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Sovereignty by design and human values in agriculture data spaces

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Abstract
Because of the importance of data-sharing for the economy, improved products and services, and to benefit society, the European Union has proposed developing a Common European Data Space (CEDS). The goal is to create a single European data market through 14 domain-specific data spaces (e.g., agriculture, or the Common European Agricultural Data Space (CEADS)). One of the central tenets of the CEDS is to ensure that those who share data can maintain control over who has access to, use of, and ability to share it (or 'data sovereignty'). Data sovereignty is an umbrella concept with many different values comprising its implementation. Therefore, to successfully implement data sovereignty in the CEADS (and all CEDS for that matter), it is important to identify what values are important for stakeholders.This paper examines the CEADS to identify the most critical values for potential stakeholders of this data space. We implement a six-phase value-sensitive design methodology called 'value mapping' by interviewing stakeholders from an incipient Spanish data-sharing initiative (potentially representing over 1 million farmers) and conducting a workshop with 42 international stakeholders at an agri-tech summit. Our findings demonstrate the different values that are important for stakeholders of an agricultural data space: farmers (privacy, control, and trust); farm advisors (human welfare and autonomy); farmer associations (trust and human welfare); technology providers and intermediaries (autonomy and human welfare); public and regulatory bodies (autonomy); and society (justice). Furthermore, we describe different interdisciplinary steps to ensure and protect these values to ensure sovereignty-by-design in the CEADS.

Keywords Data sovereignty · Value sensitive design · Agriculture · Ethics · Farm data · Data spaces

Introduction

In recent years, the European Parliament (EP) has promoted the idea that increased data sharing will bring economic benefits, innovation, and improved products and services for European citizens (European Parliament 2023). It emphasises the importance of data sharing in different domains, such as agriculture (European Commission 2024c). Agricultural data can be retrieved from drones, robots, sensors, satellites and farm vehicles, and the data types can range from weather, crop, machinery, and livestock data (e.g., temperature, movements, eating patterns) (Kelly 2024). The assumption is that increased agricultural data sharing will be used to ensure sustainability, allow for greater yields using fewer resources, help curb pollution (e.g., less pesticide use), reduce energy consumption, and protect biodiversity (European Parliament 2023).

One of the most significant steps to ensure these goals, the European Commission (EC) claims, is developing a Common European Data Space (CEDS) in the European Union (EU). The goal of the EC (as described in the European Strategy for Data (Carvalho and Kazim 2022; European Commission 2024d)) is to create a single European data market through 14 domain-specific data spaces[1] (one of which is agriculture) (Curry et al. 2022; Scerri et al. 2022). Data spaces keep data at its source and allow data-sharing in

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[1] The nine domain-related data spaces: health; industrial and manufacturing; agriculture; finance; mobility; Green Deal; energy; public administration; and skills.

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a decentralised way (Kirstein and Bohlen 2022; Otto et al. 2022; Scerri et al. 2022). Data spaces are decentralised data-sharing ecosystems with no central data storage location. Instead, they allow for data exchange directly between those involved in the data space. Therefore, there is no standard database scheme, but instead, a coexistence of varying data 'achieved on a semantic level using shared vocabularies' (Otto 2022, p. 7). In recent years, they have developed into large multi-stakeholder international collaboration (e.g., the International Data Space Association, Gaia-X), of which the CEDS is the most recent and largest European data space effort (Lohmöller et al. 2022; Mertens et al. 2022; Pedreira et al. 2021; Torre-Bastida et al. 2022).

As part of this drive toward data space collaboration, the agricultural component of the CEDS - namely, the Common European Agricultural Data Space (CEADS) - aims for the large collections of data and sharing potential at a much lower cost for businesses in the EU and provide a 'level playing field for data sharing and exchange, leading to less dominance of, and dependency on, large, quasi-monopolistic players' (Nagel and Lycklama 2022, p. 18). The EC hopes that the CEADS will allow farmers, agribusinesses, and society to benefit from increased digitalisation and improved data sharing (European Parliament 2023). It is envisioned that the CEADS will work as a central hub for data sharing in Europe, making its reach and impact very significant. The CEADS aims to provide the benefits of data sharing in an 'open', 'fair and transparent', 'trustworthy', and 'secure and privacy-preserving' way (European Commission 2024a). While this is certainly a commendable goal of the European Commission, there is little research on these 'socio-ethical' or critical data governance aspects in the literature on data spaces (except for the recently published Ryan et al. (2024) paper; however, this paper focuses more on the legal dimensions of data sovereignty in data spaces and is on data spaces generally, rather than agriculture-specific).

However, the analysis of the socio-ethical implications and critical data governance in agriculture is not in itself new. There has been a growing discourse for several years that critically examines the goals and practices of data sharing and data governance in the agricultural sector (both within the EU and globally) (de Beer et al. 2022; Bronson 2018; Bronson and Sengers 2022; Brown et al. 2023; Carbonell 2016; Fleming et al. 2018; Jakku et al. 2019; Jouanjean et al. 2020; Raturi et al. 2022; Stock and Gardezi 2022; van der Burg et al. 2020; Zhang et al. 2021). This literature has focused on many topics related to agricultural data sharing; for example, in the context of specific technologies (e.g., artificial intelligence (AI); see Ryan (2019a, 2019b, 2022), policies (e.g., the EU Code of Conduct (van der Burg et al. 2020), and values (e.g., trust (Sullivan et al. 2024)). While much has been written on data governance and the socio-ethical implications of data sharing in the agricultural sector, this literature has not yet focused on data spaces, the CEADS, or the types of values that will be impacted in the process.

Our paper contributes to the socio-ethical and 'critical data scholarship' (Bronson and Knezevic 2016) in agriculture (which has not given much attention to agricultural data spaces) and the emerging body of literature on data spaces, which has not fully developed a critical data governance analysis of the values and socio-ethical impacts of data spaces or implementing the CEADS. Because of the potential magnitude and far-reaching effects of the CEADS in the EU, it should be analysed to ensure that it is designed, developed, and implemented in an 'open', 'fair and transparent', 'trustworthy', and 'secure and privacy-preserving' way, as promoted by the EC (European Commission 2024d). A significant step toward achieving these goals, according to the European Commission (2024d) and often mentioned in the data space literature (Curry 2020; Duisberg 2022; Nagel and Lycklama 2022), is protecting the 'data sovereignty' of those involved in the CEADS, which is the main focus of this paper.

In the context of data spaces, we will use the definition provided by Ryan et al. (2024): 'Data sovereignty in data spaces is control by an individual, organisation, or state over the access, use, storage, and sharing of their data' (Ryan et al. 2024, p. 15). Essentially, the actor is 'sovereign' (i.e., has control) over their data. They can set the requirements for how their data is treated and have 'freedom to take independent decisions and the request for fair conditions [of their data]' (Usländer and Teuscher 2022, p. 315). However, data sovereignty acts more as an umbrella concept (rather than being a singular value), where many different values comprise its overall meaning (Ryan et al. 2024). For example, in the data space literature, data sovereignty is often defined by many different values, such as fairness (preface in Otto et al. (2022), p. v); privacy (Gabrielli et al. 2022); transparency (Vassilev et al. 2022); autonomy (Usländer and Teuscher 2022); and consent (Torre-Bastida et al. 2022).

Therefore, if we take data sovereignty to be an important requirement of protecting the socio-ethical implications of the CEADS, as recommended by the EC (European Commission 2024a), and that it consists of many different values (depending on the actors involved and context), then it is important to identify what these values are in the context of the CEADS. To do this, we discuss with key stakeholders what values are important to ensure data sovereignty in the CEADS. As the CEADS has yet to be designed and implemented, this paper identifies what values are relevant

for future stakeholders[2] in the CEADS and provides recommendations for how to implement these values in the design process, hence ensuring a sovereignty-by-design approach in the CEADS. To achieve this, we apply the six-phase Value-Sensitive Design (VSD) process (Bocken et al. 2013): stakeholder identification, value elicitation, value selection, value conflict analysis, value realisation, and iterative design.

This paper is divided as follows: Following this introduction (Sect. "Introduction"), Sect. "Reference set of human values" explores existing proposals of human values from the literature and synthesises a list of those most commonly used and relevant to information systems and data sharing. Section "Methodology" details the methodology implemented in our empirical research, which combines interviews with seven stakeholders from C3-SIGCEX (an initiative of the Spanish Agrifood Cooperatives) and an international ag-tech workshop (42 international stakeholders). Section "Value mapping results" outlines the results of applying the six-phase VSD process to the interviews conducted with C3-SIGCEX members (results are Sects. "Stakeholder identification results", "Value elicitation results", "Value selection results", "Value conflict analysis results", "Value realization results") and the results from the 42-person workshop we conducted (resulting in Sect. "Iterative design results"). Section "Discussion" provides recommendations for the future development of the CEADS that implements the data sovereignty values discussed in the interviews and workshop. Finally, Sect. "Conclusion" presents the studies' conclusion and limitations and the proposed future work.

Reference set of human values

Before analyzing what values to consider in the application of data sovereignty in the CEADS, we identify some of the prevailing values being discussed in key policy documents and the literature. The purpose of this is to identify a broad range of values that could be specifically applicable to data sovereignty in the CEADS and to use this list of values in our empirical work later in the paper. By values, we mean things that are typically understood from an ethical and social science context to refer to what people find normatively important to lead a good and worthwhile life. They are what underpins our actions and belief systems and are considered things that should be respected, protected, or implemented. Values influence actions and behaviour and give guidance on how to live and behave towards others. While there is an abundance of literature defining and delving into the nuances of values, this is not the purpose of our paper. The purpose of this section is to identify the most relevant values to use in our empirical analysis to identify what values are important for applying data sovereignty in the CEADS.

