



Gaia-X Domain Agriculture

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Data and agriculture, a state of play

Available data are only valuable when shared.

An enormous digitalisation effort is underway in the AgriFood sector. Agricultural and horticultural companies produce an enormous amount of products every day, but more and more also a mass of data. It is generally known that this data only has value if it is shared, brought together and then converted into useful applications or advice.

Therefore, throughout the entire chain from farm to fork, traditional supply companies such as machinery constructors and agrochemists, as well as new players are positioning themselves on this subject, as the data economy constitutes a new growth driver for them. They are deploying digital tools and new data-driven applications, aiming as end-user not only farmers or AgriFood business, but also the consumers. To scale up and to make optimal use of this data revolution in the near future, the willingness to share data between all AgriFood supply chain partners is crucial to keep innovating.

The common European agriculture dataspace should ensure data sharing over the full supply chain from farm to fork. So indeed, the European agriculture data space cannot be an isolated data space as agriculture and food is not an isolated domain but connected to other domains like public sector, energy, mobility, health, and so forth.

This position paper is a first step in identifying the current situation, challenges, and possibilities for an agricultural data space. The next step will be engaging with already existing platforms and their use cases that are already building towards a common agricultural dataspace. To identify what they have in common and to understand their common needs and challenges so we can define how Gaia-X can support them in taking steps toward this common agricultural data space. The paper was produced by ambassadors from the Gaia-X Hubs in Belgium, Finland, France, and Germany.

Challenges addressed

Building trust through consent

The asymmetry of size between the players, where multinationals, SME's, one-man businesses, and family farms collaborate, requires building a climate of trust between the business operators and the farmers. For this to happen, the consent of the data owners on the use of the data seems to be an essential base for the construction of a dynamic ecosystem. A first set of guidelines for this ecosystem was developed with the "EU code of Conduct on agriculture data sharing by contractual agreement"¹. The Code puts the farmers in control of their data and. At the same time, it promotes the benefits of sharing data and enables agri-business models, including agri-cooperatives and other agri-businesses, but needs to be further developed and integrated into the emerging data sharing initiatives in AgriFood. In this

¹ This Code of Conduct was jointly developed by CEETTAR, CEJA, CEMA, COPA-COGECA, ECPA, EFFAB, ESA, FEFAC and Fertilizers Europe and endorsed by Animalhealth Europe and CLIMMAR. <https://old.fefac.eu/files/81630.pdf>

way, mechanisms taking care of possible power imbalances become part of the data ecosystem to guarantee fair compensation to all involved actors and a trustful environment that incentivises participation.

Data Interoperability and portability

A lot of different actors in the Agri-Food ecosystem have developed data driven tools and platforms. The current situation is, that there is **little interoperability and portability** between these different initiatives, which results in the fact that for instance a farmer has to use many different platforms on a daily basis, not being able to integrate the knowledge gained from one platform onto another. Interoperability between these existing initiatives is one of the key barriers for working towards a common agricultural data space.

Access to the digital single market

The spectrum of European farms is wide, as also the selection of available digital technologies. On the one hand, at European scale, it is usually difficult for new start-ups or SMEs with novel applications to **reach viable number of customers** fast enough. On the other hand, farms may struggle with technology solutions that are not fully suitable for them, do not obviously show their benefits is not directly obvious, solutions which are not comparable, or the farmers just do not know that better solutions exist. There is a need for a single market of available technologies/services/data sources and their accessibility in cross-country scale.

Need for sustainable business models

Data sharing initiatives are emerging in the AgriFood system, but all of them **are struggling to find a sustainable business model**. Moreover, when connecting data sharing platforms in a federation, new federated business models are necessary.

Involving the whole chain from farm to fork

When thinking of governance of agricultural data space, technical, legal, ethical, socio economical and business aspects need to be considered. But also, from farmers' point of view, to fully deploy the possibilities of data sharing, it is important to connect with the rest of the food system. Especially consumers are in the position to impact on 'data-driven farming practices' through their informed choices based on rich product data. Rich product data could contain physical quality, origin, responsibility indicators, production methods from farm to markets. Reaching out to the consumer offers great potential for farmers to be transparent and to show how to produce high quality food in a sustainable way.

Common European Agricultural Data Space

A federation of existing IT infrastructures including platforms that deliver data sharing services (data intermediaries), is needed. The definition and development of a federated governance structure that will define the scope, the openness, the technical interfaces and the 'federated'

services is a challenge for the AgriFood community: a governance model with the right balance between sufficiently open so that companies are prepared to come up with joint innovations through data sharing and sufficiently protected so that they still retain control over their own data and intellectual property.

