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Disclaimer

Glossary - Acronyms

EC	European Commission
EEA	European Economic Area
EU	European Union
FAIR	Findable, Accessible, Interoperable, and Reusable
GDPR	General Data Protection Regulations
ADSE	Agriculture Data Space Ecosystem
UC	Use Case

Revision History

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1 Executive Summary

The document begins with an in-depth exploration of the regulatory frameworks governing agricultural data and data spaces within the agricultural domain. Drawing on the contributions of the consortium members involved in Deliverable 6.1, entitled "*Development & Integration of Agri Data Sharing Governance Models, Policies, and Regulations - Release 1*", a foundational model for agricultural data governance policies has been constructed, considering their core components.

In addition, the analysis is strengthened by exploring the underlying objectives and procedural complexities that underpin the adoption of agricultural data sharing policy frameworks. A central focus of this exploration is the importance attached to privacy and trustworthiness in the seamless integration of policies. In this context, the document articulates the indispensable standards that are critical to the successful adoption of the Agricultural Data Space Ecosystem (ADSE). In addition, it underlines the need to address the multiple technical considerations associated with GDPR compliance, covering vital aspects such as data integrity, confidentiality, security measures, access control, traceability, encryption algorithms and data provenance. At the same time, a first release of ADSE Data Exchange Policy Manual is introduced, with the aim to prioritise the cardinal principles of data interoperability, trust, data sovereignty and value creation. These principles of Data Spaces are intrinsically the basis of ADSE.

Moving beyond theoretical discourse, the analysis extends to practical insights from real-world use cases. Each use case is presented, beginning with a concise general overview, followed by a mapping of relevant policies, regulations and models of agricultural data sharing. This methodological approach allows a comprehensive examination of the critical issues and opportunities that have emerged within each specific use case.

In conclusion, the ideas articulated in this deliverable outline a transformative pathway for the field of agricultural data governance. By embracing these perspectives, stakeholders can collectively steer towards a future characterised by sustainable, innovative and prosperous agricultural data sharing practices.

2 Agricultural data sharing regulatory analysis within data spaces

This chapter presents a comprehensive regulatory analysis of agricultural data sharing within data spaces, examining the legal and policy frameworks that govern data ownership, privacy and security. By taking these crucial considerations into account, the DIVINE project aims to provide policymakers, stakeholders, and the wider agricultural community with valuable insights and recommendations for the development of an inclusive and effective Agri Data Sharing Policy Framework.

2.1 Data spaces overview in agro domains

In the agricultural sector, data spaces have emerged as a transformative tool, enabling stakeholders to share and access a wealth of data, thereby enhancing productivity, sustainability, and resilience. These data spaces, which serve as digital platforms, facilitate the exchange of diverse agricultural data, including crop yields, weather patterns, market trends, and supply chain information. Furthermore, these data spaces reach beyond the confines of agriculture, extending into other industries that are intrinsically linked to it. This includes sectors such as logistics, retail, supply chain, environmental management, and technology, among others. By encompassing these interconnected industries, data spaces can offer a holistic perspective, fostering cross-sector collaborations and innovative solutions that can further enhance the efficiency, sustainability, and resilience of the agricultural sector. These data spaces facilitate the sharing and analysis of supply chain data, supporting decision-making and collaboration among various stakeholders, from farmers to retailers. Some examples of these data spaces (from various industries) could be seen via Data Spaces Radar[1] of IDSA, categorised by their level of maturity. In addition to these data spaces, AgriDataSpace (CSA) website[2] lists the data sharing initiatives (DSI) from Europe.

The interoperability of these data spaces, their ability to communicate and exchange data with other systems and platforms, is key to creating a connected and efficient digital ecosystem in agriculture. This ecosystem allows for the integration and analysis of data from various sources, driving innovations in areas such as precision farming, supply chain management, and climate-smart agriculture.

The operation of these data spaces is supported by a range of technologies, including Internet of Things (IoT) devices, remote sensing technologies, and advanced data analytics. These technologies enable the collection, transmission, and analysis of vast amounts of agricultural data, thereby driving innovation. However, the development and operation of data spaces in agro domains also present challenges. These include technical issues related to data quality, security, data sovereignty and interoperability, as well as legal and ethical concerns around data ownership, privacy, and consent. Addressing these challenges requires a robust regulatory framework, which is the focus of the subsequent chapters of this deliverable.

In summary, data spaces in agro domains, including their extension to the supply chain, hold great potential for transforming agriculture and contributing to sustainable development. However, realising

[1] https://internationaldataspaces.org/adopt/data-space-radar/
[2] https://agridataspace-csa.eu/dsis-map/

this potential requires careful attention to technical, legal, and ethical issues, as well as the development of supportive policies and regulations. The DIVINE project is committed to exploring these issues and contributing to the development of an effective and inclusive Agri Data Sharing Policy Framework. The current state of the regulatory framework in these data spaces, along with the policies and regulations obtained from chapter 3 "Data Policies and Governance Models in EU Agro Domains", will define the perimeter of our ADSE framework, setting the stage for the subsequent chapters.

2.2 Status of regulatory framework within data spaces in agro domains

In this chapter, we delve into the current state of the regulatory framework within data spaces, with a specific focus on the agricultural sector. By examining the analysis presented in the International Data Spaces (IDS) Rulebook[3], we explore the key legal dimensions and regulatory considerations shaping data sharing practices in agro domains.

The International Data Spaces Rulebook provides comprehensive insights into the regulatory framework governing data sharing within data spaces. Section 6.1 of the Rulebook, titled "Regulatory Framework," offers a detailed examination of the existing regulations and initiatives relevant to data spaces that are valid for all domains. Analysing this information enables us to understand the current regulatory landscape and its implications for agro domains.

Within the regulatory framework, data sovereignty emerges as a fundamental principle. It emphasises the importance of data owners having control over their data and being able to determine its usage. The Rulebook highlights the need for technical and organisational measures that enable secure and controlled data sharing while ensuring data sovereignty for participants in agro domains.

The regulatory framework for data in the EU is currently fragmented and incomplete, with no general legal status for data and limited protection for intellectual property rights and personal data. In response to these shortcomings, the EU Commission introduced the "European strategy for data" in 2020, aiming to create a common European data space. As part of this strategy, the Commission proposed several regulations, such as the Digital Markets Act, Digital Services Act, and AI Act, to establish harmonised rules for data governance, access, and use.

Two significant acts have been implemented to address data sharing and reuse: the Data Governance Act (DGA) and the Data Act Proposal (DA-E). The DGA aims to promote data sharing by regulating the reuse of publicly held and protected data, encouraging data sharing for altruistic purposes and through novel data intermediaries. It focuses on public sector data that is legally restricted and provides guidelines for member states to establish mechanisms for the reuse of such data. On the other hand, the DA-E aims to ensure fairness in the digital environment, stimulate a competitive data market, and make data more accessible for all. It establishes a contractual framework to provide clarity on rights and remedies for accessing, processing, sharing, and storing data.

[3] https://docs.internationaldataspaces.org/idsa-rulebook-v2/idsa-rulebook/6_legal_dimension

In summary, the EU is working towards a common European data space by implementing regulations such as the DGA and the DA-E. T. Other legal aspects, such as antitrust, data protection, and copyright, also need to be considered. A robust methodology and collaboration among initiatives are essential to navigate the regulatory landscape and create a trustworthy and reliable data sharing landscape in the EU.

In addition to these acts, other legal aspects need to be considered when sharing data, including antitrust/competition, data protection and security, copyright, and intellectual property. The development of regulations in these areas will impact the concept and operationalisation of data spaces in the future. To navigate through the existing regulatory patchwork and implement the upcoming legislative agenda, a robust methodology is required, which includes a four-pillar data governance framework covering:

- Substantive rights
- Contractual dimension
- Organisational aspects
- and technical implementation

In addition to the legislative framework, the legal dimension of a data space includes a contractual framework that allows participants to establish specified rules for data sharing. In a decentralised organisation, where participants have the freedom to choose their contract partners and agree on terms, a suggested model of terms that can be customised is essential (template approach).

The International Data Spaces Association (IDSA) takes an "adopting and consolidation approach" to the contractual framework, aligning and collaborating with other initiatives. One such initiative is SITRA's rulebook[4] for a fair data economy, which provides tools for data sharing networks. The rulebook model includes contractual templates and tools for building a data sharing network, covering legal, business, technical, security, administrative rules, and ethical guidelines. SITRA published the first version of the rulebook in 2020 and has since updated it based on contributions from experts and organisations. The principles of the SITRA rulebook align well with the goals of IDSA, particularly in terms of data sovereignty and enabling trust.

Data sovereignty, a key design principle of the IDS, is emphasised in the rulebook, giving data providers control over their data through terms of use. Trust is fostered through a balance between data providers and users, allowing for provisions on data access, termination, and the boundary between data and derived material. The rulebook also addresses auditing, data security, and ethical principles in data networks. The IDSA recognises the value of the SITRA templates as a basis for creating a contractual framework that aligns with IDS principles and specifications. The suggested contract templates serve as a general framework that can be customised according to specific needs.

[4] https://www.sitra.fi/en/publications/rulebook-for-a-fair-data-economy/

In summary, the analysis of the regulatory framework within data spaces in agro domains reveals the significance of data sovereignty, data protection, transparency, accountability, interoperability, and liability in facilitating responsible and effective data sharing. Although IDSA Rulebook offers valuable guidance and insights into the legal dimensions of data sharing, there should also be reusable elements, such as data sharing contracts that are legally binding. As DIVINE consortium, we will be keeping an eye on the developments on that end and will try to adopt when possible.

2.3 Regulatory gaps and challenges as agriculture innovation opportunities

Agriculture is a sector where digital innovations and technologies are increasingly applied (FAO, 2022 *The State of Food and Agriculture*5). In the European Strategy for Data for the 2021-2027 period the Commission acknowledges the importance of data sharing for improving the availability of data. In the strategy, the Commission announced its plan to establish nine EU-wide sectoral common data spaces, including a "Common European Green Deal data space" and a "Common European agricultural data space". In particular, the strategy aims to realise the "vision for a genuine single market for data" through actions such as setting a governance framework for data access and use and investing in data infrastructure and skills. The latter aims to make it easier to share, process and analyse production data, open data, and possibly other public data. The issues to be tackled include data availability, data interoperability and quality, data governance, data infrastructure and technologies (e.g., data-processing capacity and cloud infrastructure), and cybersecurity. Under this perspective, technological advances can reduce the timeframe for policy formation, and increase the evidence base for policy decisions.

The European strategy for data aims at creating a single market for data that will ensure Europe's global competitiveness and data sovereignty. Common European data spaces will ensure that more data becomes available for use in the economy and society, while keeping the companies and individuals who generate the data in control. Data driven applications will benefit citizens and businesses in many ways. They can: improve health care, create safer and cleaner transport systems, generate new products and services, reduce the costs of public services, improve sustainability and energy efficiency. To further ensure the EU's leadership in the global data economy the European strategy for data intends to:

a. adopt legislative measures on data governance, access and reuse. For example, for business-to-government data sharing for the public interest;
b. make data more widely available by opening up high-value publicly held datasets across the EU and allowing their reuse for free;
c. enable access to secure, fair and competitive cloud services by facilitating the set-up of a procurement marketplace for data processing services and creating clarity about the applicable regulatory framework on cloud framework of rules on cloud.

These improvements allow governments to adopt data-driven policies, in particular by making it possible to: — understand the environmental impacts of agriculture better and formulate policy objectives; —

5 https://www.fao.org/publications/home/fao-flagship-publications/the-state-of-food-and-agriculture/en

design differentiated and targeted policies; and — apply new data-driven monitoring systems. In detail, the European Commission has issued several documents emphasising the need to improve and maximise the use of data for better policy-making, or impacting data sharing or tools in the EU (DataStrategy@EC, C(2018) 7118, COM(2021) 37). The Commission has proposed a Regulation on European data governance as part of its data strategy in order to harmonised rules on fair access to and use of data (Data Act). The Data Act is a key pillar of the European strategy for data. Its main objective is to make Europe a leader in the data economy by harnessing the potential of the ever-increasing amount of industrial data, in order to benefit the European economy and society. DGA aimed to facilitate the reuse of certain categories of protected public-sector data, increase trust in data intermediation services, and promote data altruism in the EU. The DGA, the European Regulation on Data Governance, came into force on 23 June 2023 and applies from 24 September 2023. The Regulation marks a turning point in the European Union's strategy, which now also focuses on enhancing and on data sharing and not only on their protection.

Data-driven innovation has already brought, and can further produce, great benefits for the economy and society, improving decision-making processes in various fields, increasing productivity and competitiveness and contributing to the quality of public services and the effectiveness of policies for health, mobility and environmental protection. At the same time, however, there are fundamental values of European society that must be safeguarded, from the protection of personal data to the protection of competition and consumers, from security to information pluralism up to the safeguarding of democratic institutions themselves.

Based on an overview of the possible applications of digital technologies in agriculture, the figure below offers an analysis of the challenges and limitations of the legal framework governing digitalisation in agriculture and beyond. In particular the reliability with regard to product liability and product safety as well as data confidentiality, data access and data security is important in this context. Furthermore, the CAP as the most important financing instrument for digital innovations in the agricultural sector should be designed in such a way that it links digitalisation-related goals more closely with sustainability goals. The risk is that of not exploiting the potential of digitisation for the protection of the environment, losing sight of the numerous negative effects.

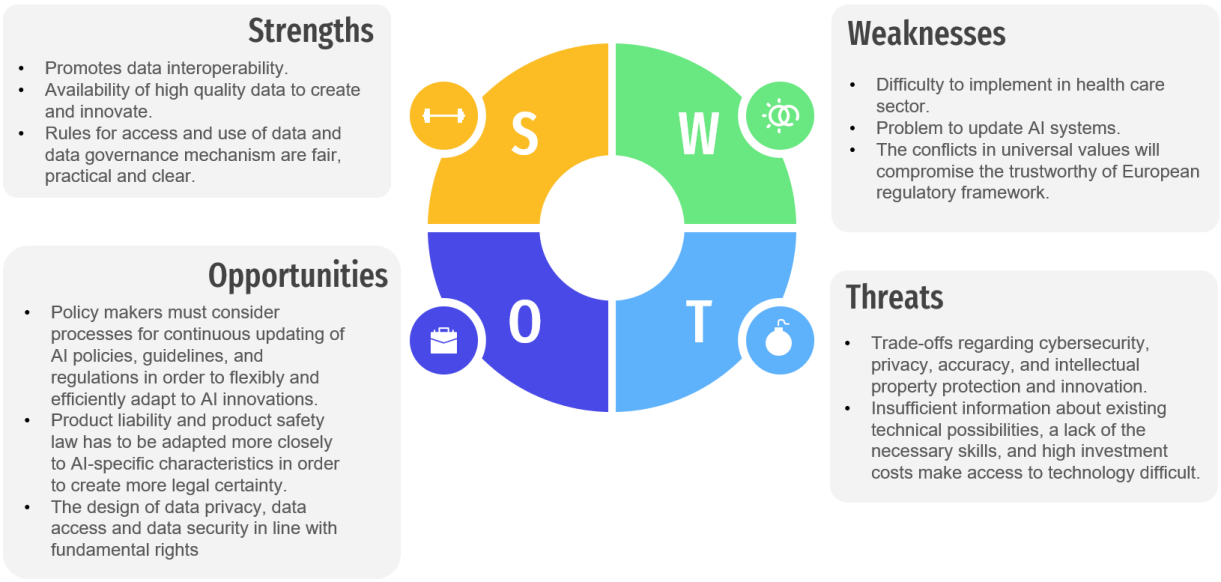

Figure 1: Regulatory gaps and challenges: SWOT Analysis

In specific of contexts of agricultural sector, in 2016 communication on data, information and knowledge management to the European Commission, the Commission highlighted the need to improve information retrieval and provision, as well as to optimise the use of data to improve policy making. The Commission's internal data strategy has emerged as the main tool for putting the 2016 Communication into practice. Against this background, the Commission started putting its data strategy into practice in 2018 by taking several actions that could help better policy analysis by improving data infrastructures and data usage for the CAP. The Commission has introduced two new regulations and modified an existing one (see Figure 2: Legal framework regulation of European agricultural statistics data).