The first document that we used for identifying values important for stakeholders in the CEADS is from the *EU Code of Conduct on agricultural data sharing by contractual agreement*[3] (EUCC) (van der Burg et al. 2020). The reason for choosing this document is that it has been at the forefront of European agricultural data-sharing discussions for the past six years and is seen as the 'go-to' document by policymakers, national representatives, and data-sharing initiatives within the EU (van der Burg et al. 2020). The EUCC states that trust (which can be seen as an overarching value in the document) is required to ensure fair agricultural data-sharing and the purpose of the EUCC is to build trust between the data originator and those they are sharing their data with (van der Burg et al. 2020). The EUCC wants to instil confidence and trust in farmers when they share data while promoting and encouraging the process of data-sharing itself. The EUCC has five main principles that underpin responsible data-sharing (Ryan and van der Burg 2021):

1. Data ownership: The EUCC formulates data ownership in the context of rights given to the person/business that creates/collects agricultural data or commissions others to do so on their behalf. The 'data originator' is the individual or organization the data is about, while the data producer is who creates the data or makes it usable. The claim to ownership of data is often a challenge between the originator and producer.
2. Data access, control, and portability: Data originators should be able to access, control, and reuse their data, and any third-party access needs to be explicitly consented to by the data originator.
3. Transparency and data protection: The sharing of data must be transparent and cannot be done with any third parties that are not listed in the contractual agreement. If there are changes to the contract, these must be agreed upon by all parties. The EUCC emphasizes that data should be protected by GDPR (General Data Protection Regulation) and other EU legislation.
4. Privacy and security: Personal or sensitive information should be anonymized and all efforts to protect the identity of individuals whom the data may identify should be made. If there are potential security breaches, those affected need to be informed immediately.

[2] By stakeholders, we refer to direct and indirect stakeholders who impact or are impacted by the particular topic being discussed (in this case, the CEADS) (Freeman and Reed 1983).

[3] EU Code of Conduct on agricultural data sharing by contractual agreement, https://copa-cogeca.eu/img/user/files/EUCODE/EU_Code_2018_web_version.pdf

5. Liability and intellectual property: There must be a clear liability when there are breaches of the contractual agreement for data-sharing. Intellectual property needs to be protected so that there is no subsequent loss of business by those entering the agreement.

While this list of values is a significant start for evaluating what values may be important for stakeholders considering data sovereignty in the CEADS, it may not be comprehensive enough. As the EUCC is not explicitly about data spaces, it may be worthwhile evaluating what values are often discussed in the context of data spaces and data sovereignty. In the data space literature, the values that are commonly described as being part of 'data sovereignty' range from control (Ryan et al. 2024), fairness (preface in Otto et al. (2022), p. v); privacy (Gabrielli et al. 2022); transparency (Vassilev et al. 2022); autonomy (Usländer and Teuscher 2022); and consent (Torre-Bastida et al. 2022).

Therefore, the two sets of values that we start with are:

1. The values highlighted by the data space literature in connection to data sovereignty are control, fairness, privacy, transparency, autonomy and consent.
2. The principles identified by Ryan and van der Burg (2021) in the EUCC are trust (as an overarching value), data ownership, data control (including consent), transparency, privacy and liability.

Both of these lists could be seen as representative of values in EU agricultural data-sharing (i.e., the EUCC values) and values important for data space development (i.e., the values in data space literature), thus, making them a good basis to evaluate data sovereignty in the CEADS. However, these two lists may not cover all possible values related to data sovereignty in the CEADS, so we evaluated the wider scholarship on human values that may be relevant. We evaluated an additional five sets of values that consider technology values or focus on information systems, big data, or biotechnology. These five sets of values were considered relevant when evaluating the values of stakeholders concerning emerging technologies and data-sharing systems, such as the CEADS. These five sets of values are:

1. The Technomoral values by Vallor (2016).
2. Values from VSD and Information Systems by Friedman et al. (2013).
3. Values from Anticipatory Emerging Technology Ethics by Brey (2012).
4. The Values in Biomedical Ethics by Beauchamp (2019).
5. Values for big data technologies by La Fors et al. (2019)

We use the work done by La Fors et al. (2019), to contrast these five sets of values in Table 1.

From the values alignment proposed by La Fors et al. (2019), we have opted to use the list by La Fors et al. (2019). The details about the decisions made for each value are detailed below, in the list detailing the reference set of values considered throughout the rest of this paper.[4] However, two values have not been included in our final list of values: 'non-maleficence' and 'beneficence'. Non-maleficence and beneficence are avoiding harm and ensuring the benefit of humans. However, we believe that both of these values are encapsulated in the broader distinction of human welfare, instead.

The proposed set of values, their definitions, and, when relevant, the motivations behind choosing them are:

1. Human Welfare: people's physical, material, and psychological well-being (Friedman et al. 2013; La Fors et al. 2019). Including avoiding actions that can go against human welfare.
2. Privacy: the right of an individual to determine what information about himself or herself can be communicated to others (Friedman et al. 2013; La Fors et al. 2019).
3. Informed Consent: to garner people's voluntary and reviewable agreement using accurate information about what is being agreed, including potential benefits and harms. Though this value is just proposed in the context of (Friedman et al. 2013), it has been included because of its relevance in the context of data sharing, especially in agriculture. It is explicitly mentioned in the *EU Code of Conduct on agricultural data sharing by contractual agreement (EUCC)* previously introduced.
4. Control: right to control access to information, use it, manage it, derive income from it, and bequeath it. This value is just included as 'Ownership and property' by Friedman et al. (2013) and indirectly as 'Property' by Brey (2012) as one of the rights and freedoms. However, it is of most relevance in the context of data sovereignty (Ryan et al. 2024). It has been renamed as *control* due to the issues identified in Sect. 1 regarding the applicability of the terms ownership and property to data.
5. Autonomy: people's ability to decide, plan, and act in ways that they believe will help them achieve their goals without being controlled by anyone else (Vallor

[4] It must be noted that La Fors et al., 2019, combined virtues found in Shannon Vallor's text, which can be seen in the first column. While virtues are characteristics that humans should aspire to possess, they also correlate to a strong degree with values, which are things that give guidance to people (often, to achieve the virtues Vallor mentions).

Table 1 Values proposed for technologies and data spaces, with selected values for this study bolded, table adapted from La Fors et al. (2019)

Technomoral values (Vallor 2016)	Values from VSD and Information Systems (Friedman et al. 2013)	Values from Anticipatory emerging technology ethics (Brey 2012)	Values in biomedical ethics (Beauchamp 2019)	Values for big data technologies (La Fors et al. 2019)
Care	**Human Welfare**	Well-being and the common good	Beneficence	**Human welfare**
N/A	**Privacy** **Informed consent** **Ownership and property**	Rights and freedoms, including **Property**	N/A	**Privacy** N/A
Autonomy	**Autonomy**	**Autonomy**	**Autonomy**	**Autonomy**
Humility, self-control	Calmness	Health, (no) bodily and psychological harm	Non-maleficence	Non-maleficence
Justice	Freedom from bias Universal usability	Justice (distributive)	**Justice**	**Justice** (incl. equality, nondiscrimination, digital inclusion)
Perspective	**Accountability**	N/A	N/A	**Accountability** (incl. transparency)
Honesty, self-control	**Trust**	N/A	Veracity	**Trust**worthiness (including honesty and underpinning security)
Empathy	Identity	Human **dignity**	Respect for **dignity**	**Dignity**
Empathy, flexibility, courage, civility	Courtesy	N/A	N/A	**Solidarity**
Courage, empathy Environmental	**Sustainability**	(No) environmental harm, Animal welfare	N/A	**Environmental welfare**

2016; Friedman et al. 2013; Brey 2012; Beauchamp 2019; La Fors et al. 2019).

6. Justice: refers to the level of fairness in how people are treated (Vallor 2016; Brey 2012; Beauchamp 2019; La Fors et al. 2019). Also avoiding social or technical bias, especially in making all people successful users of information technology (Friedman et al. 2013).
7. Accountability: A situation in which someone can be made responsible for things that happen and can give a satisfactory reason for them (Friedman et al. 2013; La Fors et al. 2019).
8. Trust: existing expectations between people who can experience goodwill, extend goodwill toward others, feel vulnerable, and experience betrayal (Friedman et al. 2013; La Fors et al. 2019). This value has been included due to its relevance in the context of sovereignty and data sharing. Moreover, it has been considered that, in this particular context, it includes Non-maleficence (Beauchamp 2019), which has not been included in this reference set.
9. Solidarity: unity or agreement of feeling or action, especially among individuals with a common interest; mutual support within a group (La Fors et al. 2019).
10. Dignity: avoiding discrimination or stigmatization, including lack of empathy and respect for identity. For instance, when a person is no longer treated as someone with particular interests, feelings, and commitments, but merely as a bundle of data, her dignity can be compromised (Brey 2012; Beauchamp 2019; La Fors et al. 2019).
11. Sustainability: sustaining ecosystems such that they meet the needs of the present without compromising future generations (Friedman et al. 2013; La Fors et al. 2019).

The same holds with the principles identified by Ryan and van der Burg (2021) in the EUCC. Data ownership and control are covered by the control value, while consent is considered by informed consent. The transparency and privacy principles are directly included in the proposed set of values, whereas liability is addressed by accountability.

In addition, this list of values may be contrasted to a wide range of data management principles such as FAIR (findable, accessible, interoperable, and reusable) and CARE (collective benefit, authority to control, responsibility, and ethics) (de Beer et al. 2022). However, the purpose of this paper is to evaluate the values implicit in the context of the CEADS, while FAIR focuses more so on the quality, effectiveness, and structure of the data being shared. While we accept that these are important factors that should underpin

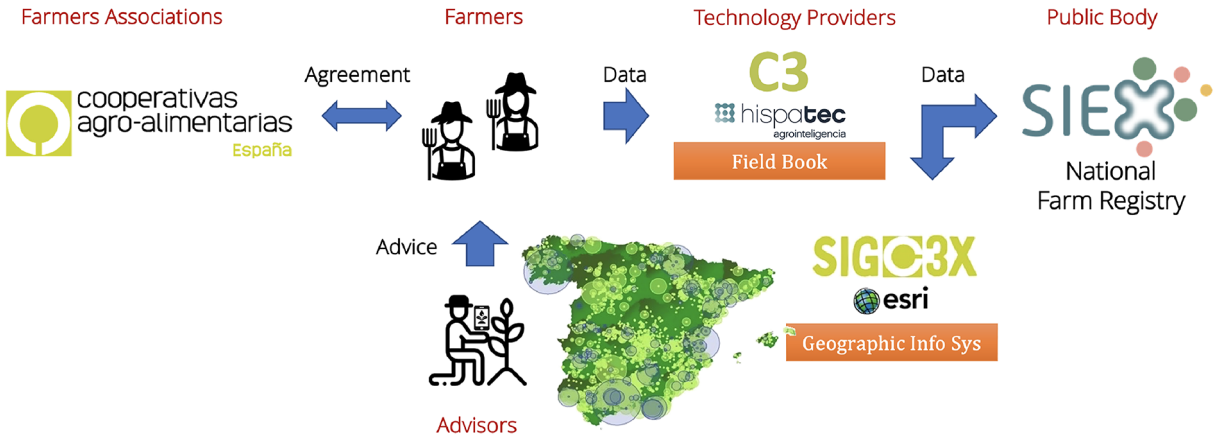

Fig. 1 C3-SIGCEX case study stakeholders and the main flows among them

data-sharing, they are not suitable for inclusion in our list as they are not values in themselves. The CARE principles are more value-based and the C is represented in our solidarity value, A in control, R in responsibility, while E is encompassed throughout all of the values as 'ethics' is an overarching domain rather than a value as such.