The federated governance structure needs to determine the adequate legal, organizational, semantic, and technical interoperability levels, ensuring innovation and scale-up of data sharing at the EU level, preventing lock-in situations, enabling new ways of coordination and value creation and achieving a sustainable digital and societal transformation.

Thus, based on these observations, the objective is to move towards **a common European agricultural data space** that is dynamic and capable of addressing all these challenges collectively. The infrastructures, which will be developed at a later stage, should be able to contribute to the emergence of artificial intelligence solutions, data analysis, etc., which are useful to the agricultural and Agri-Food sectors.

In agriculture, there are already various data intermediaries and companies that cooperate with them. In a way these data intermediaries act as regional data spaces, and they usually also represent regional conditions, so a future EU-wide data space has to consider these existing regional actions. It is through these data intermediaries that a network can be formed to increase interoperability. These existing data intermediaries could be connected based on the Gaia-X Federated Services. This includes a unified identity management, the sovereign data exchange including data usage control possibilities between the brokers and within the systems, and the Federated Catalogue to identify the actors, services and available data items in the network across intermediaries.

An important aspect of the common European agricultural data space is the enforcement of data sovereignty for the farmer as data originator according to the European Code of Conduct on agricultural data sharing. For this purpose we need to provide the farmer with the necessary tools to give consent on the use of the data by a network of data intermediaries and to stay in full control of his data and, if desirable also add independent, federated storage solution for the farmers.

In addition to the technical layer of this data space, the non-technical layers are equally important. Like a unified compliance framework based on Gaia-X. Hence, all Gaia-X Federated Services are needed and will be integrated to set up the common European agriculture data space.

Use-cases within the Agricultural Data Space

As referenced above, data sharing in the field of agriculture and food is not something new, but a lot of existing data sharing initiatives already exist all over Europe. These existing initiatives are all in a way building towards a common European data space, but often have different architectures, requirements, stakeholder and make use of different standards, which makes it a challenge to connect them at the European level. That is where Gaia-X could bring a lot of value.

Below you can find some of these existing initiatives which could be further enabled by Gaia-X. This list is not exhaustive, but gives a general overview of what is already existing and what the specific requirements would be for Gaia-X to further develop these use cases. The Gaia-X Agriculture community plans to further expand this list and plans to include other use cases as well in the future.

Next to existing data sharing initiatives, some horizontal use cases are also referenced.

Description Use Case: AgriFood Data Space (Finland)

Solution

The use case AgriFood Data Space (AFDS) approaches the data space with a wide scope including the entire food system from field to consumers. It focuses on core functionalities that the data space should provide to all actors, and that are missing in present systems of platform economy. Thus, our use case contributes to data intermediary (federation) services, data usage control and data governance mechanisms.

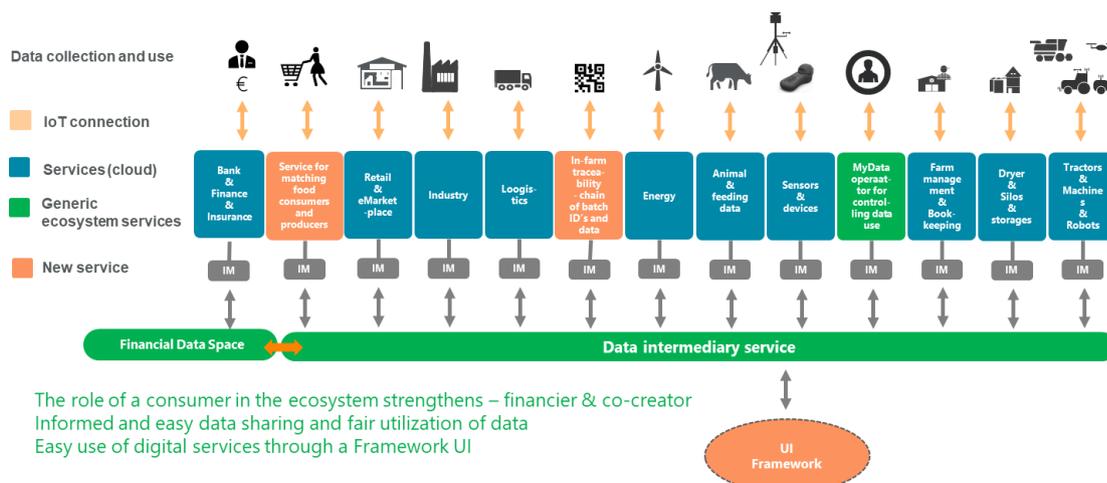


Figure 1: High level illustration of the use case AFDS. Green colored parts represent common ecosystem services needed in the data space and orange parts illustrate new services that implement functionalities that are desired in food ecosystem and made possible

Data intermediary (federation) routes the data, delivers it reliably to the destinations, provides event registering and monitoring. Services are integrated through an Integration Module that encrypts/decrypts the data. Data intermediary routes the data to authorized receivers.

