D4.4 Decision Enablers, Advisory Support Tools and DEMETER Stakeholder Open Collaboration Space – Release 2

Dissemination level: Public
Submission date: 30th June 2021

Contents

List of Figures

List of Tables

1 Executive Summary

DEMETER aims to lead the Digital Transformation of the European Agrifood sector based on the rapid adoption of advanced technologies, such as Internet of Things, Artificial Intelligence, Big Data, Decision Support, Benchmarking, Earth Observation, etc., to increase performance in multiple aspects of farming operations, as well as to assure the viability and sustainability of the sector in the long term. It aims to put these digital technologies at the service of farmers using a human-in-the-loop approach that constantly focuses on mixing human knowledge and expertise with digital information. DEMETER focuses on interoperability as the main digital enabler, extending the coverage of interoperability across data, platforms, services, applications, and online intelligence, as well as human knowledge, and the implementation of interoperability by connecting farmers and advisors with providers of ICT solutions and machinery.

To enable the achievement of the aforementioned objectives, and to promote the targeted technological, business adoption and socio-economic impacts, DEMETER is designing and developing a targeted set of decision support system (DSS) related services to enable the delivery of tailored advisory services to the agricultural sector. These DSS-related services will combine the data analytics from WP2 with AI-based expert system, machine learning and benchmarking techniques to provide precision decision support to the users.

This deliverable provides an update of the different components that the DEMETER DSS-related services are developing to cover the needs from the pilots. Starting from the initial description of these DSS components from D4.2, the components have been updated to cover more aspects, some of them key for the farmer: an intuitive visualisation, where applicable. As it will be seen below, some of the components are making good progress, such that the current status of the DEMETER DSS-related services is well on track, with an average completion of 80%. Thus, next actions will focus in finishing all components at the same time that they are being deployed at farms' sites and, thus, validated by the farmers (pilots).

The other two important points under the scope of this document are the data visualisation module, and the implementation of SOCS. The data visualisation module presents the user with intuitive meaning thanks to Knowage, with which a catalogue of panels has been developed and with which the DSS-related services are being enhanced so the pilots will be presented with intuitive meaning. SOCS provides a collaboration space which makes a farmer's needs visible to advisors and developers. Following on from the initial steps taken to described spaces for collaboration, exchange of good practices and participation in the co-creation processes, recent discussions and workshops have been held with the Multi-stakeholder Approach (MAA, within WP7) team resulting in an improvement to both the look and the features of SOCS.

Finally, the results of the validation of the DSS-related services themselves will be considered and these DSS-related services together with some of the dashboards present in the Knowage catalogue might be improved while others may be enriched with new elements. Next actions under SOCS activity will be focusing on boosting the usability for non-technical users. A second iteration of workshops with SOCS users will aim at collecting feedback from them on the first version of the co-creation application. The workshop's results will converge in the SOCS Final version and will include a refinement of all SOCS services and the final version of the co-creation application.

2 Acronyms and Abbreviations

ACS	Access Control System
AI	Artificial Intelligence
AIM	Agricultural Information Model
AIS	Agricultural Interoperability Space
API	Application Programming Interface
AR	Augmented Reality
asWKT	As Well-Known Text
BBCH	Bayer, BASF, Ciba-Geigy, and Hoechst A numeric value representing the phenological development stages of plants
BOA	Bottom Of Atmosphere
BSE	Brokerage Service Environment
CAN	Controller Area Network
CAP	Common Agricultural Policy
CE	Community Edition
CMS	Catalogues Management System
CP	Collaboration Portal
CRUD	Create, Read, Update, Delete operations
CSV	Comma-Separated Values
DEE	DEMETER Enhanced Entities
DEH	DEMETER Enabler Hub
DOY	Day of the Year
DSS	Decision Support System
DYMER	Dynamic Information ModElling & Rendering
EIP	European Innovation Partnership
ET_0	Reference Evapotranspiration
FADN	Farm Accountancy Data Network
FAPAR	Fraction of Absorbed Photosynthetically Active Radiation
FaST	Farm Sustainability Tool
FTIR	Fourier Transform InfraRed Transform
GDD	Growing Degree Day
GeoJSON	JSON for Geographical data
GPRS	General Packet Radio Service
GPS	Global Positioning System
HCD	Human-Centred Design
HTTP	Hypertext Transfer Protocol
IDM	Identity Manager
IOT	Internet of Things
ICT	Information and Communications Technology
IT	Information Technology
JSON	JavaScript Object Notation
JSON-LD	JSON Linked Data
KPI	Key Performance Indicators
MAA	Multi-Actor Approach
ML	Machine Learning
NDVI	Normalised Difference Vegetation Index
OPTRAM	OPtical TRApezoid Model
OS	Operating System
POS	Pollination Optimisation Service

RBAC	Role-based Access Control
REST	Representational state transfer
RFC	Request for Comments
RNN	Recurrent Neural Network
SAR	Specific Absorption Rate
SCP	Specialty Crops Platform
SOCS	Stakeholders Open Collaboration Space
SOSA	Sensor-Observation-Sampling-Actuator ontology
STR	Shortwave-infrared Transformed Reflectance
TOC	Table of Contents
UI	User Interface
URL	Uniform Resource Location
UX	User Experience
YAML	YAML Ain't Markup Language

3 List of Authors and Reviewers

Company	Author
ICE	John Beattie (Editor)
	Oscar Garcia (Editor)
	Ross Campbell
ENG	Antonio Caruso
	Francesca Cantore
AGRICOLUS	Diego Guidotti
	Susanna Marchi
ATOS	Sergio Salmerón
DNET	Nenad Gligoric
JD	Andreas Schröder
MIMIRO	Harald Volden
	James Guy
SIMAVI	Mihai Angheloiu
TRAGSA	Azucena Sierra
	Eladio Rego
UBI	Vitor Sousa
UMU	Manuel Mora
VICOM	Izar Azpiroz
VITO	Bart Beusen

Company	Reviewer
SINTEF	Arne J. Berre
UDG	Stevan Čakić
	Tomo Popović
ATOS	Diego Esteban

4 Document History

Version	Date	Change editors	Changes
0.1	20/01/2021	Oscar Garcia (ICE)	First draft with TOC
0.2	25/01/2021	John Beattie (ICE) Oscar Garcia (ICE) Antonio Caruso (ENG) Francesca Cantore (ENG)	Comments to first draft + final TOC
0.3	05/02/2021	John Beattie (ICE) Ross Campbell (ICE)	Sample component update
0.4	30/04/2021	Bart Beusen (VITO) Izar Azpiroz (VICOM) Mihai Angheloiu (SIMAVI) Manuel Mora (UMU) Vitor Sousa (UBI) Andreas Schröder (JD) Nenad Gligoric (DNET) Sergio Salmerón (ATOS) Diego Guidotti (AGR) Susanna Marchi (AGR) Harald Volden (MIMIRO) James Guy (MIMIRO) Antonio Caruso (ENG) Azucena Sierra (TRAGSA) Eladio Rego (TRAGSA) Francesca Cantore (ENG)	Input to sections 6, 7 and 8 Input to Annexes A to E
0.5	28/05/2021	Oscar Garcia (ICE) John Beattie (ICE)	Input to sections 1, 2, 5 and 9
0.6	02/06/2021	Oscar Garcia (ICE) John Beattie (ICE)	Final check before peer review
0.7	11/06/2021	Tomo Popovic (UDG) Stevan Cakic (UDG) Arne Berre (SINTEF)	Peer review
0.8	18/06/2021	Oscar Garcia (ICE) John Beattie (ICE) Manuel Mora (UMU) Antonio Caruso (ENG) Francesca Cantore (ENG)	Updates to peer review
0.9	25/06/2021	Diego Esteban (ATOS)	Final format review
1.0	30/06/2021	Oscar Garcia (ICE)	Final version to be submitted

5 Introduction

This deliverable summarises the progresses made since the initial D4.2 was released reporting on WP4 tasks related to **Decision Enablers, Advisory Support Tools and DEMETER Stakeholder Open Collaboration Space**. Aims of these tasks were:

- to develop a self-service dashboard framework capable of integrating a number of service frontends, transformation operators and visualisation widgets.
- to develop generic enablers as open components that accelerate the development of sector or pilot specific decision support systems.
- to develop cloud-based collaboration tools that enable and support collaboration among different stakeholders in a pilot domain.

The document is structured as follows.

Section 6 details the different components that the DEMETER DSS is developing to cover the needs from the pilots. Starting from the list of components elaborated in D4.1 and D4.2, where a complete description of the features and functionality of the DSS components to be integrated in the frame of DEMETER was included, the component descriptions have been updated to reflect the progress carried out during this period. Besides the progress reported for each DSS-related services, a screenshot of their visualisation, where applicable, is provided along with a description of the view it presents to the user.

Section 7 shows the progress carried out for the data visualisation module, in which users will be presented with intuitive means to interactively explore and analyse data. This way, the users would be able to effectively identify interesting patterns and infer correlations and causalities. Thus, the users would have visual support for planning and undertaking meaningful activities on the farm. During this period, the different DSS component owners have provided requirements and guidelines to the visualisation team with views to implementing these in Knowage [1]. Knowage is an open-source suite developed by ENG that combines traditional data and big data sources into valuable and meaningful information. Further, to increase its interoperability, every exchange of information between any of the Knowage dashboards and its corresponding DSS component is performed using AIM, the Agricultural Information Model developed within WP2. Since the AIM model is based on the JSON-LD format, the integration between the analytical components, DSS and Knowage took place following a standardised and consolidated approach. Knowage supports JSON format (JSON-LD compatible) in data acquisition and provides standard APIs to extract this data into a correct format, normalising the information in a common dataset model. This approach allowed the rapid development of the different DSS dashboards and their internal components such as graphical widgets used to render information.

Section 8 provides an update of the progress performed for the Stakeholders Open Collaboration Space **(SOCS)**. The SOCS is a space **dedicated to all stakeholders** (farmers, advisors, and suppliers) where they can **collaborate, share best practices, and participate in the co-creation processes**. This collaboration space makes a farmer’s need visible to advisors and developers and conveys the information coming from the farmers as input to select the most suitable resources registered in DEH to be used to build the optimal solution. The improvements that have occurred in SOCS have been leveraged after several workshops organised together with the Multi-Actor Approach (MAA) team from WP7 so that easier access and navigation has been added to improve the User Experience (UX) of the farmers.

Finally, the document is completed with a set of annexes dedicated to the following aspects:

- Annex A provides a follow up of the requirements tracking activities.
- Annex B provides an update to the REST APIs of the different DSS components.
- Annex C provides the inputs and outputs for the different DSS components which are compliant with the AIM developed within WP2.
- Annex D describes the underlying technology used for constructing SOCS, namely DIHIWARE.
- Annex E reports on the results of a SOCS-WP7 workshop to identify the specific data that would be needed to describe the main components within the SOCS platform after WP7 previously introduced an improved layout and design.

6 Decision Support Enablers and Advisory Support Tools

After the activities reported in D4.2, the following is the classification adopted by WP4 to the different pilots. It is worth noting that the list of components from D4.2 has been updated resulting in change of assignments and responsibilities, a couple of name updates to make those components more descriptive and Area B has been completely reorganised with the changes below:

- Changes in responsibilities:
    - Component 4.C.1 has been finally assigned to SIMAVI.
    - Component 4.C.2 has been finally assigned to Ubiwhere.
    - Area 4.D and 4.H are now under the responsibility of ICE and TRAGSA, respectively, since it has been proven difficult for both JD and ROTECH to lead these areas.

- Renamed components:
    - (old) Component 4.E.1 Computer Vision-based Counting Module is now called **4.E.1 Pest Estimation with Sterile Fruit Flies**.
    - (old) Component 4.G.2 Stress Recognition: Support Vector Machine for Poultry Stress detection is now called **4.G.2 Poultry Well Being**.
    - (old) Component 4.H.1 Traceability is now called **4.H.1 Milk Quality Prediction**.

- Area B components:
    - **(old) Component 4.B.1 Water Balance Model** has been removed.
    - **(old) Component 4.B.2 Data Fusion for Irrigation** has been removed.
    - **(new) Component 4.B.1 DSS for Irrigation Management** has been added.
    - **(new) Component 4.B.2 Reference Evapotranspiration Prediction** has been added.
    - **(new) Component 4.B.3 Soil Moisture Estimation** has been added.
    - **(new) Component 4.B.4 Crop Water Status Anomalies Detection** has been added.

The table below details the final list of components classified by their areas and the lead partner as well as their completion percentage:

Type of Area	Area	Component	Responsible (Partner)	Completion
Crop Farming	4.A - Crop Growth, Status and Yield (VITO)	4.A.1 Plant Yield Estimation	Bart Beusen (VITO)	80%
		4.A.2 Plant Phenology Estimation	Izar Azpiroz (VICOM)	90%
		4.A.3 Plant Stress Detection	Mihai Angheloiu (SIMAVI)	70%
		4.A.4 Crop Type Detection	Bart Beusen (VITO)	70%
		4.A.5 Estimate Beehive	Ross Campbell (ICE)	50%

Type of Area	Area	Component	Responsible (Partner)	Completion
	4.B - Irrigation Management (UMU)	4.B.1 DSS for Irrigation Management	Manuel Mora (UMU)	70%
		4.B.2 Reference Evapotranspiration Prediction	Manuel Mora (UMU)	100%
		4.B.3 Soil Moisture Estimation	Manuel Mora (UMU)	100%
		4.B.4 Crop Water Status Anomalies Detection	Manuel Mora (UMU)	20%
	4.C - Nutrition Management (SIMAVI)	4.C.1 Nitrogen Balance Model	Mihai Angheloiu (SIMAVI)	70%
		4.C.2 Nutrient Monitor	Vitor Sousa (UBI)	90%
	4.D - Machinery and Field Operations (ICE)	4.D.1 Emission	Andreas Schröder (JD)	40%
		4.D.2 Field Operation	Nenad Gligoric (DNET)	90%
		4.D.3 Variable Rate	Bart Beusen (VITO)	100%
	4.E - Pest and Disease Management (ICE)	4.E.1 Pest Estimation with Sterile Fruit Flies	Sergio Salmerón (ATOS)	40%
		4.E.2 Estimate Temperature-related Pest Events	Diego Guidotti (AGRICOLUS)	80%
Livestock Farming	4.F - Animal Yield (MIMIRO)	4.F.1 Estimate Milk Production	Harald Volden (MIMIRO)	70%
		4.F.2 Poultry Feeding	Nenad Gligoric (DNET)	100%
	4.G - Animal Welfare (ENG)	4.G.1 Estimate Animal Welfare Condition	Antonio Caruso (ENG)	100%
		4.G.2 Poultry Well-Being	Nenad Gligoric (DNET)	90%
General decisions about farm management	4.H - Traceability (TRAGSA)	4.H.1 Milk Quality Prediction	Antonio Caruso (ENG)	100%
		4.H.2 Transport Condition	Nenad Gligoric (DNET)	90%
		4.H.3 Field Book and FaST	Azucena Sierra	75%

Type of Area	Area	Component	Responsible (Partner)	Completion
	4.I - Benchmarking (AGRICOLUS)	4.I.0 Indicator Engine for Benchmarking Purpose	Diego Guidotti (AGRICOLUS)	90%
		4.I.1 Generic Farm Comparison	Diego Guidotti (AGRICOLUS)	100%
		4.I.2 Neighbour Benchmarking	Diego Guidotti (AGRICOLUS)	100%
		4.I.3 Technology Benchmarking	Diego Guidotti (AGRICOLUS)	90%

Table 1: DEMETER Decision Support Components

The next sections describe the updates on every single component of the DEMETER DSS. These consist of progress made to the features of each component and, where applicable, an update on the description of the components. In addition, some components include a mock-up or an early development stage of their UI, developed by means of Knowage, and as such the business description and usage of the UIs are incorporated as well. Finally, the development plan is also updated.

6.1 *DSS AREA: 4.A - Crop Growth, Status and Yield*

6.1.1 Component 4.A.1 Plant Yield Estimation

Description	The yield prediction component will receive a field as input, including attributes such as geometry and crop information (with start date of crop). A request can be made against the field which will return the predicted yield. The request can only be made 1 to 4 weeks before expected harvest date.
Responsible Partner	Bart Beusen (VITO)
Partners	VITO
Pilots	3.4

Table 2: Component 4.A.1 Metadata

Dashboard Widget

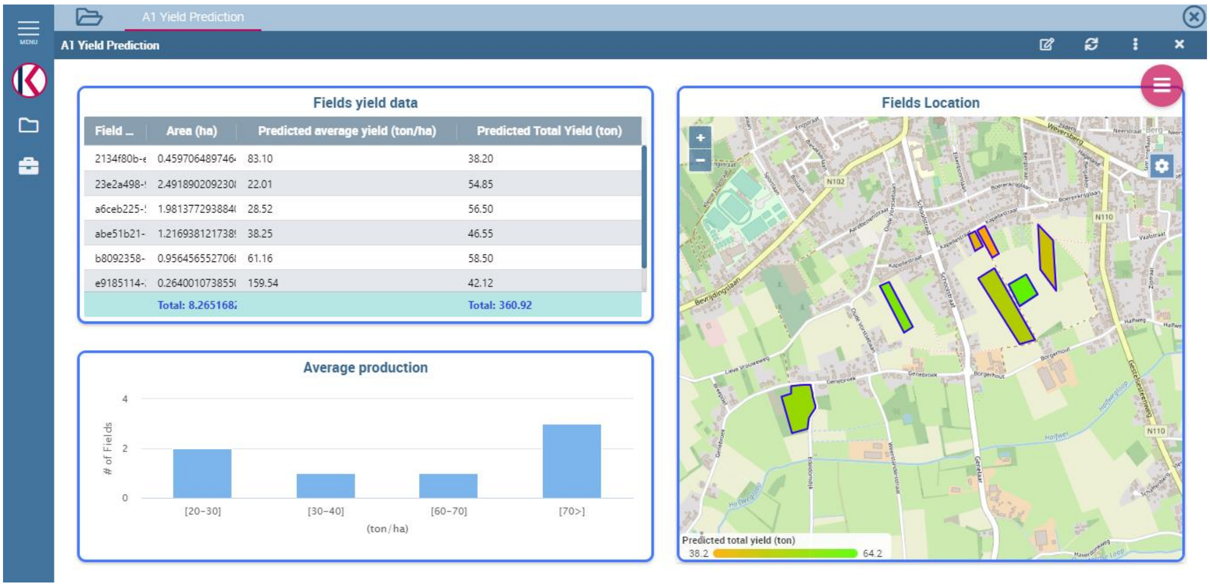


Figure 1: Component 4.A.1 Dashboard Widgets

The dashboard for the Yield Prediction Component (see Figure 1) will take the form of a single visualisation that will be represented in Knowage. This will display a table with a row per field, indicating the predicted yield and measured yield when available. Next to the table, a map is shown with the fields coloured by predicted yield. A histogram showing the distribution of predicted yields is shown at the bottom, allowing the user to compare the production of different fields to each other.

Dependencies (either internal to DEMETER or bound to the pilot)

1. Sentinel-2 Time Series Service – This service is available free of charge on the Terrascope platform hosted by VITO.
2. Meteo data and meteo prediction.

Core Enablers Used

1. BSE - Brokerage Service Environment – Providing mechanism for the discovery of services.
2. ACS - Access Control System – Providing Authentication and Authorisation mechanisms for the yield prediction component.
3. Model Management: MLflow for model management.

Security Usage (Data & User)

4.A.1 - Yield prediction component will make use of the DEMETER ACS to ensure security for both the user and data managed by the component.

Current Status

Feature	Short description	Status
Research requirements of yield prediction	Researching and identification of WP4 requirements of the yield prediction Service	Done
Development of AIM model (Input & Output)	Development of the input and output schemas for the yield prediction ensuring this is AIM compliant	Done
Visualisation Design	Mock-ups of the Knowage visualisations that will be produced for the yield prediction component	Done

Feature	Short description	Status
Integration with DEH	Integration and testing of the yield prediction component as a registered enabler in the DEMETER Enabler Hub	In Progress
Backend Development	Implementation and testing of the component's REST API and connection to WatchItGrow database	In Progress
Integration of AIM in component	Aligning the communication schema of the yield prediction component with the AIM model defined in stage 1	Done
Data Integration: Meteorological Data	Integration of meteorological data into the algorithm defined for the calculation of pollination requirements	Not Started
Basic algorithm Implementation	Implementation of the yield prediction algorithm excluding the integration of meteorological data	Done
Advanced algorithm Implementation	Implementation of the yield prediction algorithm including the integration of meteorological data	Not started
ACS Implementation and Integration	Integration of the component with the DEMETER ACS to provide authentication and authorisation mechanisms compliant with the DEMETER project	In progress
Deployment and Evaluation (Test Environment)	Deployment, evaluation and validation of the yield prediction component and its integration with AVR and WIG in a test environment	Not Started
Component Refinement	Review of evaluation and validation reports with component refinement if needed (e.g., bug fixes)	Not Started
Deployment and Evaluation (Production Environment)	Deployment, evaluation and deployment of the yield prediction component and its integration with the service in the production environment	Not Started

Table 3: Component 4.A.1 Status

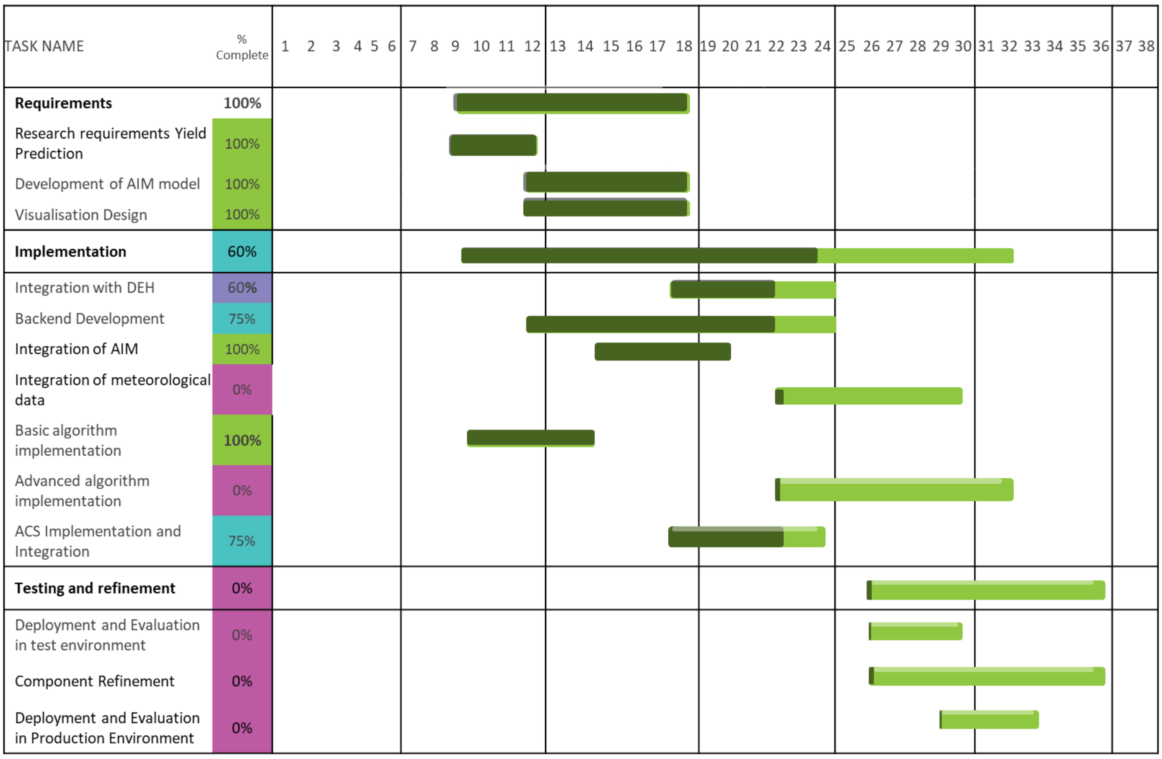


Figure 2: Component 4.A.1 GANTT Chart

6.1.2 Component 4.A.2 Plant Phenology Estimation

Description	The DSS component on Plant Phenology Estimation provides the farmer with a prediction of the olive phenology state for the next six days. In other words, it allows the farmer to estimate the best day to harvest as well as being a tool to monitor growing conditions. The internal functionality design of this component is based on data extracted from external weather API Meteostat. The final output of this component is presented to the farmer using the DEMETER visualisation and adaptive framework module, Knowage. In addition, this DSS component employs a previously trained Random Forest Model, a model that has been constructed using the DSS of the WP2 Prediction Model Training Web Service Enabler. In summary, this component receives the latitude and longitude coordinates of several places, makes a query to Meteostat API to receive temperature measurements, predicts the BBCH phenology state using a trained model and provides the results using the visualisation tool of Knowage.
Responsible Partner	Izar Azpiroz (Vicomtech)
Partners	Vicomtech, Agricolus
Pilots	3.1

Table 4: Component 4.A.2 Metadata

Dashboard Widget

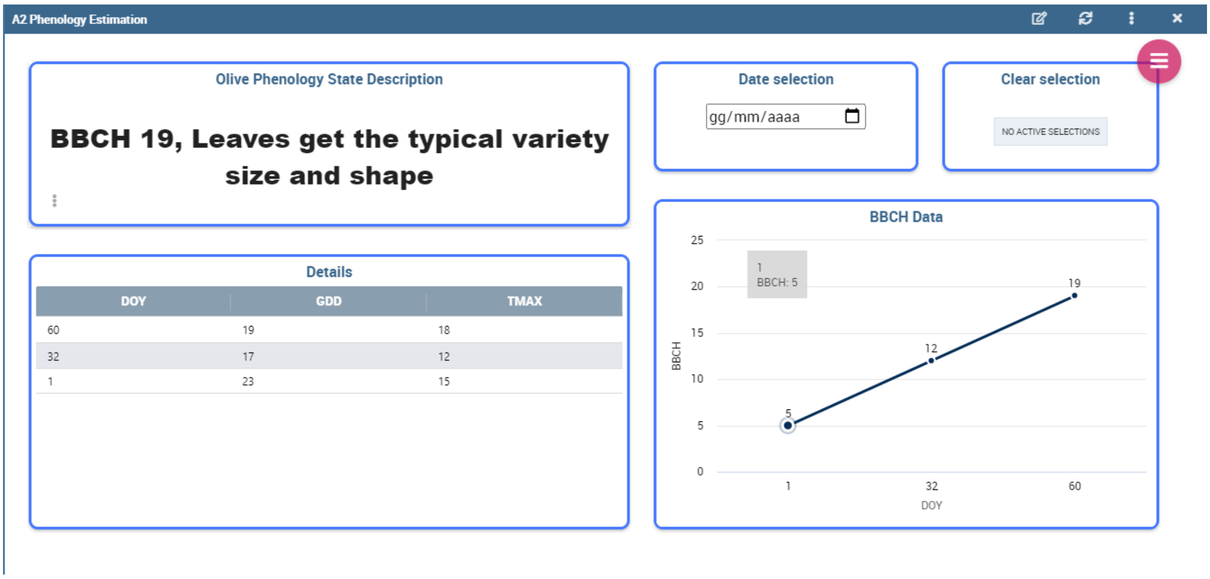


Figure 3: Component 4.A.2 Dashboard Widgets

The output data model of this DSS component is based on the DEMETER AIM data model and will be available using a REST API. Using the Knowage module, the output data will be visualised in a web front-end using graphical widgets based on a previously designed mock-up (shown Figure 3) so the farmer can visualise the predicted olive phenology state, its physical description and the historical temperature measurements of the place of interest (Table of details), and a line chart visualising the historical evolution of the BBCH (numeric value representing the olive phenology state) depending on the Day Of Year (DOY).

The following shows the flow steps to produce the BBCH Olive Phenology State prediction:

1. Enter the coordinates using the dashboard interface or place names if using the URL, *http://localhost:5003/phenology_prediction_api/v1.1/place1;place2;place3*.
2. Using the Meteostat weather API we extract the historic temperature measurements from the first of January until the day of interest.
3. We compute the Growing Degree Day (GDD), the accumulated energy from maximum and minimum temperature values.
4. Using the previously trained model, we compute the BBCH for every day until the current date and for a further six forecasted days.
5. We associate the corresponding physical description to each observation and translate to its corresponding AIM format.
6. The AIM format will be available in *http://localhost:5003/demeter_AIM/* or it will be received by Knowage visualisation component using a GET call.

Dependencies (either internal to DEMETER or bound to the pilot)

1. DEE for BBCH Olive Phenology State prediction “Plant Phenology Estimation”.
2. DEE for data training “Prediction Model Training Web Service Enabler” (WP2).
3. DEMETER visualisation and adaptive framework Knowage module.

Core Enablers Used

1. BSE - Brokerage Service Environment – Providing mechanism for the discovery of services.
2. ACS - Access Control System – Providing Authentication and Authorisation mechanisms for the yield prediction component.
3. DEH - DEMETER Enabler Hub – Registering in DEMETER the virtualised component.

Security Usage (Data & User)

4.A.2 - Plant Phenology Estimation component will make use of the DEMETER ACS to ensure security for both the user and data managed by the component.

Current Status

Feature	Short description	Status
Current version	Status of expected functionality of the latest version of the component	Advanced. Functional with already integrated components returning data as AIM for several places
Initial Design	Designing the DSS structure (i.e., required external components, service, etc.), REST API, and backend methods for implementation	Done
Visualisation Design	Mock-up for the Knowage visualisation module	Done
AIM output model	Development of the output AIM data model also needed for Knowage to visualise the information	Done

Feature	Short description	Status
Backend Development	Development for AIM wrappers for data coming from all external components. Implementation of the REST API core	Not necessary
Component Integration/ Interoperability: Prediction Model Training Web Service (WP2)	Integration with the external DEE to train models.	Advanced
Component integration/ Interoperability: Plant Phenology Estimation	Integration with the DEE to provide BBCH Olive Phenology State prediction	Done
Integration with ACS	Use of credential mechanism for DEH and BSE	Done
Integration with DEH	Integration of component as a registered DEE in the DEMETER Enabler Hub	Done/tested with current version
Integration with BSE	Integration of component as a registered DEMETER service in the BSE	Done/tested with current version
Deployment and evaluation in test environment	Deployment, evaluation, and validation of the DSS component and its integration with the external components in a test environment	Done/tested with current version
Deployment and evaluation in production environment	Deployment, evaluation, and validation of the DSS component and its integration with the external components in a production environment	In progress
Component Refinement	Review of evaluation and validation reports with component refinement if needed (i.e., bug fixes, frontend, etc.)	Not Started

Table 5: Component 4.A.2 Status

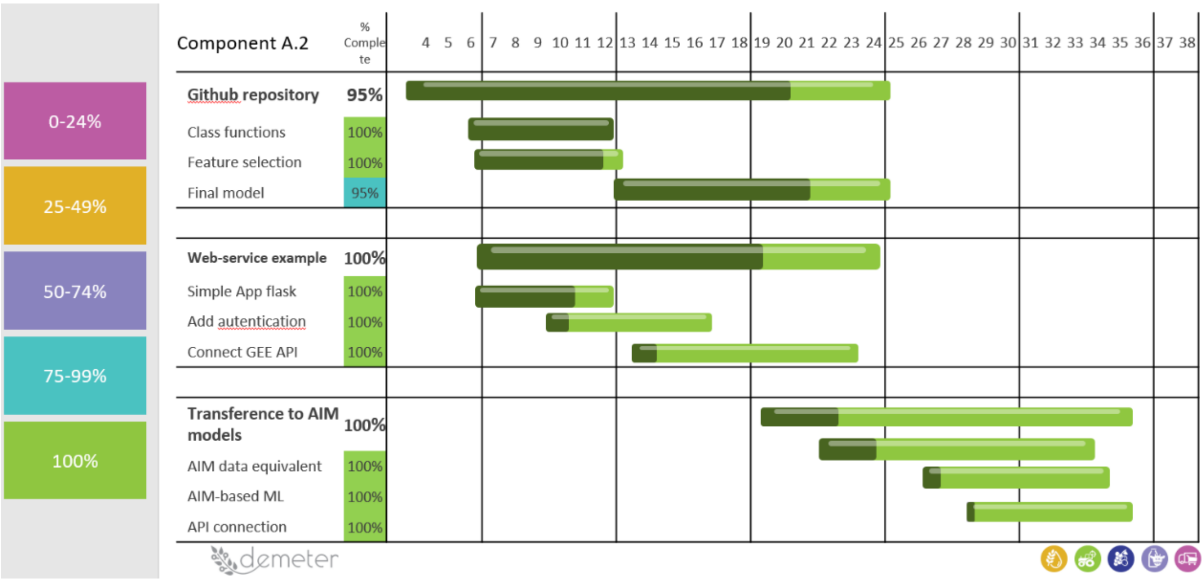


Figure 4: Component 4.A.2 GANTT Chart

6.1.3 Component 4.A.3 Plant Stress Detection

Description	Plant stress can come from many causes such as: extreme temperatures (scorching heat and winter harshness), lack/excess of water, etc. The composition of the NDVI vegetation plan will be used as a modern method of determining plant problems.
Responsible Partner	Mihai Angheloiu (SIMAVI)
Partners	SIMAVI & APPR (Romanian Corn Producers Association)
Pilots	1.4

Table 6: Component 4.A.3 Metadata

Dashboard Widget

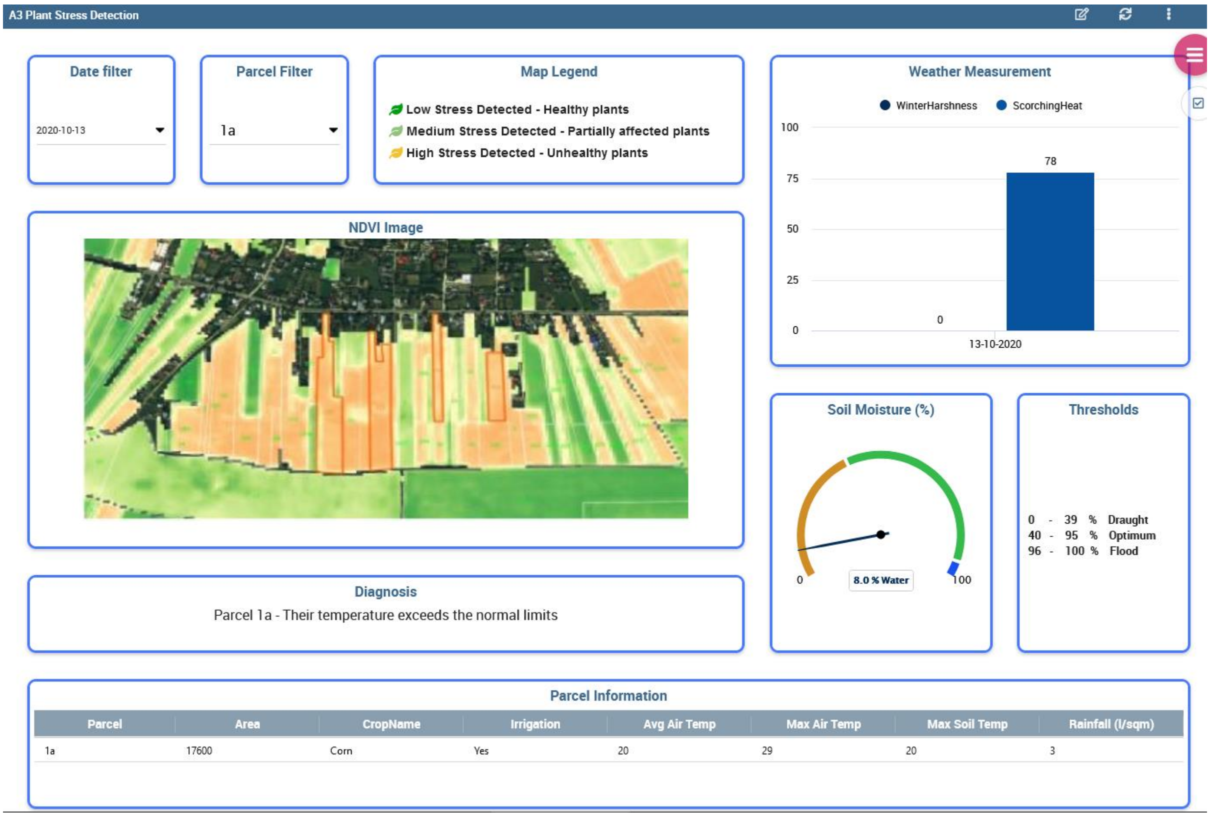


Figure 5: Component 4.A.3 Dashboard Widgets

The dashboard will contain a **map widget** showing different levels of stress in the same plot. This map will be obtained from NDVI images (Terrascope) by using the pixel classification method. Therefore, the image will be differentiated according to the stress level of the plants. Stress can be due to lack or excess of water or very high temperatures, over several consecutive days.

Based on this map, it will be easier to identify problem areas and it will be possible to go to the field and act directly with the necessary treatments.

The **Weather Measurement widget** indicates the scorching heat and winter harshness units based on the temperatures received from the agrometeorological station installed in the respective plot. The determination of the indices is based on an algorithm for gathering consecutive days with degrees exceeding the threshold of 32 degrees - in summer or which are below the freezing threshold of -10 degrees in winter.

The **Soil Moisture widget** together with **Thresholds** graphically indicates the volumetric water content in the soil for the selected parcel.

The **Diagnosis textbox widget** will display a text with the diagnosis according to the data received from weather station, forecast and Terrascope, that will indicate if there is any stress in the plot.

Dependencies (either internal to DEMETER or bound to the pilot)

1. Terrascope Satellite Imagery Service.
2. WatchItGrow.be – NDVI pixels classification into polygons (from VITO partner).
3. OpenWeather.com – Weather forecast service.

Core Enablers Used

1. AIM for data exchange.
2. DSS Visualisation Dashboard (Knowage).
3. BSE - Brokerage Service Environment – Providing mechanism for the discovery of services.
4. ACS - Access Control System – Providing Authentication and Authorisation mechanisms for the plant stress detection component.

Security Usage (Data & User)

4.A.3 - Plant Stress Detection component will make use of the DEMETER ACS to ensure security for both the user and data managed by the component.

Current Status

Feature	Short description	Status
Data Collector	Implement data collector service to gather information from ground weather stations, Terrascope satellite imagery, OpenWeather and in-situ farmers' data	Done
Development of AIM model (Input & Output)	Manipulate and process AIM format as data inputs/outputs (read, search, update and write) using third-party framework	In Progress
DSS Visualisation Design	Mock-ups of the Knowage visualisations that will be produced for the plant stress detection component	Done
Integration with DEH, BSE, ACS	Register this service to BSE, DEH and integrate it with ACS and Knowage	In progress
Initial Component Architecture	Designing the project structure, REST API and backend methods for implementation	Done
Algorithm Research	Research and define the DSS algorithm that determines the plant stress	Done
Algorithm Development	Implement the DSS algorithm that determines the plant stress detection	In Progress
Backend Development	Develop the backend services to make the service available through REST API	In Progress
Test and validation	Test and validate the component	Not Started
Component Refinement	Review of evaluation and validation reports with component refinement if needed (e.g., bug fixes)	Not Started
Publish the component	Publish the component docker image to Docker Hub	Not Started

Table 7: Component 4.A.3 Status

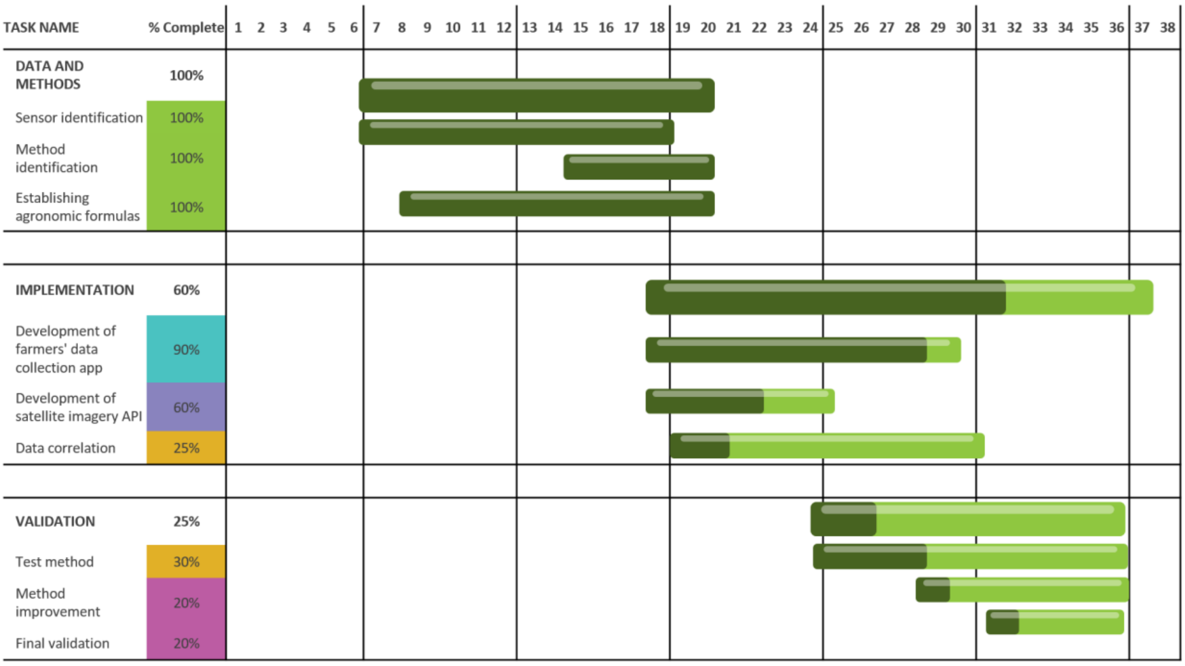


Figure 6: Component 4.A.3 GANTT Chart

6.1.4 Component 4.A.4 Crop Type Detection

Description	The goal of this component is to detect the crop type for a given polygon and a given timeframe (growing season of the crop), using satellite data as input. The model for crop type detection in this component is implemented as a Recurrent Neural Network (RNN) using the TensorFlow deep learning framework. A recurrent architecture is chosen because we need to take into account not just individual images, but timeseries of images. Instead of looking at individual pixels in the field, the timeseries is composed of data averaged over the parcel, e.g., 1 NDVI value per field per timestep. Behind the scenes, the component uses a combination of Sentinel-1 and Sentinel-2 data to detect the crop type. While optical imagery from Sentinel-2 provides us with information on biophysical plant properties, the images may be obscured by clouds. We therefore also use Sentinel-1 radar data that can look through clouds, providing us with a reliable source of information at regular time intervals. In addition, Sentinel-1 data provides us with information on plant structural properties as well (e.g., elongated plant structures of maize vs. low closed canopy structures of potato).
Responsible Partner	Bart Beusen (VITO)
Partners	VITO
Pilots	3.4

Table 8: Component 4.A.4 Metadata

Dashboard Widget

No dashboard widget is foreseen for this component. However, if the need arises for a certain pilot, a widget can be created in a quick way by using the Dashboard and Visualisation features.

Dependencies (either internal to DEMETER or bound to the pilot)

1. WatchItGrow crop detection service will be accessible to DEMETER partners; however, it is not yet designed to handle large loads. This service takes a polygon and a year as input and provides as a result a crop type description in AIM format. This service depends on other services hosted by VITO, all part of the Terrascope[1] platform.

Core Enablers Used

1. BSE - Brokerage Service Environment – Providing mechanism for the discovery of services.
2. ACS - Access Control System – Providing Authentication and Authorisation mechanisms for the crop type detection component.

Security Usage (Data & User)

4.A.4 - Crop Type Detection component will make use of the DEMETER ACS to ensure security for both the user and data managed by the component.

Current Status

Feature	Short description	Status
Research requirements of crop type detection	Researching and identification of WP4 requirements of crop type detection	Done
Development of AIM model (Input & Output)	Development of the input and output schemas for the crop type detection ensuring this is AIM compliant	Done
Visualisation Design	Mock-ups of the Knowage visualisations that will be produced for crop type detection.	Not started
Integration with DEH	Integration and testing of the variable rate component as a registered enabler in the DEMETER Enabler Hub	Not started
Algorithm Research and Development	Researching and defining the attributes that can be taken into account to detect the crop type	In progress
Backend Development	Implementation and testing of the project, REST API and methods defined in the Algorithm Research and Development Stage	In Progress
Integration of AIM in component	Aligning the communication schema of the crop type detection component with the AIM model defined in stage 1	In Progress
Algorithm Implementation	Implementation of the crop type detection algorithm	In Progress
ACS Implementation and Integration	Integration of the component with the DEMETER ACS to provide authentication and authorisation mechanisms compliant with the DEMETER project	Not Started
Deployment and Evaluation (Test Environment)	Deployment, evaluation and validation of the component and its integration with WatchItGrow within a test environment	Not Started
Component Refinement	Review of evaluation and validation reports with component refinement if needed (e.g., bug fixes)	Not Started

[1] https://terrascope.be/en/sectors/agriculture

Feature	Short description	Status
Deployment and Evaluation (Production Environment)	Deployment, evaluation and deployment of the variable rate component and its integration with the WatchItGrow service in the production environment	Not Started

Table 9: Component 4.A.4 Status

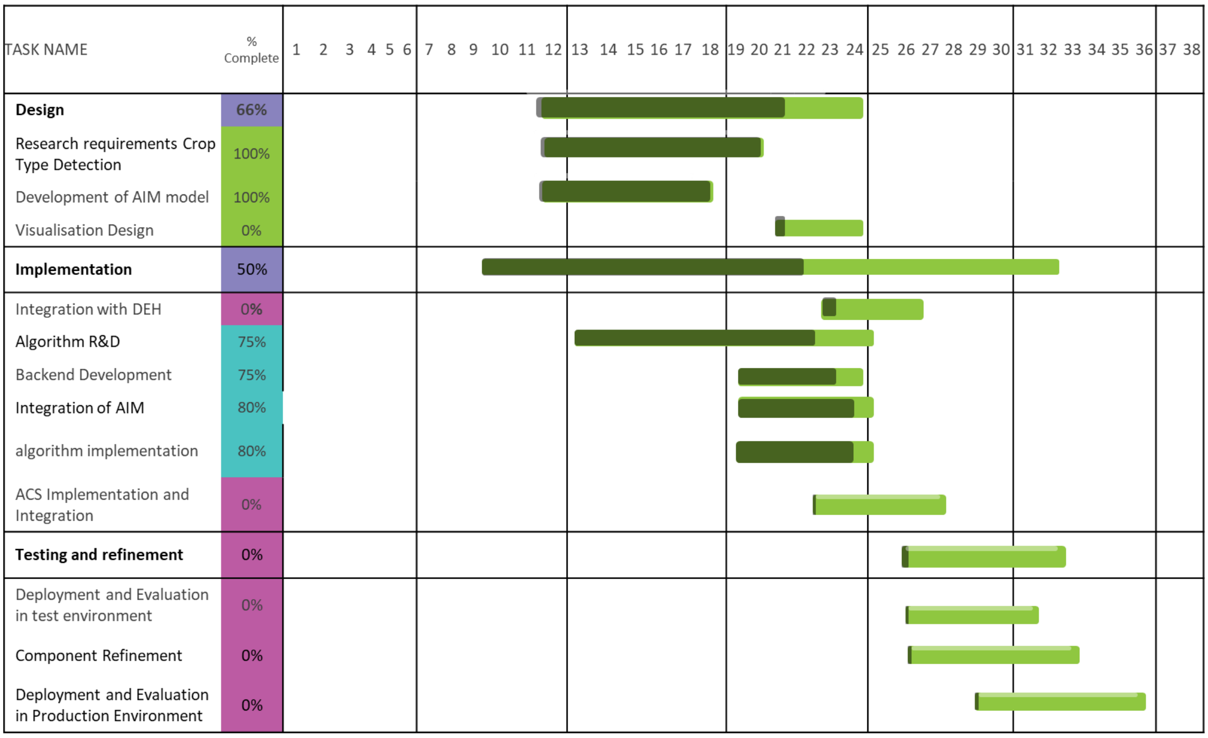


Figure 7: Component 4.A.4 GANTT Chart

6.1.5 Component 4.A.5 Estimate Beehive

Description	The Estimate Beehive component will receive a field as input, including attributes of the field that may affect the calculation of pollination requirements. Once the field has been registered with the component, a request can be made against the field which will return the estimated number of beehives required to optimally pollinate the identified field.
Responsible Partner	Ross Campbell (ICE)
Partners	Information Catalyst for Enterprise (ICE), Poznan Supercomputing and Networking Centre (PSNC)
Pilots	5.3

Table 10: Component 4.A.5 Metadata

Dashboard Widget

Figure 8: Component 4.A.5 Dashboard Widgets

The dashboard for the Estimate Beehive Component (see Figure 8) will take the form of a single map-based visualisation that will be represented in Knowage. This will display the field identified for pollination estimation, alongside the number of hives required for optimal pollination.

Dependencies (either internal to DEMETER or bound to the pilot)

1. Pollination Optimisation Service – The service being created by pilot partners to interact with existing Farm Management and Apiary Management Systems. Within DEMETER it is this service that is expected to call the estimate beehive component for pollination estimations.

Core Enablers Used

1. BSE - Brokerage Service Environment – Providing mechanism for the discovery of services.
2. ACS - Access Control System – Providing Authentication and Authorisation mechanisms for the estimate beehive component.

Security Usage (Data & User)

4.A.5 - Estimate Beehive component will make use of the DEMETER ACS to ensure security for both the user and data managed by the component.

Current Status

Feature	Short description	Status
Research requirements of POS	Researching and identification of WP4 requirements of the Pollination Optimisation Service	In Progress
Development of AIM model (Input & Output)	Development of the input and output schemas for the estimate beehive component and ensuring this is AIM compliant	In Progress – Not yet Validated
Visualisation Design	Mock-ups of the Knowage visualisations that will be produced for the estimate beehive component	Done

Feature	Short description	Status
Integration with DEH	Integration and testing of the estimate beehive component as registered enabler in the DEMETER Enabler Hub	Not Started
Initial Design	Designing the project structure, REST API and backend methods for implementation in the estimate beehive component	In Progress
Algorithm Research and Development	Researching and defining the attributes that can be taken account of to define the algorithm that will be used to calculate the required number of beehives to optimally pollinate a field.	In Progress
Backend Development	Implementation and testing of the project, REST API and methods defined in the Algorithm Research and Development Stage	In Progress
Usage and Integration of AIM in component	Aligning the communication schema of the estimate beehive component with the AIM model define in stage 1	In Progress
Data Integration: Meteorological Data	Integration of meteorological data into the algorithm defined for the calculation of pollination requirements	Not Started
Algorithm Implementation	Implementation of the beehive estimation algorithm including the integration of meteorological data	Not Started
ACS Implementation and Integration	Integration of the component with the DEMETER ACS to provide authentication and authorisation mechanisms compliant with the DEMETER project.	Not Started
Interoperability Integration with POS system	Integration tests with the Pollination Optimisation Service	Not Started
Deployment and Evaluation (Test Environment)	Deployment, evaluation and validation of the estimate beehive component and its integration with the POS within a test environment	Not Started
Component Refinement	Review of evaluation and validation reports with component refinement if needed (e.g., bug fixes)	Not Started
Deployment and Evaluation (Production Environment)	Deployment, evaluation and deployment of the estimate beehive component and its integration with the POS in the production environment	Not Started

Table 11: Component 4.A.5 Status

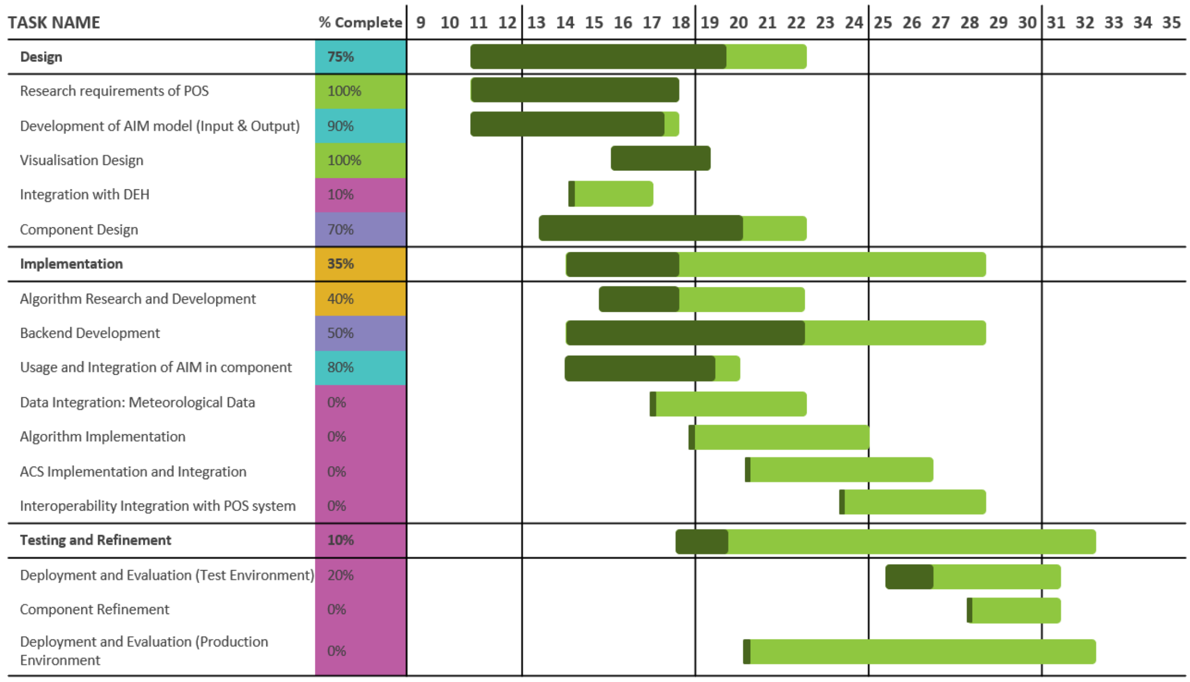


Figure 9: Component 4.A.5 GANTT Chart

6.2 *DSS AREA: 4.B - Irrigation Management*

6.2.1 Component 4.B.1 DSS for Irrigation Management

Description	The DSS component for Irrigation Management provides the farmer with information to estimate the irrigation water needed for a crop using other components and data retrieved from the pilot cloud platform. The final output of this component is presented to the farmer using the DEMETER visualisation and adaptive framework Knowage module.
Responsible Partner	Manuel Mora (UMU)
Partners	UMU
Pilots	1.1_1.2

Table 12: Component 4.B.1 Metadata

Dashboard Widget

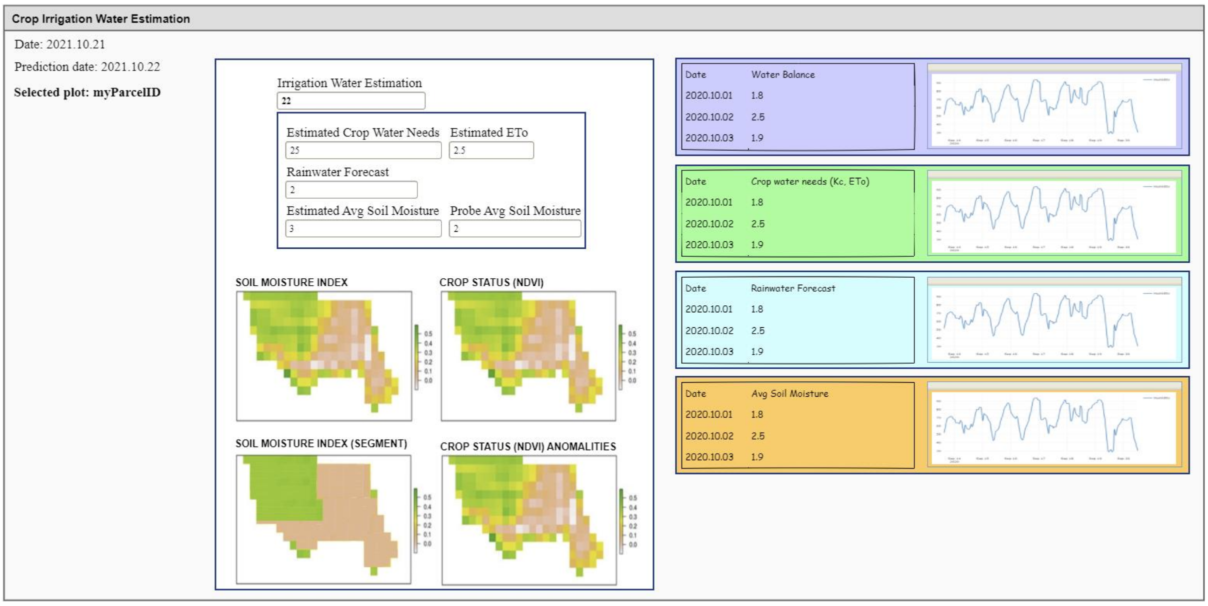


Figure 10: Component 4.B.1 Dashboard Widgets

The output data model of this DSS component is based on the DEMETER AIM data model and will be available using a REST API. Using the Knowage module, the output data will be visualised in a web front-end using graphical widgets based on a previously designed mock-up (as shown in Figure 10) so the farmer can take the final decisions to commit the required irrigation tasks taking into account the estimated amount of water, the rainwater forecast, the soil moisture and the possible water anomalies found along the crop. The dashboard shows a box with numeric data related to the estimations. Below are some images about the soil moisture and water status anomalies, and on the right some time series.

The internal functionality design of this component has been split and now it is based in data calculated by other external components. The flow steps are shown next:

1. Using a component from WP2 to retrieve data from the pilot cloud infrastructure, it retrieves agronomic data in AIM format using the id of a plot.
2. Using a component from WP2 to retrieve weather forecast data, it retrieves rainwater forecast information in AIM format using the plot location.
3. Using the Reference Evapotranspiration Prediction component (4.B.2), it retrieves the prediction of the reference evapotranspiration (ET_0) in AIM format using the plot location.
4. Using a component from WP2 to estimate the crop irrigation water, and the retrieved agronomic data, rainwater forecast and ET_0 prediction it retrieves the estimation of irrigation water in AIM format.
5. Using the Soil Moisture component (4.B.3): it retrieves information about the soil moisture along the plot, in an image and calculates the average value in AIM format.
6. Using the Crop Water Status Anomalies Detection component (4.B.4), it retrieves information about possible plant water status anomalies along the crop in an image in AIM format.
7. With all retrieved data, this DSS component offers the final output using AIM format, data that is represented by the DEMETER visualisation and adaptive framework module, Knowage.

Dependencies (either internal to DEMETER or bound to the pilot)

1. DEE for Reference Evapotranspiration Prediction component (4.B.2).
2. DEE for Soil Moisture component (4.B.3).
3. DEE for Crop Water Status Anomalies Detection component (4.B.4).
4. DEE for Plot Agronomic data (WP2 Data Analytics), that retrieves plot agronomic data from the pilot cloud infrastructure.
5. DEE for Plot Device data (WP2 Data Analytics), that retrieves historical data of deployed IoT devices (i.e., water counters, etc.) from the pilot cloud infrastructure in AIM format.
6. DEE for Weather Forecast data (WP2 Data Analytics), that retrieves weather forecast data from external services (i.e., OpenWeather, Weatherbit, etc.).
7. DEE for Crop Irrigation Water Estimation (WP2 Data Analytics), that estimates irrigation based on a mathematical model that uses crop agronomic data, weather forecast data, and the reference evapotranspiration value.
8. DEMETER visualisation and adaptive framework Knowage module.

Core Enablers Used

1. BSE - Brokerage Service Environment – Providing mechanism for the discovery of services.
2. ACS - Access Control System – Providing Authentication and Authorisation mechanisms for the DSS for Irrigation Management component.
3. DEH - DEMETER Enabler Hub – Registering in DEMETER the virtualised component.

Security Usage (Data & User)

4.B.1 - Irrigation Management component will make use of the DEMETER ACS to ensure security for both the user and data managed by the component.

Current Status

Feature	Short description	Status
Current version	Status of expected functionality of the latest version of the component. Functional with most integrated components returning data as AIM. Needed integration with component 4.B.4, some time series data acquisition, and Knowage module for visualisation	Advanced
Initial Design	Designing the DSS structure (i.e., required external components, service, etc.), REST API, and backend methods for implementation	Done
Visualisation Design	Mock-up for the Knowage visualisation module	Done
AIM output model	Development of the output AIM data model also needed for Knowage to visualise the information	Done
Backend Development	Development for AIM wrappers for data coming from all external components. Implementation of the REST API core	In progress
Component Integration/ Interoperability: Weather forecast (WP2)	Integration with the external DEE to retrieve weather forecast data	Done

Feature	Short description	Status
Component integration/ Interoperability: Pilot plot data (WP2)	Integration with the component that will retrieve agronomic information of a farm from the pilot cloud infrastructure	Done
Component integration/ Interoperability: Crop Irrigation based on ET_0-Kc	Integration with the DEE to retrieve the estimation of needed irrigation water based on the predicted ET_0 and agronomic data	Done
Component integration/ Interoperability: Reference evapotranspiration (ET_0) prediction	Integration with the DEE to retrieve the prediction of the ET_0	Done
Component integration/ Interoperability: Soil moisture estimation	Integration with the DEE to retrieve the estimation of soil moisture along the crop soil	Done
Component integration/ Interoperability: Plant water status	Integration with the DEE to retrieve plant water status anomalies	In progress
Integration with ACS	Use of credential mechanism for DEH and BSE	Done
Integration with DEH	Integration of component as a registered DEE in the DEMETER Enabler Hub	Done/tested with current version
Integration with BSE	Integration of component as a registered DEMETER service in the BSE	Done/tested with current version
Deployment and evaluation in test environment.	Deployment, evaluation, and validation of the DSS component and its integration with the external components in a test environment	Done/tested with current version
Deployment and evaluation in production environment.	Deployment, evaluation, and validation of the DSS component and its integration with the external components in a production environment	In progress
Component Refinement	Review of evaluation and validation reports with component refinement if needed (i.e., bug fixes, frontend, etc.)	Not Started

Table 13: Component 4.B.1 Status

The component DSS for Irrigation Management is integrated with other different DEMETER DEE components (WP4 and WP2). A global development plan conditioned by those components developments was scheduled.

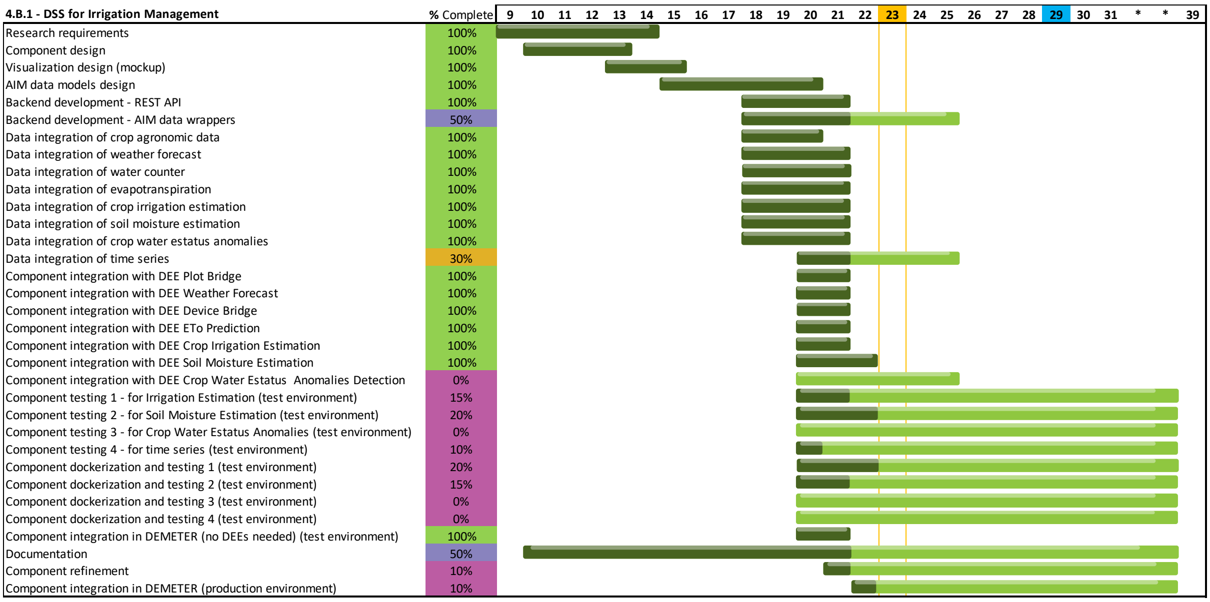


Figure 11: Component 4.B.1 GANTT Chart

6.2.2 Component 4.B.2 Reference Evapotranspiration Prediction

Description	The DSS component for Irrigation Management provides the farmer with information to estimate the irrigation water needed for a crop using other components. This component is one of those other components. It presents a solution for the prediction of the reference evapotranspiration (ET_0). This component uses an ensemble prediction model to estimate the ET_0 based on the *Penman-Monteith* model using weather forecast and historical data (temperature, humidity, wind speed, and solar radiation) for a given location (latitude, longitude, and elevation) from trustworthy external sources (i.e., OpenWeather, Weatherbit, AEMET, etc.), and predictive time series models such as naive approaches to complex autoregressive neural nets. The user can provide the number of historical data sets to be considered as well as the "forecast horizon" or number of days in the future, counted from the present day (zero day), to get ET_0 predictions. Then an ensemble model, developed using R language, calculates the future ET_0 for all the specified days. The resulting predictions are returned in AIM format and the accuracy of the different methods are stored for assessing the historical accuracy of each unique method in future forecasts. The current version of this component uses an internal library, developed in R language, to retrieve the weather forecast information. The next version will be integrated with the component meteoForecast (WP2) which has the same functionality but can expose weather data in DEMETER using AIM format.
Responsible Partner	Manuel Mora (UMU)
Partners	UMU
Pilots	1.1_1.2

Table 14: Component 4.B.2 Metadata

Dashboard Widget

No dashboard widget is being developed for this component as the component is purely backend routines to feed Component 4.B.1 DSS for Irrigation Management.

Dependencies (either internal to DEMETER or bound to the pilot)

1. DEE for Plot Device data (WP2 Data Analytics), that retrieves historical weather data from the pilot cloud infrastructure in AIM format.
2. DEE for Weather Forecast data (WP2 Data Analytics), that retrieves weather forecast data from external services (i.e., OpenWeather, Weatherbit, etc.) in AIM format.
3. In the current version of this component, it is using the same functionality as the WP2 component but using an internal R library. In the next version, this library will be replaced to integrate the WP2 Weather Forecast component.

Core Enablers Used

1. BSE - Brokerage Service Environment – Providing mechanism for the discovery of services.
2. ACS - Access Control System – Providing Authentication and Authorisation mechanisms for the Reference Evapotranspiration Prediction component.
3. DEH - DEMETER Enabler Hub – Registering in DEMETER the virtualised component.

Security Usage (Data & User)

4.B.2 - Evapotranspiration Prediction component will make use of the DEMETER ACS to ensure security for both the user and data managed by the component.

Current Status

Feature	Short description	Status
Current version	Status of expected functionality of the latest version of the component	Done (1st version) To be updated using external DEE meteoForecast component.
Initial Design	Designing the component structure (i.e., required ML techniques, access to external weather services, internal DB, etc.), REST API, and backend methods for implementation	Done
AIM input model	Development of the input AIM data model needed for the weather historical data	Done
AIM input model	Development of the input AIM data model needed for the weather forecast data	Done
AIM output model	Development of the output AIM data model for the calculated ET_0 values.	Done
Backend Development	Development for AIM wrapper for historical data Development of the internal library to retrieve weather forecast data (raw) Development of the REST API core Development of ML models	Done (1st version)

Feature	Short description	Status
Backend Development	Development for AIM wrapper for data retrieved from meteoForecast component	In progress
Component Integration/ Interoperability: pilotdevicebridge	Integration with the external component to retrieve weather historical data (AIM)	Done
Component Integration/ Interoperability: meteoForecast	Integration with the external component meteoForecast to retrieve weather forecast data	In progress (2nd version)
Component integration/ Interoperability: DSS for Irrigation Management	Integration with the main DSS component that will use this one	Done (1st version)
Integration with ACS	Use of credential mechanism for DEH and BSE	Done/tested (1st version)
Integration with DEH	Integration of component as a registered DEE in the DEMETER Enabler Hub	Done/tested (1st version)
Integration with BSE	Integration of component as a registered DEMETER service in the BSE	Done/tested (1st version)
Deployment and evaluation in test environment.	Deployment, evaluation, and validation of the component and its integration with other external components in a test environment	Done/tested (1st version)
Deployment and evaluation in production environment.	Deployment, evaluation, and validation of the DSS component and its integration with other external components in a production environment	In progress
Component Refinement	Review of evaluation and validation reports with component refinement if needed (i.e., bug fixes, new ML techniques, optimisation, etc.)	Not started

Table 15: Component 4.B.2 Status

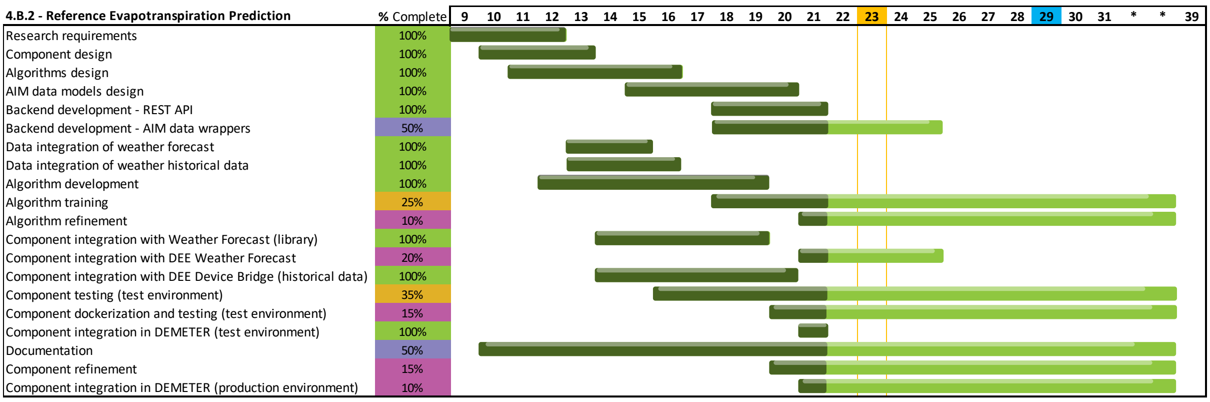


Figure 12: Component 4.B.2 GANTT Chart

6.2.3 Component 4.B.3 Soil Moisture Estimation

Description	The DSS component for Irrigation Management provides the farmer with information to estimate the irrigation water needed for a crop using other components. This is one of those components. It presents an optical trapezoidal model (OPTRAM) algorithm to infer the surface soil moisture with physical units using ML techniques and data fusion with remote sensing using satellite multispectral imagery and local sensing using ground soil moisture probes data. Data fusion techniques combine data from multiple sensors and related information from associated databases to achieve improved accuracy and more specific inferences than could be achieved using a single sensor alone. In the case of this component, data fusion with remote sensing satellite imagery and with data of local soil moisture sensor allows to infer the soil moisture along the crop soil (2D). To do so, this component needs hourly historical soil moisture multilevel data from in field soil moisture probes, as well as remote sensing from Sentinel-2 satellite multispectral imagery (NDVI for *Normalized Difference Vegetation Index* and STR for *Shortwave-infrared Transformed Reflectance*) from BOA (*Bottom-Of-Atmosphere*) layer. The model is based on the paper Sadeghi et al 2017 ([1]), an optical trapezoid model which can infer the surface soil humidity in a parcel using the local ground measurements as a calibration. Typically, this method needs enough examples to cover a season of irrigations to be fitted, so it is recommended to provide a full year of data. The Sentinel-2 multispectral images are downloaded in the pilot cloud infrastructure by a service that periodically downloads and process the new images from the Copernicus Hub API ready to be retrieved latter by this component to be processed. In the current version of this component, the final model, developed using R language, is adjusted by a trained technician so in the production library the model will be already trained for a given parcel to perform the 2D predictions. In next versions this component will be parametrised.
Responsible Partner	Manuel Mora (UMU)
Partners	UMU
Pilots	1.1_1.2

Table 16: Component 4.B.3 Metadata

Dashboard Widget

No dashboard widget is being developed for this component as the component is purely backend routines to feed Component 4.B.1 DSS for Irrigation Management.

Dependencies (either internal to DEMETER or bound to the pilot)

1. DEE for Plot Device data (WP2 Data Analytics), that retrieves historical data of deployed IoT devices (i.e., soil moisture probes) from the pilot cloud infrastructure in AIM format.
2. Pilot cloud infrastructure, to retrieve remote sensing satellite multispectral imagery of plots. The current version of this component is using an internal R library to access needed imagery from the pilot cloud infrastructure for a plot.

Core Enablers Used

1. BSE - Brokerage Service Environment – Providing mechanism for the discovery of services.
2. ACS - Access Control System – Providing Authentication and Authorisation mechanisms for the Soil Moisture Estimation component.
3. DEH - DEMETER Enabler Hub – Registering in DEMETER the virtualised component.

Security Usage (Data & User)

4.B.3 - Soil Moisture Estimation component will make use of the DEMETER ACS to ensure security for both the user and data managed by the component.

Current Status

Feature	Short description	Status
Current version	Status of expected functionality of the latest version of the component	Done
Initial Design	Designing the component structure (i.e., needed ML techniques, access to external DB with Sentinel-2 imagery, access to soil moisture data, etc.), the OPTRAM model, REST API, and backend methods for implementation	Done
AIM input model	Development of the input AIM data model needed for the soil moisture data	Done
AIM output model	Development of the output AIM data model needed for the calculated image showing the soil moisture along the crop and its average value	Done
Backend Development	Development for AIM wrappers for soil moisture data together with the REST API core. Integration of ML techniques for image analysis and development of the OPTRAM model	Done
Component Integration/ Interoperability: Pilot device bridge	Integration with the external component to retrieve soil moisture historical data (AIM)	Done
Component Integration/ Interoperability: pilot cloud infrastructure	Integration with the pilot cloud infrastructure to retrieve satellite multispectral imagery	Done
Integration with ACS	Use of credential mechanism for DEH and BSE	Done/tested
Integration with DEH	Integration of component as a registered DEE in the DEMETER Enabler Hub	Done/tested
Integration with BSE	Integration of component as a registered DEMETER service in the BSE	Done/tested
Deployment and evaluation in test environment.	Deployment, evaluation, and validation of the standalone component and also once integrated by the DSS for Irrigation Management component in a test environment	Done
Deployment and evaluation in production environment.	Deployment, evaluation, and validation of the standalone component and also once integrated by the DSS for Irrigation Management component in a production environment	In progress

Feature	Short description	Status
Component Refinement	Review of evaluation and validation reports with component refinement if needed (i.e., bug fixes, other math models, optimisation, etc.)	Not started

Table 17: Component 4.B.3 Status

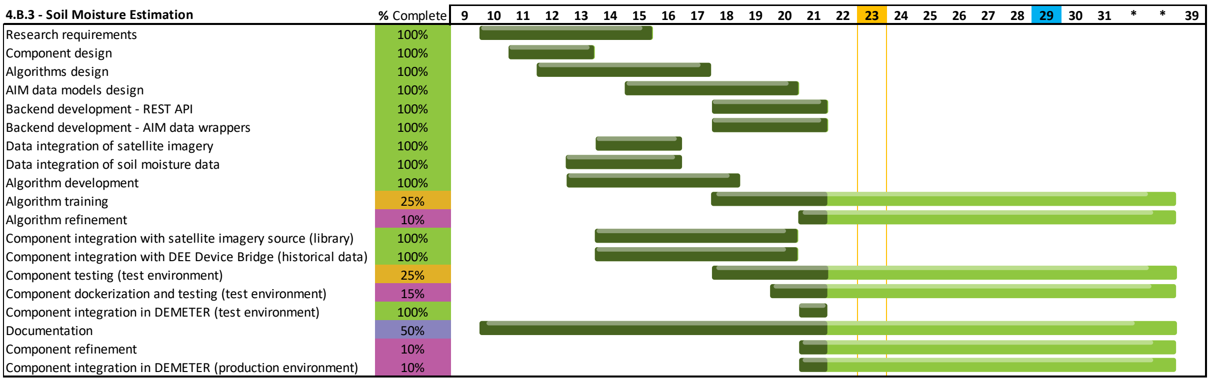


Figure 13: Component 4.B.3 GANTT Chart

6.2.4 Component 4.B.4 Crop Water Status Anomalies Detection

Description	This component provides the farmer with information to estimate the needed irrigation water for a crop using other components. This is one of those other components. It presents a solution for plant water status anomalies detection. This component, developed in R language, is based on multispectral analysis of images provided by Sentinel-2 satellite. The images, corresponding to the crop over several seasons, are compared with the last image obtained to classify using ML the pixels in several categories according to the expected behaviour extracted from the history of the same crop or the adjacent ones.
Responsible Partner	Manuel Mora (UMU)
Partners	UMU
Pilots	1.1_1.2

Table 18: Component 4.B.4 Metadata

Dashboard Widget

No dashboard widget is being developed for this component as the component is purely backend routines to feed Component 4.B.1 DSS for Irrigation Management.

Dependencies (either internal to DEMETER or bound to the pilot)

1. Pilot cloud infrastructure, to retrieve remote sensing satellite multispectral imagery of plots. The current version of this component is using an internal R library to access needed imagery from the pilot cloud infrastructure for a plot.

Core Enablers Used

1. BSE - Brokerage Service Environment – Providing mechanism for the discovery of services.
2. ACS - Access Control System – Providing Authentication and Authorisation mechanisms for the Crop Water Status Anomalies Detection component.

3. DEH - DEMETER Enabler Hub – Registering in DEMETER the virtualised component.

Security Usage (Data & User)

4.B.4 - Crop Water Status Anomalies Detection component will make use of the DEMETER ACS to ensure security for both the user and data managed by the component.

Current Status

Feature	Short description	Status
Current version	Status of expected functionality of the latest version of the component	In progress
Initial Design	Designing the component structure (i.e., required ML techniques, access to DB with Sentinel-2 imagery, etc.), REST API, and backend methods for implementation	Done
AIM output model	Development of the output AIM data model needed for the calculated image showing anomalies.	In progress
Backend Development	Implementation of the REST API core. Development for AIM wrappers for retrieved data. ML techniques for image analysis	In progress
Integration with ACS	Use of credential mechanism for DEH and BSE	Not started
Integration with DEH	Integration of component as a registered DEE in the DEMETER Enabler Hub	Not started
Integration with BSE	Integration of component as a registered DEMETER service in the BSE	Not started
Deployment and evaluation in test environment.	Deployment, evaluation, and validation of the standalone component and also once integrated by the DSS for Irrigation Management component in a test environment	Not started
Deployment and evaluation in production environment.	Deployment, evaluation, and validation of the standalone component and also once integrated by the DSS for Irrigation Management component in a production environment	Not started
Component Refinement	Review of evaluation and validation reports with component refinement if needed (i.e., bug fixes, other math models, optimisation, etc.)	Not started

Table 19: Component 4.B.4 Status

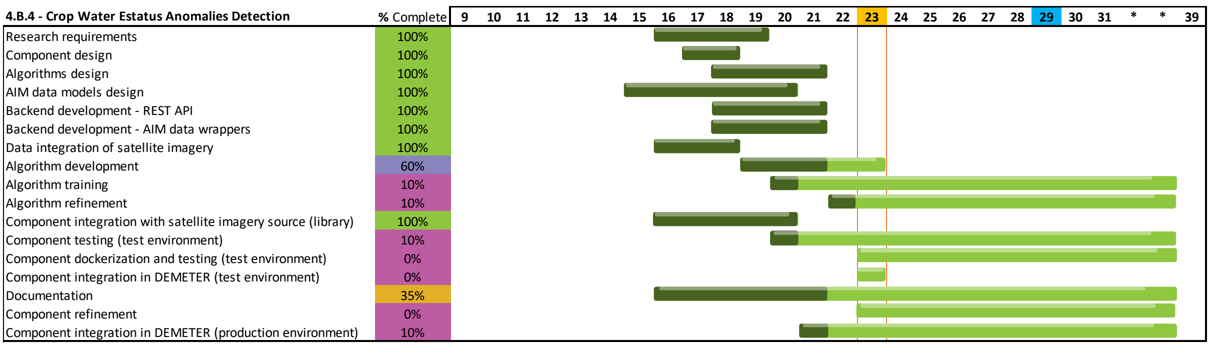


Figure 14: Component 4.B.4 GANTT Chart

6.3 *DSS AREA: 4.C - Nutrition Management*

6.3.1 Component 4.C.1 Nitrogen Balance Model

Description	This component describes a crop nitrogen balance model that estimates crop nitrogen requirements and provides the scheduling of fertilisation. SIMAVI (pilot 1.4 DSS to support maize crops) will develop a nitrogen balance model which will be integrated in platform along with remotely sensed indices. This model can be used by other pilots dealing with fertilisation management. A component that estimates crop nitrogen needs and the crop fertilisation scheduling during the season to optimise nitrogen fertilisation, avoiding nitrogen excess.
Responsible Partner	Mihai Angheloiu (SIMAVI)
Partners	SIMAVI & APPR (Romanian Corn Producers Association)
Pilots	1.4

Table 20: Component 4.C.1 Metadata

Dashboard Widget

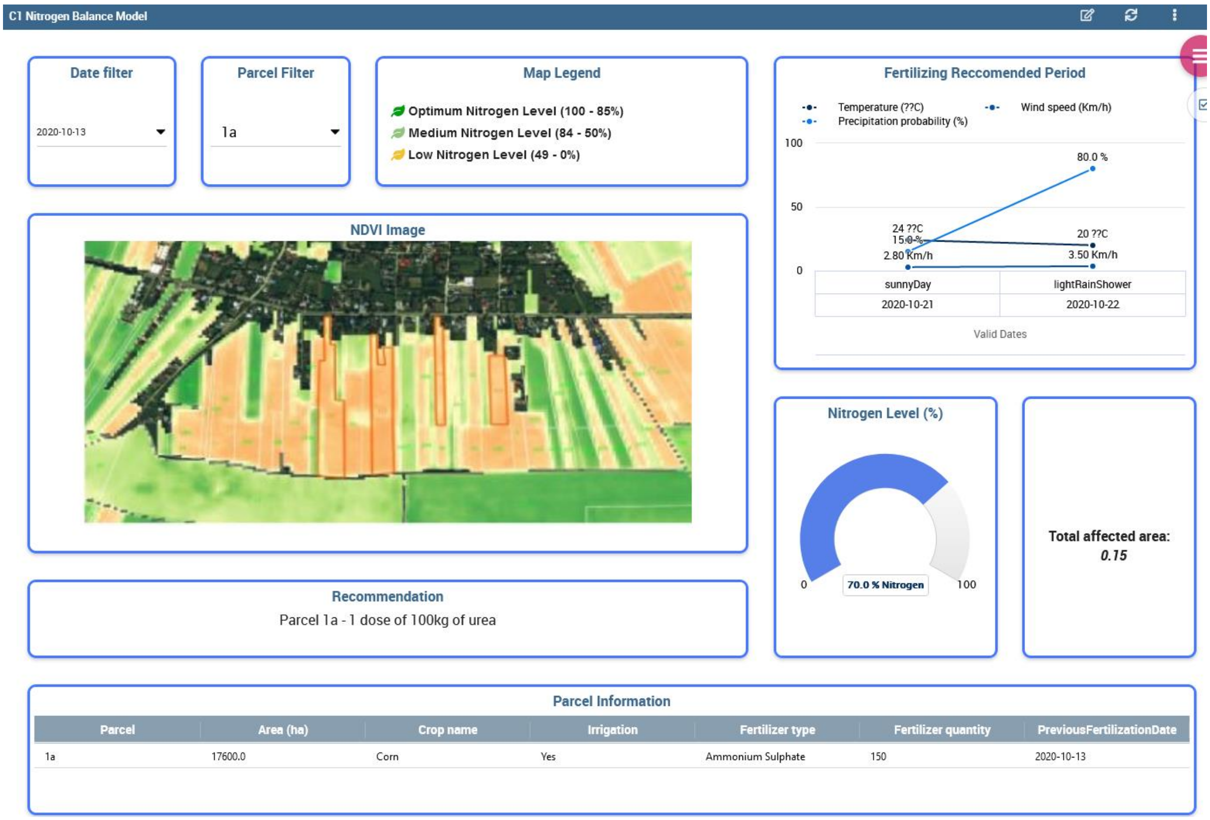


Figure 15: Component 4.C.1 Dashboard Widgets

The Nitrogen Balance Model Dashboard will contain a **map widget** with different levels of nitrogen in the same plot. This map will be obtained from NDVI images (Terrascope) by using the pixel classification method. Therefore, the image will be differentiated according to the nitrogen level of the plants.

Based on this map, it will be easier to identify the areas with lower level of nitrogen and it will be helpful for those who want to distribute the fertiliser with variable rate.

The **Nitrogen Level widget** sums up the number of pixels from the lowest class on the map, to determine the percentage occupied by the areas with low nitrogen level relative to the entire plot.

Farmers want to know the total surface area with lower nitrogen level, in order to establish the right quantity of nitrogen that can be administrated in order to obtain a higher yield.

The **Recommendation widget** will display text with a recommendation of the active substance for fertilisation (e.g., nitrogen) and quantity, based on an algorithm that has as parameters: soil type, type of crop, sowing date etc.

Short-term weather forecasts are important for planning agricultural work. Extreme weather events cannot be predicted very far in advance, but they can be predicted 2 days in advance. Thus, the temperature and the probability of rain for the next 2 days will be displayed by the **Recommended Fertilisation Period widget**. This may be increased to a 3-day forecast in the near future.

Dependencies (either internal to DEMETER or bound to the pilot)

1. Terrascope Satellite Imagery Service.
2. WatchItGrow.be – NDVI pixels classification into polygons (from VITO partner).
3. OpenWeather.com – Weather forecast service.

Core Enablers Used

1. AIM for data exchange.
2. DSS Visualisation Dashboard (Knowage).
3. BSE - Brokerage Service Environment – Providing mechanism for the discovery of services.
4. ACS - Access Control System – Providing Authentication and Authorisation mechanisms for the nitrogen balance model component.

Security Usage (Data & User)

4.C.1 - Nitrogen Balance Model component will make use of the DEMETER ACS to ensure security for both the user and data managed by the component.

