proficiency of diverse end-users (e.g., IT experts, inspectors, farmers).
The table below (Table 5) presents a synthesis of external developers and farmers views regarding the three features and functionalities of the ENVISION platform they liked the most and those they liked the least, as well as farmers responses regarding additional potential uses of the platform and perceived benefits for use within the PA or CB they are affiliated with.

While the feedback obtained from developers and farmers external to the ENVISION consortium were not directly fed into the coproduction process reported on in D2.7., they were communicated directly by the project management team who attended both coproduction workshops, and were considered by the development teams as elements that could be materialised through future updates and enhance product desirability.

Further to the coproduction workshops, to date, WP2 has gathered 118 survey responses from 5 different EU Member States regarding the level of awareness and involvement of farmers in coproduction activities for the development of digital, innovative solutions for sustainable agriculture. These data are not reported on here as they are currently being analysed and will be developed for publication.

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*Table 5: External to ENVISION consortium developers' satisfaction scoring and perspectives**

Question	Participant	Responses
Could you list three features / functionalities of the ENVISION platform and mobile app that you liked the best? Why do you think these are important?	Developers & farmers	1. Ability to visualise data as maps and timeseries, an essential element for such platforms / systems, especially as it is featured in the homepage. 2. User-friendliness, ease of navigation and searching 3. The traffic light system indicating validity of applications and cross-compliance 4. Ability to upload geotagged and timestamped images, which introduces transparency in the inspection process
Could you list three features / functionalities of the ENVISION platform and mobile app that you liked the least? How could these be improved?	Developers & farmers	1. Ability to log in with personal credentials and have personalised functionalities, such as past searches 2. More in-depth documentation regarding the methodology followed to produce ENVISION outputs 3. After a certain point of zooming in the map there is no valuable information as the parcels are no longer distinguishable. It would make sense if the parcels are coloured based on the application status (i.e., following the traffic light system) 4. Ability for PAs to visualise the parcels they need to inspect in a separate screen and upon clicking each parcel bring up specific information per parcel
Would you use the ENVISION tools and services for purposes other than to aid your applications for subsidisation? If yes, what would some of these purposes be?	Farmers	Uploading geotagged photos and relevant information to evaluate damages at crops, thereby facilitating Geospatial Aid Application (GSAA) services. Sharing such information with other authorities to assist their support and subsidisation schemes.
Do you believe that the ENVISION platform and tools can facilitate your communications and collaboration with Paying Agencies and Certification Bodies? If yes, in what ways and how could it help further?	Farmers	Yes, through recording of potential disputes and disparities between the information provided by the farmers and that provided by the Paying Agencies or Certification Bodies, and enhancing quality and availability of information to address such potential disputes.

** The results refer to external to ENVISION consortium developers' satisfaction scoring and perspectives regarding specific ENVISION platform and service functionalities and features after exposure and testing of the ENVISION platform. Eight developers were grouped randomly in two groups of four and assigned a single score for each of the listed features after consensus.*

4.4 Analysis of successful coproduction

4.4.1 Continuous feedback on coproduction

The primary sources for continuous feedback on coproduction through WP2 were the two surveys: i) reflection on coproduction activities for the first half of the ENVISION project, with feedback collected in May 2022, and ii) monthly feedback survey on Qualtrics, which ran from October 2022 until July 2023. This section presents the specific findings of these two surveys in table format.

*Table 6: Mean monthly score representing ENVISION partners' reflection on monthly coproduction activities and engagement**

Questions	October 2022	December 2022	February 2023	March 2023	April 2023	June 2023	July 2023
Within ENVISION, the coproduction process has not restricted me and I have been able to express my needs, concerns and opinions	4.80	4.80	4.80	4.75	5.17	5.50	6.00
The coproduction process has been important in keeping track of and updating user requirements at this stage of development of ENVISION platform & services	4.30	5.40	5.00	5.00	4.67	5.25	6.00
Discussions, debates and disagreements between partners have been amiable and respectful	5.50	5.00	5.20	5.25	5.33	5.38	5.00
My opinions have been valued and heard equally as everyone else's	5.40	5.20	4.60	4.25	5.50	5.50	6.00
The contributions from other partners have been useful, accurate and without bias	4.90	4.60	5.00	4.75	5.33	5.50	5.00
There have not been any conflicts of interest between partners, and if yes, they have been addressed and resolved in a collegial and respectful manner	5.30	4.80	5.40	5.50	5.17	5.75	5.00

** The questionnaire took place together with the monthly project meeting, therefore it was cancelled in the months of November 2022, January 2023, and May 2023 due to the annual project meeting (Nov. 22) and official closure days (i.e., Christmas and Easter closures). Responses for those months were collected in the following months i.e., bi-monthly reflection. Responses were recorded on a Strongly Disagree = 0 to Strongly Agree = 6 scale*

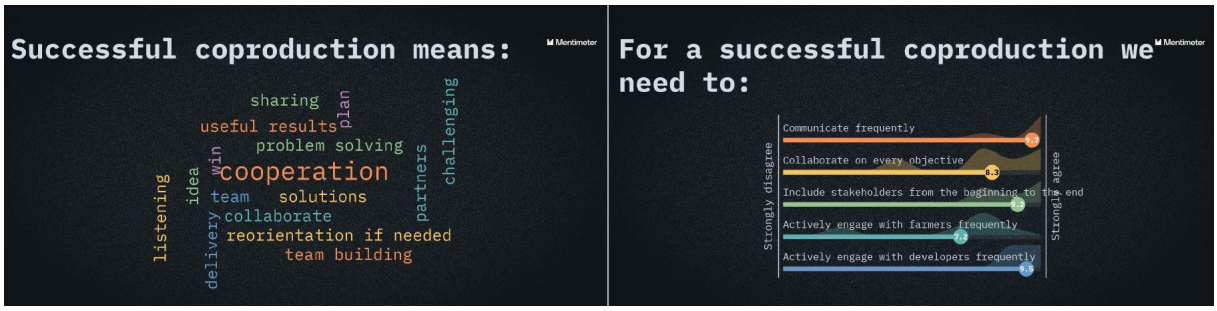

Figure 7. ENVISION end-user perspectives on coproduction and key concepts of sustainable agriculture at an intermediate stage of ENVISION coproduction and product development

The specific findings of the monthly feedback survey showed that the ENVISION coproduction process was overall perceived as an effective, inclusive, and respectful environment in promoting efficient communications and active engagement of ENVISION partners. Out of the 234 scores received throughout, only a single "Disagree" and 11 "Neutral" scores were recorded for the Strongly Disagree to Neutral area. The majority of participant responses were in the "Agree" (46.2%) and "Strongly Agree" (36.8%) area. The one partner that expressed their disagreement in October 2022 for the statement "The coproduction process has been important in keeping track of and updating user requirements at this stage of development of ENVISION platform & services" explained that in this specific reporting period they felt disengaged from the ENVISION product coproduction process due to other organisational commitments, however expected more proactivity on behalf of the facilitators in helping them stay updated despite their limited resources.

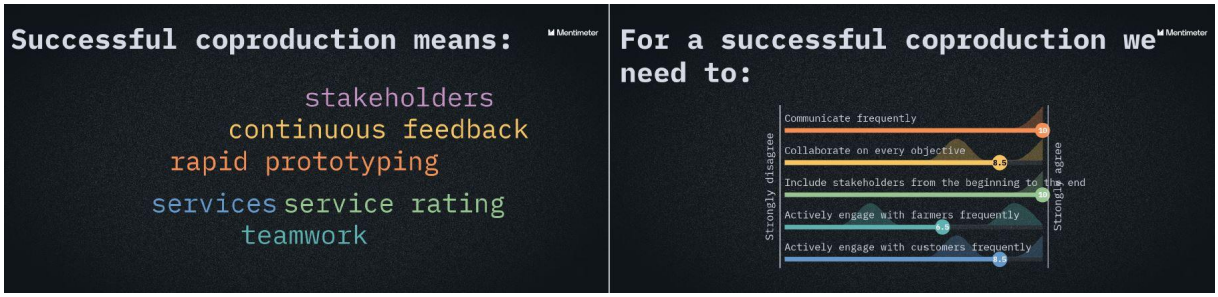

Figure 8. ENVISION developer perspectives on coproduction and key concepts of sustainable agriculture at an intermediate stage of ENVISION coproduction and product development

4.4.2 Analysis of factors for successful coproduction

This section presents the results of the two Delphi online survey rounds and the concluding workshop that took place in Athens on November 2022. While the Delphi was a sequential approach, where the outputs of one phase were indeed used as inputs to inform the activities of the next, there are important messages to be reported for the identification of frameworks that enable successful coproduction of innovative and commercially viable solutions through the specific outputs of each Delphi component.

Table 7 summarises key findings from the first online Delphi survey round averaged for the different groups of ENVISION stakeholders that participated, accounting for the score of individual representatives as opposed to aggregating at organisation level.