As the EU's policies evolve and adapt to changing circumstances, European statistics need to develop and meet users' information needs efficiently. New technologies can help to combine and integrate different data sources without too great a burden on data producers. Farm statistics are the backbone of the EU's agricultural statistical system. To increase their response speed to new data needs, the Commission put forward a new approach based on an integrated, flexible and modular framework. The agricultural statistics of the European Union (EU) have as primary objective that of providing the basic data for constructing valid indicators for EU policies - from the Common Agricultural Policy (CAP) to all aspects related to sustainable agriculture, whether they are environmental, social or economic. For several decades, Eurostat has compiled European statistics on EU agriculture covering: farm structure, farm economic performance, agricultural economic accounts, plant and animal production, organic farming, fisheries and aquaculture, agricultural prices, pesticides, nutrients and other agri-environmental aspects.

These statistics are strictly regulated by European legislation - which is frequently updated - or implemented through gentlemen's agreements and agreements within the framework of the European

Statistical System (ESS). In the context of the modernisation of European statistics and the evaluation of the current agricultural statistics system of the European Union, a strong recommendation emerged to adopt a systematic approach for all agricultural statistics, the basic principles of which are precisely described in the proposal regulation under discussion today.

Indeed, these changes require a simplification of the European system of agricultural statistics which should be governed by three regulations. Two of these are new framework regulations which will replace several previous EU regulations on the subject, eliminating fragmentation, while the third will amend an already existing regulation: - The first, Regulation (EU) 2018/1091 on integrated farm statistics (IFS), covering data on farm structure, orchards and vineyards, was adopted in 2018 – The second of these regulations, relating to statistics on agricultural inputs and outputs, is being of this proposal and concerns the inputs and outputs of the agricultural sector (SAIO). The third regulation will concern an amendment of the regulation (CE) n. 138/2004 relating to the economic accounts of agriculture (CEA).

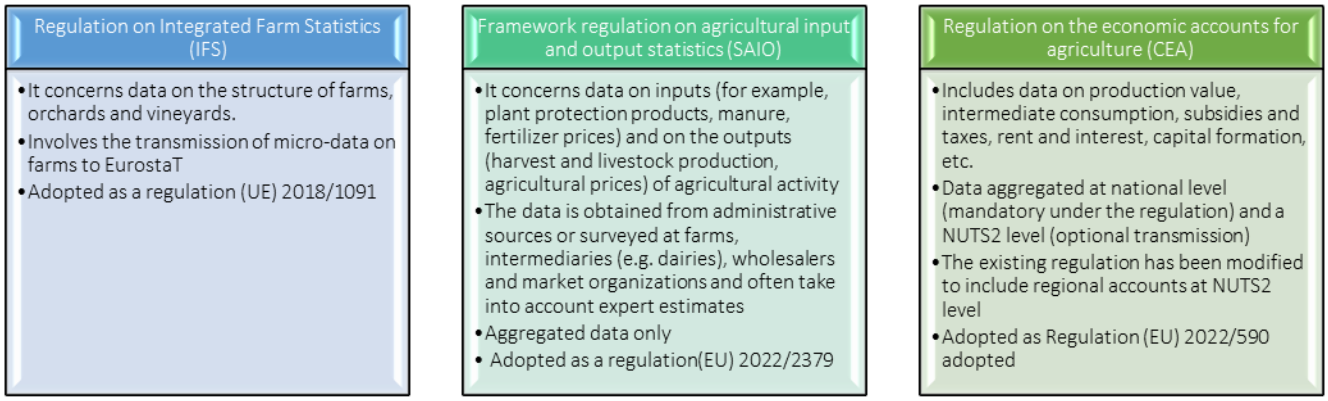

Figure 2: Legal framework regulation of European agricultural statistics data

3 EU Agro Data Governance: Policies & Models

3.1 Rules on Agri Data Management

The following section will focus on the analysis of the current regulation, policies and codes developing on the topic of agri-data sharing and management. Understanding these documents is vital in the development of DIVINE, as they establish the legal framework within which the project must operate. Through this analysis, we will identify potential challenges and opportunities associated with agri-data management, enabling us to design an innovative and sustainable solution that aligns with global best practices.

3.1.1 Context with F2F

The Farm to Fork (F2F) Strategy is an integral part of the European Green Deal, aimed at creating fair, healthy, and environmentally-friendly food systems. It focuses on transitioning to sustainable food systems to achieve various goals, including environmental impact reduction, climate change mitigation, food security, public health promotion, and ensuring access to sustainable food.

The F2F Strategy emphasises the importance of (agri) data sharing in achieving its objectives. It recognises the significance of research and innovation, technology, advisory services, and knowledge sharing in promoting sustainable practices. The strategy proposes creating a common European agriculture data space to collect data on sustainability indicators, targets, and other relevant information.

To achieve its goals, the strategy plans to foster investments in research and technology, including digital technologies and satellite technology, to benefit farmers and improve the environment. Advisory services and knowledge sharing will play a crucial role in supporting farmers in making sustainable choices.

Data ownership, control, privacy, safety, security, and transparency are not explicitly mentioned in the F2F Strategy, but the emphasis on data collection and processing indicates the importance of addressing these aspects while implementing the strategy.

3.1.2 Common Agriculture Policy CAP 2021-2027 regulation

The Common Agricultural Policy (CAP) is an EU policy designed to support farmers, ensure food security, and enhance agricultural productivity. Moreover, it aims to safeguard farmers' livelihoods, address climate change and sustainable resource management, maintain rural areas and landscapes, and promote job creation in farming and related sectors. The CAP provides income stability, encourages sustainable farming practices, and supports rural communities. The following section will outline the different regulations that make up the Common Agricultural Policy.

3.1.3 Regulation 2021/2115

Regulation which defines the CAP Strategic Plans and explains how the development of agricultural activities should be supported by EU funds (EAGF, EAFRD). The payments and aids have to be given according to the plan the Member States produced, and interventions are different according to the agricultural products (Fruit, Apiculture, Wine, Hops, Olive, Other).

Overall, the regulation does not directly deal with data nor defines best practices to share or process them, but it refers to other acts for specific cases (such as the GDPR) and advocates for the application of base principles like transparency in processing data.

The text was implemented in 2022 by Regulation 2022/1475, which focuses more on the technological and data-related aspect of asking EU funds. MS are in charge of providing a certain amount of aggregated information on the funds beneficiaries, such as personal information, but also farming specificities.

WHO	WHAT	WHEN
Member States	Requiring EU Funds (EAGF, EAFRD)	2021

Table 1. Regulation 2021/2115 resume

3.1.4 Regulation 2021/2116

The main objectives of Regulation 2021/2116 are to support environmental protection and climate action, contribute to Union environmental and climate objectives, and ensure sustainable agriculture within the Common Agricultural Policy (CAP). The regulation aims to bolster the implementation of Union strategies such as "The Future of Food and Farming," "The European Green Deal," "Farm to Fork Strategy," "EU Biodiversity Strategy for 2030," and "Bringing nature back into our lives."

To achieve these objectives, the regulation emphasises the importance of transparency and data sharing from the integrated administration and control systems, which include identification systems, monitoring tools, and control and penalty systems. These systems play a crucial role in monitoring agricultural land use, climate conditions, and the resilience of agricultural systems, contributing to the achievement of environmental and climatic goals.

Additionally, the regulation highlights the financing structure and management of the European Agricultural Guarantee Fund (EAGF) and the European Agricultural Fund for Rural Development (EAFRD). To guarantee transparency, Member States are required to publish a list of EAGF and EAFRD beneficiaries, promoting accountability and openness in the use of CAP funds. However, this must be done while respecting the beneficiaries' right to privacy and data protection.

WHO	WHAT	WHEN
Member States	Allocating Funds	2021

Table 2. Regulation 2021/2116 resume

3.1.5 Regulation 2021/2117

The regulation establishes that producers using GI must allow MS authorities to access and verify the information provided in their application to ensure accuracy, in order to improve transparency in the food supply chain. To do so, Union market observatories for selected agricultural sectors have to be established. These observatories provide statistical data and information necessary for monitoring market developments and potential disturbances, and the information obtained are shared with international

organisations, financial market authorities, and competent authorities of third countries, while also being made public, considering data protection and business secrets.

Moreover, to provide consumers with more information, producers are required to include a nutrition declaration and a list of ingredients on their packages (even if the full nutrition declaration and list of ingredients can be uploaded through electronic means). Exceptions apply for substances causing allergies or intolerances, which must still be listed on the package.

WHO	WHAT	WHEN
Agricultural Producers and Sellers	Labelling Rules	2021

Table 3. Regulation 2021/2117 resume

3.2 General Rules on Data Management

Section 3.2 aims at analysing all the technical rules and requirements that will be necessary to follow when processing, collecting, and sharing data. The main difference with the previous section - Section 3.1- is that the policies analysed hereafter are equally applied to all sectors – and not to agriculture or farming activities only - as long as data is involved. Among the main regulation, the new DSA and Data Act Proposals have been considered, as their development may impact DIVINE's structure.

3.2.1 Digital Services Act (DSA) and Digital Market Act (DMA)

Both Falling under the Digital Services Act Package, they differ by subject of application. In fact, while the DSA regulates online intermediary services (divided in *mere conduit*, *caching* and *hosting* services), the DMA focuses on the concept of gatekeeper.

3.2.1.1 DSA

Defines the behavior of data-sharing platforms used in different sectors. The responsibilities of each type of service are defined in Art. 4 for "mere conduit," Art. 5 for "caching," and Art. 6 for "hosting" services. Large online platforms have additional requirements, including complaint-handling systems, transparent reports on terms and conditions, and measures against data misuse. Very large online platforms have further obligations, such as conducting risk assessments and independent audits. The regulation encourages the creation of codes of conduct in accordance with the EC regulations and member state laws. Non-compliance penalties are defined in Chapter 6, with supervision at the member state level and the possibility of fines and compensation for affected users.

WHO	WHAT	WHEN
Online Intermediary Services	Regulates the behavior of the service providers	Nov 2022

Table 4. DSA resume

3.2.1.2 DMA

The DMA (Digital Markets Act) aims to ensure fair competition in the digital sector by regulating core platform services provided by gatekeepers. Gatekeepers are companies with significant power and control over the market due to extreme scale economies and strong network effects. The DMA covers various core platform services, including online intermediation, search engines, social networking, cloud computing, and more.

Gatekeepers must comply with rules related to data usage, data portability, interoperability, and non-discrimination. They cannot use end-users' data from third-party services or cross-use data from different services. Moreover, they must ensure easy download, erase, and modification of their operating systems and support interoperability with third-party services and devices.

WHO	WHAT	WHEN
Gatekeepers	Behavior, data processing and portability	Nov 2022

Table 5. DMA resume

3.2.2 Artificial Intelligence Act

Regulation developed to control the safety and security of newly developed AI tools. Valid for all Member States in the EU, it establishes rules for categorising Artificial intelligence based on their risk of harm and defines testing and analysis requirements.

Still in the form of a proposal, it applies to all AI service providers offering their services or located in the EU, and requires high transparency, as well as accountability and human oversight, prohibiting the use of AI for malicious purposes or subliminal practices.

Nonetheless, the regulation applies only to new AI developed tools and is not retroactive, meaning that all the existing Artificial Intelligences will not be subject to the rules laid down in this regulation.

WHO	WHAT	WHEN
AI Developers	Testing and Conformity assessments for AI	Still a proposal

Table 6. AI Act resume

3.2.3 Data Governance Act

The regulation EU 2022/868, also known as Data Governance Act, applicable form September 2023, is a text focusing on establishing the rules and best practices public sector bodies will need to keep into account when using and sharing non-personal databases. Specifically, it applies to all public sector organisations exchanging data, and to intermediary services companies; moreover, the data subject to this regulation include data covered by Trade Secret, IP Rights, Commercial Confidentiality and Personal Data not covered by Directive EU 2019/1024.

According to the regulation, the bodies will need to make sure the data processing is following FAIR principles, where anonymity and security are safeguarded. Sharing data with third parties such as stakeholders is allowed but may be required to provide information on themselves or pay some fee. A Specific mention on Data Altruism arrangements done in Chapter 4.

WHO	WHAT	WHEN
Public sector bodies	Non-personal data, Data under Trade Secret, IP Rights, Commercial Confidentiality	Sept 2024

Table 7. Data governance act resume

3.2.4 GDPR

The EU regulation 2026/679 aims to harmonise the protection of fundamental rights and freedoms of natural persons regarding the processing and flow of personal data. It applies to data relating to identified or identifiable individuals and governs data processing activities in the EU, regardless of whether they are handled through automated or manual means.

The regulation outlines principles for processing personal data, including lawful processing based on consent, contract performance, legal obligation, vital interests, public interest, or legitimate interests. Transparency in data collection and processing is essential, and individuals have the right to access, rectify, and erase their data. Data processing should be fair, free of charge, and limited to necessary purposes. Measures should be in place to ensure data accuracy, security, and confidentiality. According to the regulation, data cannot be transferred to third countries or international organisations unless appropriate safeguards and data subject rights are in place.

WHO	WHAT	WHEN
Everyone processing personal data	Sharing data, data portability, Transparency, Control over own data	May 2018

Table 8. GDPR resume

3.2.5 Open data Directive & Implementing list of High Value Datasets

The open data Directive is a Text of law which aims at promoting the share and exchange of information from Public Sector bodies to strengthen the EU data Economy. This information are available to everyone and free for reuse, and the list of free data is defined in Annex 1 of the regulation.

The text which entered into force in 2019 was further enlarged thanks to the Implementing Act of High Value Dataset, which further extended the list of free of charge reusable information. Overall, the dataset which can be used focus on: Geospatial, Earth observation and environment, Meteorological, Statistics, Companies and company ownership, Mobility data.

WHO	WHAT	WHEN

Public Sector Bodies	Sharing data	2019

Table 9. Open data directive & Implementing list of high value datasets

3.2.6 ePrivacy Directive

Directive 2009/136/EC, commonly known as the "E-privacy Directive," took effect in May 2011 and focuses on safeguarding personal data and privacy in the electronic communications industry. It includes measures for network security, communication confidentiality, data access, traffic and location data processing, and regulates unsolicited communications ("spam"). Moreover, it introduced new rules for data breach notifications and expanded its scope to cover electronic tags with enhanced enforcement measures.

WHO	WHAT	WHEN
People and firms providing publicly available electronic communications services in public communications networks	Processing and storing data	Dec 2009

Table 10. ePrivacy directive resume

3.2.7 Data Act

Still a proposal, the Data Act has for main objective the promotion of data sharing, while guaranteeing an improved transparency and control over own-data, by establishing a clear and transparent data access and processing framework. The regulation applies to manufacturers, suppliers, data holders, data recipients, public sector bodies, Union institutions, and providers of data processing services. However, it does not apply to gatekeepers and SMEs.

The regulation impacts IoT technologies collecting data, as IoT service providers are obliged to share data collected by them with users, and users should have the right to access and control their information. The regulation focuses on the fact that data-sharing practices should not be unfair to small companies, and on the relevance of interoperability: providers must ensure customers can easily switch between services without bearing excessive charges.

WHO	WHAT	WHEN
Data holders, data recipients, data providers, public sector bodies and institutions, manufacturers of products and suppliers of related services in the EU	Sharing data, data portability, Transparency	Still a proposal

Table 11. Data act resume

3.2.8 EU Cybersecurity Strategy & Framework for Free Flow of Non-Personal Data

Framework aiming at constructing and developing a Network protecting EU Citisens, firms, and organisation from cyber threats. The framework builds on a different text of law and directives, among which we find the ePrivacy Directive and the Framework for Free Flow of Non-Personal Data.

Framework for Free Flow of Non-Personal Data

The regulation, adopted in 2018, aims to facilitate the free movement of non-personal data within the European Union. It applies to all entities that handle electronic data. Despite being concise with only 9 articles, the key points are found in Article 4, which prohibits localisation restrictions on such data, and Article 6, which encourages the establishment of codes of conduct for various aspects like switching service providers, transparent information provision, and certification schemes to compare products and services.

WHO	WHAT	WHEN
Individuals and companies processing electronic data	Handling electronic data	2018

Table 12. EU Cybersecurity strategy & Framework for free flow of non-personal data resume

3.3 General Rules on Agri Data Regulation

The Agri-Data Regulation Section contains less, but extremely important, regulation over the management of data in agriculture. These EU rules aim to promote responsible data practices, ensure data protection, and foster collaboration while driving innovation in sustainable agriculture. The following pages explore key provisions, data rights, and implications, emphasizing the EU's commitment to promote digitalization in agriculture and farming.