Finally, the initial set of five values identified in connection to data sovereignty is covered by the previous reference to values found in the data space literature: autonomy (Usländer and Teuscher 2022) and privacy (Gabrielli et al. 2022) are directly included, while fairness (Otto et al. 2022) is covered by justice, transparency (Vassilev et al. 2022) by accountability and consent (Torre-Bastida et al. 2022) by informed consent. Our analysis is supported by Ryan et al. (2024), who highlighted the following values are commonly associated with data sovereignty in data spaces: data ownership, transparency, privacy, and control.

Methodology

Based on the reference set of values identified in Sect. 2, we implemented the Value Sensitive Design (VSD) methodology by Friedman et al. (2013). VSD is grounded in the recognition that technology design is not value-neutral and has profound implications for individuals and society. VSD integrates human values into the design process to ensure that the resulting technology aligns (i.e., the CEADS) with societal values and promotes human well-being (Friedman and Hendry 2019). We apply VSD to understand, first, the role values play in agricultural data sharing through an existing initiative and, second, how to incorporate these values into the data sovereignty design of the CEADS.

Given that the CEADS is still being defined, we elicit values through interviews with participants in an existing agricultural data-sharing initiative, who are prospective future users of CEADS. We conduct the interviews with a Spanish agricultural data-sharing initiative called C3-SIGCEX (MEF4CAP 2023), whose overview is provided in Fig. 1.

C3-SIGCEX is an initiative of the Spanish Agrifood Cooperatives based on a digital field book, which will be offered to farmers who are members of any of the cooperatives that are part of this confederation. Cooperativism is very relevant in the digital transformation of the agriculture sector in Spain, constituted mainly by small farms. Based on (Álvarez Ondina 2023), more than half of the 914,871 farms in the last 2020 census have 5 hectares or less. Even more relevant, though the average production is around 49,600 euros per year per farm, 63% produce less than 15,000 euros per year. 94% are owned by individuals, who are usually the head of the farm (81%) and of an advanced age (41% are aged over 65).

With more than one million affiliates representing 69% of the Spanish final agricultural production,[5] these cooperatives have more than 2,000 advisors that will facilitate the adoption of digital technologies like C3-SIGCEX. The objective of C3-SIGCEX is to help farmers cope with the digital reporting for Common Agriculture Policy (CAP) tracking to the Spanish Farm Registry (SIEX[6]) while guaranteeing that they remain in control of their data. As shown in the upper-left part of Fig. 1, farmers agree contractually to share the data and receive farm management advisory services in exchange. They share the data through the C3 field book developed by the technology provider Hispatec, which facilitates mandatory reporting to SIEX on the upper-right part of the figure. Moreover, farmers agree to share this data through a Geographic Information System (GIS) called SIGCEX and provided by the technology provider ESRI, which is used by the advisors of the Spanish Agrifood

[5] About Spanish Agrifood Cooperatives, https://www.agro-alimentarias.coop/quienes_somos

[6] Spanish Farm Registry (SIEX), https://www.fega.gob.es/es/content/siex

Cooperatives to support farmers and facilitate benchmarking. The initiative, though still being tested on a dozen cooperatives, has an enormous potential to scale through the network of stakeholders involved in Spanish Agrifood Cooperatives.

The relevance of discussing the data-sharing needs of stakeholders from the C3-SIGCEX initiative is to find out about their values and needs as a future potential user of the CEADS. To do this, we conducted interviews with C3-SIGCEX's stakeholders, identifying what are the most relevant values for them, the potential conflicts among stakeholders' values, and the harms that they perceive.

Overall, we have applied the six-phase VSD Value Mapping (Bocken et al. 2013) methodology with C3-SIGCEX (phases 1 to 5 below) and a 42-person workshop at an ag-tech conference in Thessaloniki, Greece (phase 6). Value Mapping not only helps guide the design process but also shapes the overall ethical and social implications of the technology being developed. It enables designers to be mindful of the impact their designs can have on individuals and society as a whole. The six phases in value mapping are:

1. Stakeholder Identification: Value Mapping's first phase is to identify all the stakeholders involved in the design context. We first did a generic exploration of the stakeholders involved in agriculture data sharing, based on the work done in the context of the AgriDataSpace[7] project. Using that set of stakeholders, we identify those participating in the C3-SIGCEX case study.
2. Value Elicitation: The next phase is to elicit the values held by potential stakeholders. This can be done through interviews, surveys, focus groups, or workshops. The goal is to extract personal, cultural, and social values that may impact the design process. In our case, this is done through interviews with stakeholders of a future potential agricultural data space (i.e., stakeholders of C3-SIGCEX). The value elicitation was conducted through interviews with seven people chosen to represent the whole spectrum of stakeholders participating in the case study: two farmers, a farmer advisor, a Spanish Agrifood Cooperatives representative, a technology provider involved in C3-SIGCEX, a public body representative and a former Spanish Senate member representing the society perspective.

Semi-structured interviews following the template in Appendix A were conducted, from January 11th to February 24th 2023 for about one hour per interviewee. Two researchers participated in each interview, one conducting it and the other transcribing the responses to each question. Then, the transcriptions were translated from Spanish to English and reviewed by both researchers. The Atlas.ti[8] software (version 24.1.1) was used to conduct a first analysis of the transcriptions, concretely an AI-based coding of the texts. We obtained 54 codes (e.g. 'data privacy', 'control', 'transparency', 'access',...)[9] used as the starting points to connect the annotated interview fragments to values, and later to the perceived impact on them in the Value Selection phase.

3. Value Selection: Once the values are elicited, they are categorized and prioritized. This involves identifying which values are favoured or harmed for each stakeholder while selecting the most salient ones for the design process. One must consider the perspectives of all the case study's stakeholders to ensure the representation of diverse values. The technique deployed in value selection is called 'Benefits, Harms, and Values' (Friedman and Hendry 2019). This technique is used to analyze and evaluate the ethical implications of a technology or system by considering the following aspects from the point of view of each of the stakeholders:

- Benefits: This aspect involves identifying and assessing the potential positive impacts or advantages the technology can bring to that particular stakeholder.
- Harms: Here, the focus is on understanding and evaluating the potential negative consequences or harms associated with the technology, from the point of view of the stakeholder under consideration.
- Values: It emphasizes the examination of the underlying human values that are embedded in the technology and its design choices. Based on identified benefits and harms, we identify the stakeholder values affected respectively positively or negatively.

By systematically considering the benefits and harms perceived by the stakeholders through the interviews and the associated values, the technique helps designers, stakeholders, and users to understand the potential ethical implications and make informed decisions during the design process. It enables the identification of trade-offs, the mitigation of risks, and the exploration of design alternatives that align with the desired values and avoid or minimize harm.

4. Value Conflict Analysis: In this phase, potential conflicts between values are identified. Conflicts can arise when one value is prioritized over another, leading to ethical or social dilemmas. For instance, a value that is favoured for a particular stakeholder while causing

[7] AgriDataSpace project, https://agridataspace-csa.eu

[8] Atlas.ti, AI tools for qualitative insights, https://atlasti.com

[9] The full list available upon request.

Fig. 2 Posters used during the workshop to gather input from the participants

value harm to another. In this section, the interviewees spoke of where and when values conflicted in the context of data sovereignty implementation in the CEADS. We also analysed where some of the values being discussed may, or commonly conflict in the literature.

5. Value Realization: After analyzing the conflicts, we work towards realizing the values in the design. This involves exploring design alternatives that can support and promote the selected values while finding ways to mitigate value conflicts. This is done considering that the data-sharing system being designed guarantees that the data remains under the control of those sharing it. Following the Value Mapping guidelines (Bocken et al. 2013), value realization is implemented by using a Value Map diagram. This is often structured in different sections that group stakeholders and the values impacted. The tool adopts a multiple-stakeholder view of values and introduces value destroyed, wasted, or missed, in addition to the current value proposition and new opportunities for value creation. The purpose of this visual map is the culmination of the previous four phases in the Value Mapping process and provides a clear visual to allow organisations to see the values impacted for different stakeholders (Bocken et al. 2013). By illustrating all stakeholders and all values affected, it provides a more holistic representation of the topic being discussed (Bocken et al. 2013) - in our case, the values of data sovereignty that must be developed in the CEADS.
6. Iterative Design: Finally, given that Value Mapping is an iterative process, the design needs to be continuously refined based on feedback and evaluations, as shown in the second iteration of our study. Therefore, after we retrieved feedback from the C3-SIGCEX case study, we conducted a workshop with 42 international stakeholders ranging from policymakers, legal scholars, ethicists, farmer representative groups, AgriTech providers, farming machinery manufacturers, and so forth (all working in the intersection of AgriTech).[10] The reason for conducting this workshop was to find out if the values of other stakeholders throughout Europe corresponded or differed from the findings of the case study. As the design is of a future agricultural data space and not C3-SIGCEX, it was important to get input from others who will be affected by the CEADS. Therefore, for the iterative design phase, we got input from 42 agri-food data-sharing stakeholders in a workshop at a large European annual Agri-Tech event in Thessaloniki, Greece (300+ attendees, and 30 large Agri-Tech projects, from throughout Europe).