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ENVISION Developers (n = 5) considered following factors summarized in Table 7 as significant potential disruptors to a successful coproduction process:

Table 7: Key findings from the first online Delphi survey (ENVISION developers)

Theme	Key disruptors
Communication & Dissemination	Infrequent communication makes engagement with stakeholders difficult Effective communication determines the quality of facilitation Communications and collaboration with partners I don't directly work delay progress
Cultural implications	Difficulties associated with reconciling with different perspectives over the same topic Different priorities concerning sustainable development of the agri-food sector (i.e., environmental, economic, social priorities) Different attitudes towards decision-making processes (individualism versus collectivism)
Project Management	Poor leadership in assigning "best-fit" tasks / roles considering stakeholder abilities and interests Lack of flexibility to address the needs of coproduction (e.g., inability to redirect priorities and adapt workflows to overcome obstacles) Poor time management
Technological challenges	Difficulty in maintaining engagement to communications if the technologies used in coproduction do not allow for interactive discussions Lack of support to assist me with technical difficulties when engaging with specific technologies during coproduction Technologies used in coproduction are often too specific to relevant tasks (e.g., Miro only for workshops) and too much time is lost in engaging with them
Stakeholder Relationships	Lack of mechanisms to resolve conflicts when prioritising time and resources over different stakeholders Lack of opportunities to expand network beyond direct relationships within coproduction team Inconsistencies / inequalities / limitations in stakeholder participation
Knowledge & Experiences sharing	Knowledge, experience and opinions are not equally appreciated among stakeholders Changing current workflows based on third-party knowledge, experiences and opinions is too risky and time consuming Difficulties in sharing knowledge and experience because of the specific format of information (e.g., technical reports not effective for knowledge exchange)

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The responses collected from ENVISION Project managers (n = 3) presented great similarities with those of ENVISION Developers (above) considering that the same disrupting factors were ranked the highest across most themes, however in different order of significance (i.e., different specific scores assigned to them than the developers). Most commonalities were observed for the Communication & Dissemination, Knowledge & Experience Sharing, and Project Management themes.

Table 8: Key findings from the first online Delphi survey (ENVISION managers)

Theme	Key disruptors
Communication & Dissemination	Effective communication determines the quality of facilitation Infrequent communication makes engagement with stakeholders difficult Communications and collaboration with partners I don't directly work delay progress
Cultural implications	Different priorities concerning sustainable development of the agri-food sector (i.e., environmental, economic, social priorities) Difficulties with understanding the contribution of and showing respect towards different disciplines Different attitudes towards understanding the importance of inclusivity
Project Management	Poor leadership in assigning "best-fit" tasks / roles considering stakeholder abilities and interests Poor time management Poorly defined roles and responsibilities amongst stakeholders
Technological challenges	Difficulty in maintaining engagement to communications if the technologies used in coproduction do not allow for interactive discussions Lack of technologies that facilitate project management and monitoring of progress in relation to specific tasks Restricted access to broadband and poor bandwidth quality where I work from
Stakeholder Relationships	Lack of understanding of other partners / stakeholders responsibilities and interests Lack of diversity in stakeholders Lack of opportunities to expand network beyond direct relationships within coproduction team
Knowledge & Experiences sharing	Knowledge, experience and opinions are not equally appreciated among stakeholders Difficulties in sharing knowledge and experience because of the specific type of information (e.g., weekly progress not considered important to share) Lack of opportunities for engagement in collaborative activities (e.g., workshops) limits opportunities for knowledge, experience and opinion sharing

While all responses received equal weighting for the purposes of this Delphi approach and the specific survey, the following feedback from ENVISION End-users (n = 8) perhaps should be viewed as one of the more important inputs in identifying ways to maximise effectiveness and satisfaction when coproducing commercial products, like the ENVISION solutions for sustainable agriculture.

Table 9: Key findings from the first online Delphi survey (ENVISION end-users)

Theme	Key disruptors
Communication & Dissemination	Infrequent communication makes engagement with stakeholders difficult Effective communication determines the quality of facilitation Communications and collaboration with partners I don't directly work delay progress
Cultural implications	Difficulties associated with reconciling with different perspectives over the same topic Different priorities concerning sustainable development of the agri-food sector (i.e., environmental, economic, social priorities) Different attitudes towards decision-making processes (individualism versus collectivism)
Project Management	Poor leadership in assigning "best-fit" tasks / roles considering stakeholder abilities and interests Lack of flexibility to address the needs of coproduction (e.g., inability to redirect priorities and adapt workflows to overcome obstacles) Poor time management
Technological challenges	Difficulty in maintaining engagement to communications if the technologies used in coproduction do not allow for interactive discussions Lack of support to assist me with technical difficulties when engaging with specific technologies during coproduction Technologies used in coproduction are often too specific to relevant tasks (e.g., Miro only for workshops) and too much time is lost in engaging with them
Stakeholder Relationships	Lack of mechanisms to resolve conflicts when prioritising time and resources over different stakeholders Lack of opportunities to expand network beyond direct relationships within coproduction team Inconsistencies / inequalities / limitations in stakeholder participation
Knowledge & Experiences sharing	Knowledge, experience and opinions are not equally appreciated among stakeholders Changing current workflows based on third-party knowledge, experiences and opinions is too risky and time consuming Difficulties in sharing knowledge and experience because of the specific format of information (e.g., technical reports not effective for knowledge exchange)

As anticipated, the responses of ENVISION Coproduction facilitators (n = 3) reflect a synthesis of lessons learnt through an equal interaction with the development, project management, and pilot testing groups of stakeholders.

Table 10: Key findings from the first online Delphi survey (ENVISION coproduction facilitators)

Theme	Key disruptors
Communication & Dissemination	The dissemination channels of the results have not been reaching the correct audience Effective communication determines the quality of facilitation Inability to understand different languages creates communication & dissemination issues and makes collaboration difficult
Cultural implications	Difficulties associated with individuals not expressing their opinion within a team Difficulties associated with reconciling with different perspectives over the same topic Different work ethos
Project Management	Lack of flexibility to address the needs of coproduction (e.g., inability to redirect priorities and adapt workflows to overcome obstacles) Poorly defined roles and responsibilities amongst stakeholders Poor communication / definition of the coproduction milestones
Technological challenges	Lack of information regarding the scope and the use of specific technologies during coproduction Difficulty in maintaining engagement to communications if the technologies used in coproduction do not allow for interactive discussions Technologies used in coproduction are often too specific to relevant tasks (e.g., Miro only for workshops) and too much time is lost in engaging with them
Stakeholder Relationships	Lack of opportunities to expand network beyond direct relationships within coproduction team Lack of understanding of other partners / stakeholders responsibilities and interests Inconsistencies / inequalities / limitations in stakeholder participation
Knowledge & Experiences sharing	Produced knowledge is too specific to the outcome-related boundaries - i.e., not useful beyond coproduction / project lifetime Changing current workflows based on third-party knowledge, experiences and opinions is too risky and time consuming / Difficulties in understanding differences between theoretical and practical knowledge, the importance of each and how to share each Lack of opportunities for engagement in collaborative activities (e.g., workshops) limits opportunities for knowledge, experience and opinion sharing

Finally, for the first online Delphi survey round, we present the highest ranked responses from the only ENVISION Lighthouse customer (n = 1) that participated. Due to the single-unit input, we present the three top responses for each theme, however unordered unless it was evident from the scoring that the participant suggested a clear priority (i.e., different scores for each disrupting factor) – specifically, for the Project Management and Stakeholder Relationship themes.

Table 11: Key findings from the first online Delphi survey (ENVISION lighthouse customers)

Theme	Key disruptors
Communication & Dissemination	Effective communication determines the quality of facilitation The dissemination channels of the results have not been reaching the correct audience The type (e.g., user stories, action points, technical methodologies) of information provided is often not appropriate, considering the audience
Cultural implications	Different attitudes towards understanding the importance of inclusivity Different priorities concerning sustainable development of the agri-food sector (i.e., environmental, economic, social priorities) Different work ethos / Difficulties with understanding the contribution of and showing respect towards different disciplines
Project Management	Poorly defined roles and responsibilities amongst stakeholders *(1)* Poor time management *(2)* Poor delegation of tasks *(3)*
Technological challenges	Technologies used in coproduction are often too specific to relevant tasks (e.g., Miro only for workshops) and too much time is lost in engaging with them The tasks to complete via technologies used in coproduction required advanced ICT skills that I am not comfortable with Difficulty in maintaining engagement to communications if the technologies used in coproduction do not allow for interactive discussions / Lack of technologies that facilitate project management and monitoring of progress in relation to specific tasks
Stakeholder Relationships	Lack of diversity in stakeholders *(1)* Coproduction does not enable relationship development amongst stakeholders beyond outcome-related activities (outcome = product, service, knowledge) *(2)* Lack of mechanisms to resolve conflicts when prioritising time and resources over different stakeholders *(3)*
Knowledge & Experiences sharing	Changing current workflows based on third-party knowledge, experiences and opinions is too risky and time consuming Difficulties in understanding differences between theoretical and practical knowledge, the importance of each and how to share each Lack of opportunities for engagement in collaborative activities (e.g., workshops) limits opportunities for knowledge, experience and opinion sharing /

	Receiving knowledge from other stakeholders does not help me achieve my goals and is a waste of time

Table 12 below, presents the specific results obtained through the second online Delphi survey round in descending order of mean scores representing the potential for a factor to enable successful coproduction, according to stakeholder perspectives. For the second Delphi survey round, and in preparation of the group discussions and consensus panel, no background information was collected for the participants (i.e., role) and criteria were evaluated based on aggregate scores of all respondents.