The federation and data usage control services of AFDS are designed to match the principles set for MyData Operators. These Federation Services have two main directions in which they operate:

- **For individuals:** MyData Operators provide transparency, understandability, and convenience to individuals when they share data or receive services using data. Operators provide an aggregated view to data, allow them to control who can use

the data and for which purpose, and transparently expose past data use and sharing. Other benefits include intuitive user interfaces, enhanced security, and the tools for managing relationships with different services that process the data.

- **For organizations:** MyData Operators provide easy, legally compliant connectivity to an ecosystem of Data Providers and Data Consumers as well as a relevant base of potential users. Operators facilitate access to high quality, up-to-date data in real time, offer tools and mechanisms for legal compliance such as logging and audit trails of permissions, and offer outsourced tools for complying with data portability requirements.

Data governance

The ecosystem of the use case needs to agree upon the rules that the data is shared and used within the partners. The rights and duties of data source, data provider, data consumer must be clear to all ecosystem participants. Setting the rules and monitoring them in practice require a governance structure that the ecosystem must set up. Data governance must comply with EU and national legislation and it can utilize the ‘EU Code of Conduct on agricultural data sharing by contractual agreement’. The ecosystem may also agree more detailed and specific rules, where the Fair Data Economy Rulebook model provides guidance. The ecosystem of AFDS may include several business clusters, which may have their own specific data governance rules and models within the common AFDS ecosystem rules. For example, diverse data cooperatives could be possible.

Problem solved

The basic data space functionalities enable new services that have been seen vital for sustainable and safe food systems in a manner that are available for all actors, especially farmers. This is due to possibility to create agile low-cost data connections between the actors and the ability to control the sharing and use of their own data by each partner. The needs that our use case addresses are:

- Connections between farmer and consumer: Direct data connection between consumers and farmers, which leads to agile demand-driven production and increased awareness of food and its value.
- Connections between farmers/farms: Services that enable farmers’ organizations or groups to share data in a controlled matter for closer collaboration, e.g. for shared tasks or united market power.
- In-farm traceability despite diverse IT systems: Traceability of food and its journey from field to fork. Not only the traceability of material flow but also the traceability of data is important.

Partners/Ecosystem

The use case has been developed in Finland, and the consortium has 50 + members altogether along the food chain, and includes private companies, research organizations,

agriculture cooperatives, and farmers union as core members. The consortium collaborates with AgriFood administration and authority services.

Main technology/Gaia-X components

AFDS uses the Fair Data Economy Rulebook model as its basis to agree upon common business, legal, technical, and ethical practices regarding the AgriFood data ecosystem.

AFDS focuses on the following aspects of the Gaia-X Architecture and Gaia-X Federation Services:

- **Data and Service Catalogue** are service functions to be implemented based on Gaia-X Federated Catalogue features where AFDS resources, assets and participants can be found by potential consumers and end users.
- **User Management and Authentication** is required for the participants in the AFDS ecosystem and for using the Gaia-X Federated Catalogue. These features are built using the Self-Sovereign Identity approaches within the Gaia-X Federation Services.
- **Data Usage Control** is built on the service functions that enable data transactions in a secure, trusted, and auditable way within the data ecosystem. We offer interfaces for the negotiation of data exchange contracts and usage policies for data assets. These functionalities will be compliant with Data Contract and Data Exchange Logging features of Gaia-X Federation Services.
- **Continuous Automated Monitoring** provides transparency to the AFDS members about the compliance of the individual services to common rules. The basis for this compliance is a combination of rules and requirements imposed by Gaia-X itself and AFDS, such as adherence to data policies, cyber security, data privacy or interoperability.

Concrete benefits

Benefits to farms

- Possibility to compose a tailored farm-specific Farm Information Management System from services and data sources within the data space.
- Combining data from diverse sources to calculate carbon footprint or other responsibility indicators for a sales batch of grain.
- Gaining higher price from farm products by connecting data-based product information to the sales batch when taking it to (electronic) markets.
- In-farm traceability of farm produce, even though farm processes are performed using diverse IT and automation systems.
- Possibility to participate in various AI developments by sharing farm data to developers and being able to test and implement solutions in an agile manner.

Benefits to all

- Possibility to create new connections between actors and their data sources cost-efficiently, e.g. among farmers' groups, farmer – consumer, etc. to understand needs and business opportunities, leading to continuous improvement of each actor's processes (production, marketing, consuming...).