Current Status

Feature	Short description	Status
Data Collector	Implement data collector service to gather information from ground weather stations, Terrascope satellite imagery, OpenWeather and in-situ farmers' data	Done
Development of AIM model (Input & Output)	Manipulate and process AIM format as data inputs/outputs (read, search, update and write) using third-party framework	In Progress
DSS Visualisation Design	Mock-ups of the Knowage visualisations that will be produced for the Nitrogen Balance Model component	Done
Integration with DEH, BSE, ACS	Register this service to BSE, DEH and integrate it with ACS and Knowage	In progress
Initial Component Architecture	Designing the project structure, REST API and backend methods for implementation	Done
Algorithm Research	Research and define the DSS algorithm that determines the plant stress	Done

Feature	Short description	Status
Algorithm Development	Implement the DSS algorithm that determines the nitrogen needs	In Progress
Backend Development	Develop the backend services to make the service available through REST API	In Progress
Test and validation	Test and validate the component	Not Started
Component Refinement	Review of evaluation and validation reports with component refinement if needed (e.g., bug fixes)	Not Started
Publish the component	Publish the component docker image to Docker Hub	Not Started

Table 21: Component 4.C.1 Status

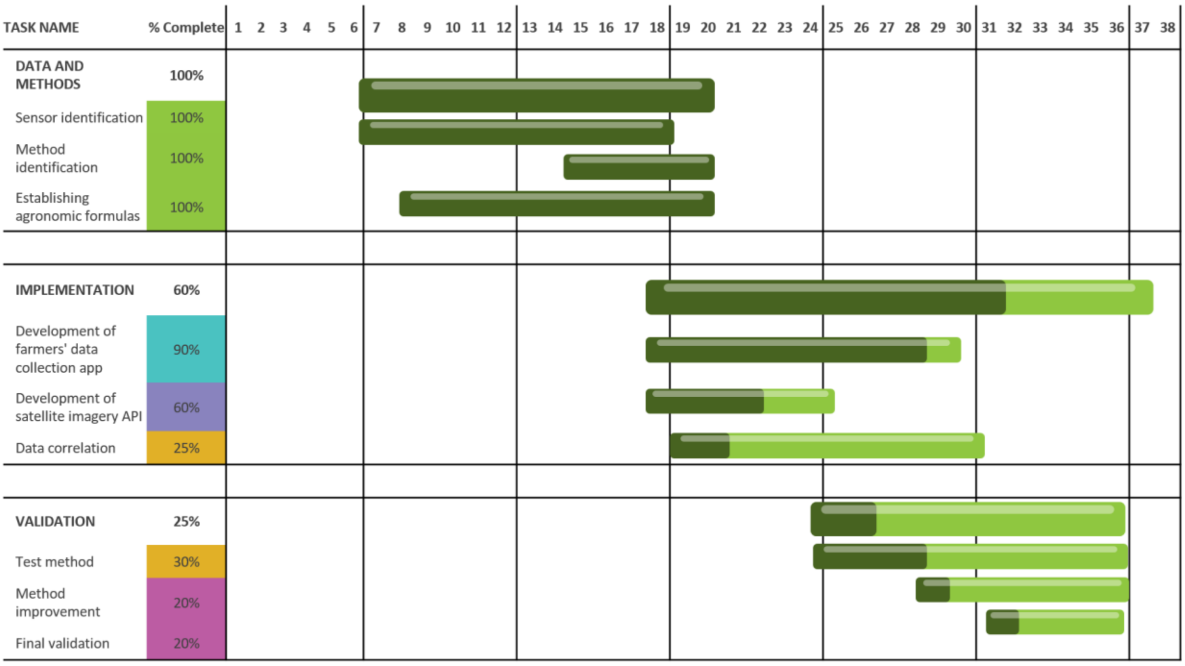


Figure 16: Component 4.C.1 GANTT Chart

6.3.2 Component 4.C.2 Nutrient Monitor

Description	The Nutrient monitor component estimates the quantity of crop seeds to be applied to different areas. The analysis performed by the DSS takes into account data samples from two types of sources: data from farmers such as field coordinates and geometry etc.; and data from external systems such as satellite images and weather forecasts. The analysis of the parameters will determine recommendations for the future planting, allowing an increase in agricultural productivity.
Responsible Partner	Stefan Loureiro (Ubiwhere)
Partners	Agricolus, SIMAVI, Ubiwhere
Pilots	3.2, 1.4, 2.3, (1.3, 3.1)

Table 22: Component 4.C.2 Metadata

Dashboard Widget

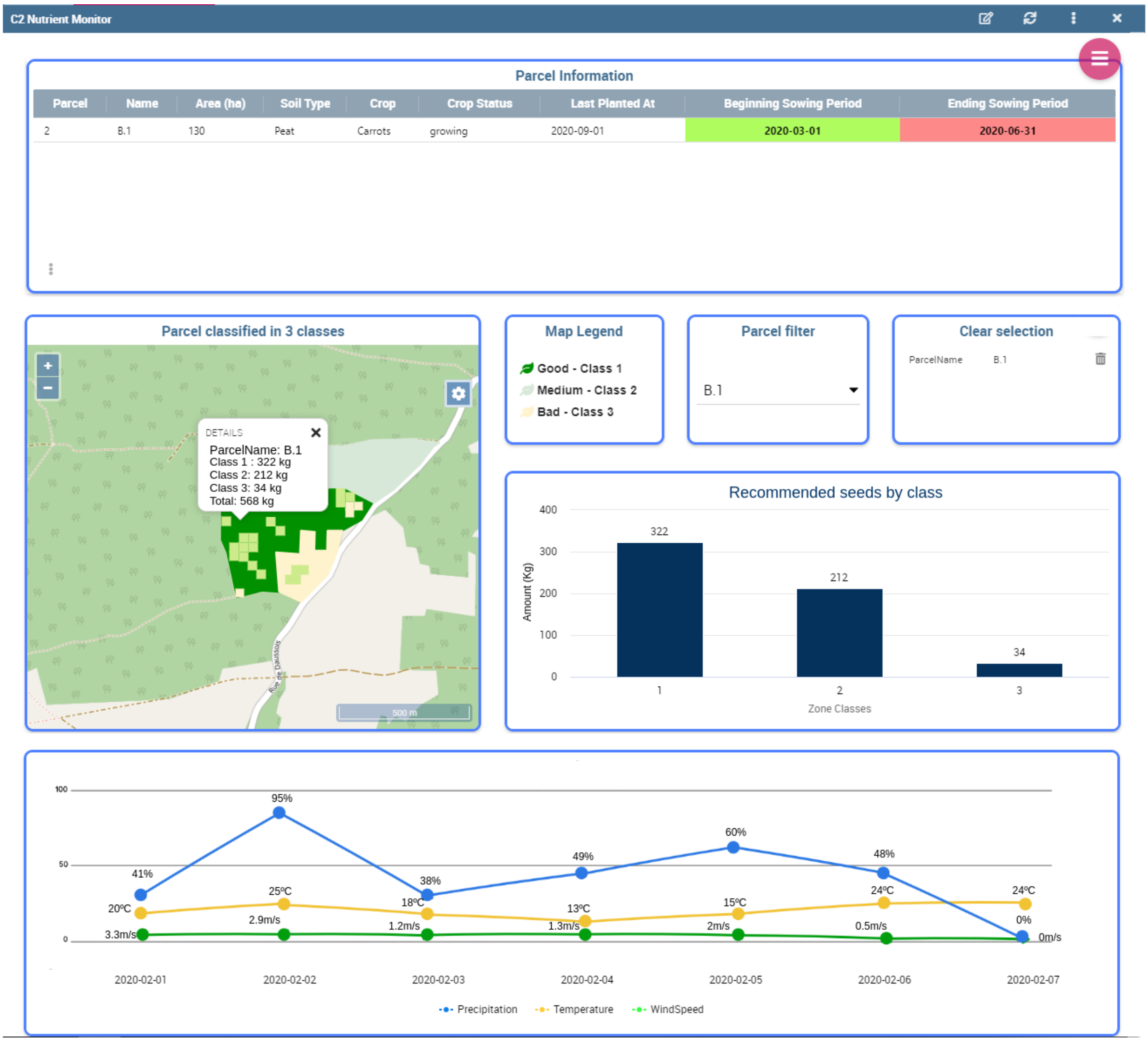


Figure 17: Component 4.C.2 Dashboard Widgets

Using this DSS dashboard, a farmer can visualise the crop recommendations. The recommendations are able to provide the farmer with an overview of the crop, i.e., in which areas they should sow, the quantity of seeds for these areas, and help in the decision of when to sow, since knowing the planting period of the crop and the weather forecast helps the farmer to choose the best day to sow. By selecting the parcel, they can use the map widget to visualise the different management zones and their respective amounts of seeds by class. Through this dashboard, the farmer is able to understand and optimise the soil and the production.

Dependencies (either internal to DEMETER or bound to the pilot)

1. Sentinel-2 Time Series Service - Terrascope Satellite Imagery Service hosted by VITO.
2. WatchItGrow - NDVI polygonization service hosted by VITO.
3. OpenWeathermap API – Weather forecast service.

Core Enablers Used

1. AIM for data exchange.
2. DSS Visualisation Dashboard (Knowage).
3. BSE - Brokerage Service Environment – Providing mechanism for the discovery of services.
4. ACS - Access Control System – Providing Authentication and Authorisation mechanisms for the nutrient monitor component.

Security Usage (Data & User)

4.C.2 - Nutrient Monitor component will make use of the DEMETER ACS to ensure security for both the user and data managed by the component.

Current Status

Feature	Short description	Status
Data Collector	Implement data collector service to gather information from ground weather stations, Terrascope satellite imagery, OpenWeather and in-situ farmers' data	Done
Development of AIM model (Input & Output)	Development of the input and output schemas for the estimate nutrient monitor component and ensuring this is AIM compliant	Done
DSS Visualisation Design	Mock-ups of the Knowage visualisations that will be produced for the estimate nutrient monitor component	Done
Integration with DEH, BSE, ACS	Register this service to BSE, DEH and integrate it with ACS and Knowage	Done
Initial Design	Designing the project structure, REST API and backend methods for implementation in the estimate nutrient monitor component	Done
Algorithm Research and Development	Researching and defining the attributes that can be taken into account to define the algorithm that will be used to calculate the required number of seeds to optimally sow a plot	In Progress
Backend Development	Implementation and testing of the project, REST API and methods defined in the Algorithm Research and Development Stage	In Progress
Algorithm Implementation	Implementation of the nutrient algorithm including the integration of satellite/meteorological data	In Progress
ACS Implementation and Integration	Integration of the component with the DEMETER ACS to provide authentication and authorisation mechanisms compliant with the DEMETER project	Not Started
Deployment and Evaluation (Test Environment)	Deployment, evaluation and validation of the component and its integration in a test environment	Not Started
Component Refinement	Review of evaluation and validation reports with component refinement if needed (e.g., bug fixes)	Not Started
Deployment and Evaluation (Production Environment)	Deployment and evaluation of the component and its integration in the production environment	Not Started

Table 23: Component 4.C.2 Status

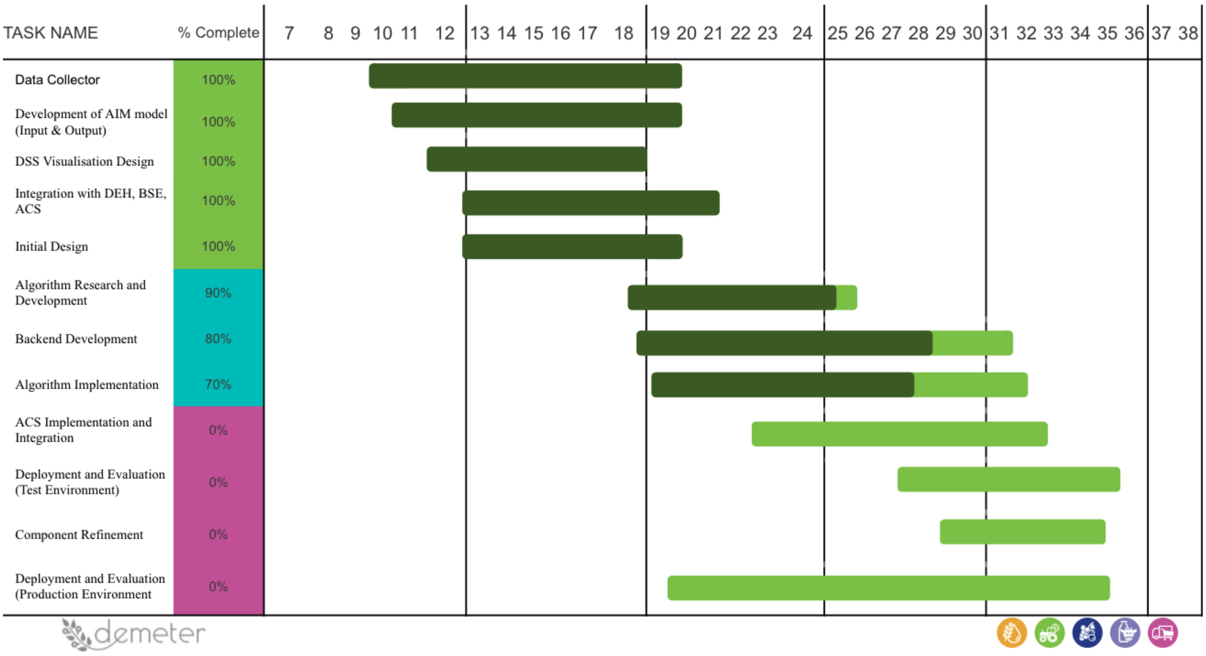


Figure 18: Component 4.C.2 GANTT Chart

6.4 *DSS AREA: 4.D - Machinery and Field Operations*

6.4.1 Component 4.D.1 Emission

Description	The component on emissions will receive engine data as input, including data from the engine after treatment system. This data will be analysed and as an output there will be an overview of the status of different engine conditions. In case of malfunctions there will be instructions and/or recommendations for the farmer.
Responsible Partner	Andreas Schröder (JD)
Partners	John Deere (JD), Fraunhofer IESE (IESE)
Pilots	2.1

Table 24: Component 4.D.1 Metadata

Dashboard Widget

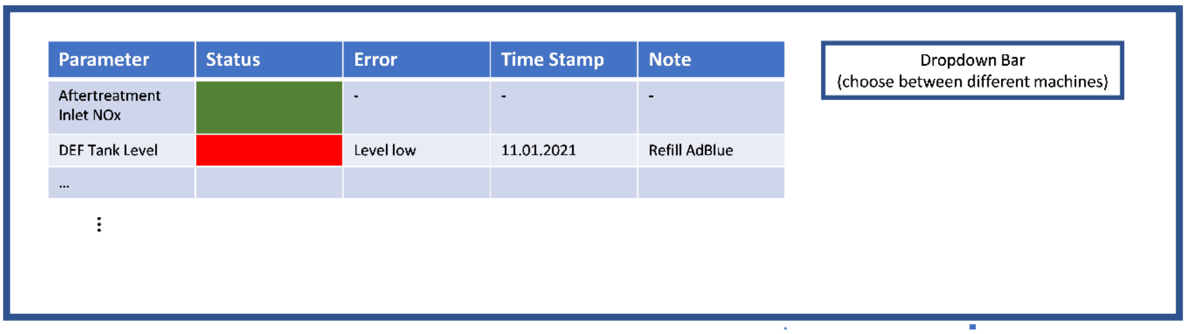


Figure 19: Component 4.D.1 Mock-up of Dashboard Widgets

The dashboard for the component Emissions will show a list of parameters from machines (tractors) of the farmer. There will be a drop-down bar where the farmer can select the machine which needs to be checked. Once the machine is selected there will be a table showing different parameters of the engine and exhaust gas after treatment. Every parameter will also have a status where the farmer can immediately see if everything is working properly. The dashboard will show a traffic light system with green for “no errors”, yellow for “non-critical errors” and red for “severe errors”. Next to the status it will also show a short description of the error, the time stamp of the occurrence and a note with recommended actions. Figure 19 shows a mock-up of what the dashboard could look like.

Dependencies (either internal to DEMETER or bound to the pilot)

1. In Service Condition Monitoring – There is one pilot (2.1) which will use the services provided by component D1. Machine Data from the CAN-Bus will be collected and stored (e.g., in a cloud) within the pilot. This data will be analysed, and the outcome of the analysis will be shown in the dashboard.

Core Enablers Used

1. ACS - Access Control System – Providing Authentication and Authorisation mechanisms for the emissions component.

Security Usage (Data & User)

4.D.1 - Emissions component will make use of the DEMETER ACS to ensure security for both the user and data managed by the component.

Current Status

Feature	Short description	Status
Analysis of machine data	Analysis of engine and after treatment data (e.g., temperature checks, emission checks)	In progress
Visualisation Design	Mock-ups of the Knowage visualisations that will be produced for the emissions component	In progress
Usage and Integration of AIM in component	Aligning the communication schema of the emission component with the AIM model	In progress
Integration with DEH	Integration and testing of the emission component as a registered enabler in the DEMETER Enabler Hub	Not Started
Data Integration: Machine Data	Integration of machine data into the algorithm defined for the data checks	Not Started
ACS Implementation and Integration	Integration of the component with the DEMETER ACS to provide authentication and authorisation mechanisms compliant with the DEMETER project	Not Started

Table 25: Component 4.D.1 Status

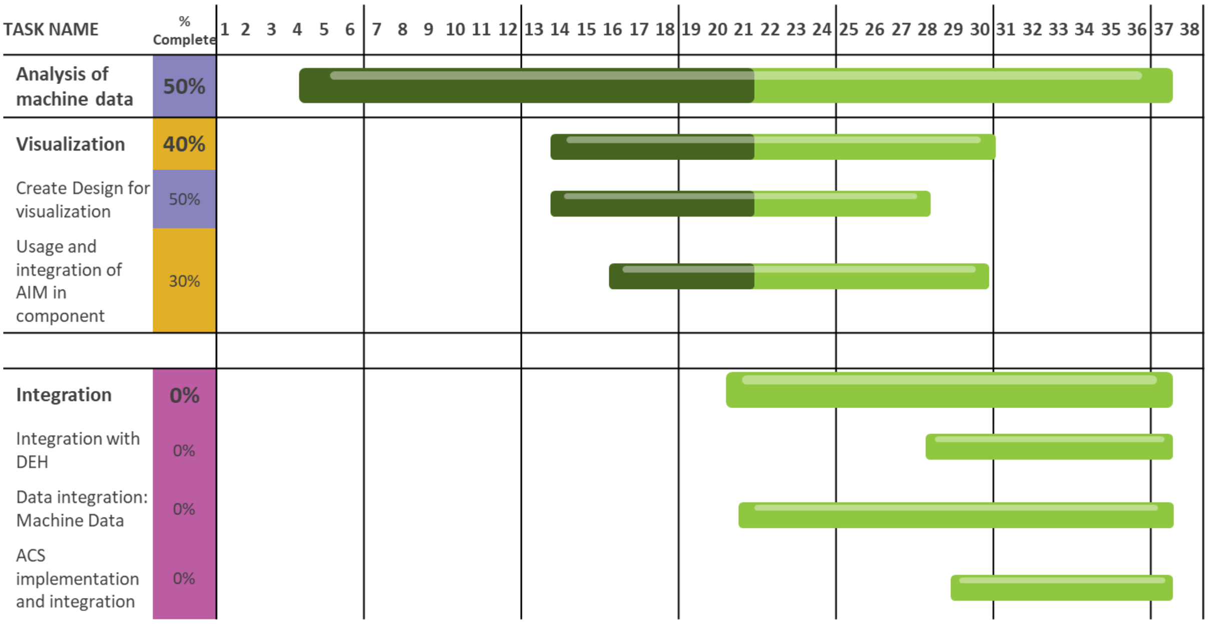


Figure 20: Component 4.D.1 GANTT Chart

6.4.2 Component 4.D.2 Field Operation

Description	The component provides the table with a list of drivers and list of machines with details about the driver behaviour, machine distance covered and vehicle average speed. The components receive data about latitude, longitude, speed, breaking and fuels consumption as an input in the DEMETER AIM format. These data are then analysed, and the output of the classification process is then provided to the dashboard output including the data about the users' behaviour, distance covered and average speed. The component is generic in a sense it can be used not only for field operations, but with slight adaptation it can be employed in any use cases involving transport, where it is necessary to monitor the driver behaviour, or the performance of the vehicles (for low fuel consumption, high-risk and sensitive merchandise, etc.).
Responsible Partner	Nenad Gligoric (DNET)
Partners	DNET, UDG, Plantaze, FEDE, OriginTrail
Pilots	5.1

Table 26: Component 4.D.2 Metadata

Dashboard Widget

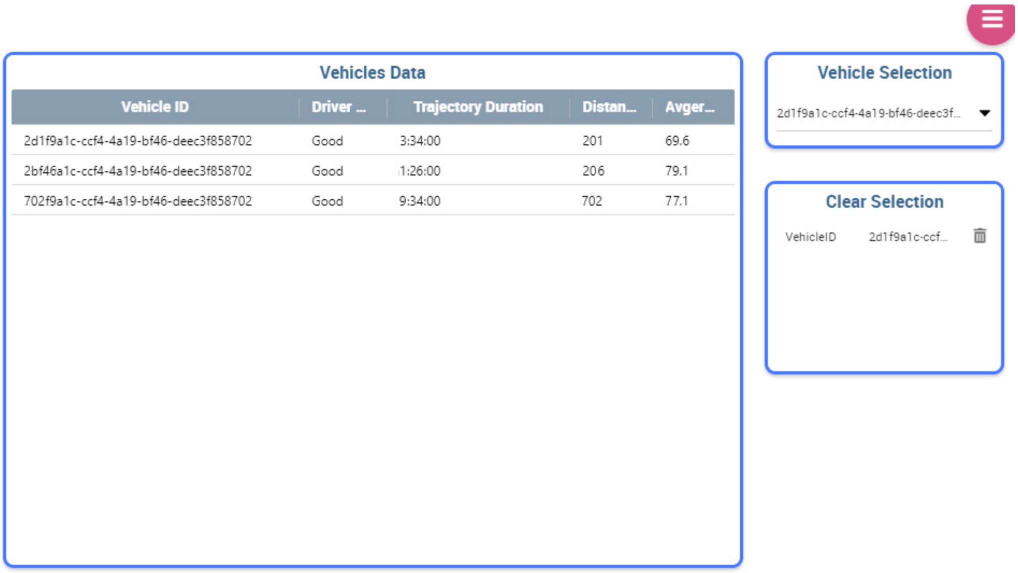


Figure 21: Component 4.D.2 Dashboard Widgets

The dashboard for the Field operation Component (see Figure 21) provides tabular view for the list of the available machinery. The vehicle selection filter has an option to select the vehicle ID. The simplistic interface shows all the necessary data directly, indicating driver behaviour as an output of classification based on the requirements given in the pilot 5.1.

Dependencies (either internal to DEMETER or bound to the pilot)

1. FleetNET platform - fleet monitoring platform for tracking of vehicles GPS location, and collection of various statistics for vehicle over the CAN interface
2. FEDE Machinery control exercised by Fede *Specialty Crops Platform* (SCP) that links via GPRS to the tractors and sprayers in the field.

Core Enablers Used

1. BSE - Brokerage Service Environment – Providing mechanism for the discovery of services.
2. ACS - Access Control System – Providing Authentication and Authorisation mechanisms for the component.

Security Usage (Data & User)

4.D.2 - Field operation component will make use of the DEMETER ACS to ensure security for both the user and data managed by the component.

Current Status

Feature	Short description	Status
Requirements, data specification and models	Initial requirements of the field operations data, classification analysis models	Done
Development of AIM model (Input & Output)	Development of the input and output schemas for the variable rate application ensuring this is AIM compliant	Done
Visualisation Design	Mock-ups of the Knowage visualisations that will be produced for the variable rate component	Done

Feature	Short description	Status
Integration with DEH	Integration and testing of the variable rate component as a registered enabler in the DEMETER Enabler Hub	In Progress
Development of DEMETER AIM compliant adapter for fleetNET webservice	REST API and backend methods for implementation of the service	Done
Classification algorithm Development	Development of the classification algorithm to generate driver behaviour, travel distance and speed	Done
Usage and Integration of AIM in component	Aligning the communication schema of the variable rate component with the AIM model defined in stage 1	Done
ACS Implementation and Integration	Integration of the component with the DEMETER ACS to provide authentication and authorisation mechanisms compliant with the DEMETER project	In Progress
Deployment and Evaluation (Test Environment)	Deployment, evaluation, and validation of the field operation component in test environment	Done
Component Refinement	Review of evaluation and validation reports with component refinement if needed (e.g., bug fixes)	Not Started
Deployment and Evaluation (Production Environment)	Deployment, evaluation, and validation of the field operation component and its integration with fleetNET devices deployed in field	Not Started

Table 27: Component 4.D.2 Status

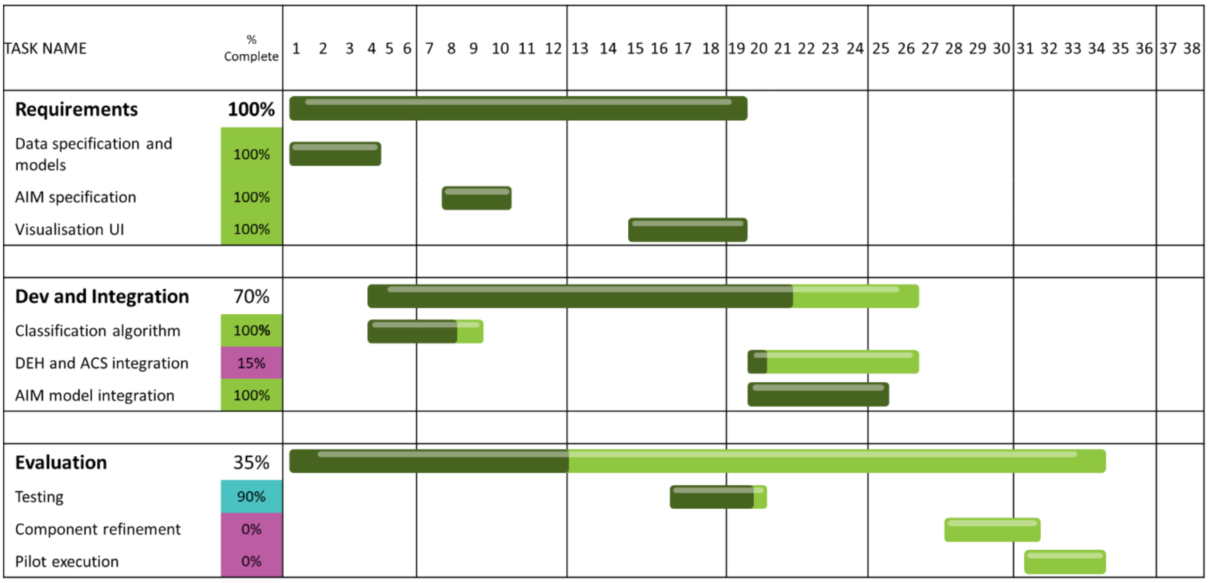


Figure 22: Component 4.D.2 GANTT Chart

6.4.3 Component 4.D.3 Variable Rate

Description	The variable rate application component provides a taskmap in AIM format, based on a WatchItGrow service that generates a polygonization of a Sentinel-2 NDVI image. The component will start a flask server on localhost:5000, to which you can send a HTTP POST request containing, as payload, an AIM JSON object holding the field information, notably the field geometry, and a Treatment description containing a base application rate and also the definition of the application width of the field machinery that will execute the variable rate actions. The service will then check for a cloud-free Sentinel-2 NDVI image for the 30 days prior to the date specified in the Treatment "interventionStart" parameter. All acquisition dates with a minimum 95% of cloud-free pixels are withheld, and of those dates the last one is chosen to retrieve the NDVI information. For the chosen date, the component will request the WatchItGrow service for a JSON-description of the NDVI field values grouped by interval. The component specifies a minimum, maximum and a step value that will guide how the service groups the NDVI pixel values into groups of pixels with an associated class. The minimum and maximum values define the percentage of the mean NDVI value that will serve as the minimum and maximum bin edge values respectively. The 'step' value defines how big the percentage interval bin steps should be. In this case, 5 classes are defined: *<0.80*, *0.8-0.9*, *0.9-1.0*, *1.0-1.1*, *>1.1*, with values expressed in terms of ratio to the average NDVI value for the field. In a final step, the 5 classes of the JSON file are converted into an AIM JSON-LD, by translating the class-nr into an actual application rate, which is a percentage of the base rate specified in the treatment object of the input file. This translation steps creates a Foodie:Treatment entry with an associated Foodie:ManagementZone as geometry, for every class entry in the returned JSON file.
Responsible Partner	Bart Beusen (VITO)
Partners	VITO
Pilots	3.4

Table 28: Component 4.D.3 Metadata

Dashboard Widget

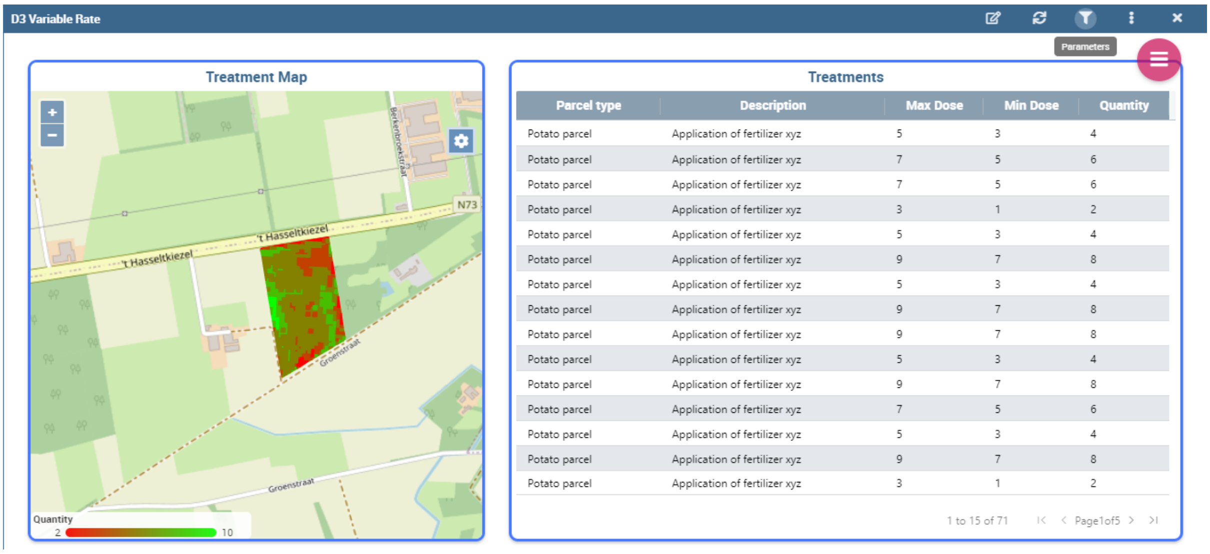


Figure 23: Component 4.D.3 Dashboard Widgets

The dashboard for the Variable Rate Application Component (see Figure 23) will take the form of a 2-step interface. First, the user selects the field for which they want to see the variable rate task map. When the field is selected, Knowage will display a table with a row per zone (polygons defined as Foodie:ManagementZones), indicating the dose to be applied to each zone, and optionally also minimum and maximum dose. Next to the table, a map is shown with the zones coloured by quantity of the application rate.

Dependencies (either internal to DEMETER or bound to the pilot)

1. Sentinel-2 Time Series Service – This service is available free of charge on the Terrascope platform hosted by VITO.
2. WatchItGrow NDVI polygonization service is accessible to DEMETER partners; however, it is not yet designed to handle large loads. This service takes a polygon, a date and interval parameters as input, and provides as a result a GeoJSON feature collection that groups NDVI pixels with similar values (same interval) into one GeoJSON feature.

Core Enablers Used

1. BSE - Brokerage Service Environment – Providing mechanism for the discovery of services.
2. ACS - Access Control System – Providing Authentication and Authorisation mechanisms for the variable rate component.

Security Usage (Data & User)

4.D.3 - Variable Rate component will make use of the DEMETER ACS to ensure security for both the user and data managed by the component.

Current Status

Feature	Short description	Status
Research requirements of Variable Rate Application	Researching and identification of WP4 requirements of variable rate applications	Done
Development of AIM model (Input & Output)	Development of the input and output schemas for the variable rate application ensuring this is AIM compliant	Done
Visualisation Design	Mock-ups of the Knowage visualisations that will be produced for the variable rate component	Done
Integration with DEH	Integration and testing of the variable rate component as a registered enabler in the DEMETER Enabler Hub	In Progress
Algorithm Research and Development	Researching and defining the attributes that can be taken account to generate a variable rate taskmap	Done
Backend Development	Implementation and testing of the project, REST API and methods defined in the Algorithm Research and Development Stage	Done
Usage and Integration of AIM in component	Aligning the communication schema of the variable rate component with the AIM model defined in stage 1	Done
Basic algorithm Implementation	Implementation of the taskmap generation algorithm	Done

Feature	Short description	Status
ACS Implementation and Integration	Integration of the component with the DEMETER ACS to provide authentication and authorisation mechanisms compliant with the DEMETER project	In Progress
Deployment and Evaluation (Test Environment)	Deployment, evaluation, and validation of the taskmap component and its integration with WatchItGrow within a test environment	Not Started
Component Refinement	Review of evaluation and validation reports with component refinement if needed (e.g., bug fixes)	Not Started
Deployment and Evaluation (Production Environment)	Deployment, evaluation and deployment of the variable rate component and its integration with the WatchItGrow service in the production environment	Not Started

Table 29: Component 4.D.3 Status

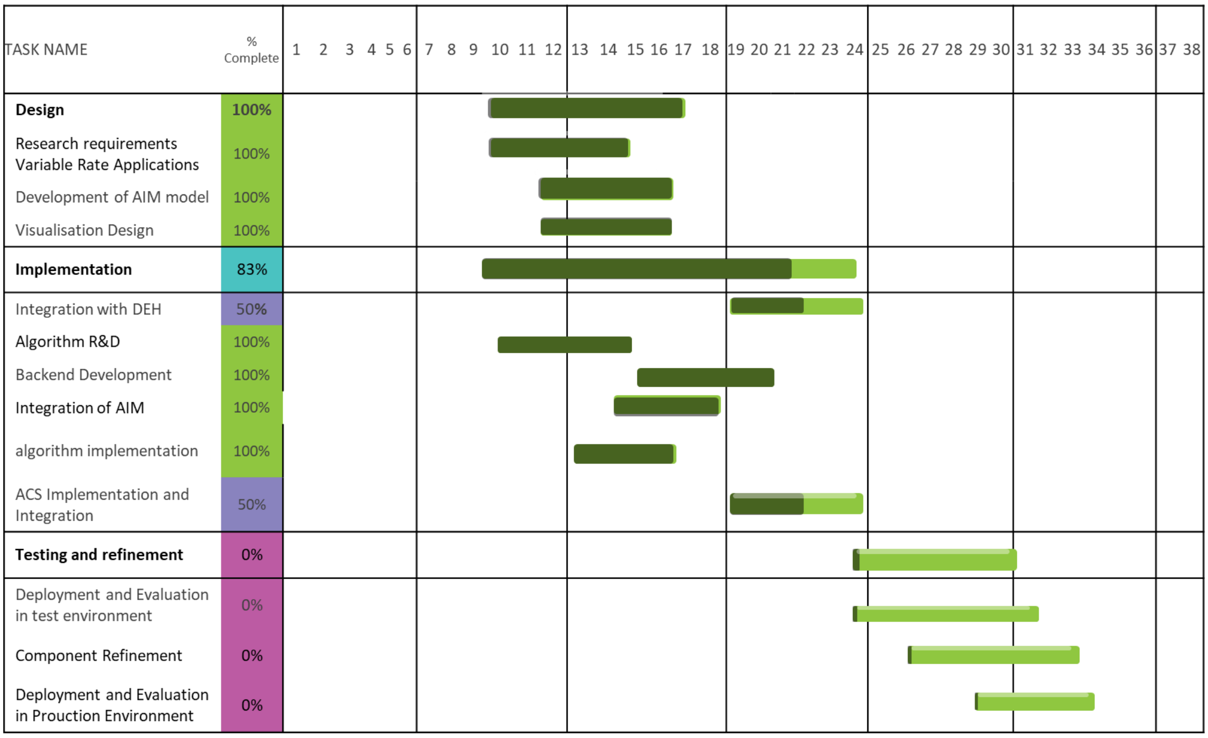


Figure 24: Component 4.D.3 GANTT Chart

6.5 *DSS AREA: 4.E - Pest and Disease Management*

6.5.1 Component 4.E.1 Pest Estimation with Sterile Fruit Flies

Description	The Pest Estimation with Sterile Fruit Flies component aims at monitoring the fruit fly pest tracking providing an estimation of the current and future population. To do so, this DSS component has been designed to receive images taken from fruit fly traps and get an estimation of the flies captured. This estimation is carried out by using a WP2 component (pattern-extraction-with-computer-vision) that performs element identification in images from a trained model. This module keeps track of the different estimations over time and calculates a tendency based on the last observations.
Responsible Partner	Sergio Salmerón (ATOS), Jesús Martínez (ATOS)

Partners	ATOS
Pilots	3.3

Table 30: Component 4.E.1 Metadata

Dashboard Widget

Figure 25: Component 4.E.1 Dashboard Widgets

The dashboard widget for Pest Estimation with Sterile Fruit Flies component (Figure 25) will consist of one (optional) selector to choose the trap and two date selectors used to delimitate the range of the data gathered by traps that will be shown in a table and in a graphic chart below. The graphic visualisation will also display an estimated prediction of the future captures. Figure 25 shows a mock-up of such widget.

Dependencies (either internal to DEMETER or bound to the pilot)

1. Component “Pattern extraction with computer vision” from WP2. Such component will be used to create the model and to perform the identification of flies in the pictures using the generated model.

Core Enablers Used

1. DEH - DEMETER Enabler Hub – Registering in DEMETER the virtualised component.
2. BSE - Brokerage Service Environment – Providing mechanism for the discovery of services.
3. ACS - Access Control System – Providing Authentication and Authorisation mechanisms for the variable rate component.

Security Usage (Data & User)

4.E.1 - Pest Estimation with Sterile Fruit Flies component will not include an access control system for users, but it will be integrated with the DEMETER Access Control System, what will restrict the users able to locate/use the component itself.

Current Status

Feature	Short description	Status
Initial component architecture design	Create an initial design of the component, defining its functionality, inputs and outputs	Done
Database schema Design	Define the data architecture to use in the component to keep track of the models created and the different fruit fly estimation results	Done
Visualisation Initial Design	Mock-ups of the Knowage visualisations that will be produced for the Pest Estimation with Sterile Fruit Flies component	Done
Database implementation	Implement the database schema in a database management system	Done
Backend development	Define and implement the different services that will serve the functionalities of the component	In progress
Algorithm Development	Design and implement an algorithm to analyse the tendency of the fruit flies captured by the traps in pilot 3.3	In progress
Pattern-extraction-with-computer-vision component integration	Integration with the WP2 component “pattern-extraction-with-computer-vision” to generate the computer vision models and perform the element counting from the images	Not started
Development of AIM model (Input & Output)	Development of the input and output schemas for the fruit fly estimation ensuring it is AIM compliant	In progress
Integration with DEH	Integration of the component in the DEH (DEMETER Enabler Hub)	Not started
Integration with BSE	Integration of the component in the BSE (Brokerage Service Environment)	Not started
Integration with ACS	Integration of the component in the ACS (Access Control System)	Not started
Deployment and Evaluation (Test Environment)	Deployment, evaluation and validation of the Pest Estimation with Sterile Fruit Flies component and its integration with all the dependencies in a test environment	Not started
Component Refinement	Review of evaluation and validation reports with component refinement if needed (e.g., bug fixes)	Not started
Deployment and Evaluation (Production Environment)	Deployment, evaluation and deployment of the Pest Estimation with Sterile Fruit Flies component and its integration with the service in the production environment of the pilot 3.3	Not started

Table 31: Component 4.E.1 Status

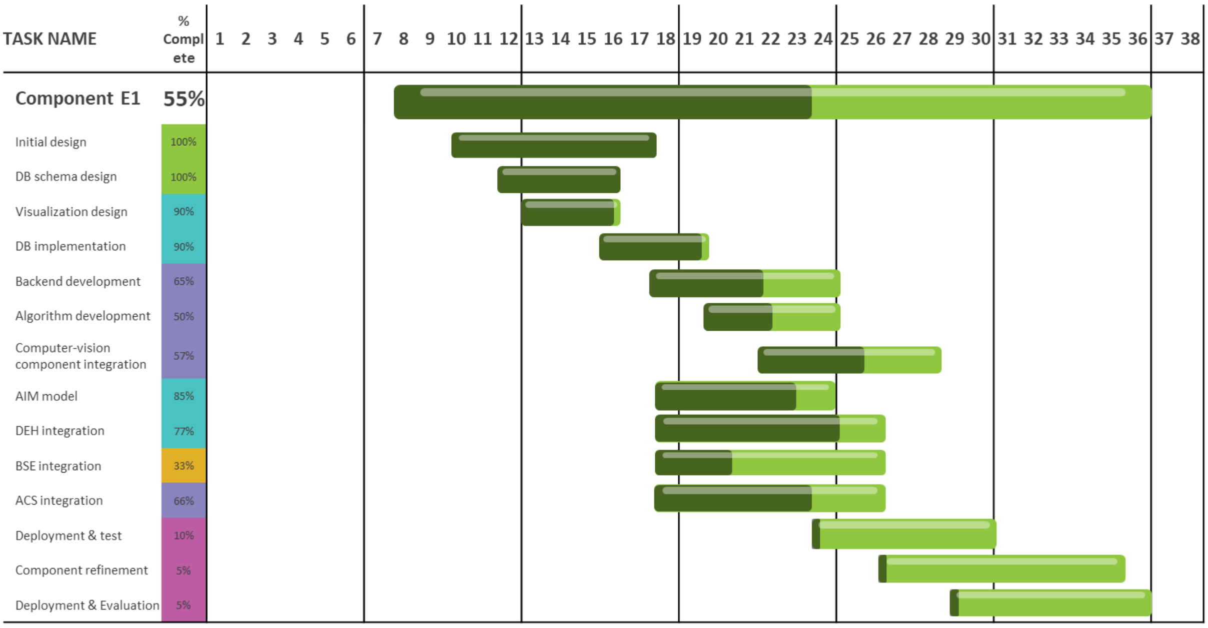


Figure 26: Component 4.E.1 GANTT Chart

6.5.2 Component 4.E.2 Estimate Temperature-related Pest Events

Description	The DSS component on the estimation of temperature-related pest events provides the farmer with a prediction of the occurrence and of the trend of pest flight. As target species, the olive fruit fly (*Bactrocera oleae*) has been selected since it is the most harmful pest of the olive tree causing dramatic quality deterioration and product loss. The component is focused on specific pest events: (i) absence (no flight), (ii) start of the flight, (iii) peak of the flight, (iv) end of the flight. The broader aim of this component is that it should be easy to apply to other pests and crops. A machine learning (ML) model has been trained on historical data from a monitoring network in central Italy. The trained model has been later constructed using the DSS of the WP2 Prediction Model Training Web Service Enabler. The internal functionality design of this component is based on data extracted from external weather API to connect with Copernicus ERA5 temperature data. The final output is shown to the farmer using the DEMETER visualisation and adaptive framework module, Knowage. This component predicts the current status of the olive fruit flight for each generation during summer with a daily time step for a given location (i.e., geographic location), using temperature data from Copernicus ERA5 data service.
Responsible Partner	Diego Guidotti (AGRICOLUS)
Partners	AGRICOLUS, TRAGSA, ICE
Pilots	3.1

Table 32: Component 4.E.2 Metadata

Dashboard Widget

Figure 27: Component 4.E.2 Dashboard Widgets

The output data model of this DSS component is based on the DEMETER AIM data model and will be available using a REST API. The Knowage module allows a clear visualisation of the model output data in a web front-end using graphical widgets based on a previously designed mock-up (Figure 27). End-users can visualise the current status of the pest flight: (i) absence (no flight), (ii) the flight period is starting, (iii) the peak is reaching, (iv) the flight period is ending. A chart showing the trend of the flight vs date is available for visualisation as well.

The following lists the workflow of the component for the prediction of temperature-based pest events:

1. Get the latitude and longitude of the farm (field) from the farm AIM data model.
2. Connection to Copernicus ERA5 data service to gather daily temperature data for the geographic location of the farm.
3. Calculation of degree-day accumulation using daily minimum and maximum temperature data from Copernicus ERA5 with the Allen formula (Allen [3]), considering the biology of the olive fruit fly and of the olive tree.
4. The component predicts the status of the olive fly flight: (i) not started, (ii) starting, (iii) peak, (iv) end of the flight.
5. The output of the model has a daily time step as well the probability level of the RF algorithm.
6. The result of the model is formatted according with the AIM data format, using the Observation Class from the Sensor-Observation-Sampling-Actuator ontology (SOSA, [4]).
7. The API is used by the Knowage visualisation component to make the result accessible to the final user.
8. A Python web application developed with the Flask framework has been used to publish the result of the API.

Dependencies (either internal to DEMETER or bound to the pilot)

1. Copernicus ERA5 dataset.
2. Datasets for training the model.
3. DEMETER visualisation and adaptive framework Knowage module.

Core Enablers Used

1. AIM for data exchange.
2. BSE - Brokerage Service Environment – Providing mechanism for the discovery of services.
3. ACS - Access Control System – Providing Authentication and Authorisation mechanisms for the component on the estimation of the temperature-related pest events.
4. DEH - DEMETER Enabler Hub – Registering in DEMETER the virtualised component.

Security Usage (Data & User)

4.E.2 - Estimate Temperature-related pest event component will make use of the DEMETER ACS to ensure security for both the user and data managed by the component.

Current Status

Feature	Short description	Status
Research requirements	Researching and identification of WP4 requirements of the "Estimate temperature-related pest events" service	Done
Development of AIM model (Input & Output)	Development of the input and output schemas for "estimate temperature-related pest event component" and ensuring this is AIM compliant	Done
Component Design	Designing the component structure (i.e., required external components, service, etc.), REST API, and backend methods for implementation	Done
Visualisation Design	Mock-up for the Knowage visualisation module	Done
Algorithm Research and Development	The Random Forest algorithm has been pre-trained with historical data of pest monitoring network and temperature data of local weather stations	In progress
Data Integration: Meteorological Data	Integration of Copernicus ERA5 data into the algorithm defined for the estimation of temperature-related pest events	Done
Algorithm Implementation	Implementation of the algorithm for the estimation of the temperature-related pest events including the integration of Copernicus ERA5 data	In progress
ACS and BSE Implementation and Integration	Integration of the component with the DEMETER ACS to provide authentication and authorisation mechanisms compliant with the DEMETER project	Done
Deployment and Evaluation (Test Environment)	Deployment, evaluation, and validation of the "estimate temperature-related pest event" component integrated with the test environment; release of docker component	Started
Component Refinement	Review of evaluation and validation reports with component refinement if needed (e.g., bug fixes)	Not Started
Deployment and Evaluation (Production Environment)	Deployment, evaluation, and deployment of the component in the production environment	Not Started

Table 33: Component 4.E.2 Status

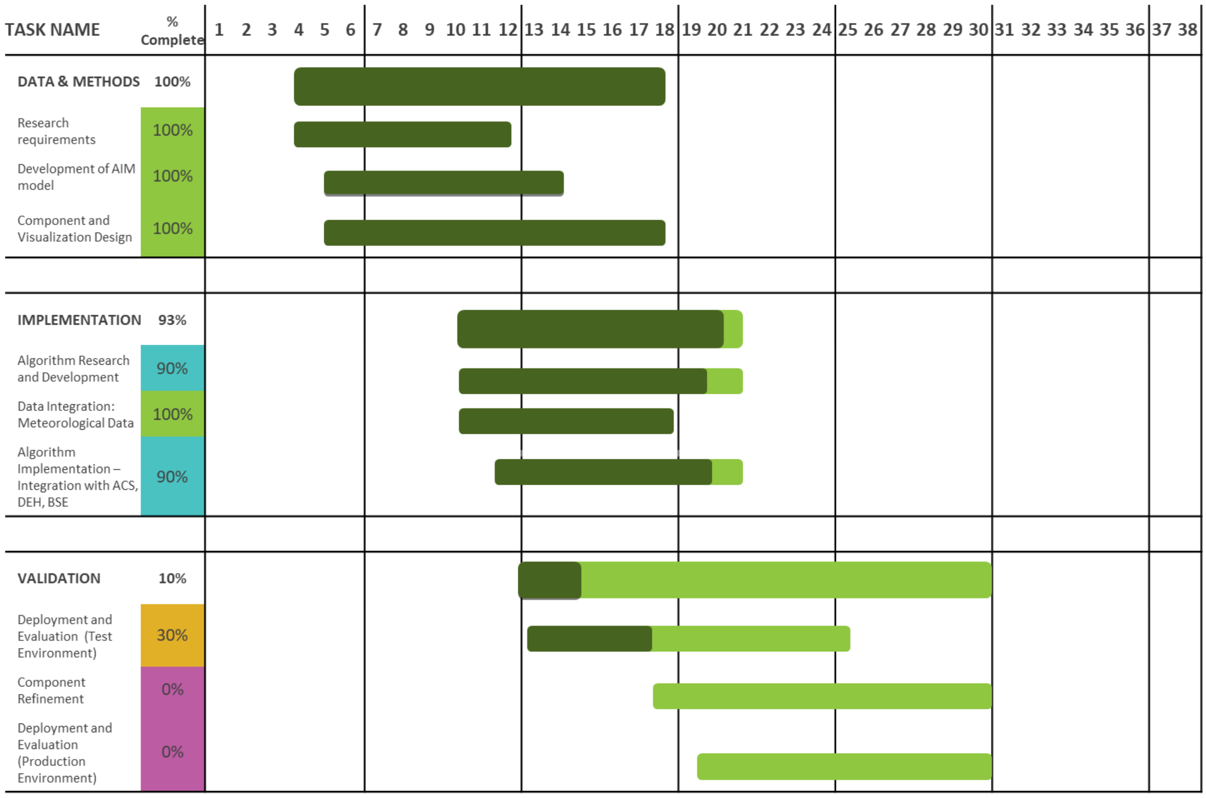


Figure 28: Component 4.E.2 GANTT Chart

6.6 *DSS AREA: 4.F - Animal Yield*

6.6.1 Component 4.F.1 Estimate Milk Production

Description	The Estimate Milk Production component will receive milking events for an individual cow as input, including attributes describing the individual cow's current lactation. The component then returns a forecast describing the estimated yield still remaining in the current lactation.
Responsible Partner	Harald Volden (MIMIRO)
Partners	SINTEF
Pilots	4.1, 4.2, 4.4, 5.4

Table 34: Component 4.F.1 Metadata

Dashboard Widget

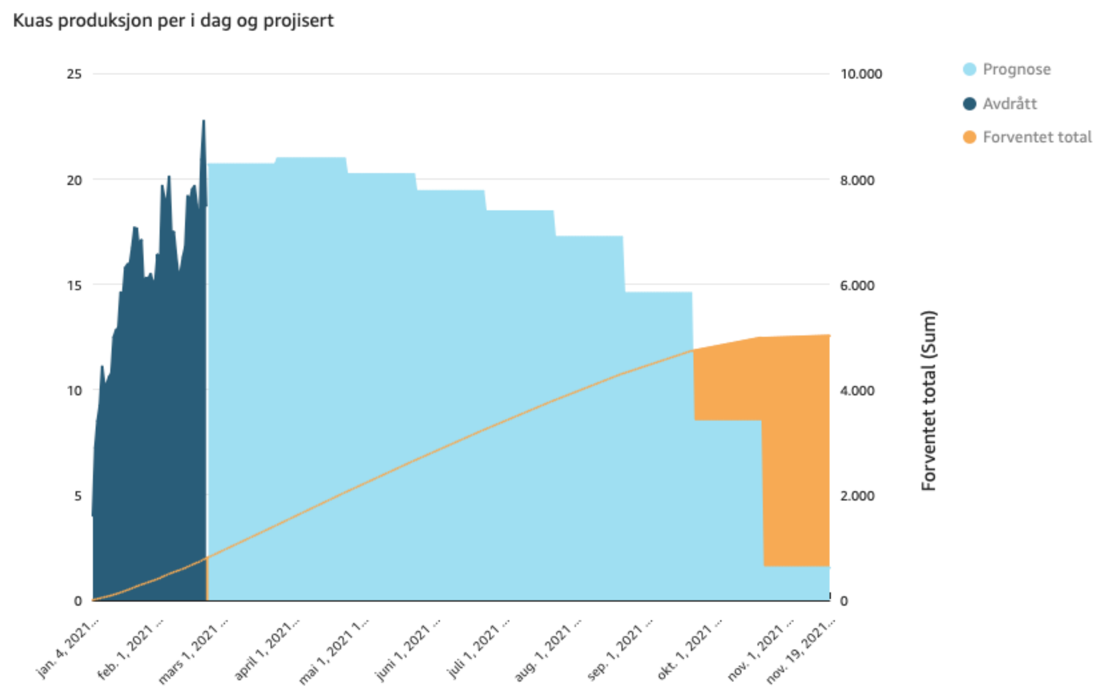


Figure 29: Component 4.F.1 Dashboard Widgets

The dashboard for the Estimate Milk Component (see Figure 29) will take the form of a single visualisation. This will display the milk yield so far, and complete the milk yield out to the expected end of the current lactation cycle with an estimated forecast. As such the expected cumulative total can be calculated and visualised as well.

Dependencies (either internal to DEMETER or bound to the pilot)

No direct dependencies. A source for milking events would be needed to provide data to the component for estimation.

Core Enablers Used

1. BSE - Brokerage Service Environment – Providing mechanism for the discovery of services.
2. DEH - DEMETER Enabler Hub – Registering in DEMETER the virtualised component.
3. ACS - Access Control System – Providing Authentication and Authorisation mechanisms for registering component in the DEMETER enabler hub. No access control is intended to be used for the component itself as it provides an idempotent service and neither contains nor holds any data, see below.

Security Usage (Data & User)

4.F.1 - Estimate Milk Production component has no specific security requirements as it provides an idempotent data classifier service. It simply takes input data and returns the output forecast based on it and does not need to store any data.

Current Status

Feature	Short description	Status
Training of the ML component to estimate milk production	Training of the Estimate Milk Production component based on 1000s of NCDX data points for milking events from milk robots	Complete
Development of AIM model (Input & Output)	Development of the input and output schemas for the estimate milk production component and ensuring this is AIM compliant	Complete
Visualisation Design	Mock-ups of the visualisations for the dashboard showing the output of the component	Complete
Integration with DEH	Integration and testing of the component as a registered enabler in the DEMETER Enabler Hub	Tested, not published
Initial Design	Designing the project structure, REST API and backend methods for implementation in the estimate milk production component	Complete
Backend Development	Implementation and testing of the project, REST API and methods defined in the Algorithm Research and Development Stage	In Progress
Usage and Integration of AIM in component	Aligning the communication schema of the component with the AIM model defined in stage 1	Complete
Component Refinement	Review of evaluation and validation reports with component refinement if needed (e.g., bug fixes)	In Progress
Deployment and Evaluation (Production Environment)	Deployment, evaluation, and deployment of the component.	Not Started
Further scientific development	Evaluation new data sources and new algorithm with the Norwegian cattle database data (animal health and milk chemical composition)	Not started

Table 35: Component 4.F.1 Status

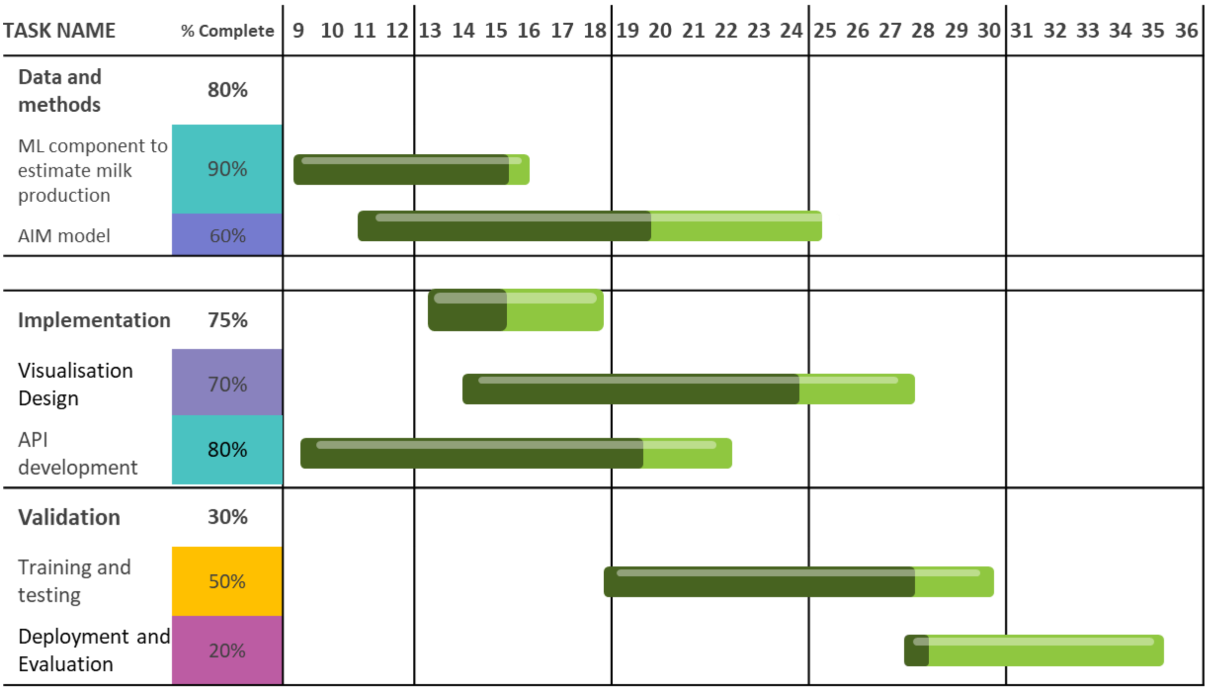


Figure 30: Component 4.F.1 GANTT Chart

6.6.2 Component 4.F.2 Poultry Feeding

Description	This component presents the overall animal feeding quality based on a food and water level in the silo with estimated water and food consumption intake. The component provides the UI dashboard with food level in the silo with estimated consumption. The animal feeding quality can be then assessed by farmers based on the level of the food in the silo. The components receive data as an input in the DEMETER AIM format. More specifically, data about silo volume, flock age, animal species, food type, food density and the silo empty threshold value. These data are then analysed, and the output of the classification process is then provided to the dashboard output. The component is generic in a sense it can be used not only for poultry, but it can be employed in any use cases, where it is necessary to monitor the feeding of the animals.
Responsible Partner	Nenad Gligoric (DNET)
Partners	DNET, Sinkovic
Pilots	4.4

Table 36: Component 4.F.2 Metadata

Dashboard Widget

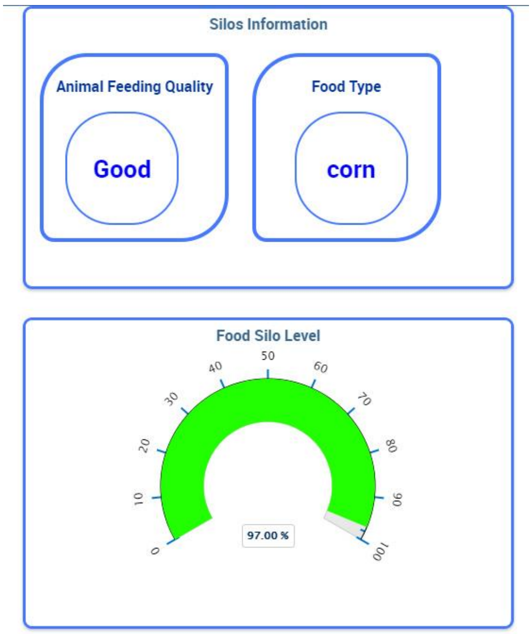


Figure 31: Component 4.F.2 Dashboard Widgets

The dashboard for the Poultry feeding Component (see Figure 31) provides graphical view for the animal feeding quality, food type and food silo level. The simplistic interface shows all necessary data directly, indicating the animal feeding quality and level of the food in the silo as an output of classification based on the requirements given in the pilot 4.4.

Dependencies (either internal to DEMETER or bound to the pilot)

1. agroNET platform - agriculture platform for monitoring on parameters in field using sensors (temperature, humidity, rain perception leaf wetness, soil moisture), pheromone traps with cameras to detect number of insects, advanced algorithms for providing instructions to farmers.

Core Enablers Used

1. BSE - Brokerage Service Environment – Providing mechanism for the discovery of services.
2. ACS - Access Control System – Providing Authentication and Authorisation mechanisms for the component.

Security Usage (Data & User)

4.F.2 - Poultry feeding component will make use of the DEMETER ACS to ensure security for both the user and data managed by the component.

Current Status

Feature	Short description	Status
Requirements, data specification and models	Initial requirements of the field operations data, classification analysis models	Done
Development of AIM model (Input & Output)	Development of the input and output schemas for the variable rate application ensuring this is AIM compliant	Done
Visualisation Design	Mock-ups of the Knowage visualisations that will be produced for the variable rate component	Done
Integration with DEH	Integration and testing of the variable rate component as a registered enabler in the DEMETER Enabler Hub	In Progress
Development of DEMETER AIM compliant adapter for poultryNET webservice	REST API and backend methods for implementation of the service	Done
Classification algorithm Development	Development of the classification algorithm to generate animal feeding	Done
Usage and Integration of AIM in component	Aligning the communication schema of the variable rate component with the AIM model defined in stage 1	Done
ACS Implementation and Integration	Integration of the component with the DEMETER ACS to provide authentication and authorisation mechanisms compliant with the DEMETER project	In Progress
Deployment and Evaluation (Test Environment)	Deployment, evaluation, and validation of the field operation component in test environment	Done
Component Refinement	Review of evaluation and validation reports with component refinement if needed (e.g., bug fixes)	Not Started
Deployment and Evaluation (Production Environment)	Deployment, evaluation, and validation of the field operation component and its integration with agroNET devices deployed in field	Not Started

Table 37: Component 4.F.2 Status

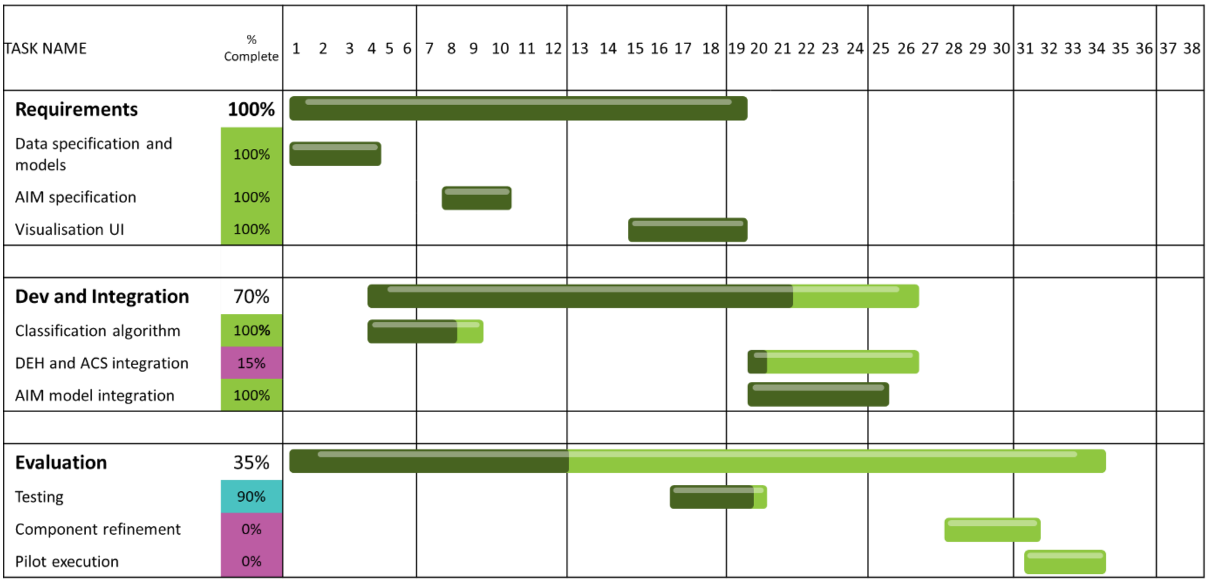


Figure 32: Component 4.F.2 GANTT Chart

6.7 *DSS AREA: 4.G - Animal Welfare*

6.7.1 Component 4.G.1 Estimate Animal Welfare Condition

Description	The DSS on animal welfare makes it possible to evaluate the state of health of the analysed cows, to determine the degree of well-being, in terms of nutrition, hygiene, rest and movement and consequently also to evaluate their productivity (which is strictly connected to their welfare). The flows, containing the data relating to the nutritional and milking values of the milk produced by the livestock farm, and those relating to the activities and rest periods of the analysed cows, are acquired by Knowage module or DEMETER adaptive visualisation framework, which processes them both to visualise the parameters values and the results of the training and prediction algorithm analysis, regarding the cows health status, based on the pathologies like ketosis, mastitis and lameness, obtained by processing data from the Random Forest algorithm.
Responsible Partner	Antonio Caruso (ENG), Gianluca Isgrò (ENG), Massimo Giacalone (ENG)
Partners	Engineering (ENG)
Pilots	4.2

Table 38: Component 4.G.1 Metadata

Dashboard Widget

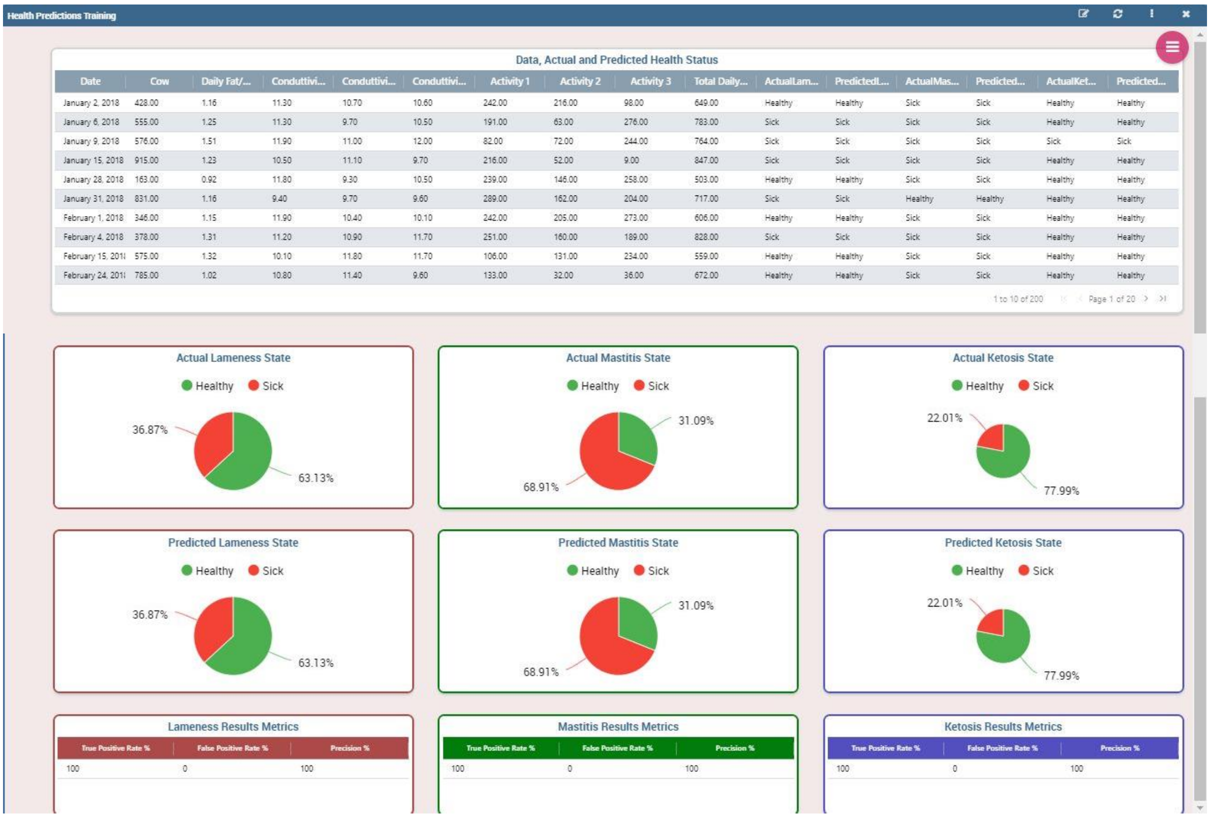


Figure 33: Component 4.G.1 Training Dashboard Widgets

The DSS dashboard created using the Knowage module provides for the monitoring of the health status of the livestock using graphical widgets. Through this DSS, the farmer can establish their current health status on a limited number of animals (object of the DEMETER project execution), by means of specific predictions of ML algorithms. Through these predictions the farmer can understand and optimise the health of the herd.

The dashboard shows a table (Figure 33) containing the data concerning the fat/protein ratio, the electrical conductivity, the activities related to the animal movement and the total daily rest, accompanied by two parameters: the health status by pathology (ketosis, mastitis and lameness) assigned "manually" by the farmer and the health status by pathology assigned by the machine learning algorithm, determined by the latter through training performed by studying the values assigned by the farmer. The dashboard also shows, for each pathology, two pie charts, to compare the health status assigned "manually" with those determined by the algorithm and a table showing the metrics: parameters that allow the farmer to determine the accuracy of the algorithm.

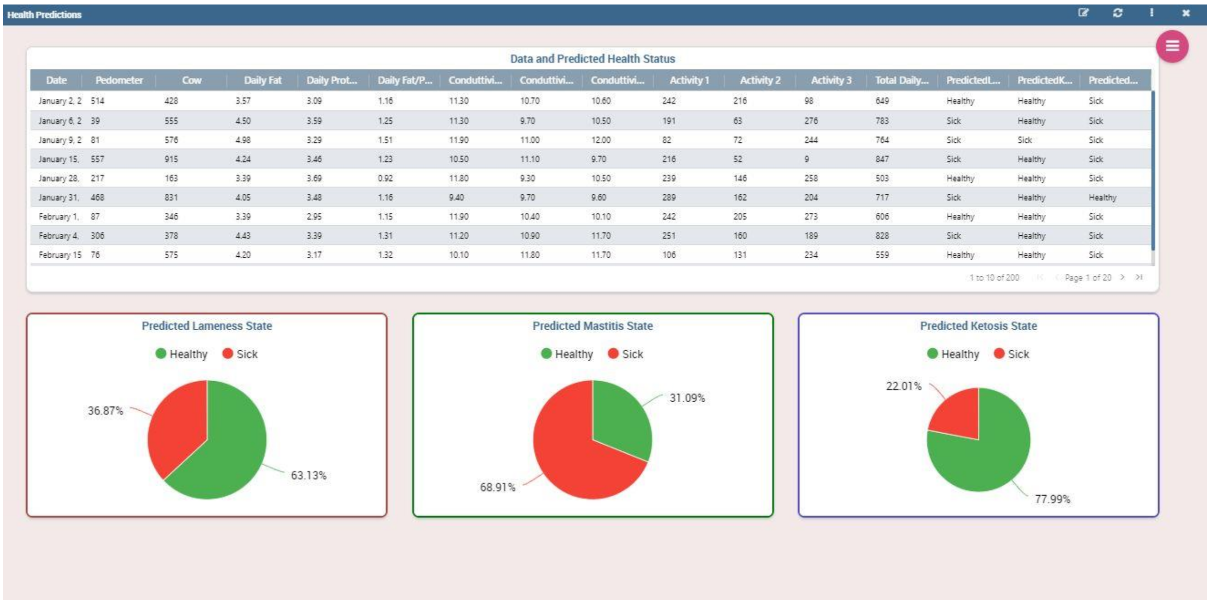


Figure 34: Component 4.G.1 Prediction Dashboard Widgets

After obtaining a high degree of precision from the predictive algorithm analysis, this is performed autonomously: in fact, in the data table shown in the Figure 34, it is possible to visualise only the column relating to the classifications determined by the predictive algorithm with regards the health status by pathology.

Dependencies (either internal to DEMETER or bound to the pilot)

1. AIM Translator Module – It manages the Pilot data translation from CSV to AIM providing a data model for **Animal Welfare** component.

Core Enablers Used

1. BSE - Brokerage Service Environment – Providing mechanism for the discovery of services.
2. ACS - Access Control System – Providing Authentication and Authorisation mechanisms for Knowage module to access Animal Welfare dashboard.

Security Usage (Data & User)

4.G.1 - Estimate Animal Welfare Condition component will make use of the DEMETER ACS to ensure security for both the user and data managed by the component. The integration between this component and ACS will be examined in Pilot Round 2, to understand if it is necessary to increase the security level of this component that currently runs within the Pilot 4.2 cloud infrastructure without exposing services outside or on the internet but only inside the network infrastructure.

Current Status

Feature	Short description	Status
Data source selection #1	Pilot data source selection	Done
Data collection #1.1	Pilot data collection	Done
Data preparation #1.2	Pilot data preparation	Done
Data integration #1.3	Pilot data integration	Done
Data modelling #2	Pilot data modelling in AIM format	Done for Pilot Round 1

Feature	Short description	Status
Model for algorithm training #2.1	AIM data modelling for algorithm training and prediction phases	Done for Pilot Round 1
AIM Model integration #2.2	AIM data model integration in the Pilot technical solution	Done for Pilot Round 1
Development & Integration #3	Pilot DSS development and data integration	Done for Pilot Round 1
Research discovery in scientific algorithm classification and regression #3.1	Study and discovery of a most suitable machine learning algorithm capable of satisfying the data analysis needs regarding the animal welfare	Done
Analysis of composing technology for the implementation phase #3.2	Study and technological selection most appropriate for the implementation of the algorithm selected in # 3.1	Done
Backend component design and implementation #3.3	Technical design and implementation of the algorithm	Done for Pilot Round 1
Frontend DSS dashboard design and implementation #3.4	Technical design using mock-up definition and implementation of the fronted part capable of displaying the data produced by the algorithm in the AIM format	Done for Pilot Round 1
DEMETER data visualisation framework advanced enabler integration #3.5	Integration with DEMETER's DSS visualisation framework (Knowage) and with other advanced enablers	Done for Pilot Round 1
Software component implementation: testing & bug fixing #3.6	Algorithm implementation using the technology choice in activity #3.2	Done for Pilot Round 1
Software component implementation: code review #3.7	Algorithm code review after first implementation	Done for Pilot Round 1
Component deployment: test environment #3.8	Algorithm deployment in the development test environment	Done
Delivery and component evaluation #4	Verification of the quality of the software produced in the implementation of the component	Done for Pilot Round 1
Predictive performance evaluation: component training setup #4.1	First component training and prediction evaluation based on the Pilot data and algorithm analysis	Done
Component refinement #4.2	Component improvement after the quality code review and the accuracy of the algorithm output after prediction test on animal welfare	Done for Pilot Round 1
Component deployment: production environment (Pilot side) #4.3	Component deployment (docker module) in the production environment	Done

Table 39: Component 4.G.1 Status

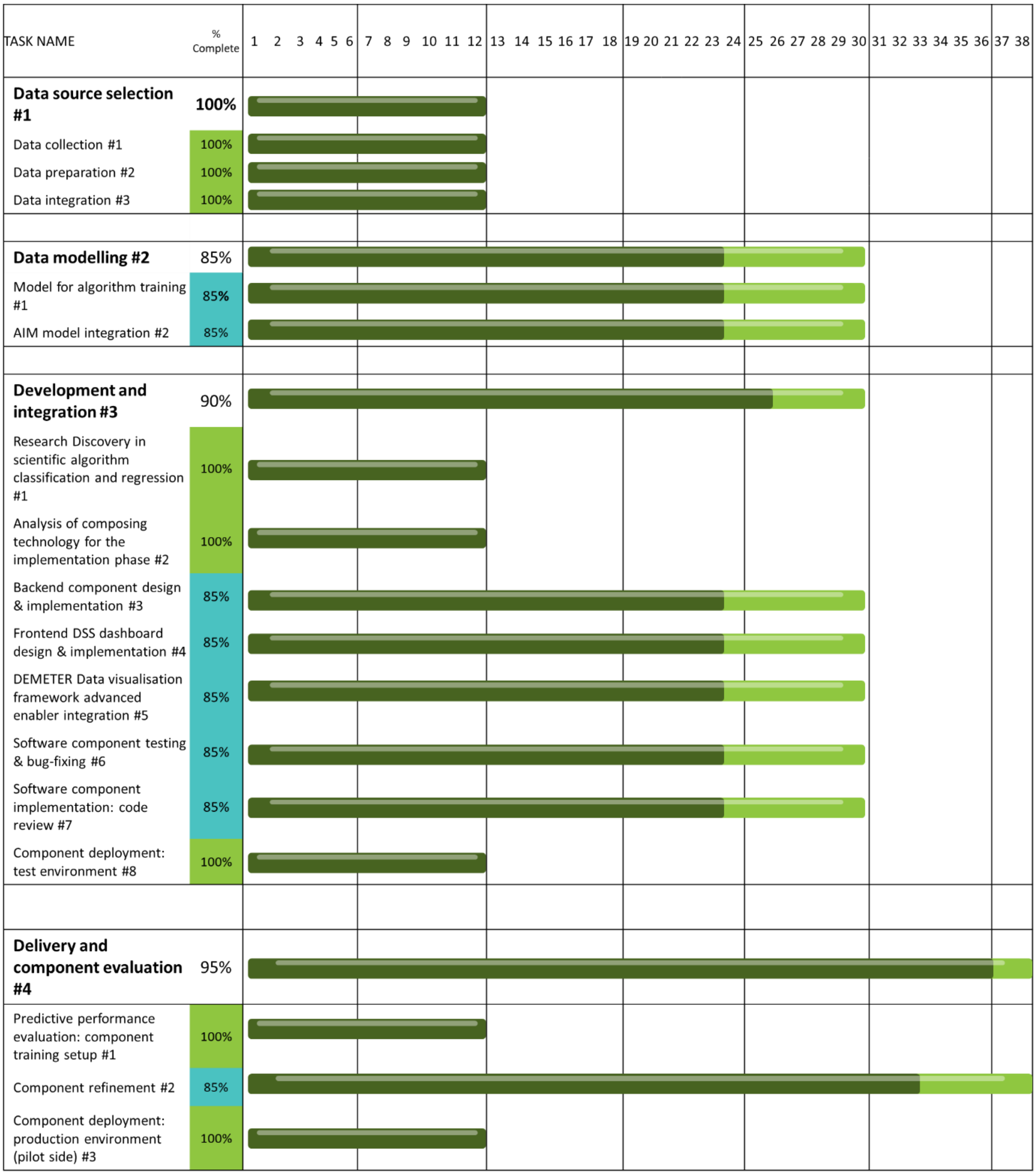


Figure 35: Component 4.G.1 GANTT Chart

6.7.2 Component 4.G.2 Poultry Well-Being

Description	This component for poultry well-being provides the overall poultry stress based on parameters from environment and patterns detected from environment and video/ microphone. The component provides the UI dashboard with the following data: Air temperature, Humidity, Air flow, Light intensity, CO_2, Power loses, Animal species, Detected stress level, Flock age, Safety instruction. The components receive data as an input in the DEMETER AIM format. These data are then analysed, and the output of the classification process is then provided to the dashboard output. The animal well-being quality can be then directly monitored by farmers altogether with a set of parameters captured from the environment.
Responsible Partner	Nenad Gligoric (DNET)
Partners	DNET, Sinkovic
Pilots	4.4

Table 40: Component 4.G.2 Metadata

Dashboard Widget

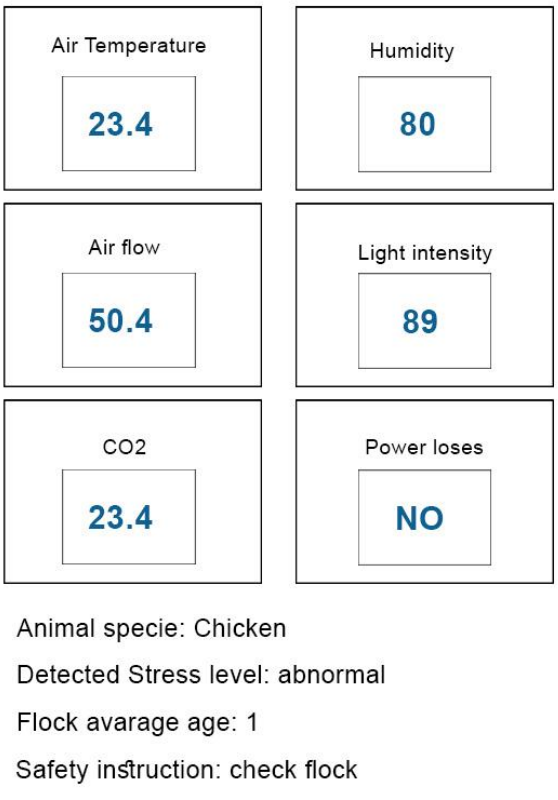


Figure 36: Component 4.G.2 Dashboard Widgets

The dashboard for the Poultry well-being Component (see Figure 36) provides graphical view for the animal well-being based on a stress level and environmental parameters. The simplistic interface shows all necessary data directly, indicating the animal well-being as an output of classification based on the requirements given in the pilot 4.4.

Dependencies (either internal to DEMETER or bound to the pilot)

1. poultryNET platform - platform advance farm management operations and performance optimisations and monitoring on parameters on farm using sensors and edge devices (temperature, humidity, camera, microphone, CO_2). Platform has embedded algorithms and own dashboard and analytics for providing instructions to farmers.

Core Enablers Used

1. BSE - Brokerage Service Environment – Providing mechanism for the discovery of services.
2. ACS - Access Control System – Providing Authentication and Authorisation mechanisms for the component.

Security Usage (Data & User)

4.G.2 - Poultry well-being component will make use of the DEMETER ACS to ensure security for both the user and data managed by the component.

Current Status

Feature	Short description	Status
Requirements, data specification and models	Initial requirements of the field operations data, classification analysis models	Done
Development of AIM model (Input & Output)	Development of the input and output schemas for the variable rate application ensuring this is AIM compliant	Done
Visualisation Design	Mock-ups of the Knowage visualisations that will be produced for the variable rate component	Done
Integration with DEH	Integration and testing of the variable rate component as a registered enabler in the DEMETER Enabler Hub	In Progress
Development of DEMETER AIM compliant adapter for poultryNET webservice	REST API and backend methods for implementation of the service	Done
Classification algorithm Development	Development of the classification algorithm to generate animal feeding	Done
Usage and Integration of AIM in component	Aligning the communication schema of the variable rate component with the AIM model defined in stage 1	Done
ACS Implementation and Integration	Integration of the component with the DEMETER ACS to provide authentication and authorisation mechanisms compliant with the DEMETER project	In Progress
Deployment and Evaluation (Test Environment)	Deployment, evaluation, and validation of the field operation component in test environment	Done
Component Refinement	Review of evaluation and validation reports with component refinement if needed (e.g., bug fixes)	Not Started
Deployment and Evaluation (Production Environment)	Deployment, evaluation, and validation of the field operation component and its integration with agroNET devices deployed in field	Not Started

Table 41: Component 4.G.2 Status

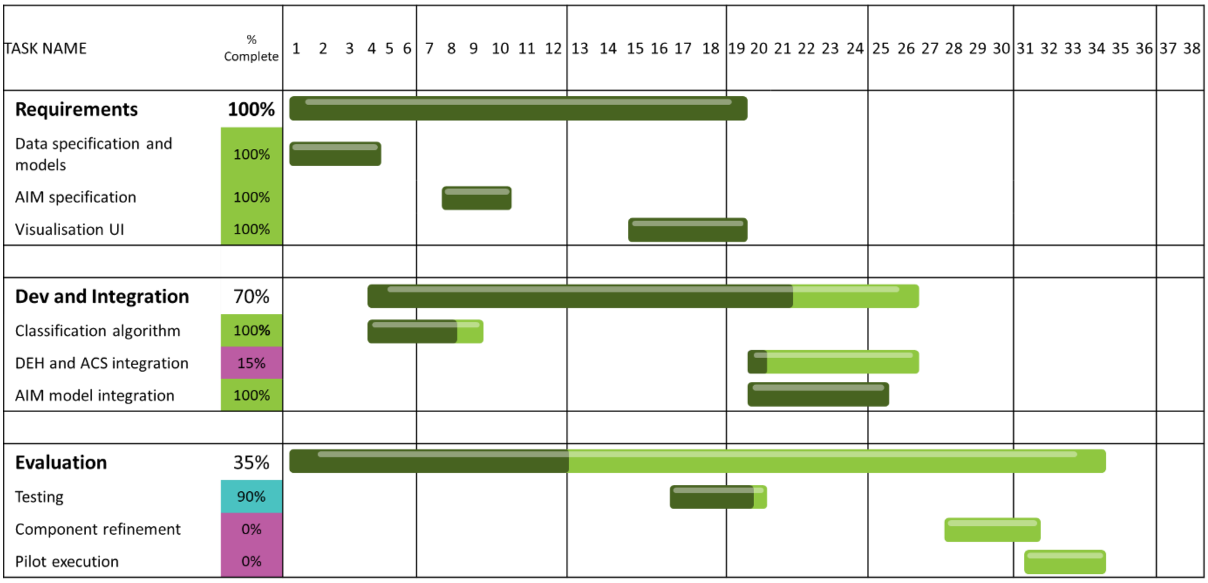


Figure 37: Component 4.G.2 GANTT Chart

6.8 *DSS AREA: 4.H - Traceability*

6.8.1 Component 4.H.1 Milk Quality Prediction

Description	The DSS on Milk Quality Prediction, within the milk processing chain, allows to evaluate the analysis of raw and processed milk samples coming from dairy farm, to determine the quality level of the milk, thus identifying the goodness both of the milk arriving at the processing company and of the processed milk ready for packaging, in order to understand if and what choice to make in order to improve its quality. The analysis of the milk samples taken into consideration by the DSS concerns 2 events: samples collected on arrival of the tanker, before unloading and samples collected before packaging. The samples are processed by Pilot machinery, a device which analyses them using FTIR (Fourier Transform InfraRed Transform) spectroscopy.
Responsible Partner	Antonio Caruso (ENG), Gianluca Isgrò (ENG), Massimo Giacalone (ENG)
Partners	Engineering (ENG)
Pilots	4.2

Table 42: Component 4.H.1 Metadata

Dashboard Widget

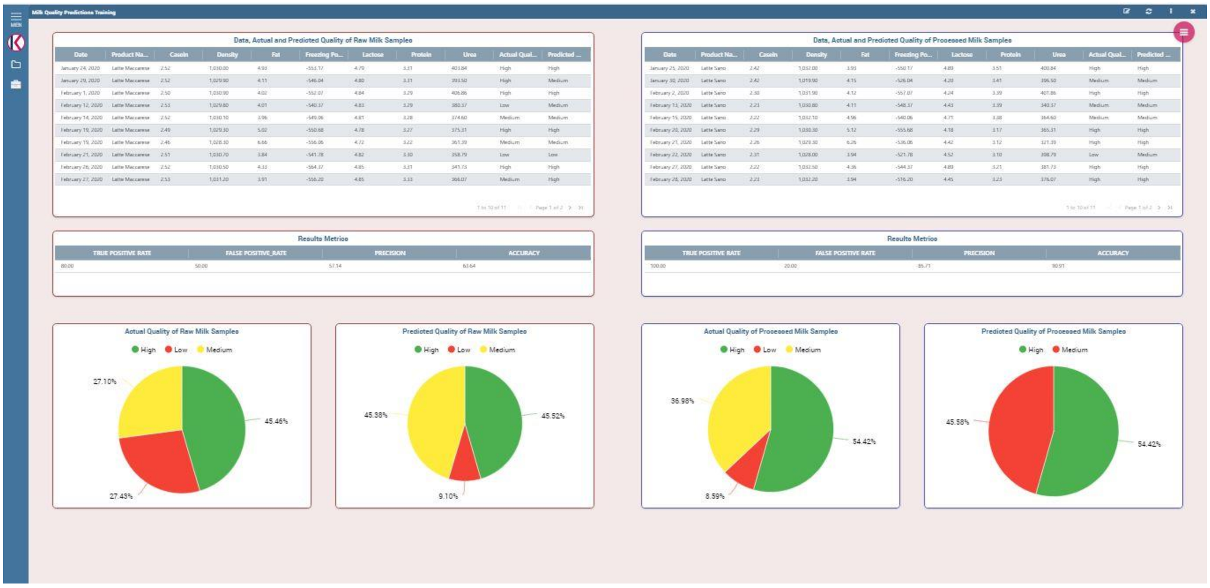


Figure 38: Component 4.H.1 Training Dashboard Widgets

The DSS dashboard produced using the Knowage module provides monitoring of the quality degree of milk using Knowage graphical widgets. This DSS enables the farmer to establish the current level of milk quality on a limited number of animals (the object of the DEMETER project implementation), by means of specific predictions of Machine Learning algorithms. These predictions enable the farmer to understand and optimise the quality of the milk produced by their whole herd.