For this workshop, we briefly presented the concept of data sovereignty, the values that we have collated as part of this study, and the preliminary results from C3-SIGCEX. Following this, we broke the participants into three groups, where the authors of this paper coordinated and led the

[10] Because of the very nature of the conference and the workshops, retrieving specific information about the individuals in attendance would have been very difficult practically, time-consuming, and would have dramatically eaten into the workshop time. The workshop was part of a 2-day large EU Agri-Tech Conference with 300+ attendees. Our workshop was given a respective time and location within this conference, in parallel with many other adjacent sessions. Participants could freely choose where they wanted to be during these sessions, thus, there was no assignment or allocation in advance. As the workshop was only 2 h long, and because there were so many attendees (42), it was too difficult to find and take note of all attendees and their respective backgrounds, nationalities, and other information that is commonly helpful in empirical studies. In addition, because attendees arrived after the designated start time of the workshop and because we wanted to dedicate the time to focus on the content of the workshops, it was too difficult to get this additional information. Between the three workshop facilitators, we knew many participants already, and those we did not, we met during the 3-day event. Hence, we were able to detail the range of participant backgrounds, albeit, unable to specifically enumerate how many from each background attended. Thus, while we do not have exact figures of how many participants from each type of stakeholder group, those attending were all experienced and knowledgeable in Agri-Tech, with 10 attendees being explicitly involved in a large agricultural data space project.

discussion. All three groups had a wide diversity of stakeholders, as mentioned earlier. We had posters on the walls of the room with the six stakeholder groups and the list of relevant values that we identified in the earlier phases. Through an open discussion and dialogue, the participants spoke about what values they felt were impacted most in each of the six stakeholder groups on the sheets. During and following the discussion in each group, the participants assigned green or red stickers to each of the values for the stakeholders, depending on whether they had a positive or negative impact on that value for that stakeholder (see Appendix B and Fig. 2).

Each group discussed the different values in each group and placed a sticker in the designed box if they felt that those values would be impacted positively or negatively. Participants had an open amount of stickers to use, so they did not have to vote on all values if they felt they were unimportant. We took notes of their reasoning for such decisions and discussed when and where there may be a potential clash or conflict of values in the process. We noticed many similarities and overlaps with the results from the Spanish case study and additional insights and feedback. The overall results from our value mapping are described in the following section.

Value mapping results

This section details the results of the methodology introduced in the previous section, VSD Value Mapping (Bocken et al. 2013). It involves six phases, detailed in the following subsections, namely: stakeholder identification, value elicitation, value selection, conflicts analysis, value realization, and iterative design.

Stakeholder identification results

Value Mapping adopts a multiple-stakeholder view, which we focus on data sharing in agriculture. To identify the stakeholders' categories involved in the C3-SIGCEX case study to be interviewed, we considered the categories proposed by the Digital Europe project AgriDataSpace.[11] Moreover, to get the complete multi-stakeholder perspective, we involved at least one person from each of the six stakeholder categories. Next, we detail each category and, between parentheses, the number of interviewees from that category for a total of seven interviews:

1. Farmers (2): two members of cooperatives that are part of the Spanish Agrifood Cooperatives, concretely in the Catalonia region and related to fruit production.
2. Advisors (1): one agronomy technician advising the members of a farmers' cooperative in the fruit production sector in the Catalonia region.
3. Farmers Associations (1): a Spanish Agrifood Cooperatives representative who is also leading the C3-SIGCEX initiative. The Spanish Agrifood Cooperatives is a Level 3 confederation at the national level of Level 2 cooperatives federations at the regional level. In turn, these federations group the Level 1 cooperatives with directly affiliated farmers.
4. Technology Providers and Intermediaries (1): an agrifood digital solutions provider for the agrifood sector participating in the C3-SIGCEX initiative.
5. Public and Regulatory Bodies (1): a member of the Spanish Ministry of Agriculture, Fisheries and Food, together with its dependant paying agency, FEGA, which runs the SIEX platform for agriculture reporting.
6. Society (1): one former member of the Spanish Senate, also participating in its Agriculture Commission. Spanish Senate comprises members elected directly by the public and appointed by autonomous communities, ensuring a combination of popular representation and regional interests.

Value elicitation results

We conducted seven interviews to understand stakeholders' values, concerns, and aspirations as part of the VSD Value Mapping methodology, Sect. "Methodology". The analysis of the interviews' transcriptions identified the values explicitly or implicitly mentioned by the interviewees concerning the six stakeholders identified earlier as shown in Table 2.

From this analysis, we have identified the values most prominently referred to during our interviews and were seen as the most relevant values for these particular stakeholders (by the interviewees):

1. Farmers: Human Welfare, Control, Privacy, Justice, Trust, Informed Consent, Solidarity, Sustainability.
2. Advisors: Human Welfare, Justice, Autonomy, Solidarity, Sustainability.
3. Farmers Associations: Human Welfare, Justice, Trust, Solidarity.
4. Technology Providers and Intermediaries: Human Welfare, Trust, Autonomy, Solidarity.
5. Public and Regulatory Bodies: Justice, Autonomy, Accountability, Sustainability.
6. Society: Human Welfare, Justice, Sustainability.

[11] AgriDataSpace project, https://agridataspace-csa.eu

Table 2 Some excerpts from the case study interviews highlighting the perceived values

Value	Interview Excerpt	Stakeholder
Control	"We need agreements with the technology providers to limit their use and **control** of the data".	Farmers
Privacy	"Raw data could hide **privacy** and security risks for farmers. For example, if data about a pest infestation leaks, farmers could lose all their crops – no matter if the crop is healthy".	Farmers
Trust	"In agriculture, reputation and **trust** need to be protected. Sometimes privacy can be broken, for instance, if the monitoring information contains sensitive data".	Farmers
Informed Consent	"I should be able to choose if my data is not to be in open access, who I share it with, and for what".	Farmers
Solidarity	"In fact, **benchmarking** with other farmers and cooperatives, especially in other productive areas, might be a desired outcome".	Advisors
Trust	"...to be **confident** on the way we process their data, we need a clear categorisation of what constitutes personal data and what does not in agriculture".	Farmers' associations
Trust	"... **participation** should be facilitated because farmers will be able to decide to stop sharing so data is no longer considered...".	Tech Providers
Accountability	"...implement technical measures to protect confidential data, such as encryption, access control, and **audit trails**".	Public and Regulatory Bodies
Justice	"As conflicts will most likely arise from data in several countries in Europe, there would be a need for a European **arbitration** authority in this regard".	Society

Value selection results

Continuing with the analysis of the interviews, in addition to eliciting the values, we also analysed the context of each value mentioned to identify if the interviewee saw it as positively or negatively impacted. As shown in Table 2, we highlighted in red the words with negative connotations, and in green those with positive ones. Based on the positive and negative impacts on those values, a complete list of benefits, harms, and values per stakeholder is reported in Table 3, where the values mainly benefited are highlighted in green and those harmed in red. The whole list of values under consideration is included in each case for completeness, though those not elicited during the previous methodology phase appear unhighlighted.

This table identifies the potential benefits, harms, and values to consider for a data-sharing initiative aiming to participate in the CEADS. The purpose of this is to identify the values that are most relevant and impactful to different stakeholders, what values may potentially be harmed, and what values offer the most benefit and room for innovation. The following sections will develop upon our findings and map the values outlined to improve, adjust, and implement a data sovereign-by-design CEADS.

Value conflict analysis results

From the Benefit, Harms, and Values analysis presented in Table 3, the first conclusion might be that there are significantly more values positively influenced (17) than negatively (11) in the context of this data-sharing initiative. Therefore, there is a positive effect from a value perspective, even when considering data-sharing initiatives that might not guarantee data sovereignty legally or technically.

Moreover, the interviewees noted that there may be harm related to the lack of a precise valuation of the data contributed by farmers. However, farmers are compensated with free access to C3 and SIGCEX services through their advisors, and thus we have considered the human welfare value positively. The main drawbacks from a values perspective are on the farmers, who give away control of their data, without clear mechanisms to track what they are used for, and guarantees of being able to regain control in case they revoke consent. Data is copied to information systems controlled in most cases by third parties. These remain opaque to the farmers who do not have a way to know how their data is being actually used or if it is completely removed when they want to step down.

Moreover, there is a privacy problem with personal data and potential data leaks once it is shared and copied to the databases of different stakeholders or service providers they rely on. This is especially relevant in the agriculture sector for small farms where it is difficult to distinguish the operation from the people running it, and thus the distinction between personal and non-personal data.

This leads to a conflict as farmers are obliged to share data with public and regulatory bodies, which is the main requirement being satisfied by the C3 field book reporting to the Spanish Farm Registry (SIEX). Even when data is anonymized or aggregated, there is always the risk that a combination of different data points might allow identifying the farmer. Consequently, farmers' *privacy* value is in clear conflict with public and regulatory bodies' *accountability*, as highlighted in Table 4.