Description Use Case: Agricultural Datasharing Platform (Belgium)

Solution

As a public private cooperation, DjustConnect offers a regional Flemish agricultural data space that

- (1) makes the data available for the whole sector in one data market,
- (2) ensures safe, transparent, and controlled transport of the data with one open Platform,
- (3) gives 100% control and respect to the farmer who, as the data owner with one dashboard decides when to share his data, with whom and why
- (4) has clear rules in accordance with the legislation and the Code of Conduct on agricultural data sharing in one contract

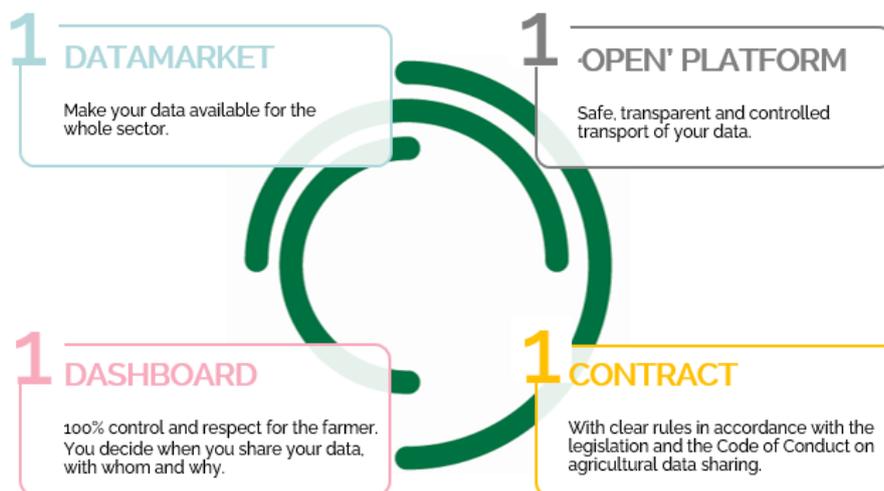


Figure 2

Problem solved

An agricultural business is a rich source of not only quality products, but also data. A lot of these company data are shared with others, such as the government, suppliers, buyers,

producer organizations or cooperations. This data sharing has great advantages like smarter digital tools, optimal service or less administration.

However, the Farmer and company manager can't always keep a clear overview of who makes a request or who already has access to which part of his/her company data. All these requests are followed by complex contracts and agreements, which makes the administrative load of the agricultural business even bigger.

Data Providers, like supplier, buyer, producer organizations or agricultural cooperation's, have access to a lot of data. This is either their own company data or they manage the data from their affiliated farmers. So, it is easy to imagine how quickly you would lose a clear overview of all the data transactions/contracts made, with whom and why.

Because there are numerous data sources, it is not always easy for Data Consumers to find the right data for their product or service and to connect with the right data-owner.

Our use case:

- Makes sure that the whole AgriFood chain can be involved, including the small actors: farmers, food businesses
- Demonstrates a sustainable business model for data sharing and shows the way to the digital single market
- Builds trust via data sovereignty for the farmer as data originator
- Delivers data Portability and interoperability

Partners/Ecosystem

DjustConnect is a neutral platform available for everyone who wants to contribute to innovative agriculture through data sharing with respect for farmers. Respecting the rules is the only condition to get permission to use the platform.

DjustConnect grew from the research project 'Datahub for Agrofood'. With the financial support of the EFRO – European Fund for Regional Development and the 5 founding members (AVEVE, Boerenbond, CRV, DGZ and Milcobel) the state-of-the-art infrastructure was built. This infrastructure is now made available for the whole AgriFood sector.

The first applications have been launched. ILVO, in cooperation with the founding companies, is developing DjustConnect further to the needs of the users.

From the research project onwards, we want to make DjustConnect a stable, full public private, go to solution. Expansions, maintenance, and permanent supervision by ILVO are contained within a future plan which goes far beyond the duration of a research project.

Main technology/Gaia-X components

DjustConnect Reference Architecture model and its technological components

- focus on security
- aim to deliver a trusted platform, incorporating crucial building blocks
- prioritize on identity & trust management for authenticating communicating parties
- apply technical enforcement to shape trusted relationships between partners
- apply trustworthy communication based on authenticated and encrypted connections
- apply access & usage control

Specific architectural and technological choices of DjustConnect have been inspired by the International Data Space Association RAM.

- Many similarities exist especially on the Business and Functional layer
- The Business Layer specifies and categorizes the different roles which the participants of the International Data Spaces can assume, and it specifies the main activities and interactions connected with each of these roles.
- The Functional Layer defines the functional requirements of the International Data Spaces, plus the concrete features to be derived from these.