The DSS dashboard, both for raw and processed milk, shows a table (see Figure 38) containing the FTIR analysis accompanied by two parameters: the degree of quality assigned "manually" by the farmer for each sample and the degree of quality assigned by the algorithm, determined through the training performed studying the values assigned "manually". The dashboard also shows, for each type of milk, two pie charts to compare the quality degree assigned "manually" with that determined by the algorithm, and a table showing the metrics: parameters that allow you to determine the accuracy of the algorithm.

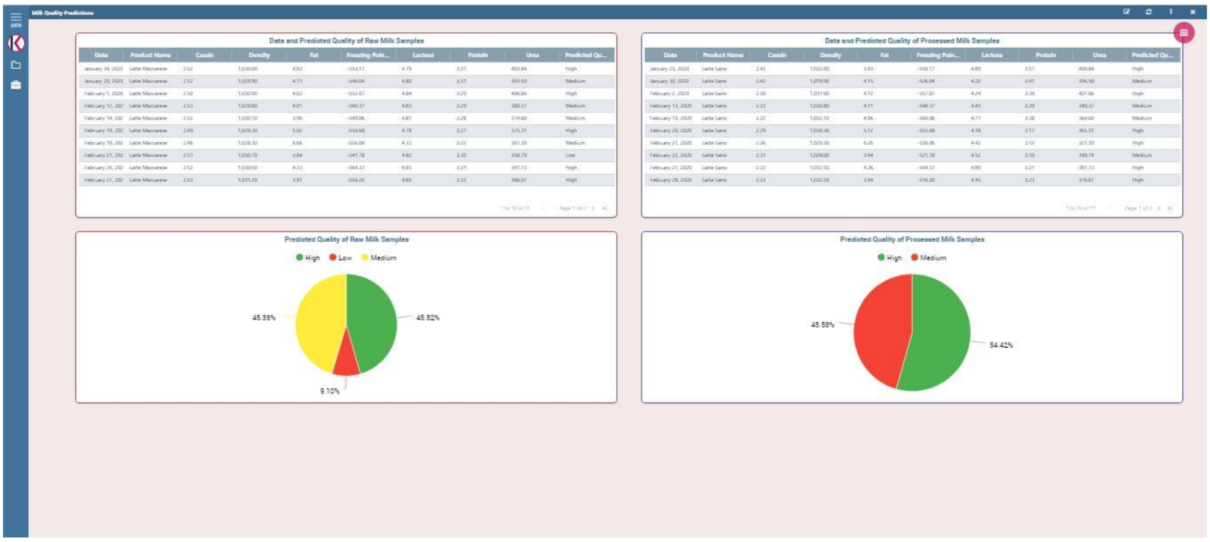


Figure 39: Component 4.H.1 Prediction Dashboard Widgets

After obtaining a high degree of accuracy from the predictive algorithm, the prediction is performed autonomously. The table in Figure 39 shows the results of FTIR analysis but, with regards to the milk quality level, only the column relating to the classifications determined by the predictive algorithm are shown.

Another dashboard implemented using Knowage module within this area, but which is not directly linked to the AIM output of the 4.H.1 component (but equally noteworthy to be report here in this document) is the Estimate Milk Quality dashboard. This dashboard also includes an end-user visualisation interface specifically implemented for the milk processing company staff and related also to Pilot 4.2. It analyses in detail some parameters provided by the company machinery in order to relate some additional data which are not included in the DEMETER AIM as they are not directly connected to the artificial intelligence algorithms developed within WP4. This new dashboard also covers some aspects relating to the milk quality prediction process as it shows the comparison process with respect to some evaluation ranges, to allow the staff of the milk processing company to understand if the milk arriving at the dairy is of the expected quality or not.

The dashboard consists of 2 end-user interfaces. The first one, depicted in the Figure 40 provides a table that shows all the parameters extracted using the FOSS[2] analyses method and two bar graphs: the first relates the values of proteins, caseins, and urea and the second compares the values of not-fat solids with those of lactose.

The weighted averages dashboard shown in the Figure 41 contains a table that shows the values of fats, proteins, cryoscopic point, lactose, non-fat solids, and surface tension to be analysed and their detailed graphs. In particular, for each parameter the following graphical widgets are displayed:

- Two bar charts, one showing the values of the parameter found in the company samples taken during the milk collection phase from the individual farms and one to compare the value of the parameter detected in acceptance at the processing company (sample 2RL) and the value of the weighted average of the parameter with respect to individual samples taken in the various milk collection phases.
- Three tables containing the values of the weighted averages and the deviations in absolute value of the latter from the values of the 2RL samples. The reference limits have been set in the same way for all the parameters, but it is possible to update by setting them in the individual tables, which contain:
    - Coincident values (green border): deviation <0.02.
    - In the attention threshold (orange border): gap between 0.02 and 0.03.
    - Unacceptable (red border): deviation> 0.03.

[2] Tool used to extract data related to milk analyzes (https://www.fossanalytics.com/en/products/milkoscan-ft1)

Figure 40: Milk Analysis Dashboard

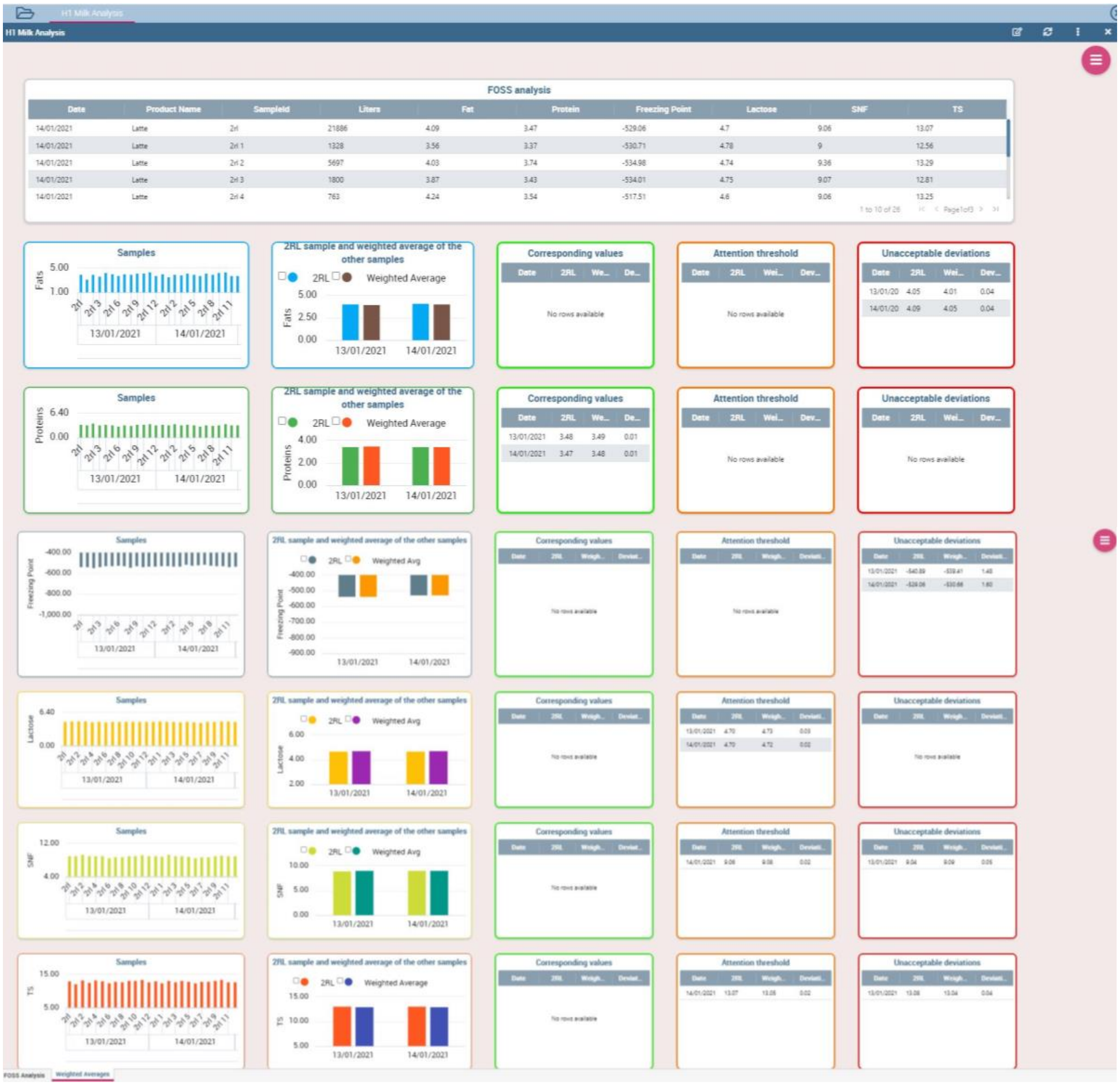


Figure 41: Milk Analysis – Weighted Averages Dashboard sheet

The data to feed the dashboard are retrieved from a REST API which acquires the CSV file, not in AIM format but extrapolated from the processing company's data. This contains the analysis of the milk results from both the tank containing the milk from the individual farmers and for the tank containing all the milk received, and calculates the weighted averages described above, producing a JSON file.

The strength of the milk analysis dashboard is the weighted average. Making an arithmetic average of the individual tank compartments, for each parameter, the deviation from the value of the corresponding tank parameter would not emerge, because it would be distributed in the various compartments, which does not happen thanks to the difference detected by the weighted average. Hence, even if it is true that each compartment is contained in the tank, if a farmer alters the milk, compared to the others, or if there is already water in a compartment, this way it comes out.

Dependencies (either internal to DEMETER or bound to the pilot)

1. AIM Translator Module – manage the Pilot data translation from CSV to AIM providing a data model for component.

Core Enablers Used

1. BSE - Brokerage Service Environment – Providing mechanism for the discovery of services.

Security Usage (Data & User)

4.H.1 - Milk Quality Prediction component will make use of the DEMETER ACS to ensure security for both the user and data managed by the component. The integration between this component and ACS will be examined in Pilot Round 2, to understand if it is necessary to increase the security level of this component that currently runs within the Pilot 4.2 cloud infrastructure without exposing services outside or on the internet but only inside the network infrastructure.

Current Status

Feature	Short description	Status
Data source selection #1	Pilot data source selection	Done
Data collection #1.1	Pilot data collection	Done
Data preparation #1.2	Pilot data preparation	Done
Data integration #1.3	Pilot data integration	Done
Data modelling #2	Pilot data modelling in AIM format	Done for Pilot Round 1
Model for algorithm training #2.1	AIM data modelling for algorithm training and prediction phases	Done for Pilot Round 1
AIM Model integration #2.2	AIM data model integration in the Pilot technical solution	Done for Pilot Round 1
Development & Integration #3	Pilot DSS development and data integration	Done for Pilot Round 1
Research discovery in scientific algorithm classification and regression #3.1	Study and discovery of a most suitable machine learning algorithm capable of satisfying the data analysis needs regarding the milk quality	Done
Analysis of composing technology for the implementation phase #3.2	Study and technological selection most appropriate for the implementation of the algorithm selected in # 3.1	Done

Feature	Short description	Status
Backend component design and implementation #3.3	Technical design and implementation of the algorithm	Done for Pilot Round 1
Frontend DSS dashboard design and implementation #3.4	Technical design using mock-up definition and implementation of the fronted part capable of displaying the data produced by the algorithm in the AIM format	Done for Pilot Round 1
DEMETER data visualisation framework advanced enabler integration #3.5	Integration with DEMETER's DSS visualisation framework (Knowage) and with other advanced enablers	Done for Pilot Round 1
Software component implementation: testing & bug fixing #3.6	Algorithm implementation using the technology choice in activity #3.2	Done for Pilot Round 1
Software component implementation: code review #3.7	Algorithm code review after first implementation	Done for Pilot Round 1

Table 43: Component 4.H.1 Status

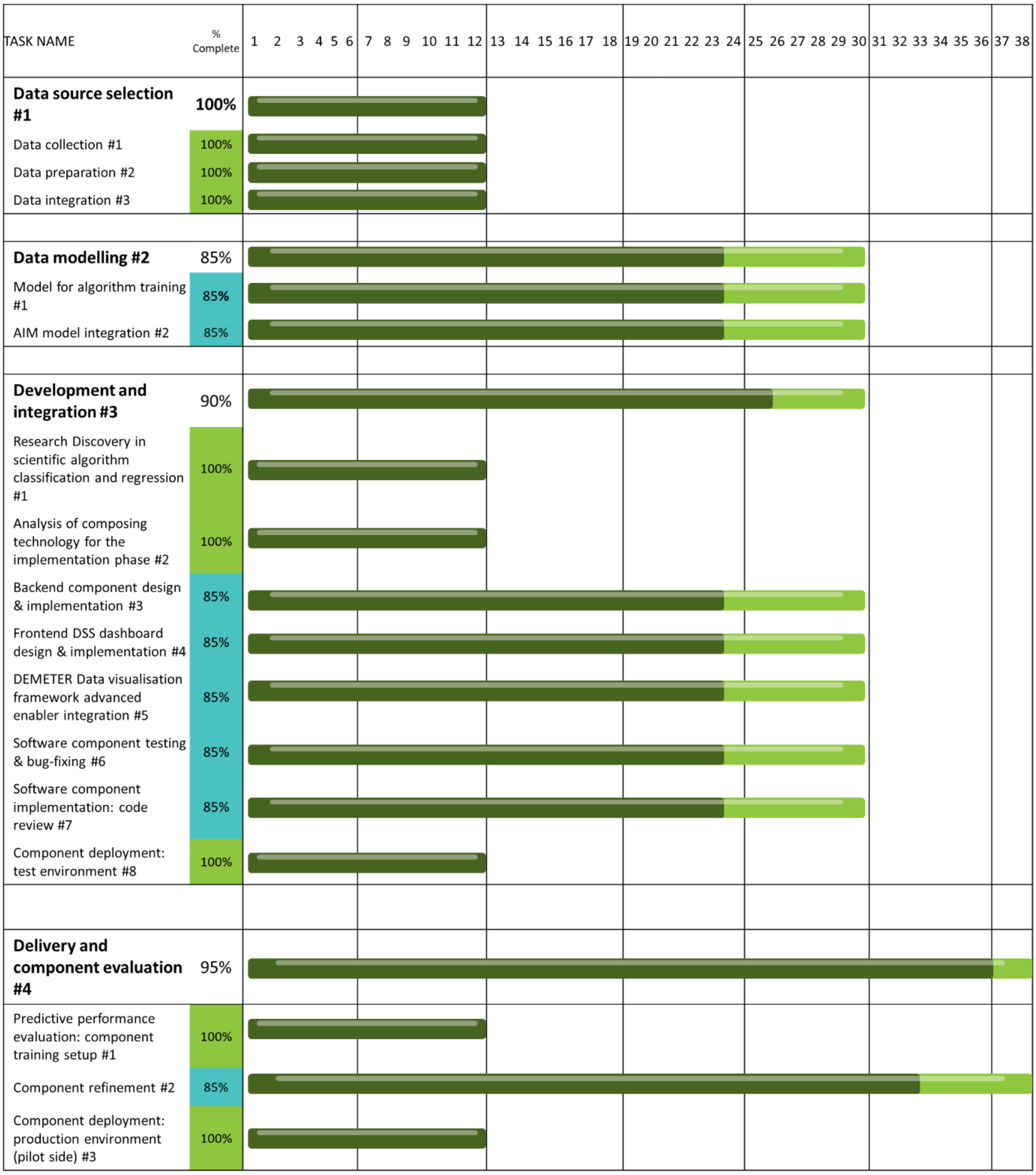


Figure 42: Component 4.H.1 GANTT Chart

6.8.2 Component 4.H.2 Transport Condition

Description	This component for transport condition covers the post-farm cycle for poultry and it provides output of the classification for the environmental conditions during the transport. The overall assessment of the environment based on parameters collected from IOT devices enables direct insight to farmers and involved stakeholders over the UI dashboard if transport conditions are meeting the requirements. The components receive data (latitude, longitude, CO_2, temperature and humidity) as an input in the DEMETER AIM format. These data are then analysed, and the output of the classification process is then provided to the dashboard.

Responsible Partner	Nenad Gligoric (DNET)
Partners	DNET, Sinkovic
Pilots	4.4

Table 44: Component 4.H.2 Metadata

Dashboard Widget

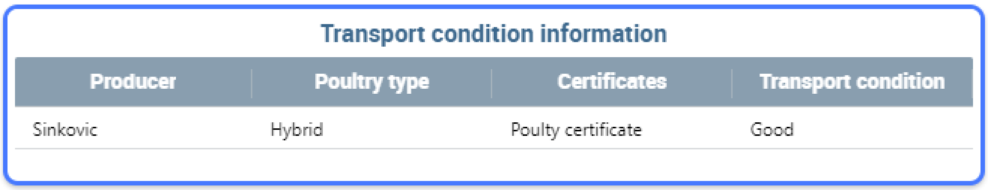


Figure 43: Component 4.H.2 Dashboard Widgets

The dashboard for the Poultry well-being Component (see Figure 43) provides a graphical view for the animal transport condition based on specific environmental parameters. The simplistic interface shows all the necessary data, indicating the animal transport during the exchange of goods between actors in the supply chain. The main output is a classification of transport conditions based on the requirements given in the pilot 4.4.

Dependencies (either internal to DEMETER or bound to the pilot)

1. fleetNET and agroNET platforms - platform is based on the devices for monitoring position of the vehicle and environmental parameters inside the vehicles, coming from two different commercial services. The devices with sensors for temperature, humidity, and CO2 are combined with the GPS tracker. Platform has embedded algorithms and own dashboard and analytics for providing instructions to farmers.

Core Enablers Used

1. BSE - Brokerage Service Environment – Providing mechanism for the discovery of services.
2. ACS - Access Control System – Providing Authentication and Authorisation mechanisms for the component.

Security Usage (Data & User)

4.H.2 - Transport condition component will make use of the DEMETER ACS to ensure security for both the user and data managed by the component.

Current Status

Feature	Short description	Status
Requirements, data specification and models	Initial requirements of the field operations data, classification analysis models	Done
Development of AIM model (Input & Output)	Development of the input and output schemas for the variable rate application ensuring this is AIM compliant	Done

Feature	Short description	Status
Visualisation Design	Mock-ups of the Knowage visualisations that will be produced for the variable rate component	Done
Integration with DEH	Integration and testing of the variable rate component as a registered enabler in the DEMETER Enabler Hub	In Progress
Development of DEMETER AIM compliant adapter for fleetNET and agroNET webservice	REST API and backend methods for implementation of the service	Done
Classification algorithm Development	Development of the classification algorithm to generate animal feeding	Done
Usage and Integration of AIM in component	Aligning the communication schema of the variable rate component with the AIM model defined in stage 1	Done
ACS Implementation and Integration	Integration of the component with the DEMETER ACS to provide authentication and authorisation mechanisms compliant with the DEMETER project	In Progress
Deployment and Evaluation (Test Environment)	Deployment, evaluation, and validation of the field operation component in test environment	Done
Component Refinement	Review of evaluation and validation reports with component refinement if needed (e.g., bug fixes)	Not Started
Deployment and Evaluation (Production Environment)	Deployment, evaluation, and validation of the field operation component and its integration with fleetNET and agroNET devices deployed in field	Not Started

Table 45: Component 4.H.2 Status

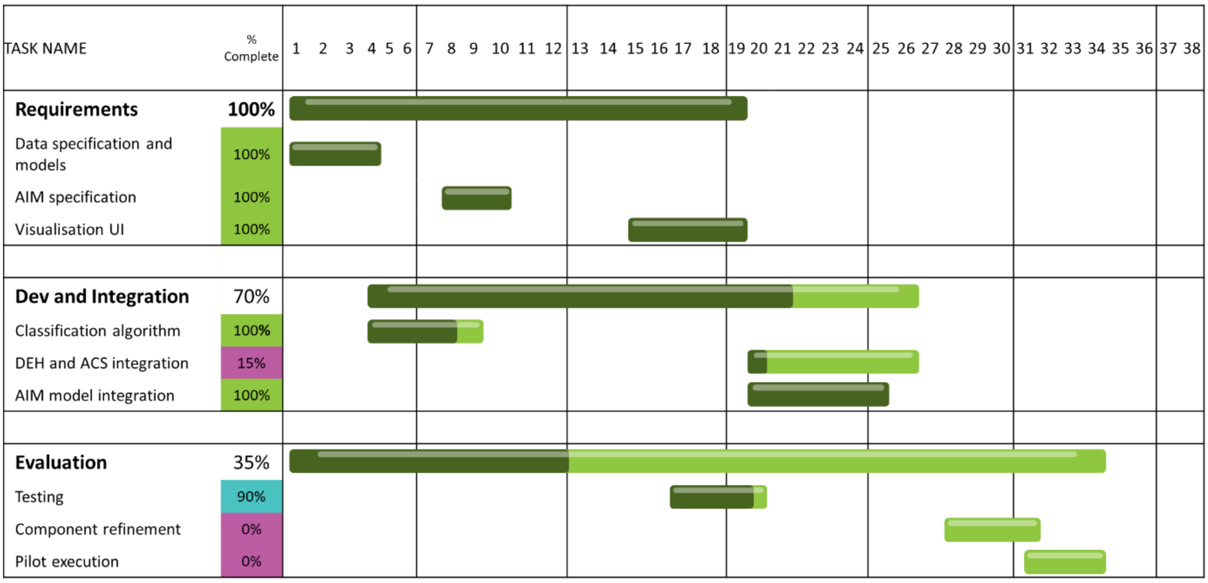


Figure 44: Component 4.H.2 GANTT Chart

6.8.3 Component 4.H.3 Field Book and FaST

Description	The Field Book and FaST component will record information about farms, including all the information related to phytosanitary treatments. This field book is currently being done on paper, which is a tedious process and does not allow this information to be exploited properly. Each region, even those within the same country, requires different entries, so the main objective of this component is to make it easier for the farmers to maintain this field book by providing them with a tool that allows them to do it digitally and that can be adaptable to the different mandatory entries.
Responsible Partner	Azucena Sierra de Miguel (TRAGSA)
Partners	ODINS
Pilots	1.1-1.2

Table 46: Component 4.H.3 Metadata

Dashboard Widget

A field book is a necessary tool for farmers so that they can have a detailed log of the actions taken on the farm. Additionally, according to the new Common Agricultural Policy (CAP)[3], this document will be fundamental for guaranteeing the quality of the products and also for tracking the operations performed on them.

The field book designed in the frame of DEMETER is extensive in detail and data, but at the same time easily manageable by the user, so when we create a field book, we will have a list of the sections associated with it.

The list (Figure 45) allows us to quickly access the field book we want. The list is sorted by date, which will speed up the consultation of previous data or the most recent period.

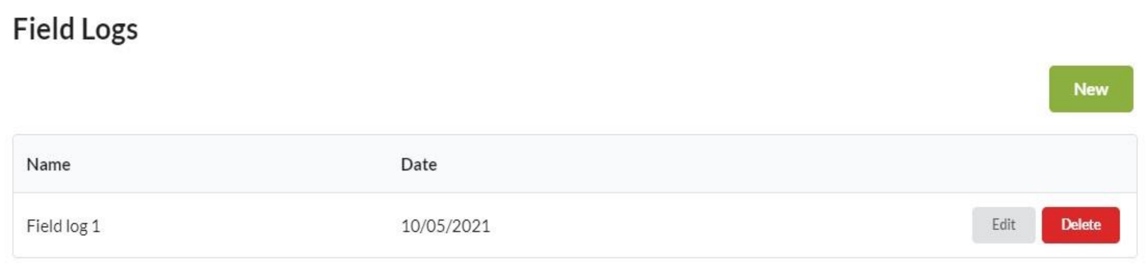


Figure 45: Component 4.H.3 - List of field books

All data are modifiable and accessible. Once the notebook has been created (see Figure 46), we can add data to the different sections.

[3] https://ec.europa.eu/info/food-farming-fisheries/key-policies/common-agricultural-policy_en

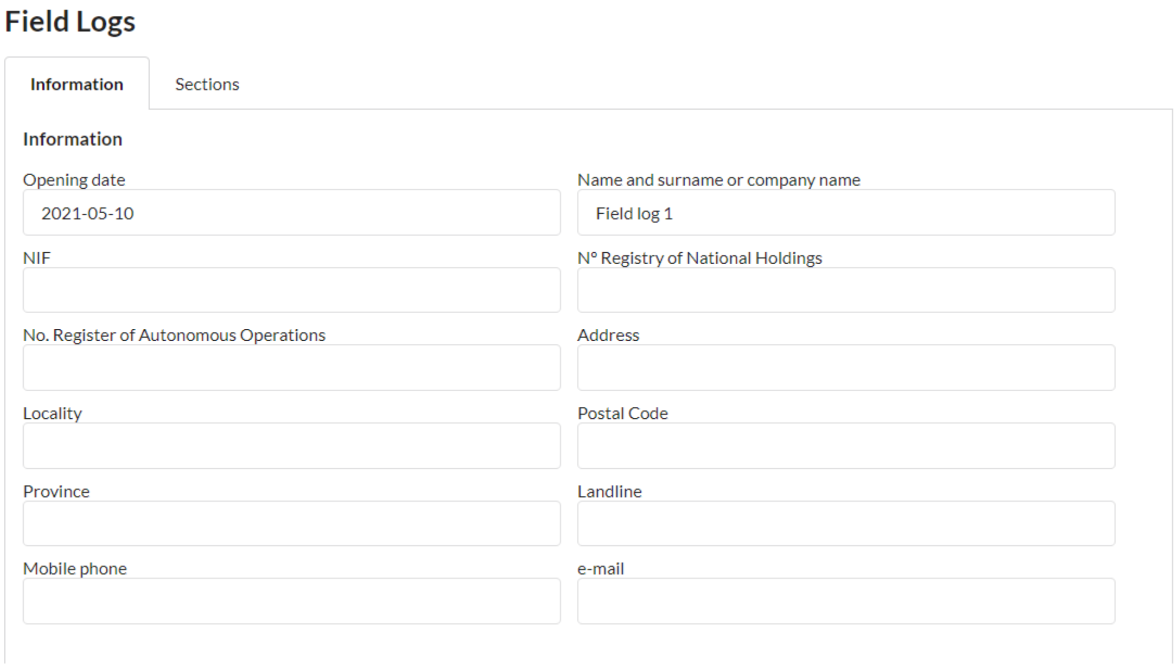


Figure 46: Component 4.H.3 - Creating a new Field Book

Field books need to record various events, and for this we have the **sections** (see Figure 47). Each section contains a simple form for entering data, which once entered can be modified or deleted. These data allow us to establish relationships for future calculations and studies. Below we list some examples:

- 1.2 People or companies involved in the treatment with phytosanitary products (Figure 48).
- 1.3 Equipment for the application of phytosanitary products of the farm (Figure 49).
- 1.4 Advisor, Group or Advisory entity to which the exploitation belongs.
- 2.1 Identifying and agronomic data of the plots.
- 2.2 Environmental identification data of the plots.
- 3.1 Record of phytosanitary actions of the plot.
- 3.1 Record of phytosanitary actions per plot (Only for crops and areas subject to advice).
- 3.2 Record of use of treated seed.
- 3.3 Record of post-harvest treatments (in plant product).
- 3.4 Register of treatments of storage premises.
- 3.5 Record of treatments of the means of transport.
- 4. Record of analysis of phytosanitary products if they have been carried out.
- 5. Record of commercialised harvest.
- 6. Fertilisation registration (optional [Except vulnerable areas]).

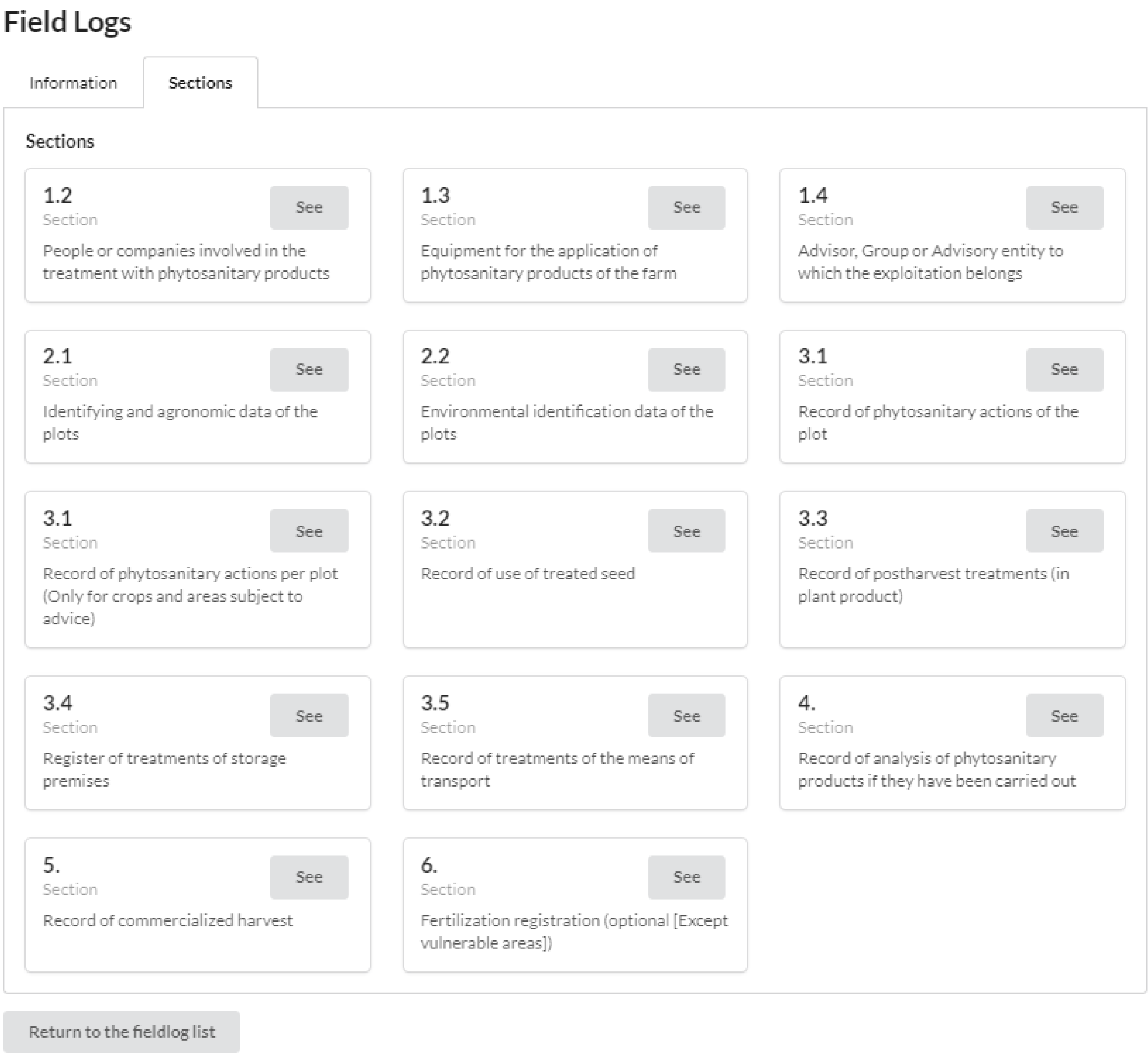


Figure 47: Component 4.H.3 - List of Sections

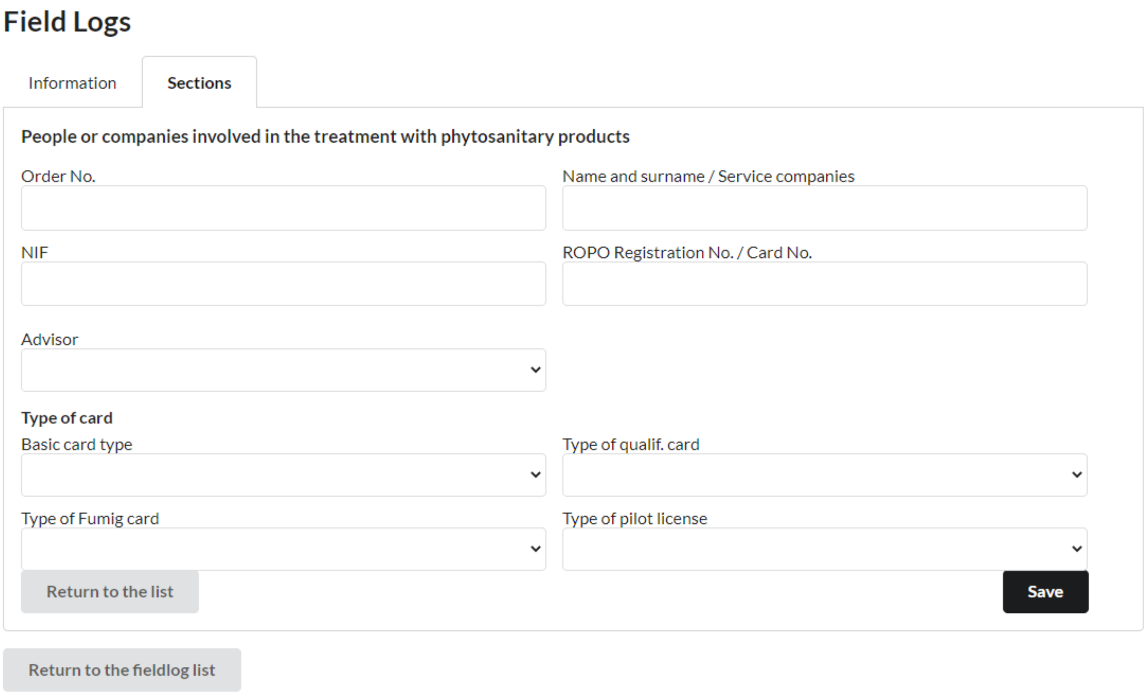


Figure 48: Component 4.H.3 - Section 1.2 *People or companies involved in the treatment with phytosanitary products*

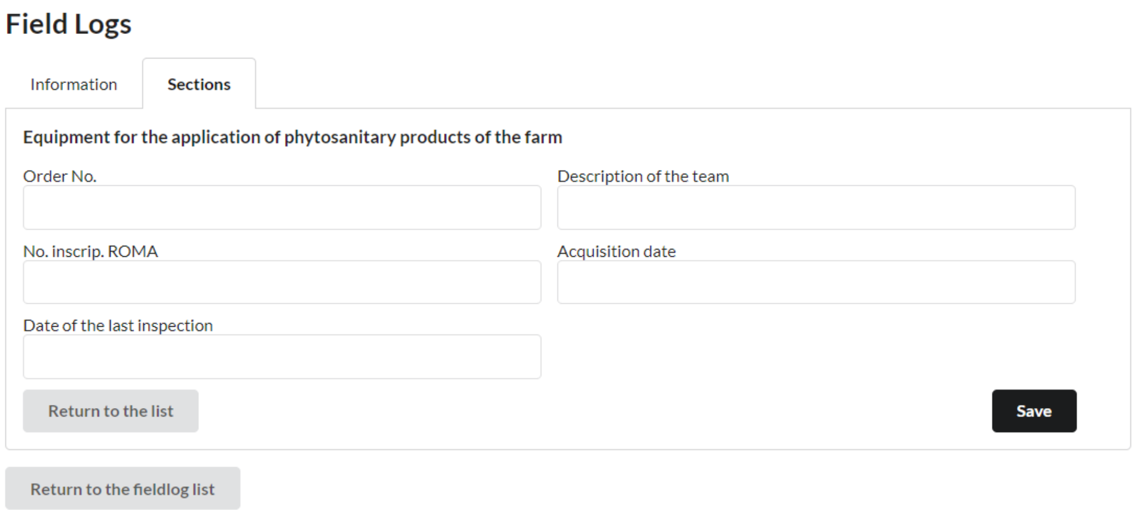


Figure 49: Component 4.H.3 - Section 1.3 *Equipment for the application of phytosanitary products of the farm*

Dependencies (either internal to DEMETER or bound to the pilot)

1. WP2 Pilot Plot Bridge component for parcel information.

Core Enablers Used

1. AIM for data exchange (AgriParcel, AgriCorp).
2. BSE - Brokerage Service Environment – Providing mechanism for the discovery of services.
3. ACS - Access Control System – Providing Authentication and Authorisation mechanisms to access to the Field book component.

Security Usage (Data & User)

4.H.3 - Field book component will make use of the DEMETER ACS to ensure security for both the user and data managed by the component.

Current Status

Feature	Short description	Status
Data modelling	Model how the different data are stored and separated into models	Done
Backend development	Implement API access and data structures needed to store information	In progress
Frontend development	Implement the forms for data entry	In progress
Multi language frontend	Implement the interface in English and Spanish	Done
Test with real data	Test the component with real data	Not Started

Table 47: Component 4.H.3 Status

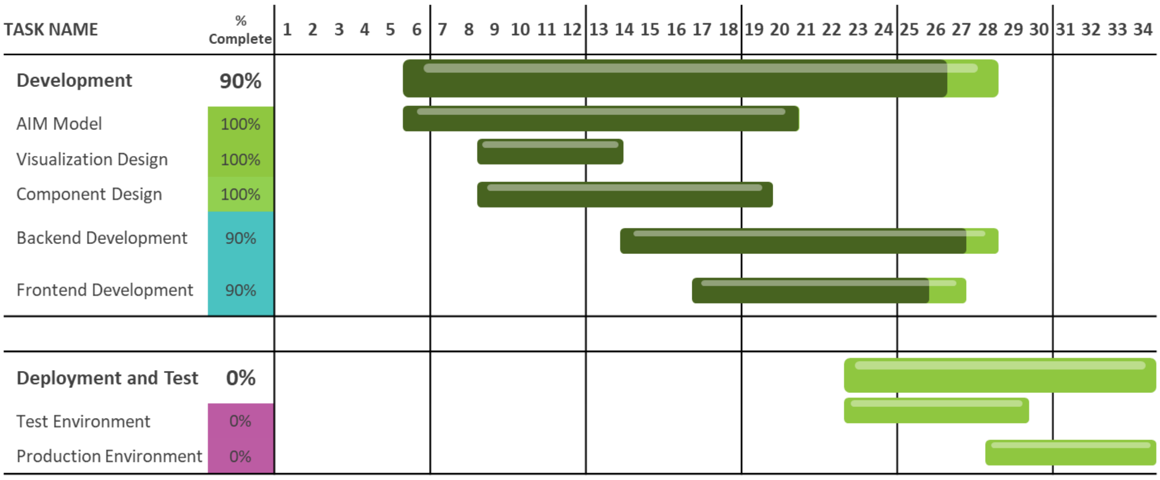


Figure 50: Component 4.H.3 GANTT Chart

6.9 *DSS AREA: 4.I - Benchmarking*

6.9.1 Component 4.I.0 Indicator Engine for Benchmarking Purpose

Description	The main target of this component is the management of indicators to evaluate the efficacy of the practices adopted and of the digital solutions delivered to boost economic, environmental, and agronomic sustainability at the farm level. Indicators managed with this component, will be used in "generic farm comparison", "neighbour benchmarking" and "technology benchmarking" components described in the following paragraphs. The indicator engine component (i) publishes and keeps track of the list of indicators defined in D4.3, (ii) enables pilot developers to calculate the indicators and to extend the list of indicators following the provided framework, (iii) stores the indicator results if the values are needed for benchmarking components.
Responsible Partner	Diego Guidotti (AGRICOLUS)
Partners	AGRICOLUS
Pilots	All

Table 48: Component 4.I.0 Metadata

Dashboard Widget

The component has no interface; it works only on the management of the indicators.

Dependencies (either internal to DEMETER or bound to the pilot)

The component has no strict dependencies on external components.

Core Enablers Used

1. AIM - Agricultural Information Model – input and output, since data is in the AIM format.
2. BSE - Brokerage Service Environment – providing mechanism for the discovery of services.
3. ACS - Access Control System – providing authentication and authorisation mechanisms; all the benchmarking data, excluding the list of the public indicators definition will be available only for users with a valid OAUTH2 token provided by the DEMETER ACS.
4. DEH - DEMETER Enabler Hub – the benchmarking components have been registered on the DEMETER Enabler Hub.

Security Usage (Data & User)

4.I.0 - Indicator Engine for Benchmarking Purpose component will make use of the DEMETER ACS to ensure security for both the user and data managed by the component.

Current Status

Feature	Short description	Status
Research requirements	Researching and identification of WP4 requirements of the “indicator engine for benchmarking purpose” service	Done
Development of AIM model (Input & Output)	Development of the input and output schemas for the “indicator engine for benchmarking purpose” component and ensuring this is AIM compliant	Done
Initial Design	Designing the component structure (i.e., required external components, service, etc.), REST API, and backend methods for implementation	Done
Backend Development	Implementation and testing of the project, REST API and methods	Advanced
Usage and Integration of AIM in component	Aligning the communication schema of the “indicator engine for benchmarking purpose” component with the AIM model define in stage 1	Advanced
Algorithm Implementation	Implementation of the “indicator engine for benchmarking purpose” component	Advanced
Integration with ACS, DEH and BSE	Integration of the component with the DEMETER ACS to provide authentication and authorisation mechanisms compliant with the DEMETER project. Integration with DEH and BSE to ensure interoperability	Advanced
Deployment and Evaluation (Test Environment)	Deployment, evaluation, and validation of the component integrated with the test environment; release of docker component	Started
Component Refinement	Review of evaluation and validation reports with component refinement if needed (e.g., bug fixes)	Not Started

Feature	Short description	Status
Deployment and Evaluation (Production Environment)	Deployment, evaluation, and deployment of the component in the production environment	Not Started

Table 49: Component 4.I.0 Status

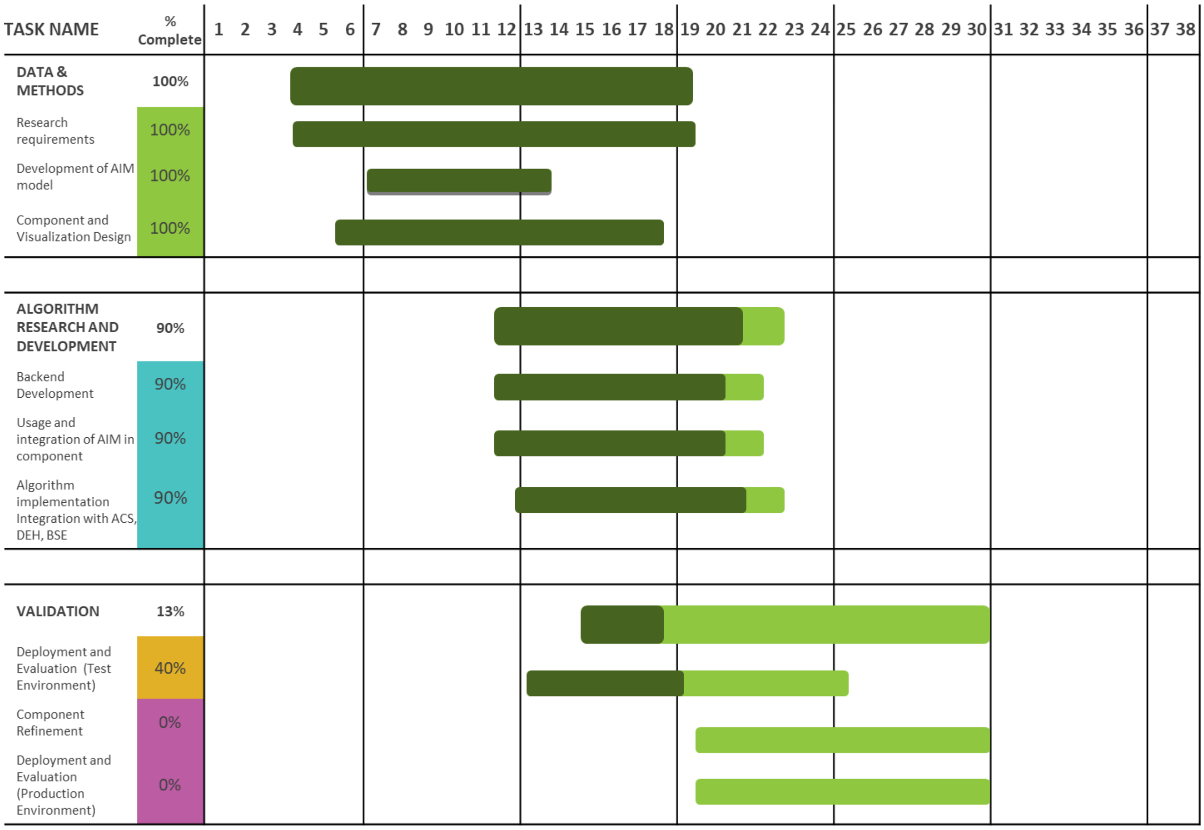


Figure 51: Component 4.I.0 GANTT Chart

6.9.2 Component 4.I.1 Generic Farm Comparison

Description	The DSS component "generic farm comparison" provides a set of basic economic indicators (plus simple agronomic indicators) to obtain a basic benchmark of the farm economic activities. This component is usable by all EU farms, as it requires a minimum set of requested inputs. This component has been designed to provide a benchmark solution reducing the amount and the quality of data required to calculate economic indicators, since it delivers economic comparisons even if the farm has no data to share. The economic indicators provided by this component allowing farm comparisons are based on the database of Farm Accountancy Data Network (FADN) which delivers a set of reference values calculated with data of similar farms (e.g., same area, similar surface per crop) belonging to the FADN network.
Responsible Partner	Diego Guidotti (AGRICOLUS)
Partners	AGRICOLUS
Pilots	All

Table 50: Component 4.I.1 Metadata

Dashboard Widget

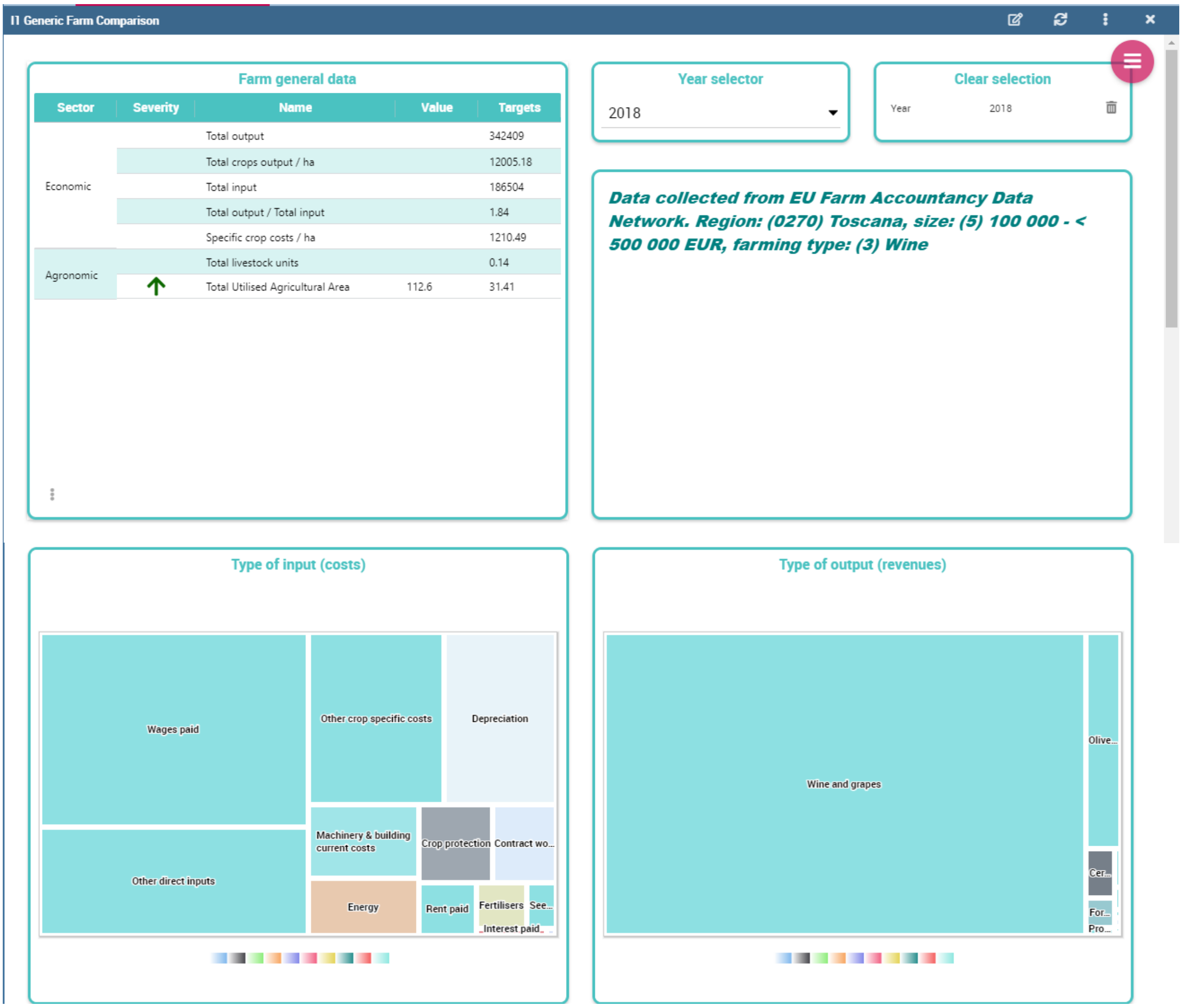


Figure 52: Component 4.I.1 Dashboard Widgets

The output of this component is based on the DEMETER AIM data model and will be available using a REST API. The Knowage module allows a clear visualisation of the output in a web front-end using graphical widgets based on a previously designed mock-up. End-users can visualise the results of the comparison of indicators belonging to the economic sector and also some basic indicators belonging to the agronomic (structural) sector (Figure 52). Indicators calculated with farm data (if available) are indicated in the widget as well as target values for the same indicators calculated with data from FADN. If indicators calculated with farm data are available, coloured arrows (severity) describe how the farm performs in comparison with the target values. The year of comparison can be selected. In addition, treemap charts present the size of the different indicators based on the type costs (inputs) and type of output.

The following describes the workflow of the component for the generic farm comparison:

1. Acquisition of farm data in AIM data format.

2. Extraction of the farm geographic location and combination with the correspondent FADN region.
3. Calculation of a set of basic structural indicators to define a generic description of the farm dimension and typology (e.g., total utilised agricultural area, vineyards surface, total livestock units).
4. Applying a multidimensional-distance algorithm to search, within the specific region, for the closest of size and typology of the farm in order to minimise the distance between the farm indicators and the average values of indicators.
5. Obtain a sub-set of indicators from the selected DB row for the last 10 years.
6. Obtain the output of the component which is a set of indicators (e.g., total input and total output) allowing the farmers to compare their performance with average values of the same indicators calculated with data gathered from similar farm in the same area.
7. Definition of a minimum set of easily available data allowing the farm to get an estimated reference of the economic farm performance indicators: expected output, expected input and expected profit.
8. The API is used by the Knowage visualisation component to make accessible the results to the final user.
9. A Python web application developed with the Flask framework has been used to publish the result of the API.

To perform the analysis, a schema has been created in the Benchmarking database containing the following datasets:

- Spatial reference of the European Administrative division; the geometry allows the extraction of the administrative division and the relative average data from the FADN.
- FADN data extracted from the FADN website.

Dependencies (either internal to DEMETER or bound to the pilot)

1. DEMETER visualisation and adaptive framework Knowage module.

Core Enablers Used

1. BSE - Brokerage Service Environment – Providing mechanism for the discovery of services.
2. ACS - Access Control System – Providing Authentication and Authorisation mechanisms for the component on the generic farm comparison component.
3. DEH - DEMETER Enabler Hub – Registering in DEMETER the virtualised component.

Security Usage (Data & User)

4.I.1 - Generic farm comparison component will make use of the DEMETER ACS to ensure security for both the user and data managed by the component.

Current Status

Feature	Short description	Status
Research requirements	Researching and identification of WP4 requirements of the “generic farm comparison” service	Done
Development of AIM model (Input & Output)	Development of the input and output schemas for the component and ensuring this is AIM compliant	Done

Feature	Short description	Status
Initial Design	Designing the component structure (i.e., required external components, service, etc.), REST API, and backend methods for implementation	Done
Visualisation Design	Mock-up for the Knowage visualisation module	Done
Backend Development	Implementation and testing of the project, REST API and methods	Advanced
Usage and Integration of AIM in component	Aligning the communication schema of the "indicator engine for benchmarking purpose" component with the AIM model define in stage 1	Advanced
Algorithm Implementation	Implementation of the "indicator engine for benchmarking purpose" component	Advanced
Integration with ACS, DEH, and BSE	Integration of the component with the DEMETER ACS to provide authentication and authorisation mechanisms compliant with the DEMETER project. Integration with DEH and BSE to ensure interoperability	Not Started
Deployment and Evaluation (Test Environment)	Deployment, evaluation, and validation of the component integrated with the test environment; release of docker component	Started
Component Refinement	Review of evaluation and validation reports with component refinement if needed (e.g., bug fixes)	Not Started
Deployment and Evaluation (Production Environment)	Deployment, evaluation and deployment of the component in the production environment	Not Started

Table 51: Component 4.I.1 Status

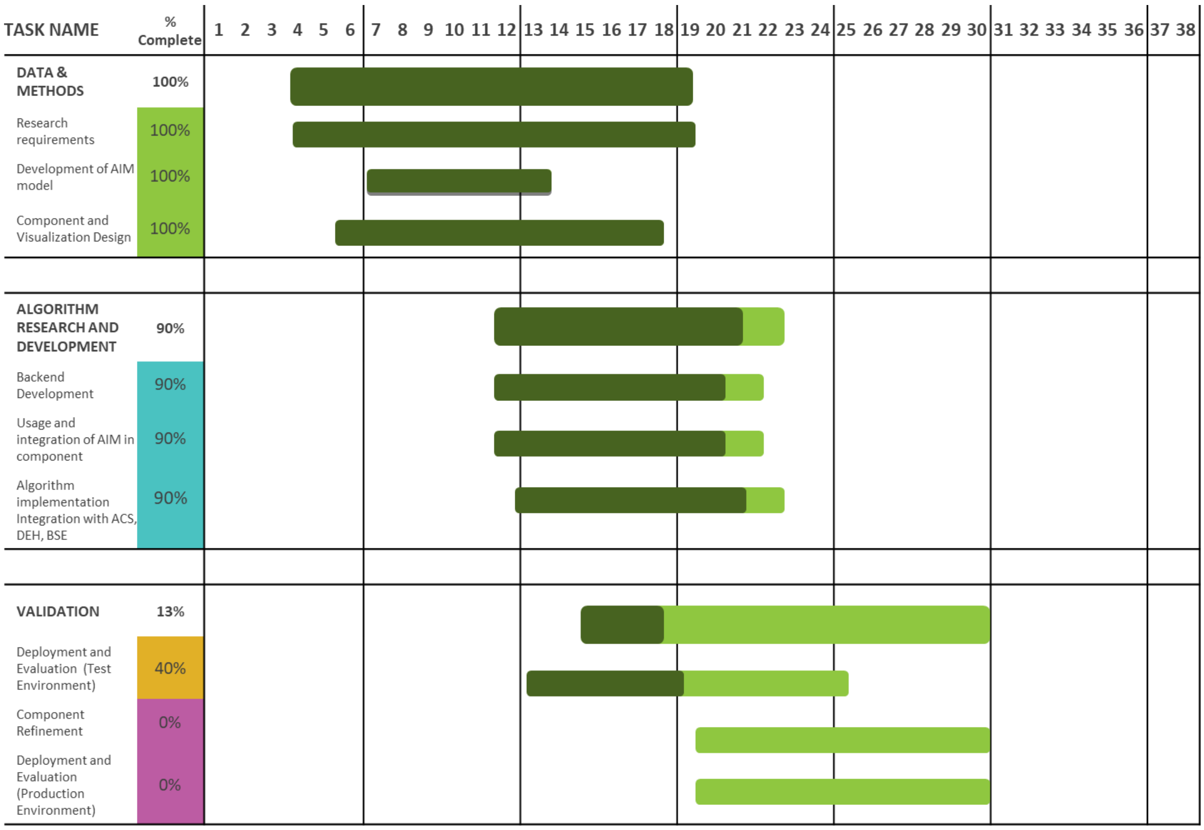


Figure 53: Component 4.I.1 GANTT Chart

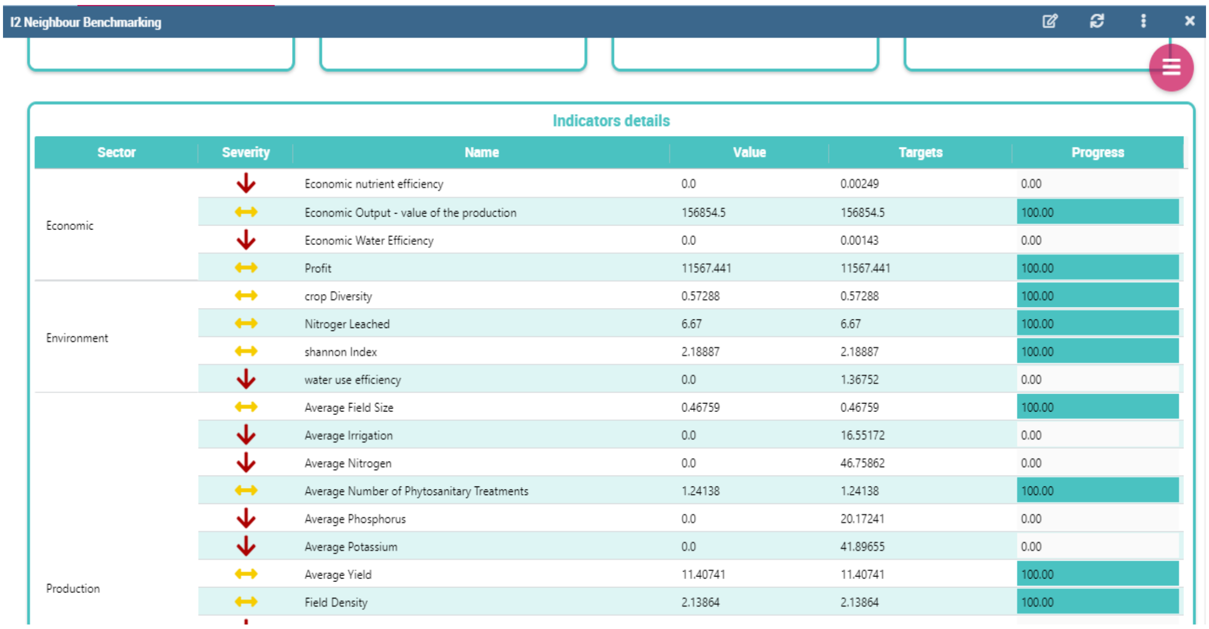
6.9.3 Component 4.I.2 Neighbour Benchmarking

Description	The DSS component on the neighbour benchmarking allows a group of farms belonging to the same area and of the same typology (e.g., DEMETER pilot, consortia, cooperatives) to share data in order to compare performance. The component provides comparison of agronomic, economic, and environmental indicators.
Responsible Partner	Diego Guidotti (AGRICOLUS)
Partners	AGRICOLUS
Pilots	All

Table 52: Component 4.I.2 Metadata

Dashboard Widget

Figure 54: Component 4.I.2 Dashboard Widgets (1)



Sector	Severity	Name	Value	Targets	Progress
Economic	↓	Economic nutrient efficiency	0.0	0.00249	0.00
	↔	Economic Output - value of the production	156854.5	156854.5	100.00
	↓	Economic Water Efficiency	0.0	0.00143	0.00
	↔	Profit	11567.441	11567.441	100.00
Environment	↔	crop Diversity	0.57288	0.57288	100.00
	↔	Nitroger Leached	6.67	6.67	100.00
	↔	shannon Index	2.18887	2.18887	100.00
	↓	water use efficiency	0.0	1.36752	0.00
Production	↔	Average Field Size	0.46759	0.46759	100.00
	↓	Average Irrigation	0.0	16.55172	0.00
	↓	Average Nitrogen	0.0	46.75862	0.00
	↔	Average Number of Phytosanitary Treatments	1.24138	1.24138	100.00
	↓	Average Phosphorus	0.0	20.17241	0.00
	↓	Average Potassium	0.0	41.89655	0.00
	↔	Average Yield	11.40741	11.40741	100.00
	↔	Field Density	2.13864	2.13864	100.00

Figure 55: Component 4.I.2 Dashboard Widgets (2)

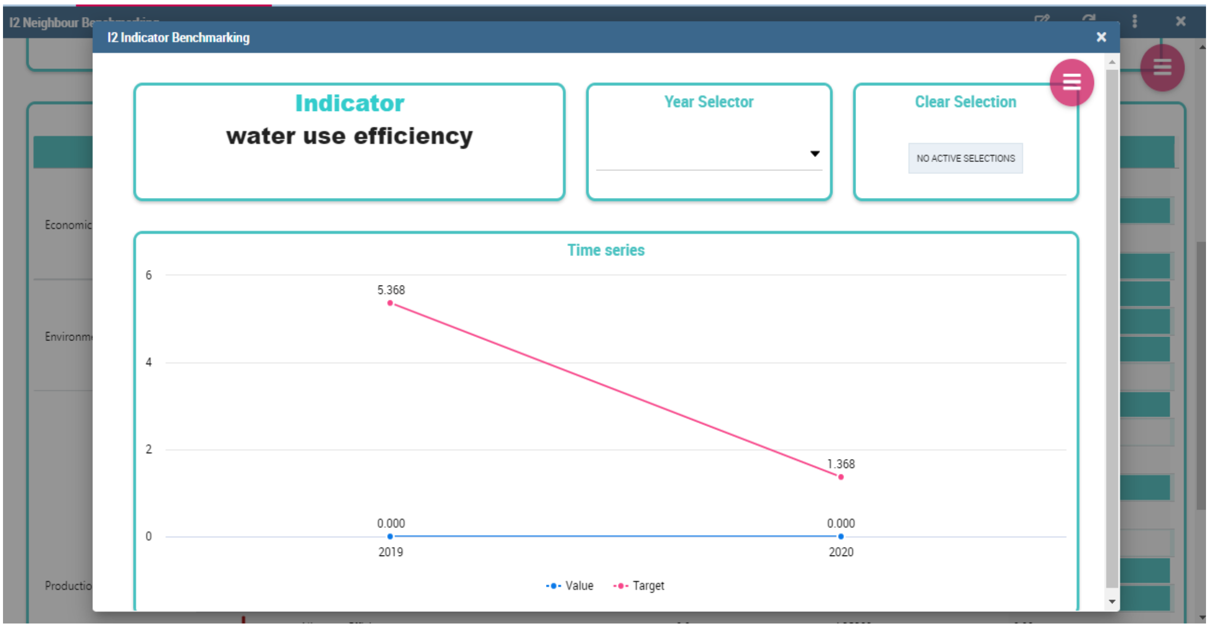


Figure 56: Component 4.I.2 Dashboard Widgets (3)

The output of this DSS component is based on the DEMETER AIM data model and will be available using a REST API. The Knowage module allows a clear visualisation of the output in a web front-end using graphical widgets based on a previously designed mock-up (Figure 56). End-users can visualise the results of the calculation indicators belonging to the three sectors and related sub-sectors.

Figure 56 shows (i) the visualisation shows the average benchmarking results for the three main sectors of indicators: agronomic, economic and environmental; (ii) the comparison of the selected indicators for each of the three sectors, showing the values for each indicator for the farms, the target values which are calculated as average of the values of the farms of the same groups, the farm performs respect to the target values (severity), (iii) further in the details of each indicator, by selecting the year of interest and the comparison of the value from the farm indicator and the target.

The following describes the workflow of the component for the neighbour benchmarking:

1. Creation of the group of farms and assigning group name.
2. Description of the group: if it is closed (only a set of users can participate at the benchmarking) or open (all valid users can push their own data).
3. Create the array of the selected indicators to be associated with the group (if the group is closed), if the array is empty all the system indicators can be collected, and it is possible to add other indicators to be added to the system using the component 4.I.0 REST API.
4. Calculation of the reference value which can be done by (i) averaging the values of the group, (ii) calculating the median value of the group, (iii) calculation of the top 25 percentiles (best in class).
5. A user with the valid credential can associate the farm to a specific group, the system checks if the association can be done (according to group features) and accepts the farm in the group; the system produces a guide for that specific FARM allowing the data entry and the benchmarking.
6. A new set of indicators can be added to the farm space. Indicators which are not in the list yet can be pushed in the farm space using an UPSERT method of data entry with indicator id and the time reference as identifiers.

7. Farms can access with their specific URL the results of the indicators showing how the farm performs compared to the other farms in the group.
8. The API is used by the Knowage visualisation component to make accessible the result from the final user.
9. A Python web application developed with the Flask framework has been used to publish the result of the API.

Dependencies (either internal to DEMETER or bound to the pilot)

1. DEMETER visualisation and adaptive framework Knowage module.

Core Enablers Used

1. BSE - Brokerage Service Environment – Providing mechanism for the discovery of services.
2. ACS - Access Control System – Providing Authentication and Authorisation mechanisms for the component on the estimation of the temperature-related pest events.
3. DEH - DEMETER Enabler Hub – Registering in DEMETER the virtualised component.

Security Usage (Data & User)

4.I.2 - Neighbouring benchmarking component will make use of the DEMETER ACS to ensure security for both the user and data managed by the component.

Current Status

Feature	Short description	Status
Research requirements	Researching and identification of WP4 requirements of the "Neighbour Benchmarking" service	Done
Development of AIM model (Input & Output)	Development of the input and output schemas for the component and ensuring this is AIM compliant	Done
Initial Design	Designing the component structure (i.e., required external components, service, etc.), REST API, and backend methods for implementation	Done
Visualisation Design	Mock-up for the Knowage visualisation module	Done
Backend Development	Implementation and testing of the project, REST API and methods	Advanced
Usage and Integration of AIM in component	Aligning the communication schema of the "indicator engine for benchmarking purpose" component with the AIM model define in stage 1	Advanced
Algorithm Implementation	Implementation of the "indicator engine for benchmarking purpose" component	Advanced
Integration with ACS, DEH and BSE	Integration of the component with the DEMETER ACS to provide authentication and authorisation mechanisms compliant with the DEMETER project. Integration with DEH and BSE to ensure interoperability	Not Started
Deployment and Evaluation (Test Environment)	Deployment, evaluation, and validation of the component integrated with the test environment; release of docker component	Started
Component Refinement	Review of evaluation and validation reports with component refinement if needed (e.g., bug fixes)	Not Started

Feature	Short description	Status
Deployment and Evaluation (Production Environment)	Deployment, evaluation, and deployment of the component in the production environment	Not Started

Table 53: Component 4.I.2 Status

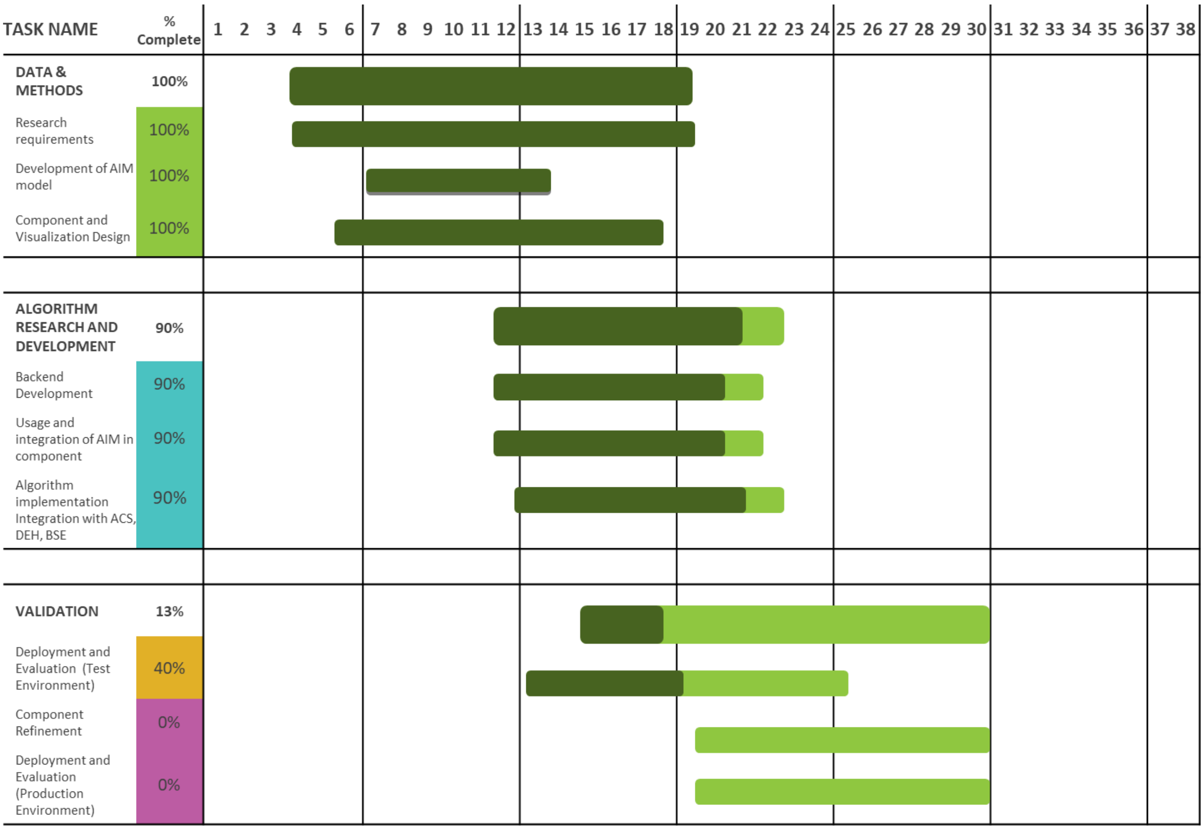


Figure 57: Component 4.I.2 GANTT Chart

6.9.4 Component 4.I.3 Technology Benchmarking

Description	The aim of DSS component - technology benchmarking is to support the general DEMETER Objective 3: "Establish a benchmarking mechanism for agriculture solutions and business, targeting end-goals in terms of productivity and sustainability performance of farms, services, technologies, and practices based on a set of key performance indicators that are relevant to the farming community". The component has therefore two potential types of use: (i) allow a farmer or a group of farmers to evaluate the impact of a technology in terms of agronomic, economic, and environmental sustainability (e.g., compare the value of a specific indicator before and after the adoption of a technology); (ii) support the overall DEMETER benchmarking by using data collected at the farm/pilot level for the calculation of the DEMETER KPIs.
Responsible Partner	Diego Guidotti (AGRICOLUS)
Partners	AGRICOLUS
Pilots	All

Table 54: Component 4.E.2 Metadata

Dashboard Widget

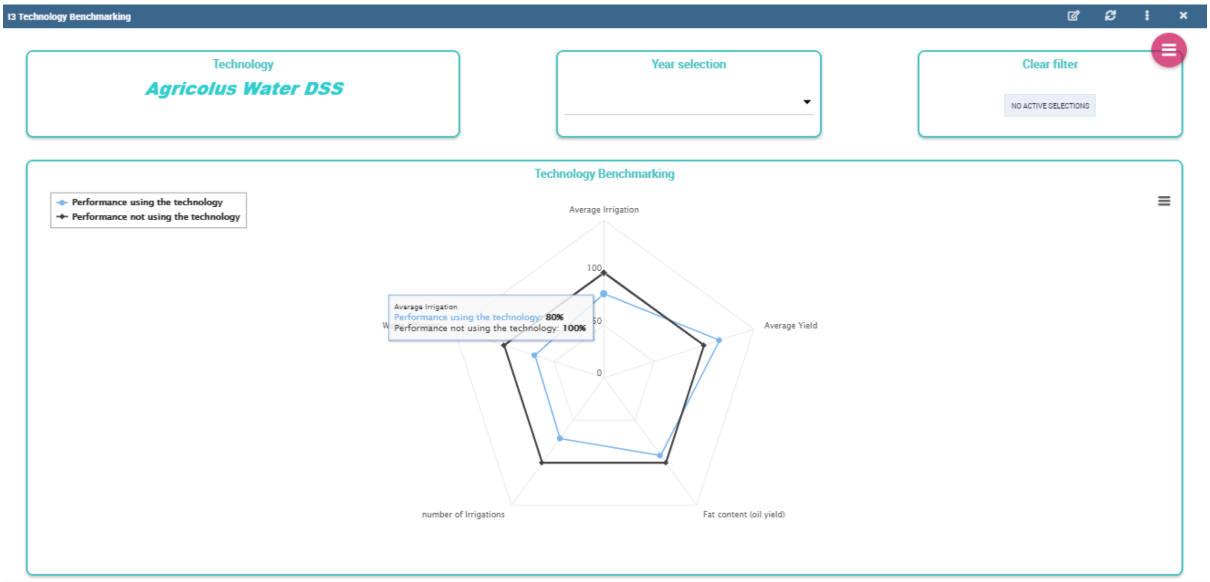


Figure 58: Component 4.I.3 Dashboard Widgets

The output of this DSS component is based on the DEMETER AIM data model and will be available using a REST API. The Knowage module allows a clear visualisation of the output data in a web front-end using graphical widgets based on a previously designed mock-up (Figure 58). End-users can visualise the results of the calculation indicators associated with a specific technology.

Figure 58 shows as an example of technology adoption: the Decision Support System for irrigation of olive orchards. A radar chart which shows the average values of selected indicators before and after the adoption of a technology is available. The indicators selected are: total number of irrigation, total volume of irrigation water, average yield, fruit fat content (oil yield), the water use efficiency (yield/volume of irrigation water). For a clearer visualisation, the values of indicators are expressed in percentage, considering 100% the value before the adoption of the DSS.

The following describes the workflow of the component for the technology benchmarking:

1. Create a new entry in the benchmarking system with specific information: type of technology to be compared, level of adoption (i.e., adopter and non-adopter).
2. New set of indicators can be added into the technology space, each user will have a separate space and have no access to other users' data.
3. Use of an UPSERT method of data entry meaning that it will use the indicator ID and the time reference as identifiers if an indicator value already exists for that technology and level the system updates to the current value.
4. The coordinator and all the users belonging to the group can access with the summary of the results, individual data are not shown.
5. The API is used by the Knowage visualisation component to make accessible the result from the final user.
6. A Python web application developed with the Flask framework has been used to publish the result of the API.

To perform the analysis, a schema has been created in the Benchmarking database containing the following datasets:

- Spatial reference of the European Administrative division; the geometry allows the extraction of the administrative division and the relative average data from the FADN.
- FADN data extracted from the FADN website.

Dependencies (either internal to DEMETER or bound to the pilot)

1. DEMETER visualisation and adaptive framework Knowage module.

Core Enablers Used

1. BSE - Brokerage Service Environment – Providing mechanism for the discovery of services.
2. ACS - Access Control System – Providing Authentication and Authorisation mechanisms for the component on the estimation of the temperature-related pest events.
3. DEH - DEMETER Enabler Hub – Registering in DEMETER the virtualised component.

Security Usage (Data & User)

4.I.3 - Technology benchmarking component will make use of the DEMETER ACS to ensure security for both the user and data managed by the component.

Current Status

Feature	Short description	Status
Research requirements	Researching and identification of WP4 requirements of the “Technology Benchmarking” service	Done
Development of AIM model (Input & Output)	Development of the input and output schemas for the component and ensuring this is AIM compliant	Done
Initial Design	Designing the component structure (i.e., required external components, service, etc.), REST API, and backend methods for implementation	Done
Visualisation Design	Mock-up for the Knowage visualisation module	Done
Backend Development	Implementation and testing of the project, REST API and methods	Advanced
Usage and Integration of AIM in component	Aligning the communication schema of the “indicator engine for benchmarking purpose” component with the AIM model defined in stage 1	Advanced
Algorithm Implementation	Implementation of the “indicator engine for benchmarking purpose” component	Advanced
Integration with ACS, DEH and BSE	Integration of the component with the DEMETER ACS to provide authentication and authorisation mechanisms compliant with the DEMETER project. Integration with DEH and BSE to ensure interoperability	Not Started
Deployment and Evaluation (Test Environment)	Deployment, evaluation, and validation of the component integrated with the test environment; release of docker component	Started
Component Refinement	Review of evaluation and validation reports with component refinement if needed (e.g., bug fixes)	Not Started

Feature	Short description	Status
Deployment and Evaluation (Production Environment)	Deployment, evaluation, and deployment of the component in the production environment	Not Started

Table 55: Component 4.I.3 Status

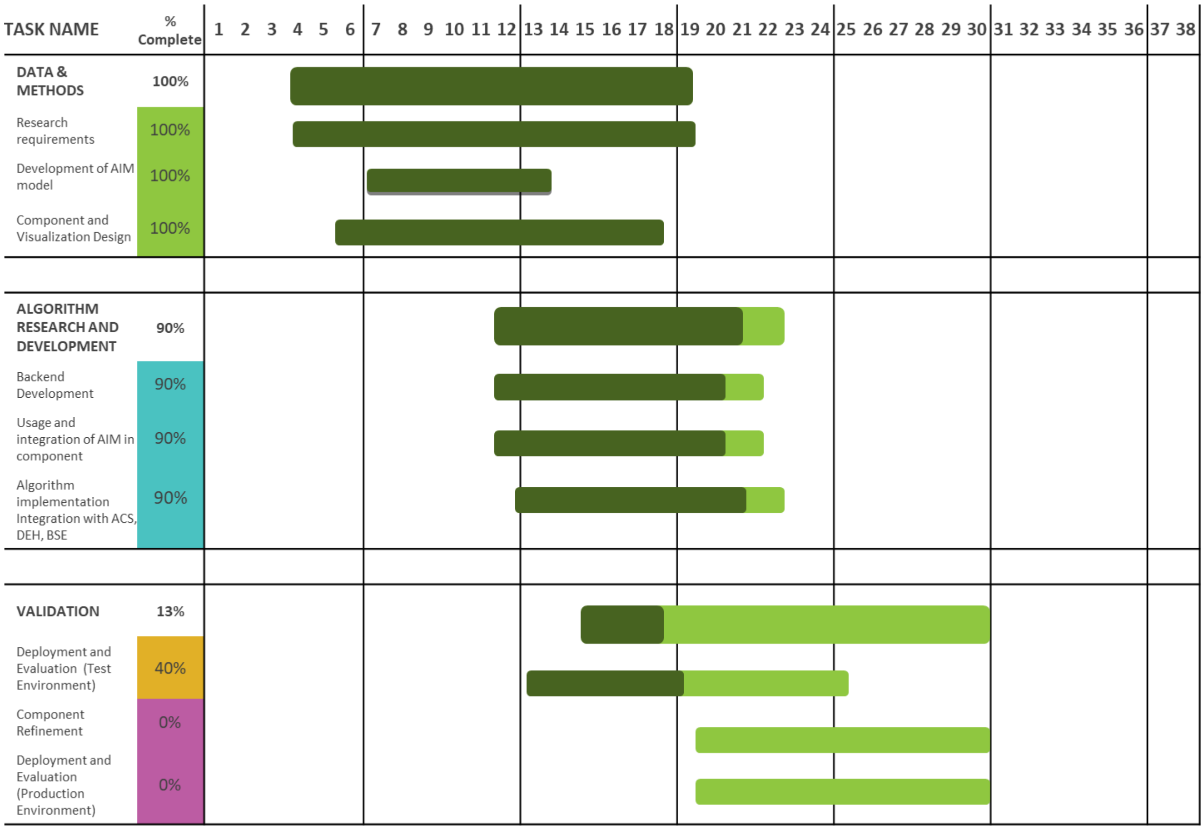


Figure 59: Component 4.I.3 GANTT Chart

7 Adaptive Visualisations for Dashboards

7.1 *Overview*

This section aims to report the updated and final version of D4.2 regarding the data visualisation framework related to T4.3 activities and the progress made on visualisation of decision support systems in the DEMETER pilots. It also provides all the information related to the main changes brought by technical Partners to align this section with respect to D4.2.

After the first iteration of work on this task, the technical and functional requirements were collected by all WP4 partners, since the task activities were mostly focused on the DSS Pilot visualisation, the real development activities using Knowage module began first, and the integration of the dashboards in the deputed Knowage instance have followed.

The technological choice made during the first phase of the project was successful, being based on using Knowage as a visualisation and adaptive framework for building and developing the DSS user interfaces (business driven and not pilot specific). Given the great demand coming from DEMETER pilots for heterogeneity, both in the graphics and in the specific elements of each dashboard and given the multiplicity of user visualisation requirements gathered by the area and component leaders, Knowage module was able to support these challenges, leveraging the modular structure of its components and integrated technologies that make it a complete visualisation suite.

This activity saw the collaboration of many partners in a joint and collaborative work that also provided the production of a whole series of technical specifications documents. Each DSS area provided technical content regarding the user requirements, the dashboard mock-up from which to start to implement the DSS user interface with Knowage, the graphical widgets preferred and requested by the user or Pilot technical staff. The implementation activity was very demanding but given the organisation of work on several levels, good results have been achieved thanks to the adoption of Knowage for the visualisation dashboards. In fact, a DSS visualisations catalogue of for agriculture has been implemented, which is very accurate and specific with respect to the different areas of expertise. This catalogue, which is described in more detail in Section 7.3, represents a real outcome for the DEMETER project not only for the technical and technological collaborative work that took place throughout the dashboard development period between all the consortium, but also because the results of adaptive dashboards focused more on the business than on the single specificity of each agricultural context.

The development activities foreseen for this task will respect the deadline foreseen for M22. However, the main technical partners like ENG, will continue to provide support in the dashboard development managing any change requests coming from the Pilots and managing any refinements and enrichments compared to the actual implementation of any pilot dashboards, also giving support in the installation and configuration of dedicated Knowage docker instance in each Pilot.

7.2 *Pilots DSS integration with Knowage module*

As described in detail in the Deliverable D4.2, the Knowage module offers different technological ways to integrate with other platforms or existing technologies either through an entire set of data connectors or through support of built-in analytical drivers. This module is able to integrate with a whole series of heterogeneous user interfaces, and DEMETER core enablers. In fact, Knowage is not only able to integrate with the DEMETER identity provider, Access Control Server Module (ACS), but also with the Brokerage Service Environment module (BSE) for the dynamic execution of the services exposed through REST endpoints of the analytical components or advanced DEMETER enablers implemented within WP2 and WP4. However, the integration process required some architectural refinements and enrichments concerning the integration flow established in the first phase of solution design, to support the DEMETER DSS visualisation in the first iteration of the T4.3 activity, providing for some additional developments that allowed the Knowage module to be integrated with one of the main DEMETER enablers. The addition of these services did not bring further added value in terms of technological improvements but has made the integration of this module with the other DEMETER enablers more complete and exhaustive, going against the changed technological conditions that the project required. This implementation activity is considered to be added to that foreseen for the porting of the dashboard from the pilots to the Knowage module.

Having a more mature vision of the technological and application context after the first iteration on the technical aspects of the DEMETER project, the adaptive framework for visualisation in DEMETER is enriched with value-add contents for the project and for the pilots who requested a new visualisation considering a vision more of the business than the specific pilot context. The integration method foreseen from the beginning of this activity will remain active supporting those pilots who want to choose, for reasons related to their data or technological infrastructure, a more direct and immediate integration simply by connecting their Dataset to the visualisation framework using the REST Dataset approach natively supported by the module itself. This diversity and heterogeneity ensure that we have the right solution for each individual use case and, above all, take into account the business needs of the pilots themselves. For this reason, the integration flow has been consolidated on the basis of different integration solutions, made optional from the beginning. The more flexible solution has already demonstrated and will continue to have a greater impact in the adoption of this technologically advanced module in terms of the ability to aggregate different results together in a single dashboard. Greater entropy in the use of the Knowage module in DEMETER and greater heterogeneity in the integration solution allows the organisations participating in the DEMETER project to be more similar and sensitive to the use of data visualisation tools even after the project has finished, to better contextualise their business by aggregating information from various sources in a centralised view.

In order to be as exhaustive as possible in the description of this section, even if some contents were taken from the deliverable D4.2, the two main technological solutions, for DSS porting from existing pilot systems to the Knowage module, are detailed below and made available to DEMETER pilots to link their services and data, defined according to the AIM model, to the data visualisation suite.

In the first solution, the integration of analytics software components that produce the AIM output data, necessary for the functioning of the DSS interfaces, will connect to Knowage through the REST Dataset features; the output values extracted from the algorithms feed the Knowage dashboards for the DSS and the data will be graphically represented inside the cockpit.