3.3.1 Regulation on regional Economic Account

The regulation on regional economic account, amending EC Regulation 138/2004, seeks to update the rules on agricultural data, particularly in line with changes in agriculture, the CAP, and other related EU policies. The objective is to produce high-quality statistics that meet users' needs and improve harmonisation and coherence of European agricultural statistics.

Eurostat has been compiling European agricultural statistics on various aspects of EU agriculture for many years, including farm structure, economic accounts, animal and crop production, organic farming, agricultural prices, pesticides, and agri-environmental aspects. The main objective of these statistics was to monitor and evaluate the Common Agricultural Policy (CAP) and other important EU policies, supporting policy-making. To adapt to changing circumstances and evolving EU policies, the new regulation aims to develop European statistics efficiently to meet users' information needs, by proposing a new integrated, flexible, and modular framework for agricultural statistics to increase their response speed to new data requirements. The text provides guidelines for collecting, storing, and standardising agricultural data, ensuring its shareability with the European Commission and other Member States.

WHO	WHAT	WHEN
Member States	Harmonising Agricultural Data	2020

Table 13. Regulation on regional economic account resume

3.3.2 SAIO & IFS

The European agricultural statistics system (EASS) is undergoing a modernisation plan to provide accurate data for evaluating agricultural and related EU policies, while reducing data collection costs. The plan includes two new framework regulations: Statistics on agricultural input and output (SAIO) and Integrated farm statistics (IFS). These regulations aim to integrate various data, including agricultural production, prices, plant protection products, and farm structure, orchards, and vineyards. The goal is to simplify the system and improve data quality, efficiency, and adaptability. The plan is a collaborative effort by the European Statistical System Committee and Eurostat, aiming to produce high-quality statistics that meet users' needs, integrate agriculture and environmental statistics, and enhance consistency and harmonisation across European agricultural statistics.

WHO	WHAT	WHEN
Member States	Harmonisation & Quality of Agricultural Data	2022

Table 14. SAIO & IFS resume

3.3.3 EU Code of Conduct on Agri Data Sharing

The EU code of conduct on agricultural data sharing is a joint effort by multiple organisations to promote transparency and mutual trust in agri-data sharing within the agro-food chain. The code provides guidance on contractual relations and the use of agricultural data, focusing on non-personal data.

The code introduces default principles in five categories, covering data ownership, access, control, and portability, data protection, privacy and security, and liability and intellectual property rights, and emphasises the importance of transparency in data sharing relationships between farmers and agribusinesses. It defines the data originator as the person or entity that holds the exclusive right to license access to the data and control its downstream use. According to the text, the data originator should have the control over its data and must grant explicit consent via contractual arrangements for data collection and usage.

Security and confidentiality responsibilities of data users and providers are outlined, and pseudonymization of personal data in databases should be granted.

WHO	WHAT	WHEN
Everyone processing and sharing data	Best Practices for Data sharing	2018

Table 15. EU Code of Conduct on agri data sharing resume

3.4 Relevant EU projects

The following page highlights the key points of platforms already developed by the EU which could be of inspiration for the development of DIVINE's structure. The platforms and projects do not only focus on agriculture – as it is the case for the EHDSR – as they aim at giving an overview of the best procedures and behaviours to consider for DIVINE's architecture.

3.4.1 EHDSR

The European Health Data Space (EHDS) is a regulation proposed by the European Commission to establish a common EU data space in the healthcare sector. It aims to unlock the potential of health data by empowering individuals to control their own health data and facilitate its secure exchange, use, and reuse for better healthcare delivery, research, innovation, and policy making. The EHDS supports the EU Strategy for Data and focuses on strengthening the rights of individuals in controlling their electronic health data. While not directly related to agriculture, the EHDS provides insights into data safety and security that could be relevant for the development of the agri-data sharing platform, DIVINE; thus, the development of the proposal will need to be closely followed during the next months.

3.4.2 IACS

The Integrated Administration and Control System (IACS) is a crucial system established by the European Union (EU) to manage and control payments to farmers in EU countries. It operates through interconnected databases and digital systems, including the Land Parcel Identification System, Geospatial Aid Application, and Animal Database. Farmers submit their aid applications online, and national administrations conduct administrative and on-farm checks to verify compliance with eligibility criteria. The IACS ensures accurate payment calculations and standardised procedures for managing income support, preventing irregularities, and recovering unduly paid amounts. It efficiently controls taxpayer funds and supports farmers in the aid application process while minimising administrative burdens.

3.5 Existing Projects

The pages below illustrate other Agricultural Projects that have been / are being developed in the EU which may inspire the development, characteristics and usages of DIVINE's platform. The projects cover different digital aspects of agriculture, and aim at making data collection easier and safer:

3.5.1 AgDataHub

Ag Datahub is a company that aims to provide agriculture in France and Europe with a shared and sovereign technological infrastructure to promote digital agriculture. It has a significant presence in the agricultural sector, with 113,000 individuals involved in France. The company's market has seen a 28% increase in the last 6 years and it is supported by French public authorities.

Ag Datahub offers various platforms to assist farmers in collecting, securing, and deploying their agricultural data. The main solutions provided by the company are three different applications: AgriConsent (AgriTrust), API-Agro, and Capdata. AgriTrust focuses on protecting privacy and sensitive data, while API-Agro serves as a trusted third party for data exchange in the agricultural sector. Capdata

provides tailor-made support for agri-data projects, facilitating collaboration with experts on implementing new technologies or projects.

The Project is almost completed, as the final product will be ready by September 2023.

3.5.1.1 AgriConsent (AgriTrust)

Agritrust is a free mobile application designed for farmers in France to secure digital exchanges with their partners. It allows farms to control their digital identities and consents easily and securely. The platform was developed by Agdatahub in collaboration with Orange Business Services and IN Groupe, specifically for the agricultural sector. It utilises the agricultural digital identity, established through FranceConnect and the Register of Agricultural Assets, to enable secure and authenticated exchanges with partners.

The digital identity module of Agritrust complies with the principles of the Data-Agri agricultural data charter, ensuring transparency, control, and security in the use of farm data.

3.5.1.2 API-Agro

API-Agro is an agricultural data exchange platform that enables secure data sharing, data visibility, and control over data usage. Secure transactions are ensured, and different sales options are available based on agricultural sectors. The platform acts as a trusted third party, ensuring and verifying the identity of registered members, both data senders and buyers. It enables users to add value and develop new uses for data through a dashboard and catalog, allowing data cross-referencing, customisation, and updates. A support team is available to help manage and structure data offers and explore monetisation opportunities, with additional services like algorithms and data visualisation to assess data quality and potential.

3.5.2 DJustConnect

DjustConnect started as an EFRO project, and now it is a mature data exchange platform in the Agrifood sector, connecting data users and farmers. Hosted by ILVO, it ensures data ownership, decision power, and clear data exchange declarations. The platform guarantees data exchange with explicit permissions and revokes access when needed. Data is not stored by DjustConnect; it is retrieved from providers and delivered to consumers with farmer consent. The platform provides control over data sharing, offering benefits to farmers while maintaining data safety and respecting privacy.

DjustConnect originated from the research project "DataHub for Agrofood." With financial support from the EFRO - European Regional Development Fund and five partners (AVEVE, Boerenbond, CRV, DGZ, and Milcobel), an advanced infrastructure was constructed. This infrastructure is now available to the entire sector.

3.5.3 AgriRouter

Agrirouter is a specialised data exchange platform for the agricultural sector, connecting machinery, software applications, and stakeholders in real-time. Developed by DKE-Data, it facilitates secure and seamless data sharing, streamlining farming operations and decision-making. Operating on a cloud-based infrastructure with standardised interfaces, Agrirouter ensures compatibility and data privacy. Farmers

can share various types of data with authorised parties, promoting interoperability between different agricultural technologies. The vendor-neutral approach allows flexibility in choosing tools and technologies, enhancing efficiency and sustainability in farming practices.

3.5.4 AgriMetrics

Agrimetrics is a UK-based organisation specialising in agricultural data and analytics. It operates as a data marketplace and analytics platform, collecting and analysing agricultural data from various sources to support decision-making in the agricultural sector. They offer data integration, analytics, decision support tools, and collaborate with research institutions to drive innovation. Agrimetrics' goal is to harness the power of data science to enhance productivity, sustainability, and collaboration in agriculture.

3.5.5 Join Data

JoinData is a cooperative data-sharing platform in the Netherlands that facilitates the exchange of agricultural data between stakeholders in the farming sector. It aims to overcome data silos by providing a standardised framework for collecting and sharing diverse agricultural data. The platform prioritises data privacy and security, allowing users to control data access and permissions. It promotes collaboration, innovation, and sustainability by enabling data-driven decision-making and optimising farming practices.

3.5.6 FIWARE

FIWARE differentiates itself from the above-mentioned projects as it is an independent open community focused on building a sustainable ecosystem around public, royalty-free, and implementation-driven software platform standards for creating smart applications in various sectors. Being an open source platform growing thanks to both contributors and members, it simplifies the development of smart applications for different domains like smart cities, agriculture, healthcare, and transportation. It offers reusable components for data management, context awareness, security, and more. FIWARE leverages context information to make intelligent decisions based on real-time data. The platform follows open standards, APIs, and supports various protocols, ensuring interoperability and flexibility. It also fosters a collaborative ecosystem for knowledge-sharing and innovation within its open-source community.

Type of Policy	Topic Covered	Regulation
Regulation for Framework	Farm to Fork Strategy	
	CAP	***Regulation 2021/2115*** ***Regulation 2022/1475*** ***Regulation 2021/2116*** ***Regulation 1308/2013*** ***Regulation 2021/2117***
Regulation for Data	Digital Services Act	***Regulation EU 2022/2065*** ***Regulation EU 2022/1925***
	Artificial Intelligence Act	***Proposal – AI Act***
	General Data Protection (GDPR)	***Regulation EU 2016/679***
	Open Data	***Open Data Directive 2019/1024***
	Data Privacy	***E-privacy directive 200/136***
	Shared Data	***Proposal – Data Act***
	Cybersecurity Act	***Regulation (EU) 2019/881***
	Framework for Free Flow of non-Personal Data	***Regulation (EU) 2018/180***
Regulation for Agri data	Eurostat	***Regulation 138/2004***
		SAIO & IFS
	Private Data Sharing	***COPA – COGECA EU Code of Conduct***[6]

Table 16. Main regulation to be considered for the development of the DIVINE ADSE

[6] Does not have Force of Law

The WP6 policy and frameworks analysis has been developed around multiple documents and regulations which are vital for the proper implementation of DIVINE. Nonetheless, the listed documents and the framework development may be subject to changes during all the implementation of DIVINE (2023-2025). In fact, new regulation may be inserted in the analysis, current proposals may be modified, and pilots' deployment may highlight further regulation gaps or necessities.

4 Objectives and procedures for Agricultural Data Sharing Policy Framework Adoption

Since data is essential to transactions and the ecosystem of shareholders, it has become the new currency in today's economy. Partners, analytical platforms, public or private organisations, and the ecosystem of shareholders all exchange information between organisations on a regular basis. Data security and protection, however, ought to come first. Modern science and information technology advancements have facilitated social progress and improved the environment for intelligent agriculture. However, there are still unresolved issues with the current big data management model.

Due to the variety of data assets that must be collected, stored, and analysed on a large scale, problems can arise when using on-premises data warehouses, cloud services, or distributed data assets across multiple layers. Data consolidation is time-consuming, skill-intensive, and financially impractical due to capital or ongoing costs because there is a lack of standardised data.

The development of information technology is gradually integrating and penetrating into various fields of agriculture, and the smart agriculture model has become an inevitable choice under the development of the times. In this era of big data, data can create unimaginable value. Big data in the agricultural field is actually a summary of our country's years of agricultural development experience, which contains the essence of people's knowledge in agricultural production, agricultural management.[7]

Digital farming makes the collection and exchange of data possible at an unprecedented level. In order to tap into all of the potential benefits, data sharing between different stakeholders must be conducted under fair and transparent rules. The increasing exchange of data poses a major challenge for the EU agri-food sector. It raises questions about privacy, data protection, intellectual property, data attribution (sometimes referred to as ownership), relationships of trust/ power, storage, conservation, usability and security.

4.1 Privacy and trustworthiness: key factors of data sharing policy integrations

Agricultural data is a diverse and specific collection of information, including livestock, fish, land, agronomic, climate, machine, financial, and compliance data. It is of economic importance for farmers and the entire value chain, and it is crucial to implement necessary safeguards. The non-physical nature of data makes it difficult to monitor who is authorised to share it and what data is shared. Unintentional and uninformed sharing can disadvantage data originators and the value chain, leading to cautious data sharing. Farmers often hesitate to share data or adopt digital technologies due to unclear consequences and legal rules.

[7] https://sci-hub.se/https://www.sciencedirect.com/science/article/abs/pii/S0959652621020874?via%3Dihub

A higher adoption rate and legal clarity can lead to cheaper and more efficient services, increasing the adoption of digital technologies among farmers. Building trust in the emerging digital agriculture sector requires understanding data ownership and alternative designs to address trust-related challenges.[8]

A common political view suggests that mandatory data sharing is necessary for increased data sharing, but farmers and agri-businesses are more open to sharing data. To encourage this, it's crucial to define key principles on data rights, including proprietary, access, and re-use rights. Transparency and responsibility are essential for gaining trust, and establishing these principles can lead to business models benefiting all stakeholders involved.

Transparency in data sharing in the agricultural sector is important for the steady food supply in the EU. Sharing knowledge through (open) data can help to tackle challenges and connect people in the agricultural sector in Europe.[9]

There are multiple policy framework or regulation which talks about privacy and hence trustworthiness.

4.1.1 Farmer Trust for Data Sharing

By giving farmers the impression that they have control over any unintended re-use of data through their ownership rights, an ag data ownership regulation could, in the short term, increase their trust and decrease their reluctance to share data. However, over time, the concentration of data rights in the hands of massive, vertically integrated agricultural conglomerates may aggravate farmers and erode their confidence in digital technologies and data sharing in the Data Act (Data Act) industry. This would be at odds with the goal of EU policy, which is to accelerate the adoption of digital technologies in the industry. Defensive rights like consent for re-use may be useful in addressing farmers' trust-related issues.

Defensive data rights may give farmers more negotiating leverage and control, which could encourage the adoption of digital technologies and lessen reluctance to share data. They might, however, also put obstacles in the way of data flow. The welfare gains for society from non-exclusive access to ag-data must be weighed against the welfare gains for farmers from defensive rights by policymakers. Legitimate concerns should be addressed proportionately by rule makers without harming other stakeholders or jeopardising the enforcement of public policies. [10]

Farmers' worries can be addressed by hybrid models, such as limiting data reuse. Farmers' concerns are addressed in Art. 4(6) of the Data Act proposal, which stipulates that data holders may only use non-personal data produced by a good or service in accordance with a written contract. According to Art. 34 of the Data Act, the Commission intends to create non-binding contractual clauses, which might inspire more confidence in farmers to adopt digital technologies and share data. However, overcoming exclusive data control and locked-in users for businesses is necessary for widespread adoption. Given the early

[8] https://link.springer.com/article/10.1007/s40319-022-01191-w
[9] https://data.europa.eu/en/news-events/news/agricultural-data-sharing-europe
[10] https://link.springer.com/article/10.1007/s40319-022-01191-w page 25 to 27, “Ensuring Farmers Trust”

stages of the digital transformation in European farmers, market dynamics, such as competition for better contractual terms, may force players to adopt these tools, but this still raises concerns. [11]

4.1.2 Trust issues among Farmers in Agro domains

To address the farmers' trust issue, a neutral public authority to run the CEADS and be responsible for enforcing the sectoral rules might be helpful. It might increase trust inter alia amongst farmers as it would not have separate commercial interests in data sets. However, there might still be some hesitation towards public bodies or governments. So, to increase trust, wider stakeholder participation (by, for instance, including the stakeholders, especially farmers' representatives, in the management or at least the auditing body of the sectoral authority) should be ensured when setting up the sectoral authority. [12]

Despite said limitations/ambiguities of the provisions on ''competent authorities'' in the recent Data Act, it is a positive step, which might generate trust amongst farmers. In particular, Art. 31(3) of the Data Act provides horisontal tasks and powers when designing the competent authorities, such as promoting awareness among users and entities, handling complaints arising from alleged violations, imposing dissuasive financial penalties, and cooperating with other competent authorities to ensure consistent application. Each of these actions can help build trust amongst farmers, especially when enforcement is aligned with sectoral needs in future sectoral interventions. [13]

4.2 Policy adoption framework: definition the standards for ADSE adoption

Data sharing in the agricultural sector is important to guarantee a steady supply of food and biomaterials in the EU. The agricultural European Innovation Partnership (EIP-AGRI) works to foster competitive and sustainable farming and forestry that achieves more and better from less. Sharing knowledge through (open) data can help to tackle challenges and connect people in the agricultural sector in Europe.