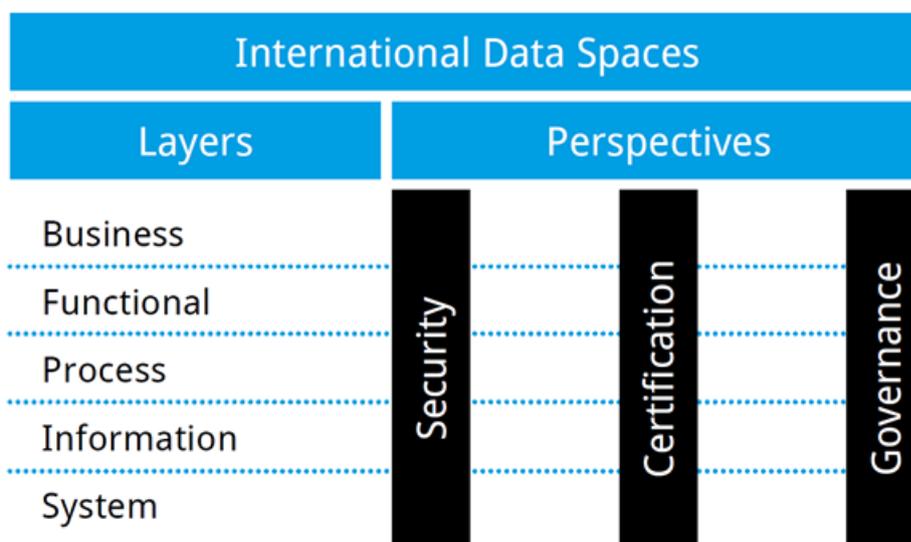


Figure 3

The next step, that will allow us to fully align with IDSA and Gaia-X design principles, is to use the Connector and adopt a more decentralized approach.

The adoption of REST binding by IDSA connectors, is a good step that will support our data providers to maintain the way they expose their data (RestAPIs).

Concrete benefits

Every actor, namely farmers and horticulturists, data providers and data consumers, benefits from the use of DjustConnect.

Farmers and Horticulturists get a lot of benefits by sharing their data, like smarter digital tools, optimal service or less administration. When connecting with DjustConnect:

- you decide who has access to your data,
- you keep a clear overview using your personal dashboard,
- you can change your mind at any time and retract your permission,
- data sharing leads to better advice tools and helps simplify administration.

As Data Provider

- you make your APIs available in our API shop,
- you reach more potential clients,
- you decide who you share with, the farmer decides whether the transaction will take place,
- all transactions are legally covered and replace your individual contracts with farmers and data consumers.

As Data Consumer

- you have a central point for all your data connections,
- you ask the farmer and data provider's permission in one click,
- after gaining permission you have access to data from the AgriFood sector,
- thanks to the shared data you can expand and improve your products and services.

Description Use Case: Data intermediaries: Consent and data exchange in agriculture (France)

Solution

Agdatahub is supporting the agricultural sector by implementing tools to ensure, that data sovereignty can be a day-to-day reality for French and European farmers, as the sector is an attractive cradle of data. Their vision of high-performance and sustainable agriculture, which is open to the world, is firmly anchored in the four pillars of innovation, community, European sovereignty, and fair governance. The use case is acting in creating value in agricultural chains by mobilizing data intelligence for healthy, traceable, and environmentally friendly food, and for technical advice tools to farmers. It gives operational advice on the structuring and exploitation of agricultural data, support, and as well as advice data scientists and marketing managers to communicate about their data offers.

Problem solved

Digital Identity

Digital identity makes it possible for:

- linking the identity of farmers (natural person) with the identity of their farm (legal person) to create a digital agricultural identity recognized by the whole sector.
- securing the information given by the different actors in the chain of consent, from field to plate
- simplify and speed up dematerialized transactions in complete confidence: CAP tele-declarations, contracts for the sale of their products to buyers of agricultural production (cooperatives, traders, industrialists, distributors, etc.).

The benefits of digital identity are the trust in consolidating the relationship between farmers and their partners in digital relationships, the safety in using blockchain technologies which allows to instantly check the origin and authenticity of the identity certificate. Also the digital identity allows the control to provide protection against the risks inherent in data in terms of operations, marketing and identity theft.

Farmer Consent

The main issue of consent is to enable farmers to regain control of their data by having a decentralized and multi-actor consent monitoring system.

This will allow farmers to list, add or revoke consent easily.

Associated with the digital identity device, the device created will allow the user to link his identity as a producer (person) with the identity of the operation (company). He will thus have a dematerialized portfolio in the cloud (wallet) which will be provided by Agdatahub and in which all identities are grouped and secure.

Access to this portfolio is then limited to authorized individuals only. Users will have access to the Agri-consent portal, where they will have a cockpit to manage their identities, authorized persons as well as digital interactions with their partners.