This approach involves generating a general-purpose dashboard and not a Pilot-driven one, that is, not a mirror copy of the DSS interface that the pilot has so far, but a common interface as much as possible for the pilots involved in a specific DSS area. Figure 60 shows this basic approach for all the pilots who intend to connect their data with the data visualisation framework. The steps to generate these common interfaces are:

1. Step 1 – Pilot produces raw data (static, sensors, file, services, database, broker).
2. Step 2 – Pilot Translators facilities (T1, T2, …) service translates raw data into AIM format (INPUT).
3. Step 3 – Analytics service for training/prediction acquires INPUT Data and run their own analysis (Business Logic).
4. Step 4 – Analytics service produces OUTPUT Dataset into AIM format.

5. Step 5 – Knowage REST Dataset technology engages the Dataset.
6. Step 6 – Knowage cockpit technology use this dataset to generate the Dashboard.

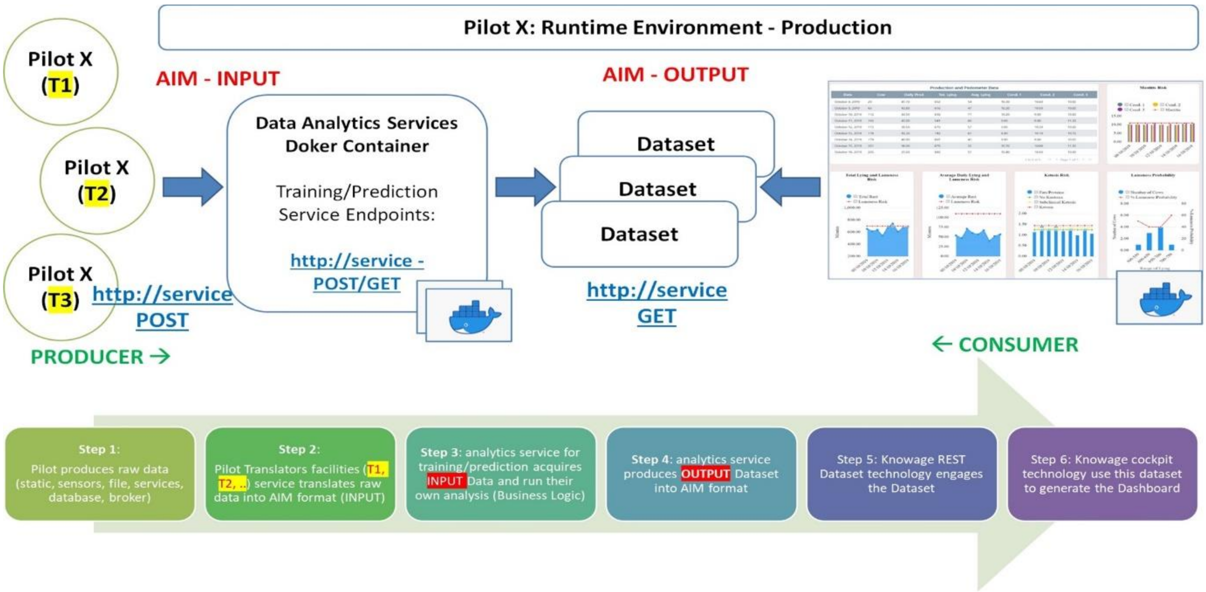


Figure 60: Knowage integration flow: basic approach

The pilots run the analytical components in their environment, covering both the training phase and the prediction phases, feeding them with the raw data coming from the available sources (sensors, databases, static data etc.). Knowage REST dataset services hook the output of the data produced by the algorithms in AIM format; Knowage, depending on the type of service and the output produced, is able to select the most appropriate DSS interface or dashboard, showing the end user the result of the processing.

The second option foresees the interaction in the data flow of the DEMETER core enabler or Brokerage Service Environment. In this case, for the Knowage dataset initially used by the Pilot but also, as far as possible, for future DSS developments, it was decided to take a further step in the direction of simplifying and improving the relationship between Knowage and analytics components. This evolution is based on the assumption that the analytics services are reachable from Knowage (exposed on the internet or using local pilot network) and that they are registered on Brokerage Service Environment (BSE) and on the DEMETER Enabler Hub (DEH). In a nutshell, this evolution allows Knowage to discover this service using the "DEHId" information, which interconnects the resource defined on DEH with the actual service execution on BSE. In fact, this information allows Knowage to identify the right service using the relative information in BSE (via a shared id) and know the service endpoints related to the single analytics component. This process is managed by the Knowage module through a web proxy features that is placed between Knowage and the analytics component. Knowage in this case, will not have to worry about calling the service through the native features or REST Dataset but simply using the proxy service that will perform this operation in its place. The proxy is responsible for discovering the service parameters on demand using the BSE facilities services. By extracting the right parameters for each analytics service, such as endpoint, ports, protocol and also information related to the security of the component itself, the proxy can make the request and receive the response from the service or the output of the AIM model which is then used internally by Knowage for data visualisation. To work properly, the proxy must be able to connect to the DEMETER cloud instance of the ACS via https protocol to first obtain an authentication token, and then, also via https, to obtain a capability token. The proxy is an additional module, developed for the DEMETER project, which is released as an optional service together with the core functionalities of the visualisation framework an contained in the Knowage docker image. Figure 61 show this process highlighting the entire application flow and the different phases in which data exchanges take place:

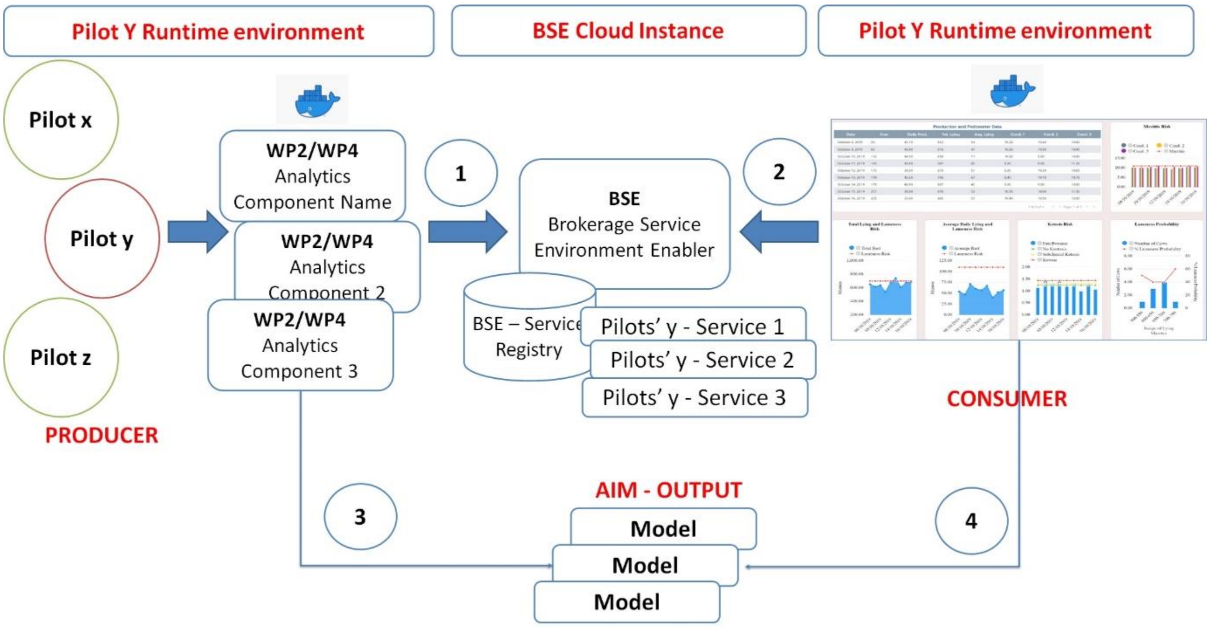


Figure 61: Knowage integration flow using BSE DEMETER enabler

As shown in the figure above, the raw data coming from the DEMETER pilot and translated into the AIM format, are sent to the analytics component or DEMETER advanced enablers. These components recorded their execution information (like endpoint and all their metadata) on the BSE side (step 1 of the Figure 61). At this point, the service REST endpoint is ready to be consumed by Knowage module to reach the dataset produced by each component (step 2 of the figure). However, Knowage does not hook the endpoint exposed by the analytics service directly using the native REST Dataset feature, but by connecting to the BSE and discovering the services to get information such as the endpoint to invoke it. In the steps 3 and 4 of the figure Knowage consume the data produced by each analytics component using AIM format, to get the data needed for the visualisation for each dashboard developed.

As for the main steps, to allow integration between pilot DSS and Knowage module, they remain the same as defined in the deliverable D4.2 and can be summarised as follows:

- **Pilot selection**: Make an analysis of possible DSS that may have common views (involving Pilot Technology Providers).
- **Merging data visualisation UI**: Make a match between the proposed user interface (mock-up) to standardise the DSS view in a single general-purpose dashboard.
- **Dataset selection**: Selection of datasets that is used to feed models and dashboards.
- **Widgets and charts selection**: Selection of widgets and graphs/charts that are shape the dashboards (by using Knowage suite primitives).
- **Inserting the dashboard**: Finally, inserting the dashboard into the DSS catalogue which contains all technological details about the visualisation UI produced: the analytical software components for training and prediction phase, user DSS dashboard used to feed algorithm data output in AIM format for end-user visualisation.

7.3 *Knowage dashboard catalogue*

7.3.1 Overview

This section aims to report all the technical details related to the implementation of the pilots DSS dashboards catalogue for agriculture, which involves the work of all partners involved in T4.3. All the technical details, relating to visualisation are reported for each individual dashboard implemented for the data produced by the analytics components or DEMETER advanced enablers, produced by WP2 and WP4. This activity became the focus of attention, and there was an immediate collaborative response from all the technical people involved in this activity. The result was beyond expectations, ensuring the creation of a complete catalogue of dashboards (business driven and non-pilot specific) for DSS on agriculture that cover the needs related to visualisation in all (or almost all) DEMETER pilots. The work to achieve this goal was quite difficult and complex, it took absolute coordination between the parties and a cross-WP collaboration to have this common and shared outcome. First, the data models based on the DEMETER AIM model were defined with the close collaboration of WP2 (work still in progress in some cases), then the most appropriate visualisation solution is applied to the data from the results of the processing of each advanced enabler. In terms of organising the work to be carried out to manage all the technical phases of the implementation of the dashboards, it was decided to follow the same model established within WP4, that is to assign responsibilities to the DSS area leader who took care of coordinating the contributions of each individual component leader assigned to a specific DSS area. In this way, the technical coordination work between the personnel involved had the support of different levels of competence, which allowed both centralised and peripheral management of the work. In parallel during the development phase, the technical details relating to each component and also the associated dashboard were addressed also time by time during the WP4 technical meetings and those explicitly relating to Task 4.3. In this way and following this approach, the partners involved, immediately proceeded to develop the dashboards. This work will also continue in the coming period as the AIM data models will be further refined and the DSS visualisation graphical interfaces will be aligned. Further additions are not excluded, due to some changing requirements coming from the pilot, or to integrate new data available at a later stage than the submission of this deliverable. Although the task was originally intended to reach its conclusion in month M22, ENG, as task leader will offer the required technical support related both to the development of the dashboard and to the installation and configuration of the Knowage instance in each of the pilot production environments until the end of the project.

The DSS dashboards catalogue on agriculture follows the trend of the DSS areas defined in the context of WP4 and represents a list of user interfaces (UI) related to specific analytical components. The coverage areas of this catalogue range from a series of contexts ranging from **Crop Growth**, **Status and Yield**, **Milk Quality** to the **Benchmarking**, passing through other contexts such as **Irrigation Management**, **Animal Welfare**, **Traceability** and so on. The catalogue contains a list of heterogeneous visualisations, showing the results of machine learning or computer vision algorithms to give the end-user a clear idea of what is being monitored. There is no doubt that this was possible thanks to the Knowage module used to implement these Dashboards, to the functional and contextual maturity of the partners involved and to the technical skills of the task leader in the area of data visualisation. The very flexible and dynamic software module has made it possible to deliver an adaptive framework that allowed the porting of existing DSS (before DEMETER project) into new concept about visualisation. The Knowage adaptability has been amply demonstrated during the development phases of each individual dashboard as it allowed the technical coverage of all the specifications introduced by the area and component leaders. The use of different graphical widgets, such as tables, charts, or custom widgets have made up for the many requests and solved some problems that would occur using non-adaptive technologies. However, even if the technological framework used has responded very positively to the demand for DSS visualisation in DEMETER, satisfied heterogeneous requests, the path of technological maturity is constantly evolving and foresees areas for improvement, supporting also particularly heterogeneous data formats. Constant improvements of Knowage module will be supported by ENG managing also an open-source community that offers this software completely free to anyone in the world who wants to take advantage of a very flexible and easy to use data visualisation suite.

For each DSS area and component created in WP4, the related DSS dashboard is presented below. For each component area a screenshot related to Knowage dashboard is shown. Furthermore, each graphical widget used inside the dashboard is presented and described in more detail. The catalogue could be enriched with new dashboards that will be reported in D4.5 expected for M38.

The dashboard catalogue is presented in the following sections (from 7.3.2 to 7.3.10). It should be emphasised here, that many of the data processed in the dashboards and shown below, represent dummy data (as a result there may be inconsistencies in data format or value). However, the catalogue just wants to demonstrate the dashboards functionalities and the descriptions of the graphic widgets they contain. In a further note, the dashboards shown in the catalogue below have evolved from those shown in section 6 to be the almost final versions.

7.3.2 Area 4.A - Crop Growth, Status and Yield

7.3.2.1 Dashboard 4.A.1 - Yield Prediction overview all fields

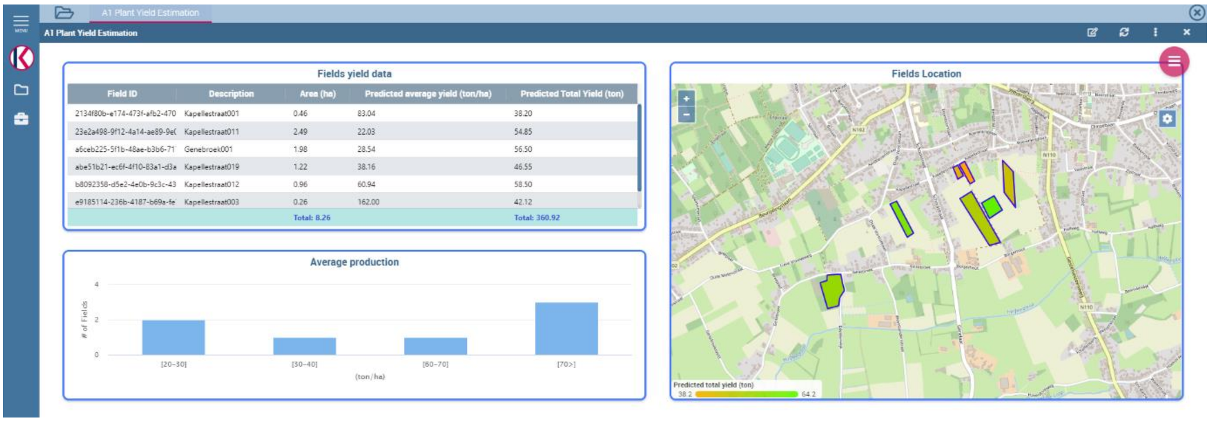


Figure 62: Dashboard 4.A.1 - Yield Prediction overview all fields

The dashboard shows information related to the predicted yields for each field (ton/ha). It is composed of the following widgets:

- **Table widget (Fields yield data)**: shows the **Field ID**, **Area in hectares**, **predicted average yield** (ton/ha) and **Predicted Total Yield** (ton) for each field. The Predicted average yield (ton/ha) column is a calculated field, that divides predicted average yield (ton/ha) value with the corresponding area value.
- **Map widget (Fields Location)**: plots the fields on an OpenStretMap[4] using two layers. The first one is used for drawing the fields borders highlighted with a blue colour. The second layer draws the field areas and contains all the required data to be shown on the details tooltip

[4] https://www.openstreetmap.org/

when the field is clicked. The area colour is configured using the choropleth style measuring the predicted total yield value on each field.

- **Custom chart widget (Average production)**: contains a bar chart from the highcharts[5] library. The X-Axis contains fixed thresholds which refers to the predicted average yield, while the Y-Axis show the numbers of fields whose predicted average yield value falls on the respective threshold.

7.3.2.2 Dashboard 4.A.2 - Phenology Estimation

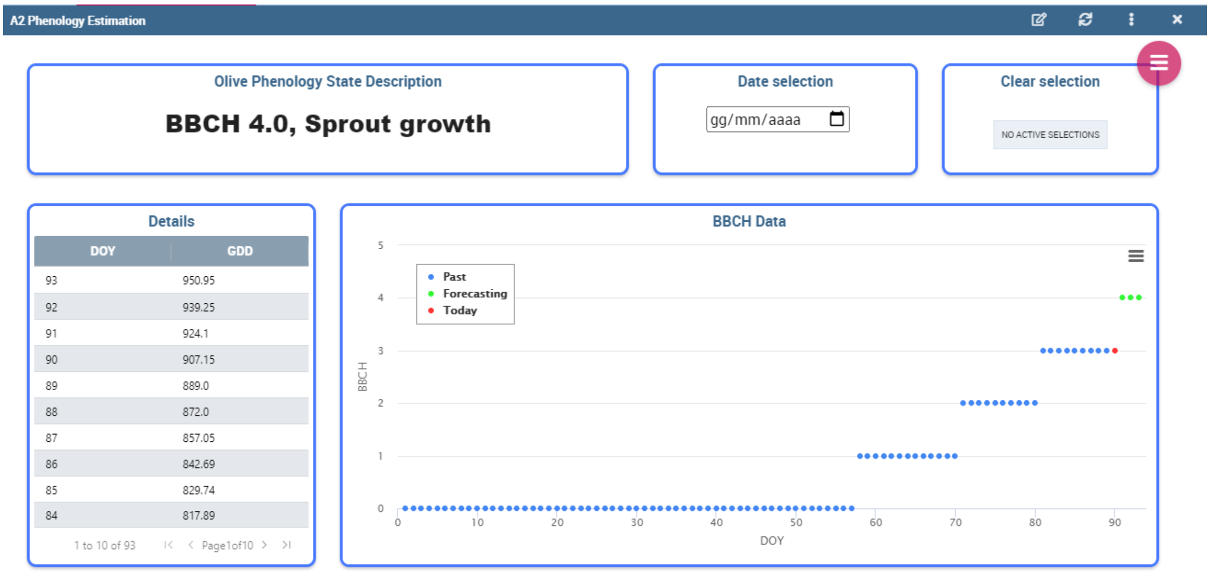


Figure 63: Dashboard 4.A. 2 - Phenology Estimation

The dashboard shows information regarding the phenology state (BBCH-scale) of a crop over the time (DOY-Days-Of-Year), including the estimation on the next five days. It is composed of the following widgets:

- **Text widget (Olive Phenology State Description)**: describes the state of the crop at the chosen date and shows the respective BBCH value.
- **Custom chart widget (Date selection)**: date picker, allow the user to choose a date up to five days after the current date.
- **Active selection widget (Clear selection)**: clear the dashboard filter.
- **Table widget (Details)**: shows DOY (Days-Of-Year) value and the GDD (Growing degree-day).
- **Custom chart widget (BBCH Data)**: contains a scatter chart from the highcharts library. The X-Axis contains the DOY value, while the Y-Axis show the respective BBCH value using different colours, blue for past values, red for current day value and green for predicted values.

[5] https://www.highcharts.com/

7.3.2.3 Dashboard 4.A.3 - Plant Stress Detection

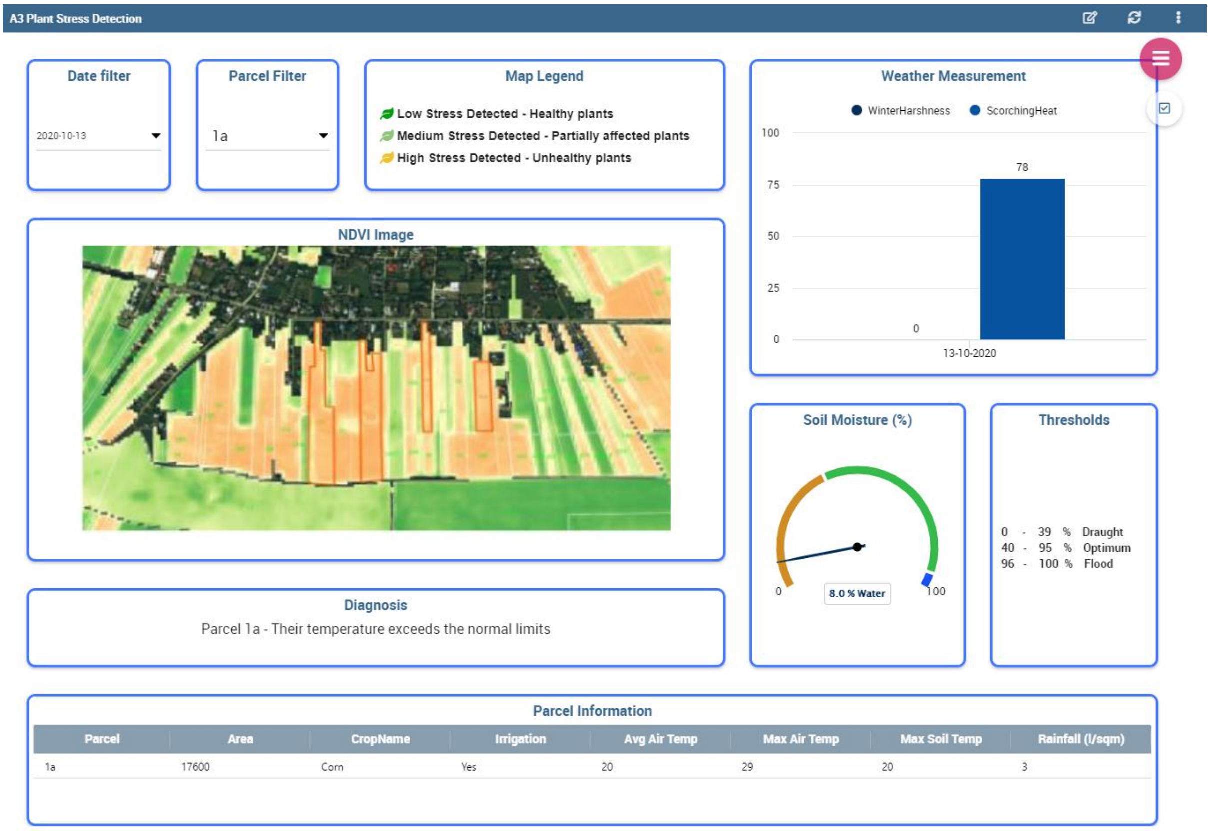


Figure 64: Dashboard 4.A.3 - Plant Stress Detection

The dashboard allows the user to select a crop field and shows processed data with plant stress detection derivate information. The end-user can select the period and a parcel for further filter the data.

The dashboard displays an NDVI image and the output table containing the processed data, crop parameters and corresponding meteorological data. The end-users can identify based on the results, the crop stress and recommendations for each selected field. The dashboard also provides a gauge that display the level of soil moisture percentage. The bar chart graphs contain weather data for scorching heat intensity or winter harshness. The dashboard is composed of the following widgets:

- **Selection widget (Date filter)**: date selection filter.
- **Selection widget (Parcel filter)**: parcel id selection filter.
- **Custom chart widget (Map Legend)**: shows a legend for the NDVI image.
- **Custom chart widget (NDVI Image)**: shows an NDVI image of selected parcel.
- **Chart widget (Weather Measurement)**: bar chart containing weather data for scorching heat and winter harshness.
- **Chart widget (Soil Moisture)**: gauge chart that show the water percentage value for the soil moisture.
- **Text widget (Thresholds)**: describes the water percentages values that can identify a Draught, Optimum or Flooded soil.
- **Text widget (Diagnosis)**: describes the current status of the parcel.
- **Table widget (Parcel Information)**: contains all the data processed at the selected date, regarding the selected parcel.

7.3.2.4 Dashboard 4.A.5 - Estimate Pollination Requirements

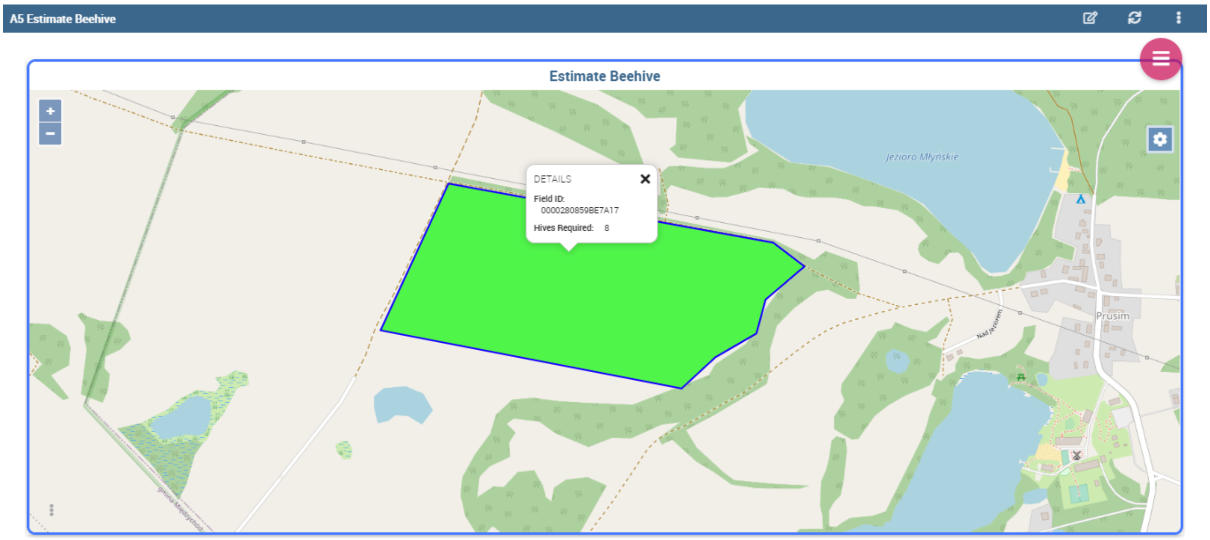


Figure 65: Dashboard 4.A.5 - Estimate Pollination Requirements

The dashboard shows a map of the farmer's / user's field, with an icon used to represent the location. Clicking on the icon, a tooltip with details shows the number of hives recommended to be provided by the apiary farmer. It is composed of the following widgets:

- **Map widget (Estimate Pollination Requirements)**: plots the fields on a OpenStreetMap using three layers. The first one, is used for drawing the field borders highlighted with a blue colour. The second layer draws the fields area and the third one draws a marker and contains all the required data to show on the details tooltip when an end-user clicks the icon. The area colour is configured using the choropleth style measuring the required hives value on each field.

7.3.3 Area 4.B - Irrigation Management

7.3.3.1 Dashboard 4.B.1 - Irrigation Management (+B2, B3)

The dashboard shows the next day estimations of average soil moisture, crop water needs, ET_0 (Irrigation Requirements Estimation, Evapotranspiration), and rainwater forecast, as well as the final irrigation recommendations. It shows up to four images for soil moisture estimation, segmented areas of soil moisture estimation, crop status using an NDVI image and crop status anomalies. It also shows time series of previous estimated values in tables and charts. It is composed of the following widgets:

- **Table widget (Estimation Details)**: contains all the estimation data processed regarding the selected parcel.
- **Selection widget (Parcel selector)**: parcel id selection filter.
- **Custom chart widget (Soil Moisture Index)**: shows an image of the soil moisture estimation.
- **Custom chart widget (Soil Moisture Index Segment)**: shows an image of segmented area of the soil moisture estimation.
- **Custom chart widget (Crop Status NDVI)**: shows an NDVI image regarding the status of the crops.
- **Custom chart widget (Crop Status NDVI Anomalies)**: shows an NDVI image regarding the anomalies of the crops.
- **Table widget and Chart widget Line type**: shows time series of previous values.

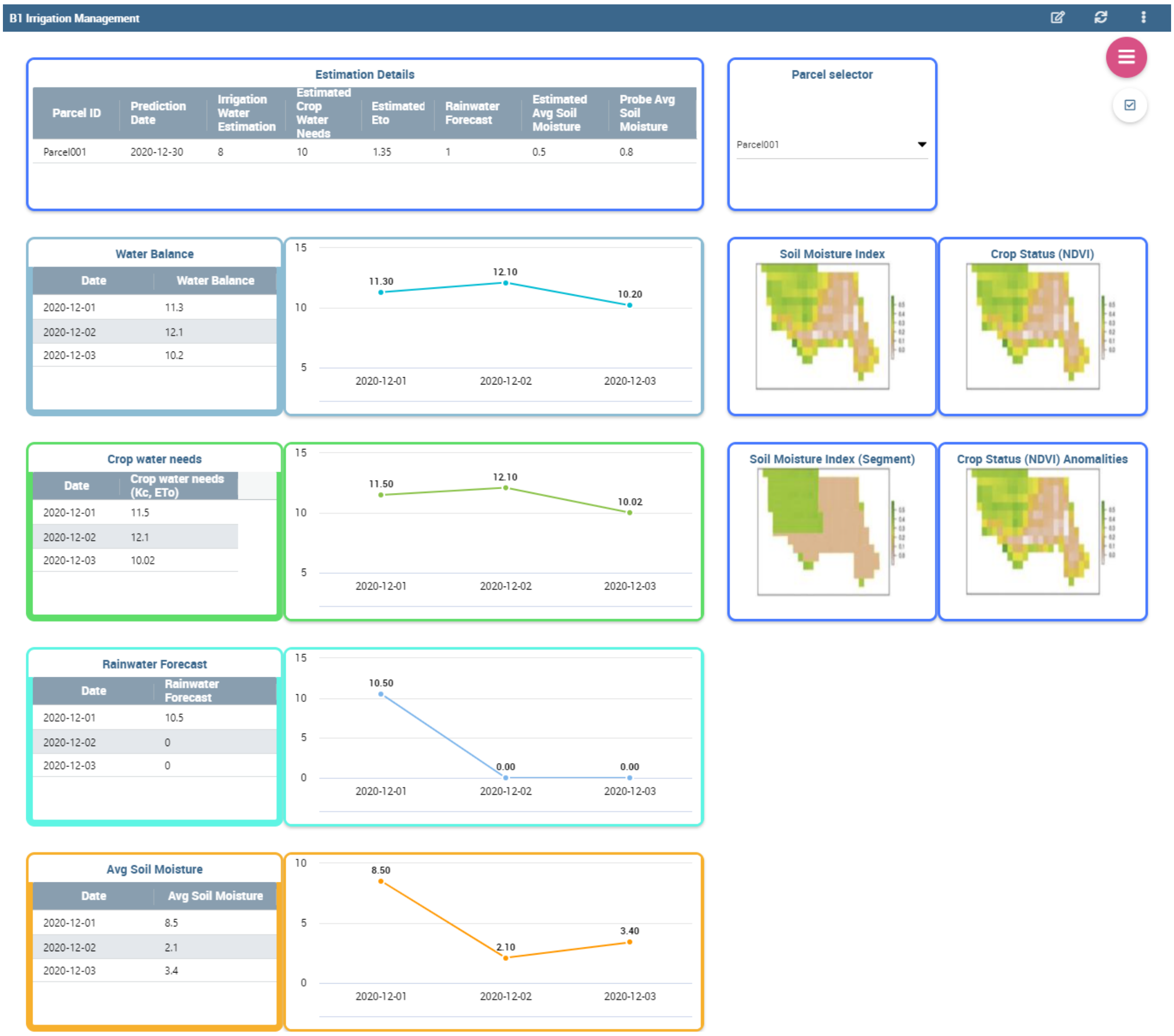


Figure 66: Dashboard 4.B.1 - Irrigation Management

7.3.4 Area 4.C - Nutrition Management

7.3.4.1 Dashboard 4.C.1 - Nitrogen Balance Model

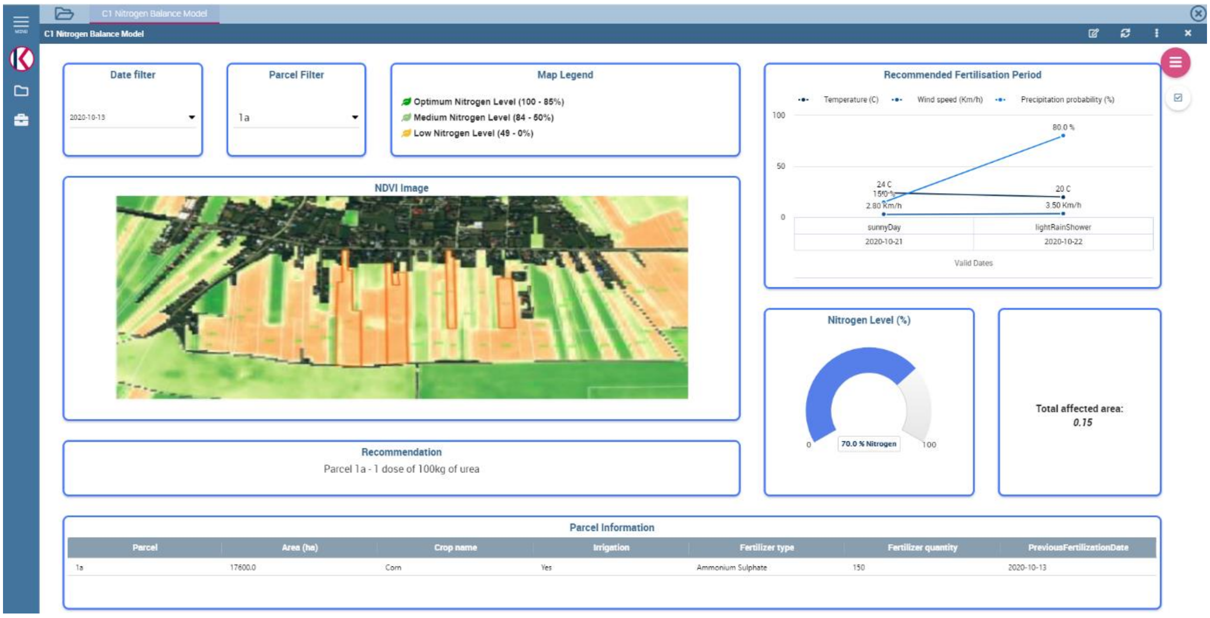


Figure 67: Dashboard 4.C.1 - Nitrogen Balance Model

The dashboard allows the end-user to select a crop field and display analysed data based on the latest NDVI image with plant stress detection derivate information. The end-users can identify based on the results the fertiliser needs and recommendations for the selected parcel.

The dashboard displays an NDVI image and the output table containing the processed data, crop parameters and resulted meteorological data. The dashboard also provides a gauge that displays the level of nitrogen and the total affected area. The line chart graph contains weather data for fertilising recommended period, and a description containing fertiliser distribution and recommendations. It is composed of the following widgets:

- **Selection widget (Date filter)**: date selection filter.
- **Selection widget (Parcel filter)**: parcel id selection filter.
- **Custom chart widget (Map Legend)**: shows a legend with nitrogen percentage values for the NDVI map.
- **Custom chart widget (NDVI Image)**: shows an NDVI Image of the parcel selected.
- **Chart widget (Recommended Fertilisation Period)**: line chart containing weather data like temperature, precipitation probability, wind speed and a description that identify the overall day weather (sunny, rainy day and so on).
- **Chart widget (Nitrogen Level)**: gauge chart that shows the nitrogen percentage value.
- **Text widget (Total affected area)**: describes the total affected area.
- **Text widget (Recommendations)**: describes the fertiliser distribution and recommendations for the selected field.
- **Table widget (Parcel Information)**: contains all the data processed at the selected date, regarding the selected parcel.

7.3.4.2 Dashboard 4.C.2 - Nutrient Monitor

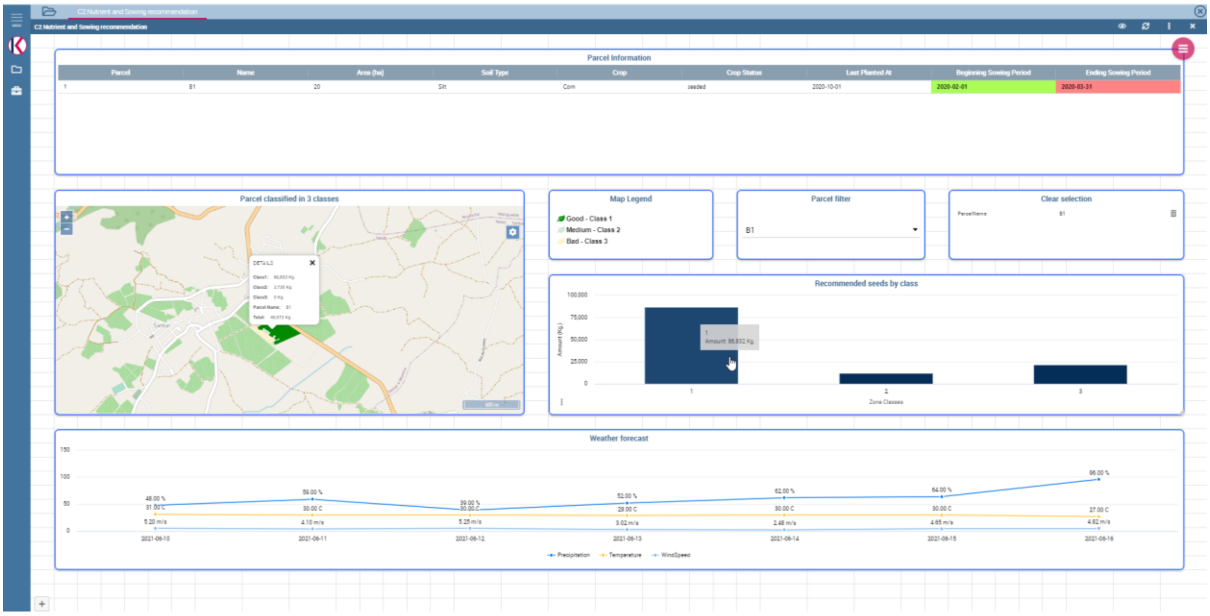


Figure 68: Dashboard 4.C.2 - Nutrient Monitor

Using this DSS dashboard, a farmer can view the recommendations about the crop. The recommendations are able to provide the farmer with an overview of the crop, i.e., in which areas they should sow, the quantity of seeds for these areas and a recommendation of when they should do it. Through this dashboard, the farmer is able to understand and optimise the soil and the production.

This dashboard is composed of the following widgets:

- **Table widget (Parcel Information):** a table containing information like "Name", "Area", "Soil Type", "Crop", "Crop Status", "Last Planted At", "Beginning Sowing Period" and "Ending Sowing Period" for each parcel.
- **Map widget (Parcel classified in 3 classes)**: for each parcel, shows all the zones classified by a class (1, 2, 3). Each class has a different colour set. Selecting a parcel shows up the details containing some information like "Parcel Name", "Total", "Class1", "Class2" and "Class3". It is possible to use the map filter to show only the desired class zones.
- **Custom chart widget (Map Legend)**: details the zone class colours.
- **Selection widget (Parcel Filter):** allows the selection of a single parcel to filter the data.
- **Clear selection widget (Clear selection):** clear the filter selected.
- **Chart widget (Recommended seeds by class):** a bar chart that shows the sum of the quantities of seeds for each zone class on each parcel.
- **Chart widget (Weather forecast):** a line chart that shows weather forecast like the values of air temperature, wind speed and precipitation chance.

7.3.5 Area 4.D - Machinery and Field Operations

7.3.5.1 Dashboard 4.D.2 - Field Operation

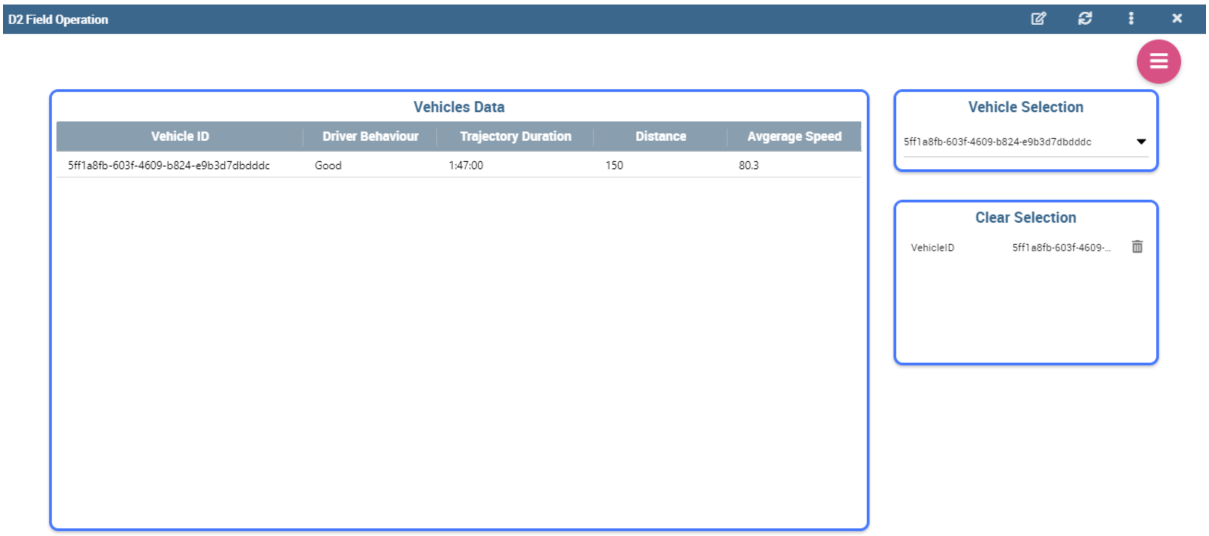
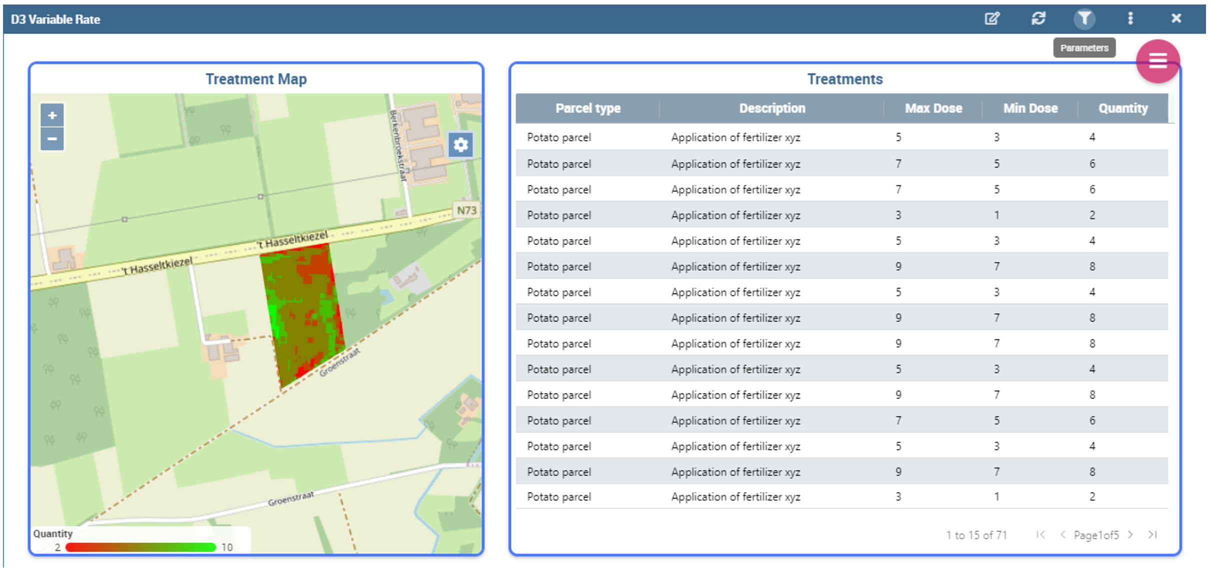


Figure 69: Dashboard 4.D.2 - Field Operation

The dashboard shows information regarding the vehicle, driver behaviour, trajectory duration, trajectory distance and average speed. It is composed of the following widgets:

- **Selection widget (Vehicle selection)**: select a vehicle id to filter data.
- **Active selection widget (Clear selection)**: clear the active filters.
- **Table widget (Vehicle's data)**: shows vehicle data.

7.3.5.2 Dashboard 4.D.3 - Variable Rate



Parcel type	Description	Max Dose	Min Dose	Quantity
Potato parcel	Application of fertilizer xyz	5	3	4
Potato parcel	Application of fertilizer xyz	7	5	6
Potato parcel	Application of fertilizer xyz	7	5	6
Potato parcel	Application of fertilizer xyz	3	1	2
Potato parcel	Application of fertilizer xyz	5	3	4
Potato parcel	Application of fertilizer xyz	9	7	8
Potato parcel	Application of fertilizer xyz	5	3	4
Potato parcel	Application of fertilizer xyz	9	7	8
Potato parcel	Application of fertilizer xyz	9	7	8
Potato parcel	Application of fertilizer xyz	5	3	4
Potato parcel	Application of fertilizer xyz	9	7	8
Potato parcel	Application of fertilizer xyz	7	5	6
Potato parcel	Application of fertilizer xyz	5	3	4
Potato parcel	Application of fertilizer xyz	9	7	8
Potato parcel	Application of fertilizer xyz	3	1	2

Figure 70: Dashboard 4.D.3 - Variable Rate

This dashboard allows the end-user to select the field for which they want to build a variable rate map. More selections can be performed using a drop-down list from using parameters section of the dashboard. The dashboard uses Knowage analytical driver that lists all the available fields.

Once a field is selected, the map visualises all the different zones (management zones) requiring different application rates. It is composed of the following widgets:

- **Map widget (Treatment map)**: shows the management zones with different colour based on different application rates.
- **Table widget (Treatments)**: contains all the application rates for each management zone.

7.3.6 Area 4.E - Pest and Disease Management

7.3.6.1 Dashboard 4.E.1 - Pest Estimation with Sterile Fruit Flies

Figure 71: Dashboard 4.E.1 - Pest Estimation with Sterile Fruit Flies

The dashboard provides a visualisation of the evolution of the sterile and non-sterile fruit flies captured by the traps as well as an estimation of the amount of sterile and non-sterile fruit flies expected during the next dates (based on a number of flies observed during the last days). It is composed of the following widgets:

- **Selection widget (Choose Trap)**: selects one or multiple traps to filter the data.
- **Active selection widget (Clear selections)**: clear the current filters.
- **Custom chart widget (Period filter)**: selects a period to filter the data.
- **Table widget (Files Data)**: contains files data for each date regarding each selected trap.
- **Custom chart (Flies counting)**: contains a line chart from the highcharts library. The X-Axis contains the date, while the Y-Axis shows the respective flies count value. Each trap id defines colour and exposes three series, sterile flies, non-sterile flies, and total. The solid line represents current values, while dashed lines are used for estimations.

7.3.6.2 Dashboard 4.E.2 - Estimate Temperature-Related Pest Events

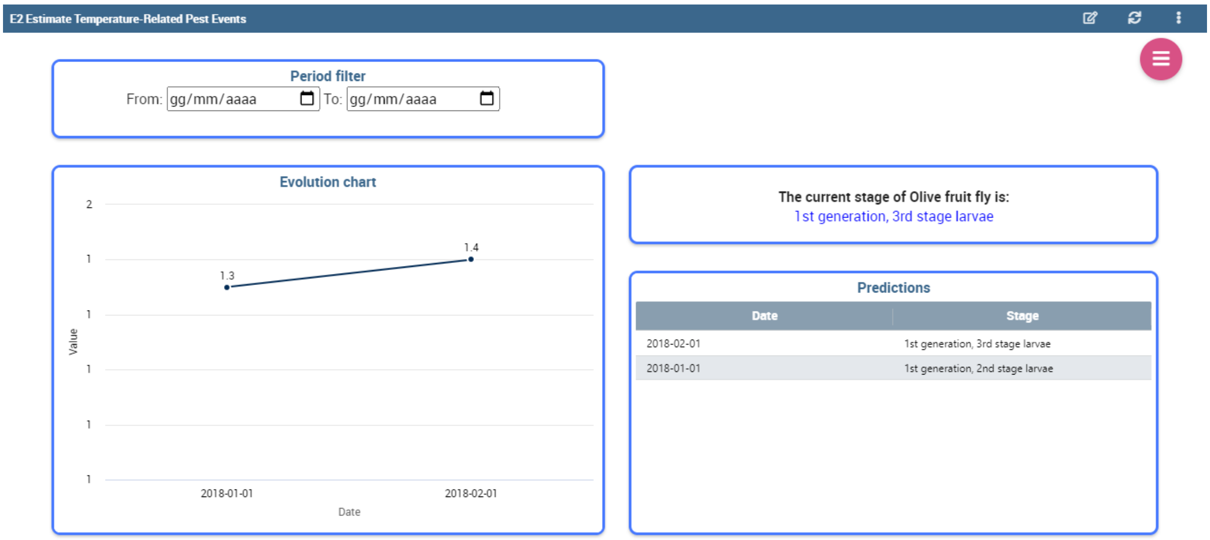


Figure 72: Dashboard 4.E.2 - Estimate Temperature-Related Pest Events

The dashboard shows the last temperature prediction related to pest events and a dynamics prediction for the previous date. A line-chart describes the evolution between the date and the current stage until the selected day. The table shows the last predictions. The predicted pest state is described in a text area. It is composed of the following widgets:

- **Custom chart widget (Period filter)**: selects a period to filter the data.
- **Chart widget (Evolution chart)**: line chart that shows the pest evolution over time.
- **Table widget (Predictions)**: contains the last predictions data with a state description for each date.
- **Text widget**: describes the current stage of the pest on the selected day.

7.3.7 Area 4.F - Animal Yield

7.3.7.1 Dashboard 4.F.1 - Estimate Milk Production

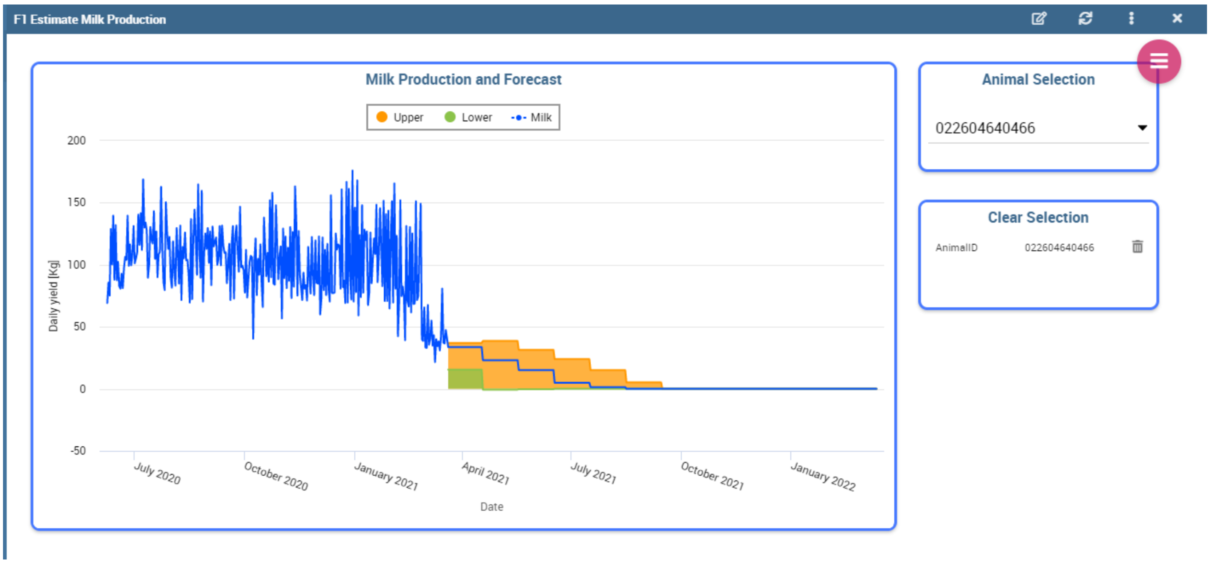


Figure 73: Dashboard 4.F.1 - Estimate Milk Production

The dashboard shows the status of the current lactation curve of the animal selected, or all animals in the herd, with the predicted output for the rest of the lactation. It is composed of the following widgets:

- **Selection widget (Animal Selection)**: selects one or more animal ids.
- **Active selection widget (Clear selection)**: clear the current active filters.
- **Chart widget (Milk Production)**: line chart that contains information regarding the lactation over time. The X-Axis shows date periods grouped by animal id, while Y-Axis is about daily yield value. The chart exposes three series, upper confidence (orange colour) and lower confidence (green colour) take values only on estimation dates, while milk series (blue colour) shows the actual value on past dates and predicted values on estimated period.

7.3.7.2 Dashboard 4.F.2 - Poultry Feeding

Figure 74: Dashboard 4.F.2 - Poultry Feeding

The dashboard shows the overall food level in the silo with estimated food consumption. It is composed of the following widgets:

- **Custom chart widget (Silo information)**: describes the type of food and feeding quality.
- **Chart widget (Clear selection)**: shows the overall food level in the silos.

7.3.8 Area 4.G - Animal Welfare

7.3.8.1 Dashboard 4.G.1 - Estimate Animal Welfare Condition

7.3.8.1.1 Cow Health Training

The dashboard intends to monitor the health status of the livestock using graph widgets, during the training phase. Through this DSS, the farmer is able to establish their current health status, determining the accuracy of their predictions based on the data provided in the training. Furthermore, through these predictions the farmer is able to understand and optimise the health of the herd. It is composed of the following widgets:

- **Table widget (Data, Actual and Predicted Health Status)**: a table containing the data concerning the fat/protein ratio, the electrical conductivity, the motor activity and the total daily rest, accompanied by two sets of parameters (see Figure 75, "Actual" and "Predicted" columns in the table above): the health status by pathology (ketosis, mastitis and lameness) assigned "manually" and the health status by pathology assigned by the algorithm, determined by the latter through training performed by studying the values assigned "manually".
- **Chart widget (Actual/Predicted Lameness, Ketosis, Mastitis Status)**: for each pathology, two pie charts, to compare the health status assigned "manually" with those determined by the algorithm.
- **Table widget (Lameness, Ketosis, Mastitis Results Metrics)**: a table showing parameters that allows a farmer to determine the accuracy of the algorithm.

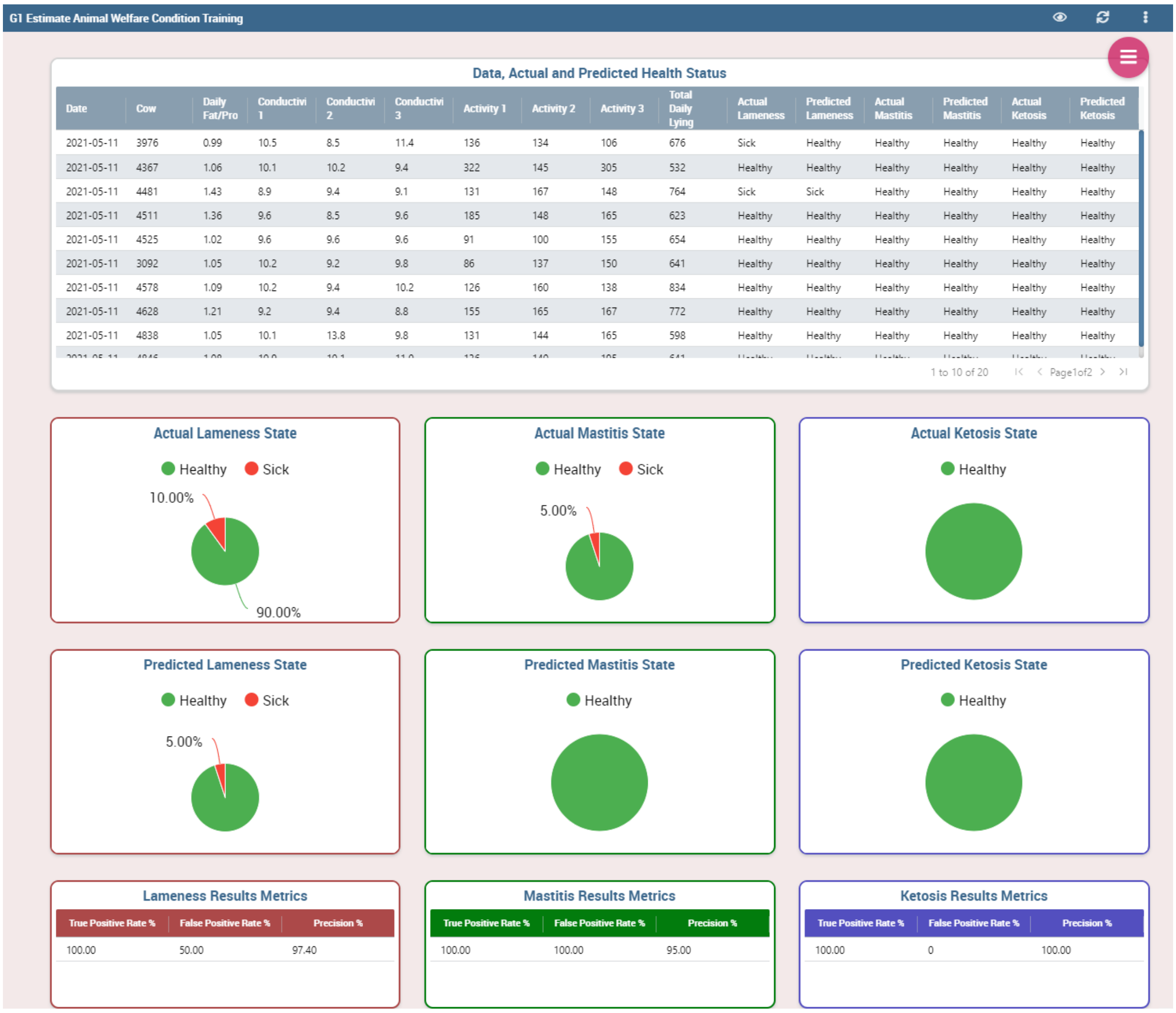


Figure 75: Dashboard 4.G.1 - Estimate Animal Welfare Condition - Cow Health Training

7.3.8.1.2 Cow Health Prediction

Figure 76: Dashboard 4.G.1 - Estimate Animal Welfare Condition - Cow Health Prediction

Once the predictive algorithm has achieved a high degree of precision, the prediction is performed autonomously: in the data table, there are no longer any manual entries for health status by pathology, only the columns relating to the classifications determined by the predictive algorithm. It is composed of the following widgets:

- **Table widget (Data and Predicted Health Status)**: a table containing the data concerning the fat/protein ratio, the electrical conductivity, the motor activity, and the total daily rest, accompanied by the health status by pathology (ketosis, mastitis, and lameness) assigned by the algorithm.
- **Chart widget (Predicted Lameness, Ketosis, Mastitis Status)**: for each pathology, a pie chart, that shows the cows' health status determined by the algorithm.

7.3.8.2 Dashboard 4.G.2 - Poultry Well-being

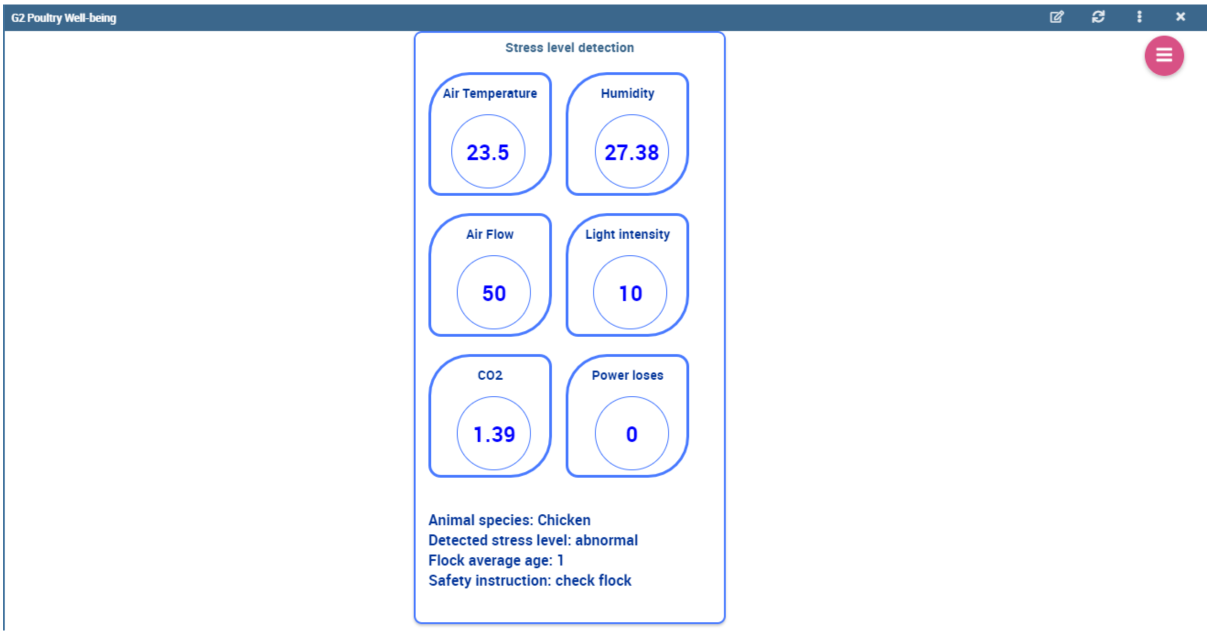


Figure 77: Dashboard 4.G.2 - Poultry Well-being

The dashboard presents the overall poultry stress based on parameters from environment and patterns detected from environment and video. It is composed of the following widgets:

- **Custom chart widget (Stress Level Detection)**: shows the environment parameters, animal species and average age, the detected stress level, and the recommended instructions the user should undertake.

7.3.9 Area 4.H - Traceability

7.3.9.1 Dashboard 4.H.1 - Estimate Milk Quality

7.3.9.1.1 Milk Quality Training

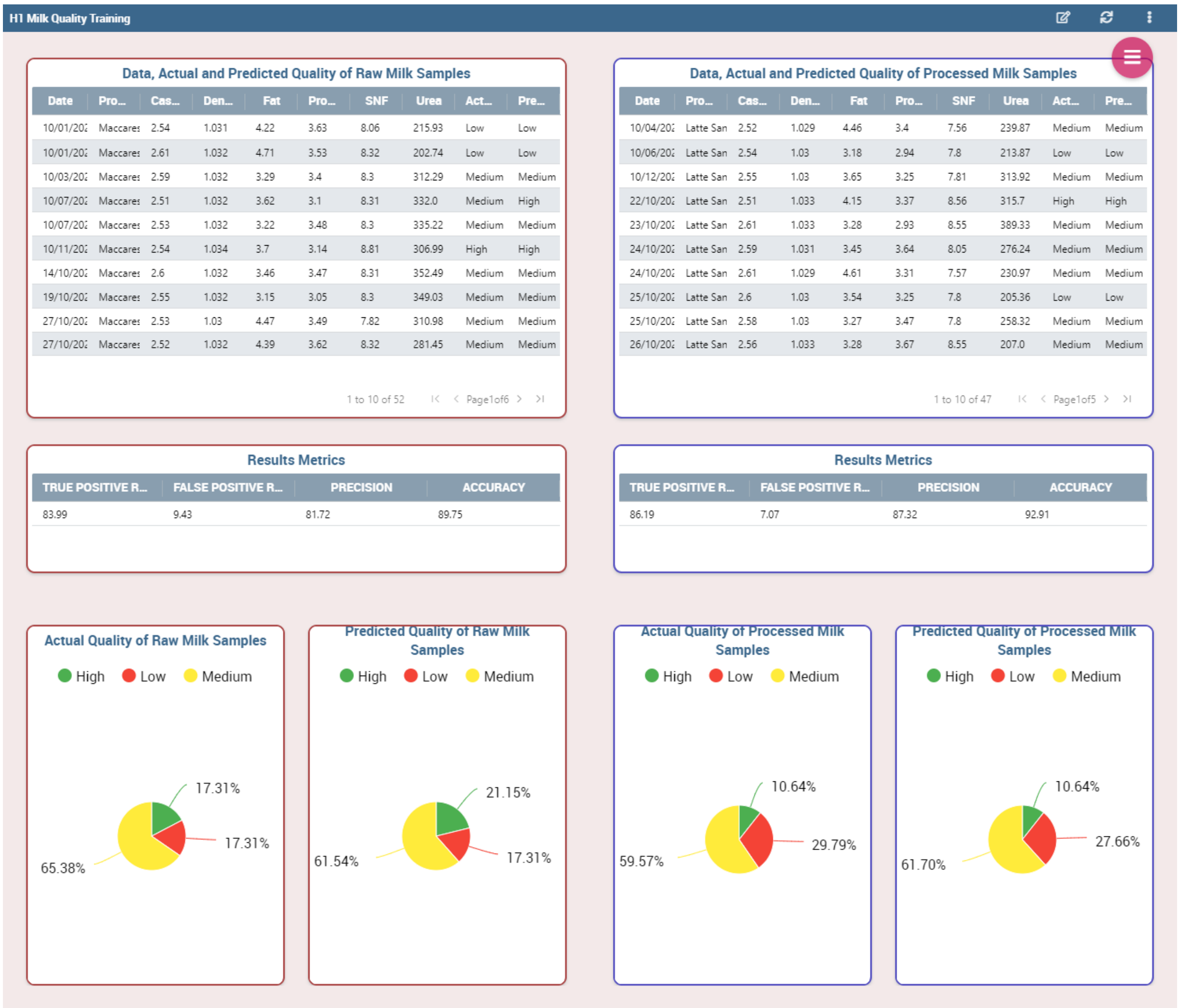


Figure 78: Dashboard 4.H.1 - Estimate Milk Quality – Milk Quality Training

The dashboard intends to monitor the milk quality degree using graph widgets. Through this dashboard, the farmer is able to establish the current milk quality degree, by means of specific predictions from Machine Learning algorithms. Through these predictions the farmer is able to understand and optimise the quality of milk produced by their herd. It is composed of the following widgets:

- **Table widget (Data, Actual and Predicted Quality of Raw/Processed Milk Samples)**: a table containing the FTIR analysis accompanied by two parameters: the degree of quality assigned "manually" for each sample and the degree of quality assigned by the algorithm, determined through the training performed studying the values assigned "manually".

- **Chart widget (Actual/Predicted Quality of Raw/Processed Milk Samples)**: for each type of milk (raw and processed), two pie charts, to compare the quality degree assigned "manually" with that determined by the algorithm.
- **Table widget (Results Metrics)**: a table showing parameters that allows the accuracy of the algorithm to be determined.

7.3.9.1.2 Milk Quality Prediction

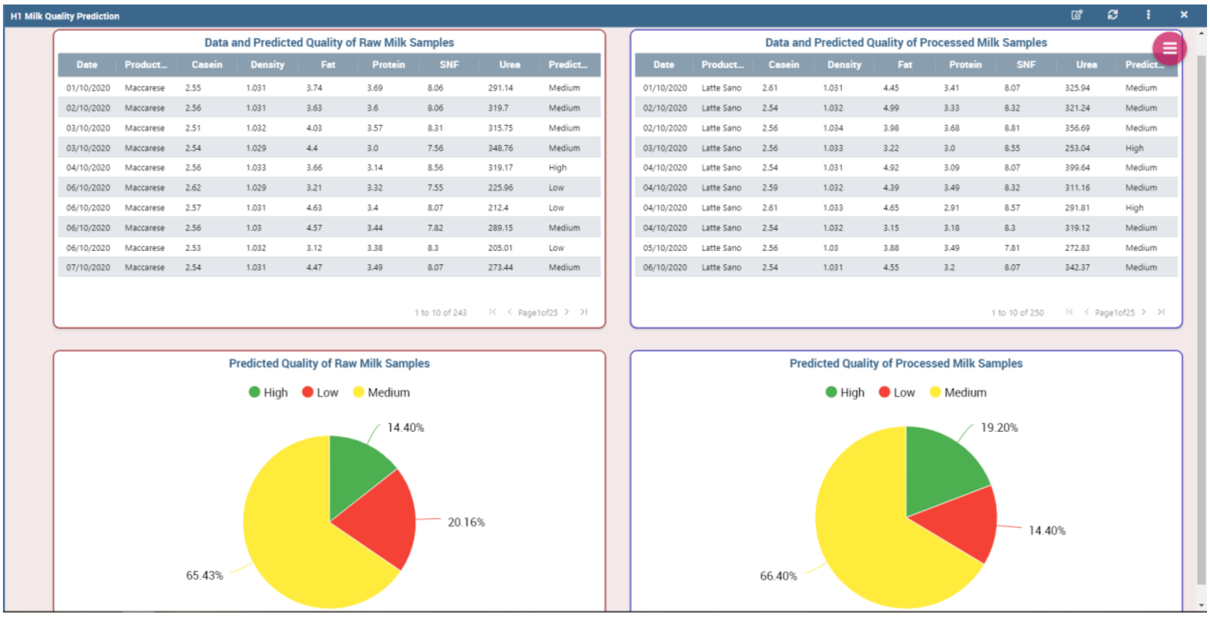


Figure 79: Dashboard 4.H.1 - Estimate Milk Quality – Milk Quality Prediction

Once the predictive algorithm has achieved a high degree of precision, the prediction is performed autonomously: in the data table, there are no longer any manual entries for FTIR analysis, only the column relating to the classifications determined by the predictive algorithm. It is composed of the following widgets:

- **Table widget (Data and Predicted Quality of Raw/Processed Milk Samples)**: a table containing the FTIR analysis accompanied by the degree of quality for each sample assigned by the algorithm.
- **Chart widget (Predicted Quality of Raw/Processed Milk Samples)**: for each type of milk (raw and processed), a pie chart, that shows the milk quality degree.

7.3.9.2 Dashboard 4.H.2 - Transport Condition

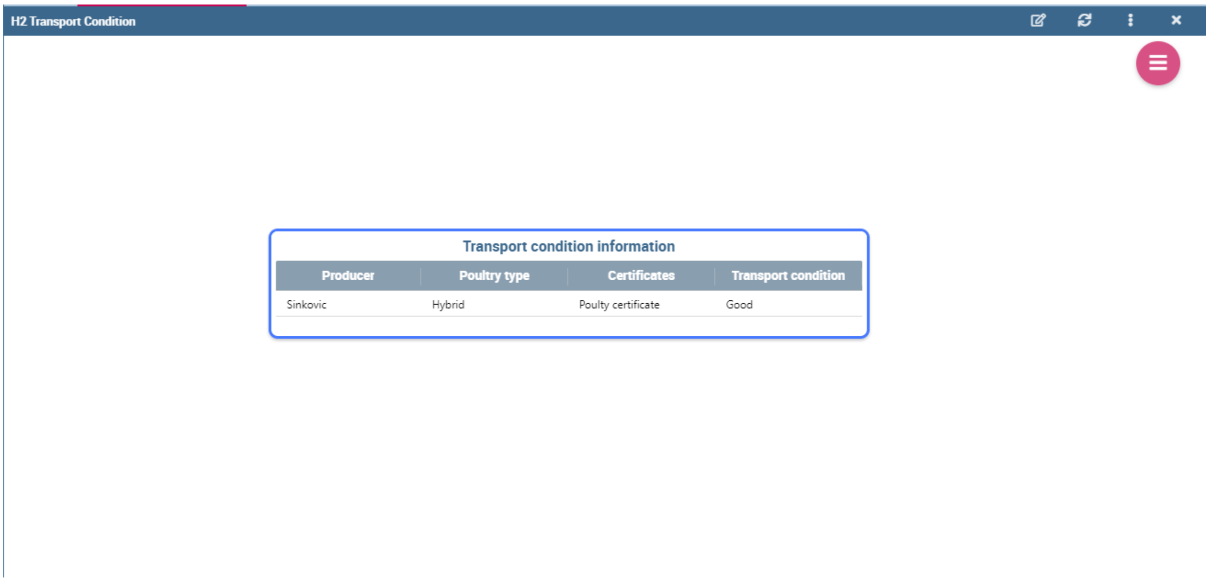


Figure 80: Dashboard 4.H.2 - Transport Condition

The dashboard presents the transport condition for the poultry. It is composed of the following widgets:

- **Table widget (Transport condition information)**: contains information regarding the producer, poultry type, certificates and transportation condition.

7.3.10 Area 4.I - Benchmarking

7.3.10.1 Dashboard 4.I.1 - Generic Farm Comparison

The dashboard visualises a set of basic economic indicators, used to get a general benchmark of the farm activities over the selected year. The table shows a trend symbol according with the data. It is composed of the following widgets:

- **Table widget (Farm General data)**: contains information regarding the basic indicators of the farm grouped by sector. The comparison column shows a trend icon, that changes according to the data processed.
- **Selection widget (Year Selector)**: selects the year to view the corresponding indicator values.
- **Active selection widget (Clear selection)**: clear the current filter.
- **Text widget (General description)**: shows some information regarding the collected data.
- **Chart widget (Type of input costs)**: tree-map graph that contains all the input indicators values that refer to costs of the farm activities.
- **Chart widget (Type of output revenues)**: tree-map graph that contains all the output indicator values that refer to revenues of the farm activities.

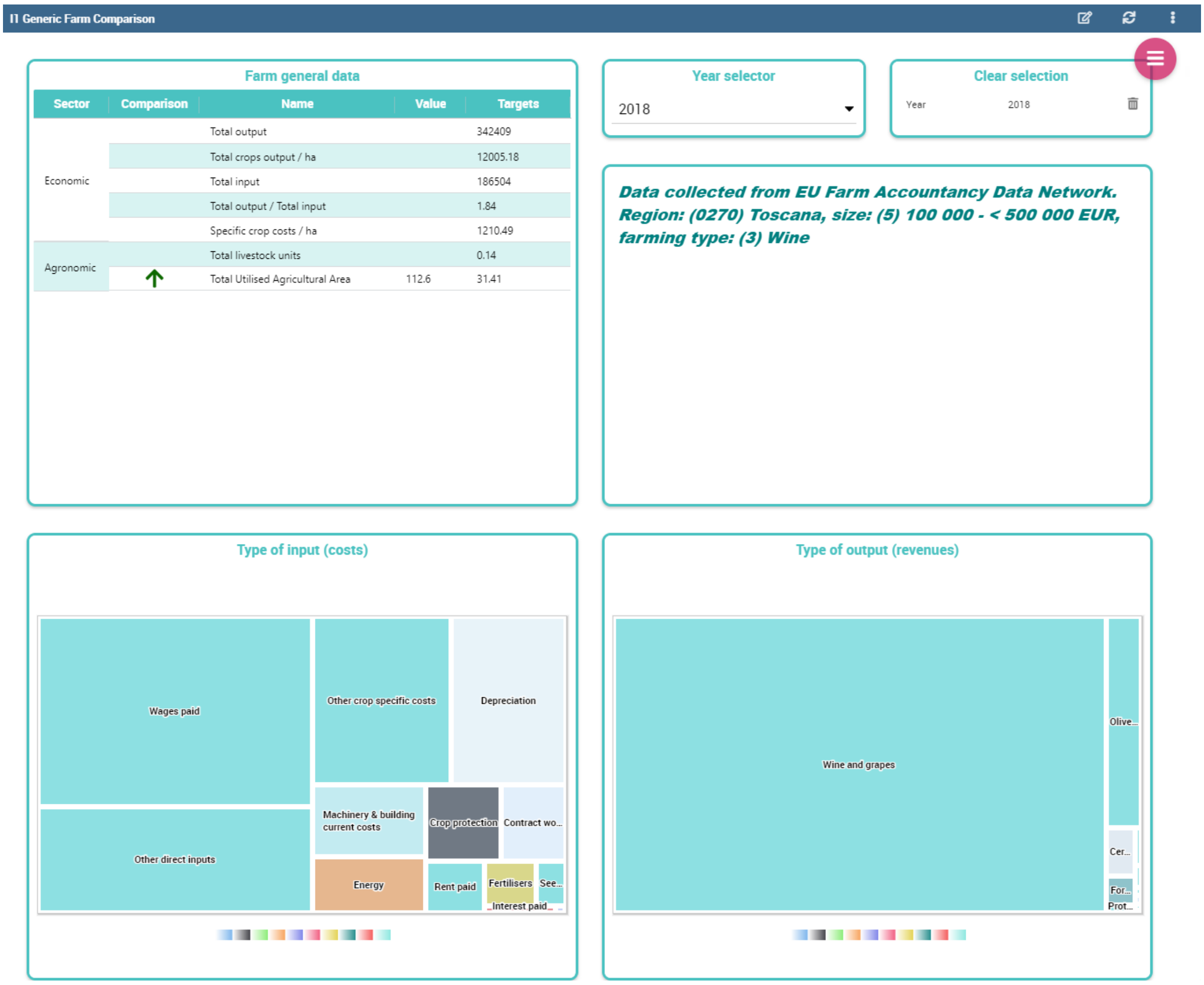


Figure 81: Dashboard 4.I.1 - Generic Farm Comparison

7.3.10.2 Dashboard 4.I.2 - Neighbour Benchmarking

The dashboard presents an overall progress view of the indicators for all sectors of a farm in the selected year. The indicators are grouped by sectors and are dynamically inserted into a table. A trend icon is displayed based on the data processed between the current value and the target. A gauge chart with text shows the progress of the value (related to each indicator), towards the target value, also monitoring any exceeding. By clicking on an indicator, a pop-up is shown, that contains a graph with the time series related to that indicator value over the years. The dashboard is composed of the following widgets:

- **Table widget (Farm General data)**: contains information regarding the indicators of the farm grouped by sector. The comparison column shows a trend icon, that changes according to the processed data. A cross navigation is defined within each row, making them clickable for showing a pop-up with the time series details.
- **Selection widget (Year Selector)**: selects the year to view the corresponding indicators.
- **Active selection widget (Clear selection)**: clears the current filter.
- **Text widget (General description)**: shows the farm description.
- **Chart widget (Production/Economic/Environment Indicator Progress)**: gauge type chart that shows the average indicator progress for each sector.

Figure 82: Dashboard 4.I.2 - Neighbour Benchmarking

Figure 83: Dashboard 4.I.2 - Neighbour Benchmarking (pop-up)

The pop-up dashboard (see Figure 83) is composed of the following widgets:

- **Selection widget (Year Selector)**: selects the year to view the corresponding indicators.
- **Active selection widget (Clear selection)**: clears the current filter.
- **Text widget (Indicator)**: shows the indicator name.
- **Chart widget (Time series)**: shows the indicator value and target over the years.

7.3.10.3 Dashboard 4.I.3 - Technology Benchmarking

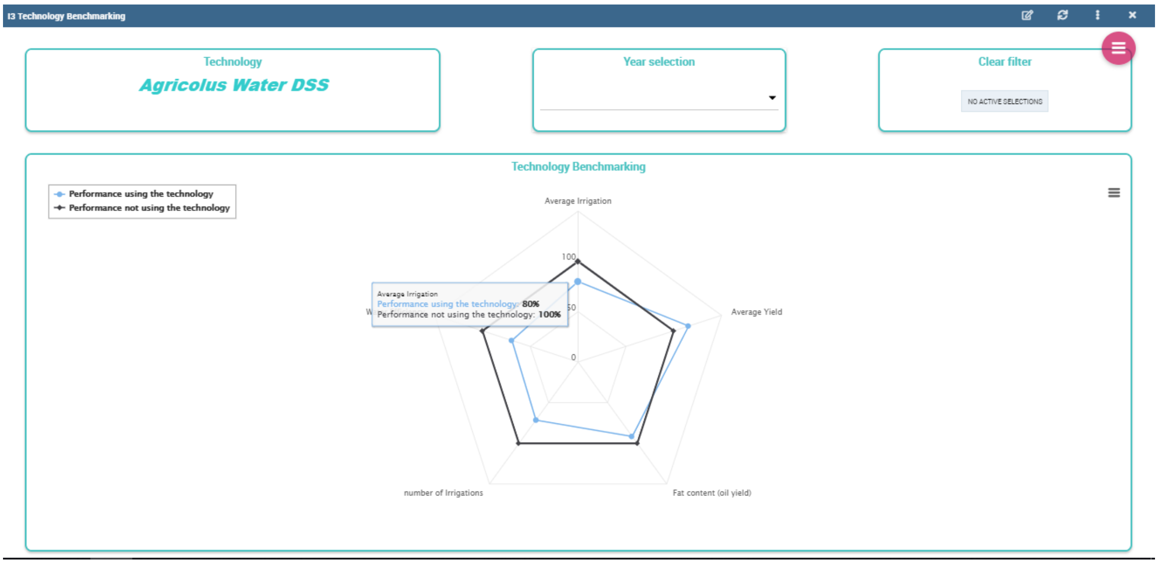


Figure 84: Dashboard 4.I.3 - Technology Benchmarking

This DSS shows the results of indicators before and after the adoption of a technology. This dashboard (Figure 84) is composed of the following widgets:

- **Custom chart widget (Technology Benchmarking)**: contains a spiderweb chart defined using the highcharts library. The indicators are dynamically added, and each spoke of the chart shows the indicator's name. The Y-axis defines two series, the black one shows the percentage value of each indicators when not using the technology, while the blue one shows the percentage value of each indicators when using the technology.
- **Selection widget (Year Selection):** selects a year to view the corresponding indicators.
- **Clear selection widget (Clear filter):** clears the current filter.
- **Text widget (Technology):** shows the name of the technology being analysed.

7.4 *Knowage validation*

The validation of the adaptive framework on the visualisation in DEMETER follows the same *iter* as all the other modules or enablers implemented during the first period of the project. The details on the validation template for this module will be contained in D3.4 to be delivered by WP3 at the same time as this deliverable (M22).

7.5 *Knowage DEMETER factsheet*

The following table summarises all the resources related to the Knowage module released for DEMETER project. The Knowage instance, that will be distributed in all DEMETER pilots is based on the Knowage v7.2.0 Community Edition (CE). The possibility of updating this version over time is not excluded to ensure that the most suitable software version is used within the DEMETER project.

Package	Link
DEMETER Docker images for download	• Knowage (link) • Knowage DB (link)
DEMETER GitLab repository	Link
DEMETER GitLab dashboard catalogue	Link
DEMETER GitLab Installation Manual	Link
DEMETER Knowage Roadmap	Link
Knowage Release	Community Edition 7.2.0 (Link)
Question & Answers	Link
Bug tracker	Link

Table 56: DEMETER Knowage factsheet

7.6 *Knowage deployment*

There are two options for the deployment of the Knowage module in the DEMETER context: centralised on the DEMETER cloud or on-premises at pilot site. Once again, the module has proven flexible in this choice, allowing the most appropriate option to be selected for the project. Obviously, in this case too, the decisions were made in agreement with all the partners involved and with the pilots, taking into consideration all the technical implications. Finally, the option selected for the deployment, was to deliver Knowage instance decentralised (in each pilot) and not on DEMETER cloud. Each pilot has the ability to deploy an instance of Knowage on-premises, choose the DSS visualisation they need by having a complete catalogue available, and also choose the analytical services to produce the data. The instance is released as a docker image, and a first version is already available for download (see 7.5 for more information). Furthermore, in some pilots the installation of Knowage has already started with ENG support. The data produced within each DEMETER pilot are managed and preserved by pilot itself, or even exposed through the BSE. This is a choice that each pilot can make within the DEMETER project. The account (or digital identity) remains centralised and managed through the DEMETER Access Control Server to guarantee a single access to all DEMETER services and enablers and therefore also for the Knowage module. This choice was made at the central level of the entire DEMETER Consortium, in order to allow a single registration point for the users and a single access to all DEMETER modules. Thus, avoiding having a user registration form and different access credentials (e.g., login and password) for each individual DEMETER tool, module, and platform.

The Knowage docker container at execution time provides some basic configurations, such as connectivity to the Access Control Server module like Fiware-IDM[6], and some variables for basic operation. The pilot has only to connect the analytics services using Knowage REST Datasets or the Brokerage Service Environment (BSE) to produce the data for the DSS dashboard visualisation. Obviously, a step by test configuration procedure will be adopted, also providing the necessary support through specific technical documentation. The pilots have to previously test those analytical services to verify the data production for a specific DSS in the AIM data format, which represents the basic information model exchanged between all the DEMETER module and enablers.

Below is the main information about Knowage deployment, that each pilot has to follow to install and configure the Knowage docker instance in their production environments. Before any installation within a pilot infrastructure, you should refer to the basic requirements for installing a docker image

[6] https://fiware-idm.readthedocs.io/en/latest/

and running the container. The table shows the basic information requirements to use docker technology, compatible with the Knowage version released for DEMETER project:

Name	Version	Build	Notes
Docker	19.03.11	42e35e61f3	Docker docs
Docker-Compose	1.26.0	d4451659	

Table 57: Knowage installation requirements

In addition to the requirements, some guidelines are also provided below, regarding the basic hardware resources that the pilot production environments should make available (if possible) to allow the docker Knowage instance to run:

Docker Host (OS)	CPU	RAM	Disk space
CentOS 7	8 Core	32GB	50GB (but dependent on the data to be produced and managed)

Table 58: Knowage basic environment requirements

As widely explained in the previous sections of this Deliverable, it is necessary to register an account in the Access Control DEMETER server, and perform a basic configuration using its interfaces, to obtain a basic configuration between the Knowage instance and the ACS server. These kinds of configurations are common when a pilot (but in general a third-party service) wants to put web applications in communication (using OAuth20[7] protocol) with ACS identity provider. The third-party service, in this case Knowage, uses the ACS module to allow access to their user accounts. The ACS module, being aligned with the OAuth20 standard, generates security secret keys, such as Client ID and Client Secret, as per standard RFC 6749[8] as shown in the image below:

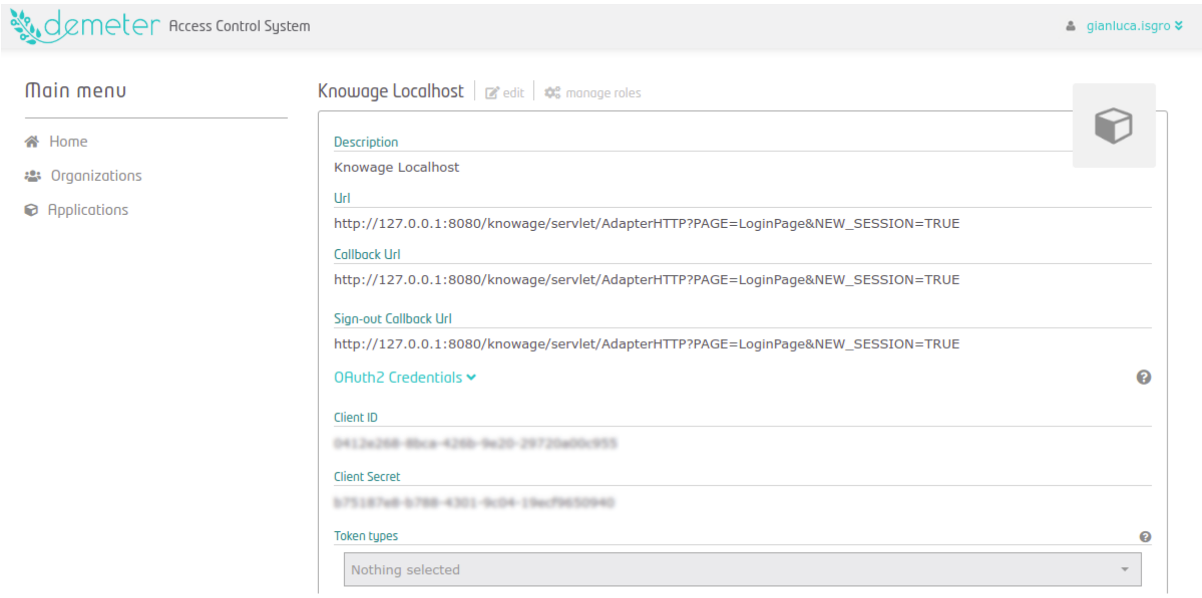


Figure 85: Access Control Server – Knowage OAuth20 configuration

[7] https://oauth.net/2/
[8] https://tools.ietf.org/html/rfc6749

After the ACS configuration has been performed, the next step is to use the docker-compose file supplied with the Knowage docker image, which allows the installation and configuration of the Knowage docker containers in the target environment. The installation and configuration operations of the Knowage docker instance, can only be performed by the pilot technical staff, specialised in networking configuration, who are familiar with the production environments and the networking policies. Obviously, this staff need to know the docker technology, selected within the DEMETER project as the reference technology for the deployment of each single software module used and implemented within the project. The following instructions shown in the Table 59, refer to a configuration procedure using docker technology. Also, docker commands are normally used from the command line. Certainly, does not exclude the use of technologies compliant with docker technology. that also make use of high-level user interfaces to interact with the docker runtime.