We must first examine frameworks and regulations without a specific focus on agri-data and then rules that are focused specifically on agri-data in order to develop standards for ADSE.

4.2.1 Farm to Fork strategy

The Farm to Fork Strategy is at the heart of the European Green Deal aiming to make food systems fair, healthy and environmentally friendly.

Food systems cannot be resilient to crises such as the COVID-19 pandemic if they are not sustainable. We need to redesign our food systems which today account for nearly one-third of global GHG emissions, consume large amounts of natural resources, result in biodiversity loss and negative health impacts (due to both under- and over-nutrition) and do not allow fair economic returns and livelihoods for all actors, in particular for primary producers.

[11] https://link.springer.com/article/10.1007/s40319-022-01191-w page 25 to 27, "Ensuring Farmers Trust"
[12] https://link.springer.com/article/10.1007/s40319-022-01191-w page 32 to 33, "Enrusing Farmers Trust" part 2
[13] https://link.springer.com/article/10.1007/s40319-022-01191-w page 32 to 33, "Enrusing Farmers Trust" part 2

4.2.1.1 What role does the regulation play for data sharing and/or agricultural data?

Overall, the F2F Regulation does focus on ruling over data sharing. However, its relevance in relation to the DIVINE's scope comes from the focus of the report on agricultural data (the importance of which is explained in Chapter III of the 2020 F2F Strategy Report[14]). In fact, the acceleration of the transition towards sustainable, healthy, and inclusive food systems requires significant investments in **research and innovation (R&I), technology**, and advisory services.

4.2.1.2 How/why is it relevant to data sharing and/or agricultural data?

According to the Strategy, *knowledge and advice are key to enabling all actors in the food system to become sustainable*. Primary producers, in particular, require objective and customised advisory services to make sustainable management choices. The European Commission plans to promote effective Agricultural Knowledge and Innovation Systems (AKIS) that involve all actors in the food chain to support producers in their choices. The new legislative Network will benchmark farm performance against regional, national, or sectoral averages and provide feedback and guidance to farmers through tailored advisory services.

4.2.2 CAP

The common agricultural policy supports farmers and ensures Europe's food security. Launched in 1962, the EU's common agricultural policy (CAP) is a partnership between agriculture and society, and between Europe and its farmers. It aims to:

- support farmers and improve agricultural productivity, ensuring a stable supply of affordable food;
- safeguard European Union farmers to make a reasonable living;
- help tackle climate change and the sustainable management of natural resources;
- maintain rural areas and landscapes across the EU;
- keep the rural economy alive by promoting jobs in farming, agri-food industries and associated sectors.

The CAP is a common policy for all EU countries. It is managed and funded at European level from the resources of the EU's budget.

To consolidate the role of European agriculture for the future, the CAP has evolved over the years to meet changing economic circumstances and citizens' requirements and needs.

The CAP 2023-27 entered into force on 1 January 2023. Support for farmers and rural stakeholders across the 27 EU countries is based on the CAP 2023-27 legal framework and the choices detailed in the CAP Strategic Plans[15], approved by the Commission. The approved Plans are designed to make a significant

[14] https://food.ec.europa.eu/system/files/2020-05/f2f_action-plan_2020_strategy-info_en.pdf
[15] https://agriculture.ec.europa.eu/cap-my-country/cap-strategic-plans_en

contribution to the ambitions of the European Green Deal[16], Farm to Fork Strategy[17] and Biodiversity Strategy[18].

4.2.2.1 Regulation 2021/2115

Regulation 2021/2115, also known as the "Rules and Financial for CAP Strategic Plans" applies to EU aid financed by the European Agricultural Guarantee Fund (EAGF) and the European Agricultural Fund for Rural Development (EAFRD) for submissions made by Member States and approved by the European Commission, during the period from 1 January 2023 to 31 December 2027.

The financial allocations under the 2021–2027 multiannual financial framework are:

- €291.1 billion for the EAGF; and
- €95.5 billion for the EAFRD[19].

4.2.2.2 Regulation 2022/1475, Implementing Regulation 2021/2115

Regulation (EU) 2021/2115 lays down a new legal framework for the common agricultural policy (CAP) to improve its delivery on the Union objectives set out in the Treaty. That Regulation further specifies these Union objectives to be achieved by the CAP and defines the types of intervention as well as the common Union requirements applicable to Member States, while leaving flexibility for Member States in the design of the interventions to be provided in their CAP Strategic Plans.

Commission Implementing Regulation (EU) 2022/1475 of 6 September 2022 laying down detailed rules for implementation of Regulation (EU) 2021/2115 of the European Parliament and of the Council as regards the evaluation of the CAP Strategic Plans and the provision of information for monitoring and evaluation. The regulation specifies the content and structure of the forms to be used for reporting and publishing information on EAFRD-funded projects, including their objectives, costs, and results. The regulation applies to all Member States of the European Union and comes into effect on 1 January 2023.

4.2.2.3 Regulation 2021/2116

One of the basic acts of the European Union's (EU) common agricultural policy (CAP), this regulation lays down rules for financing, management and monitoring under the two main CAP funds.

This regulation sets out rules covering:

- the financing of expenditure under the CAP;
- the management and control systems to be put in place by the EU Member States;
- clearance and conformity procedures.

[16] https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en

[17] https://food.ec.europa.eu/horisontal-topics/farm-fork-strategy_en

[18] https://environment.ec.europa.eu/strategy/biodiversity-strategy-2030_en

[19] https://agriculture.ec.europa.eu/common-agricultural-policy/financing-cap/cap-funds_en

Specifically, while Regulation 2021/2115 explains how MS Strategic Plans should be developed, in order to fall under the scope of EAGF and EAFRD, Regulation 2021/2116 illustrates the European Agricultural Guarantee Fund as well as the European Agricultural Fund for Rural Development structure, *financing, management, and monitoring* [Art. 1].

MS should agree with the EC on the list, and the use of these data by the MS should be done free of charge (see High Value Dataset Regulation). In the case of DIVINE, these articles and information – regarding the high Value Dataset Regulation – may assume relevance as a certain amount of data to integrate in the platform should be obtained free of charge.

The Commission will fund initiatives to keep an eye on agricultural land use, crop and soil quality, and system resilience. This covers global projections, market openness, and technological monitoring. The funding will go toward data gathering, purchases, spatial data infrastructure, climatic studies, remote sensing, and model updates. A framework for satellite data and meteorological data will be implemented, along with cooperation with organisations. Farmers must have access to accurate information, and Member States and the Commission must protect the confidentiality of sensitive business information. Beneficiaries who violate policies, guidelines, and quality standards risk facing penalties.

4.2.2.4 Regulation 2021/2116 & Data

The regulation requires the European Commission (EC) to provide evidence of the need for funds and information to monitor project development. Member states must provide satellite and expenditure data to the EC, with proper data-mining tools provided by 2025. Member states should continue using Copernicus program data and information technologies, and aggregated data provided by MS to the EC must be reliable and verifiable. Data must be used for climate and sustainable purposes, and sensitive information must remain confidential. Beneficiaries of funds should be informed of data publication before publication. Information received from the EC should include beneficiary identity, award amount, fund source, and operation purpose.

Competent authorities have to make sure that the data that are collected “are shared free of charge between its public authorities and made publicly available at national level”, as they are for European institutions. Moreover, it is specified that data that are relevant for statistics, have to be shared “free of charge with the Commission (Eurostat), national statistical institutes, and other national authorities responsible for the production of European statistics”. These data can be shared with beneficiaries, so to allow them to submit accurate applications (regarding the land they use or intend to use).

Particular attention is given to privacy, and the public access to data can be limited in the case “such access would adversely affect the confidentiality of personal data”. When published, MS shall inform the beneficiaries (Art. 99).

4.2.2.5 Regulation 1308/2013

One of the key features of the regulation is the promotion of agricultural products. This includes provisions for the funding of promotion campaigns for EU agricultural products, both within the EU and in third countries.

The regulation also sets out rules for the use of quality schemes, such as geographical indications and traditional specialities guaranteed, to promote and protect traditional and high-quality EU agricultural products.

Another important aspect of the regulation is the management of supply and demand. The regulation establishes a number of market management tools, such as intervention and private storage aid, which are designed to help stabilise markets and ensure that farmers receive a fair price for their products. The regulation also includes provisions for the management of production, including the establishment of quotas and the use of voluntary production reduction schemes.

The regulation covers all agricultural products, including fruit and vegetables, dairy products, meat, and cereals. It sets out detailed rules for the production and marketing of each product, including specific quality standards and labelling requirements. The regulation also establishes a number of measures to support small farmers and ensure that they have access to markets.

In terms of interests for DIVINE's development, the regulation is not the most relevant piece of legislation. On the other hand, the Regulation 2021/2117, which implements the 1308/2013, amends and changes some articles in light of more recent electronic technologies.

4.2.2.6 Regulation EU 1308/2013 & Data

Some mentions to agriculture-related data are done in the regulation's preamble, where it is explained that the EC should, in order to take advantage of potential data synergies, adopt clear and necessary measures regarding their communication. These measures include determining the nature and characteristics of the information that needs to be reported, specifying the types of data to be processed and establishing maximum retention periods for such data. The communication requirements are developed in Art. 223. Additionally, the Commission should have the authority to define the purpose of processing, especially concerning the publication and transfer of data to third countries. The Commission should also regulate the access rights to the information or information systems provided and establish the conditions for publishing the information. Personal data are on the other hand regulated under the GDPR [Art. 224].

4.2.2.7 Regulation 2021/2117, Amending Regulation 1308/2013

Overall, what relates mostly to DIVINE's scope are the changes in regulation 1308/2013 taking into account the developed technologies.

Specifically, the guidelines explain that, when producers are using the Geographical "indication of origins" for a certain product, the MS authority should be authorised to access and verify the information provided in the producers' application. The MS assessment is carried out to ensure the accuracy of information provided. The resulting assessment will then be summarised in a reliable and accurate document. According to Art. 222a, the Commission must then establish different Union market observatories to improve transparency in the food supply chain, inform economic operators and public authorities, and monitor market developments and threats of market disturbance, after having defined which agricultural sectors require observatories. These observatories will be in charge of providing statistical data as well as

information necessary for monitoring the market development. According to Article 223(1) *the information obtained may be transmitted or made available to international organisations, Union and national financial market authorities, the competent authorities of third countries and may be made public, subject to the protection of personal data and the legitimate interest of undertakings in the protection of their business secrets, including prices.*

4.2.2.8 Regulation 2021/2117 & Data

In the CMO, reference to data is done when talking about the obligation concerning information to consumers (nutrition declaration and list of ingredients -no personal data shall be collected through this operation) (Art. 116a), monitoring of the agricultural markets (Art. 222a).

4.2.3 Digital markets act - Regulation EU 2022/2065

The regulation aims to guarantee a competitive and fair digital sector, allowing innovative digital businesses to grow and ensuring the safety of users online, through:

- clear obligations and prohibitions for large online platforms;
- better services and fairer prices for consumers;
- promoting innovation and a fairer online platform environment for technology start-ups;
- giving business users the ability to offer consumers greater choice;
- banning unfair practices on large online platforms.

The Digital Services Act significantly improves the mechanisms for the removal of illegal content and for the effective protection of users' fundamental rights online, including the freedom of speech. It also creates a stronger public oversight of online platforms, in particular for platforms that reach more than 10% of the EU's population.

This means concretely:

- measures to counter illegal goods, services or content online
- new obligations on traceability of business users
- effective safeguards for users
- ban on certain type of targeted adverts on online platforms
- transparency measures for online platforms
- obligations for very large platforms
- access for researchers to key data
- oversight structure to address the complexity of the online space

DIVINE aims to create an online platform for agri-data sharing under Regulation 2022/2065, ensuring compliance with relevant regulations. The platform may originate from various sources, such as other websites or applications. Understanding the Regulation's requirements enables DIVINE to effectively manage and utilise data from other platforms while respecting data protection principles. In the agricultural sector, online platforms and intermediary services must comply with standards governing

agricultural practices, food safety, and traceability. DIVINE can ensure its operations within the legal framework and safeguards the interests of its users and stakeholders by studying and complying with Regulation EU 2022/2065.

4.2.4 Digital markets act - Regulation EU 2022/1925

DIVINE, an online platform, faces challenges from the Regulation EU 2022/1925, which targets large online platforms as gatekeepers. These platforms have unique characteristics, such as extreme scale economies and strong network effects, which can lead to imbalances in bargaining power and unfair practices for business users. The regulation primarily targets major technology giants like GAFAM, but as the technology sector evolves, more platforms may become subject to the obligations outlined in the regulation.

While it is unlikely that DIVINE will be considered a gatekeeper in the market anytime soon, it is essential to consider the potential exchange of data between DIVINE and these large technology companies. In such cases, Regulation EU 2022/1925 should be taken into account to ensure compliance with the provisions related to data sharing, interoperability, and other relevant aspects.

4.2.5 Artificial intelligence act – proposal

The proposal aims to establish a legal framework for AI development and use in the EU, based on European values and fundamental rights. It categorises AI systems into four risk levels: unacceptable risk, high risk, limited risk, and minimal risk. High-risk systems undergo rigorous testing and certification, while limited-risk systems meet specific requirements. The regulation addresses transparency, accountability, and human oversight, requiring users to have clear information about AI systems and appeal decisions. It also prohibits certain AI uses, such as manipulating behavior or creating "deepfakes," to ensure their development and use align with European values and respect fundamental rights.

Even if the connection among AI and Agriculture does not seem evident, more and more firms and companies are relying on artificial intelligence be supported in the completion of different tasks. In fact, the AI has multiple and variate applications in the sector such as:

- It allows for precision farming;
- Machine Learning Algorithms can be used to study and monitor crops and soils;
- Generating prediction on yields and pests' infestations;
- Help optimising the farming supply chain.

However, the proposed articles primarily focus on ruling and regulating the creation and development of new AI tools, while it does not cover the utilisation of existing solutions. Therefore, in the context of DIVINE and the prospective establishment of Agri-data-sharing platforms, project managers would not be obligated to adhere to the aforementioned rules if the solution they intend to employ has already met the AI Act requirements. Nevertheless, the implementation of a new AI tool within the project would necessitate compliance with the Artificial Intelligence act.

4.2.6 General Data Protection Regulation – GDPR – Regulation EU 2016/679

The goal of the regulation EU 2026/679 is, as the Directive 95/46/EC that is repealing, to *harmonise the protection of fundamental rights and freedoms of natural persons*, laying down rules aiming at protecting the processing and the flow of personal data [Art. 1], handled both through automated and manual means [Art. 2]. Personal data are referring to natural persons data – and not to legal persons, to which this regulation does not apply, and are defined by Art. 4 as *any information relating to an identified or identifiable natural person ('data subject'); an identifiable natural person is one who can be identified, directly or indirectly, in particular by reference to an identifier such as a name, an identification number, location data, an online identifier or to one or more factors specific to the physical, physiological, genetic, mental, economic, cultural or social identity of that natural person.*, The activities or establishments processing these kind of data are always subject to the rules defined in this regulation, as long as their data subject is located in the EU. The processing of personal data for archiving purposes in the public interest, scientific or historical research purposes or statistical purposes should be subject to appropriate safeguards for the rights and freedoms of the data subject pursuant to this Regulation. Where personal data are processed for scientific research or statistical purposes, this Regulation should also apply to that processing.