*Table 12: Top 20 criteria selected after the first online Delphi survey round**

Criteria	Mean score	SEM	n
Agree on commonly understood and simplified terminology early-on	67.88	0.09	18
Use various tools-processes to allow for different voices to be heard	56.12	0.08	20
Multidisciplinary presentations to gain knowledge of different subjects involved in coproduction and explore integration of this knowledge	56.06	0.09	17
Frequent consensus-meetings to consolidate different perspectives on common action points	55.28	0.07	20
Communication and task delegation / reporting tools are interactive and user-friendly	55.28	0.08	19
Each WP has a dedicated communications manager that can summarise information and link with different WPs	54.47	0.12	17
Early identification of different abilities and interests of stakeholders for delegation of roles and tasks	53.78	0.08	19
Early agreement and provision on ICT tools to facilitate coproduction	51.50	0.08	19
Dedicated knowledge and experience exchange sessions / frequently and from early on	51.47	0.09	18
Frequent progress meetings regardless of specific tasks / action points / KPIs	51.22	0.09	17
Inclusive coproduction framework	50.63	0.07	18
Communication & Dissemination WP frequently circulates simplified / filtered outputs from each WP to communications managers	50.47	0.09	17
Coordinate dissemination activities / channels in line with market audience	50.05	0.12	16
Collective framework for decision making within coproduction	49.53	0.11	18
User Stories are derived from a consolidated list of sustainable development priorities for each stakeholder nation / region	48.84	0.08	18
Dissemination strategies should be audience-relevant and summarise information	47.05	0.10	18
Frequent meetings to expand network of stakeholders	44.85	0.08	18
Coordinate dissemination of outputs according to external decision-making mechanisms	36.61	0.08	19

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Revisit roles and responsibilities very frequently and rotate to avoid staleness/disengagement	34.06	0.09	18

**ENVISION stakeholders assigned a score from 0 to 100 considering the importance of each criterion to enabling a successful coproduction (0 not important at all – 100 very important) at the physical ENVISION project meeting in Athens, November 2022.*

Finally, the two online surveys allowed us to synthesise the following Top 10 of criteria that are essential to a successful coproduction process, which ensures i) the development of desirable, sustainable, and viable solutions, ii) coproduction of knowledge and sharing of experiences to advance science through enhanced stakeholder networks, and iii) equal participation of stakeholders in a respectful and inclusive environment.

Table 13: Top 10 of criteria that are essential to a successful coproduction process

Key theme	Criteria
Project Management	Early identification of different abilities and interests of stakeholders for delegation of roles and tasks
Coproduction Facilitation	User Stories are derived from a consolidated list of sustainable development priorities for each stakeholder nation / region
Project Management	Collective framework for decision making within coproduction
Communication / Technological	Use various tools / processes to allow for different voices to be heard
Project Management / Communication	Each WP has a dedicated communications manager that can summarise information and link with different WPs
Communication / Technological	Use interactive and user-friendly communication and task delegation tools
Coproduction Facilitation / Communication	Hold dedicated “knowledge and experience sharing” sessions frequently and from early-on
Project Management / Communication	Frequent progress meetings regardless of specific tasks / action points / KPIs
Project Management / Communication	Agree on commonly understood and simplified terminology from early-on
Communication / Dissemination	Dissemination strategies should be audience-relevant and summarise information

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These will be summarised into Guiding Principles as shown in Figure 9.

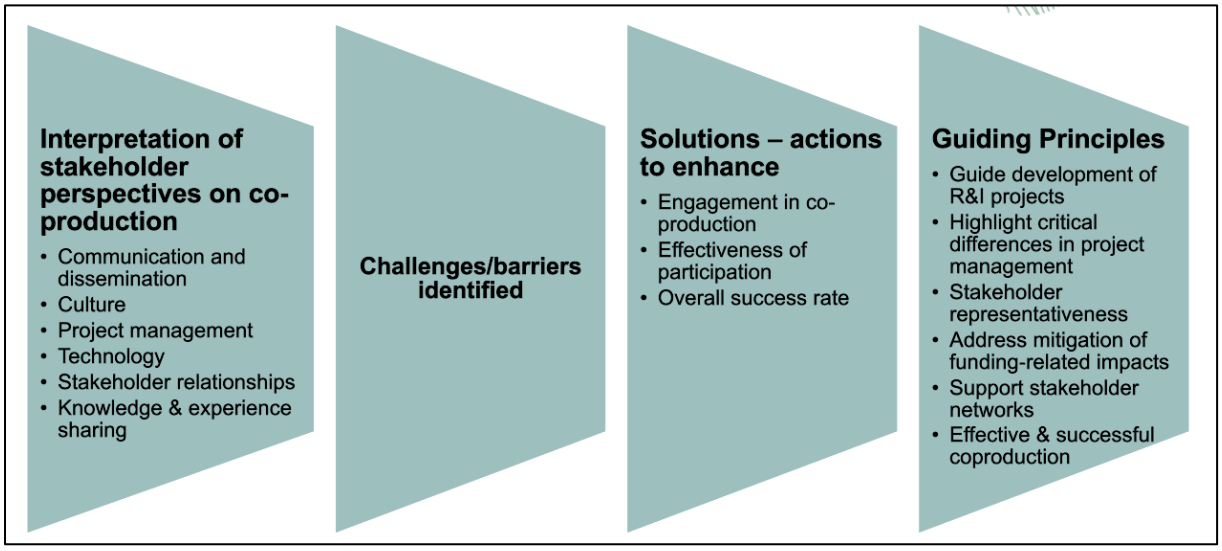

Figure 9. Process of development of coproduction guidelines

4.5 Use case reflections

4.5.1 Most integrated use case

NMA is the national paying agency of Lithuania, under the Ministry of Agriculture, they intended to use the ENVISION platform to look at grazed and fallow land and develop crop-type maps in order to determine CAP compliance. They worked with NOA (National Observatory of Athens) to develop the algorithms needed.

NMA encountered problems in the development process due to the failure of Sentinel IB, this meant cloud cover prevented or made monitoring more difficult. However, NMA noted that this was an issue with all platforms using sentinel data and was not specific to ENVISION. Changing CAP rules during the project also meant that one set of measurements they had originally wanted were no longer required. NMA noted how being part of the ENVISION project highlighted some of the issues in EO data collection and that whatever platform is being used, an alternative or back-up tools are sometimes needed.

The coproduction process enabled NMA and NOA to overcome some of issues arising regarding accuracy of measurements when working with small parcels and they highlighted the need to keep solutions simple. NMA felt that communication levels were good, and that they would take part in coproduction processes again. NMA worked with NOA to ensure delivery of the services they wanted. Plans for algorithms were made in the first quarter of year and they provided a time schedule for when data needed to be collected to get results needed. Several meetings between NMA and NOA over the course of the season helped to create a smooth process, results came in quickly and in the timeframe they needed.

NMA were pleased with the speed at which they received results and EO data. For example, data relating to crop types and grassland mowing from June was received in July, this meant farmers could see very soon after a particular period if they had met compliance conditions or if they needed to make adjustments to meet requirements. NMA also highlighted how quick data turnaround meant that if

there was an error in crop type classification it could be quickly rectified. If grassland had not been mown or grazed farmers know the PA would see this and could work on it (sanction prevention measure).

Testing, feedback and updates to the algorithms went well. The algorithms were good quality, NOA's response to feedback was rapid and NMA could see how algorithm quality was changing and improving in response to feedback. NMA noted that it was important to take into account that several 'sets' of data can be required to ensure good quality and accurate results. They need to be able to show the farmers that results were good quality, and that good quality data prevented sanctions being applied wrongly.

NMA also gave an example of how the data from ENVISION was, fields which were not mowed or grazed (i.e. were not compliant) did not receive payments, NMA could decide to reallocate payments based on compliance as determined through use of ENVISION; "we won't be paying a support and we will change whether we will reallocate that money for the partners who this, who does this compliance, who do this compliant".

4.5.2 Use case requiring further integration

OCS (Organic Control System) are a certification body based in Serbia, and certify organic producers in line with EU legislation. OCS worked with AgroApps in order to explore the use of EO data and the ENVISION platform to monitor organic crops, pesticide use and parallel monitoring of organic and conventionally farmed small land parcels. This was to confirm organic compliance and standards and to identify instances of malpractice.