The compose file released for the DEMETER project by the ENG development team is proposed below and released also on DEMETER GitLab repository[9]:

```
version: "3"
services:

   knowagedb:
      hostname: knowagedb
      image: demeterengteam/knowagedb-7.2.0:v1.6
      networks:
         - hostnet
      ports:
       - "3306:3306"
      environment:
         - MYSQL_ROOT_PASSWORD=r00t
         - MYSQL_DATABASE=knowagedb
      volumes:
         - ./mariadb_conf:/home/knowage/mariadb_conf

   knowage:
      hostname: knowage
      image: demeterengteam/knowage-7.2.0:idm-v1.6
      networks:
         - hostnet
      ports:
         - "8080:8080"
      depends_on:
         - knowagedb
      environment:
         - DB_HOST=knowagedb
         - DB_PORT=3306
         - DB_USER=root
         - DB_PASS=r00t
         - DB_DB=knowagedb
         env_file:
         - ./KnowageParameters.env

networks:
   hostnet:
```

Table 59: Knowage docker-compose file

[9] https://gitlab.com/demeterproject/wp4/visualizations/knowagefordashboards/

The parameters of the YAML[10] file, are almost the same. Obviously if there are some specific needs related to docker container execution, the network ports of each image contained in the docker compose file could be modified. Pilot's technical staff is able to choose the best solution to their needs, changing as appropriate, the values related to each variable or YAML attributes within the file. For instance, if host port 3306 is unavailable, is possible to set another one for knowagedb docker image like "3307: 3306".

After installing the docker-compose file in any folder of the host Operating System (i.e., on the docker host), is possible to create a new configuration file in which all the environment variables for the Knowage docker instance take place. These too configurations are provided together with the instance and documented on the project GitLab repository. The environment variables configuration file or KnowageParameters.env, it must be installed in the same folder as docker-compose. Table 60 shows the contents of this file, and all the environment variables that need to be used by the docker container execution or run-time:

```
ACS_INTEGRATION=true
SECURITY_LOGOUT_URL=https://acs.bse.h2020-demeter-
cloud.eu:5443/auth/logout?_method=DELETE
OAUTH2_CLIENT_ID=INSERT APP CLIENT ID FROM IDM
OAUTH2_SECRET=INSERT APP CLIENT SECRET FROM IDM
ACS_BASE_URL=https://acs.bse.h2020-demeter-cloud.eu:5443
ACS_ADMIN_ID=ADMIN ID
ACS_ADMIN_EMAIL=ADMIN EMAIL
ACS_ADMIN_PASSWORD=ADMIN PASSWORD
REDIRECT_URL=http://localhost:8080/knowage/servlet/AdapterHTTP?PAGE=LoginPage\&NEW_SESSI
ON=TRUE
PROXY_HOST=
PROXY_PORT=
```

Table 60: Knowage docker container environment variables

The last operation concerns the docker container run of the newly configured instance using the docker commands for containers: "*# docker-compose up -d*". Once the command has been executed, and verified any docker errors shows in a shell, the next step is to open an instance of a web browser and connect to the following URL:

```
http://docker_host_ip_address:8080/knowage/servlet/AdapterHTTP?PAGE=LoginPage&NEW_SESSION=T
RUE
```

One last tip is to use the docker host IP address where the Knowage instance is installed. Appropriate tuning configurations will be performed by the technical staff in each pilot to have the more appropriate deployment solution in terms of networking configuration.

7.7 *Next Steps*

The next steps for the Task 4.3, will be to continue to work on multiple aspects related to the visualisation activities, to develop and support new visualisation requests coming from the DEMETER pilot and support them in the installation and configuration of Knowage module on-premises.

[10] https://yaml.org/

However, these activities, can be summarised as follows:

- Data visualisation development improvement and refinement.
- Change request management, to support the integration of new row data coming from the DEMETER pilot or new required visualisation requested, to integrate new graphical widgets supported by Knowage module in the existing dashboard.
- Deployment support activities in each DEMETER pilot environment.
- Functionality test and connection tuning support.
- Bug-fixing and integration of new Knowage versions (CE) if required and/or necessary.

8 Stakeholders Open Collaboration Space (SOCS)

8.1 *Overview*

To understand the Stakeholders Open Collaboration Space (SOCS) scope better, it is worth starting from the high-level overview of the main DEMETER components and concepts (i.e., DEH, SOCS, AIS, Dashboard), presented in the Figure 86 below, where a **human focused interaction space** on the left is connected with the actual **digital implementation space** on the right. This ensures the fact that DEMETER remains fully human centric and human driven - delivering digital enablers that are fully aligned to the needs expressed by the farmers and based on the knowledge and wisdom captured through structured mechanisms.

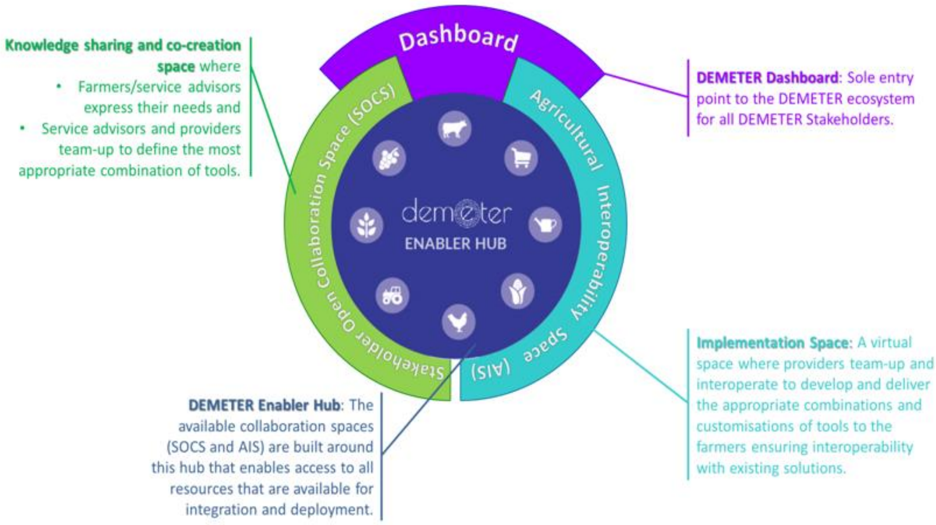


Figure 86: The main DEMETER concepts

The DEMETER **SOCS** is a space **dedicated to all stakeholders** (farmers, advisors, and suppliers) where they can **collaborate, share knowledge and best practices, and participate in the co-creation processes**.

The focus of the **SOCS** is on **resolving the needs of the farmers** using a structured process that converts either an individual need or the most relevant / shared need from a set of previously identified requirements for a **challenge**. A challenge is then resolved through a unique **co-creation process**, in which farmers, service advisors and providers can select together the most appropriate set of tools, devices, components, data sources, etc., taking into account the existing ones already deployed at the farms as well as the farmer-defined improvement goals. This process goes through the DEMETER Enabler Hub (DEH) to register and discover available components.

The SOCS is strongly inspired by the EIP-Agri[11] Social Spaces and Operational Groups, operating as a set of defined activities for multiple actors implemented through physical meetings, workshops, hackathons, etc., and supported by a dedicated online platform. In DEMETER, the multi-actor approach (MAA) is addressed by WP7 "Multi-actor Ecosystem Development" and has an impact on the SOCS design as it is showed in the next sections.

[11] https://ec.europa.eu/eip/agriculture

The SOCS is based on well- established technologies, further described in DIHIWARE technology description (see Annex D), which give a set of basic services and tools to create, share and find contents, information, knowledge, experts, and ideas as well as to effectively and productively manage collaboration and work together.

This deliverable intends to give some insights about the methodology (connected with MAA) that has been followed for the SOCS design and the impact that it has on the first Beta release of the SOCS available at M22.

8.2 *The interaction with WP7*

A close collaboration between T4.5 and WP7 has enabled the upgrade from the Alpha to the first Beta release of the SOCS, with the aim that the MAA can strongly influence the DEMETER collaborative space.

ENGINEERING has presented the SOCS Alpha release (Figure 87) to WP7 participants to demonstrate and open discussion on:

- The collaboration and knowledge **basic services**.
- **User needs** that SOCS can satisfy for its stakeholders that can be farmers, advisors and IT providers (Table 61).
- Some of the main **user journeys** (knowledge sharing, requirement definition, implementation) that SOCS can enable through its basic services (Table 62).

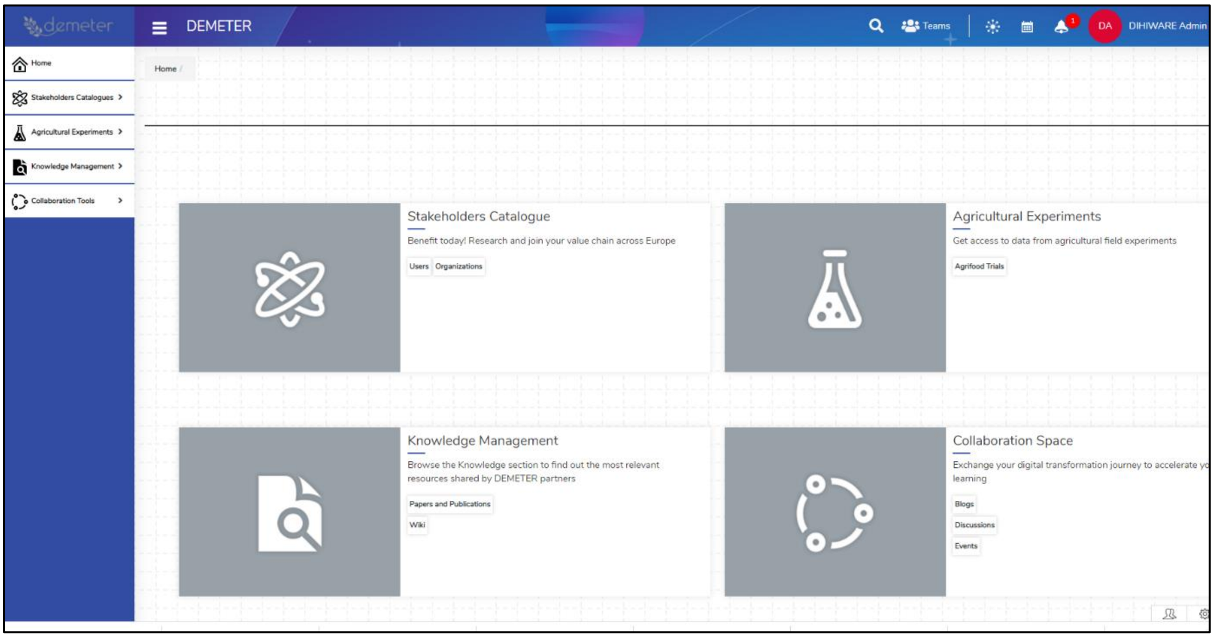


Figure 87: SOCS Alpha release

Type of user	Needs
Farmers	• Discuss with someone to better explicit a need. • Find advisory support. • Find other farmers with the same needs to join forces. • Share successful agricultural experiments. • Look for partners. • Co-design new solutions.

Type of user	Needs
Advisors	• Knowledge sharing. • Joint events. • Access to success stories. • Look for collaborators / new clients. • Support farmers in expressing a need. • Learn about new software/technology. • Co-design new solutions.
IT providers	• Knowledge sharing. • Joint events. • Access to success stories. • Look for collaborators / new clients. • Meet farmers and support them. • Learn about new software/technology. • Co-design new solutions.

Table 61: User needs

Type of user	Journeys
Knowledge sharing	• In a webinar, important insights related to DEMETER were shared. • the user who has participated creates a blog to share the interesting concepts. • The user uploads the webinar materials to the Documents library connecting this resource to the blog entry. • The user tags the two resources for easier searching later.
Requirement definition	• The farmer has a need, but they would like to talk to someone who can help them in expressing their requirements better. • the farmer searches for someone who has "advisory" skill who can help them. • The farmer opens a discussion and notifies the advisor. • The discussion allows him to enrich the list of requirements.
Implementation	• A developer wants to implement a new solution. • Since they need input on a particular technology, they read the available experiments that have used that particular technology. • Through the Experiment app they find a contact • They start a discussion with them.

Table 62: Some SOCS User journeys

The interaction with WP7 was carried on through the organisation of some workshops which were mainly focused on defining:

- A **new design of the SOCS** which aimed not at facing technical discussion but at creating more motivation and enhance the gamification.
- The **SOCS applications data model**, which takes into consideration the DEMETER objectives and the needs/interests that the stakeholders can have with respect to its applications (i.e., organisation, agricultural trial, etc.).
- The **co-creation application,** through which DEMETER stakeholders can co-design new solutions based on the farmers' needs.

8.2.1 The SOCS design workshop

Based on the SOCS Alpha release, WP7 worked on a new layout and organised a SOCS design workshop aimed at collecting feedback from WP7 participants on the new design, represented in Figure 88.

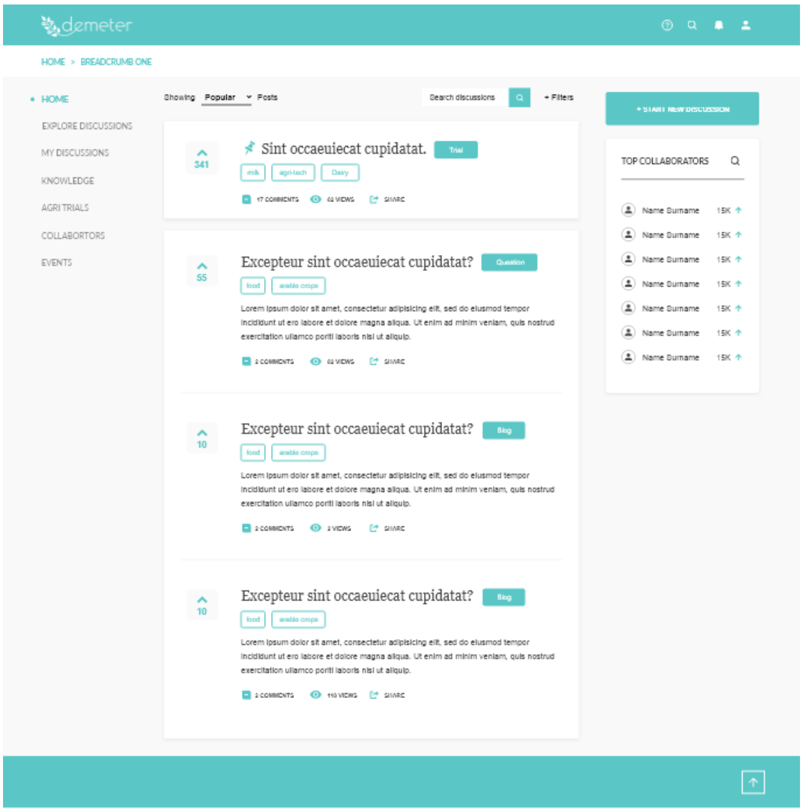


Figure 88: WP7 vision of the SOCS

The workshop focused on collecting feedback using Mural[12], which is a digital workspace for visual collaboration. It was delivered in two parts, the first part included an exercise to review the new wireframe, where the participants were encouraged to leave comments and feedback on the Mural board (Figure 89). The feedback was collected from this exercise and used in the second part. The second exercise encouraged users to move the feedback within a grid to define whether this feedback was positive, a needed change, a new feature, or an unanswered question (Figure 90).

[12] https://www.mural.co/

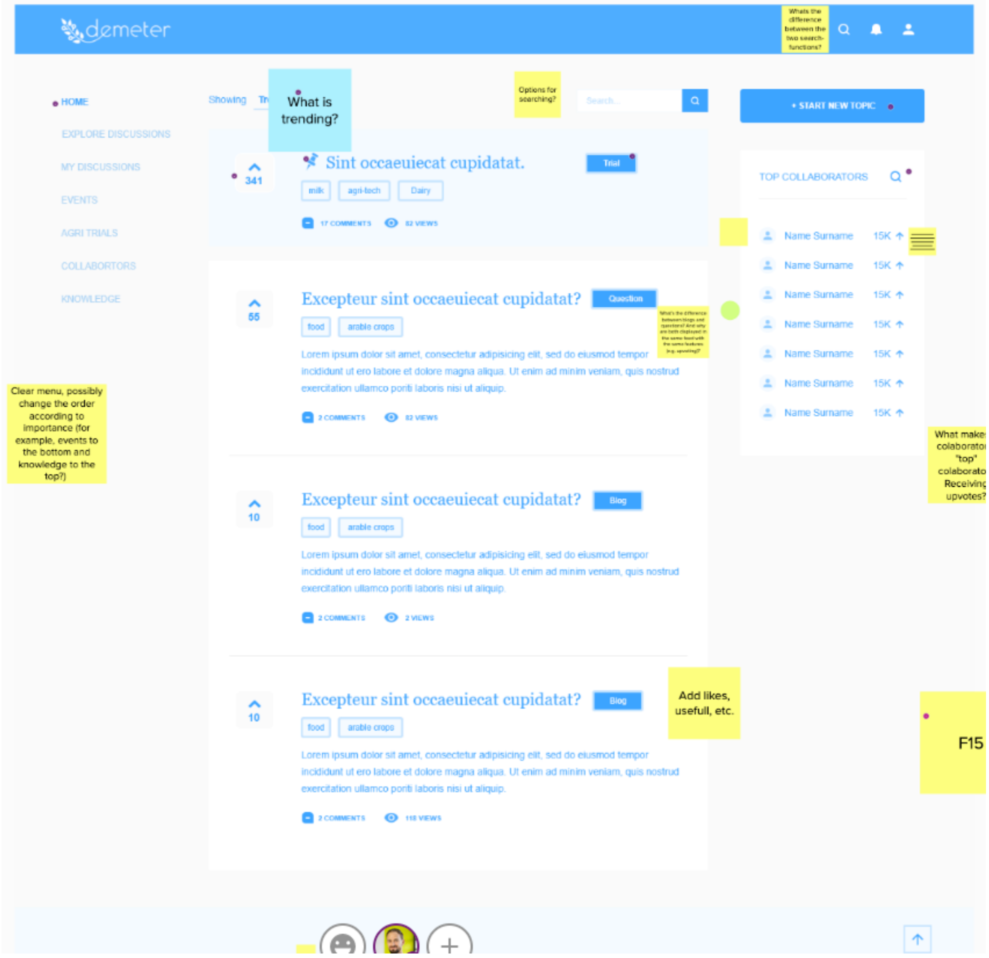


Figure 89: SOCS design review

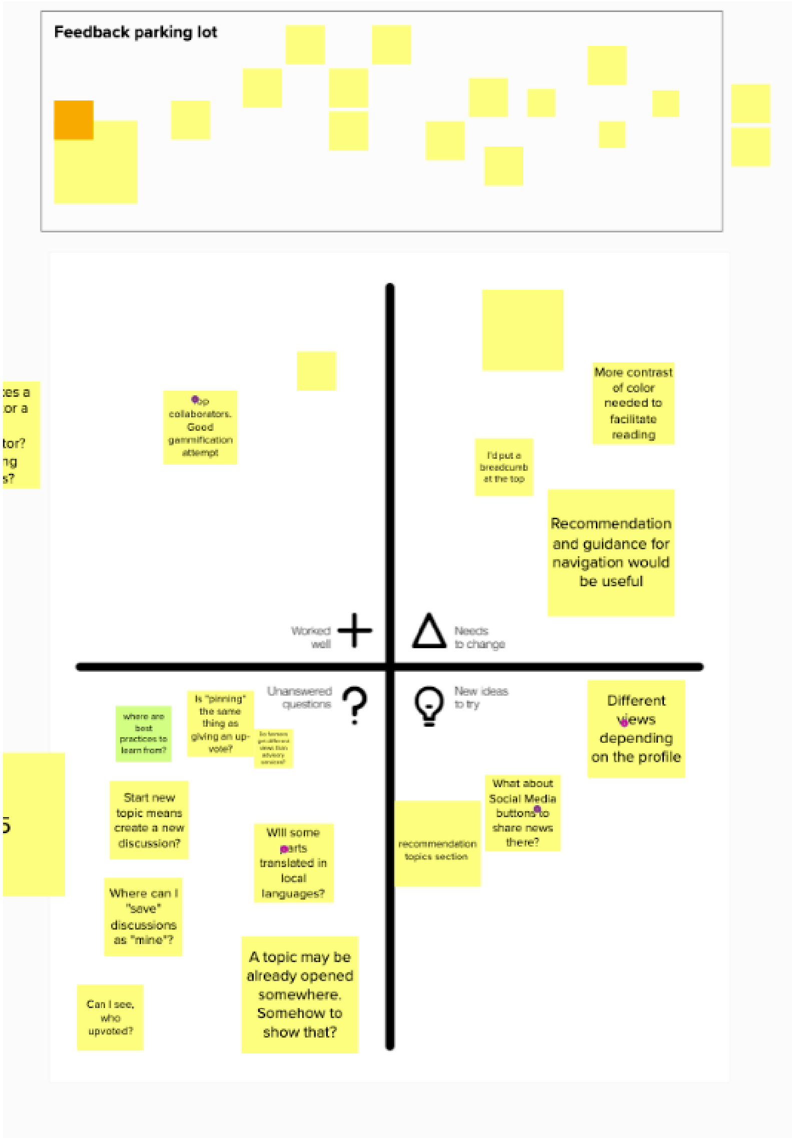


Figure 90: Feedback grid exercise

The main feedback in relation to the new design had as main focus to create motivation through a clear menu and to use a clear layout and new colour also to be in-line with DEMETER brand. This came up with the following main change requests with respect to the SOCS first version: Order of items in menu updated, help icon added to top bar, Breadcrumbs added, Trending changed to Popular, Share link added, Search updated to 'Search Discussions', Filter button added to search.

8.2.2 SOCS entities definition

The design of the DEMETER SOCS' applications has to take into consideration the DEMETER objectives and the needs/interests that the stakeholders (farmers, advisors and IT providers) can have with respect to a digital collaboration space (i.e., searching for collaborators with specific skills, registering a farm using the appropriate data model, defining and using the most appropriate vocabularies to categorise contents created, registering an agricultural experiment, etc.).

For this reason, it was asked to WP7 to organise a workshop. This workshop (Figure 91), was hosted on Mural and involved participants that could give alternative views for the different types of stakeholders in the SOCS platform. The workshop included similar exercises to discuss the applications and their data structures.

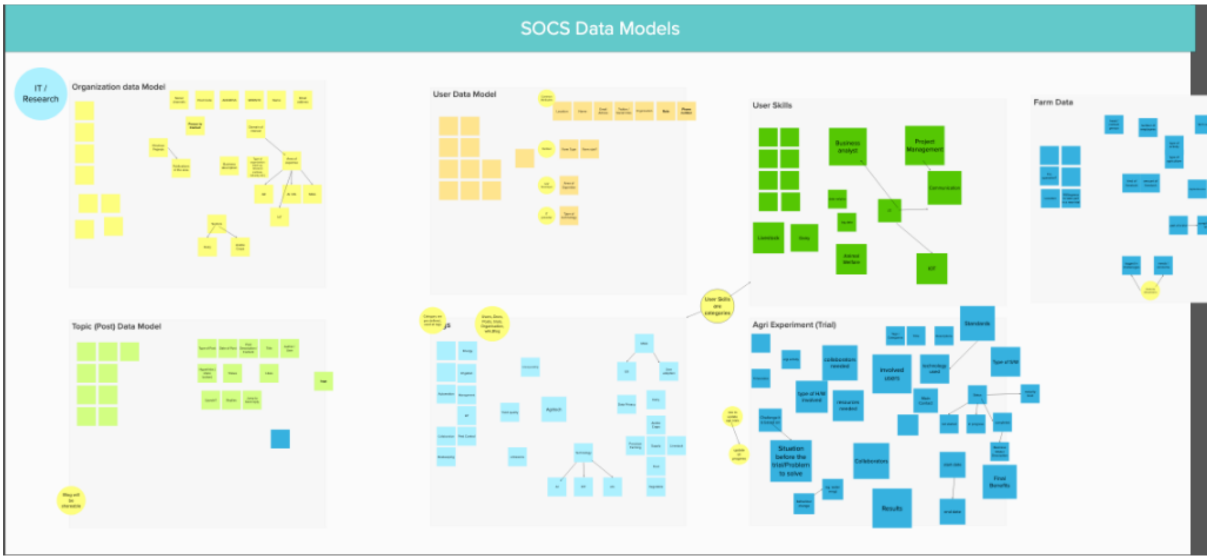


Figure 91: SOCS Data model workshop

The workshop's results allowed the most crucial SOCS entities to be defined, in particular it is worth highlighting:

- Specific attributes for the DEMETER organisations were identified and it was recommended that the organisation catalogue should highlight the difference between an IT/Research organisation and a Farm.
- The user in SOCS can be part of many different stakeholder groups including Farm, Software providers, Industry and Research and consequently it can have different interests and needs with respect to the SOCS, but also different competences and skills.
- Content categories[13] were investigated specifically with respect to user skills, DEMETER components, Multi-actor approach, Agriculture technology.
- Specific characteristics were identified for the agricultural trials (that will be used to describe DEMETER pilots and successful agricultural cases).

In the SOCS Data workshop (see Annex E) detailed information and findings in relation to these exercises is collected.

The goal of this workshop was to share with the audience important aspects of the SOCS applications and functionalities and look at them from different user perspectives. Overall, the workshop provided key information to address the further development of the SOCS.

[13] Categories represent DEMETER vocabularies. They are words or phrases predefined by the administrator. The user can use these predefined words to tag contents in the SOCS which, in that way, will be easily findable.

8.2.3 The co-creation application

One of the main functionalities offered by the SOCS is, undoubtedly, gathering and addressing farmers' needs according to a co-creation process. Through this process, farmers' needs can be better elicited, through the collaboration tools and thanks to the help of other users (i.e., advisors). A need expressed by a farmer is analysed and can evolve into a **challenge** which represents an area of interest requiring new solutions or approaches. The creation of a challenge aims to involve stakeholders in the creation of solutions (**ideas**) that represent their contributions to the requests expressed through the challenge. The final result of the challenge is the selection of the idea that best matches with the challenge and the elaboration of the optimal solution, relying on the resources present in the DEMETER Enabler Hub (DEH). The DEH centralises the full description of all the components, devices, services, data sources, platforms etc that are accessible for deployment.

Building on this broad vision of the co-creation process that is to be implemented in the SOCS, a **human-centred design (HCD)** approach will be utilised for the development, in order to create the most possible value for the users. HCD (see Figure 92) is a process that involves constant feedback loops from users, iteration cycles and extensive user research with empathy being at the core. Throughout the design process and to come up with innovative solution, HCD requires the designers to diverge and converge several times on the possible solutions. By going really big and broad during the ideation phase, it helps the designers to come up with a range of all possible solutions. This constant converging and diverging cycle would enable designers to come up with a highly innovative and sustainable market-ready solution that caters to the users' needs and desires.

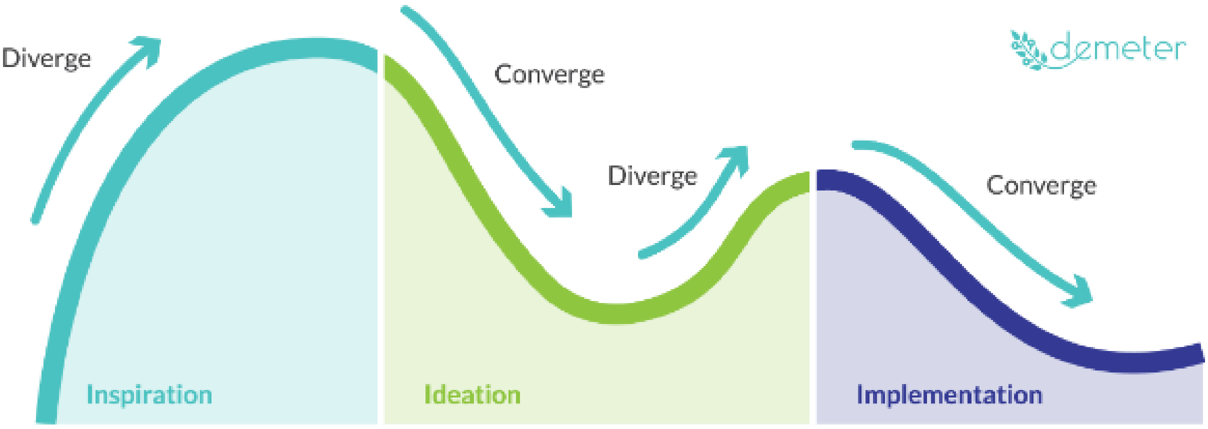


Figure 92: DEMETER HCD Process

Human-centred design is an approach to interactive systems' development that aims to make systems usable and useful by focusing on the users, their needs, and requirements, and by applying human factors/ergonomics, and usability knowledge and techniques. This approach enhances effectiveness and efficiency, improves human well-being, user satisfaction, accessibility, and sustainability; and counteracts possible adverse effects of use on human health, safety, and performance (ISO 9241-210:2019(E), [5]).

Human-Centred Design is a creative approach to problem solving that starts with the people with a problem to be solved and ends with new solutions to suits their needs. It consists of three phases:

1. **Inspiration**: Through conversation and observation, the inspiration phase is about understanding the stakeholders' needs and challenges. It is important to remove any pre-conceptions at this early stage to allow a wide variety of solutions to be discovered.

2. **Ideation**: Also known as the brainstorming phase, this takes place once the initial research and findings have been formulated. Co-creation workshops are used to create potential solutions with the stakeholders. All stakeholders are encouraged to contribute ideas to promote the multi-directional flow of knowledge and information.
3. **Implementation**: At this point solutions have been mapped out and the implementation of a prototype can begin. This prototype will then be tested with the end users and multiple iterations can occur. This phase can also be referred to as the 'testing' phase.

Figure 93 shows a roadmap for the planned development efforts in the months to come (phase 1 "June 2021" and phase 2 "from July to December 2021"):

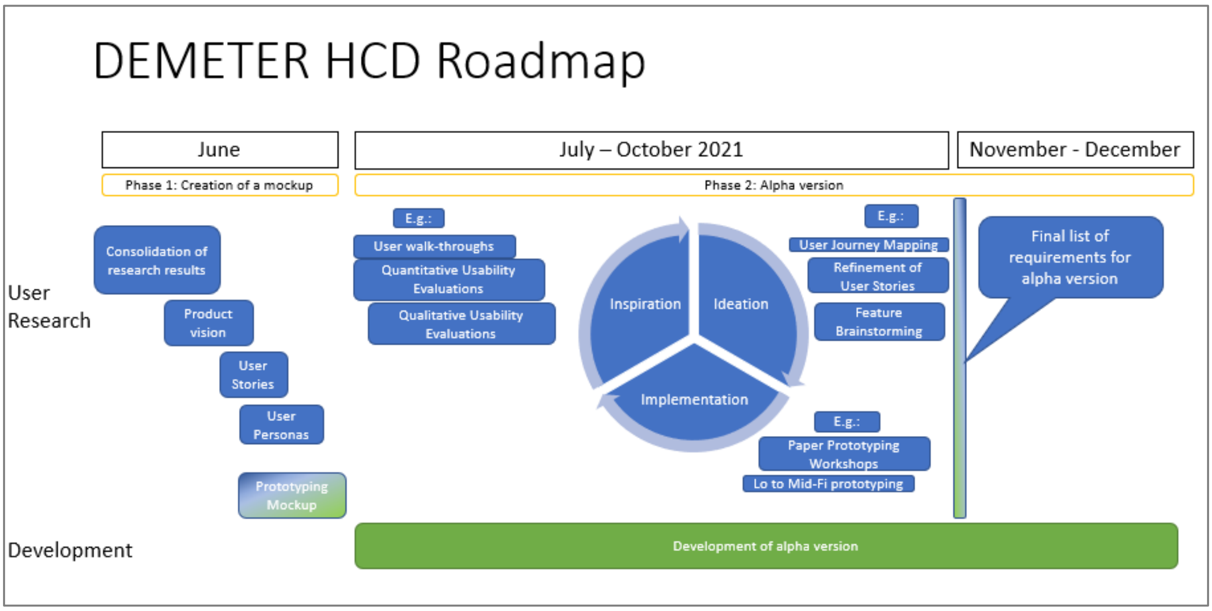


Figure 93: HCD Roadmap Co-Creation for phases 1&2 – from June to December 2021

Phase 1 will kick off the human centered design approach by consolidating all the research insights that have been made throughout the entire project (the inspiration phase). Based on these insights, a product vision, user personas, as well as user stories will be developed (ideation stage). Next, a wireframe mockup will be designed to build the basis for the alpha version development (implementation phase). This wireframe mockup will contain the barebone features for the co-creation feature of the SOCS platform. The wireframe mockup will be handed over to development by the end of June 2021 and the first results of the HCD process will be collected in deliverable D7.3. Hence, D7.3, which is due end of July 2021 (M23), will include a first product specifications (i.e., product vision, personas, design challenge and possibly a paper prototype).

In phase 2, the development of the alpha version of the co-creation feature will be kicked off. For this, further user research will be conducted in order to gather more information from potential users of the SOCS platform (inspiration). These insights will then be translated into new user stories (ideation), and subsequently be implemented in the alpha version (implementation). This iterative loop resembles a continuous process that will be repeated multiple times. The final list of requirements to be implemented in the alpha version will be ready by October 2021. Figure 93 shows also the roadmap from August to December of 2021. By the end of December, the alpha version of the co-creation feature of the SOCS will be ready for deployment.

Phase 3 (from January 2022 to October 2022) will be devoted to the development phase of the beta version and the test of the alpha version. The roadmap for phase 3 can be seen in Figure 94.

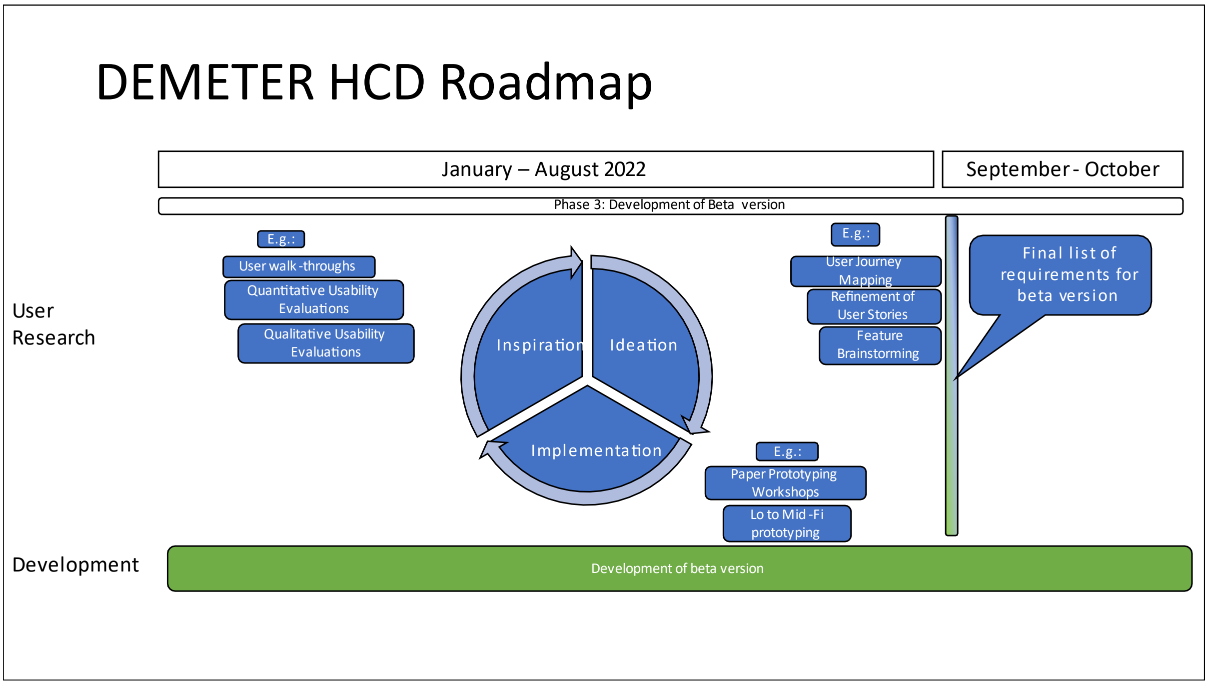


Figure 94: HCD roadmap Co-Creation for phase 3 – from January to October 2022

Depending on the sophistication of the product developed by then, different measures of user research can be undertaken. Hence, the iterative approach that applied to the alpha version will also be applied to the beta version. This will start in January 2022 and last until August 2022. By then, the final list of requirements for the beta version will be ready. Final development efforts will be conducted until October 2022 (M38). The final product, the beta version, will be described in deliverable D4.5 (M38).

8.3 *SOCS Beta release*

The implementation of the Beta release of the SOCS takes into account the WP7 workshop's findings just described.

8.3.1 The Platform Accessibility and the Enrolment Process

8.3.1.1 Enrolment process

DEMETER stakeholders are able, through a link in the DEMETER website, to access to a registration section (managed by the DEMETER Access Control Server).

The basic registration consists of a form through which the user is able to provide:

- Name and Surname.
- Email address.

Once the user has filled in the form, their registration inside the DEMETER SOCS is completed by the System Administrator who can assign specific roles (8.3.2).

8.3.1.2 Access to the platform

Registered users are able, through a link in the DEMETER website, to access to a login section, sign-up as users in the SOCS and start collaborating within the ecosystem. This allows them to update their profile and access to the SOCS Home page and to the different applications through the menu (Figure 95).

At the beginning, all the DEMETER stakeholders will have access to the same workspace which is a space with available applications common to all the users. Next, dedicated workspaces will be created to satisfy specific collaboration interests (i.e., a workspace for each pilot cluster, a workspace for developers, etc.).

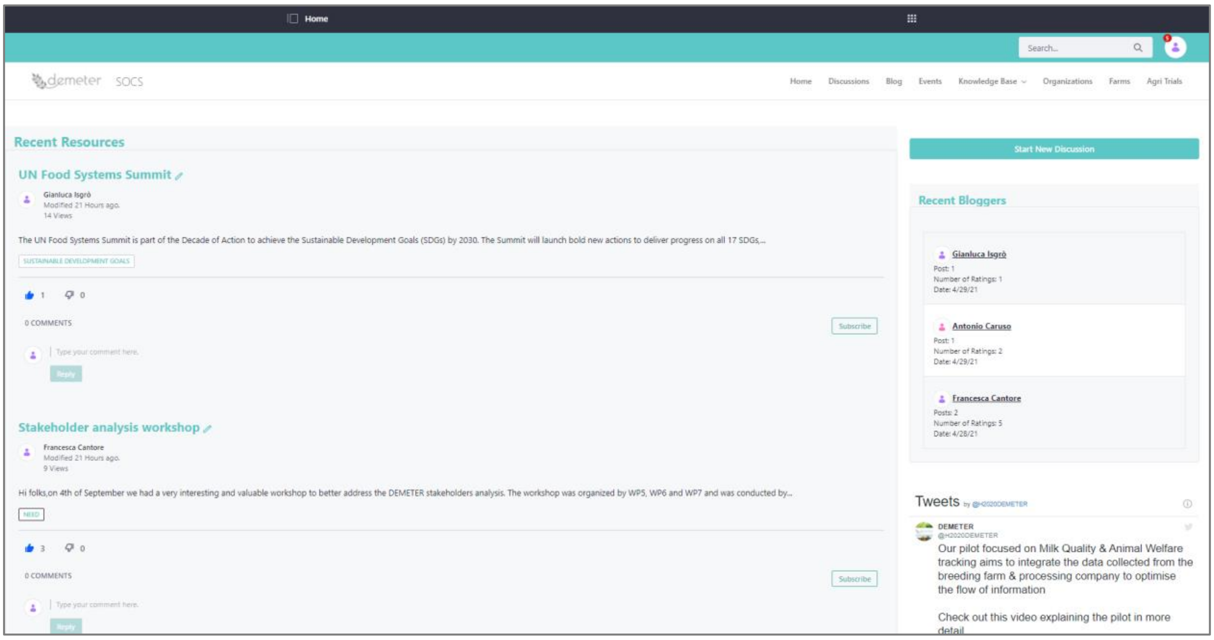


Figure 95: SOCS Home page

8.3.2 Platform roles

To access the SOCS functionalities, several user roles and permissions are associated with the Platform. The SOCS module provides for a role management based on the RBAC (Role-Base-Access-Control) paradigm, and consequently a certain flexibility in the management of user profiles. The main foreseen roles are presented here below:

- **System Administrator**: The system administrator is the person who is responsible for the upkeep, configuration, and reliable operation of the SOCS Platform, seeking to ensure that the uptime, performance, resources, and security of the system. System administrator responsibilities are, fundamentally, about the care of the general system and also cover the specific applications. He is responsible for effective provisioning, installation/configuration, operation, and maintenance of systems hardware and software and related infrastructure. The main responsibilities are related to: installing and configuring software, setting up users' accounts and roles, managing technology tools, monitoring system performance, ensuring security through access controls, providing technical support.
- **Content Manager**: The Content Manager is a professional who provides expert advice in a particular area, such as the different agricultural domains (this for example can coincide with cluster topics), technology, or any of many other specialised fields. They represent an expert

or an experienced professional in a specific domain and has a wide knowledge of the subject matter, being able to use it for business purposes. They have no administrative role, but he acts as an honest broker, trying to help people and organisations to resolve a problem or arrange a deal by talking to all sides and finding out what they want, without favouring any one side but factorising competences and solutions. Besides being a mediator, considering their long business experience and domain knowledge, they will represent an animator of discussions, becoming also an innovation booster.

- **Organisation Content Manager**: The Organisation Content Manager represents a specific role dedicated for detailing organisation characteristics for each specific organisation registered. The organisation content manager will be responsible for the updating of all aspects of the organisation. He has good communication skills and advanced knowledge of organisations' main distinctive elements, so he will be in charge of writing, editing and proofreading these contents generally referring to the overall organisation itself. For example, only certain organisation members will be allowed to add agricultural success stories provided by the selected organisation.
- **SOCS publisher**: This role represents every single user accessing the Platform and using its functionalities; he can belong to a specific organisation or could be an individual member. He can access a collaboration workspace where he can collaborate with other users and exploits all platform functionalities according to his requirements. Through the Platform, he can find all that he needs to know about, navigating and using the community, taking advantage of the tools provided to make the most of the potential in a network. The platform member manages to stay informed, to seek experts and specialists, to find and get expert shared knowledge.

8.3.3 The SOCS services

The objective of the **SOCS** is to enable a space **dedicated to all stakeholders** where they can find services to **collaborate, share best practices and contribute to the co-creation processes.**

The services available are shown in the following picture:

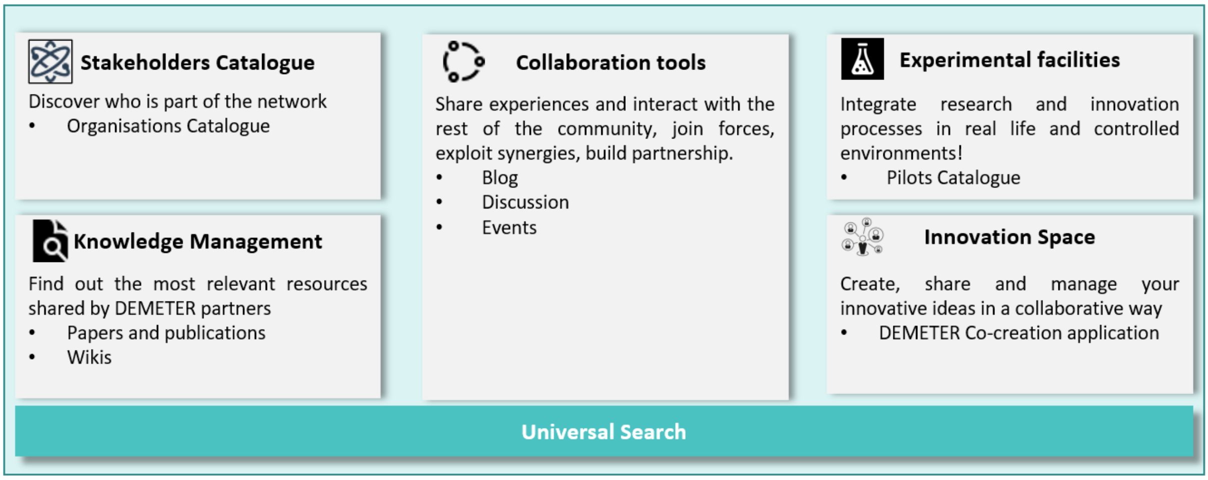


Figure 96: SOCS Portfolio of services

8.3.3.1 Organisation catalogue

In case a new application requires specific knowledge, a collaborative process may be initiated to find the right competences. This is the reason why it is necessary to develop a common repository to discover companies' core activities, to enable partners' selection.

The **Organisations catalogue** is an application used to define an organisation's main characteristics and offered competencies, described according to a predefined taxonomy for organisations. This catalogue will take into consideration different data models based on the organisation type (Research/Industry or Farm).

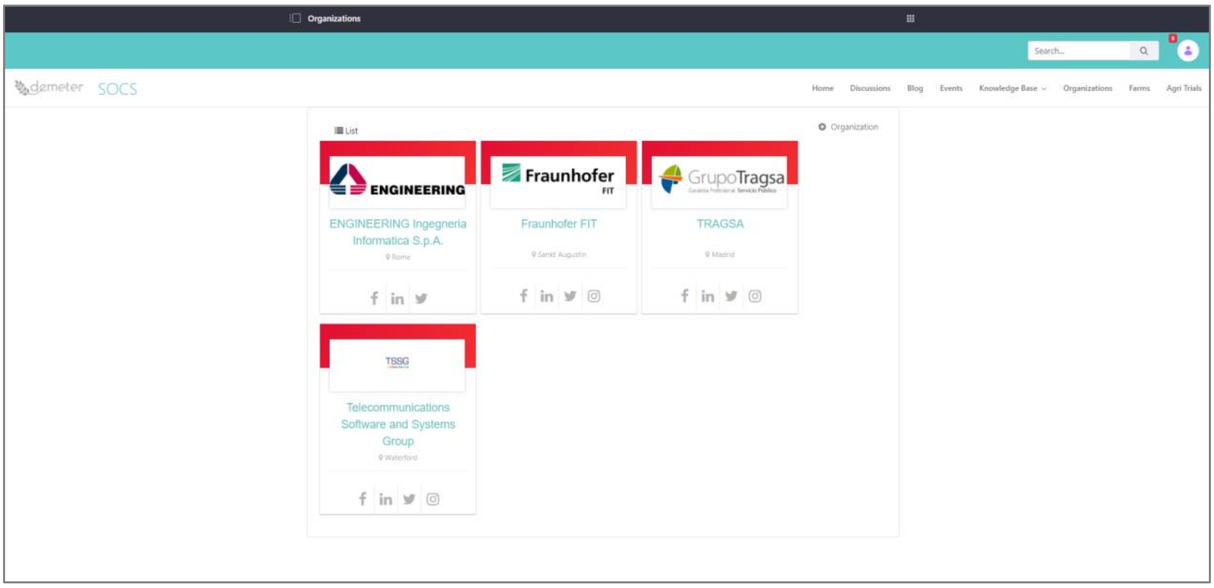


Figure 97: DEMETER SOCS Organisation catalogue

8.3.3.2 Knowledge base services

The Knowledge base services include online access to information and consultancy services related to different thematic domains. It will be a multimedia library based on two main services:

- **Wiki**: It is a collaborative tool to formalise users' knowledge in a structured way, making it available to all SOCS members. For example, a wiki can be used to define DEMETER vocabularies to use to assign categories to the contents that will be created (Figure 98).
- **Documents**: It represents a knowledge base, structured according to partners' needs; here it will be possible to find paper or publications related to DEMETER domain of interest (Figure 99).

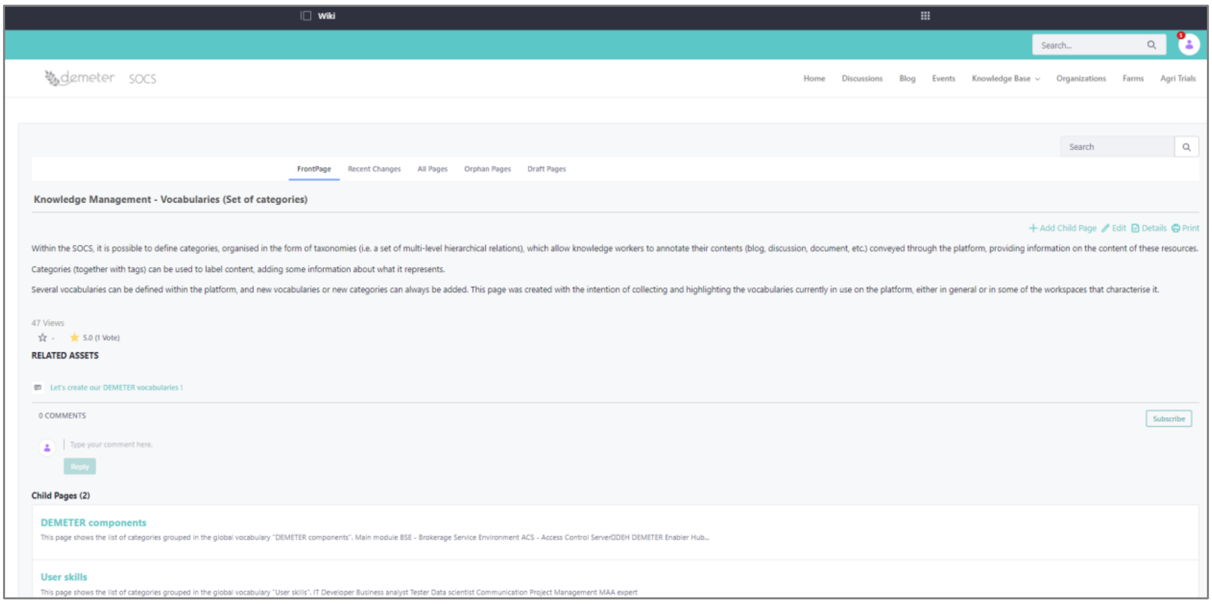


Figure 98: DEMETER SOCS Wiki

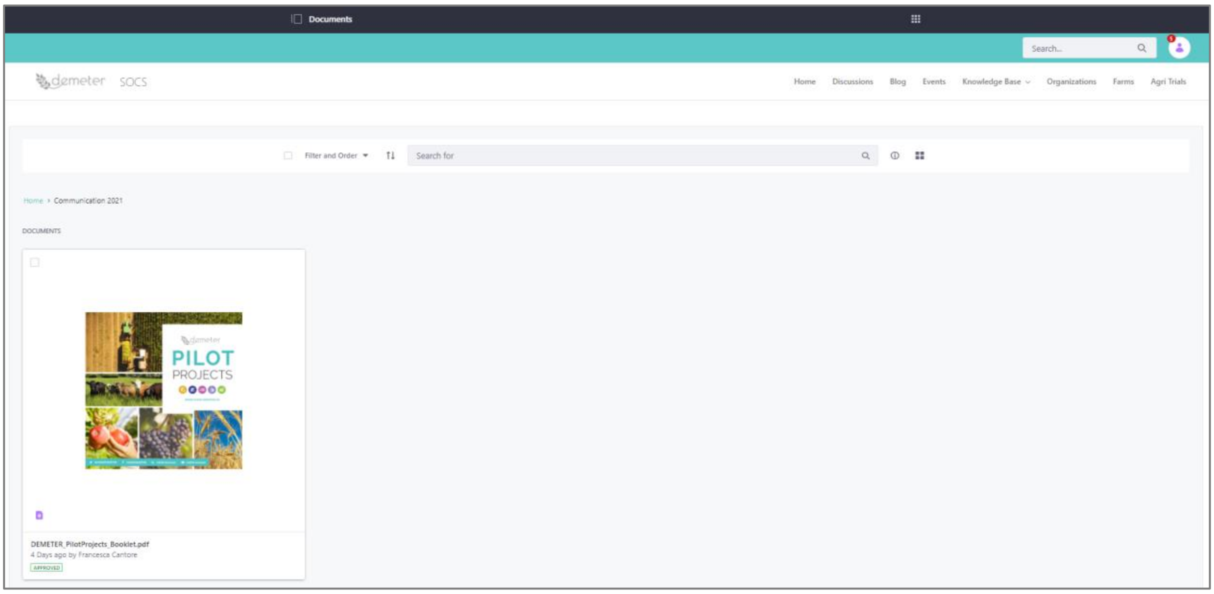


Figure 99: DEMETER SOCS Documents

8.3.3.3 Agricultural trials catalogue

Farmers can get inspiration for their ideas, by analysing the existing experiments. The objective is to support farmers and advisors in understanding new experimental and technological trends in agriculture domains and explore and test new technologies that can be potentially applied to processes or products, with a "hands on" approach.

The main service here is the **Agricultural trials catalogue**, which is a showcase of successful agricultural cases and DEMETER pilots. The final Agricultural trials data model will take into consideration findings from the data model workshop.

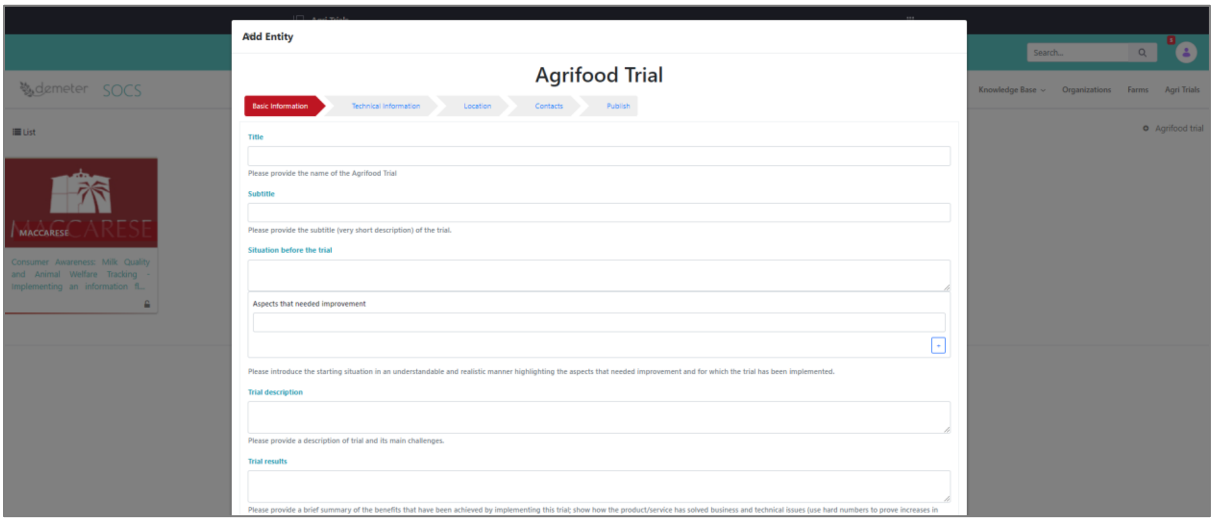


Figure 100: DEMETER SOCS Agricultural trials (Agrifood trial form abstract)

8.3.3.4 *Collaboration services*

Collaboration services will offer the opportunity to connect and interact with all individuals and organisations contributing to the ecosystem. Social networking spaces have been created to facilitate communication between all the actors accessing to the SOCS Space, sharing information in the easiest way. It is possible to find:

- **Blog**: This represents an informal way to share and publish different types of content (e.g., news, experiences, observations, opinions, etc.); posts are displayed in reverse chronological order, so that the most recent post appears first, at the top of the web page (Figure 101).
- **Discussion**: This is a dedicated space for informal debate allowing the consideration of a question in open and usually informal debate; (Figure 102). A discussion could be a consideration or an examination of a particular topic or a comment, especially one to explore possible solutions.
- **Events**: This represents a useful way to share information about interesting events, project meetings, etc. (Figure 103).

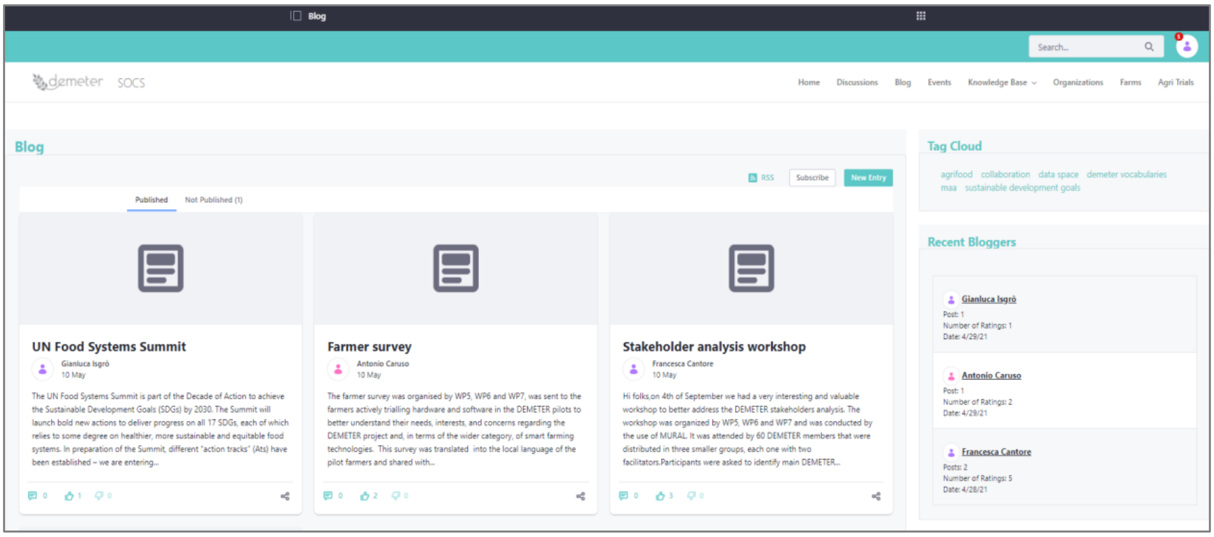


Figure 101: DEMETER SOCS Blog

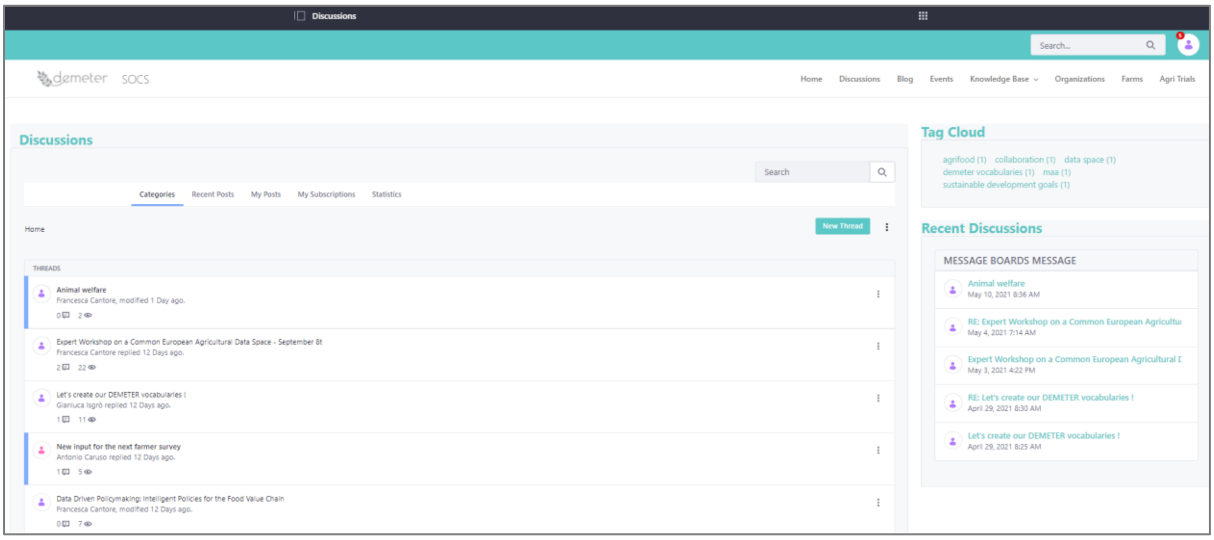


Figure 102: DEMETER SOCS Discussion

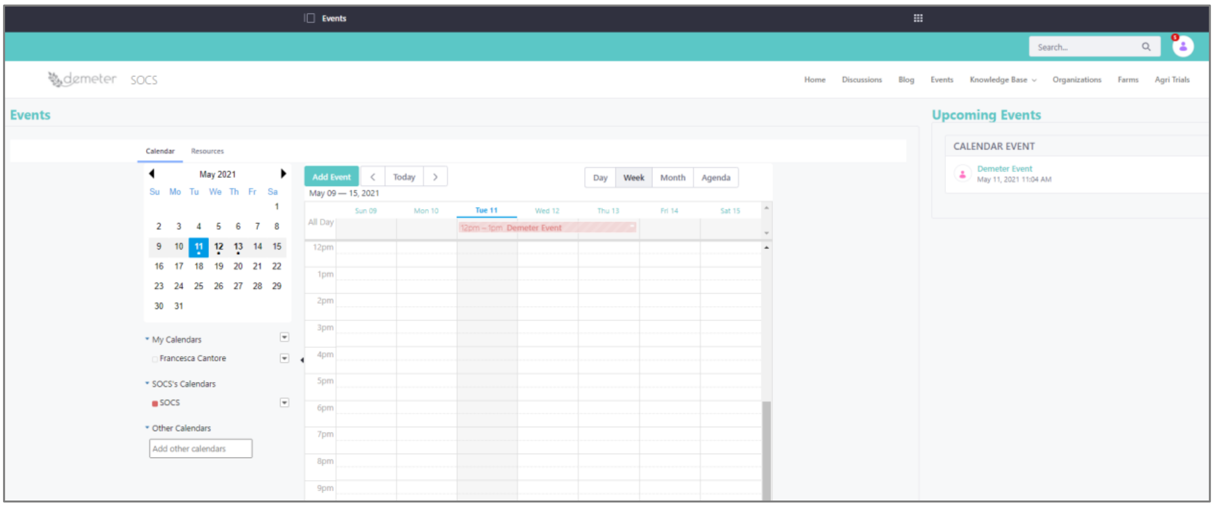


Figure 103: DEMETER SOCS Events

8.3.3.5 Cross Functional Services

There are two features of the SOCS that represent important cross functional services:

- **Universal Search:** The platform includes several search features to help users quickly find what they are looking for, or just to browse through content and people. With this service (always at the top of the user interface) it is possible to search for specific words, to find content by categories or tags or restrict the search to certain resources (e.g., blog) (Figure 104).
- **Notification services:** The Notification services are used to send a notification to user. The notification can be sent to the inbox section of the platform or to the inbox of the user's email account based on user preferences (Figure 105).

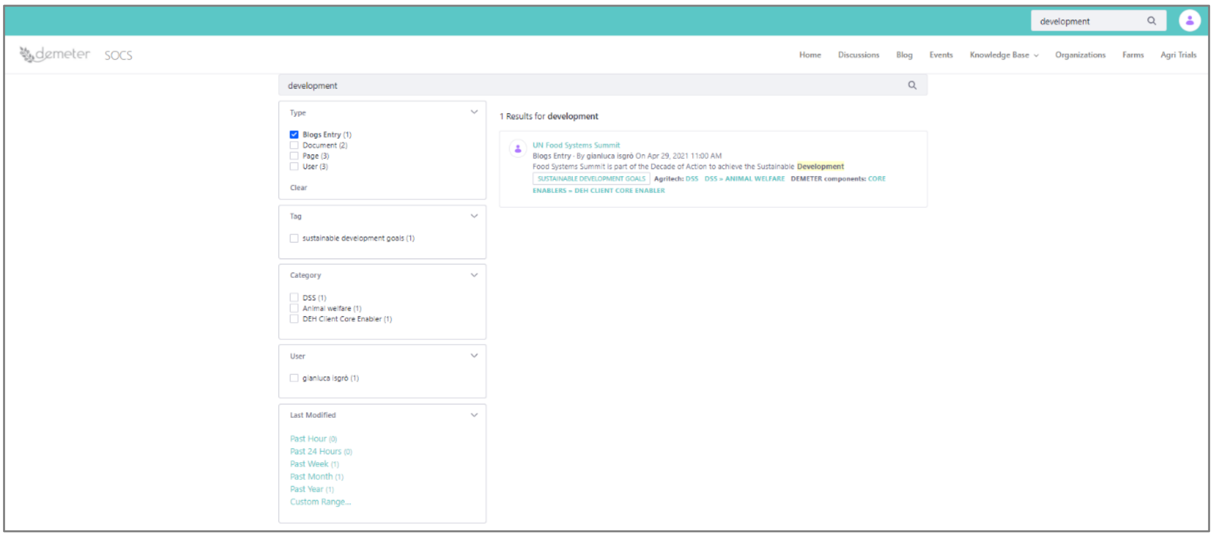


Figure 104: Search for category "development"

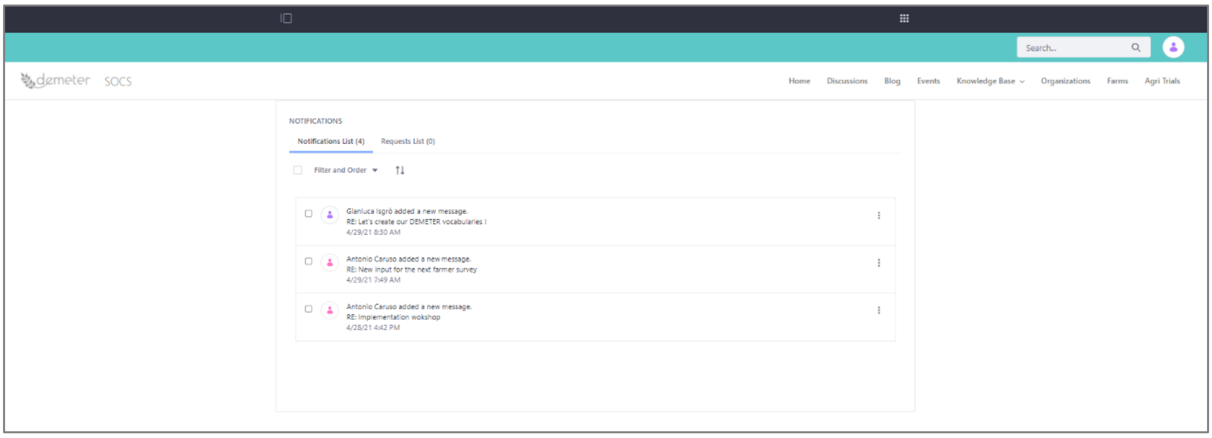


Figure 105: Notifications

8.4 *SOCS development planning*

The SOCS has been released in its Alpha version at M10 as instance of DIHIWARE that is a result of an ongoing private research project under development at ENGINEERING R&D Department. This first version takes into account results of a survey sent to pilot leaders with the scope to understand the feeling that pilots have with respect to the use of the social digital space and to define the basic SOCS features.

Then the Alpha version was presented to pilots and WP7. Through WP7, DEMETER stakeholders were involved, through a series of workshop, in the definition of: a new SOCS design, the data models for the DEMETER SOCS entities and the first version of the co-creation application. Results of this interaction with WP7 will be taken into account in the development phase that will produce the **SOCS Beta version** at M22 (including the new SOCS design and data model) and with the **SOCS Pre-final version** at M28 (including the first version of the co-creation app).

A second iteration of workshops with SOCS users will aim at collecting feedback from them on the first version of the co-creation application. The workshop's results will converge in the **SOCS Final version** that will be available at M38 (D4.5 – Final Release and Support Report for Decision Enablers, Advisory Support Tools and DEMETER Stakeholder Open Collaboration Space) and will include a refinement of all SOCS services and the final version of the co-creation application.

The following table is used to outline the SOCS development planning. For each of the selected features is shown the development scope meaning in which iteration the initial, refined, pre-final and final version of each service is planned.

Service	Scope				Implemented/Enhanced in DEMETER project
	Alpha version M10	Beta version M22	Pre-final version M28	Final version M38	
Organisations Catalogue	Initial	Refined	Pre- final	Final	Yes
Farms		Initial	Refined	Final	Yes
Agricultural trials Catalogue	Initial	Refined	Pre- final	Final	Yes
Documents	Initial	Final			Yes
Wiki	Initial	Final			Yes
Blog	Initial	Final			Yes
Discussion	Initial	Final			Yes
Events	Initial	Final			Yes
Instant messaging			Initial	Final	
Co-creation application			Initial	Final	

Table 63: SOCS development planning

9 Conclusions

This document has been devoted to three main tasks, with the objectives of:

- developing a self-service dashboard framework capable of integrating a number of service frontends, transformation operators and visualisation widgets.
- developing generic enablers as open components that accelerate the development of sector or pilot specific decision support systems.
- developing cloud-based collaboration tools that enable and support collaboration among different stakeholders in a pilot domain.

From the initial definition of the different DSS-related services in D4.1 and augmented in D4.2, several progresses have been documented. Starting from changes in names, assignments, and responsibilities to the inclusion of visualisation features to some of the components and finishing with an overall good progress, the current status of the DEMETER DSS-related services is well on track. The progress of each component is shown at the beginning of Section 6 making it an average completion of 80%. Next actions will focus in finishing all components at the same time that they are being deployed at farms' sites and, thus, validated by the farmers (pilots).

Regarding the other two important topics reported in this deliverable, the first one is the data visualisation module with which the DSS-related services are being enhanced so the pilots will be presented with intuitive meaning thanks to Knowage, developed by ENG. For each DSS area and component created in WP4, the related visualisation dashboard, where one exists, was presented and explained from the technical point of view. Finally, and although since this activity is reaching its end, the results of the validation of the DSS-related services themselves will be considered and some of the dashboards present in the Knowage catalogue might be improved while others may be enriched with new elements.

The second point deals with the progresses relating to the SOCS, where the support from the community has been sought to incorporate their views and improvements ideas so a clearer and easier to navigate interface is under development. This space makes farmer's needs visible to advisors and developers. Next actions under this activity will be focusing on boosting the usability for non-technical users. A second iteration of workshops with SOCS users will aim at collecting feedback from them on the first version of the co-creation application. The workshop's results will converge in the SOCS Final version and will include a refinement of all SOCS services and the final version of the co-creation application.

Activities are constantly monitored during the bi-weekly WP4 conference call. All partners have been, and still will be, encouraged to share their components source-code in the DEMETER GitLab, where a dedicated space for WP4 has been created. Final advancements, including the results of the validation phase, will be reported in the final WP4 deliverable, namely Deliverable 4.5 "Final Release and Support Report for Decision Enablers, Advisory Support Tools and DEMETER Stakeholder Open Collaboration Space" due in M38 (October 2022).

10 References

[1] Knowage suite. https://www.knowage-suite.com/site. Online, accessed April 2020.

[2] Sadeghi M., Babaeian E., Trenton E. F., Jones S., Tuller M. (2017). The optical trapezoid model (OPTRAM): A novel approach to remote sensing of soil moisture applied to Sentinel-2 and Landsat-8 observations. Remote Sensing of Environment. 198. 52-68. https://doi.org/10.1016/j.rse.2017.05.041.

[3] Allen C. (1976). A modified sine wave method for calculating degree days. Environmental Entomology, 5, 388-396.

[4] Janowicz K., Haller A., Cox S. J., Le Phuoc D., Lefrançois M. (2019). SOSA: A lightweight ontology for sensors, observations, samples, and actuators. Journal of Web Semantics, 56, 1-10.

[5] ISO 9241-210:2019. Ergonomics of human-system interaction — Part 210: Human-centred design for interactive systems. https://www.iso.org/standard/77520.html. Online, accessed June 2020.

Annex A Requirements tracking

This annex provides a follow up of the requirements tracking activities. This activity was initially reported in D4.1 (Section 7.3) where only the decision-related components were considered. Within a decision area, each pilot request has been associated with a potential general component developed in WP4. We consider the WP4 components as generic DEMETER enablers, dedicated to support the farmers in taking one type of decision and that have a fixed data structure for input and output.

The following establishes the path followed by WP4 components to manage the requirements gathered from DEMETER Pilots:

- **First round**, where from basic needs obtained from internal analysis of the Pilot Factsheet generated by WP5. This gave some very high-level requirements but was not sufficient to plan out components. Various stages of the analysis can be seen in next cloud WP4/Pilot Factsheet Analysis for WP4. An initial round of possible component from this analysis was recorded in "Types of DSS.docx".
- **Survey by WP3 and WP4**, which resulted in the architectural instantiations, which can be found in WP3/T3.1/D3.1, and a table and diagrams, which can be found in WP4/Pilot Requirements. These surveys were sent to the pilot leads, not to the actual farmers so as to not swamp the farmers with requests for information. The information was still vague or ambiguous. The results of these were analysed independently by Diego Guidotti (AGRICOLUS), Sergio Salmerón (ATOS), and John Beattie (ICE). From these analyses, the Areas were created and sent back to the pilot leads for more information.
- **Individual component-based requirements**, where the individual requirements from the previous phase were assigned to the appropriate component.

A.1. DSS-related Pilots' Requirements

The table below lists and classifies the different needs extracted from the Pilots' requirements. In this annex, an update of these needs and their status is provided.

Req_ID	Pilot-defined component	Pilot	DSS component affected	Status	Notes
REQ.DSS.COMP.001	Estimate crop yield using satellite Sentinel-2 data	1.1	4.A.1	90%	
REQ.DSS.COMP.002	Estimate olive yield from remote sensing data	3.1	4.A.1	DEPRECATED	
REQ.DSS.COMP.003	Estimate crop yield using remote data and ground data	3.2	4.A.1	DEPRECATED	
REQ.DSS.COMP.004	Predict the expected yield under a selection of future meteo scenarios	3.4	4.A.1	75%	

Req_ID	Pilot-defined component	Pilot	DSS component affected	Status	Notes
REQ.DSS.COMP.005	Compare the crop yields per field to similar field with similar crop types	5.3	4.A.1	DEPRECATED	
REQ.DSS.COMP.006	Evaluation of the current status of the crop from the different data sources available	N/A	4.A.1	DEPRECATED	
REQ.DSS.COMP.007	Predict olive phenology phases from weather data using ML	3.1	4.A.2	90%	
REQ.DSS.COMP.008	Estimate crop maturity per field	5.3	4.A.2, 4.A.5	90%	
REQ.DSS.COMP.009	Detect plant stress	1.1	4.A.3	DEPRECATED	
REQ.DSS.COMP.010	Diagnosis of agricultural crops in terms of agropedoclimatic parameters	1.4	4.A.3	60%	
REQ.DSS.COMP.011	Detect crop status (water stress, water irrigations, fertilisation) for woody crops	3.2	4.A.3	DEPRECATED	
REQ.DSS.COMP.012	Identify crop type per field based on satellite imagery	5.3	4.A.4	80%	
REQ.DSS.COMP.013	Pollination matching	5.3	4.A.5	DEPRECATED	
REQ.DSS.COMP.014	Estimate the number of bees/hives required to pollinate each field	5.3	4.A.5	50%	
REQ.DSS.COMP.015	Estimate the water requirements for corn	1.3	4.B.1	80%	
REQ.DSS.COMP.016	Estimate the water requirements for rice	1.3	4.B.1	80%	
REQ.DSS.COMP.017	Identify water needs for crops from different data sources available	1.4	4.B.1	DEPRECATED	
REQ.DSS.COMP.018	Estimate the water requirements and consumption	2.3	4.B.1	80%	
REQ.DSS.COMP.019	Olive DSS for irrigation	3.1	4.B.1	80%	
REQ.DSS.COMP.020	Plant water requirements and soil availability	3.2	4.B.1	80%	
REQ.DSS.COMP.021	Prediction of reference evapotranspiration to calculate crop water needs	1.1	4.B.2	100%	
REQ.DSS.COMP.022	Estimation of soil water availability	3.2	4.B.3	100%	
REQ.DSS.COMP.023	Detect crop water status anomalies along the plot	1.1	4.B.4	25%	
REQ.DSS.COMP.024	Nutrient balance for fertilisation	1.1	4.C.1	DEPRECATED	
REQ.DSS.COMP.025	Estimate the nitrogen requirements using soil, weather, and crop data	1.3	4.C.1	UNKNOWN	Pilot 1.3 to identify if DEPRECATED
REQ.DSS.COMP.026	Identify fertiliser need for crops from different data sources available	1.4	4.C.1	60%	
REQ.DSS.COMP.027	Estimate the nutrient consumption	2.3	4.C.1	UNKNOWN	Pilot 2.3 to identify if DEPRECATED
REQ.DSS.COMP.028	Olive DSS for fertilisation	3.1	4.C.1	70%	Pilot 3.1 to identify if DEPRECATED

Req_ID	Pilot-defined component	Pilot	DSS component affected	Status	Notes
REQ.DSS.COMP.029	Estimation of soil availability and online fertilisers consumptions	3.2	4.C.1	UNKNOWN	Pilot 3.2 to identify if DEPRECATED
REQ.DSS.COMP.030	Estimation online fertilisers consumptions	3.2	4.C.1	UNKNOWN	Pilot 3.2 to identify if DEPRECATED
REQ.DSS.COMP.031	Plant nutrient requirements and soil availability	3.2	4.C.1	UNKNOWN	Pilot 3.2 to identify if DEPRECATED
REQ.DSS.COMP.032	Monitorisation of the fertilisation processes followed in citric crops	3.3	4.C.1	DEPRECATED	
REQ.DSS.COMP.033	Monitorisation of the fertilisation needs	1.1	4.C.2	DEPRECATED	
REQ.DSS.COMP.034	Monitorisation of the fertiliser consumption	1.3	4.C.2	DEPRECATED	
REQ.DSS.COMP.035	Fertiliser data management component	1.4	4.C.2	DEPRECATED	
REQ.DSS.COMP.036	Estimate the NOx based on different (engine) data	2.1	4.D.1	DEPRECATED	
REQ.DSS.COMP.037	Extend the pilot specific data by using external data bases regarding NOx values or emission data to enrich the analysis possibilities	2.1	4.D.1	0%	
REQ.DSS.COMP.038	Using on-board sensors for monitoring engine data (e.g., Diesel consumption) as well as data about the exhaust gas after treatment will help to monitor that machines follow the regulations	2.1	4.D.1	DUPLICATED	
REQ.DSS.COMP.039	Using on-board sensors for monitoring engine data (e.g., emissions or Diesel consumption) as well as data about the exhaust gas after treatment will help to monitor that machines follow the regulations	2.1	4.D.1	60%	
REQ.DSS.COMP.040	Farm process management component	1.4	4.D.2	DEPRECATED	
REQ.DSS.COMP.041	Control of farm processes	2.3(?)/5.1	4.D.2	80%	
REQ.DSS.COMP.042	Control of machines	2.3(?)/5.1	4.D.2	80%	
REQ.DSS.COMP.043	Farm work organisation	2.3	4.D.2	DUPLICATED	
REQ.DSS.COMP.044	Farm work organisation	5.2	4.D.2	80%	
REQ.DSS.COMP.045	Convert NDVI or FAPAR map to a map that can be used to control amount of fertiliser or water	3.4	4.D.3	95%	
REQ.DSS.COMP.046	Instructions for spraying for the sprayer based on the collected data	5.1	4.D.3	DEPRECATED	OUT OF SCOPE of component
REQ.DSS.COMP.047	Control of variable rate spraying by uploading a shapefile (taskmap) to the machine	5.2	4.D.3	90%	
REQ.DSS.COMP.048	Classification of the images about insect according to their content	3.3	4.E.1	55%	
REQ.DSS.COMP.049	Recognition of insects from imagery data	3.3	4.E.1	55%	

Req_ID	Pilot-defined component	Pilot	DSS component affected	Status	Notes
REQ.DSS.COMP.050	Detect and analyse the amount of varroa mites present in each hive	5.3	4.E.1	DEPRECATED	
REQ.DSS.COMP.051	DSS for olive fruit fly pest management	3.1	4.E.2	100%	
REQ.DSS.COMP.052	Decision support for orchard & grapevine	5.1	4.E.2	80%	
REQ.DSS.COMP.053	Analyse and predict milk fat content	4.1	4.F.1	20%	
REQ.DSS.COMP.054	Analyse and predict milk yield based on animal individual lactation curves. Aggregated to herd level	4.1	4.F.1	80%	
REQ.DSS.COMP.055	Based on observed and predicted milk production, feed requirement is calculated to optimise herd forage production. Observed feed intake and milk production are used to calculate feed efficiency and the cost of feed into milk	4.1	4.F.1	30%	
REQ.DSS.COMP.056	Based on observed and predicted milk production, fertility and health, animal economical value is predicted	4.1	4.F.1	20%	
REQ.DSS.COMP.057	Analyse and predict milk nutritional values	4.2	4.F.1	100%	
REQ.DSS.COMP.058	Analyse and predict, lactation days, milking days	4.2	4.F.1	100%	
REQ.DSS.COMP.059	Analyse cattle performance within the automated milking system	4.3	4.F.1	60%	
REQ.DSS.COMP.060	DSS for animal production and quality	5.2	4.F.1	50%	
REQ.DSS.COMP.061	Optimise cattle production	5.2	4.F.1	20%	
REQ.DSS.COMP.062	Silo conditions detection for poultry feeding data	4.4	4.F.2	90%	
REQ.DSS.COMP.063	Silo conditions detection for poultry feeding data	4.4/5.4	4.F.2	DEPRECATED	
REQ.DSS.COMP.064	Classifiers created	4.2	4.G.1	100%	
REQ.DSS.COMP.065	DSS should also be able to display recommended actions to correct and improve animal welfare measures and consequently milk quality	4.2	4.G.1	100%	
REQ.DSS.COMP.066	Estimate the animal health and welfare to improve accuracy in making decisions when a livestock is sick or healthy	4.2	4.G.1	100%	
REQ.DSS.COMP.067	Livestock farms should implement technologies able to perform predictive analyses to guide the decisions of the farmers/advisors in the animal production	4.2	4.G.1	100%	
REQ.DSS.COMP.068	From Ear Tag behaviour characteristics to be monitored may include cow grazing time, rumination time, activity, and movement	4.2	4.G.1	DEPRECATED	OUT OF SCOPE of component
REQ.DSS.COMP.069	Optimise cattle animal welfare	5.2	4.G.1	100%	
REQ.DSS.COMP.070	Advice for farmers	4.4/5.4	4.G.2	90%	
REQ.DSS.COMP.071	Detect poultry stress	4.4/5.4	4.G.2	100%	

Req_ID	Pilot-defined component	Pilot	DSS component affected	Status	Notes
REQ.DSS.COMP.072	Environment condition assessment for poultry	4.4/5.4	4.G.2	100%	
REQ.DSS.COMP.073	Evaluate the potential stress on chicken due to power loss	4.4/5.4	4.G.2	100%	
REQ.DSS.COMP.074	Composed data about the product from the various input data collections	4.4/5.4	4.G.2	80%	
REQ.DSS.COMP.075	Assessment of transport condition of food	4.4/5.4	4.H.2	90%	
REQ.DSS.COMP.076	Record information about farms, among other things all the information related to phytosanitary treatments	1.1	4.H.3	90%	
REQ.DSS.COMP.077	Benchmarking solution	1.3	4.I.1	DUPLICATED	
REQ.DSS.COMP.078	Generic Benchmarking requirements	1.4	4.I.1	100%	
REQ.DSS.COMP.079	First level farm comparison	2.4	4.I.1	100%	
REQ.DSS.COMP.080	Benchmarking solution	3.3	4.I.1	DUPLICATED	
REQ.DSS.COMP.081	Monitorisation of the pesticide resources consumed for pest control	3.3	4.I.1	90%	
REQ.DSS.COMP.082	Benchmarking solution	1.1/1.3/3.3	4.I.1	80%	
REQ.DSS.COMP.083	Second level farm comparison	2.4	4.I.2	90%	
REQ.DSS.COMP.084	Compare the olive orchard yield and costs with similar farms, assess the DSS benefits	3.1	4.I.2	100%	
REQ.DSS.COMP.085	Compare milk production, i.e., milk yield and milk chemical composition to identify areas of improvement	4.1	4.I.2	100%	
REQ.DSS.COMP.086	Allow farmers to compare milk production in time; and to benchmark technologies	4.2	4.I.2	70%	
REQ.DSS.COMP.087	Financial status estimation focused on fertilisation and watering resources	1.3	4.I.3	80%	
REQ.DSS.COMP.088	Farm resources management component	1.4	4.I.3	80%	
REQ.DSS.COMP.089	Compare the results of our NOx estimation (and maybe also the real measured value) with existing (regulation) thresholds and use this as benchmarking	2.1	4.I.3	80%	
REQ.DSS.COMP.090	Estimate job cost calculation using maps overlay	2.2	4.I.3	0%	Cannot be managed by benchmark alone
REQ.DSS.COMP.091	John Deere will define a concept of how to calculate different cost data related to fixed costs	2.2	4.I.3	70%	Cannot be managed by benchmark alone
REQ.DSS.COMP.092	John Deere will define a concept of how to calculate different cost data related to variable costs	2.2	4.I.3	70%	Not clear

Req_ID	Pilot-defined component	Pilot	DSS component affected	Status	Notes
REQ.DSS.COMP.093	Farm data brokerage establishes a trust-based and compliant data market for agricultural enterprise data	2.3	4.I.3	0%	
REQ.DSS.COMP.094	DSS to support economic decision in farmers	2.4	4.I.3	80%	
REQ.DSS.COMP.095	Financial status estimation focused on pest and diseases treatments costs	3.2	4.I.3	DEPRECATED	
REQ.DSS.COMP.096	Compare and identify changes and variation to improve financial return	4.1	4.I.3	90%	
REQ.DSS.COMP.097	Feed is the highest running cost in modern milk production. Feed efficiency is a critical factor and shows a high variation between farms	4.1	4.I.3	80%	
REQ.DSS.COMP.098	Actions on field actuators for optimal irrigation. Water consumption monitoring	1.1	Unassigned	DEPRECATED	Initially assigned to Area B components, but these changed scope
REQ.DSS.COMP.099	Monitorisation of the water resources used	1.3	Unassigned	DEPRECATED	Initially assigned to Area B components, but these changed scope
REQ.DSS.COMP.100	Predict yield with specific irrigation scenarios	3.4	Unassigned	DEPRECATED	Initially assigned to Area B components, but these changed scope

A.2. Dashboard-related Requirements

The table below lists and classifies the different needs extracted from the DSS components to cover the visualisation needs.