The GDPR regulation applies to all personal data that can be referred or cross-referenced to a single natural person and does not make distinctions by sector of application. While there is no strict relationship General Data Protection Regulation and agriculture, the text of law makes it clear that the articles and rules mentioned in the regulation must be followed by all firms and activities, as long as their data are held on the European Union. DIVINE must then account for this law in its data architecture definition and management.

4.2.7 Open Data Directive 2019/1024

The Open Data Directive mandates the release of public sector data in free and open formats. Full title "Open Data and re-use of Public Sector information Directive **(EU) 2019/1024**". The overall objective of the Directive is to continue the strengthening of the EU's data economy by increasing the amount of public sector data available for re-use, ensuring fair competition and easy access public sector information, and enhancing cross-border innovation based on data.

The Directive seeks to make government data open by default and design, requiring non-personal data to be released in open formats and standards, data to be available in real-time and via APIs, new charging rules, free reuse of publicly funded research data, a list of High Value Datasets, and data lock-in prevention. It also encourages the reuse of data held by public entities such as utilities and transportation providers.

The Implementing Act of High Value Datasets is a document enlarging the list – laid down in the Open Data Act – of the so called "High Value Datasets".

Annex 1 (enlarged by Art. 1-6 of the Implementing Act, which maintains the following structure and six macro-categories) lists the thematic groups of high-value datasets - *documents the re-use of which is*

associated with important benefits for society, the environment and the economy, in particular because of their suitability for the creation of value-added services, applications and new, high-quality and decent jobs, and of the number of potential beneficiaries of the value-added services and applications based on those datasets [Art. 2]; Geospatial, Earth observation and environment, Meteorological, Statistics, Companies and company ownership and Mobility.

DIVINE, utilising the Agrifood Data Space, will benefit from high-value geo-referenced data, which will be identified and provided as reports or files. This data should be available free of charge, machine-readable, via APIs, and as a bulk download. Farmers often use high-value geo-referenced data for environmental benefits, such as measuring vegetation NVDI for ecological and environmental purposes.

DIVINE, an Agrifood Data Space, is expected to handle high-value geo-referenced data, which will be available free of charge, machine-readable, and provided via APIs. Categories 1-3 are particularly relevant for farmers, as they often deal with high-value data for environmental benefits. Stakeholders, on the other hand, can study and analyse various types of data and their interactions. Geo-localisation is crucial, as GPS location data is considered personal data and must follow GDPR regulations. The open and high-value dataset list implies that existing and government-owned data in the six categories should be permitted and accessible. Integrating these data into the platform would benefit both farmers and stakeholders, as it allows them to integrate geospatial and meteorological information, enabling better analysis and planning for planting and analysis.

4.2.8 E-privacy directive 200/136

The E-privacy Directive, enacted in May 2011, aims to protect personal data and privacy in the electronic communications sector. It is an amendment of Directive 2002/58/EC and covers network security, communication confidentiality, data access, traffic and location processing, calling line identification, public subscriber directories, and unsolicited commercial communications. The main changes include requiring notification of data breaches, an extension to cover electronic tags, and strengthened enforcement rules.

DIVINE's regulation applies to data storing systems, specifically electronic communication networks, and the project's platform. Art 4 requires service providers to ensure data protection and accessibility to authorised personnel. In case of a personal data breach, providers must inform the relevant national authority and notify the affected individual without delay, unless the issue has been resolved.

DIVINE, a public communications network or electronic communications service, requires providers to erase or anonymise traffic data once it is no longer needed for transmission purposes. This includes processing for subscriber billing, interconnection payments, marketing, and value-added services with user consent. DIVINE cannot allow connection between phone numbers and person identification, and location data relating to users or subscribers must be anonymised or with user consent for value-added services. Access to location information is only possible with explicit consent.

Unsolicited communications by a machine can be done only if the person gives consent. However, if a customer purchases something and gives his email address, that address can be used for direct marketing (even if the customer should always have the possibility to freely remove his email address). [Art 13].

4.2.9 Data Act

The Data Act aims at promoting a competitive data market, while protecting justice in the digital sphere and creating possibilities for data-driven innovation and increasing data accessibility for all.

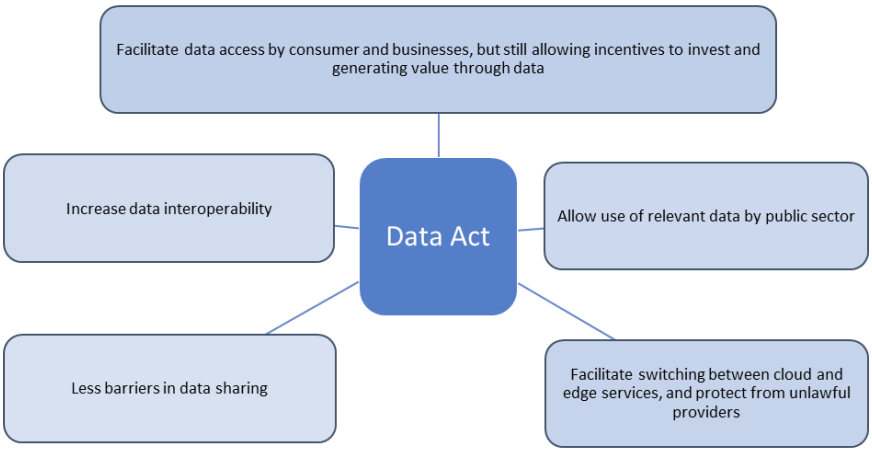

Figure 3. Data Act' objectives

The proposal, which was updated in February 2022, applies to a variety of entities in the Union, including manufacturers, suppliers, users, data holders, public sector bodies, institutions, agencies, and providers of data processing services. This is true for those who make data available for public-interest purposes as well as those who provide data in response to requests.

On the other hand, the regulation **does not apply to gatekeepers, as well as to SMEs** [Art. 7].

The proposal aims to make IoT technologies data available to users, who are natural or legal persons who own, rent, lease, or receive products or services. This regulation will affect farmers and breeders using smart technology tools like sensors, connected machines, or drones. IoT service providers must share all collected data with farmers, and users must be aware of data collection, access, and holder rights.

All these processes should be carried out in a non-discriminatory way, and, where the data collected are not directly available from the IoT tool, the data holder should make sure the user can somehow access them [Art. 4, 8]. A third party receiving the data, as well as the data holder, must not use any non-personal data generated using the product or related service to derive insights about the economic situation, assets, and production methods of the third party unless the third party has consented to such use and has the technical possibility to withdraw that consent at any time [Art. 6].

All the Chapter VI will have a strong impact on the structure of DIVINE's data sharing platform. In fact, according to the proposal, all the platform users should be allowed to easily switch between one service provider and another. This implies that the architecture of the platform needs to consider the market status and common practices, in order to comply with the law and allow for an easy data exchange between platforms.

4.2.10 Cybersecurity Act – Regulation (EU) 2019/881

Overall, the Cybersecurity Act does not strictly relate to agriculture nor define rules or best practices on how to handle data, as it strictly focuses on regulating the establishment, scope, and functions of the ENISA organisation. However, in terms of relevance with relation to the Horison-DIVINE project, ENISA produced in 2022 a report on National capabilities assessment framework[20], that aims at providing Member States with a self-assessment of their level of maturity by assessing their NCSS objectives, that will help them enhance and build cybersecurity capabilities both at strategic and at operational level[21]. Even if the guidelines are referred to the EU MS rather than to organisation, it will be relevant to monitor them and eventual future developments. Something similar can be said in relation to the Directive 2555. Unless DIVINE is established as a publicly owned online platform, the rules laid down in the law text do not directly and strictly apply to the project.

4.2.11 Framework for Free Flow of non-Personal Data – Regulation (EU) 2018/180

Adopted in 2018, the main goal of the regulation is, how defined by Art. 1, *to ensure the free flow of data other than personal data within the Union.* It applies to whoever processes electronic data. The Regulation being extremely short (9 articles only), the most interesting information can be found at Art 4, which explains that one cannot Impose localisation restriction on this kind of data and Art. 6, which encourages the development of codes of conduct (explaining the best practices for switching service providers, provision of transparent information, certifications schemes to compare different products and services).

On the other hand, DIVINE and the project of the creation of an agri-data-sharing platform will be impacted by the Framework for Free Flow of non-personal Data. As it applies to electronic data and whoever processes them. The regulation then will impact DIVINE, as, among all the farmer's data that aiming at collecting, some will be non-personal data, which will have to be processed according to the rules laid out in this framework. In brief, while data portability and cooperation on data exchange should be promoted by the EC at the EU level [Art. 4,5,6,7], all *data localisation requirements shall be prohibited, unless they are justified on grounds of public security in compliance with the principle of proportionality.* Thus, DIVINE cannot freely use and transfer data related to geo-localisation of farmers.

4.2.12 Regulation on Regional Economic Account 138/2004

Eurostat has been compiling European agricultural statistics on EU agriculture for decades, covering aspects such as farm structure, economic accounts, animal and crop production, organic farming, agricultural prices, pesticides, and other agri-environmental aspects. The primary aim is to monitor and

[20] https://www.enisa.europa.eu/publications/national-capabilities-assessment-framework
[21] https://www.enisa.europa.eu/news/enisa-news/Highlights-on-the-National-Cybersecurity-Strategies

evaluate the common agricultural policy (CAP) and other important EU policies, and to support policymaking. Farm statistics are the backbone of the EU's agricultural statistical system. To increase response speed to new data needs, the Commission proposed a new approach based on an integrated, flexible, and modular framework. The 2020 agricultural statistics strategy aims to produce high-quality statistics that meet users' needs efficiently and effectively, while improving the harmonisation and coherence of European agricultural statistics.

4.2.13 SAIO

The regulation modernises the European agricultural statistics system, focusing on aggregated European statistics on factors of production, agricultural activities, and intermediate uses. It enhances knowledge of agricultural production and practices in relation to the Common Agricultural Policy (CAP), Green deal for Europe, and Farm to fork strategy. The regulation includes inputs and products of agriculture, including organic farming, agricultural price statistics, plant protection products, and nutrients. The new regulations, adopted in 2022, will apply from January 2025.

The framework aims to improve data sharing and comparison between Member States and the European Union by rationalising agricultural statistics production. This single EU framework replaces existing rules and agreements, enabling systematic and high-quality data collection.

The Framework SAIO foresees consist of:

1. aggregated **crop** and **animal production** statistics;
2. agri-environmental statistics on **fertilisers**, **nutrient** balances and **pesticides**;
3. **agricultural price** statistics.

The SAIO regulation collects data on agricultural outputs and inputs, collected from farms, administrative sources, intermediates, wholesale entities, and market organisations. These aggregated statistics do not have micro data transmission to Eurostat, unlike the IFS. However, the new data requirements require adaptation of statistical processes, increasing the burden on National Statistical Institutes (NSIs) and other national authorities responsible for producing and disseminating statistics on agricultural inputs and outputs.

4.2.14 IFS

The Integrated Farm Statistics (IFS) is a European framework for agricultural holdings, integrating information on structure, production methods, rural development measures, and agro-environmental aspects. It defines an agricultural holding as a single unit with technical and economic management, undertaking economic activities in agriculture. The IFS provides guidelines on data related to farms, orchards, and vineyards, contrasting the SAIO framework, which regulates input and output of farming data.

In a few words, the data on how much fertiliser was used in tones/year will fall under the SAIO regulation, while the information on arable land or the NUTS3 classification will fall under the IFS framework.

The IFS framework came into force in 2018, and its initial scope was to replace the Farm Structure Survey regulation. The main idea behind the IFS is to define so-called "core structural data", for which measurements have to be taken in 2020 (in the form of census), 2023 and 2026 (which can be *carried out on samples*) [Art. 5]. The list of these core data can be found in Annex III, and is divided in macro-categories as it follows:

1. General Variables (E.g. Geographical Location, farmer's ID, Legal Person, etc.…)
2. Variables of Land (Arable Land in ha, Permanent Crops, Unutilised Land …)
3. Variables of Livestock (Bovine animals in head, Sheep and Goats, Pigs…)

The regulation introduces new data, including irrigation, manure, nutrient use, and livestock management. It also requires module data collection in different ways and times. This approach enables Member States to reduce sample sizes and set up surveys more flexibly, benefiting those with many subsistence rural households and resulting in additional savings.

Similarly, to the above-mentioned SAIO, the IFS defines not only which type of data should be collected but introduces also data quality requirements [Art. 11], as well as harmonised rules on timelines [Art. 10, 12]. This framework regulation replaced two prior statistical regulations: the Farm Structure Surveys (1166/2008), as well as the Permanent crop statistics (Orchards and Vineyards surveys) (1337/2011).

4.2.15 EU Code of Conduct

The EU Code of Conduct[22] on agricultural data sharing, set up by a coalition of associations from the EU agri-food chain, consists of contractual relations and provides guidance on the use of agricultural data, particularly the rights to access and the use of data. The code grants the data originator (the one who has created or collected the data) a leading role in controlling access to and use of data from their business. In this way, the data originator can benefit more from sharing the data with any partner that wishes to use their data. To fully reap the benefits of digital farming, sharing data between different partners in the agro-food chain must be conducted fairly and transparently.

Default principles divided into five categories are introduced:

1. Attribution of the underlying rights to derive data (also referenced as **data ownership**);
2. **Data access**, control and portability;
3. **Data protection** and transparency;
4. **Privacy** and security;
5. **Liability** and intellectual property rights.

Nonetheless, it is important to **point out that Compliance with the Code of conduct is voluntary**, and it predominantly **focuses on non-personal data**. Thus, the processing of all those data that can be linked to an identifiable person fall under the General Data Protection Regulation.

[22] https://fefac.eu/wp-content/uploads/2020/07/eu_code_of_conduct_on_agricultural_data_sharing-1.pdf

The Code focuses on the notion of **transparency when dealing with data access and usage**, with the aim of building farmers' trusts on the way that their data is being managed. The five key principles introduced serve, in this case, as a guiding framework on transparency.

To increase data trust and transparency, it is essential for data users controlling a database to establish a protocol on data protection and safeguard for individual originators, not allowing unauthorised sharing with third parties. Furthermore, **personal data in databases must be both stored under pseudonym and encrypted or protected with similar methods**. This is to render the data less identifiable and mitigate risks both during the course of normal operations and in the event of a data breach.

5 Agri data-sharing policy integrations in agriculture operational environment

The DIVINE project involves active engagement with farmers and data providers to engage technology on their farms, and to jointly evaluate the results. As part of this initiative, several considerations related to the technical aspects of the General Data Protection Regulation (GDPR) need to be addressed. These considerations include data integrity and confidentiality, security measures, access control, traceability, encryption algorithms and data provenance.

5.1 Data-sharing policy adoption framework in agro domains

External stakeholders and policy integrations wishing to adopt the DIVINE data sharing policy in the Agriculture Data Spaces Ecosystem (ADSE) are advised to follow some comprehensive guidelines that act as a data sharing policy manual. By following these guidelines, external stakeholders and policy integrations can be confidently integrated into the DIVINE data sharing ecosystem, fostering data-driven innovation while maintaining data sovereignty and privacy within the ADSE.

It is essential to understand the technical framework for data interoperability, to ensure compliance with standardised APIs for secure data exchange and to create common data models.

ADSE data model adoption provides common data models that can be transformed into formats compatible with the APIs. Prioritise transport, syntactic and semantic interoperability to ensure seamless data delivery, understanding and interpretation.

To adopt the Trust Anchor framework to promote trust and data integrity is essential for the participants as well as to implement secure identification mechanisms and transparent data use agreements to ensure a secure and trusted data exchange environment. A distributed architecture for implementing transparency validation agents has been chosen.

In terms of data-sharing policy adoption framework, the regulations to be taken into consideration for ADSE development are the ones listed in Table 16. Main regulation to be considered for the development of the DIVINE ADSE.

5.2 ADSE data sharing policy manual

In what follows, we describe the ADSE data-sharing policy manual according to the main branches of data spaces defined in Technical Convergence of Data Spaces Business Alliance (DSBA, 2023).

In this section, we will undertake a comprehensive analysis of three essential aspects that characterise data spaces in the context of ADSE. These aspects are:

- data interoperability;
- trust and data sovereignty;
- data value creation.

As the ADSE platform reaches its development phase, will be conducted a high level investigation of each of these key characteristics, providing valuable insights and actionable recommendations for achieving an optimal data environment.