Data exchange platform

As a technical data intermediary solution Agdatahub provides API-Agro, an exchange platform, to offer a functional, technical, business and legal framework for data exchange between the different stakeholders: upstream industries, upstream agriculture, AgriFood companies, digital agriculture, financial services, professional organizations, public sector, education and research, using open and private data and APIs.

Digital identity and consent (in terms of authorizations) for farmers is another approach of Agdatahub. They are implementing a consent router to centralize consents from Farm Management System (FMS) and consent managers that have been developed in the

ecosystem. The router is going to be interconnected to the data exchange platform to check if farmers have consented to share their data executing the exchange.

Partners/Ecosystem

Agdatahub uses its expertise in operational consultancy to support farming industry actors in their exploitation of data and shares its knowledge in different projects. Agdatahub is currently planning to create a dashboard from which the farmer will manage the authorizations that he issues to his employees or partners to access the plan protection products room or use robotic equipment.



Figure 4

Main technology/Gaia-X components

As data intermediary using the same infrastructure as Gaia-X's, the platform can create significant synergies and added value for the entire agricultural industry. Further, both enable a visibility for the digital potential within the domain. The aim is to build a community that acts collectively by collaborating in the development of tools that facilitates the provision, sharing, exchange and interconnection of data in their territory. Gaia-X is conceived to assure data sovereignty. The user decides for himself, in every step.

Concrete benefits

Agdatahub pushes for innovation in the agricultural sector by enabling an easy and secure access to data. This stimulates innovation among industry and digital actors, and anticipates, predicts, and transforms risks into opportunities. It is important to ensure equitable access to data for all stakeholders in the European agricultural ecosystem.

Respecting the privacy by design principles, all solutions have been implemented to ensure high-security level with Know Your Customer (KYC), data encryption and full traceability of all actions. Furthermore, the Agdatahub products have integrated the recommendations from

the EU Code of conduct on agricultural data sharing by contractual agreement to empower farmers on their own data governance.

The principles of security by design and privacy by design of Gaia-X added value to the ecosystem and the guaranty of the highest security requirements and the protection of privacy.

Description Use Case: Agri-Gaia an AI ecosystem (Germany)

Solution

The Agri-Gaia project (<https://www.bmwi.de/Redaktion/EN/Artikel/Digital-World/GAIA-X-Use-Cases/agri-gaia.html>) is funded by the German Ministry of Economic Affairs and Energy. It aims for an AI ecosystem for the agricultural and food industry based on Gaia-X. For this purpose, an innovative B2B platform will be implemented, which provides industry-specific adapted AI building blocks as easy-to-use modules and brings together users and developers of AI algorithms in the AgriFood domain. Agri-Gaia closes the circle from sensor data acquisition on the agricultural machine, training of the algorithms on appropriate servers and continuous updating/optimization of the algorithms. Appropriate interfaces and standards are being developed so that a manufacturer-independent infrastructure for the exchange of data and algorithms is created.

Problem solved

AI development in the AgriFood domain is often a B2B process. Even bigger companies in this domain do not have in house AI knowledge and are forced to cooperate with AI companies in order to integrate AI in their products and processes. Agri-Gaia builds an infrastructure for these cooperation processes in order to ease the B2B AI development in the AgriFood sector.

Partners/Ecosystem

Project partners are:

- AgBrain GmbH
- Agrotech Valley Forum e.V.
- Amazonen-Werke H.Dreyer GmbH & Co. KG
- Robert Bosch GmbH
- CLAAS E-Systems GmbH
- DFKI GmbH
- University of Applied Sciences Osnabrück
- Josef Kotte Landtechnik GmbH
- Maschinenfabrik Bernard Krone GmbH & Co. KG
- LMIS AG
- Robert Bosch GmbH
- University Osnabrück

- Wernsing Feinkost GmbH

Additionally, about 30 associated companies from the AgriFood domain are involved. The ecosystem itself addresses the entire AgriFood domain.

Main technology/Gaia-X components

The Agri-Gaia ecosystem will be built based on the Gaia-X infrastructure, which ideally meets the requirements of the industry and the Agri-Gaia ecosystem in terms of data sovereignty, decentralization/multi-cloud and edge support and service delivery. A Gaia-X federator will be established that hosts the Gaia-X Federation Services. All participants in the Agri-Gaia ecosystem use these services for identity and access management, sovereign data exchange or to find other participants and services using the Gaia-X Federated Catalogue.

Concrete benefits

Agri-Gaia defines standards for AI development in the AgriFood domain and enables interoperability of data, trained models and edge devices. It eases the process of getting the needed data for AI development and B2B cooperation for AI development in this domain.

Description Use Case: Knowledge Graphs for data integration in the AgriFood sector (Poland)

Solution

Farm management is a complex process that involves multiple activities carried out by farmers and other stakeholders, who have to manage multiple and heterogeneous data sources collected and generated through various applications, services and devices. The rapid advances of IoT technologies, AI and Big Data, among others, have boosted the adoption of smart farming practices, which emphasizes the use of ICT in the farm management cycle to exploit the available data.