Table 3 Mapping case study stakeholders' Benefits and Harms to Values. In bold and preceded by an up arrow ↑, those values that are positively affected based on benefits. In italics preceded by a down arrow ↓, the harmed values. The remaining values in white are mostly unaffected

Stakeholder	Benefits	Harms	Values
Farmers	• Free access to a Digital Field Book adapted to new CAP reporting regulation • Access to agronomic services and assistance from cooperative advisors • Benchmarking against other farmers, similar crops, and other farming techniques • Informed consent and opt-out	• Though consent can be retracted, control over the data is given away at least temporarily. • Privacy risks derived from data leaks, security breaches,... • No guarantee about full data deletion and absence of copies. • Lack of a clear valuation of the contributed data.	**↑ Human Welfare** *↓ Control* *↓ Privacy* **↑ Justice** *↓ Trust* Autonomy **↑ Informed Consent** Accountability Dignity **↑ Solidarity** **↑ Sustainability**
Advisors	• Data availability makes more advanced agronomic services possible. • Access to more advanced tools to provide agronomic advice. • Increase the reach of the services provided. • Facilitate collaboration with other advisors.	• Potential automation of some of the advisor tasks. • Dependence on farmers to get access to data.	*↓ Human Welfare* Control Privacy **↑ Justice** Trust *↓ Autonomy* Informed Consent Accountability Dignity **↑ Solidarity** **↑ Sustainability**
Farmers' associations	• Provide access to more and higher quality services to affiliates. • Aggregated data to facilitate benchmarking at the regional level of federations, and the national level for the confederation of cooperatives.	• Legal uncertainties and risks derived from managing affiliates' data. • Increased management costs, especially due to dealing with personal data and generating aggregated data corresponding to the geographical range of operation of the cooperative, federation, or confederation.	*↓ Human Welfare* Control Privacy **↑ Justice** *↓ Trust* Autonomy Informed Consent Accountability Dignity **↑ Solidarity** Sustainability
Technology Providers and Intermediaries	• Appear as a more trustful partner thanks to informed consent. • Data availability makes more advanced agronomic services possible. • Increase the reach of the services provided. • Share part of data value with farmers, compensation through the provided digital tools and services.	• Delegating data control to farmers association. • Dependent on farmers' will to get access to data. • Assume part of platform development costs and maintenance.	*↓ Human Welfare* Control Privacy Justice **↑ Trust** *↓ Autonomy* Informed Consent Accountability Dignity **↑ Solidarity** Sustainability
Public and Regulatory Bodies	• Farmers have tools at their disposal to satisfy digital reporting requirements. • Higher quality of the reported data, which makes supervision and policy-making tasks easier.	• Dependence on third parties that provide better solutions for the reporting duties requested from farmers.	Human Welfare Control Privacy **↑ Justice** Trust *↓ Autonomy* Informed Consent **↑ Accountability** Dignity Solidarity **↑ Sustainability**
Society	• Advanced agronomic services make it possible to produce more food, at lower prices. • Food production is more sustainable.	• Lack of flows that bring data sharing benefits across all Agrifood value chain participants, reaching end consumers.	**↑ Human Welfare** Control Privacy *↓ Justice* Trust Autonomy Informed Consent Accountability Dignity Solidarity **↑ Sustainability**

Table 4 Conflicts among Stakeholder's Values

Farmers	Privacy	↔ Accountability	Public and regulatory bodies
Farmers	Control	↔ Autonomy	Advisors, Technology Providers and Intermediaries, and Public and Regulatory Bodies

Another value conflict in the C3-SIGCEX case study arises from farmers' additional guarantees about *control* over their data due to the use of the *EU Code of Conduct on agricultural data sharing by contractual agreement*. In this case, the main tension is with the *autonomy* value by advisors, technology providers and intermediaries, and public and regulatory bodies. All these stakeholders are less autonomous when collecting and processing data due to the higher control farmers and their associations gain. Moreover, they depend on *informed consent* to use that data.

Value realization results

Following the Value Mapping guidelines (Bocken et al. 2013), value realization is implemented by using a Value Map diagram. From the results of the previous VSD phases, this visual tool adopts a multiple-stakeholder view of values and presents value destroyed, wasted, or missed, in addition to the current value proposition and new opportunities for value creation. As shown in Fig. 3, this is done using 4 concentric circles.

'Data Sovereignty' is in the inner one because, in this value mapping exercise, we will explore how values would be impacted when data-sharing is conducted in a data space that guarantees data sovereignty. Based on the previous Benefits, Harms, and Values analysis, we identify those values that were harmed but can directly benefit from having data sovereignty as described in Sect. "Introduction". These are the 'Values Captured' (Bocken et al. 2015) for each stakeholder group and are displayed in the second circle from the centre of the figure, just around data sovereignty.

Then, we identify the potential negative outcomes from a values perspective of a data sovereign data space, those values are already negatively impacted in C3-SIGCEX and still harmed even with data sovereignty in place. They are labelled 'Negative Outcomes' (Bocken et al. 2015) and appear in the third circle from the centre. Finally, we highlight the 'New Opportunities' from a values perspective in data-sharing provided by data sovereignty in the outer circle. These are additional values that are also positively impacted, but not as directly or evidently as those in 'Value Captured'.

The circles are also divided into 4 sectors, each one grouping the stakeholders that share the same set of 'Values Captured', 'Negative Outcomes' and 'New Opportunities'. Farmers are grouped with farmers' associations, and advisors are grouped with technology providers and intermediaries because they share the same value mapping, and to improve the readability of the map.

The detailed list of values captured, negative outcomes, and new opportunities in the value map in Fig. 3 is:

1. Value Captured: refers to the value that is more directly positively impacted for that group of stakeholders when a data space providing data sovereignty is used as the means for data sharing.

    - For Farmers and Farmers Associations: *Control*
    - For Advisors, Technology Providers and Intermediaries: *Trust*
    - For Society: *Human Welfare*
    - For Public and Regulatory Bodies: *Accountability*

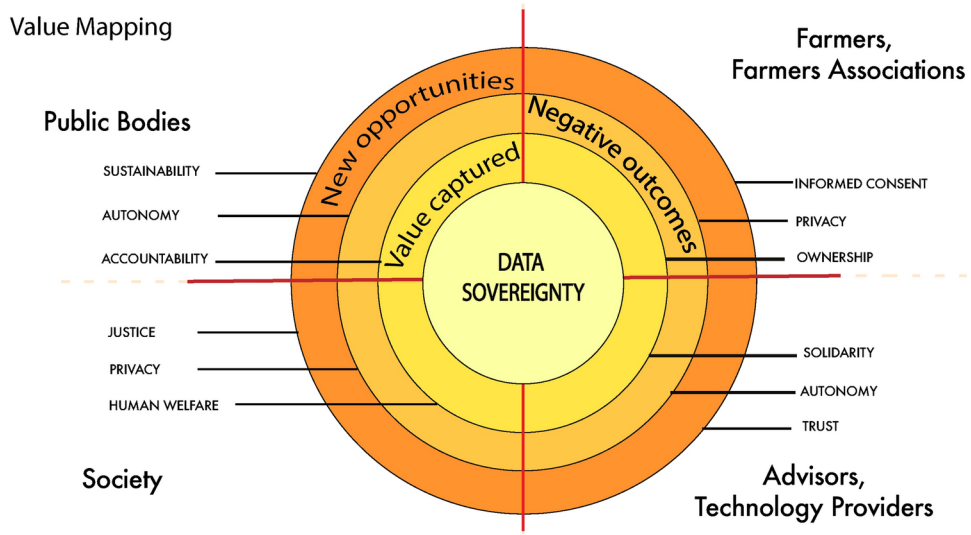

Fig. 3 Value mapping for data sovereignty in agriculture data spaces

2. Negative Outcomes: This part of the Value Map represents which value is mainly at risk in a data-sharing scenario facilitated by a data space, even if it facilitates data sovereignty.

    - For Farmers and Farmers Associations: *Privacy*
    - For Advisors, Technology Providers and Intermediaries: *Autonomy*, they become more dependent on Users to get access to data, especially non-personal data, they were previously getting access without requiring explicit consent.
    - For Society: *Privacy*
    - For Public and Regulatory Bodies: *Autonomy*.

3. New opportunities: This final part of the Value Map highlights additional values that are favoured by sovereign data spaces, especially from the point of view of new opportunities that data sovereignty might make possible.

    - For Farmers and Farmers Associations: *Informed Consent*
    - For Advisors, Technology Providers and Intermediaries: *Solidarity*
    - For Society: *Justice*
    - For Public and Regulatory Bodies: *Sustainability*

This figure and the resulting values for each stakeholder are important as they illustrate all of the stakeholder values relevant to the implementation of data sovereignty in the CEADS. We used this figure and the results from phases 1 - 5 to ground the final phase, which will be discussed in the following section.

Iterative design results

The results from the 42-person workshop were the aggregation of values assigned to their respective stakeholder groups as seen in the Table below (see Table 5). The numbers below are the total number of votes for each value affected as an aggregation of the three workshop groups.

Some of the respondents said that if there is adequate data-sharing governance in the CEADS, this may lead to an increased level of accountability for the farming advisors (Workshop, Group 3). If they are confident with the safe and trustworthy process of the CEADS, they may be more likely to support it and as a result, emphasize their confidence in this system to the farmer (Workshop, Group 3). If the farming advisor can provide better advice, based on more robust data from the data space, there is the potential they will have more trust in the CEADS themselves (Workshop, Group 3). This is aligned with the concerns about trust and control observed by farmers in the C3-SIGCEX case.

Public and regulatory bodies may benefit by contributing to the CEADS by providing data to the value chain to help them meet standardization targets, and sustainability goals, and abide by current regulations (Workshop, Group 3). They may benefit from the CEADS by receiving data from the system to implement a more evidence-based policy based on improved accountability (Workshop, Groups 2 and 3). If control is increased for certain actors, this may have a positive impact on sustainability and justice (Workshop, Group 3), as noted in the C3-SIGCEX case. Stakeholders would have more control over their data, so it would provide a more level playing field in data-sharing (Workshop, Group 3). This was illustrated as a positive contribution to the data sovereignty of the farmer in Group 2, where control was voted 5 times as positively affected for farmers (Workshop, Group 2).

In Group 1, one of the participants mentioned that farmers are not often aware of data sovereignty issues when sharing data, but when they are, they are less likely to share data because of this: “Farmers are not usually aware of privacy and control issues. But once they know, they are very reluctant to share their data, i.e., contribute to a data space.” (Workshop, Group 1). There was concern that an increased level of control by regulatory bodies over what data is shared through the CEADS would lead to a fear among farmers that they would be over-regulated or penalized by sharing their data. This may result in a decrease in trust among farmers in getting involved in the CEADS (Workshop, Group 3). This highlights the importance of providing mechanisms that guarantee privacy and sovereignty by design, even when sharing data with public and regulatory bodies, and the importance of communicating these features to all stakeholders, especially farmers.