First, concerning data interoperability, achieving transparent and efficient data interoperability is a key objective within ADSE. Will be explored the integration of standardised APIs and the creation of common data models to ensure seamless data exchange between participants, also will be explored the key components of data interoperability, including transport, syntactic and semantic interoperability.

Secondly, the application and importance of the Trust Anchor framework in establishing a secure and trusted data sharing environment will be explored. Mechanisms for onboarding, identifying and authorising data space participants will be discussed to ensure reliable and privacy-aware identity verification. It will also explore how ADSE promotes a decentralised and fault-tolerant identity verification system.

Finally, concerning that one of the primary objectives of ADSE is to create value from the shared data and services within the ecosystem, it will be analysed the mechanisms for describing and registering data and services, publishing and accessing them, and establishing commercial relationships between providers and consumers. By making data and services discoverable and accessible, ADSE can unlock the potential of data-driven innovation in the agricultural sector.

5.2.1 ADSE data interoperability

Achieving transparent and efficient data interoperability is a critical goal within the ADSE. This requires that all data space participants adhere to a unified semantic framework. The first feature is the integration of standardised Application Programming Interfaces (APIs). These APIs ensure the secure exchange of data between data service providers and consumers. The second characteristic is the creation of common data models that can be transformed into data formats that are consistent with the standardised APIs mentioned above.

From a technical point of view, achieving data interoperability involves three key components: Transport, Syntactic and Semantic interoperability as defined in ISO/IEC 21823-1[23];

- Transport interoperability ensures the delivery of data;
- syntactic interoperability facilitates the understanding of data in a unified format and grammar;
- semantic interoperability ensures the unambiguous interpretation and understanding of data.

Interoperability characteristics includes various technical aspects at a global architectural level. These aspects include interface requirements, interconnection mechanisms, data integration solutions, data presentation and exchange, and secure communication protocols. Validation of transport, syntactic and semantic interoperability procedures are essential to ensure consistent systems.

[23] https://www.iso.org/standard/71885.html

From a global architectural point of view, interoperability characteristics cover technical aspects such as: interface requirements, interconnection mechanisms, data integration solutions, data presentation and exchange, and secure communication protocols. Therefore, consistent systems that validate the Transport, Syntactic and Semantic interoperability procedures should be integrated. For clarification purposes, we propose appropriate testing tools for distinct interoperability properties. On one hand, testing of the transport layer ensures data communication and error-free delivery between participants, and tools like Postman or MQTT.fx are suitable for this goal, on the other hand, the syntactic operability can be validated by testing the syntax and data format through ShEx(Shape Expressions) and other more standard tools such as JSON Schema. Finally, semantic meaning and understanding can be tested by employing TestSuites according to the agreed communication protocols (detailed in the following subsection 5.2.1.1. ADSE Data Model).

5.2.1.1 ADSE Data Model

The ADSE Data Model includes common data models that can be translated into data formats compatible with APIs, specifically based on the Smart Data Model provided by the FIWARE organisation. This standardised collection is the result of a partnership between FIWARE, IUDX, Open & Agile Smart Cities and Tmforum. The collaboration has as a result the creation of the Smart Data Model repository[24], which integrates standardised technology into a community-driven framework to address the need for standard data models.

Within this open source configuration, organisations contribute and collaboratively maintain models either developed internally or provided by external vendors. To achieve compatibility with the APIs, the data models are published with mappings in JSON and JSON-LD formats that conform to the NGSIv2 and NGSI-LD APIs. In addition, other RESTful interfaces that adhere to the Open API protocols can be seamlessly integrated into this framework. Figure 4 shows the architecture and the entities involved in this resource organisation, specifically in the context of the Smart Agrifood sector.

[24] https://github.com/smart-data-models

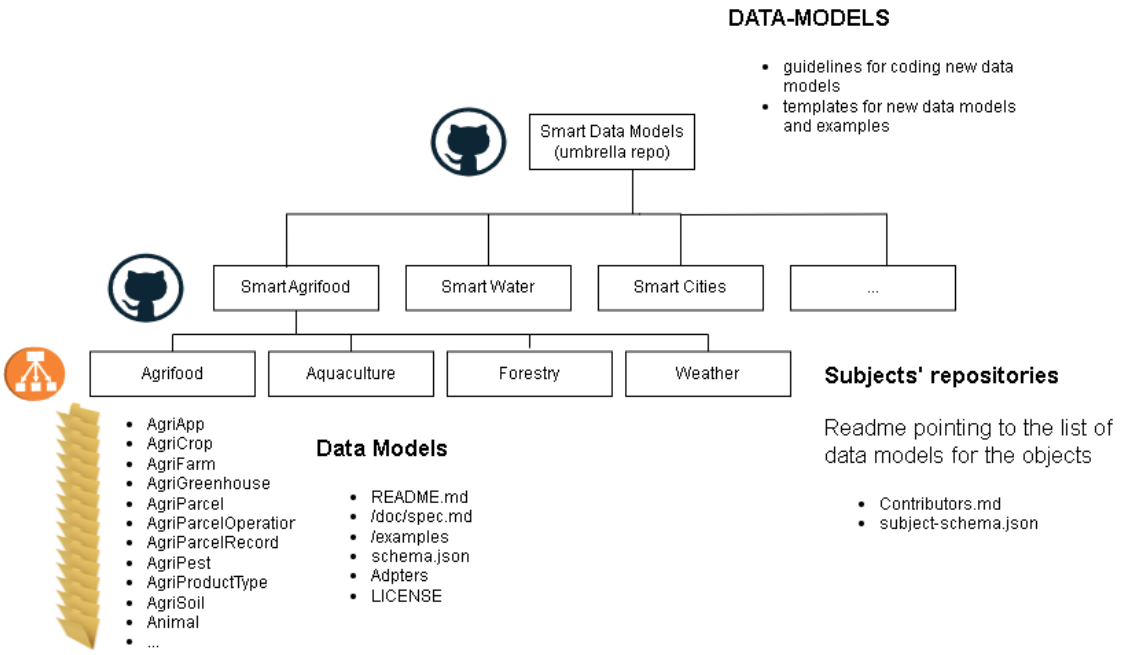

Figure 4. Architecture and entities involved in Smart Data Models repository for the specific case of the Smart Agrifood

ADSE Smart Data Models implement an open governance model that includes the lifecycle characterisation of new data models and the curation of existing ones, integrating various contributions. To facilitate participation in this global programme, a Smart Data Models Contribution Manual[25] explains how organisations can benefit from and contribute to the initiative, as detailed in Figure 5. The ADSE Data Model follows the Agile Standardisation Manifesto published in Smart Data Model repository[26], with the primary goal of standardising real cases of interest within the agricultural sector. This standardisation includes existing themes (Agrifood, Aquaculture, Forestry, Weather) and data models (AgriApp, AgriCrop, AgriFarm, etc.), as well as the creation of new data models according to the rules.

[25] Google Presentation of Smart Data Model
[26] https://github.com/smart-data-models

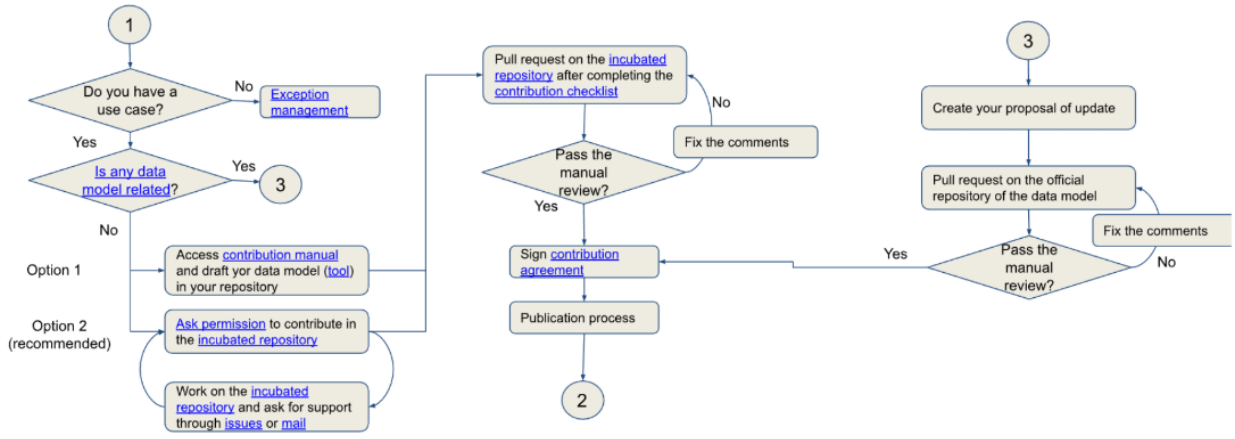

Figure 5. Contribution workflow in order to participate in Smart Data Models repository

5.2.1.2 Common APIs for the data exchange

The Data Exchange APIs framework distinguishes between two distinct aspects: the control phase and the data exchange phase. During the control phase, data assets and data exchange contracts are detailed and exchanged between the parties involved. Once the contract has been successfully agreed, the API initiates the data exchange process. This data exchange remains under the control of a data connector, using the agreed transfer protocol: NGSI-LD.

One of the key benefits of the NGSI-LD protocol is the robust and straightforward RESTful interface it provides for accessing context or digital twin data. In NGSI-LD, a "digital twin" or "context entity" represents a real-world physical asset or item in digital form. Each digital twin is uniquely identified by a Universal Resource Identifier (URI), associated with a commonly identified type (also identified by a URI), and captures multiple characteristics (properties or relationships, static or dynamic). The availability of different data models in NGSI-LD and JSON-LD within the AgriFood branch of the repository allows the extension of similar agricultural data formats to other real-world cases.

Another significant benefit of the NGSI-LD API is its versatility and the rich functionality that can be implemented through agreed NGSI-LD endpoints. Some valuable features include the ability to create and remove digital twin entities, perform complex queries, update properties associated with multiple digital twin entities, set up subscriptions to enable notifications, retrieve specific attribute values associated with digital twin entities, and register additional NGSI-LD endpoints to synchronise different resources, among others.

When considering data provenance and traceability in an agricultural dataspace ecosystem project, it is important to ensure that the origin and history of data is well documented and tracked throughout the data exchange process. Provenance information can provide insight into the source of data, its processing

history and any transformations it may have undergone. This helps to establish data trustworthiness, reliability and accountability.

In the agricultural context, data provenance and traceability are critical to maintaining the integrity of information related to crops, livestock, environmental conditions and even supply chain operations. By implementing data provenance and traceability mechanisms within the ADSE, stakeholders can have greater confidence in the accuracy and authenticity of the data. This, in turn, can lead to improved decision-making processes and build trust between the various stakeholders in the agricultural ecosystem.

To achieve data provenance and traceability in the ADAM model implemented in DIVINE project, it is necessary to incorporate metadata capture methods, data lineage tracking, and standardised protocols for recording and sharing provenance information. In addition to the described semantic level, data access controls and audit trails should be implemented to monitor the usage and response of the system to ensure compliance with electronic identities, data governance and privacy regulations.

At this level, the final architecture must contemplate two compliance levels. On the one hand, some API functions should be called explicitly by the functional modules, to intentionally trace operations over the data inside the DIVINE toolset, and the responsibility of regulation compliance is delegated on them. This could be achieved directly inside the ADAM model, including metadata to support the recording and queries of the data flow. On the other hand, some general enablers and support tools will provide a basic set of API calls that are designed to provide the basic level of traceability indicated in the legislation with independence of their specific level of instrumentalization. These legal liabilities provide the main list of functional and non-functional requirements for the use cases and technical design of the tools proposed by WP3 in terms of Access Control and Traceability. In this particular case, end user suggestions should be registered and compared with norm obligations, because the final result must be European law compliant.

By addressing data provenance and traceability, the Dataspace ecosystem in the agricultural context can strengthen data reliability, enable more informed decision making and foster collaboration among the various stakeholders involved in the agricultural industry.

5.2.1.3 Data provenance and traceability

Strictly controlled data spaces require transparency in data-sharing mainly to legal, marketing and confidence reasons. According to ADSE architecture, we can consider the following different propositions to implement transparency-validation agents in the data-sharing process:

Centralised architecture: establishing an inspection framework (inspector or surveillance agent) in distinct data exchange procedures and phases;

Decentralised architecture: the details about the agreed contracts during the data transfer and their execution in the corresponding environment are available to every participant. There are at least two

copies of related logging information in the ADSE, linked by identifier codes, which can be verified by the surveillance agent or framework.

The main technical weakness of a centralised architecture is that agents with malicious purposes may have more direct access to sensible or crucial data. Therefore, for the sake of security, a decentralised architecture is proposed despite the complex framework that its implementation may require.

The audit process involves requesting log data and publishing data contract offers that grant limited access to the auditor. In order to verify the validity of those log entries, the ADSE should establish a digital authentication system with limited access rights according to the distinct profiles. This mechanism would restrict access to sensitive observation data, qualifying the observers as trusted auditors with individualised identification. The system automatically records and monitors observer actions, establishing a trust relationship that allows participants to audit auditors. To achieve the defined restricted and secured observability level, the IDS-RAM proposes the implementation of the Clearing House Service. In addition, the profiles of users or entities should be grouped and agreed upon according to similar characteristics. Access needs vary widely between different actors, such as farmers, agricultural researchers or advisors, food processors, agronomists, government agencies or investors. Therefore, the creation of restriction levels according to profiles, as shown in Figure 6 may facilitate the transparency protocols and rank the security responsibility levels.

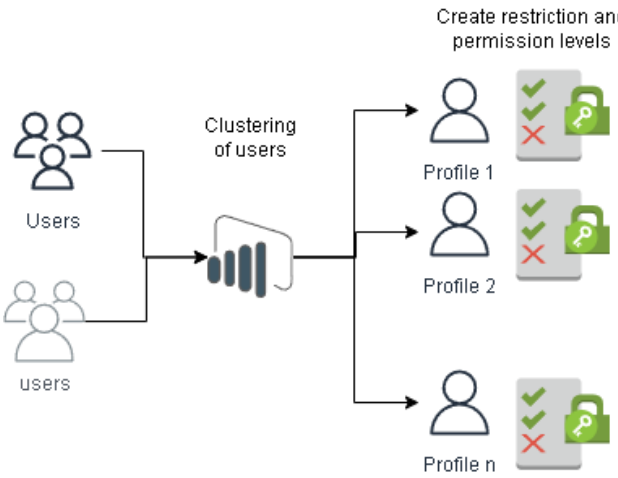

Figure 6. Security levels defined according to clustered user characteristics.

5.2.2 Trust and data Sovereignty in ADSE: overview

The Agriculture Data Spaces Ecosystem (ADSE) is an ambitious collaborative effort that brings together key organisations, including BDVA, FIWARE Foundation, Gaia-X and IDSA to foster data-driven innovation in the agricultural sector. Central to the success of ADSE are the principles of trust and data sovereignty, which underpin a robust and secure data sharing environment. This section discusses the adoption and significance of the Trust Anchor framework within DIVINE and explores the various components that contribute to building trust and ensuring data integrity among ecosystem participants.

Trust and data sovereignty are the cornerstones of the Agriculture Data Spaces ecosystem. Through the widespread adoption of the Trust Anchor Framework and secure identification mechanisms, ADSE promotes a secure and trusted data exchange environment. The unified authentication approach and transparent data use agreements further contribute to the success of ADSE, unlocking the full potential of data-driven innovation in the agricultural sector while safeguarding data sovereignty and privacy. This analysis provides valuable insights for policy makers and stakeholders, facilitating informed decision-making in the field of data-driven agriculture.

5.2.2.1 Trust Anchor framework adoption

The Trust Anchor Framework is a set of rules and procedures for the distribution and management of Trust Anchors. A trust anchor is a digital certificate that has been pre-validated by a trusted authority, such as a Certificate Authority (CA). Trust anchors are used to validate other digital certificates used to secure communications.

It complements the Gaia-X Trust Framework and ensures consistent and trusted use of digital identities and attributes. It facilitates seamless interactions, transactions and information sharing between organisations. Implemented through a Verifiable Data Registry, improves data management. In addition, it is defined a decentralised Identity and Access Management (IAM) approach based on Verifiable Credentials, promoting efficiency and scalability in interactions with data spaces, marketplaces and consumers of products/services.