Req_ID	Title	Description	Priority	DSS component affected	Status
REQ.DSS.VIZ.001	Define region/select fields	Define the region or select the fields for which to visualise the analytics results	High	4.A.1, 4.A.2	90%
REQ.DSS.VIZ.002	Select Period and images	Select a period and the image from that period that was used for analysis	Medium	4.A.3	DEPRECATED

Req_ID	Title	Description	Priority	DSS component affected	Status
REQ.DSS.VIZ.003	Display Results	Results of the analysis is displayed via tables, maps, legends, lines, and pie chart graphs in the dashboard	High	4.A.3, 4.C.1, 4.C.2	100%
REQ.DSS.VIZ.004	Select Parcel	Select the parcel for data display	Medium	4.A.3, 4.C.1, 4.C.2	100%
REQ.DSS.VIZ.005	Define crop type/select fields	Define the crop type for which to show the analytics results	High	4.A.4	0%
REQ.DSS.VIZ.006	View Results	View the number of hives recommended for a particular field	High	4.A.5	100%
REQ.DSS.VIZ.007	Historical data period	The data shown in tables and graph charts will be in pre-selected dates intervals	High	4.B.1	DUPLICATED
REQ.DSS.VIZ.008	Historical data period	The data shown in tables and graph charts will be in pre-selected dates intervals	High	4.B.1	DUPLICATED
REQ.DSS.VIZ.009	Needed data from the selected plot	We expect all needed information linked to the plot entity (area, crop-type, irrigation system type (sprinkler, drip), soil type, irrigation water EC, etc	High	4.B.1	DUPLICATED
REQ.DSS.VIZ.010	Needed data from the selected plot	We expect all needed information linked to the plot entity (area, crop-type, irrigation system type (sprinkler, drip), soil type, irrigation water EC, etc	High	4.B.1	DUPLICATED
REQ.DSS.VIZ.011	Run	Clicking on a button the analysis will start	High	4.B.1	DUPLICATED
REQ.DSS.VIZ.012	Run	Clicking on a button the analysis will start	High	4.B.1	DUPLICATED
REQ.DSS.VIZ.013	Show results	After all analysis is finished the output dataset will be available	High	4.B.1	DUPLICATED
REQ.DSS.VIZ.014	Show results	After all analysis is finished the output dataset will be available	High	4.B.1	DUPLICATED
REQ.DSS.VIZ.015	Historical data period	The data shown in tables and graph charts will be in pre-selected dates intervals	High	4.A.3, 4.B.1, 4.B.2, 4.C.1	100%
REQ.DSS.VIZ.016	Needed data from the selected plot	We expect all needed information linked to the plot entity (area, crop-type, irrigation system type (sprinkler, drip), soil type, irrigation water EC, etc	High	4.B.1, 4.B.2	100%
REQ.DSS.VIZ.017	Prediction date	Prediction (irrigation) will be done for the next day	High	4.B.1, 4.B.2	100%
REQ.DSS.VIZ.018	Run	Clicking on a button the analysis will start	High	4.B.1, 4.B.2	50%
REQ.DSS.VIZ.019	Select plot-crop	Select the plot-crop for the analytics to be done, clicking on a map, or selecting the plot name/ID from a drop-list	High	4.B.1, 4.B.2	DEPRECATED
REQ.DSS.VIZ.020	Show results	After all analysis is finished the output dataset will be available	High	4.B.1, 4.B.2	80%
REQ.DSS.VIZ.021	Prediction date	Prediction (irrigation) will be done for the next day	High	4.B.2	DUPLICATED

Req_ID	Title	Description	Priority	DSS component affected	Status
REQ.DSS.VIZ.022	Prediction date	Prediction (irrigation) will be done for the next day	High	4.B.2	DUPLICATED
REQ.DSS.VIZ.023	Select plot-crop	Select the plot-crop for the analytics to be done, clicking on a map, or selecting the plot name/ID from a drop-list	High	4.B.x	DISCARDED
REQ.DSS.VIZ.024	Select plot-crop	Select the plot-crop for the analytics to be done, clicking on a map, or selecting the plot name/ID from a drop-list	High	4.B.x	DISCARDED
REQ.DSS.VIZ.025	Display Results	Results of the analysis is displayed via table, map, legend, line, and pie chart graph	Medium	4.C.1	DUPLICATED
REQ.DSS.VIZ.026	Select Parcel	Select the parcel for data display	Medium	4.C.1	DUPLICATED
REQ.DSS.VIZ.027	Select Parcel	Select from the list the parcel to display data	Medium	4.C.2	DUPLICATED
REQ.DSS.VIZ.028	Visualise results	Results of analysis are shown as graphs, tables, pies, and maps in the dashboard	High	4.C.2	DUPLICATED
REQ.DSS.VIZ.029	Select machine and Timeframe	Define the machine or select the machines and timeframe for which to visualise the analytics results	High	4.D.1	60%
REQ.DSS.VIZ.030	View Results	View the results of the analysis of the different parameters	High	4.D.1	35%
REQ.DSS.VIZ.031	Define base rate	Define the base rate (rate if no variable rate was to be used)	High	4.D.3	DEPRECATED
REQ.DSS.VIZ.032	Define rate factor	This parameter controls the spread of the variability in the rates	High	4.D.3	DEPRECATED
REQ.DSS.VIZ.033	Define up/down	Increase or decrease application rate with higher NDVI values	High	4.D.3	DEPRECATED
REQ.DSS.VIZ.034	Export map as SHP or GeoJSON	Export the variable rate map as a SHP -file or GeoJSON (should be compatible with Field machinery)	High	4.D.3	DEPRECATED
REQ.DSS.VIZ.035	Select fields	Select the fields for which to visualise the analytics results	High	4.D.3	DUPLICATED
REQ.DSS.VIZ.036	Overlap graphs	Allow the user to overlap different line graphs in the same chart	Medium	4.E.1	45%
REQ.DSS.VIZ.037	Switch data source	Allow the user to choose between different data sources	High	4.E.1	55%
REQ.DSS.VIZ.038	Time windows	Allow the user to choose the time window of captured flies to show on the GUI	Low	4.E.1	40%
REQ.DSS.VIZ.039	Training set	To have a training set to generate a model	High	4.E.1	15%
REQ.DSS.VIZ.040	Graphs	Show the dynamics of the prediction	Medium	4.E.2	100%
REQ.DSS.VIZ.041	Prediction	Predict the current stage of an insect with weather data	High	4.E.2	100%

Req_ID	Title	Description	Priority	DSS component affected	Status
REQ.DSS.VIZ.042	Visualise Milk Yield Prognosis	Lactation forecast per animal for understanding milk delivery prognosis in line with milk quota/production target fulfilment	High	4.F.1	80%
REQ.DSS.VIZ.043	Milk Quality	Dataset containing data on productivity, days of milking, fat, protein, fat/protein ratio and lactose per cow	High	4.G.1	100%
REQ.DSS.VIZ.044	Pedometer	Dataset containing data concerning productivity, electrical conductivity, activity, and rest per cow	High	4.G.1	100%
REQ.DSS.VIZ.045	Training	Dataset containing data on productivity, fats, proteins, fat/protein ratio, electrical conductivity, activity, rest, and health status regarding the pathologies of ketosis, mastitis, and lameness for each cow	High	4.G.1	DEPRECATED
REQ.DSS.VIZ.046	FTIR Parameters	Dataset containing the parameters extracted from MilkoScan, by means of FTIR spectroscopy	High	4.H.1	DEPRECATED
REQ.DSS.VIZ.047	Training	Dataset containing some parameters extracted from MilkoScan, by means of FTIR spectroscopy, and the degree of (raw and processed) milk quality, assigned for each sample	High	4.H.1	100%
REQ.DSS.VIZ.048	Get FADN results	Get as set for reference values from the closest type of farms in the FADN DB	High	4.I.1	100%
REQ.DSS.VIZ.049	Input and output structure	Visualise the sub-component for economic input and output (structure of costs and structures of farm output)	Medium	4.I.1	100%
REQ.DSS.VIZ.050	Compare with groups	Compare the values of the indicators in the farm with group averages	High	4.I.2	100%
REQ.DSS.VIZ.051	Visualise his own indicators	Visualise the values of the indicators	High	4.I.2, 4.I.3	100%
REQ.DSS.VIZ.052	Compare the results in adopting a technology	Compare the values of the indicators before and after adopting a solution	High	4.I.3	100%

A.3. SOCS-related Requirements

The table below lists and classifies the different needs collected by WP7 through SOCS survey to cover its needs.

Req_ID	Title	Description	Priority	DEMETER component	Status
REQ.DSS.SOCS.001	Access to the platform	SOCS dashboard should be accessible via web browser or smartphone/table	High	SOCS	70%
REQ.DSS.SOCS.002	Registration	SOCS dashboard should have a user registration/login section	High	Access Control Server (ACS)	80%
REQ.DSS.SOCS.003	User profile	SOCS should allow users to create their profile (first name and surname, email address, phone number, country, the organisation/company they represent, sectors of interest, category)	High	User profile	80%
REQ.DSS.SOCS.004	Increase Knowledge	SOCS should increase knowledge among farmers' advisors about available innovation	High	Collaboration services	100%
REQ.DSS.SOCS.005	User's competence	SOCS should allow users to search for team member	High	Search	60%
REQ.DSS.SOCS.006	Exchange Knowledge	SOCS should allow user to access to Knowledge Management services	High	Wiki, Documents	100%
REQ.DSS.SOCS.007	Discussion	SOCS should allow users to access discussion threads dedicated to agriculture sector relevant topics	High	Discussion	100%
REQ.DSS.SOCS.008	Sharing experiences and events outcomes	SOCS should allow users to share experiences and interact with the community using social networking applications	High	Blog	100%
REQ.DSS.SOCS.009	Success stories	SOCS should allow users to access to success stories to get inspiration	High	Agricultural trial catalogue	60%
REQ.DSS.SOCS.010	Enable the discover of resources	SOCS should allow users to find out relevant resources (datasets, components, reusable pipelines, etc.) shared through the DEMETER Enabler HUB (DEH)	High	DYMER (Dynamic Information ModElling & Rendering) and co-creation app	50%
REQ.DSS.SOCS.011	Farmer needs	SOCS should allow farmers to work with technology suppliers to assess real needs and develop practical solutions rather than pushing technologies	High	Co-creation app	0%
REQ.DSS.SOCS.012	Innovation ideas	SOCS should allow users to create, share and manage innovative ideas in a collaborative way via applications	High	Co-creation app	0%

Annex B REST Interfaces

This annex provides an update to the REST APIs of the different DSS components. These APIs are based on the template created by WP3 in previous deliverables and their base URL is appointed as <COMPONENT-IP> which corresponds to the address/IP of system where the component is installed.

Title	
URL: This field holds the relative path to the described API. For simplicity Root path can be cut off from this description and can be placed as a hypertext above the API template	
Method This field holds the type of the Method used	
URL Params This field holds the parameters (if any). Separated based on the fields below into required and optional.	
Required:	
Optional:	
Data Params This field holds the body payload of a request.	
Required:	
Optional:	
Success response <What should the status code be on success and is there any returned data? This is useful when people need to know what their call-backs should expect>	
Error response This field holds the list of all possible error responses. Doing that, helps prevent assumptions of why the endpoint fails and saves a lot of time during the integration process.	
Sample call This field holds a possible sample call to the described endpoint in a curl-like format. Please, choose the format wisely so that is clear and easy to read by the interested parties.	
Notes This field holds any additional helpful info related to this endpoint.	

B.1. DSS AREA: 4.A - Crop Growth, Status and Yield

B.1.1. Component 4.A.1 Plant Yield Estimation

Title	Predict yield
URL	
/yield_prediction/predict	
Method	
POST	
URL Params	
Required:	
Content-Type=application/json	Header for JSON request
Optional:	

Data Params	
Required:	
identifier (from existing system)	ID of the field coming from existing systems
validFrom	Date defining when the information provided can be considered valid from
validTo	Date defining when the information provided can be considered valid to
fieldGeometry	Geometry of the identified field: asWKT
description	A description of the field
category	The category of farming used within this field. E.g., arable
cropStatus	The current status of the crops in the identified field. e.g., blooming, planted, maturing, …
lastPlantedAt	The date crops were last planted in the identified field
cropArea	Geometry of the total field area which contains the crops
cropSpecies	The species of the crop currently planted within the identified field
Production	Production amount, i.e., the total measured yield for the given geometry
Optional:	
Production	Production amount, i.e., the total measured yield for the given geometry. Only necessary when training the prediction model, not needed for inference.
Success response	
200 Content: {"result": <float: predicted yield>}	Request was successful
Error response	
400	Bad Request
403	Not authorized
Sample call	

```
curl --location --request POST ' https:// ://<COMPONENT-IP>//yield_prediction/predict ' \
--header 'Content-Type: application/json' \
--data-raw '{"@context": ["https://w3id.org/demeter/agri-context.jsonld"],
"@graph": [
  {
    "@id":"urn:ngsi-ld:Plot:72d9fb43-53f8-4ec8-a33c-fa931360259a",
    "@type": "Plot",
    "code": "Plot1a",
    "validFrom":"30/1/2018",
    "validTo":"30/10/2018",
    "hasGeometry": {
      "@id":"urn:ngsi-ld:Plot:geo:72d9fb43-53f8-4ec8-a33c-fa931360259a",
      "@type": "Polygon",
      "asWKT": "POLYGON ((2.6584237478090156 50.9580622571139870, 2.6587338968496641
50.9581579426010336, 2.6589429488131198 50.9582150219953576, 2.6591095643951315
50.9582528714251737, 2.6594131803025660 50.9583130331828329, 2.6597840234085823
50.9583763291639258, 2.6601631496043434 50.9584545804495264, 2.6603365480477104
50.9584938754040664, 2.6604075024417271 50.9584102952921612, 2.6604662546619218
50.9583568395615316, 2.6604342845380304 50.9583472936046604, 2.6605727867651963
50.9581954593736981, 2.6606363555663735 50.9581231012561133, 2.6607330759977792
50.9579965557217776, 2.6607734469812598 50.9579474185679047, 2.6608194310438913
```

```
50.9579005209109894, 2.6608524514342635 50.9578733963002009, 2.6608934925113696
50.9578449495156960, 2.6609513715096789 50.9578115321335829, 2.6612047259887084
50.9576841139061898, 2.6613162666076406 50.9576314243041466, 2.6614578206772155
50.9575716174280018, 2.6615244327002254 50.9575485769880245, 2.6616325855213563
50.9575146303461892, 2.6617372561265995 50.9574785649891382, 2.6617976757467297
50.9574535462686455, 2.6618553132177798 50.9574228224268495, 2.6618958429920814
50.9573927493935983, 2.6619421525628022 50.9573525098202822, 2.6620385672422953
50.9572498764658022, 2.6621232350015847 50.9571335851508209, 2.6621875857682133
50.9570044106813285, 2.6622157597119029 50.9569382817477106, 2.6623222637686292
50.9566443634807769, 2.6623754063259728 50.9564867027179460, 2.6623467652956743
50.9564756770014426, 2.6600325756526599 50.9558211107541226, 2.6584154185753190
50.9580525149500971, 2.6584237478090156 50.9580622571139870))"
    },
    "identifier": "example001",
    "area": "4.57",
    "description": "Potato parcel",
    "category": "arable",
    "cropStatus": "harvested",
    "lastPlantedAt": "2018-04-15T10:18:16Z",
    "crop": {
      "@id": "urn:ngsi-ld:CropSpecies:72d9fb43-53f8-4ec8-a33c-fa931360259a",
      "@type": "CropSpecies",
      "cropArea":{
        "@id": "urn:ngsi-ld:CropSpecies:geo:72d9fb43-53f8-4ec8-a33c-fa931360259a",
        "@type": "Polygon",
        "asWKT": "POLYGON ((2.6584237478090156 50.9580622571139870, 2.6587338968496641
50.9581579426010336, 2.6589429488131198 50.9582150219953576, 2.6591095643951315
50.9582528714251737, 2.6594131803025660 50.9583130331828329, 2.6597840234085823
50.9583763291639258, 2.6601631496043434 50.9584545804495264, 2.6603365480477104
50.9584938754040664, 2.6604075024417271 50.9584102952921612, 2.6604662546619218
50.9583568395615316, 2.6604342845380304 50.9583472936046604, 2.6605727867651963
50.9581954593736981, 2.6606363555663735 50.9581231012561133, 2.6607330759977792
50.9579965557217776, 2.6607734469812598 50.9579474185679047, 2.6608194310438913
50.9579005209109894, 2.6608524514342635 50.9578733963002009, 2.6608934925113696
50.9578449495156960, 2.6609513715096789 50.9578115321335829, 2.6612047259887084
50.9576841139061898, 2.6613162666076406 50.9576314243041466, 2.6614578206772155
50.9575716174280018, 2.6615244327002254 50.9575485769880245, 2.6616325855213563
50.9575146303461892, 2.6617372561265995 50.9574785649891382, 2.6617976757467297
50.9574535462686455, 2.6618553132177798 50.9574228224268495, 2.6618958429920814
50.9573927493935983, 2.6619421525628022 50.9573525098202822, 2.6620385672422953
50.9572498764658022, 2.6621232350015847 50.9571335851508209, 2.6621875857682133
50.9570044106813285, 2.6622157597119029 50.9569382817477106, 2.6623222637686292
50.9566443634807769, 2.6623754063259728 50.9564867027179460, 2.6623467652956743
50.9564756770014426, 2.6600325756526599 50.9558211107541226, 2.6584154185753190
50.9580525149500971, 2.6584237478090156 50.9580622571139870))"
      },
      "cropSpecies": {
        "@id": "urn:ngsi-ld:CropType:df72dc57-1eb9-42a3-88a9-8647ecc954b4"
      },
      "validFrom":"01/04/2018",
      "validTo":"30/09/2018",
      "production":{
        "productionAmount": {
          "propertyHasValue": 54.8,
          "isMeasuredIn":"http://www.ontology-of-units-of-measure.org/resource/om-2/tonne"
        }
      }
    }
  },
  {
    "@id": "urn:ngsi-ld:CropType:72d9fb43-53f8-4ec8-a33c-fa931360259a",
    "@type": "CropType",
    "code": "CropType2",
    "name": "Potato" ,
    "family": "Solanaceae",
```

```
    "description": "Fontane",
    "species": "Solanum tuberosum L. cv. Fontane"
  }
]}'
```

Notes

Title	Model training
URL	
/yield_prediction/train_model	
Method	
POST	
URL Params	
Required:	
Content-Type=application/json	Header for JSON request
Optional:	
Data Params	
Required:	
training_dataset_path	Path to the training dataset
validation_dataset_path	Path to the validation dataset
Optional:	
Success response	
200 Content: {"modelID": <str:modelID>, rsquare: <regression R-square metric>}	Request was successful
Error response	
400	Bad Request
403	Not authorized
Sample call	

```
curl --location --request POST ' https:// ://<COMPONENT-IP>//yield_prediction/train_model '
\
--header 'Content-Type: application/json' \
--data-raw '{
"training_dataset_path": "<path to training dataset in tfrecord format>"
"validation_dataset_path": "<path to validation dataset in tfrecord format>"

}'
```

Notes

Training and validation dataset should contain geometries (FOODIE:Plot or FOODIE:ManagementZones) with associated yield measurements and associated NDVI daily timeseries data. Instead of taking the AIM format as input, a consolidated dataset is preferred where data from AIM formats is converted into a tfrecord file containing combinations of geometries, NDVI timeseries data and associated yield measurements.

B.1.2. Component 4.A.2 Plant Phenology Estimation

Title	Olive Phenology Prediction API
URL	
https://demeter.vicomtech.org/phenology_prediction_api/v1.1/place1;place2;place3	

<table>
<tr><td colspan="2">Method</td></tr>
<tr><td colspan="2">GET</td></tr>
<tr><td colspan="2">URL Params</td></tr>
<tr><td colspan="2">Required:</td></tr>
<tr><td></td><td></td></tr>
<tr><td colspan="2">Optional:</td></tr>
<tr><td></td><td></td></tr>
<tr><td colspan="2">Data Params</td></tr>
<tr><td colspan="2">Required:</td></tr>
<tr><td></td><td></td></tr>
<tr><td colspan="2">Success response</td></tr>
<tr><td>200
Content:
{
  "@context": [
    "string",
    {"qudt-unit": "string"}
  ],
  "@graph": [
    {"@id": "string",
    "@type": "string",
    "hasGeometry": {
    "@id":"string",
    "@type": "string",
    "askWKT": "string"}},
    {"@id": "string",
    "@type": "string",
  "observedProperty": "string",
"hasFeatureOfInterest": "string",
"hasMember": ["string", "string"],
"resultTime": "2021-04-20T15:08:25.137Z"},
    {"@id": "string",
    "@type": "string",
    "identifier": "string",
    "description": "string",
    "hasResult": {
    "@id": "string",
    "@type": "string",
    "numericValue": "string",
    "unit": "string"}}]}</td><td>Contains a time series in AIM format, for the output BBCH and the input parameters DOY and GDD.</td></tr>
<tr><td colspan="2">Error response</td></tr>
<tr><td></td><td></td></tr>
<tr><td></td><td></td></tr>
<tr><td colspan="2">Sample call</td></tr>
<tr><td colspan="2">https://demeter.vicomtech.org/demeter_AIM</td></tr>
<tr><td colspan="2">Notes</td></tr>
<tr><td colspan="2"></td></tr>
</table>

B.1.3. Component 4.A.3 Plant Stress Detection

<table>
<tr><td>Title</td><td>Plant Stress Detection</td></tr>
<tr><td colspan="2">URL</td></tr>
<tr><td colspan="2">/dss-a3/demeter-services-a3/api/v1/plantStressDetection</td></tr>
<tr><td colspan="2">Method</td></tr>
<tr><td colspan="2">POST</td></tr>
<tr><td colspan="2">URL Params</td></tr>
</table>

Required:	
N/A	N/A
Optional:	
N/A	N/A
Data Params	
Required:	
AIM input file	AIM input file
Optional:	
N/A	N/A
Success response	
200 Content: { AIM output file }	OK AIM output file
Error response	
400	Bad Request
404	Resource not found
408	Request Timeout
500	Internal Server Error
503	Service Unavailable
Sample call	
`curl --location --request POST 'http://195.82.130.179/dss-a3/demeter-services-a3/api/v1/plantStressDetection’ --header 'Content-Type: application/json' --data-raw '{AIM input file}’`	
Notes	

B.1.4. Component 4.A.4 Crop Type Detection

Title	Detect crop type taskmap
URL	
/croptype /detect	
Method	
POST	
URL Params	
Required:	
Content-Type=application/json	Header for JSON request
Optional:	
Data Params	
Required:	
identifier (from existing system)	ID of the field coming from existing systems
validFrom	Date defining when the information provided can be considered valid from
validTo	Date defining when the information provided can be considered valid to
fieldGeometry	Geometry of the identified field: asWKT
Optional:	
description	A description of the field
category	The category of farming used within this field. E.g., arable
lastPlantedAt	The date crops were last planted in the identified field

Success response	

200
Content: {
"@type": "CropType",
"code": "CropType2",
"name": "Potato",
"family": "Solanaceae",
}
	Request was successful

Error response	
400	Bad Request
403	Not authorized

Sample call

```
curl --location --request POST ' https:// ://<COMPONENT-IP>//task_map/generate ' \
--header 'Content-Type: application/json' \
--data-raw '{"@context": ["https://w3id.org/demeter/agri-context.jsonld"],
"@graph": [
  {
    "@id":"urn:ngsi-ld:Plot:72d9fb43-53f8-4ec8-a33c-fa931360259a",
    "@type": "Plot",
    "code": "Plot1a",
    "validFrom":"30/1/2018",
    "validTo":"31/12/2018",
    "hasGeometry": {
      "@id":"urn:ngsi-ld:Plot:geo:72d9fb43-53f8-4ec8-a33c-fa931360259a",
      "@type": "Polygon",
      "asWKT": "POLYGON ((2.6584237478090156 50.9580622571139870, 2.6587338968496641
50.9581579426010336, 2.6589429488131198 50.9582150219953576, 2.6591095643951315
50.9582528714251737, 2.6594131803025660 50.9583130331828329, 2.6597840234085823
50.9583763291639258, 2.6601631496043434 50.9584545804495264, 2.6603365480477104
50.9584938754040664, 2.6604075024417271 50.9584102952921612, 2.6604662546619218
50.9583568395615316, 2.6604342845380304 50.9583472936046604, 2.6605727867651963
50.9581954593736981, 2.6606363555663735 50.9581231012561133, 2.6607330759977792
50.9579965557217776, 2.6607734469812598 50.9579474185679047, 2.6608194310438913
50.9579005209109894, 2.6608524514342635 50.9578733963002009, 2.6608934925113696
50.9578449495156960, 2.6609513715096789 50.9578115321335829, 2.6612047259887084
50.9576841139061898, 2.6613162666076406 50.9576314243041466, 2.6614578206772155
50.9575716174280018, 2.6615244327002254 50.9575485769880245, 2.6616325855213563
50.9575146303461892, 2.6617372561265995 50.9574785649891382, 2.6617976757467297
50.9574535462686455, 2.6618553132177798 50.9574228224268495, 2.6618958429920814
50.9573927493935983, 2.6619421525628022 50.9573525098202822, 2.6620385672422953
50.9572498764658022, 2.6621232350015847 50.9571335851508209, 2.6621875857682133
50.9570044106813285, 2.6622157597119029 50.9569382817477106, 2.6623222637686292
50.9566443634807769, 2.6623754063259728 50.9564867027179460, 2.6623467652956743
50.9564756770014426, 2.6600325756526599 50.9558211107541226, 2.6584154185753190
50.9580525149500971, 2.6584237478090156 50.9580622571139870))"
    },
    "identifier": "example001",
    "area": "4.57",
    "lastPlantedAt": "2018-04-15T10:18:16Z",
  }
]}'
```

Notes

B.1.5. Component 4.A.5 Estimate Beehive

Title	Retrieve registered fields from Estimate Beehive
URL	
/api/field-requests	
Method	

GET	
URL Params	
Required:	
Content-Type=application/json	Header for JSON request
Optional:	
Data Params	
Required:	
Optional:	
Success response	
200 Content: {[<List of Registered Fields>]} See below for format of individual field	Request was successful
Error response	
404	Not found
403	Not authorized
Sample call	
`curl --location --request GET ' https://<COMPONENT-IP>/estimatebeehive/api/fields ' \` `--header 'Content-Type: application/json' \`	
Notes	

Title	Retrieve registered field by ID from Estimate Beehive
URL	
/api/field-requests/<id>	
Method	
GET	
URL Params	
Required:	
Content-Type=application/json	Header for JSON request
Optional:	
Data Params	
Required:	
Optional:	
Success response	
200 Content: {<Field Object>} The format of the field object can be seen below in the sample call of the POST method.	Request was successful
Error response	
404	Not found

403	Not authorized
Sample call	
`curl --location --request GET ' https://<COMPONENT-IP>/ api/field-requests/<id> ' \` `--header 'Content-Type: application/json' \`	
Notes	

Title	Register field in the Estimate Beehive
URL	
/api/field-requests	
Method	
POST	
URL Params	
Required:	
Content-Type=application/json	Header for JSON request
Optional:	
Data Params	
Required:	
identifier (from existing system)	ID of the field coming from existing systems
validFrom	Date defining when the information provided can be considered valid from
validTo	Date defining when the information provided can be considered valid to
hasGeometry	Geometry of the identified field: asWKT
area	The total area of the field identified
description	A description of the field
category	The category of farming used within this field. E.g., arable
cropStatus	The current status of the crops in the identified field. E.g., blooming
lastPlantedAt	The date crops were last planted in the identified field
cropArea	Geometry of the total field area which contains the crops
cropSpecies	The species of the crop currently planted within the identified field
areaCultivated	The total area of crop that have been cultivated within the field
plantDensity	The density of plants within the field. E.g., 95%
treatment	The treatments used within the field including any chemicals or products that have been used within the field. E.g., fertiliser or pesticide
Optional:	
Success response	
200 Content: {<Field-Request Object>}	Request was successful

The field-request object identified in the body of the sample call below, will be returned if successfully registered in the beehive component. Alongside this, the field-request will include an id field which can be reference when requesting a beehive estimation.	
Error response	
400	Bad Request
403	Not authorized
Sample call	

```
curl --location --request POST ' https:// ://<COMPONENT-IP> /api/field-requests/ <field-
request-id>' \
--header 'Content-Type: application/json' \
--data-raw '{"@context": [
            "https://w3id.org/demeter/agri-context.jsonld"
    ],
    "@graph": [
    {
        "@id":"urn:ngsi-ld:Plot:72d9fb43-53f8-4ec8-a33c-fa931360259a",
        "@type": "Plot",
        "identifier": "0000280859BE7A17",
        "validFrom":"30/1/2020",
        "hasGeometry": {
            "@id":"urn:ngsi-ld:Plot:geo:72d9fb43-53f8-4ec8-a33c-fa931360259a",
            "@type": "Polygon",
            "asWKT": "POLYGON((15.982709072777158 52.57920221568363,15.984854839989072
52.582018561825926,15.99513306493414 52.58088422194763,15.996120117851621
52.58042787003856,15.99489703054083 52.57978896938458,15.994596623131162
52.5791370203432,15.993309162804014 52.57868065024535,15.992236279198057
52.57808084232016,15.982709072777158 52.57920221568363))"
        },
        "area": "35",
        "description": "Potato parcel",
        "category": "arable",
        "cropStatus": "blooming",
        "lastPlantedAt": "2020-04-15T10:18:16Z",
        "hasAgriCrop": {
            "@id": "urn:ngsi-ld:CropSpecies:72d9fb43-53f8-4ec8-a33c-fa931360259a",
            "@type": "Crop",
            "cropSpecies": {
                "@id": "urn:ngsi-ld:CropType:df72dc57-1eb9-42a3-88a9-8647ecc954b4"
            },
        },
        "areaCultivated": 32.23,
        "plantDensity": 85,
    },
    {
        "@id": "urn:demeter:Treatment1:72d9fb43-53f8-4ec8-a33c-fa931360259a",
        "@type":"Treatment",
        "interventionPlot": {"@id":"urn:demeter:Plot:72d9fb43-53f8-4ec8-a33c-fa931360259a"},
        "type": "FERTILIZATION",
        "hasTimestamp": "2020-04-17T09:33:56Z",
        "name": "Landowner Topleaf - Foliar Nitrogen",
        "substance": "Nitrogen, Sulphur",
        "quantity":{
            "@id":"urn:demeter:TQ:72d9fb43-53f8-4ec8-a33c-fa931360259a",
            "@type": "QuantityValue",
            "numericValue": "2.0",
            "unit": {"@id": "qudt-unit:L"}
        },
        "notes": "known to be harmful to honey bees",
        "area": 20,
```

"status": "completed"
},
{
"@id": "urn:demeter:Treatment2:72d9fb43-53f8-4ec8-a33c-fa931360259a",
"@type":"Treatment",
"interventionPlot": {"@id":"urn:demeter:Plot:72d9fb43-53f8-4ec8-a33c-fa931360259a"},
"type": "SPRAYING",
"hasTimestamp": "2020-04-16T12:33:56Z",
},
{
"@id": "urn:ngsi-ld:CropType:df72dc57-1eb9-42a3-88a9-8647ecc954b4",
"@type": "CropType",
"name": "Potato" ,
"family": "Solanaceae",
"description": "Fontane",
"species": "Solanum tuberosum L. cv. Fontane",
"agroVocConcept": "http://aims.fao.org/aos/agrovoc/c_1066"
}
]}'

Notes
Some data params identified may also be objects containing several properties

Title	Update registered field in the Estimate Beehive
URL	
/api/field-requests/<id>	
Method	
PUT	
URL Params	
Required:	
Content-Type=application/json	Header for JSON request
Optional:	
Data Params	
Required:	
identifier (from existing system)	ID of the field coming from existing systems
validFrom	Date defining when the information provided can be considered valid from
validTo	Date defining when the information provided can be considered valid to
fieldGeometry	Geometry of the identified field: asWKT
area	The total area of the field identified
description	A description of the field
category	The category of farming used within this field. E.g., arable
cropStatus	The current status of the crops in the identified field. E.g., blooming
lastPlantedAt	The date crops were last planted in the identified field
cropArea	Geometry of the total field area which contains the crops
cropSpecies	The species of the crop currently planted within the identified field

areaCultivated	The total area of crop that have been cultivated within the field
plantDensity	The density of plants within the field. E.g., 95%
treatment	The treatments used within the field including any chemicals or products that have been used within the field. E.g., fertiliser or pesticide
Optional:	
Success response	
200 Content: {<Field-Request Object>} The updated field-request object will be returned if successfully updated in the estimate beehive component. The field object format can be seen in the sample call below.	Request was successful
Error response	
404	Not found
400	Bad Request
403	Not authorized
Sample call	

```
curl --location --request PUT ' https://<COMPONENT-IP> /api/field-requests/<field-request-
id> ' \
--header 'Content-Type: application/json' \
--data-raw '{"@context": [
            "https://w3id.org/demeter/agri-context.jsonld"
    ],
    "@graph": [
    {
        "@id":"urn:ngsi-ld:Plot:72d9fb43-53f8-4ec8-a33c-fa931360259a",
        "@type": "Plot",
        "identifier": "0000280859BE7A17",
        "validFrom":"02/02/2020",
        "hasGeometry": {
            "@id":"urn:ngsi-ld:Plot:geo:72d9fb43-53f8-4ec8-a33c-fa931360259a",
            "@type": "Polygon",
            "asWKT": "POLYGON((15.982709072777158 52.57920221568363,15.984854839989072
52.582018561825926,15.99513306493414 52.58088422194763,15.996120117851621
52.58042787003856,15.99489703054083 52.57978896938458,15.994596623131162
52.5791370203432,15.993309162804014 52.57868065024535,15.992236279198057
52.57808084232016,15.982709072777158 52.57920221568363))"
        },
        "area": "35",
        "description": "Potato parcel",
        "category": "arable",
        "cropStatus": "blooming",
        "lastPlantedAt": "2020-04-15T10:18:16Z",
        "hasAgriCrop": {
            "@id": "urn:ngsi-ld:CropSpecies:72d9fb43-53f8-4ec8-a33c-fa931360259a",
            "@type": "Crop",
            "cropSpecies": {
                "@id": "urn:ngsi-ld:CropType:df72dc57-1eb9-42a3-88a9-8647ecc954b4"
            },
        },
        "areaCultivated": 32.23,
        "plantDensity": 85,
    },
    {
        "@id": "urn:demeter:Treatment1:72d9fb43-53f8-4ec8-a33c-fa931360259a",
```

```
        "@type":"Treatment",
        "interventionPlot": {"@id":"urn:demeter:Plot:72d9fb43-53f8-4ec8-a33c-fa931360259a"},
        "type": "FERTILIZATION",
        "hasTimestamp": "2020-04-17T09:33:56Z",
        "name": "Landowner Topleaf - Foliar Nitrogen",
        "substance": "Nitrogen, Sulphur",
        "quantity":{
            "@id":"urn:demeter:TQ:72d9fb43-53f8-4ec8-a33c-fa931360259a",
            "@type": "QuantityValue",
            "numericValue": "2.0",
            "unit": {"@id": "qudt-unit:L"}
        },
        "notes": "known to be harmful to honey bees",
        "area": 20,
        "status": "completed"
    },
    {
        "@id": "urn:demeter:Treatment2:72d9fb43-53f8-4ec8-a33c-fa931360259a",
        "@type":"Treatment",
        "interventionPlot": {"@id":"urn:demeter:Plot:72d9fb43-53f8-4ec8-a33c-fa931360259a"},
        "type": "SPRAYING",
        "hasTimestamp": "2020-04-16T12:33:56Z",
    },
    {
        "@id": "urn:ngsi-ld:CropType:df72dc57-1eb9-42a3-88a9-8647ecc954b4”,
        "@type": "CropType",
        "name": "Potato" ,
        "family": "Solanaceae",
        "description": "Fontane",
        "species": "Solanum tuberosum L. cv. Fontane",
        "agroVocConcept": "http://aims.fao.org/aos/agrovoc/c_1066"
    }
]}'
```


Notes
Some data params identified may also be objects containing several properties

Title	Delete registered field by ID from Estimate Beehive
URL	
/api/field-requests/<id>	
Method	
DELETE	
URL Params	
Required:	
Content-Type=application/json	Header for JSON request
Optional:	
Data Params	
Required:	
Optional:	
Success response	
204	Request was successful, No Content
Error response	
404	Not found
403	Not authorized

Sample call
curl --location -request DELETE ' https://<COMPONENT-IP> /api/field-requests/<field-request-id> ' \ --header 'Content-Type: application/json' \
Notes

Title	Request Pollination against registered field
URL	
/api/pollination-requirements/<field-request-id>/predict	
Method	
POST	
URL Params	
Required:	
Content-Type=application/json	Header for JSON request
Optional:	
Data Params	
Required:	
Optional:	
Success response	

200
Content: { "id": "60994cda0eb05d109c70a734",
"@context": [
"https://w3id.org/demeter/agri-context.jsonld"
],
"@graph": [
{
"@id":"urn:demeter:Plot:72d9fb43-53f8-4ec8-a33c-fa931360259a",
"@type": "Plot",
"identifier": "0000280859BE7A17",
"hasGeometry": {
"@id":"urn:demeter:Plot:geo:72d9fb43-53f8-4ec8-a33c-fa931360259a",
"@type": "Polygon",
"asWKT": "POLYGON((15.982709072777158 52.57920221568363,15.984854839989072 52.582018561825926,15.99513306493414 52.58088422194763,15.996120117851621 52.58042787003856,15.99489703054083 52.57978896938458,15.994596623131162 52.5791370203432,15.993309162804014 52.57868065024535,15.992236279198057 52.57808084232016,15.982709072777158 52.57920221568363))"
},
"area": "35",
"description": "Potato parcel",
"category": "arable",
"cropStatus": "blooming",
	Request was successful

```
            "lastPlantedAt": "2020-04-
15T10:18:16Z",
            "hasAgriCrop": {
                "@id":
"urn:demeter:CropSpecies:72d9fb43-53f8-4ec8-
a33c-fa931360259a",
                "@type": "Crop",
                "cropSpecies": {
                    "@id":
"urn:demeter:CropType:df72dc57-1eb9-42a3-
88a9-8647ecc954b4"
                },
            },
            "numberOfHivesNeeded": 8
        },
        {
            "@id":
"urn:demeter:CropType:df72dc57-1eb9-42a3-
88a9-8647ecc954b4",
            "@type": "CropType",
            "code": "CropType2",
            "name": "Potato" ,
            "family": "Solanaceae",
            "description": "Fontane",
            "species": "Solanum tuberosum L.
cv. Fontane",
            "agroVocConcept":
"http://aims.fao.org/aos/agrovoc/c_1066"
        }]}
```

Error response	
404	Not found
403	Not authorized
Sample call	

```
curl --location -request POST ' https://<COMPONENT-ID>/api/pollination-requirements/<field-
request-id>/predict ' \
--header 'Content-Type: application/json' \
```

Notes	

B.2. DSS AREA: 4.B - Irrigation Management

B.2.1. Component 4.B.1 DSS for Irrigation Management

Title	DSS for Irrigation Management API description
URL	
/plotinfo/	
Method	
GET	
URL Params	
Required:	
idPlot	ID of the plot in the pilot cloud infrastructure
Optional:	
etoNdays	number of training days (historical) for the timeseries models
etoD	“forecast horizon” or number of days to predict from today (*zero day*)
Data Params	

Required:	
Optional:	
Success response	

200
Content:
{
    "@context": [
        "https://w3id.org/demeter/agri-context.jsonld",
        {
            "qudt-unit": "http://qudt.org/vocab/unit/",
            "irrigation-water": "http://aims.fao.org/aos/agrovoc/",
            "rain-water": "http://aims.fao.org/aos/agrovoc/",
            "soil-water-content": "http://aims.fao.org/aos/agrovoc/"
        }
    ],
    "@graph": [
        {
            "@id": "urn:demeter:Parcel:12345",
            "@type": "Parcel"
        },
        {
            "@id": "urn:demeter:Forecasting:idPrediction1",
            "@type": "Forecasting",
            "description": "Irrigation prediction for the crop",
            "dateObserved": "2020-12-30T00:00:00Z",
            "hasFeatureOfInterest": {
                "@id": "urn:demeter:Parcel:12345"
            },
            "hasResult": [
                {
                    "@id": "urn:demeter:12345:Forecasting:IrrigationPredictionNeeds"
                },
                {
                    "@id": "urn:demeter:12345:Forecasting:cropWaterNeeds"
                },
                {
                    "@id": "urn:demeter:12345:Forecasting:eto"
                },
                {
                    "@id": "urn:demeter:12345:Forecasting:rainwaterForecast"
                },
                {
	This component returns an object in AIM format containing the results which will be also used in Knowage for data visualisation.
	The example is as the one returned in the current version.

```
                    "@id":
"urn:demeter:12345:Forecasting:avgSoilMoistur
e"
                },
                {
                    "@id":
"urn:demeter:12345:Forecasting:avgProbeSoilMo
isture"
                },
                {
                    "@id":
"urn:demeter:12345:Forecasting:img:soilMoistu
reImg"
                },
                {
                    "@id":
"urn:demeter:12345:Forecasting:img:segmentedS
oilMoistureImg"
                },
                {
                    "@id":
"urn:demeter:12345:Forecasting:img:PlantStatu
sImg"
                },
                {
                    "@id":
"urn:demeter:12345:Forecasting:img:anomalitie
sPlantStatusImg"
                }
            ]
        },
        {
            "@id":
"urn:demeter:12345:Forecasting:IrrigationPred
ictionNeeds",
            "@type": "QuantityValue",
            "numericValue":
"100932.81485217666",
            "unit": {
                "@id": "qudt-unit:L-PER-DAY"
            }
        },
        {
            "@id":
"urn:demeter:12345:Forecasting:cropWaterNeeds
",
            "@type": "QuantityValue",
            "numericValue": "12345",
            "unit": {
                "@id": "qudt-unit:L-PER-DAY"
            }
        },
        {
            "@id":
"urn:demeter:12345:Forecasting:eto",
            "@type": "QuantityValue",
            "numericValue": "1.112",
            "unit": {
                "@id": "qudt-unit:MilliM-PER-
DAY"
            }
        },
        {
```

"@id": "urn:demeter:12345:Forecasting:rainwaterForecast",
"@type": "QuantityValue",
"numericValue": "",
"unit": {
"@id": "qudt-unit:L-PER-DAY"
}
},
{
"@id": "urn:demeter:12345:Forecasting:avgSoilMoisture",
"@type": "QuantityValue",
"numericValue": "",
"unit": {
"@id": "qudt-unit:L"
}
},
{
"@id": "urn:demeter:12345:Forecasting:avgProbeSoilMoisture",
"@type": "QuantityValue",
"numericValue": "",
"unit": {
"@id": "qudt-unit:L"
}
},
{
"@id": "urn:demeter:12345:Forecasting:img:soilMoistureImg",
"@type": "Image",
"format": "Tiff",
"url": ""
},
{
"@id": "urn:demeter:12345:Forecasting:img:segmentedSoilMoistureImg",
"@type": "Image",
"format": "Tiff",
"url": ""
},
{
"@id": "urn:demeter:12345:Forecasting:img:PlantStatusImg",
"@type": "Image",
"format": "Tiff",
"url": ""
},
{
"@id": "urn:demeter:12345:Forecasting:img:anomalitiesPlantStatusImg",
"@type": "Image",
"format": "Tiff",
"url": ""
},
{
"@id": "urn:demeter:ObservationCollection.1",
"@type": "ObservationCollection",	

"description": "Observation timeSeries data of Irrigation prediction",
"observedProperty": {
"@id": "irrigation-water:c_3958"
},
"hasFeatureOfInterest": {
"@id": "urn:demeter:Parcel:12345"
},
"hasMember": []
},
{
"@id": "urn:demeter:ObservationCollection.2",
"@type": "ObservationCollection",
"description": "Observation timeSeries data of Estimated crop water needs based on predidected ETo",
"observedProperty": {
"@id": "irrigation-water"
},
"hasFeatureOfInterest": {
"@id": "urn:demeter:Parcel:12345"
},
"hasMember": []
},
{
"@id": "urn:demeter:ObservationCollection.3",
"@type": "ObservationCollection",
"description": "Observation timeSeries data of rainwater forecast",
"observedProperty": {
"@id": "rain-water:c_25202"
},
"hasFeatureOfInterest": {
"@id": "urn:demeter:Parcel:12345"
},
"hasMember": []
},
{
"@id": "urn:demeter:ObservationCollection.4",
"@type": "ObservationCollection",
"description": "Observation timeSeries data of predicted average soil moisture",
"observedProperty": {
"@id": "soil-water-content:c_7208"
},
"hasFeatureOfInterest": {
"@id": "urn:demeter:Parcel:12345"
},
"hasMember": []
}
]
}	

Error response	
404	Error. Invalid entry point.

Content: “”	
405 Content: “”	Error. No Plot found with that id.
Sample call	

`curl --location --request GET 'http://localhost:3000/plotinfo/?idPlot=12345' \`
`--header 'Accept: application/json' \`
`--header 'Content-Type: application/json' \`
`--data-raw ''`	

Notes	

B.2.2. Component 4.B.2 Reference Evapotranspiration Prediction

Title	Reference evapotranspiration prediction API description
URL	
/ocpu/library/predictiveET0/R/launchApp	
Method	
POST	
URL Params	
Required:	
Optional:	
Data Params This field holds the body payload of a request.	
Required:	
ndays	Number of training days (historical) for the timeseries models.
h	Forecast horizon: number of days to predict from today (zero day)
latitude	Location latitude (N)
longitude	Location longitude (W)
altitude	Location altitude
temperature	Url and query for pilotdevicebridge component endpoint exposing historical data in AIM format. “https://IP:port/aim/v1/historical/query”
humidity	Url and query for pilotdevicebridge component endpoint exposing historical data in AIM format. “https://IP:port/aim/v1/historical/query”
windspeed	Url and query for pilotdevicebridge component endpoint exposing historical data in AIM format. “https://IP:port/aim/v1/historical/query”
Optional:	
Success response	

200
Content:
`{`
`    "@context": [`
`      "https://w3id.org/demeter/agri-context.jsonld",`
`      {`
	AIM data model with ET_0 for the “h” days (mm)

```
        "qudt-unit":
"http://qudt.org/vocab/unit/"
      }
    ],
    "@graph": [
      {
        "@id": "urn:demeter:Forecasting:1",
        "@type": "Forecasting",
        "description": "et0forthecrop",
        "hasResult": [
          {
            "@id":
"urn:demeter:idParcel1:Forecasting:et0_0"
          },
          {
            "@id":
"urn:demeter:idParcel1:Forecasting:et0_1"
          }
        ]
      },
      {
        "@id":
"urn:demeter:Forecasting:Forecasting:et0_0",
        "@type": "QuantityValue",
        "numericValue": "1.916",
        "unit": {
          "@id": "qudt-unit:MilLength"
        }
      },
      {
        "@id":
"urn:demeter:Forecasting:Forecasting:et0_1",
        "@type": "QuantityValue",
        "numericValue": "1.916",
        "unit": {
          "@id": "qudt-unit:MilLength"
        }
      }
    ]
 }
```


Error response	
400 Bad Request Content: Error message in text/plain	Triggered when R engine raised an error.
502 Bad Gateway Content: (Admin needs to look in error logs)	Triggered when Nginx (opencpu-cache) cannot connect to OpenCPU server.
503 Bad Request Content: (Admin needs to look in error logs)	Triggered when a serious problem occurs in the server.
Sample call	

```
curl http://localhost/ocpu/library/predictiveET0/R/launchApp \
-H "Content-Type: application/json" -d '{"ndays":"30", "h":"2", “longitude”:10,
“latitude”:0.1, “altitude”:65, temperature = “http://IP:port/aim/...”, humidity
=“http://IP:port/aim/...”, windspeed = “http://IP:port/aim/...”, rainwater =
“http://IP:port/aim/...”,  sunradiation =“http://IP:port/aim/...”)}'
```

Notes

A REST API call to retrieve the OpenCPU server Logs will be added. This can be used to retrieve details of any errors.

B.2.3. Component 4.B.3 Soil Moisture Estimation

<table>
<tr><td>Title</td><td>Soil Moisture Estimation API description</td></tr>
<tr><td colspan="2">URL</td></tr>
<tr><td colspan="2">/ocpu/library/soilMoisture/R/optram</td></tr>
<tr><td colspan="2">Method</td></tr>
<tr><td colspan="2">GET</td></tr>
<tr><td colspan="2">URL Params</td></tr>
<tr><td colspan="2">Required:</td></tr>
<tr><td></td><td></td></tr>
<tr><td colspan="2">Optional:</td></tr>
<tr><td></td><td></td></tr>
<tr><td colspan="2">Data Params</td></tr>
<tr><td colspan="2">Required:</td></tr>
<tr><td>idPlot</td><td>Id of the plot in the pilot cloud infrastructure which satellite images have to be retrieved</td></tr>
<tr><td>humidity</td><td>Endpoint call to pilotdevicebridge component to retrieve also the needed soil moisture sensors data.
“http://IP:port/aim/v1/historical/query”</td></tr>
<tr><td colspan="2">Optional:</td></tr>
<tr><td></td><td></td></tr>
<tr><td colspan="2">Success response</td></tr>
<tr><td>200
Content:
<pre>{
  "@context": [
    "https://w3id.org/demeter/agri-
context.jsonld",
    {
      "qudt-unit":
"http://qudt.org/vocab/unit/"
    }
  ],
  "@graph": [
    {
      "@id": "urn:demeter:SoilMoisture:1",
      "@type": "Forecasting",
      "description":
"SurfaceSoilMoisturePrediction",
      "hasResult": [
        {
          "@id":
"urn:demeter:idParcel1:meanValue:2021-04-17"
        }
      ]
    },
    {
      "@id":
"urn:demeter:SoilMoisturePred:SoilMoisture:20
21-04-17",
      "@type": "Image",</pre></td><td>AIM data model with mean value of the estimated soil surface moisture (%) and coloured image.</td></tr>
</table>

"imgUri": "/home/vyago/Desktop/soilMoisture/soilMoisture-PKG-demeter/OPTRAM/A/2021-04-17.jpeg", "imgScaleUri": "", "unit": { "@id": "qudt-unit:xsd:anyURI" } }, { "@id": "urn:demeter:SoilMoisturePred:meanValue:2021-04-17", "@type": "QuantityValue", "numericValue": "47", "unit": { "@id": "qudt-unit:percentage" } }] }	
Error response	
400 Bad Request Content: Error message in text/plain	Triggered when R engine raised an error
502 Bad Gateway Content: Error message in text/plain in server's logs	Triggered when Nginx (OpenCPU-cache) cannot connect to OpenCPU server. Admin needs to look in error logs.
503 Bad Request Content: Error message in text/plain in server's logs	Triggered when a serious problem occurs in the server. Admin needs to look in error logs.
Sample call	
`curl http://localhost/ocpu/library/soilMoisture/R/optram \ -H "Content-Type: application/json" -d '{idPlot = "aq1234efdssdfsfsf2342354", humidity = "http://IP:port/aim/v1/historical/query"}'`	
Notes	
A REST API call to retrieve the OpenCPU server Logs will be added. This can be used to retrieve details of any errors.	

B.2.4. Component 4.B.4 Crop Water Status Anomalies Detection

No REST APIs are yet present since this component is still under definition and development.

B.3. DSS AREA: 4.C - Nutrition Management

B.3.1. Component 4.C.1 Nitrogen Balance Model

Title	Nitrogen Balance Model
URL	
/dss-c1/demeter-services-c1/api/v1/nitrogenBalanceModel	
Method	
POST	
URL Params	
Required:	
N/A	N/A
Optional:	

N/A	N/A
Data Params	
Required:	
AIM input file	AIM input file
Optional:	
N/A	N/A
Success response	
200 Content: { AIM output file }	OK AIM output file
Error response	
400	Bad Request
404	Resource not found
408	Request Timeout
500	Internal Server Error
503	Service Unavailable
Sample call	
`curl --location --request POST 'http://195.82.130.179/dss-c1/demeter-services-c1/api/v1/nitrogenBalanceModel' --header 'Content-Type: application/json' --data-raw '{AIM input file}'`	
Notes	

B.3.2. Component 4.C.2 Nutrient Monitor

Title	Nutrient Monitor Model
URL	
/estimate/api/v1/NutrientMonitorModel	
Method	
POST	
URL Params	
Required:	
Content-Type=application/json	Header for JSON request
Optional:	
Data Params	
Required:	
identifier	ID
containsPlot	The agricultural plots that belong to a farm
hasGeometry	Geometry of the identified farms and plots: asWKT
totalSeeds	Total seeds that the farmer usually apply to a plot
applicationWidth	The width of the field machinery that applies the seeds on the field
name	Plot name
area	The total area of the plot identified
cropSpecies	The species of the crop currently planted within the identified plot
cropStatus	The current status of the crop in the identified plot
lastPlantedAt	The date crop was last planted in the identified plot

soilProperty	Soil texture property of the soil plot. As Silt, Clay, Sand, Loam, etc...
sowingPeriod	Recommended sowing period
Optional:	
Success response	
200 Content: {AIM output}	OK AIM output
Error response	
400	Bad Request
404	Resource not Found
500	Internal Server Error
503	Service Unavailable
Sample call	

```
curl --location --request POST ' https://<COMPONENT-IP>/estimate/api/v1/NutrientMonitorModel
' \
--header 'Content-Type: application/json' \
--data-raw '{
    "@context":[
           "https://w3id.org/demeter/agri-context.jsonld"
    ],
    "@graph": [
    {
        "@id": "urn:ngsi-ld:farm:72d9fb43-53f8-4ec8-a33c-fa931360259a",
        "@type": "Farm",
        "hasGeometry": {
                    "@id": "urn:ngsi-ld:AgriFarm:geo:72d9fb43-53f8-4ec8-a33c-fa931360259x",
           "@type": "Point",
           "asWKT": "POINT(-7.8838706 40.571686)"
        },
        "containsPlot":[
        {
            "@id": "urn:ngsi-ld:plot:72d9fb43-53f8-4ec8-a33c-fa931360259a",
            "@type": "Plot",
            "name": "A1",
            "hasGeometry": {
                   "@id": "urn:ngsi-ld:plot:geo:72d9fb43-53f8-4ec8-a33c-fa931360259a",
                   "@type": "Polygon",
                 "asWKT": "POLYGON ((-7.8838706 40.571686, -7.8863275 40.5707813, -7.8838277
40.5692492, -7.8809309 40.570219, -7.8838706 40.571686))"
            },
            "area": "20",
            "totalSeeds": {
                "@id": "urn:demeter:res:72d9fb43-53f8-4ec8-a33c-fa931360259b",
                "@type": "QuantityValue",
                "numericValue": "2",
                "unit": "qudt-unit:Kg/m2",
                "applicationWidth": {
                       "@id": "urn:ngsi-ld:AW:2fcffe85-c239-3556-11c3fcc4fe29",
                       "@type": "QuantityValue",
                       "numericValue": "20",
                       "unit": {
                            "@id": "qudt-unit:M"
                       }
              }
           },
            "crop": {
                "@id": "urn:ngsi-ld:crop:df72dc57-1eb9-42a3-88a9-8647ecc954b4",
                "@type": "Crop",
                "cropSpecies":{
                       "@id":"urn:demeter:croptype:df72dc57-1eb9-42a3-88a9-8647ecc954b4",
```

```
                        "@type": "CropType",
                        "name": "Corn",
                        "description": "Spring corn parcel"
                 },
                 "cropStatus": "seeded",
                 "lastPlantedAt": "2020-10-01T12:00:00Z"
             },
            "soilProperty":  {
                 "@id": "urn:ngsi-ld:mz:soilp:df72dc57-1eb9-42a3-88a9-8647ecc954b4",
                 "@type": "PropertyType",
                     "name":"Silt",
                     "propertyType":"http://foodie-
cloud.com/model/foodie/code/PropertyTypeValue/soilType"
                 },
              "sowingPeriod":{
                     "@id": "urn:ngsi-ld:mz:sowingp:df72dc57-1eb9-42a3-88a9-8647ecc954b4",
                     "@type": "Interval",
                     "description": "Period for sowing",
                "hasBeginning":{"@id": "urn:ngsi-ld:mz:planting:beg:df72dc57-1eb9-42a3-88a9-
8647ecc954b4", "@type": "Instant", "inXSDDateTimeStamp":"2020-02-01T12:00:00Z"},
                     "hasEnd":{"@id": "urn:ngsi-ld:mz:planting:end:df72dc57-1eb9-42a3-88a9-
8647ecc954b4", "@type": "Instant", "inXSDDateTimeStamp":"2020-03-31T12:00:00Z"}
                 }
         }
       ]
     }
   ]
}'
```


Notes

B.4. DSS AREA: 4.D - Machinery and Field Operations

B.4.1. Component 4.D.1 Emission

Title	Retrieve registered machines for Emissions
URL	
/emissions/api/machines	
Method	
GET	
URL Params	
Required:	
Content-Type=application/json	Header for JSON request
Optional:	
Data Params	
Required:	
Optional:	
Success response	
200 Content: {[<List of Registered machines>]} See below for format of individual field	Request was successful
Error response	

404	Not found
403	Not authorized
Sample call	
Notes	

Title	Register field in Emissions/Update registered machine
URL	
/emissions/api/machines	
Method	
POST and PUT	
URL Params	
Required:	
Content-Type=application/json	Header for JSON request
Optional:	
Data Params	
Required:	
identifier (from existing system)	ID of the machine coming from existing systems
NOx in	Amount of NOx entering after treatment
NOx in Sensor	Status of inlet NOx Sensor
NOx out	Amount of NOx leaving after treatment
NOx out Sensor	Status of outlet NOx Sensor
Charge Air Temperature	Temperature of air after charge air cooler
DEF Level	Fluid level of diesel exhaust fluid
DEF Dosing Temperature	Dosing temperature of diesel exhaust fluid
DPF Regeneration Status	State of diesel particulate filter regeneration
Engine Coolant Temperature	Temperature of engine coolant
Fuel Temperature	Temperature of fuel
Engine Oil Temperature	Temperature of engine oil
Engine Oil Pressure	Pressure of engine oil
Crank Case Pressure	Pressure crank case
Fuel Delivery Pressure	Pressure fuel delivery
Engine Coolant Pressure	Pressure of engine coolant
Engine Coolant Level	Level of engine coolant
Engine speed	Rotations of Engine per minute
SCR in Temperature	Temperature at SCR intake
SCR out Temperature	Temperature at SCR outlet
Optional:	
Success response	
200 Content: {<machine Object>} The machine object identified in the body of the sample call below, will be returned if successfully registered in the emissions component	Request was successful

Error response	
404	Not found
403	Not authorized
Sample call	
Notes	
Some data params identified may also be objects containing several properties	

B.4.2. Component 4.D.2 Field Operation

Title	FieldOperation input
URL	
/api/FieldOperation/input	
Method	
GET	
URL Params	
Required:	
Optional:	
Data Params	
Required:	
Optional:	
Success response	
201	Success
Error response	
400	Bad Request
Sample call	


```
{
  "@context": [
    "https://w3id.org/demeter/agri-context.jsonld",
    "https://w3id.org/demeter/agri/ext/fieldOperation-context.jsonld"
  ],
  "@graph": [
    {
      "identifier": "04cad67f-0a97-4f0f-b111-cd581a42e4af",
      "_location": {
        "type": "Position",
        "lat": "45.267136",
        "lng": "19.833549"
      },
      "speed": "48.5",
      "breaking": "0",
      "fuelConsumption": "10",
      "_operator": {
        "type": "VehicleOperator",
        "id": "urn:demeter:v-operator:123",
        "identifier": "56dc8c09-03b2-47f5-a77a-b5ec00c86c16"
      },
      "@id": "urn:demeter:vehicle",
      "@type": "Vehicle"
    }
  ]
```

}
Notes

Title	FieldOperation output
URL	
/api/FieldOperation/output	
Method	
GET	
URL Params	
Required:	
Optional:	
Data Params	
Required:	
Optional:	
Success response	
201	Success
Error response	
400	Bad Request
Sample call	


```
{
  "@context": [
    "https://w3id.org/demeter/agri-context.jsonld",
    "https://w3id.org/demeter/agri/ext/fieldOperation-context.jsonld"
  ],
  "@graph": [
    {
      "identifier": "abe0770b-ae4c-4deb-9699-a3645af5c3a7",
      "@id": "urn:demeter:vehicle",
      "@type": "Vehicle"
    },
    {
      "description": "Driver behaviour based on breakage and fuel consumption",
      "driverBehaviourValue": "Bad",
      "@id": "urn:demeter:driverBehaviour",
      "@type": "DriverBehaviour"
    },
    {
      "trajectoryDuration": "0:33:00",
      "trajectoryDistance": "50",
      "trajectoryAverageSpeed": "113.7",
      "@id": "urn:demeter:vehicleTrajectory",
      "@type": "VehicleTrajectory"
    }
  ]
}
```


Notes

B.4.3. Component 4.D.3 Variable Rate

Title	Generate taskmap
URL	
/task_map/generate	
Method	
POST	
URL Params	
Required:	
Content-Type=application/json	Header for JSON request
Optional:	
Data Params	
Required:	
identifier (from existing system)	ID of the field coming from existing systems
validFrom	Date defining when the information provided can be considered valid from
validTo	Date defining when the information provided can be considered valid to
fieldGeometry	Geometry of the identified field: asWKT
treatmentQuantity	Base rate, with associated units, for the variable rate application, which will be redistributed according to NDVI values
Optional:	
description	A description of the field
category	The category of farming used within this field. E.g., arable
cropSpecies	The species of the crop currently planted within the identified field
cropStatus	The current status of the crops in the identified field. e.g., blooming, planted, maturing, …
lastPlantedAt	The date crops were last planted in the identified field
cropArea	Geometry of the total field area which contains the crops
applicationWidth	The width of the field machinery that applies the product on the field; when present in input, the service will take this parameter into account by producing rectangles of this given width in the application task map.
Success response	
200 Content: {JSON-LD AIM treatment description with associated management zones}	Request was successful
Error response	
400	Bad Request
403	Not authorized
Sample call	

```
curl --location --request POST ' https:// ://<COMPONENT-IP>//task_map/generate ' \
--header 'Content-Type: application/json' \
--data-raw '{"@context": ["https://w3id.org/demeter/agri-context.jsonld"],
```

```
"@graph": [
  {
    "@id":"urn:ngsi-ld:Plot:72d9fb43-53f8-4ec8-a33c-fa931360259a",
    "@type": "Plot",
    "code": "Plot1a",
    "validFrom":"30/1/2018",
    "hasGeometry": {
      "@id":"urn:ngsi-ld:Plot:geo:72d9fb43-53f8-4ec8-a33c-fa931360259a",
      "@type": "Polygon",
      "asWKT": "POLYGON ((2.6584237478090156 50.9580622571139870, 2.6587338968496641
50.9581579426010336, 2.6589429488131198 50.9582150219953576, 2.6591095643951315
50.9582528714251737, 2.6594131803025660 50.9583130331828329, 2.6597840234085823
50.9583763291639258, 2.6601631496043434 50.9584545804495264, 2.6603365480477104
50.9584938754040664, 2.6604075024417271 50.9584102952921612, 2.6604662546619218
50.9583568395615316, 2.6604342845380304 50.9583472936046604, 2.6605727867651963
50.9581954593736981, 2.6606363555663735 50.9581231012561133, 2.6607330759977792
50.9579965557217776, 2.6607734469812598 50.9579474185679047, 2.6608194310438913
50.9579005209109894, 2.6608524514342635 50.9578733963002009, 2.6608934925113696
50.9578449495156960, 2.6609513715096789 50.9578115321335829, 2.6612047259887084
50.9576841139061898, 2.6613162666076406 50.9576314243041466, 2.6614578206772155
50.9575716174280018, 2.6615244327002254 50.9575485769880245, 2.6616325855213563
50.9575146303461892, 2.6617372561265995 50.9574785649891382, 2.6617976757467297
50.9574535462686455, 2.6618553132177798 50.9574228224268495, 2.6618958429920814
50.9573927493935983, 2.6619421525628022 50.9573525098202822, 2.6620385672422953
50.9572498764658022, 2.6621232350015847 50.9571335851508209, 2.6621875857682133
50.9570044106813285, 2.6622157597119029 50.9569382817477106, 2.6623222637686292
50.9566443634807769, 2.6623754063259728 50.9564867027179460, 2.6623467652956743
50.9564756770014426, 2.6600325756526599 50.9558211107541226, 2.6584154185753190
50.9580525149500971, 2.6584237478090156 50.9580622571139870))"
    },
    "identifier": "example001",
    "area": "4.57",
    "description": "Potato parcel",
    "category": "arable",
    "cropStatus": "harvested",
    "lastPlantedAt": "2018-04-15T10:18:16Z",
    "crop": {
      "@id": "urn:ngsi-ld:CropSpecies:72d9fb43-53f8-4ec8-a33c-fa931360259a",
      "@type": "CropSpecies",
      "cropArea":{
        "@id": "urn:ngsi-ld:CropSpecies:geo:72d9fb43-53f8-4ec8-a33c-fa931360259a",
        "@type": "Polygon",
        "asWKT": "POLYGON ((2.6584237478090156 50.9580622571139870, 2.6587338968496641
50.9581579426010336, 2.6589429488131198 50.9582150219953576, 2.6591095643951315
50.9582528714251737, 2.6594131803025660 50.9583130331828329, 2.6597840234085823
50.9583763291639258, 2.6601631496043434 50.9584545804495264, 2.6603365480477104
50.9584938754040664, 2.6604075024417271 50.9584102952921612, 2.6604662546619218
50.9583568395615316, 2.6604342845380304 50.9583472936046604, 2.6605727867651963
50.9581954593736981, 2.6606363555663735 50.9581231012561133, 2.6607330759977792
50.9579965557217776, 2.6607734469812598 50.9579474185679047, 2.6608194310438913
50.9579005209109894, 2.6608524514342635 50.9578733963002009, 2.6608934925113696
50.9578449495156960, 2.6609513715096789 50.9578115321335829, 2.6612047259887084
50.9576841139061898, 2.6613162666076406 50.9576314243041466, 2.6614578206772155
50.9575716174280018, 2.6615244327002254 50.9575485769880245, 2.6616325855213563
50.9575146303461892, 2.6617372561265995 50.9574785649891382, 2.6617976757467297
50.9574535462686455, 2.6618553132177798 50.9574228224268495, 2.6618958429920814
50.9573927493935983, 2.6619421525628022 50.9573525098202822, 2.6620385672422953
50.9572498764658022, 2.6621232350015847 50.9571335851508209, 2.6621875857682133
50.9570044106813285, 2.6622157597119029 50.9569382817477106, 2.6623222637686292
50.9566443634807769, 2.6623754063259728 50.9564867027179460, 2.6623467652956743
50.9564756770014426, 2.6600325756526599 50.9558211107541226, 2.6584154185753190
50.9580525149500971, 2.6584237478090156 50.9580622571139870))"
      },
      "cropSpecies": {
        "@id": "urn:ngsi-ld:CropType:df72dc57-1eb9-42a3-88a9-8647ecc954b4"
```

```
      },
      "validFrom":"01/04/2018",
      "validTo":"30/09/2018",
      "production":{
        "productionAmount": {
          "propertyHasValue": 54.8,
          "isMeasuredIn":"http://www.ontology-of-units-of-measure.org/resource/om-2/tonne"
        }
      }
    }
  },
  {
    "@id": "urn:ngsi-ld:CropType:72d9fb43-53f8-4ec8-a33c-fa931360259a",
    "@type": "CropType",
    "code": "CropType2",
    "name": "Potato" ,
    "family": "Solanaceae",
    "description": "Fontane",
    "species": "Solanum tuberosum L. cv. Fontane"
  },
  {
    "@id": "urn:ngsi-ld:MZT:2fcffe85-c239-3556-11c3fcc4fe29",
    "@type": "Treatment",
    "name": "1",
    "interventionZone": {"@id": "urn:ngsi-ld:Plot:72d9fb43-53f8-4ec8-a33c-fa931360259a"},
        "interventionStart": "15/06/2018",
        "interventionEnd": "01/06/2018",
        "applicationWidth": {
          "@id": "urn:ngsi-ld:AW:2fcffe85-c239-3556-11c3fcc4fe29",
          "@type": "QuantityValue",
          "numericValue": 30,
          "unit": {
            "@id": "qudt-unit:M"
          }
        },
    "treatmentDescription": "Application of fertilizer xyz",
    "quantity": {
      "@id": "urn:ngsi-ld:TQ:2fcffe85-c239-3556-11c3fcc4fe29",
      "@type": "QuantityValue",
      "numericValue": 10,
      "unit": {"@id": "qudt-unit:KiloGM-PER-M2"}
    }
  }
]}'
```

Notes This field holds any additional helpful info related to this endpoint.

B.5. DSS AREA: 4.E - Pest and Disease Management

B.5.1. Component 4.E.1 Pest Estimation with Sterile Fruit Flies

Title	Generate a new model
URL	
/createModel	
Method	
POST	
URL Params	
Required:	

Optional:	
Data Params	
Required:	
modelName	The name of the new model
datasetFile	The zip file containing the training dataset (consisting of images and labels)
Optional:	
pretrainedModelFile	.h5 pretrained model to be used in the generation of the model
trainingRatio	Ratio of images used for the model creation
trainingBatchSize	Batch size (number of examples in parallel to train the model) in the model creation
trainingNumExperiments	Number of times the algorithm will be trained on the image dataset
Success response	
200 Content: { AIM output file } See further details in next section	AIM datamodel containing the name of the generated model.
Error response	
400	Invalid argument
500	Server error
Sample call	
Notes	
Component still under development, this may be subject to future changes	

Title	Perform the fly counting
URL	
/countElements	
Method	
POST	
URL Params	
Required:	
Optional:	
Data Params	
Required:	
ModelName	Name of the model to be used for the element counting
imageFile	Image to be used as input for the element counting.
trapID	Id of the trap that captured the image
Optional:	
threshold	Threshold of minimum certainty given by the model to a potential identified element to be included in the output.

Success response	
200 Content: { AIM output file } See further details in next section	AIM datamodel containing the results of the element counting from the image provided.
Error response	
400	Invalid argument
500	Server error
Sample call	
Notes	
Component still under development, this may be subject to future changes	

Title	Upload an existing model
URL	
/uploadModel	
Method	
POST	
URL Params	
Required:	
Optional:	
Data Params	
Required:	
ModelName	Name to save the uploaded model
ModelFile	File model (.h5 format)
JsonFile	Model configuration file (JSON format)
Optional:	
numClasses	Number of classes the model can predict
Classes	Name of the classes the model can predict
info	Information about the model
Success response	
200 Content: { AIM output file } See further details in next section	AIM datamodel containing the results of the element counting from the image provided.
Error response	
400	Invalid argument
500	Server error
Sample call	
Notes	
Component still under development, this may be subject to future changes	

Title	Get trap data
URL	
/getStatistics	

Method	
POST	
URL Params	
Required:	
Optional:	
Data Params	
Required:	
startDate	Starting date of the data requested
endDate	End date of the data requested
numStimations	Number of elements to be predicted after the requested data
Optional:	
trapID	Id of the trap ex
Success response	
200 Content: { AIM output file } See further details in next section	AIM datamodel containing the results of the element counting from the image provided.
Error response	
400	Invalid argument
500	Server error
Sample call	
Notes	
Component still under development, this may be subject to future changes	

B.5.2. Component 4.E.2 Estimate temperature-related pest events

Title	Temperature-related Pest events API
URL	
/e2.pest.event/v1/:lat/:lon/:date	
Method	
GET	
URL Params	
Required:	
lat	Latitude of the point
lon	Longitude of the point
date	Date for the prediction
Optional:	
Data Params	
Required:	
Optional:	
Success response	

200	Contains a time series in AIM format (see Annex C)
Error response	
404	Not found
403	Not authorized
Sample call	
`curl --location -request POST 'https://<COMPONENT-ID>//e2.pest.event/v1/43.12/12.45/2020-07-01' \ --header 'Content-Type: application/json' \`	
Notes	

B.6. DSS AREA: 4.F - Animal Yield

B.6.1. Component 4.F.1 Estimate Milk Production

Title	Request Milk Yield Forecast
URL	
/predictMilkYield/run	
Method	
POST	
URL Params	
Required:	
Content-Type=application/json	Header for JSON request
Optional:	
Data Params	
Required:	
Requires a JSON payload POST in the request of the input format in AIM as per Annex C below	
Optional:	
Success response	
200 Returns AIM formatted response in JSON-LD as per Annex C below	Request was successful
Error response	
404	Not found
403	Not authorized
Sample call	
`curl --location -request POST 'https://<COMPONENT-ID>//predictMilkYield/run' \ --header 'Content-Type: application/json' \`	
Notes	

B.6.2. Component 4.F.2 Poultry Feeding

Title	PoultryFeeding input
URL	
/api/PoultryFeeding/input	
Method	
GET	
URL Params	
Required:	
Optional:	
Data Params	
Required:	
Optional:	
Success response	
201	Success
Error response	
400	Bad response
Sample call	


```
{
  "@context": [
    "https://w3id.org/demeter/agri-context.jsonld",
    "https://w3id.org/demeter/agri/ext/poultryFeeding-context.jsonld"
  ],
  "@graph": [
    {
      "silosID": "5812fbbe-3ce5-4b81-a74a-b680000a5bef",
      "silosVolume": 100,
      "silosFoodType": "corn",
      "silosFoodDensity": 97,
      "silosEmptyDistance": 3,
      "@id": "urn:demeter:silos",
      "@type": "Silos"
    },
    {
      "flockId": "88acd214-f633-4db7-9560-0ca69abc1a4a",
      "animalSpecies": "Chicken",
      "flockAverageAge": 1,
      "@id": "urn:demeter:flock",
      "@type": "Flock"
    }
  ]
}
```


Notes

Title	PoultryFeeding output
URL	
/api/PoultryFeeding/output	
Method	
GET	
URL Params	

Required:	
Optional:	
Data Params	
Required:	
Optional:	
Success response	
201	Success
Error response	
400	Bad response
Sample call	

```
{
  "@context": [
    "https://w3id.org/demeter/agri-context.jsonld",
    "https://w3id.org/demeter/agri/ext/poultryFeeding-context.jsonld"
  ],
  "@graph": [
    {
      "animalSpecies": "Poultry",
      "observedAt": "2021-05-18T18:20:47.6942537+00:00",
      "animalFeedingQuality": "Good",
      "@id": "urn:demeter:animalFeeding",
      "@type": "AnimalFeeding"
    }
  ]
}
```

Notes	

B.7. DSS AREA: 4.G - Animal Welfare

B.7.1. Component 4.G.1 Estimate Animal Welfare Condition

Title	Algorithm training, calculation of metrics and sending of results data
URL	
/EstimateAnimalWelfareConditionModule/v1/animalWelfareTraining	
Method	
GET	
URL Params	
Required:	
Content-Type=application/json	Header for JSON request
Optional:	
N/A	N/A
Data Params	
Required:	
N/A	N/A
Optional:	
N/A	N/A
Success response	

200 Content: {[< Animal Welfare **AIM Model - Output - Training** >]}	Request was successful
Error response	
404	Not found
403	Not authorized
Sample call	
Notes	
Before doing any request, you must upload the data as CSV file using the **Translator Service**	

Title	Upload of data in CSV format and transformation of data in AIM format
URL	
/demeter-csvManager/rest/translator/v1/AnimalWelfareTraining	
Method	
GET	
URL Params	
Required:	
Content-Type=application/json	Header for JSON request
Optional:	
N/A	N/A
Data Params	
Required:	
N/A	N/A
Optional:	
N/A	N/A
Success response	
200 Content: {[< Animal Welfare **AIM Model - Input - Training** >]}	Request was successful
Error response	
404	Not found
403	Not authorized
Sample call	
Notes	
Converts, in JSON-LD AnimalWelfare Training AIM, the CSV file present in the folder /usr/local/pilot4.2/csv/AWT/	

Title	Estimating the health condition and sending the result data
URL	
/EstimateAnimalWelfareConditionModule/v1/animalWelfarePrediction	
Method	
GET	
URL Params	
Required:	
Content-Type=application/json	Header for JSON request

Optional:	
N/A	N/A
Data Params	
Required:	
N/A	N/A
Optional:	
N/A	N/A
Success response	
200 Content: {[< Animal Welfare **AIM Model - Output - Prediction** >]}	Request was successful
Error response	
404	Not found
403	Not authorized
Sample call	
Notes	
Before doing any request, you must upload the data as CSV file using the **Translator Service**	

Title	Upload of data in CSV format and transformation of data in AIM format
URL	
/demeter-csvManager/rest/translator/v1/AnimalWelfarePrediction	
Method	
GET	
URL Params	
Required:	
Content-Type=application/json	Header for JSON request
Optional:	
N/A	N/A
Data Params	
Required:	
N/A	N/A
Optional:	
N/A	N/A
Success response	
200 Content: {[< Animal Welfare **AIM Model - Input - Prediction** >]}	Request was successful
Error response	
404	Not found
403	Not authorized
Sample call	
Notes	
Converts, in JSON-LD Animal Welfare Prediction AIM, the CSV file present in the folder /usr/local/pilot4.2/csv/AWP/	

B.7.2. Component 4.G.2 Poultry Well Being

Title	StressRecognition input
URL	
/api/StressRecognition/input	
Method	
GET	
URL Params	
Required:	
Optional:	
Data Params	
Required:	
Optional:	
Success response	
201	Success
Error response	
400	Bad Request
Sample call	


```
{
  “@context”: [
    “https://w3id.org/demeter/agri-context.jsonld”,
    “https://w3id.org/demeter/agri/ext/poultryFeeding-context.jsonld”,
    “https://w3id.org/demeter/agri/ext/stressRecognition-context.jsonld”
  ],
  “@graph”: [
    {
      “animalRawSound”: “https://link.sound”,
      “extractedFeaturesFromSound”: “Set of characteristics extracted as numerical float
data.”,
      “airTemperature”: 23.5,
      “airHumidity”: 27.38,
      “airflow”: 50,
      “lightIntensity”: 10,
      “airCO2": 1.39,
      "powerLoses": 0,
      "@id": "urn:demeter:device",
      "@type": "Device"
    },
    {
      "identifier": "88acd214-f633-4db7-9560-0ca69abc1a4a",
      "animalSpecies": "Chicken",
      "flockAverageAge": "1",
      "@id": "urn:demeter:flock",
      "@type": "AnimalGroup"
    }
  ]
}
```


Notes

Title	StressRecognition output
URL	
/api/StressRecognition/output	
Method	
GET	
URL Params	
Required:	
Optional:	
Data Params	
Required:	
Optional:	
Success response	
201	Success
Error response	
400	Bad Request
Sample call	


```
{
  "@context": [
    "https://w3id.org/demeter/agri-context.jsonld",
    "https://w3id.org/demeter/agri/ext/poultryFeeding-context.jsonld",
    "https://w3id.org/demeter/agri/ext/stressRecognition-context.jsonld"
  ],
  "@graph": [
    {
      "identifier": "88acd214-f633-4db7-9560-0ca69abc1a4a",
      "animalSpecies": "Chicken",
      "flockAverageAge": "1",
      "@id": "urn:demeter:flock",
      "@type": "AnimalGroup"
    },
    {
      "stressLevel": "abnormal",
      "safetyInstructions": "check flock",
      "@id": "urn:demeter:stress",
      "@type": "StressOrPressure"
    }
  ]
}
```


Notes

B.8. DSS AREA: 4.H - Traceability

B.8.1. Component 4.H.1 Milk Quality Prediction

Title	Algorithm training, calculation of metrics and sending of results data
URL	
/EstimateMilkQualityModule/v1/milkQualityTraining	
Method	
GET	
URL Params	
Required:	
Content-Type=application/json	Header for JSON request
Optional:	
N/A	N/A
Data Params	
Required:	
N/A	N/A
Optional:	
N/A	N/A
Success response	
200 Content: {[< Milk Quality **AIM Model - Output - Training** >]}	Request was successful
Error response	
404	Not found
403	Not authorized
Sample call	
Notes	
Before doing any request, you must upload the data as CSV file using the **Translator Service**	

Title	Upload of data in CSV format and transformation of data in AIM format
URL	
/demeter-csvManager/rest/translator/v1/MilkQualityTraining	
Method	
GET	
URL Params	
Required:	
Content-Type=application/json	Header for JSON request
Optional:	
N/A	N/A
Data Params	
Required:	
N/A	N/A
Optional:	
N/A	N/A
Success response	

200 Content: {[< Milk Quality **AIM Model - Input - Training** >]}	Request was successful
Error response	
404	Not found
403	Not authorized
Sample call	
Notes	
Converts the CSV file present in the folder /usr/local/pilot4.2/csv/MQT/ into JSON-LD MilkQuality Training AIM	

Title	Estimating the milk quality and sending the result data
URL	
/EstimateMilkQualityModule/v1/milkQualityPrediction	
Method	
GET	
URL Params	
Required:	
Content-Type=application/json	Header for JSON request
Optional:	
N/A	N/A
Data Params	
Required:	
N/A	N/A
Optional:	
N/A	N/A
Success response	
200 Content: {[< Milk Quality **AIM Model - Output - Prediction** >]}	Request was successful
Error response	
404	Not found
403	Not authorized
Sample call	
Notes	
Before doing any request, you must upload the data as CSV file using the **Translator Service**	

Title	Upload of data in CSV format and transformation of data in AIM format
URL	
/demeter-csvManager/rest/translator/v1/MilkQualityPrediction	
Method	
GET	
URL Params	
Required:	

Content-Type=application/json	Header for JSON request
Optional:	
N/A	N/A
Data Params	
Required:	
N/A	N/A
Optional:	
N/A	N/A
Success response	
200 Content: {[< Milk Quality **AIM Model - Input - Prediction** >]}	Request was successful
Error response	
404	Not found
403	Not authorized
Sample call	
Notes	
Converts the CSV file present in the folder /usr/local/pilot4.2/csv/MQP/ into JSON-LD MilkQuality Prediction AIM	

B.8.2. Component 4.H.2 Transport Condition

Title	TransportCondition input
URL	
/api/TransportCondition/input	
Method	
GET	
URL Params	
Required:	
Optional:	
Data Params	
Required:	
Optional:	
Success response	
201	Success
Error response	
400	Bad response
Sample call	


```
{
  "@context": [
    "https://w3id.org/demeter/agri-context.jsonld"
  ],
  "@graph": [
    {
      "identifier": "b72312bb-17a0-4684-b92e-673fe4c1d06c",
      "certificates": "Poultry certificate",
      "@id": "urn:demeter:producer",
```

```
      "@type": "Flock"
    },
    {
      "placeOfProduction": {
        "name": "Sinkovic",
        "lat": "45.267136",
        "lng": "19.833549",
        "@id": "urn:demeter:placeOfProduction",
        "@type": "PlaceOfProduction"
      },
      "mhr": "vaccinated, no medical treatment",
      "poultryType": "Hybrid",
      "@id": "urn:demeter:poultryProduct",
      "@type": "StressOrPressure"
    },
    {
      "transportCondition": "Good",
      "@id": "urn:demeter:transport",
      "@type": "Transport"
    }
  ]
}
```


Notes

Title	TransportCondition output
URL	
/api/TransportCondition/output	
Method	
GET	
URL Params	
Required:	
Optional:	
Data Params	
Required:	
Optional:	
Success response	
201	Success
Error response	
400	Bad response
Sample call	


```
{
  "@context": [
    "https://w3id.org/demeter/agri-context.jsonld",
    "https://w3id.org/demeter/agri/ext/transportCondition-context.jsonld"
  ],
  "@graph": [
    {
      "packageId": "0ccd0e4c-bebe-4f85-8b47-86c40cbc7343",
      "transportCondition": 1,
      "@id": "urn:demeter:transport",
      "@type": "Transport"
    }
```

] }
Notes

B.8.3. Component 4.H.3 Field Book and FaST

No REST APIs are expected for this component as it is developed as a standalone component which does not make use of Knowage for visualisation.