At the start of the coproduction process, OCS identified the needs they had for the platform, including the monitoring and comparison of organic and conventionally farmed crops. However, issues arose in the ability of the data to distinguish between organic and conventional farming and identify inappropriate pesticide use and ENVISION is not currently providing for OCS needs or requirements; "Currently benefit ... we don't see much benefits from this".

However, the coproduction process has been beneficial to both OCS and AgroApps. OCS highlighted the benefits of learning about what was possible with the technology, for example they were unaware of what was capable of being measured using NDVI. OCS were also able to better understand and identify the type and spread of data or examples they would need to provide to support development of the platform.

AgroApps, through the coproduction process were able to work with OCS to give them a clearer understanding of what the platform could potentially do; "We started from zero". AgroApps also benefited from the process; "And they did learn a lot about the challenges, also of trying to distinguish between organic and conventional and especially those practices that are not organic".

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At the end of the project, OCS and AgroApps are working together to continue development of ENVISION. Through the process of coproduction both partners were able to discuss, share knowledge and provide feedback, OCS were satisfied with communication processes, testing, and response to feedback, and are keen to continue working with AgroApps, now that they have a better understanding of the technology and data limitations.

“Do you know that we start with the we are include including the one another project and we will work on that organic and conventional and they have more knowledge now and we can and and now we are starting from other position now we we are giving to our partners immediately what we need and what is realistic needs and that's it.”

4.5.3 Use case requiring organisational change

LEAF (Linking Environment And Farming) is a UK based organisation which aims to promote and support sustainable agriculture and sustainable development in the agri-food sector. As part of this they offer the LEAF Marque Standard, an assurance scheme showing that food has been grown sustainably and with care for the environment. The LEAF Marque is available globally through a number of Certification Bodies (CBs).

LEAF were involved with ENVISION development as stakeholders, however, due to not fully understanding LEAF’s role and capacity in the sector, a formal business case was not produced for them; “Well, basically the outcome was we couldn't use the Envision services, which was slightly frustrating for me and I imagine you know the developers and whoever, because it makes me think, why ... was this not flagged or realised before the project”.

However, being involved in the development process has enabled both LEAF and ENVISION to expand their knowledge and understanding of the use of EO data to monitor sustainable agriculture processes, the functioning of stakeholder networks and farm assurance schemes and how to engage with these networks.

LEAF are hoping to use ENVISION outputs in the future to potentially improve the measuring and reporting they undertake and support the development of their standards (such as the LEAF Marque); “And that's not only by ... having robust and reliable auditing of our farms and what they're doing but ... going into more detail about what that means in terms of impact. So yeah, that would be something we'd be interested in”. LEAF review, change and update their standards and are interested in using ENVISION services to monitor new or updated requirements, this is an ongoing project which could be piloted in the UK and then potentially tested on farms across Europe.

As mentioned above, LEAF did not test specific ENVISION services, but gained from being part of the development process; “We learned a lot and we were able to definitely identify what our gaps are in our knowledge and expertise and but also our systems and or our approach to our whole assurance system”. They valued the opportunity to explore the use of EO data in agriculture, for example raising

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farmer awareness of the positive implications of EO, how it can be used for knowledge sharing and education, and not just monitoring purposes.

LEAF also valued being involved in the coproduction process and felt that their voice had been heard, despite there being a steep learning curve for them around understanding the terminology and limitations around EO data; “I think it was really useful that Envision focused on coproduction because in these specially I know that this project has a big commercial focus. I feel like typically that [we] would have never been or typically maybe not kind of considered or incorporated into kind of projects like these”.

4.6 Consultation with partners about the future development of ENVISION to address the CAP SP 2023-2027 needs

ENVISION partners were asked to identify actions for improving the current service provision and exploring the inclusion of new users (e.g., farm managers). Data was collected in a number of workshops that were engaging partners in a discussion about the objectives of the CAP SP 2023-2027. Participants have been asked to outline how ENVISION’s products and services are linked to the requirements of the CAP SP 2023-2027, focusing particularly on their own viewpoint. The following have been identified under the broad themes of a) Environmental Monitoring, b) Precision Agriculture, c) Climate change mitigation, d) Natural Resource Management e) Biodiversity Conservation f) Innovation and Knowledge Exchange.

4.6.1 General view on the ENVISION services and the use of EO for monitoring and evaluating the CAP SP 2023-2027

Environmental Monitoring: Since the ENVISION project promotes the use of EO services, it can play a crucial role in helping to monitor and assess environmental aspects relevant to CAP 2023-2027. CAP aims to promote sustainable agriculture and environmental conservation. The ENVISION project can provide data and tools for monitoring changes in land use, biodiversity, soil health, and other environmental parameters, which are critical for CAP's goals. For instance, the ENVISION project can potentially tailor the provision of services further to help farmers to optimize their crop management and reduce their environmental impact by providing them with information on soil moisture and crop growth. The ENVISION project can also potentially help policymakers, certification bodies, paying agencies and stakeholders to evaluate the effectiveness of CAP's measures and incentives by providing them with indicators on land cover, habitat quality, and ecosystem services. Specifically, the Data Product 1 – “Analytics on vegetation and soil index time series”, is a data product that takes into advantage satellite image time series using DataCube technology and facilitates monitoring. However, further investigation should be done in order to design the respective services for future environmental monitoring.

Precision Agriculture: ENVISION services could support CAP's objective of increasing farm competitiveness by providing data for precision agriculture. Precision agriculture involves using technology to optimize farming practices, reducing waste, and improving resource efficiency. EO

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services can provide valuable information for precision agriculture, helping farmers make data-driven decisions and improve their competitiveness. For instance, EO services can monitor soil moisture, crop health, and other factors that effect crop growth and yield. Based on this information, farmers can adjust their irrigation and harvesting strategies accordingly. This can result in lower costs, higher revenues, better quality products, and less environmental impact. Moreover, this empowers them to make informed decisions and adapt their farming practices to meet for example, stringent organic standards and CAP's environmental preservation goals. By using further tailored and improved ENVISION services, farmers can enhance their productivity and profitability, while contributing to the sustainability of the agricultural sector. Precision agriculture can be accomplished though relative services designed on top of DataCube (e.g. Harvest event detection etc.).

Using accurate detections, farmers can manage and optimize their implemented farming practices. Additionally, by using exhaustive monitoring applied algorithms at national scale, CBs and PAs can handle their inspections and subsidies allocations more efficiently and at reduced cost.

Climate Change Mitigation: In addition to climate change mitigation, CAP 2023-2027 also aims to enhance the resilience and adaptation of the agricultural sector to the impacts of climate change. The services of the ENVISION project can be further developed to support this goal by providing data on climate risks, vulnerabilities, and adaptation options for different crops and regions. This information is useful for designing and implementing effective adaptation measures that can reduce the negative effects of climate change on agriculture and rural livelihoods.

Natural Resource Management: The ENVISION project can support CAP's goals of efficient natural resource management by providing data on soil quality, and other natural resources. This information can help farmers make informed decisions about resource use, reducing chemical dependency and promoting sustainable practices.

Biodiversity Conservation: ENVISION can play a role in monitoring and preserving biodiversity, a key objective of CAP. It can provide data on changes in land use and habitat quality, which is vital for assessing the impact of CAP measures on biodiversity. Biodiversity Conservation is also crucial for organic production. Specifically, the ENVISION services allow organic farmers to monitor changes in land use and habitat quality and also facilitate the implementation of targeted conservation strategies that preserve and enhance the richness of natural ecosystems. Hence, support the alignment with the CAP's goals for preserving biodiversity. It should be noted that DP2 and DP1, respectively, are already offering grassland mowing detection and Natura2000 illegal activity detection services, which enhance the management of monitoring and management of critical ecosystem factors.

Innovation and Knowledge Exchange: CAP aims to foster knowledge and innovation in agriculture. The ENVISION project can support this by providing tools and data for research and innovation in the agricultural sector, thereby helping farmers modernize their practices.

Eco-Schemes: The implementation of the ENVISION services within the framework of the CAP for 2023-2027 also holds significant potential to revolutionize various aspects of organic production. ENVISION

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can play a pivotal role in promoting sustainable agricultural practices while aligning with the overarching objectives outlined in the CAP, such as agro-forestry, carbon farming, other practices beneficial for soil, such as crop rotation, soil erosion, etc. Organic Regulations still do not fully integrate any EO services as an approved tool in inspection of organic production. ENVISION data products and services can foster the further acceptance of EO technologies with better accuracy, thus, encouraging national bodies in accepting EO technologies for improvement in control and certification of organic production and considering this in existing regulations, such as for CAP.

The data and services provided by ENVISION can be instrumental in achieving the goals of CAP 2023-2027. Monitoring and data-driven decision-making are becoming increasingly important in agriculture, and EO services like those offered by ENVISION can significantly contribute to the success of CAP's objectives. It's possible that collaborations or initiatives may develop in the future to strengthen this connection and maximize the benefits of EO services for CAP.