The framework addresses several key issues, such as ID Binding, Proof of Participation and Proof of Issuing Authority. One of its main focuses is the secure binding of participants' identities to their data through unique identifiers. In this way, the framework improves data provenance and traceability, ensuring that the origin of data can be verified and accountability established. This identity-to-data linkage promotes transparency throughout the ecosystem, creating a robust foundation for reliable data exchange.

To enhance trust between ecosystem participants, the framework suggests the Proof of Participation mechanism. Through this approach, participants provide verifiable evidence of their active engagement within the ADSE. Demonstrating commitment to the ecosystem fosters mutual trust between stakeholders, encouraging collaboration and cooperative data sharing.

Addressing data accuracy is paramount within the ADSE and that's where the Proof of Issuing Authority comes in. This mechanism validates the authenticity and reliability of data sources. By going through this validation process, shared information gains greater credibility, leading to a more trusted data sharing environment.

5.2.2.2 Onboarding of Data Space participants

In this context, onboarding refers to the process of establishing a business relationship with a new participant, limited to legal entities (excluding natural persons, except as employees of a legal entity). When carried out electronically and remotely (e.g. online), it is referred to as digital onboarding. The onboarding process varies widely in its implementation across sectors and geographies, and even within

the same sector. For Data Spaces, onboarding may also differ depending on the specific Data Space. This chapter proposes an approach based on eIDAS digital certificates to facilitate fully digital and automated cross-border onboarding in the EU and compliance with KYC requirements.

The eIDAS Regulation (EU) 910/2014, known as eIDAS, is an important step in building the EU Digital Single Market (DSM) as it provides a predictable regulatory environment for cross-border recognition of electronic identification (eID) and electronic trust services by trust service providers (TSPs). It aims to meet legal obligations regarding security, know-your-customer practices, strong authentication and interoperability.

The onboarding process consists of two logical phases: the application phase, where the applicant provides identity and KYC attributes for verification and collection, and the verification phase, which includes checks for document authenticity, applicant identity and anti-fraud measures.

Depending on the legal and regulatory requirements of the sector, a full onboarding process may include identifying the legal entity based on the documents provided and verified information from reliable sources, verifying the identity and authority of the legal representative, identifying the beneficial owner based on the information provided or verified, and obtaining details of the business relationship or transaction.

To ensure legal validity and reduce uncertainty, the onboarding process requires that the natural person driving the process should be either a legal representative of the participant or a natural person delegated by a legal representative with the necessary powers to carry out the onboarding process on behalf of the legal entity. The eIDAS framework provides different types of digital certificates for digital signatures and seals, including those for natural persons and legal entities.

In conclusion, by using eIDAS digital certificates and adopting a fully digital approach, the onboarding process can be streamlined and enhanced to meet the needs of Data Spaces, promoting efficient cross-border onboarding and data sharing while ensuring compliance and security.

The onboarding process relies on a specialised Verifiable Credential, known as a **VerifiableID**, designed for this purpose. To initiate the process, the user must be a Legal Entity Appointed Representative (LEAR) with control of a VerifiableID. There are several ways to generate the VerifiableID using one or more of the available digital certificates:

If a Legal Entity Representative (LER) already exists, they issue a Verifiable Credential to a natural person (usually an employee responsible for managing the Data Space relationship). The Verifiable Credential contains the delegated authority specified by the Data Space and is signed with the LER's digital certificate. This Verifiable Credential becomes the VerifiableID, allowing the user to authenticate and act as the LER. In addition, the LER can issue a VerifiableID to itself to perform the onboarding process.

A similar process applies when a natural person with a Legal Entity (LE) certificate digitally seals the VerifiableID.

In cases where a natural person represents the legal entity and neither LE nor LER digital certificates are available, a separate explicit authority or mandate is required. The Verifiable Credential must be signed with the natural person's electronic signature and verified by a trusted entity other than the legal entity, such as a notary or company registry. If these trusted entities are already Trust Service Providers (TSPs), the verification of the VerifiableID is similar to the mechanisms described above, the main difference being the signature by a trusted entity rather than an existing legal entity representative, which makes the process slightly more cumbersome.

This innovative method enables a decentralised and fault-tolerant identity verification system. By avoiding reliance on centralised identity providers, ADSE ensures that users can securely share data while retaining ownership of their personal information.

5.2.2.3 Identification and Authorisation iter

The Identification and Authorisation iteration within the Agriculture Data Spaces Ecosystem (ADSE) adopts a unified mechanism for online authentication, namely using OpenID Connect for Verifiable Presentations and Self-Issued OpenID Provider. This approach leverages the proven, robust, and secure standards of OpenID Connect protocols to achieve the following:

- Transport Verifiable Credentials/Presentations in OpenID Connect flows: By integrating Verifiable Credentials/Presentations within OpenID Connect flows, Relying Parties can utilise well-known mechanisms to issue and receive Verifiable Credentials. This ensures the secure and reliable verification of participants' identities within ADSE;
- Enable decentralised identity data exchange: ADSE facilitates the direct exchange of identity data and Verifiable Credentials between participants or they can delegate some function in Identity Providers enablers. This align and facilitate integration with standard OpenID Connect implementations.
- As a result, ADSE implements a distributed, fault-tolerant, trustworthy, and efficient system. This approach significantly lowers the barriers of entry for participants, as they can seamlessly implement Identity and Access Management (IAM) with widely-implemented and standardised protocols, promoting inclusivity and fostering a secure data sharing environment.

5.2.2.4 Identify legal and natural persons

The possibility of using a similar approach to identify natural persons as for legal persons is evident in the ETSI standards, which also define a 'Natural Person Semantic Identifier'. However, it is important to recognise that legal and natural persons are fundamentally different, particularly in terms of privacy considerations (as exemplified by the GDPR).

The identification of legal entities in the context of W3C Verifiable Credentials and DIDs follows a specific format to ensure compatibility with eIDAS digital certificates and legal recognition across the EU. A DID, or Decentralised Identifier, consists of three parts: the identifier for the did URI scheme ("did"), the identifier for the DID method specifying the resolution mechanism ("method") and the identifier specific to that method ("organisationIdentifier"). One of the proposed DID methods for legal persons is to use

the identifiers already embedded in eIDAS certificates, following the ETSI standards. These identifiers include attributes such as countryName, organisationName, organisationIdentifier and commonName. The organisationIdentifier attribute contains an identification of the subject organisation in a structured format, including references to the legal entity identity type, ISO 3166 country codes and relevant identifiers. By applying the appropriate rule, a DID can be derived from an eIDAS digital certificate, providing a bi-directional identification mechanism.

This approach ensures that the resulting DIDs are well integrated with eIDAS certificates and legally recognised for economic transactions across the EU, facilitating seamless and reliable verification of legal entity identities in different ecosystems. So, the structure is like **did:elsi:organisationIdentifier** and following an example is presented:

- *DIVINE MEMBER*: did:elsi:VATDE-00001111

Where:

- "did" is the W3C did uri scheme.
- "elsi" stands for ETSI Legal Semantic Identifier, which is the acronym for the name for this type of identifier used in the ETSI documents.
- "organisationIdentifier" is the exact identifier specified in the ETSI standard, and that can evolve with the standard to support any future requirement.

So, a bi-directional mechanism allows DIDs to be derived from eIDAS digital certificates and vice versa. Proof of control of an ELSI DID is possible using the associated certificate, making any existing digital signature compliant with this DID method. No need for new identifiers or central entity mapping, simplifying identity verification.

For **natural persons**, the same approach could potentially be applied as for legal persons, with ETSI standards defining a 'Natural Person Semantic Identifier'. However, due to significant differences, in particular regarding privacy considerations (as observed in the GDPR), a different approach is required for the identification of natural persons in a sharing ecosystem such as a Data Space.

5.2.2.5 Identify connectors, gateways and application context

In addition to identifiers for legal and natural persons, there is a need for identifiers for IDS connectors or gateways in the application context. These software components need to be identified in a similar way. Organisational clarity requires linking the application context to legal and/or natural person identifiers to define the delegation of authority. Such identifiers can be implemented as X.509 certificates or DIDs. A valid identifier should contain at least the following information: Issuer Distinguished Name, Subject Distinguished Name, Serial Number, Version Information and Validity Information.

5.2.2.6 Usage/Access Control

The governance of data use and access within ADSE is based on policy or contract negotiation between data providers and consumers. Providers offer assets under specific usage contracts and consumers

request access to these assets. Through this negotiation process, both parties agree on the terms of data use, ensuring compliance with data sovereignty principles and promoting a transparent and fair data sharing environment.

In summary, the Agriculture Data Spaces Ecosystem places trust and data sovereignty at the forefront. The comprehensive Trust Anchor framework, together with secure identification and authorisation mechanisms, ensures a secure and trusted data sharing environment. By fostering mutual trust among participants and promoting fair data use agreements, ADSE unlocks the full potential of data-driven innovation in the agricultural sector while protecting the privacy and sovereignty of data owners.

5.2.3 Data Value Creation in ADSE

One of the main objectives of ADSE is to create value from the data and services shared within the ecosystem. This section outlines the mechanisms for describing and registering the data/services, publishing and accessing them, and establishing commercial relationships between data/service providers and consumers.

5.2.3.1 Mechanisms for describing and registering the data and services

If data and services are to be exchanged via the ADSE, it is necessary to create descriptive information about them so that potential consumers can know about them, be interested in them and search for them. This can be done by using some metadata definition tools. It is important that these tools are as technology agnostic as possible in order to be multi-platform. Such data and service descriptions or metadata can be called "data and service descriptors".

Once the "data and service descriptors" are defined, they need to be registered in some data and service management structures. One way is to use data and service catalogues. These catalogues need to be publishable so that external users/consumers can access their data and services. One way to make these catalogues publishable is through APIs that expose a set of endpoints for accessing their data and services and/or descriptors.

Finally, some interaction between providers and consumers can be defined through the data and service descriptors. For example, consumers will normally not be able to modify descriptors, as providers remain the sovereign originators of such descriptors and their associated data and services, but they will be able to report erroneous information, including the original data, associated services and/or their descriptors.

5.2.3.2 Mechanisms for publishing and accessing the data and services

Once data and service descriptors have been defined and registered in some appropriate data and service management structures, e.g. an appropriate data and service catalogue, the latter should be made public and accessible so that potential consumers can access and consume the associated data and services.

That is, the descriptors should be made public and accessible so that potential consumers can know about them (discover them) and request them. One way of doing this is to use metadata brokers, i.e. to expose the endpoints that make the descriptors and associated data and services available to metadata brokers. Once received, the metadata brokers can store the exposed descriptors and make them available to

search requests from potential consumers of data and services. Potential consumers can then search the descriptors stored in the metadata broker, filter for relevant offers, negotiate with corresponding data and service providers, and start interacting with the associated data and services.

5.2.3.3 Mechanisms for establishing commercial relations

Finally, it is interesting to create spaces where commercial relationships can be established, i.e. to create markets where providers can "sell" (offer) data and services and consumers can "buy" (consume) the "products" offered, in this case the data and services shared in the ADSE.

Thus, in addition to the above mechanisms for describing and registering the data and services (descriptors) and for publishing and accessing the data and services (metadata brokers), mechanisms for establishing some formal commercial relationships, e.g. commercial contracts, need to be provided. These commercial contracts imply both rights and obligations on both sides.

One way to articulate such a mechanism is to implement a marketplace for the exchange of data/services in the form of a Distributed Open Marketplace Ecosystem (DOME). Such a DOME can be based on a decentralised set of federated marketplaces, all connected to a common digital catalogue of data and services and associated descriptors; these data and services and associated descriptors can be edge-based and/or cloud-based. Next, some of the key, fundamental roles of DOME users and organisations are listed:

- Federated Marketplaces
- Cloud and/or edge data and service providers
- Customers (consumers)
- Members of governance and supervisory bodies of the DOME
- Operators of the DOME technical infrastructure

Other additional roles may exist, e.g., third parties integrating/offering complementary data and services.

The mechanisms described in this section provide a foundation for creating value from the data and services shared within the ADSE. By making data and services discoverable and accessible, and by providing mechanisms for establishing commercial relationships, the ADSE can help to unlock the potential of data-driven innovation.

5.3 Guidelines specification for external stakeholders and policy integrations

Understanding the technical framework for data interoperability

5.3.1 Familiarise with the Unified Semantic Framework

To ensure transparent data interoperability within the Agriculture Data Spaces Ecosystem (ADSE), external stakeholders and policy integrators need to be aligned with the Unified Semantic Framework. This framework emphasises two critical features:

- the integration of standardised APIs to enable secure data exchange, and
- the creation of common data models that are compatible with these APIs.

A thorough understanding of the importance of transport, syntactic and semantic interoperability is essential for successful data integration. Transport interoperability ensures that data is delivered, while syntactic interoperability ensures that data is understood in a consistent format and grammar. Semantic interoperability ensures unambiguous interpretation and understanding of the data, promoting seamless communication and shared insights within the ADSE ecosystem. By addressing these interoperability aspects, stakeholders and policy integrators can confidently embrace transparent data sharing and foster data-driven innovation in the agricultural sector.

5.3.2 Adoption of the ADSE Data Model

External stakeholders and policy integrators should explore the ADSE Data Model, which includes common data models that can be transformed into data formats compatible with the standardised APIs.

This model is based on the Smart Data Model provided by FIWARE in collaboration with other organisations. To ensure consistent and standardised data representation, participants must adhere to the **Agile Standardisation Manifesto**[27], normalise agricultural data and create new data models according to regularity instructions. By following these guidelines, stakeholders can effectively use the ADSE data model to facilitate seamless data integration and promote transparent data interoperability within the Agriculture Data Spaces Ecosystem (ADSE).

5.3.3 Implement common APIs for data exchange

Understanding the Data Exchange APIs framework is critical to seamless data integration. Within this framework, a distinction is made between the control and data exchange phases, where successful agreement of data exchange contracts initiates data transfer. This data transfer process is facilitated by a data connector using the NGSI-LD protocol.

Use the NGSI-LD protocol to access a robust and RESTful interface for retrieving context or digital twin data. Leveraging this protocol provides various functionalities including digital twin entity management, queries, updates and subscriptions for notifications. By effectively implementing the NGSI-LD protocol, participants can ensure secure and efficient data exchange, promoting transparent data interoperability within the Agriculture Data Spaces Ecosystem (ADSE).

5.3.4 Ensure data provenance and traceability

To promote trust and data integrity within the Agriculture Data Spaces Ecosystem (ADSE), the adoption of the Trust Anchor Framework is paramount. Implement secure identification mechanisms, transparent data use agreements and consistent authentication approaches, as these elements are critical to the success of DIVINE. By adopting these practices, participants can create a secure and trusted environment

[27] https://github.com/smart-data-models/data-models/blob/master/MANIFESTO.md

for data exchange, fostering data-driven innovation in the agricultural sector while protecting data sovereignty and privacy.

Familiarise with the DIVINE policy, which advocates the adoption of the Trusted Issuer Lists mechanism. These lists contain details of trusted public authorities authorised to issue specific types of verifiable credentials within specific domains. This ensures the authenticity and legitimacy of the verifiable credentials received, thereby increasing trust in the data exchange ecosystem.

5.3.4.1 Joining the Agriculture Data Space Ecosystem

To participate in the Agriculture Data Space Ecosystem, you need to prove your participation status through the Trusted Participant List. This list contains identity information and metadata of legal entities actively participating in the Ecosystem.

5.3.4.2 Onboarding process

Initiate the onboarding process by contacting cooperating Trusted Participants. They are responsible for verifying the authenticity and legitimacy of your request to join the ecosystem. Successful verification will result in your addition to the Trusted Participant list.

5.3.4.3 Verify participant status

To check the status of participants, use the dedicated Verification API. By querying the Trusted Participant List, you can verify that an entity is an active participant in the ecosystem. This ensures transparency and security in data exchange.

5.3.4.4 Keep subscriber information up to date

Ensure that your participant information remains accurate and up to date by using the List Maintenance API. Regularly register and update relevant details through this API to reflect the current status of your participation in the Agriculture Data Space ecosystem.

5.3.4.5 Federated and centralised systems

The Ecosystem encourages a federated approach to efficiently maintain the Trusted Participant List. Collaborate with multiple interoperable systems to improve verification processes without relying on a single central authority. Alternatively, you have the flexibility to use centralised systems for maintenance according to your preferences and infrastructure capabilities.