B.9. DSS AREA: 4.I - Benchmarking

B.9.1. Component 4.I.0 Indicator Engine for Benchmarking Purpose

Title	Get the list of the indicators
URL	
/api/i0/indicator	
Method	
GET	
URL Params	
Required:	
Optional:	
Data Params	
Required:	
Optional:	
Success response	
200	The response contains the list of public indicators associated with the benchmarking instances
Error response	
403	Not authorized
Sample call	
`curl -X GET "https://path_to_api/api/i0/indicator" -H "accept: application/json"`	
Notes	

Title	Add a new Indicator
URL	
/api/i0/indicator	
Method	
POST	
URL Params	
Required:	
Optional:	

Data Params	
Required:	
Body	A well-formed JSON describing a KPIIndicator
Optional:	
Success response	
200	The KPIIndicator has been inserted
Error response	
401	The Indicator is not well formed
402	The indicator id already exists in the database
403	User not allowed
Sample call	
`curl -X POST "https://path_to_api/api/i0/indicator" -H "accept: application/json" -H "X-API-KEY: XXXXXX" -H "Content-Type: application/json" -d "{ \"@id\": \"https://w3id.org/demeter/agri/ext/kpiIndicator#TestIndicator\", \"@type\": \"KpiIndicator\", \"schema.name\": \"This is a test indicator\", \"sector\": { \"@id\": \"https://w3id.org/demeter/agri/ext/kpiIndicator#sectorScheme-Economic\" }}"`	
Notes	

Title	Update an existing indicator
URL	
/api/i0/indicator/<:indicator_code>	
Method	
PUT	
URL Params	
Required:	
indicator_code	the @id of the indicator
Optional:	
Data Params	
Required:	
Body	A well-formed JSON describing a KPIIndicator
Optional:	
Success response	
200	The KPIIndicator has been update
Error response	
401	The Indicator is not well formed
402	The indicator id already exists in the database
403	User not allowed
Sample call	
`curl -X PUT "https://path_to_api/api/i0/indicator/https%3A%2F%2Fw3id.org%2Fdemeter%2Fagri%2Fext%2FkpiIndicator%23TestIndicator/" -H "accept: application/json" -H "Content-Type: application/json" -d "{ \"@id\": \"https://w3id.org/demeter/agri/ext/kpiIndicator#TestIndicator\", \"@type\": \"KpiIndicator\", \"schema.name\": \"This is a test indicator\", \"sector\": { \"@id\": \"https://w3id.org/demeter/agri/ext/kpiIndicator#sectorScheme-Economic\" }}"`	
Notes	

Title	Delete an existing indicator
URL	
/api/i0/indicator/<:indicator_code>	
Method	
DELETE	
URL Params	
Required:	
indicator_code	the @id of the indicator
Optional:	
Data Params	
Required:	
Optional:	
Success response	
200	The KPIIndicator has been deleted
Error response	
401	The Indicator is not well formed
402	The indicator id already exists in the database
403	User not allowed
Sample call	
`curl -X DELETE "https://path_to_api/api/i0/indicator/https%3A%2F%2Fw3id.org%2Fdemeter%2Fagri%2Fext%2FkpiIndicator%23TestIndicator/" -H "accept: application/json"`	
Notes	

B.9.2. Component 4.I.1 Generic Farm Comparison

Title	Run the generic benchmarking component
URL	
/api/i1/generic_benchmarking	
Method	
POST	
URL Params	
Required:	
Optional:	
Data Params	
Required:	
BODY	A valid AIM Farm object
Optional:	
Success response	
200	Success; return JSON-LD with KpiIndicator and KpiIndicatorValue

Error response	
401	Input is not well-formed
403	Not authorized
Sample call	
`curl -X POST "https://api_url/api/i1/generic_benchmarking" -H "accept: application/json" -H "Content-Type: application/json" -d "{ \"@type\": \"Farm\", \"hasGeometry\": { \"asWKT\": \"POINT(11.5,42.9)\" }, \"containsPlot\": [{ \"@type\": \"Plot\", \"area\": \"12000\", \"crop\": { \"cropSpecies\": { \"name\": \"Wheat\" } } }]}"`	
Notes	

Title	Store the results of the generic benchmarking component
URL	
/api/i1/generic_benchmarking/store	
Method	
URL Params	
Required:	
Optional:	
Data Params	
Required:	
BODY	A valid AIM Farm object
Optional:	
Success response	
200	Success; return a guid that can be used to retrieve the KpiIndicatorvalue (to register in Knowage)
Error response	
401	Input is not well-formed
403	Not authorized
Sample call	
`curl -X POST "https://api_url/api/i1/generic_benchmarking/store" -H "accept: application/json" -H "Content-Type: application/json" -d "{ \"@type\": \"Farm\", \"hasGeometry\": { \"asWKT\": \"POINT(11.5,42.9)\" }, \"containsPlot\": [{ \"@type\": \"Plot\", \"area\": \"12000\", \"crop\": { \"cropSpecies\": { \"name\": \"Wheat\" } } }]}"`	
Notes	

Title	Retrieve the generic benchmarking component
URL	
/api/i1/generic_benchmarking/<string:guid>	
Method	
URL Params	
Required:	

guid	The guid of the benchmarking value (obtained by the generic_benchmarking/store call)
Optional:	
Data Params	
Required:	
BODY	A valid AIM Farm object
Optional:	
Success response	
200	Success; return JSON-LD with KpiIndicator and KpiIndicatorValue
Error response	
401	Input is not well-formed
403	Not authorized
Sample call	
`curl -X GET "https://path_to_api/api/i1/generic_benchmarking/XXXXXX" -H "accept: application/json"`	
Notes	

B.9.3. Component 4.I.2 Neighbour benchmarking

Title	Create a new benchmarking group
URL	
/i2/create_group/	
Method	
POST	
URL Params	
Required:	
Optional:	
Data Params	
Required:	
BODY	A JSON with the group data
`{ "name": "Pisa Olive growers", "mode": "closed", "users": [ "email@pisa.it", "email2@pisa.it", ] }`	
Optional:	
Success response	
200	Success; return the guid of the group
Error response	
401	Input is not well-formed
403	Not authorized

Sample call
`curl -X POST "https://path_to_api/api/i2/create_group/" -H "accept: application/json" -H "Content-Type: application/json" -d "{ \"name\": \"string\", \"mode\": \"open\", \"users\": [ \"string\" ]}"`
Notes

Title	Register a farm (if the user is allowed) to a benchmarking group
URL	
/i2/group/{group_code}/register	
Method	
POST	
URL Params	
Required:	
group_code	The guid of the benchmarking group (obtained from the create_group API)
Optional:	
Data Params	
Required:	
BODY	A valid AIM Farm object
Optional:	
Success response	
200	Success; return the farm guid for the benchmarking; (to be used in other calls)
Error response	
401	Input is not well-formed
403	Not authorized
Sample call	
`curl -X POST "https://path_to_api/api/i2/group/AAxx11/register" -H "accept: application/json" -H "Content-Type: application/json" -d "{ \"@type\": \"Farm\", \"hasGeometry\": { \"asWKT\": \"POINT(11.5,42.9)\" }, \"containsPlot\": [{ \"@type\": \"Plot\", \"area\": \"12000\", \"crop\": { \"cropSpecies\": { \"name\": \"Wheat\" } } }]}"`	
Notes	

Title	Update the farm indicators; all the data are replaced with the POST content
URL	
/i2/group/{group_code}/farm/{farm_id}	
Method	
POST	
URL Params	
Required:	
group_code	The guid of the benchmarking group (obtained from the create_group API)
farm_id	The guid of the farm in the group
Optional:	

Data Params	
Required:	
BODY	An array of KpiIndicatorValue object with indicator values
Optional:	
Success response	
200	Success
Error response	
401	Input is not well-formed
403	Not authorized
Sample call	
`curl -X POST "https://path_to_api/api/i2/group/AAxx11/farm/fam_1" -H "accept: application/json" -H "Content-Type: application/json" -d "{ \"indicators\": [ { \"type\": \"KpiIndicatorValue\", \"observedProperty\": \"string\", \"hasResult\": \"string\" } ]}"`	
Notes	

Title	Update the farm indicators; the system performs an UPSERT using the indicator_id and time_ref as keys; new data are inserted, existing data are updated
URL	
/i2/group/{group_code}/farm/{farm_id}	
Method	
PUT	
URL Params	
Required:	
group_code	The guid of the benchmarking group (obtained from the create_group API)
farm_id	The guid of the farm in the group
Optional:	
Data Params	
Required:	
BODY	An array of KpiIndicatorValue object with indicator values
Optional:	
Success response	
200	Success
Error response	
401	Input is not well-formed
403	Not authorized
Sample call	
`curl -X PUT "https://path_to_api/api/i2/group/AAxx11/farm/fam_1" -H "accept: application/json" -H "Content-Type: application/json" -d "{ \"indicators\": [ { \"type\": \"KpiIndicatorValue\", \"observedProperty\": \"string\", \"hasResult\": \"string\" } ]}"`	
Notes	

Title	Get the indicators result for group benchmarking
URL	
/i2/group/{group_code}/farm/{farm_id}	
Method	
GET	
URL Params	
Required:	
group_code	The guid of the benchmarking group (obtained from the create_group API)
farm_id	The guid of the farm in the group
Optional:	
Data Params	
Required:	
200	Success; return JSONLD with KpiIndicator and KpiIndicatorValue ready to be visualised by Knowage
Optional:	
Success response	
Error response	
401	Input is not well-formed
403	Not authorized
Sample call	
`curl -X GET "https://path_to_api/api/i2/group/AAxx11/farm/farm_1" -H "accept: application/json"`	
Notes	

B.9.4. Component 4.I.3 Technology benchmarking

Title	Create a new technology benchmarking group
URL	
/i3/technology/	
Method	
POST	
URL Params	
Required:	
Optional:	
Data Params	
Required:	
BODY	A valid AIM Farm object
`{ "name": "DSS irrigation",`	

```
  "mode": "open",
  "type": "digital_services",
  "levels": [
    "adopting","non_adopting"
  ]
}
```

Optional:	
Success response	
200	Success; return the guid of the technology
Error response	
401	Input is not well-formed
403	Not authorized
Sample call	
`curl -X POST "https://path_to_api/api/i3/technology/" -H "accept: application/json" -H "Content-Type: application/json" -d "{ \"name\": \"string\", \"mode\": \"open\", \"users\": [ \"string\" ], \"type\": \"digital_services\", \"levels\": [ \"string\" ]}"`	
Notes	

Title	Update the technology indicators; all the farm data are replaced with the POST content
URL	
/i3/technology/{tech_code}/level/{adoption_level}	
Method	
POST	
URL Params	
Required:	
tech_code	The guid of the technology benchmarking group (obtained from the create_technology API)
adoption_level	The adoption level the benchmarking indicator are referenced
Optional:	
Data Params	
Required:	
BODY	An array of KpiIndicatorValue object with indicator values
Optional:	
Success response	
200	Success
Error response	
401	Input is not well-formed
403	Not authorized
Sample call	
`curl -X POST "https://path_to_api/api/i3/technology/TECH_001/level/adopted" -H "accept: application/json" -H "Content-Type: application/json" -d "{ \"indicators\": [ { \"type\": \"KpiIndicatorValue\", \"observedProperty\": \"string\", \"hasResult\": \"string\" } ]}"`	
Notes	

Title	Update the technology indicators; the system performs an UPSERT using the farm_id, indicator_id and time_ref as keys; new data are inserted, existing data are updated
URL	
/i3/technology/{tech_code}/level/{adoption_level}	
Method	
PUT	
URL Params	
Required:	
tech_code	The guid of the technology benchmarking group (obtained from the create_technology API)
adoption_level	The adoption level the benchmarking indicator are referenced
Optional:	
Data Params	
Required:	
BODY	An array of KpiIndicatorValue object with indicator values
Optional:	
Success response	
200	Success
Error response	
401	Input is not well-formed
403	Not authorized
Sample call	
`curl -X PUT "https://path_to_api/api/i3/technology/TECH_001/level/adopted" -H "accept: application/json" -H "Content-Type: application/json" -d "{ \"indicators\": [ { \"type\": \"KpiIndicatorValue\", \"observedProperty\": \"string\", \"hasResult\": \"string\" } ]}"`	
Notes	

Title	Get the indicators value for a technology
URL	
/i3/technology/{tech_code}/	
Method	
GET	
URL Params	
Required:	
tech_code	The guid of the technology benchmarking group (obtained from the create_technology API)
Optional:	
Data Params	
Required:	
Optional:	

Success response	
200	Success; return JSON-LD with KpiIndicator and KpiIndicatorValue ready to be visualised by Knowage
Error response	
401	Input is not well-formed
403	Not authorized
Sample call	
`curl -X GET "https://path_to_api/api/i3/technology/TECH_001/" -H "accept: application/json"`	
Notes	

Annex C AIM Models

This annex provides the inputs and outputs for the different DSS components which are compliant with the AIM developed within WP2.

C.1. DSS AREA: 4.A - Crop Growth, Status and Yield

C.1.1. Component 4.A.1 Plant Yield Estimation

AIM Model - Input


```
{"@context": ["https://w3id.org/demeter/agri-context.jsonld"],
"@graph": [
  {
    "@id":"urn:ngsi-ld:Plot:72d9fb43-53f8-4ec8-a33c-fa931360259a",
    "@type": "Plot",
    "code": "Plot1a",
    "validFrom":"30/1/2018",
    "validTo":"30/10/2018",
    "hasGeometry": {
      "@id":"urn:ngsi-ld:Plot:geo:72d9fb43-53f8-4ec8-a33c-fa931360259a",
      "@type": "Polygon",
      "asWKT": "POLYGON ((2.6584237478090156 50.9580622571139870, 2.6587338968496641 50.9581579426010336, 2.6589429488131198
50.9582150219953576, 2.6591095643951315 50.9582528714251737, 2.6594131803025660 50.9583130331828329, 2.6597840234085823
50.9583763291639258, 2.6601631496043434 50.9584545804495264, 2.6603365480477104 50.9584938754040664, 2.6604075024417271
50.9584102952921612, 2.6604662546619218 50.9583568395615316, 2.6604342845380304 50.9583472936046604, 2.6605727867651963
50.9581954593736981, 2.6606363555663735 50.9581231012561133, 2.6607330759977792 50.9579965557217776, 2.6607734469812598
50.9579474185679047, 2.6608194310438913 50.9579005209109894, 2.6608524514342635 50.9578733963002009, 2.6608934925113696
50.9578449495156960, 2.6609513715096789 50.9578115321335829, 2.6612047259887084 50.9576841139061898, 2.6613162666076406
50.9576314243041466, 2.6614578206772155 50.9575716174280018, 2.6615244327002254 50.9575485769880245, 2.6616325855213563
50.9575146303461892, 2.6617372561265995 50.9574785649891382, 2.6617976757467297 50.9574535462686455, 2.6618553132177798
50.9574228224268495, 2.6618958429920814 50.9573927493935983, 2.6619421525628022 50.9573525098202822, 2.6620385672422953
50.9572498764658022, 2.6621232350015847 50.9571335851508209, 2.6621875857682133 50.9570044106813285, 2.6622157597119029
50.9569382817477106, 2.6623222637686292 50.9566443634807769, 2.6623754063259728 50.9564867027179460, 2.6623467652956743
50.9564756770014426, 2.6600325756526599 50.9558211107541226, 2.6584154185753190 50.9580525149500971, 2.6584237478090156
50.9580622571139870))"
    },
    "identifier": "example001",
    "area": "4.57",
    "description": "Potato parcel",
    "category": "arable",
```

```
    "cropStatus": "harvested",
    "lastPlantedAt": "2018-04-15T10:18:16Z",
    "crop": {
      "@id": "urn:ngsi-ld:CropSpecies:72d9fb43-53f8-4ec8-a33c-fa931360259a",
      "@type": "CropSpecies",
      "cropArea":{
        "@id": "urn:ngsi-ld:CropSpecies:geo:72d9fb43-53f8-4ec8-a33c-fa931360259a",
        "@type": "Polygon",
        "asWKT": "POLYGON ((2.6584237478090156 50.9580622571139870, 2.6587338968496641 50.9581579426010336, 2.6589429488131198
50.9582150219953576, 2.6591095643951315 50.9582528714251737, 2.6594131803025660 50.9583130331828329, 2.6597840234085823
50.9583763291639258, 2.6601631496043434 50.9584545804495264, 2.6603365480477104 50.9584938754040664, 2.6604075024417271
50.9584102952921612, 2.6604662546619218 50.9583568395615316, 2.6604342845380304 50.9583472936046604, 2.6605727867651963
50.9581954593736981, 2.6606363555663735 50.9581231012561133, 2.6607330759977792 50.9579965557217776, 2.6607734469812598
50.9579474185679047, 2.6608194310438913 50.9579005209109894, 2.6608524514342635 50.9578733963002009, 2.6608934925113696
50.9578449495156960, 2.6609513715096789 50.9578115321335829, 2.6612047259887084 50.9576841139061898, 2.6613162666076406
50.9576314243041466, 2.6614578206772155 50.9575716174280018, 2.6615244327002254 50.9575485769880245, 2.6616325855213563
50.9575146303461892, 2.6617372561265995 50.9574785649891382, 2.6617976757467297 50.9574535462686455, 2.6618553132177798
50.9574228224268495, 2.6618958429920814 50.9573927493935983, 2.6619421525628022 50.9573525098202822, 2.6620385672422953
50.9572498764658022, 2.6621232350015847 50.9571335851508209, 2.6621875857682133 50.9570044106813285, 2.6622157597119029
50.9569382817477106, 2.6623222637686292 50.9566443634807769, 2.6623754063259728 50.9564867027179460, 2.6623467652956743
50.9564756770014426, 2.6600325756526599 50.9558211107541226, 2.6584154185753190 50.9580525149500971, 2.6584237478090156
50.9580622571139870))"
      },
      "cropSpecies": {
        "@id": "urn:ngsi-ld:CropType:df72dc57-1eb9-42a3-88a9-8647ecc954b4"
      },
      "validFrom":"01/04/2018",
      "validTo":"30/09/2018",
      "production":{
        "productionAmount": {
          "propertyHasValue": 54.8,
          "isMeasuredIn":"http://www.ontology-of-units-of-measure.org/resource/om-2/tonne"
        }
      }
    }
  },
  {
    "@id": "urn:ngsi-ld:CropType:72d9fb43-53f8-4ec8-a33c-fa931360259a",
    "@type": "CropType",
    "code": "CropType2",
    "name": "Potato" ,
    "family": "Solanaceae",
```

```
    "description": "Fontane",
    "species": "Solanum tuberosum L. cv. Fontane"
  }
]}
```


AIM Model - Intermediary data: daily NDVI timeseries data


```
{"@context": ["https://w3id.org/demeter/agri-context.jsonld"],
"@graph": [
{"@id": "urn:ngsi-ld:Plot:72d9fb43-53f8-4ec8-a33c-fa931360259a",
 "@type": "Plot",
 "code": "example_001",
 "validFrom": "01/04/2018",
 "hasGeometry":{
    "@id": "urn:ngsi-ld:Plot:geo:72d9fb43-53f8-4ec8-a33c-fa931360259a",
    "@type": "Polygon",
    "asWKT": "POLYGON ((2.6584237478090156 50.9580622571139870, 2.6587338968496641 50.9581579426010336, 2.6589429488131198
50.9582150219953576, 2.6591095643951315 50.9582528714251737, 2.6594131803025660 50.9583130331828329, 2.6623467652956743
50.9564756770014426, 2.6600325756526599 50.9558211107541226, 2.6584154185753190 50.9580525149500971, 2.6584237478090156
50.9580622571139870))"},
  "identifier": "000028064C7F4F23",
  "area": "4.57",
  "description": "Potato parcel",
  "category": "arable",
  "cropStatus": "harvested",
  "lastPlantedAt": "01/04/2018",
  "crop": {
      "@id": "urn:ngsi-ld:CropType:72d9fb43-53f8-4ec8-a33c-fa931360259a",
      "@type": "CropType",
      "code": "CropType2",
      "name": "Potato",
      "family": "Solanaceae",
      "description": "Fontane",
      "species": "Solanum tuberosum L. cv. Fontane"
  }
},
{
  "@id": "urn:demeter:observation-3bc7bd11-05f5-25c8-80a13130b91b",
  "@type": "Observation",
  "observedProperty": {
```

```
      "@id": "http://purl.oclc.org/NET/ssnx/cf/cf-property#normalized_difference_vegetation_index"},
      "hasFeatureOfInterest": "urn:ngsi-ld:Plot:72d9fb43-53f8-4ec8-a33c-fa931360259a",
      "madeBySensor": {"@id": "sensor/ESA-Sentinel-2/CropSAR-001"},
      "usedProcedure": "VITO-CropSAR-001-Fusion",
      "resultTime": "2018-01-01",
      "hasSimpleResult": 0.9001308679580688
    },
…
```


C.1.2. Component 4.A.2 Plant Phenology Estimation

AIM Model - Output


```
{ "@context": [
        "https://w3id.org/demeter/agri-context.jsonld",
        {
            "qudt-unit": "http://qudt.org/vocab/unit/"
        }
    ],
    "@graph": [
        {
            "@id": "urn:demeter:geo:Feature:72d9fb43-53f8-4ec8-a33c-fa931360259a",
            "@type": "geo:Feature",
            "hasGeometry": {
                "@id": "urn:demeter:geo:Feature:Polygon:72d9fb43-53f8-4ec8-a33c-fa931360259y",
                "@type": "Polygon",
                "asWKT": "POLYGON (42.2342339 12.4564559,42.2342341 12.4564559,42.2342341 12.456456099999999,42.2342339
12.456456099999999,42.2342339 12.4564559) "
            }
        },
        {
            "@id": "urn:demeter:geo:Feature:72d9fb43-53f8-4ec8-a33c-fa931360259b",
            "@type": "geo:Feature",
            "hasGeometry": {
                "@id": "urn:demeter:geo:Feature:Polygon:72d9fb43-53f8-4ec8-a33c-fa931360259x",
                "@type": "Polygon",
                "asWKT": "POLYGON (45.2342339 12.4564559,45.2342341 12.4564559,45.2342341 12.456456099999999,45.2342339
12.456456099999999,45.2342339 12.4564559) "
            }
        },
        {
```

```
            "@id": "urn:demeter:observationCollection-20210101",
            "@type": "ObservationCollection",
            "observedProperty": "http://ontology.inrae.fr/ppdo/page/ontology/GrowthStage",
            "hasFeatureOfInterest": "urn:demeter:geo:Feature:72d9fb43-53f8-4ec8-a33c-fa931360259b",
            "hasMember": [
                "urn:demeter:Observation/20210101/BBCH",
                "urn:demeter:Observation/20210101/GDD"
            ],
            "resultTime": "2021-01-01T00:00:00Z"
        },
        {
            "@id": "urn:demeter:Observation/20210101/BBCH",
            "@type": "Observation",
            "identifier": "BBCH",
            "description": "Winter buds",
            "hasResult": {
                "@id": "urn:demeter:Observation/20210101/BBCH/result",
                "@type": "QuantityValue",
                "numericValue": "0.0",
                "unit": "qudt-unit:CountingUnit"
            }
        },
        {
            "@id": "urn:demeter:Observation/20210101/GDD",
            "@type": "Observation",
            "identifier": "GDD",
            "hasResult": {
                "@id": "urn:demeter:Observation/20210101/GDD/result",
                "@type": "QuantityValue",
                "numericValue": "6.6",
                "unit": "qudt-unit:DEG_C"
            }
        }]}
```

C.1.3. Component 4.A.3 Plant Stress Detection

AIM Model - Input


```
{
   "@context": "https://w3id.org/demeter/agri-context.jsonld",
   "@graph": [
      {
         "@id": "urn:demeter:AgriFarm:b429c6d4-676f-4807-a6c9-2c6451614c09",
         "@type": "AgriFarm",
         "name": "RomAgra Impex SRL",
         "address": {
            "@id": "43",
            "@type": "PostalAddress",
            "addressCountry": "RO",
            "addressLocality": "Manasia",
            "streetAddress": "Main Street, 22"
         },
         "contactPoint": {
            "@id": "22",
            "@type": "ContactPoint",
            "email": "contact@romagra.ro",
            "telephone": "0040 244 123 456"
         },
         "hasAgriParcel": [
            {
               "@id": "urn:demeter:AgriParcel:b429c6d4-676f-4807-a6c9-2c6451614c0a",
               "@type": "AgriParcel",
               "location": {
                  "@id": "101",
                  "@type": "Polygon",
                  "coordinates": [
                           [
                               [
                                   16.396622657775882,
                                   52.291722551113224
                               ],
                               [
                                   16.395592689514164,
                                   52.289885097096466
                               ],
                               [
```

```
                                    16.39889717102051,
                                    52.289202594763935
                                ],
                                [
                                    16.39994859695435,
                                    52.29094820478369
                                ]
                    ]
                ]
            },
            "belongsTo": "urn:demeter:AgriFarm:b429c6d4-676f-4807-a6c9-2c6451614c09",
            "area": 17600,
            "name": "1a",
            "description": "Parcel 1a",
            "cropStatus": "seeded",
            "lastPlantedAt": "2020-10-20T10:18:16Z",
            "hasAgriCrop": {
                "@id": "urn:demeter:AgriCrop:b429c6d4-676f-4807-a6ca-2c6451614c50",
                "@type": "AgriCrop",
                "name": "Corn",
                "description": "Glass Gem Corn",
                "wateringFrequency": "weekly"
            }
        },
        {
            "@id": "urn:demeter:AgriParcel:b429c6d4-676f-4807-a6c9-2c6451614c0b",
            "@type": "AgriParcel",
            "location": {
                "@id": "102",
                "@type": "Polygon",
                "coordinates": [
                    [
                                [
                                    16.396622657775882,
                                    52.291722551113224
                                ],
                                [
                                    16.395592689514164,
                                    52.289885097096466
                                ],
                                [
                                    16.39889717102051,
```

```
                                52.289202594763935
                            ],
                            [
                                16.39994859695435,
                                52.29094820478369
                            ]
                    ]
                ]
            },
            "belongsTo": "urn:demeter:AgriFarm:b429c6d4-676f-4807-a6c9-2c6451614c09",
            "area": 23200,
            "name": "1b",
            "description": "Parcel1b",
            "cropStatus": "justBorn",
            "lastPlantedAt": "2020-10-04T10:18:16Z",
            "hasAgriCrop": {
                "@id": "urn:demeter:AgriCrop:b429c6d4-676f-4807-a6ca-2c6451614c51",
                "@type": "AgriCrop",
                "name": "Corn",
                "description": "GlassGemCorn",
                "wateringFrequency": "daily"
            }
        },
        {
            "@id": "urn:demeter:AgriParcel:b429c6d4-676f-4807-a6c9-2c6451614c0c",
            "@type": "AgriParcel",
            "location": {
                "@id": "103",
                "@type": "Polygon",
                "coordinates": [
                        [
                            [
                                16.396622657775882,
                                52.291722551113224
                            ],
                            [
                                16.395592689514164,
                                52.289885097096466
                            ],
                            [
                                16.39889717102051,
                                52.289202594763935
```

```
                        ],
                        [
                            16.39994859695435,
                            52.29094820478369
                        ]
                    ]
                ]
            },
            "belongsTo": "urn:demeter:AgriFarm:b429c6d4-676f-4807-a6c9-2c6451614c09",
            "area": 35000,
            "name": "1c",
            "description": "Parcel 1c",
            "cropStatus": "maturing",
            "lastPlantedAt": "2020-08-20T10:18:16Z",
            "hasAgriCrop": {
                "@id": "urn:demeter:AgriCrop:b429c6d4-676f-4807-a6ca-2c6451614c52",
                "@type": "AgriCrop",
                "name": "Corn",
                "description": "Glass Gem Corn",
                "wateringFrequency": "other"
            }
        }
    ]
},
{
    "@id": "urn:demeter:AgriParcelRecord:b429c6d4-676f-4807-a6c9-2c6451614c0d",
    "@type": "AgriParcelRecord",
    "hasAgriParcel": "urn:demeter:AgriParcel:b429c6d4-676f-4807-a6c9-2c6451614c0a",
    "airTemperature": [
        20,
        29,
        11
    ],
    "soilTemperature": [
        14,
        20,
        8
    ],
    "relativeHumidity": 0.15,
    "soilMoistureVwc": 0.33,
    "leafWetness": 1.0,
    "rainfall": 3,
```

```
        "windSpeed": 3.88,
        "irrigation": "Yes",
        "observedAt": "2020-10-13T10:00:00Z"
    },
    {
        "@id": "urn:demeter:AgriParcelRecord:b429c6d4-676f-4807-a6c9-2c6451614c0e",
        "@type": "AgriParcelRecord",
        "hasAgriParcel": "urn:demeter:AgriParcel:b429c6d4-676f-4807-a6c9-2c6451614c0b",
        "airTemperature": [
               18,
               26,
               10
           ],
        "soilTemperature": [
               13,
               20,
               6
           ],
        "relativeHumidity": 0.2,
        "soilMoistureVwc": 0.66,
        "leafWetness": 2.0,
        "rainfall": 2.4,
        "windSpeed": 3.5,
        "irrigation": "No",
        "observedAt": "2020-10-20T10:00:00Z"
    },
    {
        "@id": "urn:demeter:AgriParcelRecord:b429c6d4-676f-4807-a6c9-2c6451614c0f",
        "@type": "AgriParcelRecord",
        "hasAgriParcel": "urn:demeter:AgriParcel:b429c6d4-676f-4807-a6c9-2c6451614c0c",
           "airTemperature": [
               15,
               23,
               7
           ],
           "soilTemperature": [
               10,
               16,
               4
           ],
        "relativeHumidity": 0.1,
        "soilMoistureVwc": 0.97,
```

```
        "leafWetness": 1.3,
        "rainfall": 4.2,
        "windSpeed": 3.0,
        "irrigation": "Yes",
        "observedAt": "2020-10-27T10:00:00Z"
      }
   ]
}
```


AIM Model - Output


```
{
  "@context": "https://w3id.org/demeter/agri-context.jsonld",
  "@graph": [
    {
      "@id": "urn:demeter:AgriFarm:b429c6d4-676f-4807-a6c9-2c6451614c09",
      "@type": "AgriFarm",
      "name": "RomAgra Impex SRL",
      "address": {
        "@id": "43",
        "@type": "PostalAddress",
        "addressCountry": "RO",
        "addressLocality": "Manasia",
        "streetAddress": "Main Street, 22"
      },
      "contactPoint": {
        "@id": "22",
        "@type": "ContactPoint",
        "email": "contact@romagra.ro",
        "telephone": "0040 244 123 456"
      },
      "hasAgriParcel": [
        {
          "@id": "urn:demeter:AgriParcel:b429c6d4-676f-4807-a6c9-2c6451614c0a",
          "@type": "AgriParcel",
          "location": {
            "@id": "101",
            "@type": "Polygon",
            "coordinates": [
              [
                [
                  16.396622657775882,
```

```
              52.291722551113224
            ],
            [
              16.395592689514164,
              52.289885097096466
            ],
            [
              16.39889717102051,
              52.289202594763935
            ],
            [
              16.39994859695435,
              52.29094820478369
            ]
          ]
        ]
      },
      "belongsTo": "urn:demeter:AgriFarm:b429c6d4-676f-4807-a6c9-2c6451614c09",
      "area": 17600,
      "name": "1a",
      "description": "Parcel 1a",
      "cropStatus": "seeded",
      "lastPlantedAt": "2020-10-20T10:18:16Z",
      "hasAgriCrop": {
        "@id": "urn:demeter:AgriCrop:b429c6d4-676f-4807-a6ca-2c6451614c50",
        "@type": "AgriCrop",
        "name": "Corn",
        "description": "Glass Gem Corn",
        "wateringFrequency": "weekly"
      }
    },
    {
      "@id": "urn:demeter:AgriParcel:b429c6d4-676f-4807-a6c9-2c6451614c0b",
      "@type": "AgriParcel",
      "location": {
        "@id": "102",
        "@type": "Polygon",
        "coordinates": [
          [
            [
              16.396622657775882,
              52.291722551113224
```

```
              ],
              [
                16.395592689514164,
                52.289885097096466
              ],
              [
                16.39889717102051,
                52.289202594763935
              ],
              [
                16.39994859695435,
                52.29094820478369
              ]
            ]
          ]
        },
        "belongsTo": "urn:demeter:AgriFarm:b429c6d4-676f-4807-a6c9-2c6451614c09",
        "area": 23200,
        "name": "1b",
        "description": "Parcel1b",
        "cropStatus": "justBorn",
        "lastPlantedAt": "2020-10-04T10:18:16Z",
        "hasAgriCrop": {
          "@id": "urn:demeter:AgriCrop:b429c6d4-676f-4807-a6ca-2c6451614c51",
          "@type": "AgriCrop",
          "name": "Corn",
          "description": "GlassGemCorn",
          "wateringFrequency": "daily"
        }
      },
      {
        "@id": "urn:demeter:AgriParcel:b429c6d4-676f-4807-a6c9-2c6451614c0c",
        "@type": "AgriParcel",
        "location": {
          "@id": "103",
          "@type": "Polygon",
          "coordinates": [
            [
              [
                16.396622657775882,
                52.291722551113224
              ],
```

```
                  [
                    16.395592689514164,
                    52.289885097096466
                  ],
                  [
                    16.39889717102051,
                    52.289202594763935
                  ],
                  [
                    16.39994859695435,
                    52.29094820478369
                  ]
                ]
              ]
            },
            "belongsTo": "urn:demeter:AgriFarm:b429c6d4-676f-4807-a6c9-2c6451614c09",
            "area": 35000,
            "name": "1c",
            "description": "Parcel 1c",
            "cropStatus": "maturing",
            "lastPlantedAt": "2020-08-20T10:18:16Z",
            "hasAgriCrop": {
              "@id": "urn:demeter:AgriCrop:b429c6d4-676f-4807-a6ca-2c6451614c52",
              "@type": "AgriCrop",
              "name": "Corn",
              "description": "Glass Gem Corn",
              "wateringFrequency": "other"
            }
          }
        ]
      },
      {
        "@id": "urn:demeter:AgriParcelRecord:b429c6d4-676f-4807-a6c9-2c6451614c0d",
        "@type": "AgriParcelRecord",
        "hasAgriParcel": "urn:demeter:AgriParcel:b429c6d4-676f-4807-a6c9-2c6451614c0a",
        "airTemperature": [
          20,
          29,
          11
        ],
        "soilTemperature": [
          14,
```

```
        20,
        8
      ],
      "relativeHumidity": 0.15,
      "soilMoistureVwc": 0.33,
      "leafWetness": 1.0,
      "rainfall": 3,
      "windSpeed": 3.88,
      “result”: "Their temperature exceeds the normal limits",
      "irrigation": "Yes",
      "observedAt": "2020-10-13T10:00:00Z",
      "containsZone": [
        {
          "@id": "urn:demeter:MgmtZone:1003",
          "@type": "ManagementZone",
          "hasGeometry": {
            "@id": "urn:demeter:MgmtZone:geo:10003",
            "@type": "POLYGON",
            "asWKT": "POLYGON ((2.658972849564151 50.95792999214172, 2.659091082268864 50.95776685575894, 2.658703633207661 
50.95765484590413, 2.658585399495478 50.95781798185575, 2.658972849564151 50.95792999214172))"
          }
        },
        {
          "@id": "urn:demeter:MgmtZone:1004",
          "@type": "ManagementZone",
          "hasGeometry": {
            "@id": "urn:demeter:MgmtZone:geo:10004",
            "@type": "POLYGON",
            "asWKT": "POLYGON ((2.659091082268864 50.95776685575894, 2.659209314101167 50.95760371922457, 2.658821866047433 
50.95749170980091, 2.658717720321181 50.95763540876296, 2.658703633207661 50.95765484590413, 2.659091082268864 50.95776685575894))"
          }
        }
      ]
    },
    {
      "@id": "urn:demeter:AgriParcelRecord:b429c6d4-676f-4807-a6c9-2c6451614c0e",
      "@type": "AgriParcelRecord",
      "hasAgriParcel": "urn:demeter:AgriParcel:b429c6d4-676f-4807-a6c9-2c6451614c0b",
      "airTemperature": [
        18,
        26,
        10
```

```
      ],
      "soilTemperature": [
        13,
        20,
        6
      ],
      "relativeHumidity": 0.2,
      "soilMoistureVwc": 0.66,
      "leafWetness": 2.0,
      "rainfall": 2.4,
      "windSpeed": 3.5,
      “result”: "Soil moisture is too low, needs daily irrigation",
      "irrigation": "No",
      "observedAt": "2020-10-20T10:00:00Z",
      "containsZone": [
        {
          "@id": "urn:demeter:MgmtZone:1001",
          "@type": "ManagementZone",
          "hasGeometry": {
            "@id": "urn:demeter:MgmtZone:geo:10001",
            "@type": "POLYGON",
            "asWKT": "POLYGON ((2.658972849564151 50.95792999214172, 2.659091082268864 50.95776685575894, 2.658703633207661
50.95765484590413, 2.658585399495478 50.95781798185575, 2.658972849564151 50.95792999214172))"
          }
        },
        {
          "@id": "urn:demeter:MgmtZone:1002",
          "@type": "ManagementZone",
          "hasGeometry": {
            "@id": "urn:demeter:MgmtZone:geo:10002",
            "@type": "POLYGON",
            "asWKT": "POLYGON ((2.659091082268864 50.95776685575894, 2.659209314101167 50.95760371922457, 2.658821866047433
50.95749170980091, 2.658717720321181 50.95763540876296, 2.658703633207661 50.95765484590413, 2.659091082268864 50.95776685575894))"
          }
        }
      ]
    },
    {
      "@id": "urn:demeter:AgriParcelRecord:b429c6d4-676f-4807-a6c9-2c6451614c0f",
      "@type": "AgriParcelRecord",
      "hasAgriParcel": "urn:demeter:AgriParcel:b429c6d4-676f-4807-a6c9-2c6451614c0c",
      "airTemperature": [
```

```
        15,
        23,
        7
      ],
      "soilTemperature": [
        10,
        16,
        4
      ],
      "relativeHumidity": 0.1,
      "soilMoistureVwc": 0.97,
      "leafWetness": 1.3,
      "rainfall": 4.2,
      "windSpeed": 3.0,
      “result”: "Plants are happy!",
      "irrigation": "Yes",
      "observedAt": "2020-10-27T10:00:00Z",
      "containsZone": [
        {
          "@id": "urn:demeter:MgmtZone:1005",
          "@type": "ManagementZone",
          "hasGeometry": {
            "@id": "urn:demeter:MgmtZone:geo:10005",
            "@type": "POLYGON",
            "asWKT": "POLYGON ((2.658972849564151 50.95792999214172, 2.659091082268864 50.95776685575894, 2.658703633207661
50.95765484590413, 2.658585399495478 50.95781798185575, 2.658972849564151 50.95792999214172))"
          }
        },
        {
          "@id": "urn:demeter:MgmtZone:1006",
          "@type": "ManagementZone",
          "hasGeometry": {
            "@id": "urn:demeter:MgmtZone:geo:10006",
            "@type": "POLYGON",
            "asWKT": "POLYGON ((2.659091082268864 50.95776685575894, 2.659209314101167 50.95760371922457, 2.658821866047433
50.95749170980091, 2.658717720321181 50.95763540876296, 2.658703633207661 50.95765484590413, 2.659091082268864 50.95776685575894))"
          }
        }
      ]
    },
    {
      "@id": "urn:demeter:WeatherObserved:b429c6d4-676f-4807-a6c9-2c6451614c10",
```

```
        "@type": "WeatherObserved",
        "observedAt": "2020-10-20T15:16:17.00Z",
        "scorchingHeat": 71,
        "winterHarshness": 0
      },
      {
        "@id": "urn:demeter:WeatherObserved:b429c6d4-676f-4807-a6c9-2c6451614c11",
        "@type": "WeatherObserved",
        "observedAt": "2020-10-13T14:24:34.00Z",
        "scorchingHeat": 78,
        "winterHarshness": 0
      },
      {
        "@id": "urn:demeter:WeatherObserved:b429c6d4-676f-4807-a6c9-2c6451614c12",
        "@type": "WeatherObserved",
        "observedAt": "2020-10-27T14:24:34.00Z",
        "scorchingHeat": 72,
        "winterHarshness": 0
      }
    ]
  }
```

C.1.4. Component 4.A.4 Crop Type Detection

AIM Model - Input

```
  {"@context": ["https://w3id.org/demeter/agri-context.jsonld"],
"@graph": [
  {
    "@id":"urn:ngsi-ld:Plot:72d9fb43-53f8-4ec8-a33c-fa931360259a",
    "@type": "Plot",
    "code": "Plot1a",
    "validFrom":"30/1/2018",
    "validTo":"31/12/2018",
    "hasGeometry": {
      "@id":"urn:ngsi-ld:Plot:geo:72d9fb43-53f8-4ec8-a33c-fa931360259a",
      "@type": "Polygon",
      "asWKT": "POLYGON ((2.6584237478090156 50.9580622571139870, 2.6587338968496641 50.9581579426010336, 2.6589429488131198
50.9582150219953576, 2.6591095643951315 50.9582528714251737, 2.6594131803025660 50.9583130331828329, 2.6597840234085823
50.9583763291639258, 2.6601631496043434 50.9584545804495264, 2.6603365480477104 50.9584938754040664, 2.6604075024417271
50.9584102952921612, 2.6604662546619218 50.9583568395615316, 2.6604342845380304 50.9583472936046604, 2.6605727867651963
```

```
50.9581954593736981, 2.6606363555663735 50.9581231012561133, 2.6607330759977792 50.9579965557217776, 2.6607734469812598
50.9579474185679047, 2.6608194310438913 50.9579005209109894, 2.6608524514342635 50.9578733963002009, 2.6608934925113696
50.9578449495156960, 2.6609513715096789 50.9578115321335829, 2.6612047259887084 50.9576841139061898, 2.6613162666076406
50.9576314243041466, 2.6614578206772155 50.9575716174280018, 2.6615244327002254 50.9575485769880245, 2.6616325855213563
50.9575146303461892, 2.6617372561265995 50.9574785649891382, 2.6617976757467297 50.9574535462686455, 2.6618553132177798
50.9574228224268495, 2.6618958429920814 50.9573927493935983, 2.6619421525628022 50.9573525098202822, 2.6620385672422953
50.9572498764658022, 2.6621232350015847 50.9571335851508209, 2.6621875857682133 50.9570044106813285, 2.6622157597119029
50.9569382817477106, 2.6623222637686292 50.9566443634807769, 2.6623754063259728 50.9564867027179460, 2.6623467652956743
50.9564756770014426, 2.6600325756526599 50.9558211107541226, 2.6584154185753190 50.9580525149500971, 2.6584237478090156
50.9580622571139870))"
    },
    "identifier": "example001",
    "area": "4.57",
    "lastPlantedAt": "2018-04-15T10:18:16Z",
  }
]}'
```


AIM Model - Output Detect Crop Type


```
 {"@context": ["https://w3id.org/demeter/agri-context.jsonld"],
"@graph": [
    {
  "@type": "CropType",
  "code": "CropType2",
  "name": "Potato" ,
  "family": "Solanaceae",
    }
]}
```


C.1.5. Component 4.A.5 Estimate Beehive

AIM Model - Input


```
{
  "@context": [
    "https://w3id.org/demeter/agri-context.jsonld"
  ],
  "@graph": [
    {
      "@id": "urn:ngsi-ld:Plot:72d9fb43-53f8-4ec8-a33c-fa931360259a",
      "@type": "Plot",
```

```
      "identifier": "0000280859BE7A17",
      "hasGeometry": {
        "@id": "urn:ngsi-ld:Plot:geo:72d9fb43-53f8-4ec8-a33c-fa931360259a",
        "@type": "Polygon",
        "asWKT":        "POLYGON((15.982709072777158        52.57920221568363,15.984854839989072        52.582018561825926,15.99513306493414
52.58088422194763,15.996120117851621                52.58042787003856,15.99489703054083                52.57978896938458,15.994596623131162
52.5791370203432,15.993309162804014 52.57868065024535,15.992236279198057 52.57808084232016,15.982709072777158 52.57920221568363))"
      },
      "area": "35",
      "description": "Potato parcel",
      "category": "arable",
      "cropStatus": "blooming",
      "lastPlantedAt": "2020-04-15T10:18:16Z",
      "hasAgriCrop": {
        "@id": "urn:ngsi-ld:CropSpecies:72d9fb43-53f8-4ec8-a33c-fa931360259a",
        "@type": "Crop",
        "cropSpecies": {
          "@id": "urn:ngsi-ld:CropType:df72dc57-1eb9-42a3-88a9-8647ecc954b4"
        },
      },
      "areaCultivated": 32.23,
      "plantDensity": 85
    },
    {
      "@id": "urn:demeter:Treatment1:72d9fb43-53f8-4ec8-a33c-fa931360259a",
      "@type": "Treatment",
      "interventionPlot": {
        "@id": "urn:demeter:Plot:72d9fb43-53f8-4ec8-a33c-fa931360259a"
      },
      "type": "FERTILIZATION",
      "hasTimestamp": "2020-04-17T09:33:56Z",
      "name": "Landowner Topleaf - Foliar Nitrogen",
      "substance": "Nitrogen, Sulphur",
      "quantity": {
        "@id": "urn:demeter:TQ:72d9fb43-53f8-4ec8-a33c-fa931360259a",
        "@type": "QuantityValue",
        "numericValue": "2.0",
        "unit": {
          "@id": "qudt-unit:L"
        }
      },
      "notes": "known to be harmful to honey bees",
```

```
      "area": 20,
      "status": "completed"
    },
    {
      "@id": "urn:demeter:Treatment2:72d9fb43-53f8-4ec8-a33c-fa931360259a",
      "@type": "Treatment",
      "interventionPlot": {
        "@id": "urn:demeter:Plot:72d9fb43-53f8-4ec8-a33c-fa931360259a"
      },
      "type": "SPRAYING",
      "hasTimestamp": "2020-04-16T12:33:56Z",
    },
    {
      "@id": "urn:ngsi-ld:CropType:df72dc57-1eb9-42a3-88a9-8647ecc954b4",
      "@type": "CropType",
      "name": "Potato",
      "family": "Solanaceae",
      "description": "Fontane",
      "species": "Solanum tuberosum L. cv. Fontane",
      "agroVocConcept": "http://aims.fao.org/aos/agrovoc/c_1066"
    }
  ]
}
```


AIM Model - Output


```
{
  "id": "60994cda0eb05d109c70a734",
  "@context": [
    "https://w3id.org/demeter/agri-context.jsonld"
  ],
  "@graph": [
    {
      "@id": "urn:demeter:Plot:72d9fb43-53f8-4ec8-a33c-fa931360259a",
      "@type": "Plot",
      "identifier": "0000280859BE7A17",
      "hasGeometry": {
        "@id": "urn:demeter:Plot:geo:72d9fb43-53f8-4ec8-a33c-fa931360259a",
        "@type": "Polygon",
        "asWKT":        "POLYGON((15.982709072777158        52.57920221568363,15.984854839989072        52.582018561825926,15.99513306493414
52.58088422194763,15.996120117851621                52.58042787003856,15.99489703054083                52.57978896938458,15.994596623131162
52.5791370203432,15.993309162804014 52.57868065024535,15.992236279198057 52.57808084232016,15.982709072777158 52.57920221568363))"
```

```
      },
      "area": "35",
      "description": "Potato parcel",
      "category": "arable",
      "cropStatus": "blooming",
      "lastPlantedAt": "2020-04-15T10:18:16Z",
      "hasAgriCrop": {
        "@id": "urn:demeter:CropSpecies:72d9fb43-53f8-4ec8-a33c-fa931360259a",
        "@type": "Crop",
        "cropSpecies": {
          "@id": "urn:demeter:CropType:df72dc57-1eb9-42a3-88a9-8647ecc954b4"
        }
      },
      "numberOfHivesNeeded": 8
    },
    {
      "@id": "urn:demeter:CropType:df72dc57-1eb9-42a3-88a9-8647ecc954b4” ",
      "@type": "CropType",
      "code": "CropType2",
      "name": "Potato",
      "family": "Solanaceae",
      "description": "Fontane",
      "species": "Solanum tuberosum L. cv. Fontane",
      "agroVocConcept": "http://aims.fao.org/aos/agrovoc/c_1066"
    }
  ]
}
```


C.2. DSS AREA: 4.B - Irrigation Management

C.2.1. Component 4.B.1 DSS for Irrigation Management

AIM Model – Input from WP2 component *Pilot Plot Bridge*


```
{
    "@context": [
        "https://w3id.org/demeter/agri-context.jsonld"
    ],
    "@graph": [
        {
```

```
            "@id": "urn:demeter:AgriFarm:5eeb76ccb8f8fe627be2b690",
            "@type": "AgriFarm",
            "name": "Almond trees farm in Cartagena, Spain",
            "hasAgriParcel": [
                {
                    "@id": "urn:demeter:AgriParcel:5eeb76ccb8f8fe627be2b690",
                    "@type": "AgriParcel",
                    "name": "Almond trees",
                    "hasGeometry": {
                                         "@id": "urn: demeter:AgriFarm:geo:1",
                                         "@type": "Point",
                                         "asWKT": "POINT(38.59436666 -0.87921111 496)"
                                },
                    "area": 9000,
                    "numberOfPlants": 270,
                    "distanceInRow": 5.5,
                    "distanceBetweenRows": 6.0,
                    "hasAgriCrop": {
                        "@id": "urn:demeter:AgriCrop:1",
                        "@type": "AgriCrop",
                        "plantDiameter": 0.236,
                        "plantType": "woody",
                        "cropCoefficient": 0.15,
                        "maxWaterConductivity": 4
                    },
                    "hasAgriSoil": {
                        "@id": "urn:demeter:AgriSoil:1",
                        "@type": "AgriSoil",
                        "percolatingEficiency": 0.9
                    },
                    "hasAgriWater": {
                        "@id": "urn:demeter:AgriWater:1",
                        "@type": "AgriWater",
                        "irrigationType": "drip",
                        "waterConductivity": 1
                    },
                    "hasDevice": [
                        {"@id": "urn:demeter:temperature:5f85693cf8fe8723e0814710:5f85693cf8fe8723e0814700"},
                        {"@id": "urn:demeter:humidity:5f85693cf8fe8723e0814710:5f85693cf8fe8723e0814703"},
                        {"@id": "urn:demeter:windspeed:5f85693cf8fe8723e0814710:5f85693cf8fe8723e081470c"},
                        {"@id": "urn:demeter:sunradiation:5f85693cf8fe8723e0814710:5f85693cf8fe8723e0814709"},
                                            {"@id": "urn:demeter:precipitation:5f85693cf8fe8723e0814710:5f85693cf8fe8723e0814706"}
```

```
                    ]
                }
            ]
        }
    ]
}{
    "@context": [
        "https://w3id.org/demeter/agri-context.jsonld"
    ],
    "@graph": [
        {
            "@id": "urn:demeter:AgriFarm:1",
            "@type": "AgriFarm",
            "name": "Almond trees",
            "hasAgriParcel": [
                {
                    "@id": "urn:demeter:AgriParcel:1",
                    "@type": "AgriParcel",
                    "name": "Almond trees",
                    "hasGeometry": {
                                                 "@id": "urn: demeter:AgriFarm:geo:1",
                                                 "@type": "Point",
                                                 "asWKT": "POINT(38.59 -0.87 49)"
                                    },
                    "area": 90,
                    "numberOfPlants": 270,
                    "distanceInRow": 5.5,
                    "distanceBetweenRows": 6.0,
                    "hasAgriCrop": {
                        "@id": "urn:demeter:AgriCrop:1",
                        "@type": "AgriCrop",
                        "plantDiameter": 0.236,
                        "plantType": "woody",
                        "cropCoefficient": 0.15,
                        "maxWaterConductivity": 4
                    },
                    "hasAgriSoil": {
                        "@id": "urn:demeter:AgriSoil:1",
                        "@type": "AgriSoil",
                        "percolatingEficiency": 0.9
                    },
                    "hasAgriWater": {
```

```
                         "@id": "urn:demeter:AgriWater:1",
                         "@type": "AgriWater",
                         "irrigationType": "drip",
                         "waterConductivity": 1
                     },
                     "hasDevice": [
                         {"@id": "urn:demeter:temperature:1:1"},
                         {"@id": "urn:demeter:humidity:1:2"},
                         {"@id": "urn:demeter:windspeed:1:3"},
                         {"@id": "urn:demeter:sunradiation:1:4"},
                                             {"@id": "urn:demeter:precipitation:1:5"}
                     ]
                 }
             ]
         }
     ]
}
```


AIM Model – Input from WP4 component 4.B.2 ***Reference Evapotranspiration Prediction***


```
{
    "@context": [
      "https://w3id.org/demeter/agri-context.jsonld",
      {
        "qudt-unit": "http://qudt.org/vocab/unit/"
      }
    ],
    "@graph": [
      {
        "@id": "urn:demeter:Forecasting:1",
        "@type": "Forecasting",
        "description": "et0forthecrop",
        "hasResult": [
          {
            "@id": "urn:demeter:idParcel1:Forecasting:et0_0"
          },
          {
            "@id": "urn:demeter:idParcel1:Forecasting:et0_1"
          }
        ]
      },
      {
```

```
        "@id": "urn:demeter:Forecasting:Forecasting:et0_0",
        "@type": "QuantityValue",
        "numericValue": "1.916",
        "unit": {
          "@id": "qudt-unit:MilLength"
        }
      },
      {
        "@id": "urn:demeter:Forecasting:Forecasting:et0_1",
        "@type": "QuantityValue",
        "numericValue": "1.916",
        "unit": {
          "@id": "qudt-unit:MilLength"
        }
      }
    ]
 }
```


AIM Model – Input from WP2 component *Weather Forecast*


```
{

    "@context": [
      "https://w3id.org/demeter/agri-context.jsonld",
      {
        "qudt-unit": "http://qudt.org/vocab/unit/"
      }
    ],
    "@graph": [
      {
        "@id": "urn:demeter:ObservationCollection:WeatherBit_temp",
        "@type": "ObservationCollection",
        "description": "Air-temperature",
        "observedProperty": {
          "@id": "http://purl.obolibrary.org/obo/IDOMAL_0000568"
        },
        "hasMember": [
          {
            "@id": "urn:demeter:Observation:WeatherBit_temp_1"
          },
          {
            "@id": "urn:demeter:Observation:WeatherBit_temp_2"
```

```
          },
          {
            "@id": "urn:demeter:Observation:WeatherBit_temp_3"
          }
        ]
      },
      {
        "@id": "urn:demeter:Observation:WeatherBit_temp_1",
        "@type": "Observation",
        "resultTime": "2021-04-28T11:00:00",
        "hasResult": [
          {
            "@id": "urn:demeter:QuantityValue:WeatherBit_temp_1_1",
            "@type": "QuantityValue",
            "numericValue": "17.1",
            "unit": {
              "@id": "qudt-unit:DEG_C"
            }
          }
        ]
      },
      {
        "@id": "urn:demeter:Observation:WeatherBit_temp_2",
        "@type": "Observation",
        "resultTime": "2021-04-28T12:00:00",
        "hasResult": [
          {
            "@id": "urn:demeter:QuantityValue:WeatherBit_temp_2_1",
            "@type": "QuantityValue",
            "numericValue": "18.4",
            "unit": {
              "@id": "qudt-unit:DEG_C"
            }
          }
        ]
      },
      {
        "@id": "urn:demeter:Observation:WeatherBit_temp_3",
        "@type": "Observation",
        "resultTime": "2021-04-28T13:00:00",
        "hasResult": [
          {
```

```
            "@id": "urn:demeter:QuantityValue:WeatherBit_temp_3_1",
            "@type": "QuantityValue",
            "numericValue": "19.2",
            "unit": {
              "@id": "qudt-unit:DEG_C"
            }
          }
        ]
      },
      {
        "@id": "urn:demeter:ObservationCollection:WeatherBit_rh",
        "@type": "ObservationCollection",
        "description": "Air-relative-humidity",
        "observedProperty": {
          "@id": "http://purl.obolibrary.org/obo/IDOMAL_0000419"
        },
        "hasMember": [
          {
            "@id": "urn:demeter:Observation:WeatherBit_rh_1"
          },
          {
            "@id": "urn:demeter:Observation:WeatherBit_rh_2"
          },
          {
            "@id": "urn:demeter:Observation:WeatherBit_rh_3"
          }
        ]
      },
      {
        "@id": "urn:demeter:Observation:WeatherBit_rh_1",
        "@type": "Observation",
        "resultTime": "2021-04-28T11:00:00",
        "hasResult": [
          {
            "@id": "urn:demeter:QuantityValue:WeatherBit_rh_1_1",
            "@type": "QuantityValue",
            "numericValue": "64",
            "unit": {
              "@id": "qudt-unit:PERCENT"
            }
          }
        ]
```

```
      },
      {
        "@id": "urn:demeter:Observation:WeatherBit_rh_2",
        "@type": "Observation",
        "resultTime": "2021-04-28T12:00:00",
        "hasResult": [
          {
            "@id": "urn:demeter:QuantityValue:WeatherBit_rh_2_1",
            "@type": "QuantityValue",
            "numericValue": "66",
            "unit": {
              "@id": "qudt-unit:PERCENT"
            }
          }
        ]
      },
      {
        "@id": "urn:demeter:Observation:WeatherBit_rh_3",
        "@type": "Observation",
        "resultTime": "2021-04-28T13:00:00",
        "hasResult": [
          {
            "@id": "urn:demeter:QuantityValue:WeatherBit_rh_3_1",
            "@type": "QuantityValue",
            "numericValue": "63",
            "unit": {
              "@id": "qudt-unit:PERCENT"
            }
          }
        ]
      },
      {
        "@id": "urn:demeter:ObservationCollection:WeatherBit_wind",
        "@type": "ObservationCollection",
        "description": "Wind-speed",
        "observedProperty": {
          "@id": "http://dbpedia.org/resource/Wind_speed"
        },
        "hasMember": [
          {
            "@id": "urn:demeter:Observation:WeatherBit_wind_1"
          },
```

```
          {
            "@id": "urn:demeter:Observation:WeatherBit_wind_2"
          },
          {
            "@id": "urn:demeter:Observation:WeatherBit_wind_3"
          }
        ]
      },
      {
        "@id": "urn:demeter:Observation:WeatherBit_wind_1",
        "@type": "Observation",
        "resultTime": "2021-04-28T11:00:00",
        "hasResult": [
          {
            "@id": "urn:demeter:QuantityValue:WeatherBit_wind_1_1",
            "@type": "QuantityValue",
            "numericValue": "1.74558",
            "unit": {
              "@id": "qudt-unit:M-PER-SEC"
            }
          }
        ]
      },
      {
        "@id": "urn:demeter:Observation:WeatherBit_wind_2",
        "@type": "Observation",
        "resultTime": "2021-04-28T12:00:00",
        "hasResult": [
          {
            "@id": "urn:demeter:QuantityValue:WeatherBit_wind_2_1",
            "@type": "QuantityValue",
            "numericValue": "2.26174",
            "unit": {
              "@id": "qudt-unit:M-PER-SEC"
            }
          }
        ]
      },
      {
        "@id": "urn:demeter:Observation:WeatherBit_wind_3",
        "@type": "Observation",
        "resultTime": "2021-04-28T13:00:00",
```

```
        "hasResult": [
          {
            "@id": "urn:demeter:QuantityValue:WeatherBit_wind_3_1",
            "@type": "QuantityValue",
            "numericValue": "1.46735",
            "unit": {
              "@id": "qudt-unit:M-PER-SEC"
            }
          }
        ]
      },
      {
        "@id": "urn:demeter:ObservationCollection:solar_rad",
        "@type": "ObservationCollection",
        "description": "Solar-radiation",
        "observedProperty": {
          "@id": "http://linkeddata.ge.imati.cnr.it:2020/resource/EARTh/12480"
        },
        "hasMember": [
          {
            "@id": "urn:demeter:Observation:solar_rad_1"
          },
          {
            "@id": "urn:demeter:Observation:solar_rad_2"
          },
          {
            "@id": "urn:demeter:Observation:solar_rad_3"
          }
        ]
      },
      {
        "@id": "urn:demeter:Observation:WeatherBit_solar_rad_1",
        "@type": "Observation",
        "resultTime": "2021-04-28T11:00:00",
        "hasResult": [
          {
            "@id": "urn:demeter:QuantityValue:WeatherBit_solar_rad_1_1",
            "@type": "QuantityValue",
            "numericValue": "621.663",
            "unit": {
              "@id": "qudt-unit:W-PER-M2"
            }
```

```
          }
        ]
      },
      {
        "@id": "urn:demeter:Observation:WeatherBit_solar_rad_2",
        "@type": "Observation",
        "resultTime": "2021-04-28T12:00:00",
        "hasResult": [
          {
            "@id": "urn:demeter:QuantityValue:WeatherBit_solar_rad_2_1",
            "@type": "QuantityValue",
            "numericValue": "811.662",
            "unit": {
              "@id": "qudt-unit:W-PER-M2"
            }
          }
        ]
      },
      {
        "@id": "urn:demeter:Observation:WeatherBit_solar_rad_3",
        "@type": "Observation",
        "resultTime": "2021-04-28T13:00:00",
        "hasResult": [
          {
            "@id": "urn:demeter:QuantityValue:WeatherBit_solar_rad_3_1",
            "@type": "QuantityValue",
            "numericValue": "861.725",
            "unit": {
              "@id": "qudt-unit:W-PER-M2"
            }
          }
        ]
      },
      {
        "@id": "urn:demeter:ObservationCollection:Precipitation",
        "@type": "ObservationCollection",
        "description": "Precipitation",
        "observedProperty": {
          "@id": "http://linkeddata.ge.imati.cnr.it:2020/resource/EARTh/37580"
        },
        "hasMember": [
          {
```

```
            "@id": "urn:demeter:Observation:WeatherBit_precipitation_1"
          },
          {
            "@id": "urn:demeter:Observation:WeatherBit_precipitation_2"
          },
          {
            "@id": "urn:demeter:Observation:WeatherBit_precipitation_3"
          }
        ]
      },
      {
        "@id": "urn:demeter:Observation:WeatherBit_precipitation_1",
        "@type": "Observation",
        "resultTime": "2021-04-28T11:00:00",
        "hasResult": [
          {
            "@id": "urn:demeter:QuantityValue:WeatherBit_precipitation_1_1",
            "@type": "QuantityValue",
            "numericValue": "1",
            "unit": {
              "@id": "qudt-unit:L-PER-HR"
            }
          }
        ]
      },
      {
        "@id": "urn:demeter:Observation:WeatherBit_precipitation_2",
        "@type": "Observation",
        "resultTime": "2021-04-28T12:00:00",
        "hasResult": [
          {
            "@id": "urn:demeter:QuantityValue:WeatherBit_precipitation_2_1",
            "@type": "QuantityValue",
            "numericValue": "2",
            "unit": {
              "@id": "qudt-unit:L-PER-HR"
            }
          }
        ]
      },
      {
        "@id": "urn:demeter:Observation:WeatherBit_precipitation_3",
```

```
        "@type": "Observation",
        "resultTime": "2021-04-28T13:00:00",
        "hasResult": [
          {
            "@id": "urn:demeter:QuantityValue:WeatherBit_precipitation_3_1",
            "@type": "QuantityValue",
            "numericValue": "5",
            "unit": {
              "@id": "qudt-unit:L-PER-HR"
            }
          }
        ]
      }
    ]
}
```


AIM Model - Input from WP2 component *Crop Irrigation Water Estimation*


```
{

    "@context": [
        "https://w3id.org/demeter/agri-context.jsonld",
        {
            "qudt-unit": "http://qudt.org/vocab/unit/"
        }
    ],
    "@graph": [
        {
            "@id": "urn:demeter:Forecasting:1",
            "@type": "Forecasting",
            "description": "Irrigation water",
            "hasResult": [
                {
                    "@id": "urn:demeter:idParcel1:Forecasting:cropWaterNeeds"
                }
            ]
        },
        {
            "@id": "urn:demeter:Forecasting:cropWaterNeeds",
            "@type": "QuantityValue",
            "numericValue": "10820.303",
            "unit": {
```

```
                "@id": "qudt-unit:L-PER-DAY"
            }
        }
    ]
}
```


AIM Model - Input from WP4 component 4.B.3 *Soil Moisture Estimation*


```
{
  "@context": [
    "https://w3id.org/demeter/agri-context.jsonld",
    {
      "qudt-unit": "http://qudt.org/vocab/unit/"
    }
  ],
  "@graph": [
    {
      "@id": "urn:demeter:SoilMoisture:1",
      "@type": "Forecasting",
      "description": "Surface Soil Moisture Prediction",
      "hasResult": [
        {
          "@id": "urn:demeter:idParcel1:meanValue:2021-04-17"
        }
      ]
    },
    {
      "@id": "urn:demeter:SoilMoisturePred:SoilMoisture:2021-04-17",
      "@type": "Image",
      "imgUri": "/home/vyago/Desktop/soilMoisture/soilMoisture-PKG-demeter/OPTRAM/A/2021-04-17.jpeg",
      "imgScaleUri": "",
      "unit": {
        "@id": "qudt-unit:xsd:anyURI"
      }
    },
    {
      "@id": "urn:demeter:SoilMoisturePred:meanValue:2021-04-17",
      "@type": "QuantityValue",
      "numericValue": "47",
      "unit": {
        "@id": "qudt-unit:percentage"
      }
```

```
    }
  ]
}
```


AIM Model - Input from WP4 component 4.B.4 *Plant Water Status Anomalies Detection*


```
{
  "@context": [
    "https://w3id.org/demeter/agri-context.jsonld",
    {
      "qudt-unit": "http://qudt.org/vocab/unit/"
    }
  ],
  "@graph": [
    {
      "@id": "urn:demeter:Observation:Anomalies:1",
      "@type": "Observation",
      "description": "Plant Water Status Anomalies Detection",
      "hasResult": [
        {
          "@id": "urn:demeter:idParcel1:Anomalies:2021-04-17"
        }
      ]
    },
    {
      "@id": "urn:demeter:idParcel1:Anomalies:2021-04-17",
      "@type": "Image",
      "imgUri": "/home/vyago/Desktop/Anomalies/Anomalies-PKG-demeter/A/2021-04-17.jpeg",
      "imgScaleUri": "",
      "unit": {
        "@id": "qudt-unit:xsd:anyURI"
      }
    }
  ]
}
```

C.2.2. Component 4.B.2 Reference Evapotranspiration Prediction

AIM Model - Input from WP2 component *Weather Forecast*


```
{

    "@context": [
      "https://w3id.org/demeter/agri-context.jsonld",
      {
        "qudt-unit": "http://qudt.org/vocab/unit/"
      }
    ],
    "@graph": [
      {
        "@id": "urn:demeter:ObservationCollection:WeatherBit_temp",
        "@type": "ObservationCollection",
        "description": "Air-temperature",
        "observedProperty": {
          "@id": "http://purl.obolibrary.org/obo/IDOMAL_0000568"
        },
        "hasMember": [
          {
            "@id": "urn:demeter:Observation:WeatherBit_temp_1"
          },
          {
            "@id": "urn:demeter:Observation:WeatherBit_temp_2"
          },
          {
            "@id": "urn:demeter:Observation:WeatherBit_temp_3"
          }
        ]
      },
      {
        "@id": "urn:demeter:Observation:WeatherBit_temp_1",
        "@type": "Observation",
        "resultTime": "2021-04-28T11:00:00",
        "hasResult": [
          {
            "@id": "urn:demeter:QuantityValue:WeatherBit_temp_1_1",
            "@type": "QuantityValue",
            "numericValue": "17.1",
            "unit": {
```

```
              "@id": "qudt-unit:DEG_C"
            }
          }
        ]
      },
      {
        "@id": "urn:demeter:Observation:WeatherBit_temp_2",
        "@type": "Observation",
        "resultTime": "2021-04-28T12:00:00",
        "hasResult": [
          {
            "@id": "urn:demeter:QuantityValue:WeatherBit_temp_2_1",
            "@type": "QuantityValue",
            "numericValue": "18.4",
            "unit": {
              "@id": "qudt-unit:DEG_C"
            }
          }
        ]
      },
      {
        "@id": "urn:demeter:Observation:WeatherBit_temp_3",
        "@type": "Observation",
        "resultTime": "2021-04-28T13:00:00",
        "hasResult": [
          {
            "@id": "urn:demeter:QuantityValue:WeatherBit_temp_3_1",
            "@type": "QuantityValue",
            "numericValue": "19.2",
            "unit": {
              "@id": "qudt-unit:DEG_C"
            }
          }
        ]
      },
      {
        "@id": "urn:demeter:ObservationCollection:WeatherBit_rh",
        "@type": "ObservationCollection",
        "description": "Air-relative-humidity",
        "observedProperty": {
          "@id": "http://purl.obolibrary.org/obo/IDOMAL_0000419"
        },
```

```
    "hasMember": [
      {
        "@id": "urn:demeter:Observation:WeatherBit_rh_1"
      },
      {
        "@id": "urn:demeter:Observation:WeatherBit_rh_2"
      },
      {
        "@id": "urn:demeter:Observation:WeatherBit_rh_3"
      }
    ]
  },
  {
    "@id": "urn:demeter:Observation:WeatherBit_rh_1",
    "@type": "Observation",
    "resultTime": "2021-04-28T11:00:00",
    "hasResult": [
      {
        "@id": "urn:demeter:QuantityValue:WeatherBit_rh_1_1",
        "@type": "QuantityValue",
        "numericValue": "64",
        "unit": {
          "@id": "qudt-unit:PERCENT"
        }
      }
    ]
  },
  {
    "@id": "urn:demeter:Observation:WeatherBit_rh_2",
    "@type": "Observation",
    "resultTime": "2021-04-28T12:00:00",
    "hasResult": [
      {
        "@id": "urn:demeter:QuantityValue:WeatherBit_rh_2_1",
        "@type": "QuantityValue",
        "numericValue": "66",
        "unit": {
          "@id": "qudt-unit:PERCENT"
        }
      }
    ]
  },
```

```
    {
      "@id": "urn:demeter:Observation:WeatherBit_rh_3",
      "@type": "Observation",
      "resultTime": "2021-04-28T13:00:00",
      "hasResult": [
        {
          "@id": "urn:demeter:QuantityValue:WeatherBit_rh_3_1",
          "@type": "QuantityValue",
          "numericValue": "63",
          "unit": {
            "@id": "qudt-unit:PERCENT"
          }
        }
      ]
    },
    {
      "@id": "urn:demeter:ObservationCollection:WeatherBit_wind",
      "@type": "ObservationCollection",
      "description": "Wind-speed",
      "observedProperty": {
        "@id": "http://dbpedia.org/resource/Wind_speed"
      },
      "hasMember": [
        {
          "@id": "urn:demeter:Observation:WeatherBit_wind_1"
        },
        {
          "@id": "urn:demeter:Observation:WeatherBit_wind_2"
        },
        {
          "@id": "urn:demeter:Observation:WeatherBit_wind_3"
        }
      ]
    },
    {
      "@id": "urn:demeter:Observation:WeatherBit_wind_1",
      "@type": "Observation",
      "resultTime": "2021-04-28T11:00:00",
      "hasResult": [
        {
          "@id": "urn:demeter:QuantityValue:WeatherBit_wind_1_1",
          "@type": "QuantityValue",
```

```
            "numericValue": "1.74558",
            "unit": {
              "@id": "qudt-unit:M-PER-SEC"
            }
          }
        ]
      },
      {
        "@id": "urn:demeter:Observation:WeatherBit_wind_2",
        "@type": "Observation",
        "resultTime": "2021-04-28T12:00:00",
        "hasResult": [
          {
            "@id": "urn:demeter:QuantityValue:WeatherBit_wind_2_1",
            "@type": "QuantityValue",
            "numericValue": "2.26174",
            "unit": {
              "@id": "qudt-unit:M-PER-SEC"
            }
          }
        ]
      },
      {
        "@id": "urn:demeter:Observation:WeatherBit_wind_3",
        "@type": "Observation",
        "resultTime": "2021-04-28T13:00:00",
        "hasResult": [
          {
            "@id": "urn:demeter:QuantityValue:WeatherBit_wind_3_1",
            "@type": "QuantityValue",
            "numericValue": "1.46735",
            "unit": {
              "@id": "qudt-unit:M-PER-SEC"
            }
          }
        ]
      },
      {
        "@id": "urn:demeter:ObservationCollection:solar_rad",
        "@type": "ObservationCollection",
        "description": "Solar-radiation",
        "observedProperty": {
```

```
          "@id": "http://linkeddata.ge.imati.cnr.it:2020/resource/EARTh/12480"
        },
        "hasMember": [
          {
            "@id": "urn:demeter:Observation:solar_rad_1"
          },
          {
            "@id": "urn:demeter:Observation:solar_rad_2"
          },
          {
            "@id": "urn:demeter:Observation:solar_rad_3"
          }
        ]
      },
      {
        "@id": "urn:demeter:Observation:WeatherBit_solar_rad_1",
        "@type": "Observation",
        "resultTime": "2021-04-28T11:00:00",
        "hasResult": [
          {
            "@id": "urn:demeter:QuantityValue:WeatherBit_solar_rad_1_1",
            "@type": "QuantityValue",
            "numericValue": "621.663",
            "unit": {
              "@id": "qudt-unit:W-PER-M2"
            }
          }
        ]
      },
      {
        "@id": "urn:demeter:Observation:WeatherBit_solar_rad_2",
        "@type": "Observation",
        "resultTime": "2021-04-28T12:00:00",
        "hasResult": [
          {
            "@id": "urn:demeter:QuantityValue:WeatherBit_solar_rad_2_1",
            "@type": "QuantityValue",
            "numericValue": "811.662",
            "unit": {
              "@id": "qudt-unit:W-PER-M2"
            }
          }
```

```
      ]
    },
    {
      "@id": "urn:demeter:Observation:WeatherBit_solar_rad_3",
      "@type": "Observation",
      "resultTime": "2021-04-28T13:00:00",
      "hasResult": [
        {
          "@id": "urn:demeter:QuantityValue:WeatherBit_solar_rad_3_1",
          "@type": "QuantityValue",
          "numericValue": "861.725",
          "unit": {
            "@id": "qudt-unit:W-PER-M2"
          }
        }
      ]
    },
    {
      "@id": "urn:demeter:ObservationCollection:Precipitation",
      "@type": "ObservationCollection",
      "description": "Precipitation",
      "observedProperty": {
        "@id": "http://linkeddata.ge.imati.cnr.it:2020/resource/EARTh/37580"
      },
      "hasMember": [
        {
          "@id": "urn:demeter:Observation:WeatherBit_precipitation_1"
        },
        {
          "@id": "urn:demeter:Observation:WeatherBit_precipitation_2"
        },
        {
          "@id": "urn:demeter:Observation:WeatherBit_precipitation_3"
        }
      ]
    },
    {
      "@id": "urn:demeter:Observation:WeatherBit_precipitation_1",
      "@type": "Observation",
      "resultTime": "2021-04-28T11:00:00",
      "hasResult": [
        {
```

```
            "@id": "urn:demeter:QuantityValue:WeatherBit_precipitation_1_1",
            "@type": "QuantityValue",
            "numericValue": "1",
            "unit": {
              "@id": "qudt-unit:L-PER-HR"
            }
          }
        ]
      },
      {
        "@id": "urn:demeter:Observation:WeatherBit_precipitation_2",
        "@type": "Observation",
        "resultTime": "2021-04-28T12:00:00",
        "hasResult": [
          {
            "@id": "urn:demeter:QuantityValue:WeatherBit_precipitation_2_1",
            "@type": "QuantityValue",
            "numericValue": "2",
            "unit": {
              "@id": "qudt-unit:L-PER-HR"
            }
          }
        ]
      },
      {
        "@id": "urn:demeter:Observation:WeatherBit_precipitation_3",
        "@type": "Observation",
        "resultTime": "2021-04-28T13:00:00",
        "hasResult": [
          {
            "@id": "urn:demeter:QuantityValue:WeatherBit_precipitation_3_1",
            "@type": "QuantityValue",
            "numericValue": "5",
            "unit": {
              "@id": "qudt-unit:L-PER-HR"
            }
          }
        ]
      }
    ]
}
```

AIM Model – Input from WP2 component *Pilot Device Bridge (example for temperature historical weather data)*


```
{
    "@context": [
        "https://w3id.org/demeter/agri-context.jsonld",
        {
            "qudt-unit": "http://qudt.org/vocab/unit/"
        }
    ],
    "@graph": [
        {
            "@id": "urn:demeter:ObservationCollection:temperature:1:1",
            "@type": "ObservationCollection",
            "description": "Air-temperature",
            "observedProperty": {
                "@id": "http://purl.obolibrary.org/obo/IDOMAL_0000568"
            },
            "madeBySensor": {
                "@id": "urn:demeter:temperature:1:1"
            },
            "hasMember": [
                {
                    "@id": "urn:demeter:Observation:temperature:1:1_1"
                },
                {
                    "@id": "urn:demeter:Observation:temperature:1:1_2"
                },
                {
                    "@id": "urn:demeter:Observation:temperature:1:1_3"
                }
            ]
        },
        {
            "@id": "urn:demeter:Observation:temperature:1:1_1",
            "@type": "Observation",
            "resultTime": "2021-04-10T00:00:00.000Z",
            "hasResult": [
                {
                    "@id": "urn:demeter:QuantityValue:temperature:1:1_1_1",
                    "@type": "QuantityValue",
                    "numericValue": 17.213,
```

```
                    "unit": {
                        "@id": "qudt-unit:DEG_C"
                    }
                }
            ]
        },
        {
            "@id": "urn:demeter:Observation:temperature:1:1_2",
            "@type": "Observation",
            "resultTime": "2021-04-10T00:30:00.000Z",
            "hasResult": [
                {
                    "@id": "urn:demeter:QuantityValue:temperature:1:1_2_1",
                    "@type": "QuantityValue",
                    "numericValue": 18.401,
                    "unit": {
                        "@id": "qudt-unit:DEG_C"
                    }
                }
            ]
        },
        {
            "@id": "urn:demeter:Observation:temperature:1:1_3",
            "@type": "Observation",
            "resultTime": "2021-04-10T01:00:00.000Z",
            "hasResult": [
                {
                    "@id": "urn:demeter:QuantityValue:temperature:1:1_3_1",
                    "@type": "QuantityValue",
                    "numericValue": 19.228,
                    "unit": {
                        "@id": "qudt-unit:DEG_C"
                    }
                }
            ]
        }
    ]
}
```

AIM Model - Output


```
{
    "@context": [
      "https://w3id.org/demeter/agri-context.jsonld",
      {
        "qudt-unit": "http://qudt.org/vocab/unit/"
      }
    ],
    "@graph": [
      {
        "@id": "urn:demeter:Forecasting:1",
        "@type": "Forecasting",
        "description": "et0forthecrop",
        "hasResult": [
          {
            "@id": "urn:demeter:idParcel1:Forecasting:et0_0"
          },
          {
            "@id": "urn:demeter:idParcel1:Forecasting:et0_1"
          }
        ]
      },
      {
        "@id": "urn:demeter:Forecasting:Forecasting:et0_0",
        "@type": "QuantityValue",
        "numericValue": "1.916",
        "unit": {
          "@id": "qudt-unit:MilLength"
        }
      },
      {
        "@id": "urn:demeter:Forecasting:Forecasting:et0_1",
        "@type": "QuantityValue",
        "numericValue": "1.916",
        "unit": {
          "@id": "qudt-unit:MilLength"
        }
      }
    ]
 }
```

C.2.3. Component 4.B.3 Soil Moisture Estimation

AIM Model – Input from WP2 component *Pilot Device Bridge (soil moisture historical data)*


```
{
    "@context": [
        "https://w3id.org/demeter/agri-context.jsonld",
        {
            "qudt-unit": "http://qudt.org/vocab/unit/"
        }
    ],
    "@graph": [
        {
            "@id": "urn:demeter:ObservationCollection:moisture:1:1",
            "@type": "ObservationCollection",
            "description": "soil-moisture",
            "observedProperty": {
                "@id": " http://aims.fao.org/aos/agrovoc/c_7208"
            },
            "madeBySensor": {
                "@id": "urn:demeter: moisture:1:1"
            },
            "hasMember": [
                {
                    "@id": "urn:demeter:Observation:moisture:1:1_1"
                },
                {
                    "@id": "urn:demeter:Observation:moisture:1:1_2"
                },
                {
                    "@id": "urn:demeter:Observation:moisture:1:1_3"
                }
            ]
        },
        {
            "@id": "urn:demeter:Observation:moisture:1:1_1",
            "@type": "Observation",
            "resultTime": "2021-04-10T00:00:00.000Z",
            "hasResult": [
                {
                    "@id": "urn:demeter:QuantityValue:moisture:1:1_1_1",
                    "@type": "QuantityValue",
```

```
                    "numericValue": 37.413,
                    "unit": {
                        "@id": "qudt-unit:PERCENT"
                    }
                }
            ]
        },
        {
            "@id": "urn:demeter:Observation:moisture:1:1_2",
            "@type": "Observation",
            "resultTime": "2021-04-10T00:30:00.000Z",
            "hasResult": [
                {
                    "@id": "urn:demeter:QuantityValue:moisture:1:1_2_1",
                    "@type": "QuantityValue",
                    "numericValue": 37.413,
                    "unit": {
                        "@id": "qudt-unit:PERCENT"
                    }
                }
            ]
        },
        {
            "@id": "urn:demeter:Observation:moisture:1:1_3",
            "@type": "Observation",
            "resultTime": "2021-04-10T01:00:00.000Z",
            "hasResult": [
                {
                    "@id": "urn:demeter:QuantityValue:moisture:1:1_3_1",
                    "@type": "QuantityValue",
                    "numericValue": 37.413,
                    "unit": {
                        "@id": "qudt-unit:PERCENT"
                    }
                }
            ]
        }
    ]
}
```

AIM Model - Output


```
{
  "@context": [
    "https://w3id.org/demeter/agri-context.jsonld",
    {
      "qudt-unit": "http://qudt.org/vocab/unit/"
    }
  ],
  "@graph": [
    {
      "@id": "urn:demeter:SoilMoisture:1",
      "@type": "Forecasting",
      "description": "Surface Soil Moisture Prediction",
      "hasResult": [
        {
          "@id": "urn:demeter:idParcel1:meanValue:2021-04-17"
        }
      ]
    },
    {
      "@id": "urn:demeter:SoilMoisturePred:SoilMoisture:2021-04-17",
      "@type": "Image",
      "imgUri": "/home/vyago/Desktop/soilMoisture/soilMoisture-PKG-demeter/OPTRAM/A/2021-04-17.jpeg",
      "imgScaleUri": "",
      "unit": {
        "@id": "qudt-unit:xsd:anyURI"
      }
    },
    {
      "@id": "urn:demeter:SoilMoisturePred:meanValue:2021-04-17",
      "@type": "QuantityValue",
      "numericValue": "47",
      "unit": {
        "@id": "qudt-unit:percentage"
      }
    }
  ]
}
```

C.2.4. Component 4.B.4 Crop Water Status Anomalies Detection

AIM Model - Input
None

AIM Model - Output


```
{
  "@context": [
    "https://w3id.org/demeter/agri-context.jsonld",
    {
      "qudt-unit": "http://qudt.org/vocab/unit/"
    }
  ],
  "@graph": [
    {
      "@id": "urn:demeter:Observation:Anomalies:1",
      "@type": "Observation",
      "description": "Plant Water Status Anomalies Detection",
      "hasResult": [
        {
          "@id": "urn:demeter:idParcel1:Anomalies:2021-04-17"
        }
      ]
    },
    {
      "@id": "urn:demeter:idParcel1:Anomalies:2021-04-17",
      "@type": "Image",
      "imgUri": "/home/vyago/Desktop/Anomalies/Anomalies-PKG-demeter/A/2021-04-17.jpeg",
      "imgScaleUri": "",
      "unit": {
        "@id": "qudt-unit:xsd:anyURI"
      }
    }
  ]
}
```

C.3. DSS AREA: 4.C - Nutrition Management

C.3.1. Component 4.C.1 Nitrogen Balance Model

AIM Model - Input


```
{
  "@context": "https://w3id.org/demeter/agri-context.jsonld",
  "@graph": [
    {
      "@id": "urn:demeter:AgriFarm:b429c6d4-676f-4807-a6c9-2c6451614c09",
      "@type": "AgriFarm",
      "name": "RomAgra Impex SRL",
      "address": {
        "@id": "43",
        "@type": "PostalAddress",
        "addressCountry": "RO",
        "addressLocality": "Manasia",
        "streetAddress": "Main Street, 22"
      },
      "contactPoint": {
        "@id": "22",
        "@type": "ContactPoint",
        "email": "contact@romagra.ro",
        "telephone": "0040 244 123 456"
      },
      "hasAgriParcel": [
        {
          "@id": "urn:demeter:AgriParcel:b429c6d4-676f-4807-a6c9-2c6451614c0a",
          "@type": "AgriParcel",
          "location": {
            "@id": "101",
            "@type": "Polygon",
            "coordinates": [
              [
                [
                  16.396622657775882,
                  52.291722551113224
                ],
                [
                  16.395592689514164,
```

```
              52.289885097096466
            ],
            [
              16.39889717102051,
              52.289202594763935
            ],
            [
              16.39994859695435,
              52.29094820478369
            ]
          ]
        ]
      },
      "belongsTo": "urn:demeter:AgriFarm:b429c6d4-676f-4807-a6c9-2c6451614c09",
      "area": 17600,
      "name": "1a",
      "description": "Parcel 1a",
      "cropStatus": "seeded",
      "lastPlantedAt": "2020-10-20T10:18:16Z",
      "hasAgriCrop": {
        "@id": "urn:demeter:AgriCrop:b429c6d4-676f-4807-a6ca-2c6451614c50",
        "@type": "AgriCrop",
        "name": "Corn",
        "description": "Glass Gem Corn",
        "wateringFrequency": "weekly"
      }
    },
    {
      "@id": "urn:demeter:AgriParcel:b429c6d4-676f-4807-a6c9-2c6451614c0b",
      "@type": "AgriParcel",
      "location": {
        "@id": "102",
        "@type": "Polygon",
        "coordinates": [
          [
            [
              16.396622657775882,
              52.291722551113224
            ],
            [
              16.395592689514164,
              52.289885097096466
```

```
              ],
              [
                16.39889717102051,
                52.289202594763935
              ],
              [
                16.39994859695435,
                52.29094820478369
              ]
            ]
          ]
        },
        "belongsTo": "urn:demeter:AgriFarm:b429c6d4-676f-4807-a6c9-2c6451614c09",
        "area": 23200,
        "name": "1b",
        "description": "Parcel1b",
        "cropStatus": "justBorn",
        "lastPlantedAt": "2020-10-04T10:18:16Z",
        "hasAgriCrop": {
          "@id": "urn:demeter:AgriCrop:b429c6d4-676f-4807-a6ca-2c6451614c51",
          "@type": "AgriCrop",
          "name": "Corn",
          "description": "GlassGemCorn",
          "wateringFrequency": "daily"
        }
      },
      {
        "@id": "urn:demeter:AgriParcel:b429c6d4-676f-4807-a6c9-2c6451614c0c",
        "@type": "AgriParcel",
        "location": {
          "@id": "103",
          "@type": "Polygon",
          "coordinates": [
            [
              [
                16.396622657775882,
                52.291722551113224
              ],
              [
                16.395592689514164,
                52.289885097096466
              ],
```

```
                [
                  16.39889717102051,
                  52.289202594763935
                ],
                [
                  16.39994859695435,
                  52.29094820478369
                ]
              ]
            ]
          },
          "belongsTo": "urn:demeter:AgriFarm:b429c6d4-676f-4807-a6c9-2c6451614c09",
          "area": 35000,
          "name": "1c",
          "description": "Parcel 1c",
          "cropStatus": "maturing",
          "lastPlantedAt": "2020-08-20T10:18:16Z",
          "hasAgriCrop": {
            "@id": "urn:demeter:AgriCrop:b429c6d4-676f-4807-a6ca-2c6451614c52",
            "@type": "AgriCrop",
            "name": "Corn",
            "description": "Glass Gem Corn",
            "wateringFrequency": "other"
          }
        }
      ]
    },
    {
      "@id": "urn:demeter:AgriParcelOperation:b429c6d4-676f-4807-a6c9-2c6451614c5d",
      "@type": "AgriParcelOperation",
      "description": "Previous fertilization for parcel 1a",
      "hasAgriParcel": "urn:demeter:AgriParcel:b429c6d4-676f-4807-a6c9-2c6451614c0a",
      "operationType": "fertilizer",
      "hasAgriProductType": {
        "@id": "urn:demeter:AgriProductType:b429c6d4-676f-4807-a6c9-2c6451614c60",
        "@type": "AgriProductType",
        "category": "fertilizer",
        "name": "Ammonium Sulphate",
        "agroVocConcept": {
          "@id": "http://aims.fao.org/aos/agrovoc/c_354"
        },
        "root": "true"
```

```
    },
    "quantity": 150,
    "status": "finished",
    "endedAt": "2020-08-13T10:00:00Z"
  },
  {
    "@id": "urn:demeter:AgriParcelOperation:b429c6d4-676f-4807-a6c9-2c6451614c5e",
    "@type": "AgriParcelOperation",
    "description": "Previous fertilization for parcel 1b",
    "hasAgriParcel": "urn:demeter:AgriParcel:b429c6d4-676f-4807-a6c9-2c6451614c0b",
    "operationType": "fertilizer",
    "hasAgriProductType": {
      "@id": "urn:demeter:AgriProductType:b429c6d4-676f-4807-a6c9-2c6451614c61",
      "@type": "AgriProductType",
      "category": "fertilizer",
      "name": "Urea",
      "agroVocConcept": {
        "@id": "http://aims.fao.org/aos/agrovoc/c_8090"
      },
      "root": "true"
    },
    "quantity": 195,
    "status": "finished",
    "endedAt": "2020-08-13T10:00:00Z"
  },
  {
    "@id": "urn:demeter:AgriParcelOperation:b429c6d4-676f-4807-a6c9-2c6451614c5f",
    "@type": "AgriParcelOperation",
    "description": "Previous fertilization for parcel 1c",
    "hasAgriParcel": "urn:demeter:AgriParcel:b429c6d4-676f-4807-a6c9-2c6451614c0c",
    "operationType": "fertilizer",
    "hasAgriProductType": {
      "@id": "urn:demeter:AgriProductType:b429c6d4-676f-4807-a6c9-2c6451614c60",
      "@type": "AgriProductType",
      "category": "fertilizer",
      "name": "Ammonium Sulphate",
      "agroVocConcept": {
        "@id": "http://aims.fao.org/aos/agrovoc/c_354"
      },
      "root": "true"
    },
    "quantity": 0,
```

```
      "status": "finished",
      "endedAt": "2020-08-13T10:00:00Z"
    }
  ]
}
```