4.6.2 Specific and tailored developments of the ENVISION services for the future monitoring and evaluation of the CAP SP 2023-2027

The ENVISION platform, built with state-of-the-art technology, makes use of EO data and analytics to address various environmental and agricultural challenges. Its capabilities can be extended to monitor ecosystem services and biodiversity, given its tools.

The Requirement of Good Agricultural and Environmental Condition 6 (GAEC06), which necessitates the sowing or planting of agricultural crops on black fallow land until October 1st each year, is a specific regulation within the CAP SP. This regulation plays a vital role in promoting sustainable land use, soil conservation, and productive agricultural practices in the EU. It is closely linked to the "Minimum Soil Cover" data, which is designed to determine whether there is adequate vegetation or soil cover on agricultural fields to prevent soil erosion and maintain soil health. Furthermore, this data product can identify applicants who fail to comply with the Cross-Compliance GAEC06 requirement, facilitating early sanctions if necessary.

The "Grasslands Mowing Events Detection" product serves as a valuable tool for monitoring and assessing mowing activities in pastures and meadows. It supports both agricultural and environmental objectives. Specifically, by providing data to ensure compliance with CAP SP rules on grasslands' management (classifier codes GPZ, DGP, DGA, DGI) and grassy nitrogen-accumulating plants on arable land (code list from the third group of the classifier). These must be mowed or grazed at least once a year, no later than September 1st of the current year. Additionally, it promotes responsible land management and the protection of meadow ecosystems, while aiding in the effective enforcement of agricultural policies and land use practices.

Another remote sensing technique that contributes to the long-term sustainability of agriculture and addresses environmental and soil health concerns is the "Stubble Burning Identification" data product, which is used to detect and monitor stubble burning in agricultural fields. This product is essential for

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compliance with environmental regulations, responsible crop residue management, and the broader environmental sustainability strategy. It is directly linked to the GAEC03 requirement, which restricts stubble burning except in specified cases related to environmental protection, such as burning dry grass, reeds, straw, forestry, and horticultural waste.

The CAP SP's requirement that the declared crop must be physically present in the field until August 1st of the current year, or clear remains of the declared crop must be evident, is a crucial and obligatory aspect of CAP compliance. It plays a significant role in ensuring the accuracy of declarations, promoting responsible land use practices, and maintaining the transparency and integrity of agricultural subsidy programs. The "Cultivated Crop Type Maps" product is closely connected to this requirement, as it provides data-driven insights into the types of crops cultivated in specific fields, assisting inspectors in verifying compliance with the declared crop type.

The prohibition on working the land and spreading mineral fertilizers, plant protection products, manure, and/or slurry in the coastal protection strips of water bodies is associated with the Cross-Compliance GAEC4 requirement. This requirement focuses on safeguarding water bodies, preventing pollution from agricultural activities, and promoting responsible land stewardship within the broader context of the CAP SP. The "Runoff Risk Assessment for the Reduction of Water Pollution in Nitrate Vulnerable Areas" ENVISION data product is used to assess and predict the risk of run-off water carrying nitrates and other pollutants from agricultural fields into nearby water bodies, such as rivers, lakes, or groundwater. This product is designed to identify areas or fields that are at a higher risk of contributing to water pollution, particularly nitrate pollution. It is a crucial tool for managing and reducing water contamination in areas where nitrate vulnerability is a concern, thereby helping protect both natural ecosystems and human health.

The rule concerning Data Points (DP) for agricultural land and other areas emphasizes the requirement that for arable land within designated agricultural plant areas, agricultural plants must be cultivated through activities such as sowing (planting seeds), plant vegetation (growth and development of plants), and harvesting (the collection of mature crops). Harvest events are a critical element of this compliance, signifying the successful completion of the agricultural plant cultivation cycle and ensuring that farmers are actively using the land for agricultural purposes. The "Harvest Events Detection" data product is a valuable technological resource that aids in the monitoring and enforcement of the aforementioned rule related to agricultural plant cultivation and harvesting on arable land. It helps verify that farmers are conducting harvest events as required, which is vital for maintaining eligibility for DP

4.6.3 Boosting monitoring and evaluation of ecosystem services and biodiversity.

ENVISION harnesses the power of satellite and remote sensing data, providing the means to capture vast landscapes. This capability is instrumental in enabling the monitoring of expansive ecosystems and tracking essential biodiversity metrics over extended periods. ENVISION's use of EO data represents a technological cornerstone for ecological observation and conservation.

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Integration with Diverse Data Sources: ENVISION goes beyond just EO data; it has the capacity to seamlessly integrate data from a wide range of sources. This includes ground-based sensors, weather stations, and data from field surveys. This holistic approach empowers users with a comprehensive and multifaceted view of ecosystem health and a more accurate assessment of biodiversity indicators. By uniting data streams from various origins, ENVISION presents a nuanced understanding of the ever-changing environmental landscape.

Machine Learning and Advanced Analytics: The incorporation of machine learning techniques within ENVISION opens up new horizons for data analysis. These algorithms can predict ecological trends, model potential scenarios, and deliver in-depth analyses of ecosystem changes. This analytical prowess is invaluable for proactively managing biodiversity and developing strategies for sustainable conservation practices.

Customizable Dashboards for Informed Decision-Making: ENVISION's user-friendly platform provides stakeholders with the flexibility to customize dashboards. This means they can access and analyse data specific to their interests, whether it be related to ecosystem services, species populations, or any other environmental parameter. Such customization ensures that decision-makers have the precise information required to make informed choices about ecological preservation and management.

Open Source and Collaborative Spirit: ENVISION's affiliation with the open-source community fosters a spirit of collaboration and continuous improvement. Tools and modules are continually developed, refined, and expanded upon by contributors from across the globe. This open approach enhances ENVISION's adaptability and responsiveness to address evolving challenges in ecosystem and biodiversity monitoring. It allows for innovation and keeps the platform at the forefront of ecological research and conservation efforts.

Stakeholder Engagement for Ground-Truthed Data: ENVISION extends its reach to ground-level workers, including farmers and local communities, through tools like mobile applications. By involving these stakeholders in data collection and validation processes, the platform ensures that biodiversity metrics are "ground-truthed." This means that data is not just accurate but also contextualized, reflecting the nuances of the environment as observed by those who interact with it daily.

In conclusion, while ENVISION's primary focus may revolve around agricultural practices and CAP monitoring, its underlying infrastructure and capabilities are indicative of a vast potential. This potential extends to meet the requirements of ecosystem service and biodiversity monitoring, making it a powerful tool for environmental conservation and sustainable management.

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5. Summary and conclusions

The work described in this Deliverable represents a considered, collaborative approach to innovation that embeds Extreme Programming into Design Thinking. XP was used as it is an agile software development framework that focuses on customer satisfaction (Erikson et al., 2005). Short development cycles have been employed with regular checkpoints for end users to provide inputs and for developers to respond to required changes. This constant, iterative communication process improves productivity but requires management to facilitate smooth communication and task focussed interactions. The framework of DT (Lindberg et al. 2011 and described in Deliverable 2.2) integrates human, business and technological factors into the problem solving and design parts of XP (Sohaib et al., 2019). The repeated exploration of the 'problem' space and 'solution' space with a team of facilitators has proven an effective way to manage the coproduction of ENVISION and has generated knowledge, experiences, networks, and collaborations beyond the specific project outputs.

The coproduction approach within ENVISION project builds on the experiences from the RECAP project (Rousi et al., 2020) and the other recent EU projects that have utilised coproduction approaches for the development of EO-based Software as a Service (SaaS). Examples include Sen4CAP (De Vroey et al., 2021), e-shape (Barbier, 2022) and the DIONE project (Karagiannopoulou, et al., 2020) which adopted a stakeholder-driven, systems participatory design that analysed the specifications from the perspectives of seven defined user persona archetypes. The ENVISION project built and improved upon these past experiences.

This collaborative approach was important as over the past decade the EU has encouraged Responsible Research and Innovation (RRI) principles to be embedded in research projects to facilitate democratisation of science and connect with citizens through participatory process. There is the need now for a theoretical framework for methodological implementation of coproduction (Robinson et al., 2021) to ensure that this legacy continues to build and improve citizens' engagement with research and innovation. A recent review by Sillak et al. (2021) provides three assessment criteria for successful coproduction namely; 1) the involvement of actors and their roles in different phases (initiation, design, and implementation) of cocreation; 2) the use of activities to foster transformative power; and 3) the outcomes of cocreation.

The coproduction of ENVISION provided the opportunity to construct a set of Guiding Principles for future projects which will be developed for publication. These principles will allow more effective implementation of coproduction processes, based on RRI principles, to support innovations within the agri-food sector and help guide the sector towards more sustainable agricultural practices (Velten et al., 2015). These principles will also consider ways to address any barriers or challenges in the implementation of coproduction in innovation projects. Since successful coproduction requires substantial commitment to three key components; interdisciplinarity, stakeholder participation, and production of knowledge that is demonstrably usable (Lemos & Morehouse, 2005) the process necessitates stakeholders to provide a significant amount of time and effort. In addition to time requirements, there can also be some challenges in the successful implementation of coproduction (Popovici et al., 2020) which can include mismatched terminology and unrealistic expectations (Briley

et al., 2015), power imbalances (Vincent et al., 2020), participation only in localised contexts (Galende-Sanchez & Sorman, 2021).