Data intermediaries may feel that their autonomy is reduced if they are forced by law when entering the CEADS, so it was reflected that less regulation and more agreements and standardization may be more suitable for increasing data-sharing in the CEADS (Workshop, Group 3). For Tech Providers and Intermediaries, in Group 2, the majority (4 to 1) stated that control and autonomy (with the same vote numbers) are negatively impacted by the fact of using CEADS in agriculture data sharing (Workshop, Group 2). This was observed in the C3-SIGCEX case study, where just the implementation of the EU CoC guidelines was in place and there were no mechanisms enforcing data sovereignty. In Group 2, human welfare was mostly considered from the income perspective, with participants stating that there was a potential that farmers would lose out (economically) from data-sharing (e.g., through high investment costs in sensors or subscription costs for using technologies

Table 5 Workshop groups aggregated results. An interactive visualization is available fromhttps://public.flourish.studio/visualisation/15380386/

Farmers	Human welfare	3	3	Justice	1	1
	Privacy	2	5	Accountability	3	
	Informed Consent	1	2	Solidarity	1	
	Control	8	1	Dignity	3	
	Trust	7		Sustainability	3	1
	Autonomy	2	3	Others:		
Farming Advisors	Human Welfare	1		Justice		
	Privacy		1	Accountability	7	1
	Informed Consent	1		Solidarity		
	Control	1	6	Dignity		
	Trust	7	1	Sustainability	4	1
	Autonomy	1	2	Others:		
Farmers associations	Human Welfare	1	4	Justice	2	
	Privacy		3	Accountability	1	2
	Informed Consent		1	Solidarity	8	
	Control	2	5	Dignity		
	Trust	4	1	Sustainability	2	
	Autonomy	2	2	Others:		
Technology providers and intermediaries	Human Welfare	1	4	Justice	1	1
	Privacy	1	5	Accountability	4	1
	Informed Consent	3	1	Solidarity		4
	Control	4	6	Dignity		3
	Trust	5		Sustainability	5	1
	Autonomy	1	6	Others:		
Public and regulatory bodies	Human Welfare		4	Justice	5	
	Privacy	1	1	Accountability	6	
	Informed Consent			Solidarity	1	
	Control	4	2	Dignity		
	Trust	9		Sustainability	6	
	Autonomy	2	1	Others:		
Society	Human Welfare	1		Justice	5	
	Privacy	1	6	Accountability	2	1
	Informed Consent		3	Solidarity	1	1
	Control		4	Dignity	1	
	Trust	4		Sustainability	9	
	Autonomy		3	Others:		

or receiving recommendations based on their data) (Workshop, Group 2). Two voted that way, using an additional value with the label 'Income (costs)' written on a Post-it (Workshop, Group 2).

One insight from the workshop was that there are different types of technology providers, and it is not a one-size-fits-all actor (Workshop, Group 3). The participants stated that there are large monopolistic players who do not particularly care about getting involved in the CEADS as they have their own abundant data and data scientists in-house (Workshop, Group 3). One of the main goals of the CEADS is to increase the power and control of SMEs and smaller players in the industry to compete with these larger monopolistic organizations (Workshop, Group 3) (this is something that was strongly reflected in the literature, see (Ryan 2022; Gardezi and Stock 2021; Ogunyiola and Gardezi 2022; Bronson and Sengers 2022; Lajoie-O'Malley et al. 2020; Stock and Gardezi 2021). The overall goal of the CEADS is to increase the control of SME organizations and to reduce the control of large monopolistic organizations in the different sectors (Workshop, Group 3) by guaranteeing small players' sovereignty. Therefore, this lack of involvement or willingness of very large technology providers is something that needs to be addressed in the implementation of data sovereignty in the CEADS.

Finally, an interesting result from the workshop was the identification by the participants of potential value conflicts beyond those identified during the C3-SIGCEX case. One example of this is the potential conflict between regulatory bodies and farmers' associations for control over who provides the recommendations and advice to the farmer (Workshop, Group 3). With increased levels of data available from the CEADS, farmers' associations may have conflicting information and provide different suggestions

than regulatory bodies that do not use the same data, or vice versa. In addition, technology providers may conflict with farming advisors for similar reasons, emphasizing a tension between who has control over the data, the advice and recommendations provided as a result, and the control over the narrative in the industry (Workshop, Group 3). The participants emphasized that the value of control was the most important consideration for data sovereignty, and the deployment of the CEADS may raise tensions among most stakeholders in different ways (raising the same concerns as listed earlier in Sect. "Value conflict analysis results", in addition to tensions with control between technology providers and intermediaries and farmer associations (Workshop, Group 3) (see Table 6).

Discussion

Based on the results of our Value Mapping as reported throughout Sect. "Value mapping results", it is clear that there are many different values involved for each of the six stakeholders that we focused on. However, what was evident is that some of these values need more attention than others to ensure that the CEADS is implemented in a fair and trustworthy way. We identified that the most significant values being impacted in each of the six stakeholder categories in the context of the CEADS are: farmers (privacy, trust, and control), advisors (human welfare and autonomy), farmer associations (trust and human welfare), technology providers and intermediaries (autonomy and human welfare), public regulatory bodies (autonomy), and society (justice).

In this section, we discuss possible recommendations for the implementation of a data sovereignty by design approach in the CEADS. The recommendations derive especially from the insights gained during value selection from benefits and harms as summarised in Table 3, the Value Map for data sovereignty in Fig. 3 and the additional input at the European scale collected during the workshop. The recommendations are organized in the following subsections per stakeholder and focus on the most relevant values for each of them.

Table 6 Tensions regarding the control value among stakeholders

Value conflicts between actors (the value of control)	
Regulatory bodies	↔ Farmers' associations
Technology providers and intermediaries	↔ Farming advisors
Technology providers and intermediaries	↔ Farmers' associations

Farmers

Privacy

Privacy was one of the most discussed values at risk for farmers in our study, a finding supported in (Raturi et al. 2022; Jouanjean et al. 2020). This study finds that data should be processed using privacy-preservation computation techniques before it is shared, which corroborates the findings in (Raturi et al. 2022; Archer et al. 2023) and the 'secure and privacy-preserving' goals of the EC (European Commission 2024a). A result of our findings was that data can be replicated at many different locations and it can be leaked from any of them, which corroborates the findings from (Ryan 2019a; Wolfert et al. 2021). A concern raised in our study is that even when certain privacy-preservation techniques are implemented, there may still be a risk that combining different data points might allow the identification of the farmer, a risk highlighted in (van der Burg et al. 2019). These findings illustrate the fact that there is a continued risk that data collected can be traced back to the source, even when there is data sovereignty by design and farmers keep control of the data. For instance, the combination of aggregated data and geographic filters might narrow down to a particular operation. This study proposes that this tension can be somewhat reduced by implementing privacy-preservation technologies that guarantee *control* over one's data, which corresponds to the conclusion in Ryan et al. (2024) that control is the most fundamentally underpinning value within definitions of data sovereignty.

Control

Control was the most discussed value in the context of farmer data sovereignty in our study, a finding that was highlighted in (Ryan et al. 2024). The respondents from the C3-SIGCEX case stated that when control is missing, other values might be more easily harmed like *privacy* or *trust*. This corroborates the hypotheses of (van der Burg et al. 2020) who states that farmers should have control over how their data is shared and used to build trust in data sharing practice. Our findings support the hypothesis that control over one's data is needed to build farmers' trust, which is emphasised by others in the literature (Gardezi et al. 2023; Bronson and Knezevic 2016; Ryan and van der Burg 2021; van der Burg et al. 2019; Wolfert et al. 2021; de Beer et al. 2022). Consequently, given its relevance in our study and the strong emphasis in the literature, we recommend that control over one's data should be a fundamental value to guide data sovereignty in the CEADS. This point corroborates the conclusion by (Ryan et al. 2024) that control is the most fundamental value in data sovereignty definitions.

Our proposal is corroborated in practice in current data space initiatives like the International Data Spaces Association, which is based on the principle of 'usage control' (Jung and Dörr 2022). The idea of usage control, which this study supports, is a way that actors (in our case, users of the CEADS) can define policies limiting the uses of their data once it is shared. Data space components are responsible for enforcing these policies, though complete control guarantees require that enforcement is feasible at the storage, application, and even the systems where the data is used. The situation is similar to that of avoiding copyright infringement through Digital Rights Management (DRM) systems, a point supported by (Bronson 2018). Security against DRM circumvention is only possible through a combination of specific hardware, applications, or operating systems, which on the other hand limit the choices of the consumer.

Consequently, our recommendation is to combine usage control and enforcement with techniques that make it possible to consume the data being shared while avoiding having to give away a copy of it. This can be achieved with privacy-preservation techniques like those based on moving the computation where the data is (e.g., Compute-to-data (McConaghy 2022)). As pointed out in Sect. "Value conflict analysis results", there is a tension between farmers' control of data and the autonomy of advisors, technology providers and intermediaries, and public bodies, an issue highlighted in (Wiseman et al. 2019). This tension might be slightly mitigated through data space mechanisms that facilitate or even automate the process of deciding if a particular data use is authorized or one that helps farmers delegate that decision to trusted third parties, as discussed in the following section.

Trust

As expressed in the introduction, one of the main goals of the EC for the CEADS is that stakeholders can share data in a trustworthy way (European Commission 2024a). In our study, we illustrated that trust can also benefit and support improvements in *privacy* or *control*. Farmers will have more confidence in sharing their data if they feel their data is secure and they retain control over it, which was reflected in (Carbonell 2016; Bronson 2018; Fleming et al. 2018; Zhang et al. 2021; Bronson and Knezevic 2016). Our study proposes that this may be achieved by including informed consent procedures per transaction, which may favour farmers to get a fairer and more transparent valuation of the data they originate, a point which corroborates the findings of (Jakku et al. 2019; Jouanjean et al. 2020). However, given the technicalities associated with the mechanisms used to ensure *privacy* and *control*, these features must be properly communicated to farmers so *trust* can be built on the knowledge that the data space makes them data sovereign, a point emphasised in (Fleming et al. 2018; Brown et al. 2023). Additionally, intermediaries might help build trust with farmers, a point supported in (Fleming et al. 2018; Jakku et al. 2019; Zhang et al. 2021). This ranges from parties farmers already trust especially regarding technological decisions like *advisors*, or intermediation mechanisms specially tailored to facilitate data sharing like data trust, which is a point also supported in (Fleming et al. 2018; Jouanjean et al. 2020) and (Durrant et al. 2021). By deploying data trusts, farmers can delegate data-sharing decisions and isolate them from the underlying technicalities.