The explosion of data availability, however, has led to new challenges. Data is usually available in different sources, in different formats, and represented according to different models, thereby hampering data interoperability and integration. The lack of integrated data access, in turn, hinders the full potential of value creation based on all the available data, and the development of smart services and applications supporting the decision-making processes. Thus, a key challenge to realise the smart farming vision to its fullest is to combine/integrate those different and heterogeneous data sources in order to support the decision-making processes.

Knowledge graphs provide a flexible and efficient solution to address some of those challenges. In particular, they can provide an integrated view over (initially) disconnected and heterogeneous datasets, through the interlinking of different entities, based on Linked Data principles, and in compliance with any privacy and access control needs.

Problem solved

The following problems are solved by this Use Case:

- Lack of/limited access to (semantically) integrated data, hindering the full potential of value creation based on all the available data
- Limited/difficult data sharing and reusability in the AgriFood sector, including a rare adoption of FAIR principles
- Hidden valuable knowledge in logically related data (e.g., relations between data elements) that could be discovered through the established links and the possibility to exploit semantic inferencing and queries
- Interoperability issues between different services/applications relying on different data models and semantics, which is a key challenge in the AgriFood sector due to the numerous solutions available from different vendors/providers.

Partners/Ecosystem

Ecosystem partners include: agriculture organizations (e.g., advisory centers), AgriFood solutions providers, infrastructure providers and semantics experts. This use case will deliver knowledge graphs providing an integrated view over different and heterogeneous datasets, which can then be exploited by the agriculture organizations or AgriFood solution providers to deliver more efficient and innovative services and applications to the final end-users (e.g., farmers, advisors) supporting their decision-making processes (e.g., benchmarking, yield optimization, improved precision fertilization, etc.). Infrastructure providers may be also involved in order to enable the storage and processing of large amounts of data.

Main technology/Gaia-X components

Main technologies include:

- Standard and/or well-established ontologies/vocabularies in the AgriFood field providing the underlying model to represent data in the knowledge graphs. Such models should be easily extensible to support a variety of data and final applications. One example for this is the DEMETER Agriculture Information Model (AIM) which provides a common vocabulary to enable different applications to interoperate and exchange data that can be understood.
- Linked Data Pipelines services/tools to facilitate the transformation/translation and publication of different datasets as Linked Data. Such pipelines should be easy to reuse, reconfigure and adapt to handle different types of data and formats. This will also include possibility handle both mostly static data and highly dynamic data, where the latter will require the creation of virtual graphs over the original data sources. Additionally, the goal of such pipelines is to automatize as much as possible the linked data generation process, abstracting the different interfaces and specificities of the different tools supporting specific aspects of this process.
- Semantic databases (triple/quad stores) that can easily scale and handle large amounts of data. Such stores should also support efficiently geospatial features to access and query data based on their geographical location/extension, which is very relevant in the AgriFood sector.
- Easy to use and customize APIs to access the integrated data in knowledge graphs.

The following Gaia-X Core Services would (potentially) be required for this Use Case: Federated Catalogue, Data Connector, Self-Description and related Compliance, and optionally IAM. Regarding the Self-Description, a Metadata Schema for the AgriFood Domain will need to be defined, potentially reusing, if possible, existing schemas that are relevant for this domain like the CYBELE common semantic model.

Concrete benefits

- Access to integrated data in the AgriFood sector that could be exploited by different services/applications to support the decision-making processes of relevant actors (farmers, advisors, public institutions (e.g., dealing with CAP), etc.)
- Improved data findability and accessibility by both humans & machines, which can foster and enhance their reusability, in alignment with FAIR principles
- Discovery of new knowledge through the established links and the possibility to exploit semantic inferencing and queries
- Federated data access over multiple sources (endpoints) via federated queries, using a single-entry point
- Improved interoperability (of services/applications) with standardized interfaces and semantics (via the underlying ontologies/vocabularies) to use data in knowledge graphs
- Improved data sharing in compliance with the security/privacy constraints to access the underlying data.

Description Use Case: Interoperable data exchange for online task management, machine tracking and sensor communication (Belgium)

Solution

Online task management

For farmers, equipment operators and agricultural software users, online task management is a solution for real-time data exchange of historic and ongoing tasks in the field, between existing data platforms belonging to several mixed-colour connected machines. The data consist mainly of static data of field activity (done, or to be executed). The solution will support the main agricultural data exchange for managing and reporting activities done in the field.