However, as with any such complex, multidimensional, and multistakeholder methodological approach, we acknowledge specific limitations and areas for improvement in the ENVISION coproduction process too. We propose a shift from a solely outcome-based evaluation system (e.g., in our case evaluating how desirable and commercially viable the ENVISION products and services will be), to a holistic system that evaluates equally i) the products of the collaborative effort, ii) the quality of relationships and collaborations between all stakeholders, iii) the advancement of scientific knowledge in the specific field, but also broader knowledge, and v) the creation, growth, and establishment of stakeholder networks for future engagement and collaborations. This ambitious systematic evaluation should run from the birth of an idea through to beyond the lifetime of the implemented project and should use both quantitative and qualitative evaluation methods.

Therefore, we suggest some recommendations for future work on coproduction in digital innovation projects for sustainable agriculture. First, we recommend conducting a stakeholder analysis before initiating cocreation to identify relevant actors and their roles, interests, and expectations. Second, we recommend designing and implementing a variety of activities that can stimulate creativity, learning, and empowerment among co-creators. Third, we recommend developing and applying a comprehensive framework for assessing the success and impact of cocreation on different levels: individual, organizational, societal, and environmental.

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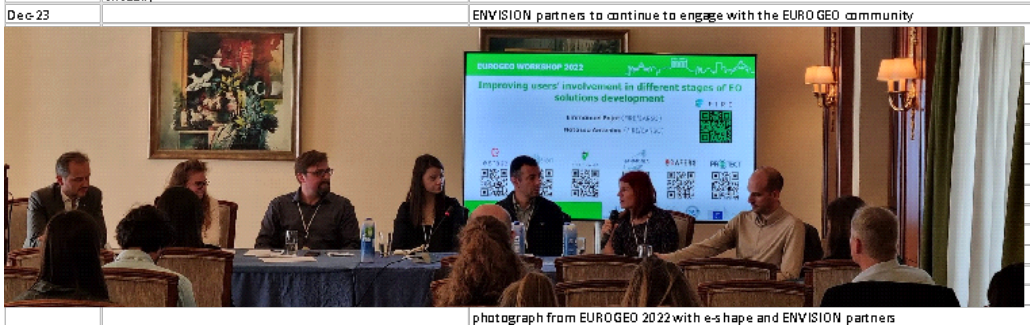
Supplementary materials

S1 Evidence of interactions between ENVISION WP2 and E-shape

Date	Interactions WP2 ENVISION & e-shape partners	Outcomes
22/09/2020	Email exchange between ENVISION WP2 and e-shape partners	e-shape shared their Deliverable D2.1, D2.2 and D2.3
24/09/2020	ENVISION WP2 - e-shape introduction meeting	Bringing together NOA, ARMINES and UoR. Brief discussion about the following topics: i) e-Shape and ENVISION synergies for user requirement identification. ii) Co-production of commercialised services with integrated Design Thinking and Extreme Programming framework. iii) Data collection process.
19/10/2020	ENVISION WP2 team attended e-shape virtual assembly	
28/10/2020	ENVISION WP2 - e-shape virtual meeting	Discussion regarding eShape "co-design" experiences, ENVISION "co-production of services" deliverables and potential synergies between the two. Please find attached two relevant documents that might be useful to review prior to our meeting: ▪ our presentation for ENVISION Work Package 2, where our specific tasks and deliverables are described ▪ RECAP's deliverable on the co-production of services with the relevant approach and outcomes detailed
24/11/2020	Email exchange between ENVISION WP2 and e-shape partners	Exchange of publications and workshop materials regarding co-design (Pluchinotta, 2019 and Berthet et al 2016)
10/12/2020	ENVISION WP2 - e-shape virtual meeting	Discussions about the methods adopted in ENVISION workshops, for the identification of Paying Agencies' and Certification Bodies' requirements from the ENVISION tools.
20/01/2021	ENVISION WP2 evidence of communications with e-shape sent to project officer by email	The University of Reading ENVISION team and the ARMINES eShape team took the initiative to meet in order to exchange knowledge, experiences and to understand the different requirement of the co-production of services. So far, we have had three scheduled meetings while an exchange of project deliverables and relevant to the task documents (i.e. research publications) has been helpful and supportive in understanding each other's tasks and objectives. The main topic of discussion is how the two teams can work together in developing a standardised approach (protocol) to effectively record information derived from workshops with the end to efficiently produce user stories or relevant tools that would serve the needs of the two projects as well as the developers. The URDG has benefited from the early discussions with the eShape team in respect to the challenges associated with a multicultural and diverse group of stakeholders with different needs and level of services developed. The discussions with ARMINES (Raphaelle Bardier, Pascal le Masson & Skander Ben Yahia) have been around the need to effectively engage all partners during the co-production phase of the project and therefore, good practices and challenges of the eShape project have been shared. ARMINES provided access to co-design workshop material in Athens as well as to deliverables D2.1, D2.2, D.23 of the eShape project. The two teams have agreed to meet frequently to share experiences, knowledge and good practices.
24/03/2021	ENVISION WP2 - e-shape virtual meeting	Discussion of co-production methods and progress in ENVISION
08/04/2021	ENVISION WP2 completed & submitted self-assessment to e-shape	Response from e-shape "The file is complete now. The distinction between "initial state" and "targeted state" is that the former is supposed to describe what has already been done, while the latter is supposed to describe what you intend to do based on what already exists. However, this distinction may not be appropriate for your project; In the framework of our methodology the notions of short-term and long-term are relative to each project. We can consider that short-term refers to the most urgent problems to be solved, whereas long-term refers to problems that you plan to solve in the future but which are not an immediate priority. In the context of your project, your interpretation of these time horizons is appropriate. We can consider that the short-term refers to the project lifetime; You will not be asked to make a presentation during the workshop. It will be up to us to present our analysis of your project. What is expected from you is interaction/discussion on what will be presented."
16/04/2021	ENVISION WP2 team attended the e-shape workshop	
20/04/2021	Feedback from ENVISION WP2 team to project officer following e-shape workshop	"We found the workshop very relevant to our work and useful. It is important for us to understand the co-design challenges that other projects also face and discuss ways to overcome these. We will be building on this workshop primarily by establishing more frequent communications / meetings with the eShape co-design team and other projects (i.e., SAFERS adopts a very similar approach to ENVISION), to share experiences and receive feedback as the co-production process progresses. Since our role in ENVISION requires the review of current service provision, needs and concerns regarding EO-based monitoring tools, we have identified potential room for improvement in the level of awareness, responsiveness, and engagement of both the public and private sectors that are the end-users of such tools (e.g., Paying Agencies, Certification Bodies, Farm Managers). It would be very useful if EuroGEO and EC could support a network of "Earth Observation Co-production Managers" specifically to facilitate communications and that have the responsibility of providing feedback and exchanging relevant information between such organisation and relevant European Research & Innovation projects like ENVISION. It is important that the contact details of such officers are up-to-date and readily available (e.g., through an official EU portal) to avoid significant delays and miscommunications in the first steps of such projects."
08/12/2022	EuroGEO workshop in Athens "Involving users in different stages of EO solutions development" conversations with e-shape partners	OCS, ETAM, AgroApps represented ENVISION at this workshop. UREAD supported the preparation of responses regarding the importance of co-production methodology in ENVISION
01/12/2022	ENVISION WP2 - e-shape in-person meeting in Reading	Discussion of e-shape publications, exchange of knowledge of participatory approaches, future collaborations
24/03/2023	ENVISION WP2 team attended Raphaelle's PhD viva virtually	Support for Raphaelle and further information gathering for ENVISION
Dec-23		ENVISION partners to continue to engage with the EUROGEO community
		 photograph from EUROGEO 2022 with e-shape and ENVISION partners

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S2 ENVISION self-diagnosis using e-shape template (April 2021)