Advisors

Human welfare

Human welfare might be at risk for advisors if their jobs are replaced by automated means, a concern echoed in (Charatsari et al. 2022). Consequently, this study proposes that the CEADS should facilitate the participation of advisors so that they can contribute and benefit from the advanced services that a greater amount of data might make possible. One of the reasons for suggesting this is because advisors are fundamental in the short and medium term for digitalization and information collection, a point corroborated by (Wolfert et al. 2021). Without them, many farmers would lack the required skills and would be left out of the system due to the existing technological gap, leading to a digital divide between who has access to and benefits from technologies, as reflected in (Ryan et al. 2023; Ryan 2022). Advisors may play an important role in ensuring that data is shared in the CEADS in a 'fair and transparent' way by providing information and assisting farmers in the process - a key goal of the EC in the development of the CEADS (European Commission 2024a).

Autonomy

Autonomy might be harmed as a result of the increased control of farmers over their data, thus, subsequently, making advisors less autonomous when collecting and processing farmers' data. This study proposes that to avoid that, the consent flow should be streamlined in the CEADS to avoid bottlenecks in data sharing. Different mechanisms might be implemented, like consent automation, based on predefined policies or delegation to entities like data cooperatives that do so based on the delegators' interests. Therefore, there is probably a significant need for advisors to help farmers navigate the intricacies of data sharing in the CEADS, thus it does not necessarily undermine their involvement: 'There is likely to be a growing need for advisory services on the

interfaces between data and intellectual property rights, laws relating to the provision of digital agricultural services of various ramifications, and domestic data governance policy frameworks' (de Beer et al. 2022, p. 11).

Farmers associations

Trust

Trust is the main value concerning farmers' associations and is one of the most fundamental values being promoted for the integration of the CEADS by the EC (European Commission 2024a). In the C3-SIGCEX case, they assumed a lot of risks by being the entities farmers trust for their data, a concern reflected in (MEF4CAP 2023). These risks are mainly due to legal uncertainties. This study proposes that the CEADS should facilitate *control* through data sovereignty by design mechanisms and should reduce that burden and clarify the situation from a legal standpoint by strengthening *privacy*, as discussed earlier in the farmers' section. We propose that farmers' associations are an important factor in achieving this, a point also highlighted by Jouanjean et al. (2020). In this article, they state that farmers' associations may help build trust with farmers, allowing them to deal with the complexities of data contracts and relationships with technology providers. Furthermore, the building of trust and involvement of farmers' associations is also reflected in (Jakku et al. 2019) where they state the following: 'Therefore, our primary recommendation is the need to invest in building the capability of growers and farm businesses to be both informed data consumers as well as co-creators and curators of data, by involving growers and their trusted information and advisory networks in the cooperative development and trialling of these systems' (p. 9).

Human welfare

Human welfare is indirectly harmed for farmers' associations due to the additional costs derived from the data management duties they may be responsible for to implement data sovereignty mechanisms (if they are not adequately in place) in the CEADS. The reason for this is that it is intended that farmers' associations will need to intervene and invest time and resources into alleviating data concerns and violations if farmers seek their mediation and help. If appropriate data sovereignty mechanisms are in place in the CEADS, to begin with, then there is the assumption that there will be fewer issues that the farmers' associations will be required to intervene, mediate, and resolve, for the farmer. Therefore, if many of the most pressing values identified about farmers are addressed in advance in the CEADS, then farmers' associations will need to do fewer interventions. Essentially, the human welfare concern for farmers' associations can be minimised if data sovereignty is appropriately implemented for the farmer in the CEADS.

Technology providers and intermediaries

Autonomy

Autonomy is the main value impacted for technology providers and intermediaries. This study demonstrated that these actors' autonomy is in tension with farmers' *control* and *informed consent* because they are dependent on farmers to get access to and process the data. To avoid that, the consent mechanisms should be streamlined, as previously detailed for advisors. Additionally, if data sovereignty is provided by the data space and farmers are in control of their data, a higher level of *trust* in technology providers and intermediaries should reduce data sharing reluctance (a point corroborated by (Brown et al. 2023)). Building trust with farmers, and ensuring they benefit from data sharing, is vital for the success of data sharing and thus the CEADS (this point was also a conclusion in (Zhang et al. 2021)). Building this trust, and demonstrating the trustworthiness of technology providers and intermediaries, should enable and grow the use of the CEADS - a point also emphasised by the EC (European Commission 2024a).

Human welfare

Human welfare is negatively affected in data-sharing initiatives, such as the C3-SIGCEX, through platform development and maintenance costs, for partaking in the CEADS. This paper proposes these challenges should be mitigated in the CEADS infrastructure, through data sharing mechanisms, which technology providers and Intermediaries can reuse to reduce their costs. One example of this is Simpl,[12] the open-source middleware platform for the deployment of European data spaces. This is a point also emphasised by the EC as they state the importance that the CEADS is 'open' and 'fair and transparent' for all stakeholders (European Commission 2024a).

Public and regulatory bodies

Autonomy

Public and regulatory bodies might experience greater barriers when accessing data that is under the control of farmers due to data sovereignty mechanisms. In the C3-SIGCEX case, this value is harmed for public and regulatory bodies

[12] Simpl: Cloud-to-edge federations empowering EU data spaces, https://digital-strategy.ec.europa.eu/en/policies/simpl

due to their dependence on third parties' solutions like the C3-SIGCEX digital field book. This study proposes that the CEADS should provide mechanisms that facilitate interoperability and avoid vendor lock-ins, a point which is strongly corroborated by Atik and Martens (2021). This is important from the point of view of data sovereignty, as stakeholders should remain in control of who and how can process their data.

Consequently, public and regulatory bodies should promote and facilitate the integration of third-party solutions, like digital field books, into the CEADS. This way, they will not see their autonomy harmed because they are not outsourcing the data processing to a third party, and have an understanding of how the technology works and also not have to worry about third-party vendor lock-in. This approach to interoperability and avoidance of vendor lock-in is also aligned with recent EU regulations regarding data, especially the Data Act (European Commission 2024b). This regulation guarantees that users of 'connected products', including connected agricultural machinery or Internet of Things (IoT) devices, to access the data that they co-create by using the connected products or related services, like a pesticide dosage planner. Additionally, the Data Act provides mechanisms to ensure that customers of data processing services can switch seamlessly among providers, like digital field book providers.

In addition, while the EC initially funds the CEADS (and other Common European Data Spaces), the EC is providing the platform for and allowing for the co-creation of the CEADS with key stakeholders in the field. The EC appears happy to allow this co-creation of the CEADS without necessarily dictating what it should look like or how it should be run. They are implementing the advice and knowledge generated in agricultural data space projects such as the AgriDataSpace project, and the follow-up CEADS project, which begins in 2025.[13] Thus, the EC appears to not view the design, development, and use of the CEADS as a threat to their autonomy as they are co-creating it with the agricultural data-sharing community.

Society

Justice

Justice is the main value impacted from a societal standpoint. Data sovereignty should facilitate data sharing benefits that are transparently and fairly split among stakeholders (European Commission 2024a), from farmers to end consumers 'while ensuring that information and knowledge are available for society to enjoy the benefits of such innovations' (Jouanjean et al. 2020, p. 11). Whilst some literature is sceptical that farmers will be the main beneficiary of data sharing (i.e., only 34 per cent in the (Zhang et al. 2021)), there should be strong efforts made in the CEADS to ensure they benefit from its implementation.

This study proposes that the CEADS should facilitate data sharing along the whole agrifood value chain and track contributions so compensations can be made transparently, a point also emphasised in (Raturi et al. 2022; Zhang et al. 2021), where they state that greater overall collaborations among stakeholders are needed. However, tension might emerge from farmers' higher control over their data guaranteed by data sovereignty and what is good for society (e.g., knowing data on chemical use might allow for reductions in its use which would benefit society through improved ecology, it might come at costs for the farmer). This point is illustrated in (Fleming et al. 2018), where they highlight the common divergence in views that big data should be used for the benefit of the farmer vs. the view that it should be beneficial for everyone. This control might impact the availability of data commons, data available under open access policies, especially for research, a point corroborated by (Raturi et al. 2022; Eschenfelder and Johnson 2014; Chamorro-Padial et al. 2024).

To mitigate this tension, this study recommends that the CEADS should implement data use policies that allow farmers or associations to delegate data control and provide open access to their data to parties previously certified as research institutions or non-profit organizations (this openness and transparency is a key ambition of the EC for the CEADS (European Commission 2024a)). Suppose these policies are enforced to guarantee that farmers remain in control of their data, so it is not copied elsewhere and is just used for the consented task at hand. In that case, the risk of losing fair revenues from for-profit activities and reluctance to contribute to the data commons will be dramatically reduced (this is demonstrated in (Wiseman et al. 2019)). This will allow agricultural data to be used in cases that are beneficial for society, while not hindering the farmer, a point emphasised in (Ryan and van der Burg 2021).

Conclusion

Data spaces, exemplified by initiatives like the CEADS, emphasize the need for reliable, decentralized data-sharing ecosystems to incentivize data sharing. Central to this development is the concept of data sovereignty, ensuring that data sharers retain control over their data. However, up to now it

[13] Policy Brief: Building a European framework for the secure and trusted data space for agriculture: https://agridataspace-csa.eu/wp-content/uploads/2024/09/AGRIDATA-SPACE-FINAL-BROCHURE-V5.pdf

was unclear what values are most important for stakeholders in the design of the CEADS.

To find the relevant values for the implementation of data sovereignty into the CEADS, we identified a reference set of human values and applied a Value Mapping methodology to explore how stakeholders view data sovereignty values. Through seven interviews with stakeholders from the C3-SIGCEX case (a real data-sharing initiative in the agriculture domain) and a 42-person workshop of experts in agricultural technology, we identified several values that were most important for stakeholders in the CEADS. There were: farmers (privacy, control, and trust), advisors (human welfare and autonomy), farmers' associations (trust and human welfare), technology providers and intermediaries (human welfare and autonomy), public and regulatory bodies (autonomy), and society (justice).

Our recommendations propose practical insights to navigate value tensions and prioritize considerations in the ever-evolving landscape of data-sharing initiatives. This approach contributes to the ongoing discourse on data sovereignty and informs the design of agriculture data spaces for optimal societal benefit and stakeholder satisfaction.