Machine tracking

An online standard interface between existing telemetry solutions or portals (cloud solutions) allows farmers/contractors to see their whole mixed machinery fleet in one system of their choice unlike today where they are forced to use several OEM portals for getting an holistic overview of their machines in action. For the initial implementation, focus should be placed on limited data sets (dynamic, pseudo real-time, live data), with a high frequency (from 1 to 5 minutes updates or less).

In-field sensor communication

For farmers, monitoring field properties from different data platforms is a solution for real-time infield data analysis including weather data, topography of fields, crop vegetation indices and soil conditions. To this end, this use case sets the foundations for communicating data across different platforms and IoT devices such as infield sensors with the agricultural software solution of choice.

Problem solved

Online task management

Each agricultural machine platform and software supports different APIs. Not all machines connect to all software. Implementation takes huge amounts of time as each connection is custom. Not all functions of the APIs are equally supported by all data players. A standardized API would support software developers, increase quality and open new opportunities for data services. The farmers will have more tools at their disposal resulting in increased value creation for the agricultural world.

Machine tracking

Today each equipment manufacturer has its own telematics platform. Farmers operate different brands of vehicles; they need to consult multiple systems in order to have a complete overview of their running fleet. This is not practical and as such hindering the value creation on real time data such as logistics optimization. Near real-time communication of data coming from moving vehicles in a standardized format will allow visualization of different sources in one integration dashboard.

In-field sensor communication

There is no standardized API to pull data from platforms used in different verticals in agriculture. This should be a universal solution for cross-functional data exchange between different sectors.

Partners/Ecosystem

Views of the personas involved in the use case:

- **Equipment Operator:** I want to exchange task sets and fieldwork documentation with multiple agriculture software solutions to be clear about what fieldwork shall be done and to document what fieldwork has been done.
- **Agricultural software user:** I want to exchange task sets and fieldwork documentation with one or more equipment of a mixed fleet to be able to steer what fieldwork shall be done and to view what fieldwork has been done.
- **Equipment Owner:** I want to be able to manage which of my equipment is usable for the online task management use case in a mixed fleet, want to be able to share

telemetric data of my machine(s), so that I can use the software solution of my choice for tracking and want to be able to share sensor data of my infield sensors to several data consumers (agricultural software solution of my choice).

- **Contractor:** As contractor, I want to be able to use any available equipment in my mixed fleet, to be able to steer and document the fieldwork I am paid for and I want the farmer to share telemetric data of their equipment with me, so that I can track progress of the mixed fleet in the software solution of my choice, while doing work on their field(s).
- **Farmer:** I want a contractor to share telemetric data of their equipment with me, so that I can track progress on my fields with the software solution of my choice and I want to be able to share sensor data of my infield sensors with the agricultural software solution of my choice.

Main technology/Gaia-X components

There are different components required to support this use case: sign-on, discovery, standardized communication, data model, field master database, machinery master database, data privacy/ownership/retention rules and contractual agreements to support all of this.

Concrete Benefits

Key benefits for the end user include:

- a) Easy reporting process: Task orders are planned in the software system and are exchanged with the machines. Results (documentation) are then transferred back to the agricultural software of choice.
- b) Reduced time and effort for managing fieldwork.
- c) Real-time documentation of task orders/ task results.
- d) Real-time exchange of infield information with service providers
- e) Informed decision-making leading to optimization of infield operations.

Having a dashboard linking to IoT platforms of different vehicle manufacturers allows real-time optimization using multi-branded fleets, amongst other functionality. With this use case, farmers are supported in fleet management in grain and forage harvest. A new area of development and benefits for farmers is expected in farm and harvest logistics operations.

Description Use Case: Connected Potato data chain (Belgium)

Solution

Allowing a direct data flow between the smart potato harvester, the farm management system and the potato processing company by connecting the AVR connect platform on the machine with the WatchItgrow decision support system and with the Agristo ICT system using the Flemish data platform DjustConnect as a data intermediary. The data can flow, from the machine to the farmer and the processing business with full control of the farmer, as data owners.

Problem solved

Delivering the needed authentication, consent management and enable the data flow in the potato supply chain.

Partners/Ecosystem

The use case partners are AVR, manufacturer of a full range of potato production systems from soil preparation to harvesting and sorting; Agristo NV, a Belgian producer of pre-baked potato-inspired frozen products in the private label market; VITO an independent Flemish research organization in the area of cleantech and sustainable development and ILVO, Flanders Research Institute for Agriculture, Fisheries and Food.

Main technology/Gaia-X components

Services for identity and access management, sovereign data exchange and services using the Gaia-X federated catalogue.

Concrete benefits

To deliver trusted data sharing to the farmers and the agribusiness, with respect for the data owners and a sustainable business model. Having an architecture to make an international setup possible and to take the next step towards creating interoperability between all machinery at farm level.