Users communities					User competencies		
User community: Precise the type of user communities: sector, types of organizations (e.g. commercial entities, public/international bodies etc)? (answer relevant also for wp4)	**Contact point:** Precise the name of the organization and department of the contact persons	**General context:** What are the main rules governing the sector (rules, standards, particular organisation, etc.) that have a potential impact on the service?	**Position in the user community** Precise if the user is an end user (e.g.farmers) or an intermediate user (e.g. a company that has its own clients) (answer relevant also for wp4) If intermediate, please precise the users of the user	**Contact point:** Precise the name of the organization and department of the contact persons	**Category of user** (e.g. EO expert, non-EO expert, software dev, etc) (answer relevant also for wp4)	Does the user already use data-based tools in their daily operations (EO/non EO)? For what purposes?	Will the user directly be able to use the pilot's output on its own? Do they need additional support?
Public organisation - Paying agency in the agri food and rural development sector	CAPO, Administrators - IT experts GIS officers Inspectors	Monitoring of agricultural practices for cross-compliance and rural development programmes, Realisation of Direct Payments scheme - application control and funds distribution	End user	CAPO, Administrators - IT experts GIS officers Inspectors	Familiar with EO data, including EO experts and software developers	Yes (EO-based tools) for monitoring of cross-compliance and checks through the Geo Spatial Aid Application system	Yes. No
Public organisation - Paying agency in the agri-food and rural development sector	NMA, Administrators - IT experts - GIS officers - Inspectors	Monitoring of agricultural practices for cross-compliance and rural development programmes, Realisation of Direct Payments scheme application control and funds distribution	End user	NMA, Administrators - IT experts - GIS officers - Inspectors	Familiar with EO data, including EO experts and software developers	Yes (EO-based tools) for monitoring of cross-compliance and checks through the Geo Spatial Aid Application system	Yes. No
Public organisation - Paying agency in the agri-food and rural development sector	LV, Administrators - IT experts GIS officers Inspectors	Monitoring of agricultural practices for cross-compliance and rural development programmes, Realisation of Direct Payments scheme - application control and funds distribution	End user	LV, Administrators - IT experts GIS officers Inspectors	Familiar with EO data, including EO experts and software developers	Yes (EO-based tools) for monitoring of cross-compliance and checks through the Geo Spatial Aid Application system	Yes. No
Private organisation - Certification body for organic production	OCS, Administrators - IT experts	Monitoring of sustainable agricultural practices under organic production standards	End user	OCS, Administrators - IT experts	Familiar with EO data, including EO experts	Yes (EO-based tools) for organic production systems inspections	Yes. No

	Service developed by the pilot								
Contact point: Provide the name of the organization and department of the contact persons	**Type of service** (indicate the relevant category based on the definitions below (answer relevant also for wp4)	**Short description** (general purpose, modules description, resolution, forecast frequency, visualization tool, etc.) ; (answer relevant also for wp1)	**EO-data derived information on which the service is based**	**Maturity** (answer relevant also for wp4)	**Level of access** (e.g. restricted to the owner, open access, partners, etc.) (answer relevant also for wp4)	**Lists of requirements:** Have you already clarified the potential lists of requirements?	**Need of customization:** Does the service need to be customized and how the pilot can anticipate the need of that customization? (answer relevant also for wp4)	**Interest of the user:** What is the added value brought by the service compared to existing sources of information?	**Service integration in user's operations:** Have you indentified the specific difficulties the user may experience when integrating the service in its current workflow?
CAPO, Administrators - IT experts GIS officers Inspectors	Monitoring system	High resolution and frequency crop type classification maps, vegetation status maps, detection of grassland mowing / ploughing events, including visualisation of these products on a web based platform	Sentinel 1 and 2 EO data		Open access, data from existing services	Yes	Yes, by using data that are specific to the country the organisation originates. Such data requirements have been clarified.	Increased spatial and temporal resolutions of existing services, addressing / overcoming specific methodological issues such as the inability to monitor due to cloud coverage	The current workflow of the organisation has been identified and detailed. Potential weaknesses have been addressed, although due to the experience of the organisation in using EO-based monitoring tools none of these should pose a problem in the case of ENVISION
NMA, Administrators - IT experts GIS officers Inspectors	Monitoring system	High resolution and frequency crop type classification maps, vegetation status maps, detection of grassland mowing / ploughing events, including visualisation of these products on a web based platform	Sentinel 1 and 2 EO data		Open access, data from existing services	Yes	Yes, by using data that are specific to the country the organisation originates. Such data requirements have been clarified.	Increased spatial and temporal resolutions of existing services, addressing / overcoming specific methodological issues such as the inability to monitor due to cloud coverage	The current workflow of the organisation has been identified and detailed. Potential weaknesses have been addressed, although due to the experience of the organisation in using EO based monitoring tools none of these should pose a problem in the case of ENVISION
LV, Administrators - IT experts GIS officers Inspectors	Monitoring system	High resolution maps of soil organic carbon and soil erosion risk, including visualisation of these data products on a web-based platform	Sentinel 1 and 2 EO data		Open access, data from existing services	Yes	Yes, by using data that are specific to the country the organisation originates. Such data requirements have been clarified.	Creation of soil organic carbon map which is not currently provided	The current workflow of the organisation has been identified and detailed. Potential weaknesses have been addressed, although due to the experience of the organisation in using EO based monitoring tools none of these should pose a problem in the case of ENVISION
OCS, Administrators IT experts	Monitoring system	High resolution and frequency of vegetation status maps and crop growth monitoring for the distinction between conventional and organic crops, including visualisation of these data products on a web-based platform	Sentinel 1 and 2 EO data		Open access, data from existing services	Yes	Yes, by using data that are specific to the country the organisation originates. Such data requirements have been clarified.	Crop growth monitoring service can be used as a proxy to identify malpractices in organic crop production	The current workflow of the organisation has been identified and detailed. Potential weaknesses have been addressed, although due to the experience of the organisation in using EO based monitoring tools none of these should pose a problem in the case of ENVISION

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	Pilot-user relationship					
Contact point: Precise the name of the organization and department of the contact persons	Please precise the partner in direct contact with the user	**Level of engagement:** What is the level of user engagement (answer relevant also for wp4)	**History of the relationship:** In what year were the first contacts made? What have been the kind of interaction since then (ponctual, close partnerships, etc.)?	**Expected inputs from the user:** Is the user also a data provider ? If yes, which type of data does he provide ? Do you expect other types of resources/inputs to be provided by the user ?	**Cooperation modalities:** Are cooperation modalities clearly formalized? What type of relationsip you would like to establish with the user? (only client, partner for exploration, etc.)	**Feedback loops:** Are the existing feedback loops sufficient to the pilot's developement needs ?
CAPO, Administrators - IT experts - GIS officers - Inspectors	NOA	Medium	Well-established relationship through direct collaboration in multiple projects (NOA - CAPO)	Yes, specific information about crop production in the country of the organisation, in-situ data related to crop production	CAPO is both a client and a partner for exploration	A timeline for detailed reporting of progress and feedback has been established. A communications channel has also been set to facilitate feedback provision throughout the multiple phases of co-production.
NMA, Administrators - IT experts - GIS officers - Inspectors	NOA	High	Already established relationship since 2016 with EU Horizon 2020 "RECAP" project	Yes, specific information about crop production in the country of the organisation, in-situ data related to crop production	NMA is both a client and a partner for exploration	A timeline for detailed reporting of progress and feedback has been established. A communications channel has also been set to facilitate feedback provision throughout the multiple phases of co-production.
LV, Administrators - IT experts - GIS officers - Inspectors	ILVO	High	Well-established relationship through direct collaboration in multiple projects (LV - ILVO)	Yes, specific information about crop production in the country of the organisation, in-situ data related to crop production	LV is both a client and a partner for exploration	A timeline for detailed reporting of progress and feedback has been established. A communications channel has also been set to facilitate feedback provision throughout the multiple phases of co-production.
OCS, Administrators - IT experts	AgroApps	Medium	Well-established relationship through direct collaboration in multiple projects (AgroApps - OCS)	Yes, specific information about crop production in the country of the organisation, in-situ data related to crop production	OCS is both a client and a partner for exploration	A timeline for detailed reporting of progress and feedback has been established. A communications channel has also been set to facilitate feedback provision throughout the multiple phases of co-production.