5.3.4.6 API recommendations

Maintain compatibility and consistency by following the EBSI standards for Trusted Lists. Interact with the Trusted Participant List using the recommended APIs:

- "GET /participants": Retrieve the list of participants.
- "GET /participants/{did}: Check the status of a participant by its Decentralised Identifier (DID).

You can also access attributes and metadata associated with participants, and list maintenance APIs managed by entities responsible for list oversight.

5.3.4.7 Ensure consistency of implementation

Follow the guiding principle for implementation, prioritising existing functionality within the EBSI wherever possible. Where specific needs are not covered, define new functionality while striving for alignment with EBSI standards, unless constraints prevent such alignment.

5.3.4.8 Role of verifiers

As a data sharing participant, it's important to act as a verifier when you receive verifiable credentials. Check these credentials against the Trusted Issuer Lists to verify their validity and authorised origin. Regular updates to the lists will increase trust within the Agriculture Data Space ecosystem.

6 DIVINE's pilots and the identified opportunities for ADSE adoption

The formulation of ADSE's core principles draws significant inspiration from the insights gained from the real-world use cases presented in the DIVINE project. This comprehensive undertaking harnesses the diverse and complex range of information emerging from the multifaceted realm of data-driven agriculture. By harmonising the nuanced experiential facets embedded within these scenarios, ADSE is meticulously crafted to meet the specific requirements and ambitions of its stakeholders. The collective information that emerges from these scenarios serves as the foundation of this initiative, enabling the cultivation of an inventive and adaptive ecosystem that is meticulously attuned to the demands of contemporary agriculture. This ecosystem fosters seamless collaborative synergies and efficient resource management and will be the ADSE's development.

In the following section, each Use Case is presented with a general overview, followed by mapping of policies, regulations and agri data-sharing models. An analysis of critical issues and opportunities have been provided from each UC.

6.1 UC#1 Neuropublic

Section	*Description*
ID	*UC#1-*
Title	Smart Farming data in the service of the new CAP monitoring
Description	The pilot will be realised in Grece with the use of a commercial FMIS, called Gaiasense that is already utilised in numerous farms. The Gaiasense system collects various types of data (agroenviromental data, cultivation activities realised by the farmers and recorded in digital farmbook) aiming to provide decision support services to farmers towards the optimisation of their inputs (e.g. irrigation, pesticides, fertilisers). Due to the new EU policy obligations (e.g. CAP 2023-2027 ecoschemes) there is a need to develop mechanisms that will record, calculate and share specific performance indicators on a farm and group of farms level. Thus, a data aggregation and sharing platform will be developed on top of the Gaiasense Smart Farming system capable to calculate selected indicators and utilise DIVINE data interoperability/sharing mechanisms. Data sets from previous cultivation periods (e.g., 2021, 2022) and upcoming (e.g., 2023, 2024) will be utilised. The indicators will reflect the use of agrochemicals (e.g. pesticides, fertilisers), irrigation, land use, soil quality, harvested yields, cultivation types in the area, etc. Example of indicators: • Crop types cultivates • Applied farming practices (Crop rotation, Ploughing)

	• Applied fertilisers (kg/ha) • Applied pesticides (kg or Lt /ha) • Applied Irrigation (m3 /ha) • Harvested yields (kg/ha) Summarising the objectives of this pilot are: a. Close-to-real time calculation of CAP relevant indicators based on agricultural practices recorded in the farm's calendar on a farm level and on a group of farms level b. Apply semantic interoperability mechanisms (provided by DIVINE) to calculated indicators and/or farmer's digital calendar. c. Apply data sharing mechanisms (provided by DIVINE) to share in a controlled manner the calculate performance indicators.
Actors	The key actors and stake holders of this case are: Individual farmers, Farmers organisations, Advisors, Agricultural Policy makers/influencers,
Policies and regulations	*The policies that are relevant with this test case are:* - *Common Agriculture Policy CAP 2021-2027 regulation* *The CAP defines specific result-indicators relevant with the use of digital technologies, the optimised use of pesticides and water and the protection of environmental sensitive areas (e.g. Natura2000).* - *Statistics on agricultural input and output (SAIO)* *On 2022 an update on SAIO was realised aiming to* bring under one legal framework the following data: • agricultural production statistics, including on organic farming, • agricultural price statistics, and • statistics on plant protection products (PPPs) and on nutrients. *More are available here: https://www.europarl.europa.eu/legislative-train/theme-agriculture-and-rural-development-agri/file-saio*
Agri data-sharing model applied	In the context of this UC all data are collected in a centralised data repository owned and administered by Neuropublic (NP). Farmers are the owners of the data that refer to the practices they apply. Data from the hardware equipment (e.g. IoT agro-environmental stations) are owned by the company. There are legal contracts among the farmers and the company dictating the rights on the use of the collected data. It should be noted that the farmers that are participating in the DIVINE UC have been informed and agreed to consent on the use of datasets for research and testing purposes. Other than that, there are no other agri data-sharing models applied.
Mapping	*This column should map the policies, regulations and agri data-sharing models described above. It should identify how the Use Case aligns or*

	complies with the relevant policies and regulations, and which data-sharing models are being used. No data sharing models are applied yet. It is among the objectives of this UC to identify, implement and evaluate the use of the appropriate agri data-sharing models.
Critical Issues	Given that the UC is not implemented yet, we can only have an estimation of critical issues/challenges with regards to data sharing. The most critical issue that is already identified is the reluctance of farmers to participate/contribute with their farm calendar data for the calculation of performance indicators. Farmers are not willing to share data that disclose their farming activities (e.g. use of pesticides including time, active substance, dose) as these can be shared with competitors or with regional agencies and cause penalties. Incentives for data sharing will be evaluated where the farmer will get back calculated aggregates on a regional bases as a reward for contributing with his/her data.
Opportunities	The potential benefits associated with this UC are: A) Use of digital technologies to implement data-driven agricultural practices that provide clear benefits for the farmers and for the climate. B) Promote farmers collaboration in the digital sphere through sharing of datasets referring to applied farming practices and other critical events (e.g. pests' infestation) C) Improve policy performance monitoring for specific indicators.

6.2 UC#2 UCD Lyons Farm – scenario description, policies used and gaps identified

Section	*Description*
ID	*UC#2-*
Title	Crop Yield Prediction Model
Description	*User story general overview. A brief description of the specific Use Case, including its purpose and objectives,* The overall goal of the pilot is to create an easy-to-use farmer friendly crop yield prediction tool from real-time inputs to enhance supply chain management strategies. This tool will act as a platform to bring together digital agriculture solutions to streamline a farmer's usage of digital technologies. This service will allow farmers to get better insights on crop developments in their region, allow for collaboration and discussion with agronomists and advisors, and allow agri-tech providers to enhance and improve decision support systems with additional sources of digitised agricultural data. This will be achieved by securely collecting both public and private data and presenting this data in a user-friendly way to allow for informed decision making. This data will also be used by the platform to create decision support tools which give suggestions of actions to be undertaken based upon real-time data. The specific objectives of the Irish pilot are – To demonstrate a data space driven pathway to transform the crop production systems through secure and systemic gathering, processing, and interpretation of relevant farming data. To develop and provide a secure, transparent, and trustworthy system of farming data collection and utilisation where all stakeholders can unleash and realise the potential of agricultural data. To demonstrate the uptake and improved use of public and private data in connection with the DIVINE data space contributing to digital transformation of farming systems. It will lead to better management of the entire value chain including (a) improvement in efficient farming practices towards sustainability, (b) achieving greater transparency on data sharing & usage, and (c) reducing raw materials like fertilisers and greenhouse gas emissions, especially carbon.
Actors	*Pilots names* UCD, farmers, farming organisations, agricultural advisors and advisory boards, agronomists, agri-tech providers

Polocies and regulations	*Data Governance Act, GDPR, EU Code of Conduct on agricultural data sharing by contractual agreement, Common Agricultural Policy* *Identify any relevant policies, regulations or legal frameworks that impact the implementation of the Use Case. This column should outline the specific rules or guidelines that are considered in UC activity.*
Agri data-sharing model applied	*Describe the different data-sharing models or approaches that are applicable to the UC. This column should include details about the methods, platforms or systems used to collect, store and share agricultural data.* All raw data to be used in this UC is being stored locally by UCD, and their partner farmers. Cleaned, anonymised data will then be stored centrally for data sharing purposes. Farmers will remain the owners of all private data used in this UC. There are no other systems in operation.
Mapping	*This column should map the policies, regulations and agri data-sharing models described above. It should identify how the Use Case aligns or complies with the relevant policies and regulations, and which data-sharing models are being used.* No data sharing models are currently being applied. This will be considered throughout the UC. This UC will adhere to all policies and regulations throughout the project. For example, any decision support systems will not suggest actions that are outside of national and european regulations, like CAP.
Critical Issues	*List any critical issues or challenges that have been identified in the implementation of the UC. This can include technical limitations, data privacy concerns, stakeholder collaboration difficulties or any other significant obstacles.* The most pressing technical difficulty is that of data interoperability and the low uptake of certain digital equipments by end user stakeholders. Stakeholders are unaware of the data economy and the frameworks surrounding it. Very simple guidance on the operation of the system will need to be provided for non-technical stakeholders. Some stakeholders, especially farmers, may not have the skills or interest required to use digital platforms. They may also be reluctant to share certain, or all, datasets relating to their business due to data privacy concerns. These concerns mainly relate to others, especially large companies and institutions, benefitting financially from the use of their data. They also do not want their fellow farmers having access to their data, unless comprehensively anonymised. Farmers are also wary of governing bodies gaining access to their data which may result in penalty. Therefore, a cost/benefit analysis of using this platform must be considered from the farmer's point of view.

Opportunities	*Highlight the potential opportunities or benefits associated with the UCc This column should outline the positive impacts, such as increased efficiency, improved decision-making, sustainability benefits, or any other positive outcomes.* The end product will be a digital crop production DSS to chart crops throughout the growing year to help farmers make improved decision making and to have access to field scale yield predictions. Farmers will benefit from having a tool that will help them to make decisions, determine their carbon balance, and predict their crop yield from real-time inputs, giving them the opportunity to implement best practice, reduce inputs where possible, and thus increase farm economic and environmental viability.

6.3 UC#3 ITC DIHAGRIFOOD – scenario description, policies used and gaps identified

Section	*Description*
ID	*UC#3-*
Title	DIH AGRIFOOD Data Space for sustainable food production
Description	*User story general overview. A brief description of the specific Use Case, including its purpose and objectives.* Livestock benchmarking platform for optimising milk production and pork production advisory service and monitoring of carbon footprint on these farms. An open access data space platform and infrastructure with existing and new set of agri-data sources, supporting actions to all agricultural value chain actors (e.g., farmers, solution providers, NGOs, advisory bodies) contributing with data or using open data in order to foster transition into a data-driven regional food system, and overcoming regulatory framework limitations and business prospects identified.
Actors	*Pilots names* *Dairy and pork producers, solution providers, advisory organisations*
Policies and regulations	*Identify any relevant policies, regulations or legal frameworks that impact the implementation of the Use Case. This column should outline the specific rules or guidelines that are considered in UC activity.* *Data Governance Act, Data Act, GDPR, EU Code of Conduct on agricultural data sharing by contractual agreement,*
Agri data-sharing model applied	*Describe the different data-sharing models or approaches that are applicable to the UC. This column should include details about the methods, platforms or systems used to collect, store and share agricultural data.*

	DIH Agrifood data space is a federated data ecosystem where organisational management is the founding members' responsibility. Currently, there are three founding members: ITC, KGSMS (farmers advisory board), University of Maribor. Accession members are all other stakeholders (data owners, data users, service(technology) providers). Accession members can influence on decisions of a steering committee, but they don't have voting rights. Technological building blocks of data sharing platform are Identity management, Consent management platform, and API market service.
Mapping	*This column should map the policies, regulations and agri data-sharing models described above. It should identify how the Use Case aligns or complies with the relevant policies and regulations, and which data-sharing models are being used.* *GDPR requirements are met with internal policies of personal data protection.* *Data Governance Act, Data Act and Code of Conduct guidelines and requirement are met bay implementation and adaptation of Sitra Rulebook for a fair data economy and OPEN DEI design principles for dataspaces.* *A fair data economy proposes pursuing two goals at once: putting individuals in control of their data and maximising the use of data. A fair data economy can serve the interests of individuals, existing service providers and data re-users alike, based on data portability and consent. The societal benefits of permission-driven data sharing include economic growth, individual empowerment, and broad societal benefits.* *In keeping with these goals, the Fair Data Economy Rulebook is a tool for governing data networks which are needed for maximising data use and for aligning them with the ethical considerations for putting individuals in control of personal data about themselves.* *Data sharing requires a certain number of rules – who can and should do what, with which data, and so on. Bilateral data sharing is relatively straightforward compared to multilateral or networked data sharing and its rules are commonly set out in a contract between the two parties which governs the terms of sharing. When a larger number of parties decide to share data between themselves, a more complex form of governance is appropriate.* *A rulebook is a collection of documents that can be used together to govern a data network, by which we mean a multilateral data sharing*

	arrangement. More precisely, a data network is a network consisting of a set of more than two parties that share data among each other. The goal of data networks is sharing data between parties in a responsible and legally sound way so that all can benefit.
Critical Issues	*List any critical issues or challenges that have been identified in the implementation of the UC. This can include technical limitations, data privacy concerns, stakeholder collaboration difficulties or any other significant obstacles.* *Technical limitations: the problem of achieving semantic data interoperability from different data silos.* *For personal data privacy concerns, we have implemented personal data protection policy at the Farmers Advisory board (KGSMS)* *Stakeholders' collaboration difficulties: stakeholders are unfamiliar with data economy concepts, so they have difficulties understanding the organisational and formal framework, which the governance model provides.* *Some of the stakeholders (some farmers) are sometimes reluctant to use digital services, which are needed for implementing fair data economy principles*
Opportunities	*Highlight the potential opportunities or benefits associated with the UCc This column should outline the positive impacts, such as increased efficiency, improved decision-making, sustainability benefits, or any other positive outcomes.* *An open access data space platform and infrastructure contributing with data or using open data to foster transition into a data-driven regional food system and overcoming regulatory framework limitations and business prospects identified.*

6.4 UC#4 ANALISIS - DSC (ADSC) - scenario description, policies used and gaps identified

Section	*Description*
ID	*UC#4-*
Title	
Description	*User story general overview. A brief description of the specific Use Case, including its purpose and objectives.*
Actors	*Pilots names*
Polocies and regulations	*Identify any relevant policies, regulations or legal frameworks that impact the implementation of the Use Case. This column should outline the specific rules or guidelines that are considered in UC activity.*

Agri data-sharing model applied	*Describe the different data-sharing models or approaches that are applicable to the UC. This column should include details about the methods, platforms or systems used to collect, store and share agricultural data.*
Mapping	*This column should map the policies, regulations and agri data-sharing models described above. It should identify how the Use Case aligns or complies with the relevant policies and regulations, and which data-sharing models are being used.*
Critical Issues	*List any critical issues or challenges that have been identified in the implementation of the UC. This can include technical limitations, data privacy concerns, stakeholder collaboration difficulties or any other significant obstacles.*
Opportunities	*Highlight the potential opportunities or benefits associated with the UC. This column should outline the positive impacts, such as increased efficiency, improved decision-making, sustainability benefits, or any other positive outcomes.*

7 Conclusion

This document represents the first release of ADSE Data Exchange Policy Manual, representing an important milestone in the journey towards establishing agricultural data governance and data sharing practices within ADSE. It highlights the importance of adhering to essential standards, such as GDPR compliance, and addresses key technical considerations for secure data exchange. The manual is also a step towards prioritising principles such as data interoperability, trust, data sovereignty and value creation for the ADSE and the wider agricultural data sharing community.

The document charts a transformative path for agricultural data governance and provides stakeholders with an initial guideline to a future characterised by sustainable agricultural data sharing practices. The close collaboration between Task 6.2 and WP3 and the provision of a comprehensive framework for the adoption of agricultural data sharing policies underlines the commitment to replicability and widespread adoption. This will ensure that the benefits of ADSE are available to all those involved in agricultural data sharing.

8 Bibliographic resources

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