Moreover, an overarching finding from our study is that there is a clear need for farmers' associations to explain the steps to follow in data sovereignty in the CEADS. This demonstrates the need to implement a human solution, in addition to technical solutions. Gaining the trust of stakeholders is not an objective that can be achieved solely through technical means, but also requires working on human relationships. If this layer is not explored and maintained, no matter how good the technological solution may be, we fear it will not be ultimately implemented.

An additional overarching conclusion of this study is the importance of control in defining and implementing data sovereignty in the CEADS. This result correlates with (Ryan et al. 2024), who concluded that while many values are related, defined or associated with data sovereignty, the value of control is the most fundamental value underpinning this concept and its implementation in data spaces.

A limitation of our study is that it only focused on one national data-sharing initiative. However, as this was an EU country subject to the same strategic and regulatory framework about data, the results should be transferrable to most other EU data-sharing initiatives and other countries entering the CEADS. Additionally, the analysis was complemented by the workshops in the second iteration of the Value Mapping methodology, which involved 42 international stakeholders from 14 different nationalities (France, Spain, Germany, Italy, Finland, Belgium, the Netherlands, China, Greece, Bulgaria, Czech Republic, Serbia, Ireland and the UK). However, a limitation of our study was that the focus was kept on data-sharing initiatives in agriculture primary production, not involving stakeholders beyond that, like consumers or agricultural labourers. Currently, consumers and farm labourers are not regularly discussed in the data space literature. However, further research could benefit from including what kind of impact CEADS will have on consumers and farm labourers.

Another insight was that all of the values listed were not necessarily applicable or relevant to the stakeholders that we evaluated. In the workshops, participants mentioned that privacy is not a sufficient value to use for organizations, as they are more concerned with a closely related value - confidentiality or protecting trade secrets. Upon reflection, there are certain limitations with a value-based approach when applying it to actors that are not individuals, such as companies, regulatory bodies, and technology providers. As a result, there were certain concerns or values from these organizational bodies that are not necessarily reflected in the value-based approaches highlighted in this paper. For example, the economic incentive and proposed efficiency benefits of adopting the CEADS were not adequately reflected in the values outlined in this paper, which need further consideration in future research. Further research in this area is needed to help clarify these points, but these are beyond the scope of this paper.

Appendix A: Interview

- Introduction: to agriculture data sharing, existing and upcoming regulations, business models, and social aspects.
- Agricultural data: determine what is specific to agricultural data and a common definition for agricultural data sharing.
  - Is a classification based on use, type, or data format relevant regarding data sharing and agricultural data?
  - How should we define the different types of data? (Raw data, secondary data, machine-readable data)
  - How could we classify the different uses of agricultural data? (Private data, public data, statistical data, industrial data...)
  - What are the main principles to comply with regarding agricultural data? (Confidentiality, right to be informed about environmental specificities, patents, industrial and trade secrets...)
  - What are the main regulations we should analyze regarding agriculture data?

- Stakeholder: determine common definitions of stakeholders needed for agricultural data sharing.
  - What are the different types of stakeholders who generate, collect, or use data?
  - Should we define the different kinds of stakeholders? (data users, data subjects, data holders, data owners,...)
  - What are the main regulations/principles we should consider regarding stakeholders?
  - Are there more relevant definitions of stakeholders suitable for agricultural data sharing?
- Principles: identify the different principles to consider regarding data sharing.
  - Confidentiality: determine the kind of agricultural data that needs to remain confidential (secondary data, primary data, farm business data...). Consider the legislative framework for confidentiality and how can it cope with agricultural data sharing.
  - Protection of privacy: determine how GDPR could cope with agricultural data sharing.
    - ∗ What is the definition of personal data for the agricultural field?
    - ∗ Is the way that GDPR is applied in the different countries of UE sufficient to protect personal data when sharing agricultural data?
  - Protection of innovation and trade secret: determine a way to identify the data that, if it is shared, could reveal trade or industrial secrets.
    - ∗ Is there a specific legislative tool to protect trade or industrial secrets?
    - ∗ Is the current legislative framework sufficient to protect innovation?
    - ∗ How are business secrets protected in practice?
    - ∗ Is there an internal legislative framework that can cope better to protect innovation in data sharing?
    - ∗ Do you think that the way participants tag their data in a data-sharing initiative could reveal business secrets?
  - Data securing: determine the needs in terms of data securitization, the obligation already into the current legislative framework.
    - ∗ Pseudonymization, anonymization, and use of aggregated data are sufficient to protect confidentiality for which kind of data?
    - ∗ How could we guarantee the use of this process? For which kind of data?
    - ∗ What kinds of stakeholders could access data?
    - ∗ Who should be able to delete data once shared? What would be the deletion process?
    - ∗ Are the essential requirements regarding interoperability for data sharing, for instance in the Data Act, sufficient to promote data valorization in agricultural data sharing?
    - ∗ Are the essential requirements regarding providers of data-sharing services, for instance in the Data Governance Act, sufficient to promote data valorization in agricultural data sharing?
  - Openness of data: determine the type of data that could be shared with everyone, the stakeholder in charge, and the legislative framework for the openness data.
    - ∗ Are there other categories of data, like trade secrets, that should not be in open access?
    - ∗ Is the condition of reuse and protection sufficient?
    - ∗ What kind of status for the environmental data?
  - Conflict resolution: determine the competent authority in case of a conflict in agricultural data sharing.
    - ∗ What kind of competent authority is foreseen for agricultural data sharing?
    - ∗ Should we have a competent authority at the EU level?
      - ∗ Is the national competent authority designed for the GDPR able to solve conflicts about non-personal data sharing?
- Any other business: is there any other topic related to what we have been discussing that you would like to add?

Table 7 Workshop group 1

Farmers	Human Welfare	2		Justice		
	Privacy		1	Accountability		
	Informed Consent		1	Solidarity		
	Control	2		Dignity	2	
	Trust	5		Sustainability		1
	Autonomy	1		Others:		
Farming Advisors	Human Welfare			Justice		
	Privacy			Accountability	2	1
	Informed Consent			Solidarity		
	Control		3	Dignity		
	Trust	2		Sustainability	2	
	Autonomy			Others:		
Farmers Associations	Human Welfare	1		Justice	2	
	Privacy			Accountability		2
	Informed Consent			Solidarity	4	
	Control		1	Dignity		
	Trust	2		Sustainability	1	
	Autonomy		2	Others:		
Technology providers and intermediaries	Human Welfare		1	Justice		
	Privacy	1	4	Accountability	2	1
	Informed Consent	2	1	Solidarity		
	Control	2	1	Dignity		2
	Trust	3		Sustainability	4	
	Autonomy		1	Others:		
Public and regulatory bodies	Human Welfare			Justice	2	
	Privacy	1		Accountability	3	
	Informed Consent			Solidarity	1	
	Control		2	Dignity		
	Trust	5		Sustainability	2	
	Autonomy			Others:		
Society	Human Welfare			Justice	1	
	Privacy		4	Accountability	1	1
	Informed Consent		1	Solidarity		
	Control		3	Dignity		
	Trust			Sustainability	5	
	Autonomy			Others:		

Appendix B: Workshop

This appendix includes the results for the individual groups that participated in the workshop presented in Sect. "Iterative design results". Group 1 results are presented in Table 7, Group 2 in Table 8 and, finally, Group 3 in Table 9.

Table 8 Workshop group 2

Farmers	Human Welfare	1	3	Justice		
	Privacy	2	4	Accountability	3	
	Informed Consent	1	1	Solidarity		
	Control	5		Dignity	1	
	Trust	1		Sustainability	3	
	Autonomy	1	2	Others:		
Farming Advisors	Human Welfare	1		Justice		
	Privacy		1	Accountability	4	
	Informed Consent	1		Solidarity		
	Control		2	Dignity		
	Trust	3		Sustainability	1	
	Autonomy		1	Others:		
Farmers Associations	Human Welfare		4	Justice		
	Privacy		3	Accountability	1	
	Informed Consent			Solidarity	3	
	Control	1	3	Dignity		
	Trust	1	1	Sustainability	1	
	Autonomy	1		Others:		
Technology providers and intermediaries	Human Welfare	1	3	Justice		
	Privacy			Accountability	2	
	Informed Consent			Solidarity		4
	Control	1	4	Dignity		1
	Trust	2		Sustainability	1	1
	Autonomy	1	4	Others:		
Public and regulatory bodies	Human Welfare		4	Justice	3	
	Privacy		1	Accountability	3	
	Informed Consent			Solidarity		
	Control	3		Dignity		
	Trust	3		Sustainability	3	
	Autonomy	1	1	Others:		
Society	Human Welfare			Justice	3	
	Privacy	1	2	Accountability		
	Informed Consent		2	Solidarity		1
	Control			Dignity	1	
	Trust	3		Sustainability	3	
	Autonomy		2	Others:		

Table 9 Workshop group 3

Farmers	Human Welfare			Justice	1	1
	Privacy			Accountability		
	Informed Consent			Solidarity	1	
	Control	1	1	Dignity		
	Trust	1		Sustainability		
	Autonomy		1	Others		
Farming Advisors	Human Welfare			Justice		
	Privacy			Accountability	1	
	Informed Consent			Solidarity		
	Control	1	1	Dignity		
	Trust	2	1	Sustainability	1	1
	Autonomy	1	1	Others		
Farmers Associations	Human Welfare			Justice		
	Privacy			Accountability		
	Informed Consent		1	Solidarity	1	
	Control	1	1	Dignity		
	Trust	1		Sustainability		
	Autonomy	1		Others		
Technology providers and intermediaries	Human Welfare			Justice	1	1
	Privacy		1	Accountability		
	Informed Consent			Solidarity		
	Control	1	1	Dignity		
	Trust			Sustainability		
	Autonomy		1	Others		
Public and regulatory bodies	Human Welfare			Justice		
	Privacy			Accountability		
	Informed Consent			Solidarity		
	Control	1		Dignity		
	Trust	1		Sustainability	1	
	Autonomy	1		Others		
Society	Human Welfare	1		Justice	1	
	Privacy			Accountability	1	
	Informed Consent			Solidarity	1	
	Control		1	Dignity		
	Trust	1		Sustainability	1	
	Autonomy		1	Others		

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Declarations

Conflict of interest The authors have no Conflict of interest to declare relevant to this article's content.

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