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	Ability of the pilot to provide the required service (prototype/operational)					
Contact point: Precise the name of the organization and department of the contact persons	Please precise the role of the different partners involved in the development of the service	**First functional service**: Do you already have a first functional prototype/service?	**Upscaling challenges:** What are the difficulties related to the extension of the service (larger number of users, geographic extension, etc.)?	**Dedicated operationalization team:** Is there already a specific team dedicated to operationalization (engineering, commercialization, etc.)? Please precise its nature (internal department, third party actor, etc.)	**Cooperation modalities:** Do the interactions between the R&D team and the operational team need to be improved/more clearly formalized?	**Resources for operationalization:** Do you already have all the required resources to make the service operational? Do you think other actors might need to be involved to support operationalization? If yes,what types of actors?
CAPO, Administrators - IT experts - GIS officers - Inspectors	DRAXIS is responsible for platform development. NOA, AgroApps and ILVO are responsible for the development of the different specific services. CAPO, NMA, LV and OCS are the pilots responsible for data provision, testing of the services and feedback provision. URDG is responsible for reviewing current service provision, identifying user requirements and potential problems to the adoption of ENVISION tools, and facilitating the co-production of services process. ETAM is responsible for development of the business plan of the ENVISION services. INOSENS is reponsible for platform and services calibration according to end-user needs. ITC is the responsible partner for dissemination and communication.	No	Need for data specific to countries of application (e.g. North of Europe requirement for additional data to overcome cloud coverage issues) and CAP specifications (i.e., due to flexible application of CAP regulations)	Engineering - DRAXIS, AgroApps and NOA. Commercialization - ITC. Business plan - ETAM. User need analysis and co-production - URDG.	A formal communications channel regarding the co-production of ENVISION tools has been established. URDG will be working on improving partner engagement throughout the project lifetime.	ENVISION tools will be fully operational by the end of the ENVISION project, however integrating the tools with DIAS systems (service providers) may improve the end-user outreach.
NMA, Administrators - IT experts - GIS officers - Inspectors	DRAXIS is responsible for platform development. NOA, AgroApps and ILVO are responsible for the development of the different specific services. CAPO, NMA, LV and OCS are the pilots responsible for data provision, testing of the services and feedback provision. URDG is responsible for reviewing current service provision, identifying user requirements and potential problems to the adoption of ENVISION tools, and facilitating the co-production of services process. ETAM is responsible for development of the business plan of the ENVISION services. INOSENS is reponsible for platform and services calibration according to end-user needs. ITC is the responsible partner for dissemination and communication.	No	Need for data specific to countries of application (e.g. North of Europe requirement for additional data to overcome cloud coverage issues) and CAP specifications (i.e., due to flexible application of CAP regulations)	Engineering - DRAXIS, AgroApps and NOA. Commercialization - ITC. Business plan - ETAM. User need analysis and co-production - URDG.	A formal communications channel regarding the co-production of ENVISION tools has been established. URDG will be working on improving partner engagement throughout the project lifetime.	ENVISION tools will be fully operational by the end of the ENVISION project, however integrating the tools with DIAS systems (service providers) may improve the end-user outreach.
LV, Administrators - IT experts GIS officers - Inspectors	DRAXIS is responsible for platform development. NOA, AgroApps and ILVO are responsible for the development of the different specific services. CAPO, NMA, LV and OCS are the pilots responsible for data provision, testing of the services and feedback provision. URDG is responsible for reviewing current service provision, identifying user requirements and potential problems to the adoption of ENVISION tools, and facilitating the co-production of services process. ETAM is responsible for development of the business plan of the ENVISION services. INOSENS is reponsible for platform and services calibration according to end-user needs. ITC is the responsible partner for dissemination and communication.	No	Need for data specific to countries of application (e.g. in-situ soil samples and detailed soil type maps) and CAP specifications (i.e., due to flexible application of CAP regulations)	Engineering - DRAXIS, AgroApps and NOA. Commercialization - ITC. Business plan - ETAM. User need analysis and co-production - URDG.	A formal communications channel regarding the co-production of ENVISION tools has been established. URDG will be working on improving partner engagement throughout the project lifetime.	ENVISION tools will be fully operational by the end of the ENVISION project, however integrating the tools with DIAS systems (service providers) may improve the end-user outreach.
OCS, Administrators - IT experts	DRAXIS is responsible for platform development. NOA, AgroApps and ILVO are responsible for the development of the different specific services. CAPO, NMA, LV and OCS are the pilots responsible for data provision, testing of the services and feedback provision. URDG is responsible for reviewing current service provision, identifying user requirements and potential problems to the adoption of ENVISION tools, and facilitating the co-production of services process. ETAM is responsible for development of the business plan of the ENVISION services. INOSENS is reponsible for platform and services calibration according to end-user needs. ITC is the responsible partner for dissemination and communication.	No	Need for data specific to countries of application (e.g. North of Europe requirement for additional data to overcome cloud coverage issues) and CAP specifications (i.e., due to flexible application of CAP regulations)	Engineering - DRAXIS, AgroApps and NOA. Commercialization - ITC. Business plan - ETAM. User need analysis and co-production - URDG.	A formal communications channel regarding the co-production of ENVISION tools has been established. URDG will be working on improving partner engagement throughout the project lifetime.	ENVISION tools will be fully operational by the end of the ENVISION project, however integrating the tools with DIAS systems (service providers) may improve the end-user outreach.

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Co-design types definition					Co-design needs self-diagnosis		
Co-design	**Overall context**	**Initial state**	**Blocking point to be addressed**	**Expected outcomes**	**How to know if this type of co-design corresponds to your co-design needs with one of the users?**	**Short-term**	**Long-term**
Type 1	Adjustment between user and service designer	(a) Usefulness already identified on a first basis but to be enhanced. Usability to be enhanced. (b) Relationship with the user to be precisely defined but at least seems favorable (user willing to devote time settling it).	Establishing adapted relationships with specific users for usefulness & usability assessment and enhancing	(a) Enhanced lists of requirements ensuring usefulness and usability (b) Cooperation modalities with these specific users clearly clearly formalized	**Co-design type 1** You must have: (1) Some knowledge on the user community (column C) (2) An existing contact point (D) (3) Some interest of the user (Q) (4) A sufficient level of engagement on the user side (at least readiness to participate to a co-design workshop) (T) You must have at least one of the following conditions: (5) Unformalized cooperation modalities (W) (6) Feedback loops to be improved (X) (7) Lists of requirements to be further clarified (O)	*With CAPO, NMA, LV, OCS* *(1) + (2) + (3) The platform and services' developers have well-established relationships and communications with the business case partners who are also end-users of the ENVISION tools.* *(4) All ENVISION partners, particularly the platform and service developers together with the business case partners, have been involved and actively engaged to several co-design workshops, where user requirements and potential problems for adoption of ENVISION tools were identified.* *(6) While a preliminary timeline for feedback / progress reports has been agreed, its implementation needs to monitored and the schedule could potentially improve.*	*Please precise for which user and give explanations on the conditions you meet (column AK)*
Type 2	Exploration for usage initiation	(a) Usefulness not well-known and/or (b) Relationship with the user appearing to be difficult to establish (uncommitted users)	Establishing adapted interactions with user communities for usefulness identification	(a) Expanded usefulness of the service (b) Expanded list of relevant stakeholders to interact with	**Co-design type 2** You must have at least one of the following conditions: (1) Little or no user interest (Q) (2) A limited knowledge of user interest (Q) (3) Low level of engagement (T) (4) Punctual cooperation modalities without sustained interactions (W)	*Please precise the community or communities of users you would like to explore and give explanations on the conditions you meet (column AK)*	*Please precise the community or communities of users you would like to explore and give explanations on the conditions you meet (column AK)*
Type 3	Engineering for operationalization	(a) Lists of requirements for usefulness and usability established. (b)Relationships with users established.	Establishing adapted relationships with relevant partners for extensive usefulness & usability realization and operationalization of the service	(a) Clarification of the service structure (parts ready to be operationalized, parts needing further exploration) (b) Cooperation modalities between R&D and operationalization entities clearly formalized	**Co-design type 3** You must have: (1) Lists of requirements clearly defined (O) (2) Some knowledge on the user community (C) (3) An existing contact point (D) (4) A clear interest of the user (Q) (5) A sufficient level of engagement on the user side (T) You must have at least one of the following conditions: (6) Upscaling challenges to meet (AA) (7) Operationalization resources unclearly defined (AB and AD) (8) Cooperation modalities betweend R&D and operationalization teams to be improved (AC) (9) Cooperation modalities between pilot partners to be improved (Y)	*With CAPO, NMA, LV, OCS* *(1) + (2) + (3) + (4) + (5) All ENVISION partners, particularly the platform and service developers together with the business case partners, have been involved and actively engaged to several co-design workshops, where user requirements and potential problems for adoption of ENVISION tools were identified.* *(6) Business plans and data requirements need to be further discussed with regard to the adoption of ENVISION tools by PAs and CBs outside of the consortium.*	*Please precise which stakeholders it would involve and give explanations on the conditions you meet (column AK)*
Type 4	Exploration for usage expansion	Usefulness, usability and relationships already established with existing users.	Establishing adapted relationships with existing & potential new users for usefulness reinvention	(a) Expanded range of potential alternatives for future usages (which usefulness for which actors) (b) Cooperation modalities and supports for interactions (proofs-of-concept) defined for existing and new users	**Co-design type 4** You must have: (1) A well-established relationship with a long history and a perspective of long-term cooperation (U) (2) A first functional service (Z) (3) A clear interest of the user (Q) You must have at least one of the following conditions: (4) Your common objective is the exploration of new uses on the basis of an existing service (K) (5) The new service might trigger new operations for the user to be explored (Q)	*Please precise the users that could be involed for the exploration of new usages (current and potential future users) and give explanations on the conditions you meet (column AK)*	*With CAPO, NMA, LV, OCS* *(1) DRAXIS, AgroApps and NOA have previously collaborated with CAPO and NMA in multiple projects and have a well-established relationship, as have ILVO and I.V.* *(4) Exploring new uses of existing services (e.g. crop growth as a proxy to monitor malpractices), improving on current services and exploring the inclusion of new users (e.g, farm managers), are common objectives for all ENVISION partners.*

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End of Document

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