AIM Model - Output


```
{
  "@context": "https://w3id.org/demeter/agri-context.jsonld",
  "@graph": [
    {
      "@id": "urn:demeter:AgriFarm:b429c6d4-676f-4807-a6c9-2c6451614c09",
      "@type": "AgriFarm",
      "name": "RomAgra Impex SRL",
      "address": {
        "@id": "43",
        "@type": "PostalAddress",
        "addressCountry": "RO",
        "addressLocality": "Manasia",
        "streetAddress": "Main Street, 22"
      },
      "contactPoint": {
        "@id": "22",
        "@type": "ContactPoint",
        "email": "contact@romagra.ro",
        "telephone": "0040 244 123 456"
      },
      "hasAgriParcel": [
        {
          "@id": "urn:demeter:AgriParcel:b429c6d4-676f-4807-a6c9-2c6451614c0a",
          "@type": "AgriParcel",
          "location": {
            "@id": "101",
            "@type": "Polygon",
            "coordinates": [
              [
                [
                  16.396622657775882,
                  52.291722551113224
                ],
                [
```

```
              16.395592689514164,
              52.289885097096466
            ],
            [
              16.39889717102051,
              52.289202594763935
            ],
            [
              16.39994859695435,
              52.29094820478369
            ]
          ]
        ]
      },
      "belongsTo": "urn:demeter:AgriFarm:b429c6d4-676f-4807-a6c9-2c6451614c09",
      "area": 17600,
      "name": "1a",
      "description": "Parcel 1a",
      "cropStatus": "seeded",
      "lastPlantedAt": "2020-10-20T10:18:16Z",
      "hasAgriCrop": {
        "@id": "urn:demeter:AgriCrop:b429c6d4-676f-4807-a6ca-2c6451614c50",
        "@type": "AgriCrop",
        "name": "Corn",
        "description": "Glass Gem Corn",
        "wateringFrequency": "weekly"
      }
    },
    {
      "@id": "urn:demeter:AgriParcel:b429c6d4-676f-4807-a6c9-2c6451614c0b",
      "@type": "AgriParcel",
      "location": {
        "@id": "102",
        "@type": "Polygon",
        "coordinates": [
          [
            [
              16.396622657775882,
              52.291722551113224
            ],
            [
              16.395592689514164,
```

```
                  52.289885097096466
                ],
                [
                  16.39889717102051,
                  52.289202594763935
                ],
                [
                  16.39994859695435,
                  52.29094820478369
                ]
              ]
            ]
          },
          "belongsTo": "urn:demeter:AgriFarm:b429c6d4-676f-4807-a6c9-2c6451614c09",
          "area": 23200,
          "name": "1b",
          "description": "Parcel1b",
          "cropStatus": "justBorn",
          "lastPlantedAt": "2020-10-04T10:18:16Z",
          "hasAgriCrop": {
            "@id": "urn:demeter:AgriCrop:b429c6d4-676f-4807-a6ca-2c6451614c51",
            "@type": "AgriCrop",
            "name": "Corn",
            "description": "GlassGemCorn",
            "wateringFrequency": "daily"
          }
        },
        {
          "@id": "urn:demeter:AgriParcel:b429c6d4-676f-4807-a6c9-2c6451614c0c",
          "@type": "AgriParcel",
          "location": {
            "@id": "103",
            "@type": "Polygon",
            "coordinates": [
              [
                [
                  16.396622657775882,
                  52.291722551113224
                ],
                [
                  16.395592689514164,
                  52.289885097096466
```

```
                ],
                [
                  16.39889717102051,
                  52.289202594763935
                ],
                [
                  16.39994859695435,
                  52.29094820478369
                ]
              ]
            ]
          },
          "belongsTo": "urn:demeter:AgriFarm:b429c6d4-676f-4807-a6c9-2c6451614c09",
          "area": 35000,
          "name": "1c",
          "description": "Parcel 1c",
          "cropStatus": "maturing",
          "lastPlantedAt": "2020-08-20T10:18:16Z",
          "hasAgriCrop": {
            "@id": "urn:demeter:AgriCrop:b429c6d4-676f-4807-a6ca-2c6451614c52",
            "@type": "AgriCrop",
            "name": "Corn",
            "description": "Glass Gem Corn",
            "wateringFrequency": "other"
          }
        }
      ]
    },
    {
      "@id": "urn:demeter:AgriParcelOperation:b429c6d4-676f-4807-a6c9-2c6451614c5d",
      "@type": "AgriParcelOperation",
      "description": "Previous fertilization for parcel 1a",
      "hasAgriParcel": "urn:demeter:AgriParcel:b429c6d4-676f-4807-a6c9-2c6451614c0a",
      "operationType": "fertilizer",
      "hasAgriProductType": {
        "@id": "urn:demeter:AgriProductType:b429c6d4-676f-4807-a6c9-2c6451614c60",
        "@type": "AgriProductType",
        "category": "fertilizer",
        "name": "Ammonium Sulphate",
        "agroVocConcept": {
          "@id": "http://aims.fao.org/aos/agrovoc/c_354"
        },
```

```
        "root": "true"
      },
      "quantity": 150,
      "status": "finished",
      "endedAt": "2020-08-13T10:00:00Z"
    },
    {
      "@id": "urn:demeter:AgriParcelOperation:b429c6d4-676f-4807-a6c9-2c6451614c5e",
      "@type": "AgriParcelOperation",
      "description": "Previous fertilization for parcel 1b",
      "hasAgriParcel": "urn:demeter:AgriParcel:b429c6d4-676f-4807-a6c9-2c6451614c0b",
      "operationType": "fertilizer",
      "hasAgriProductType": {
        "@id": "urn:demeter:AgriProductType:b429c6d4-676f-4807-a6c9-2c6451614c61",
        "@type": "AgriProductType",
        "category": "fertilizer",
        "name": "Urea",
        "agroVocConcept": {
          "@id": "http://aims.fao.org/aos/agrovoc/c_8090"
        },
        "root": "true"
      },
      "quantity": 195,
      "status": "finished",
      "endedAt": "2020-08-13T10:00:00Z"
    },
    {
      "@id": "urn:demeter:AgriParcelOperation:b429c6d4-676f-4807-a6c9-2c6451614c5f",
      "@type": "AgriParcelOperation",
      "description": "Previous fertilization for parcel 1c",
      "hasAgriParcel": "urn:demeter:AgriParcel:b429c6d4-676f-4807-a6c9-2c6451614c0c",
      "operationType": "fertilizer",
      "hasAgriProductType": {
        "@id": "urn:demeter:AgriProductType:b429c6d4-676f-4807-a6c9-2c6451614c60",
        "@type": "AgriProductType",
        "category": "fertilizer",
        "name": "Ammonium Sulphate",
        "agroVocConcept": {
          "@id": "http://aims.fao.org/aos/agrovoc/c_354"
        },
        "root": "true"
      },
```

```
      "quantity": 0,
      "status": "finished",
      "endedAt": "2020-08-13T10:00:00Z"
    },
    {
      "@id": "urn:demeter:AgriParcelRecord:b429c6d4-676f-4807-a6c9-2c6451614c0d",
      "@type": "AgriParcelRecord",
      "hasAgriParcel": "urn:demeter:AgriParcel:b429c6d4-676f-4807-a6c9-2c6451614c0a",
      "observedAt": "2020-10-13T10:00:00Z",
      "nitrogenLevel": 0.7,
      "totalAffectedArea": 0.15,
      "result": "1 dose of 100kg of urea",
      "containsZone": [
        {
          "@id": "urn:demeter:MgmtZone:1003",
          "@type": "ManagementZone",
          "hasGeometry": {
            "@id": "urn:demeter:MgmtZone:geo:10003",
            "@type": "POLYGON",
            "asWKT": "POLYGON ((2.658972849564151 50.95792999214172, 2.659091082268864 50.95776685575894, 2.658703633207661
50.95765484590413, 2.658585399495478 50.95781798185575, 2.658972849564151 50.95792999214172))"
          }
        },
        {
          "@id": "urn:demeter:MgmtZone:1004",
          "@type": "ManagementZone",
          "hasGeometry": {
            "@id": "urn:demeter:MgmtZone:geo:10004",
            "@type": "POLYGON",
            "asWKT": "POLYGON ((2.659091082268864 50.95776685575894, 2.659209314101167 50.95760371922457, 2.658821866047433
50.95749170980091, 2.658717720321181 50.95763540876296, 2.658703633207661 50.95765484590413, 2.659091082268864 50.95776685575894))"
          }
        }
      ]
    },
    {
      "@id": "urn:demeter:AgriParcelRecord:b429c6d4-676f-4807-a6c9-2c6451614c0e",
      "@type": "AgriParcelRecord",
      "hasAgriParcel": "urn:demeter:AgriParcel:b429c6d4-676f-4807-a6c9-2c6451614c0b",
      "observedAt": "2020-10-20T10:00:00Z",
      "nitrogenLevel": 0.4,
      "totalAffectedArea": 0.35,
```

```
      "result": "1 dose of 175kg of Ammonium Sulphate",
      "containsZone": [
        {
          "@id": "urn:demeter:MgmtZone:1001",
          "@type": "ManagementZone",
          "hasGeometry": {
            "@id": "urn:demeter:MgmtZone:geo:10001",
            "@type": "POLYGON",
            "asWKT": "POLYGON ((2.658972849564151 50.95792999214172, 2.659091082268864 50.95776685575894, 2.658703633207661
50.95765484590413, 2.658585399495478 50.95781798185575, 2.658972849564151 50.95792999214172))"
          }
        },
        {
          "@id": "urn:demeter:MgmtZone:1002",
          "@type": "ManagementZone",
          "hasGeometry": {
            "@id": "urn:demeter:MgmtZone:geo:10002",
            "@type": "POLYGON",
            "asWKT": "POLYGON ((2.659091082268864 50.95776685575894, 2.659209314101167 50.95760371922457, 2.658821866047433
50.95749170980091, 2.658717720321181 50.95763540876296, 2.658703633207661 50.95765484590413, 2.659091082268864 50.95776685575894))"
          }
        }
      ]
    },
    {
      "@id": "urn:demeter:AgriParcelRecord:b429c6d4-676f-4807-a6c9-2c6451614c0f",
      "@type": "AgriParcelRecord",
      "hasAgriParcel": "urn:demeter:AgriParcel:b429c6d4-676f-4807-a6c9-2c6451614c0c",
      "observedAt": "2020-10-27T10:00:00Z",
      "nitrogenLevel": 0.8,
      "totalAffectedArea": 0.25,
      "result": "1 dose of 150kg of urea",
      "containsZone": [
        {
          "@id": "urn:demeter:MgmtZone:1005",
          "@type": "ManagementZone",
          "hasGeometry": {
            "@id": "urn:demeter:MgmtZone:geo:10005",
            "@type": "POLYGON",
            "asWKT": "POLYGON ((2.658972849564151 50.95792999214172, 2.659091082268864 50.95776685575894, 2.658703633207661
50.95765484590413, 2.658585399495478 50.95781798185575, 2.658972849564151 50.95792999214172))"
          }
```

```
        },
        {
          "@id": "urn:demeter:MgmtZone:1006",
          "@type": "ManagementZone",
          "hasGeometry": {
            "@id": "urn:demeter:MgmtZone:geo:10006",
            "@type": "POLYGON",
            "asWKT": "POLYGON ((2.659091082268864 50.95776685575894, 2.659209314101167 50.95760371922457, 2.658821866047433
50.95749170980091, 2.658717720321181 50.95763540876296, 2.658703633207661 50.95765484590413, 2.659091082268864 50.95776685575894))"
          }
        }
      ]
    },
    {
      "@id": "urn:demeter:WeatherForecast:b429c6d4-676f-4807-a6ca-2c6451614c70",
      "@type": "WeatherForecast",
      "hasAgriParcel": "urn:demeter:AgriParcel:b429c6d4-676f-4807-a6c9-2c6451614c0a",
      "weatherType": "sunnyDay",
      "temperature": 24,
      "windSpeed": 2.8,
      "precipitationProbability": 0.15,
      "validFrom": "2020-10-21T00:00:00Z",
      "validThrough": "2020-10-22T00:00:00Z"
    },
    {
      "@id": "urn:demeter:WeatherForecast:b429c6d4-676f-4807-a6ca-2c6451614c71",
      "@type": "WeatherForecast",
      "hasAgriParcel": "urn:demeter:AgriParcel:b429c6d4-676f-4807-a6c9-2c6451614c0a",
      "weatherType": "lightRainShower",
      "temperature": 20,
      "windSpeed": 3.5,
      "precipitationProbability": 0.8,
      "validFrom": "2020-10-22T00:00:00Z",
      "validThrough": "2020-10-23T00:00:00Z"
    },
    {
      "@id": "urn:demeter:WeatherForecast:b429c6d4-676f-4807-a6ca-2c6451614c72",
      "@type": "WeatherForecast",
      "hasAgriParcel": "urn:demeter:AgriParcel:b429c6d4-676f-4807-a6c9-2c6451614c0b",
      "weatherType": "sunnyDay",
      "temperature": 26,
      "windSpeed": 2.2,
```

```
      "precipitationProbability": 0.12,
      "validFrom": "2020-10-24T00:00:00Z",
      "validThrough": "2020-10-25T00:00:00Z"
    },
    {
      "@id": "urn:demeter:WeatherForecast:b429c6d4-676f-4807-a6ca-2c6451614c73",
      "@type": "WeatherForecast",
      "hasAgriParcel": "urn:demeter:AgriParcel:b429c6d4-676f-4807-a6c9-2c6451614c0c",
      "weatherType": "rainShower",
      "temperature": 16,
      "windSpeed": 3.2,
      "precipitationProbability": 0.95,
      "validFrom": "2020-10-24T00:00:00Z",
      "validThrough": "2020-10-25T00:00:00Z"
    },
    {
      "@id": "urn:demeter:WeatherForecast:b429c6d4-676f-4807-a6ca-2c6451614c74",
      "@type": "WeatherForecast",
      "hasAgriParcel": "urn:demeter:AgriParcel:b429c6d4-676f-4807-a6c9-2c6451614c0c",
      "weatherType": "lightRainShower",
      "temperature": 19,
      "windSpeed": 3,
      "precipitationProbability": 0.6,
      "validFrom": "2020-10-25T00:00:00Z",
      "validThrough": "2020-10-26T00:00:00Z"
    }
  ]
}
```


C.3.2. Component 4.C.2 Nutrient Monitor

AIM Model - Input


```
{
    "@context":[
      "https://w3id.org/demeter/agri-context.jsonld"
    ],
    "@graph": [
    {
        "@id": "urn:ngsi-ld:farm:72d9fb43-53f8-4ec8-a33c-fa931360259a",
        "@type": "Farm",
```

```
        "hasGeometry": {
                    "@id": "urn:ngsi-ld:AgriFarm:geo:72d9fb43-53f8-4ec8-a33c-fa931360259x",
        "@type": "Point",
        "asWKT": "POINT(-7.8838706 40.571686)"
        },
        "containsPlot":[
        {
            "@id": "urn:ngsi-ld:plot:72d9fb43-53f8-4ec8-a33c-fa931360259a",
            "@type": "Plot",
            "name": "A1",
            "hasGeometry": {
                   "@id": "urn:ngsi-ld:plot:geo:72d9fb43-53f8-4ec8-a33c-fa931360259a",
                   "@type": "Polygon",
                 "asWKT": "POLYGON ((-7.8838706 40.571686, -7.8863275 40.5707813, -7.8838277 40.5692492, -7.8809309 40.570219, -7.8838706 
40.571686))"
            },
            "area": "20",
            "totalSeeds": {
                    "@id": "urn:demeter:res:72d9fb43-53f8-4ec8-a33c-fa931360259b",
                "@type": "QuantityValue",
                   "numericValue": "2",
                   "unit": "qudt-unit:Kg/m2",
                   "applicationWidth": {
                          "@id": "urn:ngsi-ld:AW:2fcffe85-c239-3556-11c3fcc4fe29",
                          "@type": "QuantityValue",
                          "numericValue": "20",
                          "unit": {
                                  "@id": "qudt-unit:M"
                            }
              }
           },
            "crop": {
                "@id": "urn:ngsi-ld:crop:df72dc57-1eb9-42a3-88a9-8647ecc954b4",
                "@type": "Crop",
                "cropSpecies":{
                       "@id":"urn:demeter:croptype:df72dc57-1eb9-42a3-88a9-8647ecc954b4",
                       "@type": "CropType",
                       "name": "Corn",
                       "description": "Spring corn parcel"
                },
                "cropStatus": "seeded",
                "lastPlantedAt": "2020-10-01T12:00:00Z"
```

```
          },
          "soilProperty":  {
               "@id": "urn:ngsi-ld:mz:soilp:df72dc57-1eb9-42a3-88a9-8647ecc954b4",
               "@type": "PropertyType",
                   "name":"Silt",
                   "propertyType":"http://foodie-cloud.com/model/foodie/code/PropertyTypeValue/soilType"
               },
            "sowingPeriod":{
                   "@id": "urn:ngsi-ld:mz:sowingp:df72dc57-1eb9-42a3-88a9-8647ecc954b4",
                   "@type": "Interval",
                   "description": "Period for sowing",
         "hasBeginning":{"@id": "urn:ngsi-ld:mz:planting:beg:df72dc57-1eb9-42a3-88a9-8647ecc954b4", "@type": "Instant",
"inXSDDateTimeStamp":"2020-02-01T12:00:00Z"},
                   "hasEnd":{"@id": "urn:ngsi-ld:mz:planting:end:df72dc57-1eb9-42a3-88a9-8647ecc954b4", "@type": "Instant",
"inXSDDateTimeStamp":"2020-03-31T12:00:00Z"}
               }
       }
      ]
    }
  ]
}
```

AIM Model - Output

```
{
"@context":[
    "https://w3id.org/demeter/agri-context.jsonld"
    ],
   "@graph": [
   [
     {
        "@id": "urn:ngsi-ld:farm:72d9fb43-53f8-4ec8-a33c-fa931360259a",
        "@type": "Farm",
        "hasGeometry": {
            "@id": "urn:ngsi-ld:AgriFarm:geo:72d9fb43-53f8-4ec8-a33c-fa931360259x",
        "@type": "Point",
        "asWKT": "POINT(-7.8838706 40.571686)"
        },
        "containsPlot":[
        {
            "@id": "urn:ngsi-ld:plot:72d9fb43-53f8-4ec8-a33c-fa931360259a",
            "@type": "Plot",
```

```
            "area": "100",
            "name": "B1",
            "crop": {
                "@id": "urn:ngsi-ld:crop:df72dc57-1eb9-42a3-88a9-8647ecc954b4",
                "@type": "Crop",
                "cropSpecies":{
                    "@id":"urn:demeter:croptype:df72dc57-1eb9-42a3-88a9-8647ecc954b4",
                    "@type": "CropType",
                    "name": "Corn",
                    "description": "Spring corn parcel"
                },
                "cropStatus": "seeded",
                "lastPlantedAt": "2020-10-01T12:00:00Z"
            },
     "soilProperty":  {
                    "@id": "urn:ngsi-ld:mz:soilp:df72dc57-1eb9-42a3-88a9-8647ecc954b4",
                    "@type": "PropertyType",
                    "name":"Silt",
                    "propertyType":"http://foodie-cloud.com/model/foodie/code/PropertyTypeValue/soilType"
                },
     "recommendedSowingPeriod":{
                    "@id": "urn:ngsi-ld:mz:planting:df72dc57-1eb9-42a3-88a9-8647ecc954b4",
                    "@type": "Interval",
                    "description": "Recommended period for sowing",
                    "hasBeginning":{"@id": "urn:ngsi-ld:mz:planting:beg:df72dc57-1eb9-42a3-88a9-8647ecc954b4",     "@type": "Instant",
"inXSDDateTimeStamp":"2020-02-01T12:00:00Z"},
                    "hasEnd":{"@id": "urn:ngsi-ld:mz:planting:end:df72dc57-1eb9-42a3-88a9-8647ecc954b4", "@type": "Instant",
"inXSDDateTimeStamp":"2020-03-31T12:00:00Z"}
        },
     "totalSeeds": [
                    {
                "@id": "urn:demeter:res:72d9fb43-53f8-4ec8-a33c-fa931360259b",
                "@type": "QuantityValue",
                   "numericValue": "2359",
                   "description": "Plot amount seeds",
                   "unit": "qudt-unit:Kg"
                   },
                  {
                "@id": "urn:demeter:res:72d9fb43-53f8-4ec8-a33c-fa931360259c",
                "@type": "QuantityValue",
                   "numericValue": "322",
                   "ndviClass": "1",
```

```
                    "description": "Plot amount seeds for class 1",
                    "unit": "qudt-unit:Kg"
                    },
                   {
                 "@id": "urn:demeter:res:72d9fb43-53f8-4ec8-a33c-fa931360259d",
                 "@type": "QuantityValue",
                    "numericValue": "212",
                    "ndviClass": "2",
                    "description": "Plot amount seeds for class 2",
                    "unit": "qudt-unit:Kg"
                    },
                   {
                 "@id": "urn:demeter:res:72d9fb43-53f8-4ec8-a33c-fa931360259e",
                 "@type": "QuantityValue",
                    "numericValue": "34",
                    "ndviClass": "3",
                    "description": "Plot amount seeds for class 3",
                    "unit": "qudt-unit:Kg"
                    }
            ],
     "containsZone":[
     {
                 "@id": "urn:ngsi-ld:mz:df72dc57-1eb9-42a3-88a9-8647ecc9544a",
                 "@type": "ManagementZone",
                 "hasGeometry": {
                 "@id": "urn:ngsi-ld:mz:geo:df72dc57-1eb9-42a3-88a9-8647ecc954b4",
                 "@type": "Polygon",
   "asWKT": "POLYGON ((-7.8839915006124570 40.5714463459244300, -7.8840917044300864 40.5716045860499100, -7.8839879468542790
 40.5716427912100200, -7.8838877431723890 40.5714845509491440, -7.8839915006124570 40.5714463459244300))"
                 }
         },
   {
                 "@id": "urn:ngsi-ld:mz:df72dc57-1eb9-42a3-88a9-8647ecc9544b",
                 "@type": "ManagementZone",
                 "hasGeometry": {
                     "@id": "urn:ngsi-ld:mz:geo:df72dc57-1eb9-42a3-88a9-8647ecc954b4",
                     "@type": "Polygon",
   "asWKT": "POLYGON ((-7.8840952579040320 40.5714081408260300, -7.8841954618573920 40.5715663808160000, -7.8840949033384010
 40.5716034081598400, -7.8840917044300864 40.5716045860499100, -7.8839915006124570 40.5714463459244300, -7.8840952579040320
 40.5714081408260300))"
                 }
         }
```

```
      ]
    }]
   },
[
 {
        "@id": "urn:ngsi-ld:intervention:72d9fb43-53f8-4ec8-a33c-fa931360259a",
        "@type": "Intervention",
        "description": "Recommended seeds density for the zone",
        "ndviClass": "1",
        "densityValue":"345",
        "interventionZone":"urn:ngsi-ld:mz:df72dc57-1eb9-42a3-88a9-8647ecc9544a"
    }
],
   [
    {
        "@id": "urn:ngsi-ld:intervention:72d9fb43-53f8-4ec8-a33c-fa931360259b",
        "@type": "Intervention",
        "description": "Recommended seeds density for the zone",
        "ndviClass": "2",
        "densityValue": "167",
        "interventionZone":"urn:ngsi-ld:mz:df72dc57-1eb9-42a3-88a9-8647ecc9544b"
    }
],
{
    "@id": "urn:demeter:72d9fb43-53f8-4ec8-a33c-fa931360259a",
    "@type": "WeatherForecast",
    "description": "7 days weather forecast",
    "hasMember": [
          "urn:demeter:a3b1483d-1f05-4e09-90f9-6ace1f2fd8b6",
          "urn:demeter:5b090022-dd35-41a5-bba6-2983d570daf0",
          "urn:demeter:b70035ce-7434-4da3-83a6-a70327ab2021",
          "urn:demeter:434924e7-576d-43de-8cdb-8e5038b8c9cf",
          "urn:demeter:212c04fe-af66-49c1-b296-d650706124a8",
          "urn:demeter:7920c883-1721-4782-83d1-54504aece80f",
          "urn:demeter:12c73948-ff29-43ba-9cb0-88d73e9d49b0"
        ],
    "hasFeatureOfInterest": "urn:ngsi-ld:farm:72d9fb43-53f8-4ec8-a33c-fa931360259a",
    "resultTime": "2020-02-01T12:36:12Z"
},
{
    "@id": "urn:demeter:a3b1483d-1f05-4e09-90f9-6ace1f2fd8b6",
    "@type": "Observation",
```

```
    "description": "7 days  forecast - day1",
    "phenomenonTime":"2020-02-01T12:36:12Z",
    "windSpeed": "3.5",
    "airTemperature": "23",
    "precipitation": "85"
},
{
    "@id": "urn:demeter:5b090022-dd35-41a5-bba6-2983d570daf0",
    "@type": "Observation",
    "description": "7 days  forecast - day2",
    "phenomenonTime":"2020-02-02T12:36:12Z",
    "windSpeed": "2",
    "airTemperature": "20",
    "precipitation": "50"
},
{
    "@id": "urn:demeter:b70035ce-7434-4da3-83a6-a70327ab2021",
    "@type": "Observation",
    "description": "7 days  forecast - day3",
    "phenomenonTime":"2020-02-03T12:36:12Z",
    "windSpeed": "1.4",
    "airTemperature": "22",
    "precipitation": "65"
},
{
    "@id": "urn:demeter:434924e7-576d-43de-8cdb-8e5038b8c9cf",
    "@type": "Observation",
    "description": "7 days  forecast - day4",
    "phenomenonTime":"2020-02-04T12:36:12Z",
    "windSpeed": "1.1",
    "airTemperature": "24",
    "precipitation": "5"
},
{
    "@id": "urn:demeter:212c04fe-af66-49c1-b296-d650706124a8",
    "@type": "Observation",
    "description": "7 days  forecast - day5",
    "phenomenonTime":"2020-02-05T12:36:12Z",
    "windSpeed": "1.8",
    "airTemperature": "19",
    "precipitation": "10"
},
```

```
{
    "@id": "urn:demeter:7920c883-1721-4782-83d1-54504aece80f",
    "@type": "Observation",
    "description": "7 days  forecast - day6",
    "phenomenonTime":"2020-02-06T12:36:12Z",
    "windSpeed": "3",
    "airTemperature": "18",
    "precipitation": "0"
},
{
    "@id": "urn:demeter:12c73948-ff29-43ba-9cb0-88d73e9d49b0",
    "@type": "Observation",
    "description": "7 days  forecast - day7",
    "phenomenonTime":"2020-02-07T12:36:12Z",
    "windSpeed": "3.5",
    "airTemperature": "19",
    "precipitation": "20"
      }
    ]
  ]
}
```


C.4. DSS AREA: 4.D - Machinery and Field Operations

C.4.1. Component 4.D.1 Emission

AIM Models for Input and Output for the component 4.D.1 Emission are under production since an update on the AIM model is required to cope with the needs of the component and its related pilot.

C.4.2. Component 4.D.2 Field Operation

AIM Model - Input


```
{
    "@context": [
        "https://w3id.org/demeter/agri-context.jsonld",
        "https://w3id.org/demeter/agri/ext/fieldOperation-context"
    ],
    "@id": "urn:demeter:vehicle:123",
    "@type": "Vehicle",
    "identifier": "04cad67f-0a97-4f0f-b111-cd581a42e4af",
    "location": {
        "@type": "Point",
        "lat": "45.267136",
        "long": "19.833549"
    },
    "speed": "48.5",
    "breaking": "0",
    "fuelConsumption": "10",
    "operator": {
        "@type": "VehicleOperator",
        "@id":"urn:demeter:v-operator:123",
        "identifier":"56dc8c09-03b2-47f5-a77a-b5ec00c86c16"
    }
}
```


AIM Model - Output


```
{
  "@context": [
    https://w3id.org/demeter/agri-context.jsonld,
    https://w3id.org/demeter/agri/ext/fieldOperation-context.jsonld
  ],
  "@graph": [
    {
      "identifier": "5ff1a8fb-603f-4609-b824-e9b3d7dbdddc",
      "@id": "urn:demeter:vehicle",
      "@type": "Vehicle"
    },
    {
      "description": "Driver behaviour based on breakage and fuel consumtion",
      "driverBehaviourValue": "Good",
```

```
      "@id": "urn:demeter:driverBehaviour",
      "@type": "DriverBehaviour"
    },
    {
      "trajectoryDuration": "1:47:00",
      "trajectoryDistance": "150",
      "trajectoryAverageSpeed": "80.3",
      "@id": "urn:demeter:vehicleTrajectory",
      "@type": "VehicleTrajectory"
    }
  ]
}
```


C.4.3. Component 4.D.3 Variable Rate

AIM Model - Input


```
{"@context": ["https://w3id.org/demeter/agri-context.jsonld"],
"@graph": [
  {
    "@id":"urn:ngsi-ld:Plot:72d9fb43-53f8-4ec8-a33c-fa931360259a",
    "@type": "Plot",
    "code": "Plot1a",
    "validFrom":"30/1/2018",
    "hasGeometry": {
      "@id":"urn:ngsi-ld:Plot:geo:72d9fb43-53f8-4ec8-a33c-fa931360259a",
      "@type": "Polygon",
      "asWKT": "POLYGON ((2.6584237478090156 50.9580622571139870, 2.6587338968496641 50.9581579426010336, 2.6589429488131198
50.9582150219953576, 2.6591095643951315 50.9582528714251737, 2.6594131803025660 50.9583130331828329, 2.6597840234085823
50.9583763291639258, 2.6601631496043434 50.9584545804495264, 2.6603365480477104 50.9584938754040664, 2.6604075024417271
50.9584102952921612, 2.6604662546619218 50.9583568395615316, 2.6604342845380304 50.9583472936046604, 2.6605727867651963
50.9581954593736981, 2.6606363555663735 50.9581231012561133, 2.6607330759977792 50.9579965557217776, 2.6607734469812598
50.9579474185679047, 2.6608194310438913 50.9579005209109894, 2.6608524514342635 50.9578733963002009, 2.6608934925113696
50.9578449495156960, 2.6609513715096789 50.9578115321335829, 2.6612047259887084 50.9576841139061898, 2.6613162666076406
50.9576314243041466, 2.6614578206772155 50.9575716174280018, 2.6615244327002254 50.9575485769880245, 2.6616325855213563
50.9575146303461892, 2.6617372561265995 50.9574785649891382, 2.6617976757467297 50.9574535462686455, 2.6618553132177798
50.9574228224268495, 2.6618958429920814 50.9573927493935983, 2.6619421525628022 50.9573525098202822, 2.6620385672422953
50.9572498764658022, 2.6621232350015847 50.9571335851508209, 2.6621875857682133 50.9570044106813285, 2.6622157597119029
50.9569382817477106, 2.6623222637686292 50.9566443634807769, 2.6623754063259728 50.9564867027179460, 2.6623467652956743
50.9564756770014426, 2.6600325756526599 50.9558211107541226, 2.6584154185753190 50.9580525149500971, 2.6584237478090156
50.9580622571139870))"
```

```
    },
    "identifier": "example001",
    "area": "4.57",
    "description": "Potato parcel",
    "category": "arable",
    "cropStatus": "harvested",
    "lastPlantedAt": "2018-04-15T10:18:16Z",
    "crop": {
      "@id": "urn:ngsi-ld:CropSpecies:72d9fb43-53f8-4ec8-a33c-fa931360259a",
      "@type": "CropSpecies",
      "cropArea":{
        "@id": "urn:ngsi-ld:CropSpecies:geo:72d9fb43-53f8-4ec8-a33c-fa931360259a",
        "@type": "Polygon",
        "asWKT": "POLYGON ((2.6584237478090156 50.9580622571139870, 2.6587338968496641 50.9581579426010336, 2.6589429488131198
50.9582150219953576, 2.6591095643951315 50.9582528714251737, 2.6594131803025660 50.9583130331828329, 2.6597840234085823
50.9583763291639258, 2.6601631496043434 50.9584545804495264, 2.6603365480477104 50.9584938754040664, 2.6604075024417271
50.9584102952921612, 2.6604662546619218 50.9583568395615316, 2.6604342845380304 50.9583472936046604, 2.6605727867651963
50.9581954593736981, 2.6606363555663735 50.9581231012561133, 2.6607330759977792 50.9579965557217776, 2.6607734469812598
50.9579474185679047, 2.6608194310438913 50.9579005209109894, 2.6608524514342635 50.9578733963002009, 2.6608934925113696
50.9578449495156960, 2.6609513715096789 50.9578115321335829, 2.6612047259887084 50.9576841139061898, 2.6613162666076406
50.9576314243041466, 2.6614578206772155 50.9575716174280018, 2.6615244327002254 50.9575485769880245, 2.6616325855213563
50.9575146303461892, 2.6617372561265995 50.9574785649891382, 2.6617976757467297 50.9574535462686455, 2.6618553132177798
50.9574228224268495, 2.6618958429920814 50.9573927493935983, 2.6619421525628022 50.9573525098202822, 2.6620385672422953
50.9572498764658022, 2.6621232350015847 50.9571335851508209, 2.6621875857682133 50.9570044106813285, 2.6622157597119029
50.9569382817477106, 2.6623222637686292 50.9566443634807769, 2.6623754063259728 50.9564867027179460, 2.6623467652956743
50.9564756770014426, 2.6600325756526599 50.9558211107541226, 2.6584154185753190 50.9580525149500971, 2.6584237478090156
50.9580622571139870))"
      },
      "cropSpecies": {
        "@id": "urn:ngsi-ld:CropType:df72dc57-1eb9-42a3-88a9-8647ecc954b4"
      },
      "validFrom":"01/04/2018",
      "validTo":"30/09/2018",
      "production":{
        "productionAmount": {
          "propertyHasValue": 54.8,
          "isMeasuredIn":"http://www.ontology-of-units-of-measure.org/resource/om-2/tonne"
        }
      }
    }
  },
  {
```

```
    "@id": "urn:ngsi-ld:CropType:72d9fb43-53f8-4ec8-a33c-fa931360259a",
    "@type": "CropType",
    "code": "CropType2",
    "name": "Potato" ,
    "family": "Solanaceae",
    "description": "Fontane",
    "species": "Solanum tuberosum L. cv. Fontane"
  },
  {
    "@id": "urn:ngsi-ld:MZT:2fcffe85-c239-3556-11c3fcc4fe29",
    "@type": "Treatment",
    "name": "1",
    "interventionZone": {"@id": "urn:ngsi-ld:Plot:72d9fb43-53f8-4ec8-a33c-fa931360259a"},
        "interventionStart": "15/06/2018",
        "interventionEnd": "01/06/2018",
        "applicationWidth": {
          "@id": "urn:ngsi-ld:AW:2fcffe85-c239-3556-11c3fcc4fe29",
          "@type": "QuantityValue",
          "numericValue": 30,
          "unit": {
            "@id": "qudt-unit:M"
          }
        },
    "treatmentDescription": "Application of fertilizer xyz",
    "quantity": {
      "@id": "urn:ngsi-ld:TQ:2fcffe85-c239-3556-11c3fcc4fe29",
      "@type": "QuantityValue",
      "numericValue": 10,
      "unit": {"@id": "qudt-unit:KiloGM-PER-M2"}
    }
  }
]}
```

AIM Model - Output Variable Rate Taskmap

```
{"@context": ["https://w3id.org/demeter/agri-context.jsonld"],
  "@graph": [
    {"@id": "urn:ngsi-ld:MZT:5b4ce56b-76e3-71d9-b264040c8d0d",
      "@type": "Treatment",
      "name": "0",
      "interventionZone": {"@id": "urn:ngsi-ld:Plot:MZ:5b4ce56b-76e3-71d9-b264040c8d0d"},
      "treatmentDescription": "Application of fertilizer xyz",
```

```
      "quantity": {"@id": "urn:ngsi-ld:TQ:5b4ce56b-76e3-71d9-b264040c8d0d", "@type": "QuantityValue",
        "numericValue": "10.0", "unit": {"@id": "qudt-unit:KiloGM-PER-M2"}}},
    {"@id": "urn:ngsi-ld:MZT:f13196b9-c73d-8224-7f658c8b9f3a",
      "@type": "Treatment", "name": "1",
      "interventionZone": {"@id": "urn:ngsi-ld:Plot:MZ:f13196b9-c73d-8224-7f658c8b9f3a"},
      "treatmentDescription": "Application of fertilizer xyz",
      "quantity": {"@id": "urn:ngsi-ld:TQ:f13196b9-c73d-8224-7f658c8b9f3a",
        "@type": "QuantityValue", "numericValue": "9.0",
        "unit": {"@id": "qudt-unit:KiloGM-PER-M2"}}},
……
{"@id": "urn:ngsi-ld:Plot:638ea713-fc2a-e336-824a1f25e8f5",
      "@type": "Plot",
      "code": "Plot1a",
      "identifier": "638ea713-fc2a-e336-824a1f25e8f5",
      "description": "Potato parcel",
      "containsZone": [
        {"@id": "urn:ngsi-ld:Plot:MZ:5b4ce56b-76e3-71d9-b264040c8d0d",
          "@type": "ManagementZone",
          "code": "5b4ce56b-76e3-71d9-b264040c8d0d",
          "generatedAtTime": "17/03/2021 07:53:55",
          "hasGeometry": {"@id": "urn:ngsi-ld:CropSpecies:geo:5b4ce56b-76e3-71d9-b264040c8d0d",
            "@type": "POLYGON", "asWKT": "POLYGON ((2.658972849564151 50.95792999214172, 2.659091082268864 50.95776685575894,
2.658703633207661 50.95765484590413, 2.658585399495478 50.95781798185575, 2.658972849564151 50.95792999214172))"}},
        {"@id": "urn:ngsi-ld:Plot:MZ:f13196b9-c73d-8224-7f658c8b9f3a",
          "@type": "ManagementZone",
          "code": "f13196b9-c73d-8224-7f658c8b9f3a",
          "generatedAtTime": "17/03/2021 07:53:55",
          "hasGeometry": {"@id": "urn:ngsi-ld:CropSpecies:geo:f13196b9-c73d-8224-7f658c8b9f3a",
            "@type": "POLYGON", "asWKT": "POLYGON ((2.659091082268864 50.95776685575894, 2.659209314101167 50.95760371922457,
2.658821866047433 50.95749170980091, 2.658717720321181 50.95763540876296, 2.658703633207661 50.95765484590413, 2.659091082268864
50.95776685575894))"}},
        …
]}]}
```

C.5. DSS AREA: 4.E - Pest and Disease Management

C.5.1. Component 4.E.1 Pest Estimation with Sterile Fruit Flies

AIM Model - CreateModel - Input


```
{
  "@context": [
      "https://w3id.org/demeter/agri-context.jsonld"
   ],

   "@graph": [
    {
      "@id": "urn:ngsi-ld:5xt2gh32-7phi-45i3-yt83-i8743d554321",
      "description": "Data provided to generate a new model",

    "modelName": "model_Name_Created_By_User",
    "trainingRatio": "1",
    "trainingBatchSize": "2",
    "trainingNumExperiments": "3"
    }
  ]
}
```


AIM Model - CreateModel - Output


```
{
  "@context": [
      "https://w3id.org/demeter/agri-context.jsonld"
   ],

   "@model": [
    {
      "@id": "urn:ngsi-ld:5xt2gh32-7phi-45i3-yt83-i8743d5u5f55",
    "@type": "ImageRecognitionModel",

    "modelName":"model_Name_Created_By_User",
      "description": "Model name created by the user"
    }
  ]
}
```

AIM Model - UploadModel - Input


```
{
  "@context": [
      "https://w3id.org/demeter/agri-context.jsonld"
   ],

   "@graph": [
    {
      "@id": "urn:ngsi-ld:5xt2gh32-7phi-45i3-yt83-i8743d588964",
      "description": "Data provided to upload a new model to the system",

    "modelName": "optional_model_name_for_internal_usage",
    "numClasses": 2,
    "Classes": {"class_name1", "class_name2"},
    "info": "information"
    }
  ]
}
```


AIM Model - UploadModel - Output


```
{
  "@context": [
      "https://w3id.org/demeter/agri-context.jsonld"
   ],

   "@model": [
    {
      "@id": "urn:ngsi-ld:5xt2gh32-7phi-45i3-yt83-i8743d5u5f55",
    "@type": "ImageRecognitionModel",

    "modelName":"model_Name_Created_By_User",
      "description": "Model name created by the user"
    }
  ]
}
```

AIM Model - CountElements - Input


```
{
  "@context": [
      "https://w3id.org/demeter/agri-context.jsonld"
   ],

   "@model": [
    {
      "@id": "urn:ngsi-ld:5xt2gh32-7phi-45i3-yt83-i8743d5u5f55",
      "description": "Data needed to count elements in a picture",

    "modelName":"model_name_generated_by_user",
    "threshold":"1"
    }
  ]
}
```


AIM Model - CountElements - Output


```
{
  "@context": [
      "https://w3id.org/demeter/agri-context.jsonld"
   ],

   "@graph": [
  {
    "@id": "urn:demeter:ObservationCollection/1234",
    "@type": "ObservationCollection",
    "description": "testpicture.JPG",
    "hasMember": ["urn:demeter:Observation/1a", "urn:demeter:Observation/2a"],
    "resultTime": "2020-02-01T12:36:12Z"
  },
  {
    "@id": "urn:demeter:Observation/1a",
      "@type": "Obeservation",
      "observedProperty": "Normal fly",
    "hasSimpleResult": 60.00000000000000,
    "box_points": [1396, 0, 1476,  127]
    },
  {
    "@id": "urn:demeter:Observation/2a",
      "@type": "Obeservation",
```

```
      "observedProperty": "Sterile fly",
      "hasSimpleResult": 24.00000000000000,
    "box_points": [2150, 10, 1543, 254]
    }
  ]
}
```


AIM Model - GetStatistics - Input


```
{
  "@context": [
      "https://w3id.org/demeter/agri-context.jsonld"
   ],

   "@model": [
    {
      "@id": "urn:ngsi-ld:5xt2gh32-7phi-45i3-yt83-i8743d5u5f55",
      "description": "Data needed to get statistics",

    "trapID":"a41",
    "dateIni":"2021-01-01T12:36:12Z",
    "dateEnd":"2021-02-01T13:36:12Z",
    "numStimations":"4"
    }
  ]
}
```


AIM Model - GetStatistics - Output


```
{
  "@context": [
      "https://w3id.org/demeter/agri-context.jsonld"
   ],

   "@graph": [
  {
    "@id": "urn:demeter:ObservationCollection/1234",
    "@type": "ObservationCollection",
    "description": "Statistics collection",
    "hasMember": ["urn:demeter:Observation/1a", "urn:demeter:Observation/2a", "urn:demeter:Observation/3a"],
  },
  {
```

```
    "@id": "urn:demeter:Observation/1a",
      "@type": "Obeservation",
    "resultTime": "2021-02-01T12:36:12Z",
    "label1": "Normal fly",
    "amountLabel1": 34,
      "label2": "Sterile fly",
    "amountLabel2": 21,
    "trapID": "a41",
    "realOrStimation": "real"
    },
  {
    "@id": "urn:demeter:Observation/2a",
      "@type": "Obeservation",
    "resultTime": "2021-02-01T12:36:12Z",
    "label1": "Normal fly",
    "amountLabel1": 12,
      "label2": "Sterile fly",
    "amountLabel2": 22,
    "trapID": "x45",
    "realOrStimation": "stimation"
    },
  {
    "@id": "urn:demeter:Observation/3a",
      "@type": "Obeservation",
    "resultTime": "2021-02-01T12:36:12Z",
    "label1": "Normal fly",
    "amountLabel1": 44,
      "label2": "Sterile fly",
    "amountLabel2": 35,
    "trapID": "b13",
    "realOrStimation": "real"
    }
  ]
}
```

C.5.2. Component 4.E.2 Estimate temperature-related pest events

AIM Model - Output


```
{
  "@context": [
    "https://w3id.org/demeter/agri/agriFeature-context.jsonld",
    {
      "qudt": "http://qudt.org/schema/qudt/",
      "qudt-unit": "http://qudt.org/vocab/unit/",
      "sosa": "http://www.w3.org/ns/sosa/",
      "geo": "http://www.opengis.net/ont/geosparql"
    }
  ],
  "@graph": [{
      "@id": "urn:demeter:geo:Feature:72d9fb43-53f8-4ec8-a33c-fa931360259a",
      "@type": "geo:Feature",
      "geo:hasGeometry": {
        "@id": "urn:demeter:geo:Feature:Polygon:72d9fb43-53f8-4ec8-a33c-fa931360259y",
        "@type": "geo:Polygon",
        "geo:asWKT": "POLYGON (100 0, 101 0, 101 1, 100 1, 100 0)"
      }
    },
    {
      "@id": "urn:demeter:observation-20180101",
      "@type": "sosa:Observation",
      "sosa:observedProperty": {
        "@id": "http://www.demeter.org/ontology/prop#PestStage"
      },
      "sosa:hasFeatureOfInterest": {
        "@id": "urn:demeter:geo:Feature:72d9fb43-53f8-4ec8-a33c-fa931360259a"
      },
      "sosa:Sensor": {
        "@id": "model"
      },
      "sosa:resultTime": "2018-01-01T12:36:12Z",
      "sosa:hasResult": [{
        "@id": "urn:demeter:Observation/20180101/stage"
      }]
    },
    {
      "@id": "urn:demeter:Observation/20180101/stage",
```

```
      "@type": "qudt:QuantityValue",
      "identifier": "pest_stage",
      "qudt:description": "1st generation, 2nd instar Larvae",
      "qudt:numericValue": "1.3",
      "qudt:unit": "qudt-unit:-"
    },
    {
      "@id": "urn:demeter:observation-20180201",
      "@type": "sosa:Observation",
      "sosa:observedProperty": {
        "@id": "http://www.demeter.org/ontology/prop#PestStage"
      },
      "sosa:hasFeatureOfInterest": {
        "@id": "urn:demeter:geo:Feature:72d9fb43-53f8-4ec8-a33c-fa931360259a"
      },
      "sosa:Sensor": {
        "@id": "model"
      },
      "sosa:resultTime": "2018-02-01T12:36:12Z",
      "sosa:hasResult": [{
        "@id": "urn:demeter:Observation/20180201/stage"
      }]
    },
    {
      "@id": "urn:demeter:Observation/20180201/stage",
      "@type": "qudt:QuantityValue",
      "identifier": "pest_stage",
      "qudt:description": "1st generation, 3rd instar Larvae",
      "qudt:numericValue": "1.4",
      "qudt:unit": "qudt-unit:-"
    }
  ]
}
```

C.6. DSS AREA: 4.F - Animal Yield

C.6.1. Component 4.F.1 Estimate Milk Production

AIM Model - Input


```
{
  "@context":[
     "https://w3id.org/demeter/agri-context.jsonld",
        "https://w3id.org/demeter/agri/ext/livestockFeature-context.jsonld",
    {
      "qudt-unit": "http://qudt.org/vocab/unit/"
    }
   ],
   "@graph": [
            {
                "@id": "urn:ngsi-ld:AnimalEntity:72d9fb43-53f8-4ec8-a33c-fa931360259c",
                "@type": "Animal",
                "lifetimeLactations": "urn:demeter:lactationid1"
            },
            {
                "@id": "urn:demeter:lactationid1",
                "@type": "LifetimeLactations",
                "startedAt": "2018-01-01T12:00:00Z",
                "numberOfLactation": "1"
            },
            {
                "@id": "urn:demeter:lactationMilkEvents",
                "@type": "LactationObservationsCollection",
                "description": "Milking events collection of observations",
                "milkingEvent":        ["urn:demeter:ObservationI/1a",        "urn:demeter:ObservationI/2a","urn:demeter:ObservationI/1b",
"urn:demeter:ObservationI/2b"],
                "hasFeatureOfInterest": "urn:ngsi-ld:AnimalEntity:72d9fb43-53f8-4ec8-a33c-fa931360259c"
            },
      {
                "@id": "urn:demeter:ObservationI/1a",
                "@type": "Observation",
                "observedProperty": "https://w3id.org/demeter/agri/ext/livestockFeature#feed" ,
                "hasResult": [{ "@id": "urn:demeter:ObservationI/1a/result", "@type": "QuantityValue", "numericValue": "2.3", "unit": "qudt-
unit:KiloGM"}],
                "resultTime": "2020-01-01T12:00:00Z"
```

```
      },
      {
                "@id": "urn:demeter:ObservationI/2a",
                "@type": "Observation",
                "observedProperty": "https://w3id.org/demeter/agri/ext/livestockFeature#milkingWeight" ,
                "hasResult": [{ "@id": "urn:demeter:ObservationI/2a/result", "@type": "QuantityValue", "numericValue": "1.8", "unit": "qudt-
unit:KiloGM"}],
                "resultTime": "2020-01-01T12:00:00Z"
      },
      {
                "@id": "urn:demeter:ObservationI/1b",
                "@type": "Observation",
                "observedProperty": "https://w3id.org/demeter/agri/ext/livestockFeature#feed" ,
                "hasResult": [{ "@id": "urn:demeter:ObservationI/1b/result", "@type": "QuantityValue", "numericValue": "1.4", "unit": "qudt-
unit:KiloGM"}],
                "resultTime": "2020-01-02T12:00:00Z"
      },
      {
                "@id": "urn:demeter:ObservationI/2b",
                "@type": "Observation",
                "observedProperty": "https://w3id.org/demeter/agri/ext/livestockFeature#milkingWeight" ,
                "hasResult": [{"@id": "urn:demeter:ObservationI/2b/result", "@type": "QuantityValue", "numericValue": "1.8", "unit": "qudt-
unit:KiloGM"}],
          "resultTime": "2020-01-02T12:00:00Z"
      }
  ]
}
```


AIM Model - Output


```
{
  "@context":[
     "https://w3id.org/demeter/agri-context.jsonld",
        "https://w3id.org/demeter/agri/ext/livestockFeature-context.jsonld",
    {
      "qudt-unit": "http://qudt.org/vocab/unit/"
    }
   ],
   "@graph": [
            {
                "@id": "urn:ngsi-ld:AnimalEntity:72d9fb43-53f8-4ec8-a33c-fa931360259c",
```

```
                "@type": "Animal",
                "lifetimeLactations": "urn:demeter:lactationid1"
            },
            {
                "@id": "urn:demeter:lactationid1",
                "@type": "LifetimeLactations",
                "startedAt": "2018-01-01T12:00:00Z",
                "numberOfLactation": "1"
            },
            {
                "@id": "urn:demeter:lactationMilkEvents",
                "@type": "LactationObservationsCollection",
                "description": "Milking events collection of observations",
                "milkingEvent":        ["urn:demeter:ObservationI/1a",        "urn:demeter:ObservationI/2a","urn:demeter:ObservationI/1b",
"urn:demeter:ObservationI/2b"],
                "hasFeatureOfInterest": "urn:ngsi-ld:AnimalEntity:72d9fb43-53f8-4ec8-a33c-fa931360259c"
            },
      {
                "@id": "urn:demeter:ObservationI/1a",
                "@type": "Observation",
                "observedProperty": "https://w3id.org/demeter/agri/ext/livestockFeature#feed" ,
                "hasResult": [{ "@id": "urn:demeter:ObservationI/1a/result", "@type": "QuantityValue", "numericValue": "2.3", "unit": "qudt-
unit:KiloGM"}],
                "resultTime": "2020-01-01T12:00:00Z"
      },
      {
                "@id": "urn:demeter:ObservationI/2a",
                "@type": "Observation",
                "observedProperty": "https://w3id.org/demeter/agri/ext/livestockFeature#milkingWeight" ,
                "hasResult": [{ "@id": "urn:demeter:ObservationI/2a/result", "@type": "QuantityValue", "numericValue": "1.8", "unit": "qudt-
unit:KiloGM"}],
                "resultTime": "2020-01-01T12:00:00Z"
      },
      {
                "@id": "urn:demeter:ObservationI/1b",
                "@type": "Observation",
                "observedProperty": "https://w3id.org/demeter/agri/ext/livestockFeature#feed" ,
                "hasResult": [{ "@id": "urn:demeter:ObservationI/1b/result", "@type": "QuantityValue", "numericValue": "1.4", "unit": "qudt-
unit:KiloGM"}],
                "resultTime": "2020-01-02T12:00:00Z"
      },
      {
```

```
                "@id": "urn:demeter:ObservationI/2b",
                "@type": "Observation",
                "observedProperty": "https://w3id.org/demeter/agri/ext/livestockFeature#milkingWeight" ,
                "hasResult": [{"@id": "urn:demeter:ObservationI/2b/result", "@type": "QuantityValue", "numericValue": "1.8", "unit": "qudt-
unit:KiloGM"}],
          "resultTime": "2020-01-02T12:00:00Z"
      },
      {
        "@id": "urn:demeter:72d9fb43-53f8-4ec8-a33c-fa931360259a",
        "@type": "MilkYieldPredictionsCollection",
        "description": "predicted lactation curve based on observations so far",
        "hasFeatureOfInterest": "urn:ngsi-ld:AnimalEntity:72d9fb43-53f8-4ec8-a33c-fa931360259c",
        "milkYieldPrediction": ["urn:demeter:PredictionI/1","urn:demeter:PredictionI/2","urn:demeter:PredictionI/3"]
      },
      {
        "@id": "urn:demeter:PredictionI/1",
        "@type": "DailyYieldPrediction",
                "predictedProperty": "https://w3id.org/demeter/agri/ext/livestockFeature#milkingWeight",
                "hasResult": [
                    {
                        "@id": "urn:demeter:PredictionI/1/result",
                        "@type": "QuantityValue",
                        "numericValue": "58",
                        "unit": "qudt-unit:KiloGM",
                        "upperConfidenceValue": "62",
                        "lowerConfidenceValue":"57"
                    }
              ],
          "predictionTime": "2020-04-01T12:00:00Z"
      },
      {
        "@id": "urn:demeter:PredictionI/2",
        "@type": "DailyYieldPrediction",
        "predictedProperty": "https://w3id.org/demeter/agri/ext/livestockFeature#milkingWeight",
                "hasResult": [
                    {
                        "@id": "urn:demeter:PredictionI/2/result",
                        "@type": "QuantityValue",
                        "numericValue": "35",
                        "unit": "qudt-unit:KiloGM",
                        "upperConfidenceValue":"38" ,
                        "lowerConfidenceValue":"32"
```

```
                    }
                ],
            "predictionTime": "2020-05-01T12:00:00Z"
        },
        {
          "@id": "urn:demeter:PredictionI/3",
          "@type": "DailyYieldPrediction",
          "predictedProperty": "https://w3id.org/demeter/agri/ext/livestockFeature#milkingWeight",
                  "hasResult": [
                      {
                          "@id": "urn:demeter:PredictionI/3/result",
                          "@type": "QuantityValue",
                          "numericValue": "4",
                          "unit": "qudt-unit:KiloGM",
                          "upperConfidenceValue":"8",
                          "lowerConfidenceValue":"0"
                      }
                  ],
            "predictionTime": "2020-06-01T12:00:00Z"
        }
    ]
}
```


C.6.2. Component 4.F.2 Poultry Feeding

AIM Model - Input


```
{
    "@context": [
        "https://w3id.org/demeter/agri-context.jsonld",
        "https://w3id.org/demeter/agri/ext/poultryFeeding-context.jsonld"
    ],
    "@graph":[
        {
            "@id": "urn:demeter:silos:5812fbbe-3ce5-4b81-a74a-b680000a5bef",
            "@type": "Silos",
            "identifier": "5812fbbe-3ce5-4b81-a74a-b680000a5bef",
            "silosVolume": "100",
            "silosFoodTypeName": "corn",
            "silosFoodDensity": "97",
            "silosEmptyDistance": "3"
```

```
        },
        {
            "@id": "urn:demeter:ag:88acd214-f633-4db7-9560-0ca69abc1a4a",
            "@type": "AnimalGroup",
            "identifier": "88acd214-f633-4db7-9560-0ca69abc1a4a",
            "animalSpecies": "chicken" ,
            "flockAverageAge": "1"
        }
    ]
}
```


AIM Model - Output


```
{
    "@context": [
        "https://w3id.org/demeter/agri-context.jsonld",
        "https://w3id.org/demeter/agri/ext/poultryFeeding-context.jsonld"
    ],
    "@graph":[
        {
                "@id": "urn:demeter:animalFeeding",
                "@type": "AnimalFeeding",
                "animalSpecies": "poultry" ,
                "observedAt": "2018-02-01T12:36:12Z",
                "animalFeedingQuality":"Good"
         }
     ]
}
```


C.7. DSS AREA: 4.G - Animal Welfare

C.7.1. Component 4.G.1 Estimate Animal Welfare Condition

AIM Model - Input - Training


```
{
  "@context": [
    "https://w3id.org/demeter/agri-context.jsonld",
    "https://w3id.org/demeter/agri/ext/livestockFeature-context.jsonld",
    {
      "qudt-unit": "http://qudt.org/vocab/unit/"
```

```
    }
   ],
   "@graph": [
    {
      "@id": "urn:demeter:animal1",
      "@type": "FarmAnimal",
      "description": "Animal",
      "livestockNumber" : "428"
    },
    {
      "@id": "urn:demeter:predictionMetric1",
      "@type": "PredictionMetric",
      "lamenessTruePositiveRate":"",
      "lamenessFalsePositiveRate":"",
      "lamenessPrecision":"",
      "lamenessAccuracy":"",
      "mastitisTruePositiveRate":"",
      "mastitisFalsePositiveRate":"",
      "mastitisPrecision":"",
      "mastitisAccuracy":"",
      "ketosisTruePositiveRate":"",
      "ketosisFalsePositiveRate":"",
      "ketosisPrecision":"",
      "ketosisAccuracy":""
    },
    {
      "@id": "urn:demeter:72d9fb43-53f8-4ec8-a33c-fa931360259a",
      "@type": "HealthPrediction",
      "identifier": "2",
      "description": "Health Prediction collection of observations1",
      "hasMember": [{ "@id": "urn:demeter:ObservationCollection/1a"}, { "@id": "urn:demeter:ObservationCollection/2a" } ,{ "@id":
"urn:demeter:ObservationCollection/3a" } ],
      "hasFeatureOfInterest": { "@id": "urn:demeter:animal1" },
       "predictionMetric":{ "@id": "urn:demeter:predictionMetric1" }
    },
    {
      "@id": "urn:demeter:ObservationCollection/1a",
      "@type": "ObservationCollection",
      "description": "Individual properties collection1",
      "hasMember": [{ "@id": "urn:demeter:ObservationI/1a"}, { "@id": "urn:demeter:ObservationI/2a" } ,{ "@id":
"urn:demeter:ObservationI/3a" }, { "@id": "urn:demeter:ObservationI/4a"}, { "@id": "urn:demeter:ObservationI/5a" } ,{ "@id":
"urn:demeter:ObservationI/6a" }, { "@id": "urn:demeter:ObservationI/7a"}, { "@id": "urn:demeter:ObservationI/8a" } ,{ "@id":
```

```
"urn:demeter:ObservationI/9a" }, { "@id": "urn:demeter:ObservationI/10a"}, { "@id": "urn:demeter:ObservationI/11a" } ,{ "@id":
"urn:demeter:ObservationI/12a" }, { "@id": "urn:demeter:ObservationI/13a"}, { "@id": "urn:demeter:ObservationI/14a" }, { "@id":
"urn:demeter:ObservationI/15a" } ],
      "resultTime": "2018-02-01T12:36:12Z"
    },
    {
      "@id": "urn:demeter:ObservationCollection/2a",
      "@type": "ObservationCollection",
      "description": "Conductivity properties collection1",
      "hasMember": [{ "@id": "urn:demeter:ObservationC/1a"}, { "@id": "urn:demeter:ObservationC/2a" } ,{ "@id":
"urn:demeter:ObservationC/3a" } ],
      "observedProperty": { "@id": "http://foodie-cloud.com/model/foodie#electricConductivity"}
    },
    {
      "@id": "urn:demeter:ObservationCollection/3a",
      "@type": "ObservationCollection",
      "description": "Activity properties collection1",
      "hasMember": [{ "@id": "urn:demeter:ObservationA/1a"}, { "@id": "urn:demeter:ObservationA/2a" }, { "@id":
"urn:demeter:ObservationA/3a" } ],
      "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#animalActivity"}
    },
    {
      "@id": "urn:demeter:ObservationI/1a",
      "@type": "Observation",
      "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#pedometer"} ,
      "hasResult": [{ "@type": "QuantityValue", "numericValue": "514", "unit": {"@id": "qudt-unit:xyz"} }]
    },
    {
      "@id": "urn:demeter:ObservationI/2a",
      "@type": "Observation",
      "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#MID"} ,
      "hasResult": [{ "@type": "QuantityValue", "numericValue": "319", "unit": {"@id": "qudt-unit:xyz"} }]
    },
    {
      "@id": "urn:demeter:ObservationI/3a",
      "@type": "Observation",
      "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#lactations"} ,
      "hasResult": [{ "@type": "QuantityValue", "numericValue": "4", "unit": {"@id": "qudt-unit:xyz"} }]
    },
    {
      "@id": "urn:demeter:ObservationI/4a",
      "@type": "Observation",
```

```
      "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#dailyProduction"} ,
      "hasResult": [{ "@type": "QuantityValue", "numericValue": "39.25", "unit": {"@id": "qudt-unit:xyz"} }]
    },
    {
      "@id": "urn:demeter:ObservationI/5a",
      "@type": "Observation",
      "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#averageDailyProduction"} ,
      "hasResult": [{ "@type": "QuantityValue", "numericValue": "33.54", "unit": {"@id": "qudt-unit:xyz"} }]
    },
    {
      "@id": "urn:demeter:ObservationI/6a",
      "@type": "Observation",
      "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#fat"} ,
      "hasResult": [{ "@type": "QuantityValue", "numericValue": "3.57", "unit": {"@id": "qudt-unit:xyz"} }]
    },
    {
      "@id": "urn:demeter:ObservationI/7a",
      "@type": "Observation",
      "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#protein"} ,
      "hasResult": [{ "@type": "QuantityValue", "numericValue": "3.09", "unit": {"@id": "qudt-unit:xyz"} }]
    },
    {
      "@id": "urn:demeter:ObservationI/8a",
      "@type": "Observation",
      "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#fatProteinRatio"} ,
      "hasResult": [{ "@type": "QuantityValue", "numericValue": "1.16", "unit": {"@id": "qudt-unit:xyz"} }]
    },
    {
      "@id": "urn:demeter:ObservationI/9a",
      "@type": "Observation",
      "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#totalDailyLying"} ,
      "hasResult": [{ "@type": "QuantityValue", "numericValue": "649", "unit": {"@id": "qudt-unit:xyz"} }]
    },
    {
      "@id": "urn:demeter:ObservationI/10a",
      "@type": "Observation",
      "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#actualLameness"} ,
      "hasResult": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#healthStatus-Healthy"}
    },
    {
      "@id": "urn:demeter:ObservationI/11a",
      "@type": "Observation",
```

```
      "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#predictedLameness"} ,
      "hasResult": { }
    },
    {
      "@id": "urn:demeter:ObservationI/12a",
      "@type": "Observation",
      "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#actualKetosis"} ,
      "hasResult": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#healthStatus-Healthy"}
    },
    {
      "@id": "urn:demeter:ObservationI/13a",
      "@type": "Observation",
      "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#predictedKetosis"} ,
      "hasResult": { }
    },
    {
      "@id": "urn:demeter:ObservationI/14a",
      "@type": "Observation",
      "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#actualMastitis"} ,
      "hasResult": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#healthStatus-Sick"}
    },
    {
      "@id": "urn:demeter:ObservationI/15a",
      "@type": "Observation",
      "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#predictedMastitis"} ,
      "hasResult": { }
    },
    {
      "@id": "urn:demeter:ObservationC/1a",
      "@type": "Observation",
      "hasResult": [{ "@type": "QuantityValue", "numericValue": "11.3", "unit": {"@id": "qudt-unit:xyz"} }],
      "resultTime": "2018-02-01T10:36:12Z"
    },
    {
      "@id": "urn:demeter:ObservationC/2a",
      "@type": "Observation",
      "hasResult": [{ "@type": "QuantityValue", "numericValue": "10.7", "unit": {"@id": "qudt-unit:xyz"} }],
      "resultTime": "2018-02-01T11:36:12Z"
    },
    {
      "@id": "urn:demeter:ObservationC/3a",
      "@type": "Observation",
```

```
      "hasResult": [{ "@type": "QuantityValue", "numericValue": "10.6", "unit": {"@id": "qudt-unit:xyz"} }],
      "resultTime": "2018-02-01T18:36:12Z"
    },
    {
      "@id": "urn:demeter:ObservationA/1a",
      "@type": "Observation",
      "hasResult": [{ "@type": "QuantityValue", "numericValue": "242", "unit": {"@id": "qudt-unit:xyz"} }],
      "resultTime": "2018-02-01T10:36:12Z"
    },
    {
      "@id": "urn:demeter:ObservationA/2a",
      "@type": "Observation",
      "hasResult": [{ "@type": "QuantityValue", "numericValue": "216", "unit": {"@id": "qudt-unit:xyz"} }],
      "resultTime": "2018-02-01T11:36:12Z"
    },
    {
      "@id": "urn:demeter:ObservationA/3a",
      "@type": "Observation",
      "hasResult": [{ "@type": "QuantityValue", "numericValue": "98", "unit": {"@id": "qudt-unit:xyz"} }],
      "resultTime": "2018-02-01T18:36:12Z"
    }
]
}
```


AIM Model - Output - Training


```
{
  "@context": [
    "https://w3id.org/demeter/agri-context.jsonld",
    "https://w3id.org/demeter/agri/ext/livestockFeature-context.jsonld",
    {
      "qudt-unit": "http://qudt.org/vocab/unit/"
    }
   ],
   "@graph": [
    {
      "@id": "urn:demeter:animal1",
      "@type": "FarmAnimal",
      "description": "Animal",
      "livestockNumber" : "428"
    },
```

```
    {
      "@id": "urn:demeter:predictionMetric1",
      "@type": "PredictionMetric",
      "lamenessTruePositiveRate":"95.21",
      "lamenessFalsePositiveRate":"16.67",
      "lamenessPrecision":"90.2",
      "lamenessAccuracy":"92.0",
      "mastitisTruePositiveRate":"84.48",
      "mastitisFalsePositiveRate":"21.43",
      "mastitisPrecision":"82.0",
      "mastitisAccuracy":"82.0",
      "ketosisTruePositiveRate":"100.0",
      "ketosisFalsePositiveRate":"5.88",
      "ketosisPrecision":"99.0",
      "ketosisAccuracy":"99.0"
    },
    {
      "@id": "urn:demeter:72d9fb43-53f8-4ec8-a33c-fa931360259a",
      "@type": "HealthPrediction",
      "identifier": "2",
      "description": "Health Prediction collection of observations1",
      "hasMember": [{ "@id": "urn:demeter:ObservationCollection/1a"}, { "@id": "urn:demeter:ObservationCollection/2a" } ,{ "@id":
"urn:demeter:ObservationCollection/3a" } ],
      "hasFeatureOfInterest": { "@id": "urn:demeter:animal1" },
      "predictionMetric":{ "@id": "urn:demeter:predictionMetric1" }
    },
    {
      "@id": "urn:demeter:ObservationCollection/1a",
      "@type": "ObservationCollection",
      "description": "Individual properties collection1",
      "hasMember": [{ "@id": "urn:demeter:ObservationI/1a"}, { "@id": "urn:demeter:ObservationI/2a" } ,{ "@id":
"urn:demeter:ObservationI/3a" }, { "@id": "urn:demeter:ObservationI/4a"}, { "@id": "urn:demeter:ObservationI/5a" } ,{ "@id":
"urn:demeter:ObservationI/6a" }, { "@id": "urn:demeter:ObservationI/7a"}, { "@id": "urn:demeter:ObservationI/8a" } ,{ "@id":
"urn:demeter:ObservationI/9a" }, { "@id": "urn:demeter:ObservationI/10a"}, { "@id": "urn:demeter:ObservationI/11a" } ,{ "@id":
"urn:demeter:ObservationI/12a" }, { "@id": "urn:demeter:ObservationI/13a"}, { "@id": "urn:demeter:ObservationI/14a" }, { "@id":
"urn:demeter:ObservationI/15a" } ],
      "resultTime": "2018-02-01T12:36:12Z"
    },
    {
      "@id": "urn:demeter:ObservationCollection/2a",
      "@type": "ObservationCollection",
      "description": "Conductivity properties collection1",
```

```
      "hasMember": [{ "@id": "urn:demeter:ObservationC/1a"}, { "@id": "urn:demeter:ObservationC/2a" } ,{ "@id":
"urn:demeter:ObservationC/3a" } ],
      "observedProperty": { "@id": "http://foodie-cloud.com/model/foodie#electricConductivity"}
    },
    {
      "@id": "urn:demeter:ObservationCollection/3a",
      "@type": "ObservationCollection",
      "description": "Activity properties collection1",
      "hasMember": [{ "@id": "urn:demeter:ObservationA/1a"}, { "@id": "urn:demeter:ObservationA/2a" }, { "@id":
"urn:demeter:ObservationA/3a" } ],
      "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#animalActivity"}
    },
    {
      "@id": "urn:demeter:ObservationI/1a",
      "@type": "Observation",
      "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#pedometer"} ,
      "hasResult": [{ "@type": "QuantityValue", "numericValue": "514", "unit": {"@id": "qudt-unit:xyz"} }]
    },
    {
      "@id": "urn:demeter:ObservationI/2a",
      "@type": "Observation",
      "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#MID"} ,
      "hasResult": [{ "@type": "QuantityValue", "numericValue": "319", "unit": {"@id": "qudt-unit:xyz"} }]
    },
    {
      "@id": "urn:demeter:ObservationI/3a",
      "@type": "Observation",
      "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#lactations"} ,
      "hasResult": [{ "@type": "QuantityValue", "numericValue": "4", "unit": {"@id": "qudt-unit:xyz"} }]
    },
    {
      "@id": "urn:demeter:ObservationI/4a",
      "@type": "Observation",
      "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#dailyProduction"} ,
      "hasResult": [{ "@type": "QuantityValue", "numericValue": "39.25", "unit": {"@id": "qudt-unit:xyz"} }]
    },
    {
      "@id": "urn:demeter:ObservationI/5a",
      "@type": "Observation",
      "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#averageDailyProduction"} ,
      "hasResult": [{ "@type": "QuantityValue", "numericValue": "33.54", "unit": {"@id": "qudt-unit:xyz"} }]
    },
```

```
    {
      "@id": "urn:demeter:ObservationI/6a",
      "@type": "Observation",
      "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#fat"} ,
      "hasResult": [{ "@type": "QuantityValue", "numericValue": "3.57", "unit": {"@id": "qudt-unit:xyz"} }]
    },
    {
      "@id": "urn:demeter:ObservationI/7a",
      "@type": "Observation",
      "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#protein"} ,
      "hasResult": [{ "@type": "QuantityValue", "numericValue": "3.09", "unit": {"@id": "qudt-unit:xyz"} }]
    },
    {
      "@id": "urn:demeter:ObservationI/8a",
      "@type": "Observation",
      "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#fatProteinRatio"} ,
      "hasResult": [{ "@type": "QuantityValue", "numericValue": "1.16", "unit": {"@id": "qudt-unit:xyz"} }]
    },
    {
      "@id": "urn:demeter:ObservationI/9a",
      "@type": "Observation",
      "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#totalDailyLying"} ,
      "hasResult": [{ "@type": "QuantityValue", "numericValue": "649", "unit": {"@id": "qudt-unit:xyz"} }]
    },
    {
      "@id": "urn:demeter:ObservationI/10a",
      "@type": "Observation",
      "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#actualLameness"} ,
      "hasResult": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#healthStatus-Healthy"}
    },
    {
      "@id": "urn:demeter:ObservationI/11a",
      "@type": "Observation",
      "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#predictedLameness"} ,
      "hasResult": {"@id": "https://w3id.org/demeter/agri/ext/livestockFeature#healthStatus-Healthy" }
    },
    {
      "@id": "urn:demeter:ObservationI/12a",
      "@type": "Observation",
      "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#actualKetosis"} ,
      "hasResult": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#healthStatus-Healthy"}
    },
```

```
{
  "@id": "urn:demeter:ObservationI/13a",
  "@type": "Observation",
  "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#predictedKetosis"} ,
  "hasResult": {"@id": "https://w3id.org/demeter/agri/ext/livestockFeature#healthStatus-Sick" }
},
{
  "@id": "urn:demeter:ObservationI/14a",
  "@type": "Observation",
  "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#actualMastitis"} ,
  "hasResult": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#healthStatus-Sick"}
},
{
  "@id": "urn:demeter:ObservationI/15a",
  "@type": "Observation",
  "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#predictedMastitis"} ,
  "hasResult": {"@id": "https://w3id.org/demeter/agri/ext/livestockFeature#healthStatus-Sick" }
},
{
  "@id": "urn:demeter:ObservationC/1a",
  "@type": "Observation",
  "hasResult": [{ "@type": "QuantityValue", "numericValue": "11.3", "unit": {"@id": "qudt-unit:xyz"} }],
  "resultTime": "2018-02-01T10:36:12Z"
},
{
  "@id": "urn:demeter:ObservationC/2a",
  "@type": "Observation",
  "hasResult": [{ "@type": "QuantityValue", "numericValue": "10.7", "unit": {"@id": "qudt-unit:xyz"} }],
  "resultTime": "2018-02-01T11:36:12Z"
},
{
  "@id": "urn:demeter:ObservationC/3a",
  "@type": "Observation",
  "hasResult": [{ "@type": "QuantityValue", "numericValue": "10.6", "unit": {"@id": "qudt-unit:xyz"} }],
  "resultTime": "2018-02-01T18:36:12Z"
},
{
  "@id": "urn:demeter:ObservationA/1a",
  "@type": "Observation",
  "hasResult": [{ "@type": "QuantityValue", "numericValue": "242", "unit": {"@id": "qudt-unit:xyz"} }],
  "resultTime": "2018-02-01T10:36:12Z"
},
```

```
    {
      "@id": "urn:demeter:ObservationA/2a",
      "@type": "Observation",
      "hasResult": [{ "@type": "QuantityValue", "numericValue": "216", "unit": {"@id": "qudt-unit:xyz"} }],
      "resultTime": "2018-02-01T11:36:12Z"
    },
    {
      "@id": "urn:demeter:ObservationA/3a",
      "@type": "Observation",
      "hasResult": [{ "@type": "QuantityValue", "numericValue": "98", "unit": {"@id": "qudt-unit:xyz"} }],
      "resultTime": "2018-02-01T18:36:12Z"
    }
]
}
```

AIM Model - Input - Prediction

```
{
  "@context": [
    "https://w3id.org/demeter/agri-context.jsonld",
    "https://w3id.org/demeter/agri/ext/livestockFeature-context.jsonld",
    {
      "qudt-unit": "http://qudt.org/vocab/unit/"
    }
   ],
   "@graph": [
    {
      "@id": "urn:demeter:animal1",
      "@type": "FarmAnimal",
      "description": "Animal",
      "livestockNumber" : "428"
    },
    {
      "@id": "urn:demeter:predictionMetric1",
      "@type": "PredictionMetric",
      "lamenessTruePositiveRate":"",
      "lamenessFalsePositiveRate":"",
      "lamenessPrecision":"",
      "lamenessAccuracy":"",
      "mastitisTruePositiveRate":"",
      "mastitisFalsePositiveRate":"",
```

```
      "mastitisPrecision":"",
      "mastitisAccuracy":"",
      "ketosisTruePositiveRate":"",
      "ketosisFalsePositiveRate":"",
      "ketosisPrecision":"",
      "ketosisAccuracy":""
    },
    {
      "@id": "urn:demeter:72d9fb43-53f8-4ec8-a33c-fa931360259a",
      "@type": "HealthPrediction",
      "identifier": "2",
      "description": "Health Prediction collection of observations1",
      "hasMember": [{ "@id": "urn:demeter:ObservationCollection/1a"}, { "@id": "urn:demeter:ObservationCollection/2a" } ,{ "@id":
"urn:demeter:ObservationCollection/3a" } ],
      "hasFeatureOfInterest": { "@id": "urn:demeter:animal1" },
       "predictionMetric":{ "@id": "urn:demeter:predictionMetric1" }
    },
    {
      "@id": "urn:demeter:ObservationCollection/1a",
      "@type": "ObservationCollection",
      "description": "Individual properties collection1",
      "hasMember": [{ "@id": "urn:demeter:ObservationI/1a"}, { "@id": "urn:demeter:ObservationI/2a" } ,{ "@id":
"urn:demeter:ObservationI/3a" }, { "@id": "urn:demeter:ObservationI/4a"}, { "@id": "urn:demeter:ObservationI/5a" } ,{ "@id":
"urn:demeter:ObservationI/6a" }, { "@id": "urn:demeter:ObservationI/7a"}, { "@id": "urn:demeter:ObservationI/8a" } ,{ "@id":
"urn:demeter:ObservationI/9a" }, { "@id": "urn:demeter:ObservationI/10a"}, { "@id": "urn:demeter:ObservationI/11a" } ,{ "@id":
"urn:demeter:ObservationI/12a" }, { "@id": "urn:demeter:ObservationI/13a"}, { "@id": "urn:demeter:ObservationI/14a" }, { "@id":
"urn:demeter:ObservationI/15a" } ],
      "resultTime": "2018-02-01T12:36:12Z"
    },
    {
      "@id": "urn:demeter:ObservationCollection/2a",
      "@type": "ObservationCollection",
      "description": "Conductivity properties collection1",
      "hasMember": [{ "@id": "urn:demeter:ObservationC/1a"}, { "@id": "urn:demeter:ObservationC/2a" } ,{ "@id":
"urn:demeter:ObservationC/3a" } ],
      "observedProperty": { "@id": "http://foodie-cloud.com/model/foodie#electricConductivity"}
    },
    {
      "@id": "urn:demeter:ObservationCollection/3a",
      "@type": "ObservationCollection",
      "description": "Activity properties collection1",
```

```
      "hasMember": [{ "@id": "urn:demeter:ObservationA/1a"}, { "@id": "urn:demeter:ObservationA/2a" }, { "@id":
"urn:demeter:ObservationA/3a" } ],
      "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#animalActivity"}
    },
    {
      "@id": "urn:demeter:ObservationI/1a",
      "@type": "Observation",
      "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#pedometer"} ,
      "hasResult": [{ "@type": "QuantityValue", "numericValue": "514", "unit": {"@id": "qudt-unit:xyz"} }]
    },
    {
      "@id": "urn:demeter:ObservationI/2a",
      "@type": "Observation",
      "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#MID"} ,
      "hasResult": [{ "@type": "QuantityValue", "numericValue": "319", "unit": {"@id": "qudt-unit:xyz"} }]
    },
    {
      "@id": "urn:demeter:ObservationI/3a",
      "@type": "Observation",
      "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#lactations"} ,
      "hasResult": [{ "@type": "QuantityValue", "numericValue": "4", "unit": {"@id": "qudt-unit:xyz"} }]
    },
    {
      "@id": "urn:demeter:ObservationI/4a",
      "@type": "Observation",
      "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#dailyProduction"} ,
      "hasResult": [{ "@type": "QuantityValue", "numericValue": "39.25", "unit": {"@id": "qudt-unit:xyz"} }]
    },
    {
      "@id": "urn:demeter:ObservationI/5a",
      "@type": "Observation",
      "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#averageDailyProduction"} ,
      "hasResult": [{ "@type": "QuantityValue", "numericValue": "33.54", "unit": {"@id": "qudt-unit:xyz"} }]
    },
    {
      "@id": "urn:demeter:ObservationI/6a",
      "@type": "Observation",
      "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#fat"} ,
      "hasResult": [{ "@type": "QuantityValue", "numericValue": "3.57", "unit": {"@id": "qudt-unit:xyz"} }]
    },
    {
      "@id": "urn:demeter:ObservationI/7a",
```

```
      "@type": "Observation",
      "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#protein"} ,
      "hasResult": [{ "@type": "QuantityValue", "numericValue": "3.09", "unit": {"@id": "qudt-unit:xyz"} }]
    },
    {
      "@id": "urn:demeter:ObservationI/8a",
      "@type": "Observation",
      "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#fatProteinRatio"} ,
      "hasResult": [{ "@type": "QuantityValue", "numericValue": "1.16", "unit": {"@id": "qudt-unit:xyz"} }]
    },
    {
      "@id": "urn:demeter:ObservationI/9a",
      "@type": "Observation",
      "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#totalDailyLying"} ,
      "hasResult": [{ "@type": "QuantityValue", "numericValue": "649", "unit": {"@id": "qudt-unit:xyz"} }]
    },
    {
      "@id": "urn:demeter:ObservationI/10a",
      "@type": "Observation",
      "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#actualLameness"} ,
      "hasResult": {}
    },
    {
      "@id": "urn:demeter:ObservationI/11a",
      "@type": "Observation",
      "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#predictedLameness"} ,
      "hasResult": {}
    },
    {
      "@id": "urn:demeter:ObservationI/12a",
      "@type": "Observation",
      "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#actualKetosis"} ,
      "hasResult": {}
    },
    {
      "@id": "urn:demeter:ObservationI/13a",
      "@type": "Observation",
      "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#predictedKetosis"} ,
      "hasResult": {}
    },
    {
      "@id": "urn:demeter:ObservationI/14a",
```

```
      "@type": "Observation",
      "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#actualMastitis"} ,
      "hasResult": {}
    },
    {
      "@id": "urn:demeter:ObservationI/15a",
      "@type": "Observation",
      "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#predictedMastitis"} ,
      "hasResult": {}
    },
    {
      "@id": "urn:demeter:ObservationC/1a",
      "@type": "Observation",
      "hasResult": [{ "@type": "QuantityValue", "numericValue": "11.3", "unit": {"@id": "qudt-unit:xyz"} }],
      "resultTime": "2018-02-01T10:36:12Z"
    },
    {
      "@id": "urn:demeter:ObservationC/2a",
      "@type": "Observation",
      "hasResult": [{ "@type": "QuantityValue", "numericValue": "10.7", "unit": {"@id": "qudt-unit:xyz"} }],
      "resultTime": "2018-02-01T11:36:12Z"
    },
    {
      "@id": "urn:demeter:ObservationC/3a",
      "@type": "Observation",
      "hasResult": [{ "@type": "QuantityValue", "numericValue": "10.6", "unit": {"@id": "qudt-unit:xyz"} }],
      "resultTime": "2018-02-01T18:36:12Z"
    },
    {
      "@id": "urn:demeter:ObservationA/1a",
      "@type": "Observation",
      "hasResult": [{ "@type": "QuantityValue", "numericValue": "242", "unit": {"@id": "qudt-unit:xyz"} }],
      "resultTime": "2018-02-01T10:36:12Z"
    },
    {
      "@id": "urn:demeter:ObservationA/2a",
      "@type": "Observation",
      "hasResult": [{ "@type": "QuantityValue", "numericValue": "216", "unit": {"@id": "qudt-unit:xyz"} }],
      "resultTime": "2018-02-01T11:36:12Z"
    },
    {
      "@id": "urn:demeter:ObservationA/3a",
```

```
      "@type": "Observation",
      "hasResult": [{ "@type": "QuantityValue", "numericValue": "98", "unit": {"@id": "qudt-unit:xyz"} }],
      "resultTime": "2018-02-01T18:36:12Z"
    }
]
}
```


AIM Model - Output - Prediction


```
{
  "@context": [
    "https://w3id.org/demeter/agri-context.jsonld",
    "https://w3id.org/demeter/agri/ext/livestockFeature-context.jsonld",
    {
      "qudt-unit": "http://qudt.org/vocab/unit/"
    }
   ],
   "@graph": [
    {
      "@id": "urn:demeter:animal1",
      "@type": "FarmAnimal",
      "description": "Animal",
      "livestockNumber" : "428"
    },
    {
      "@id": "urn:demeter:predictionMetric1",
      "@type": "PredictionMetric",
      "lamenessTruePositiveRate":"",
      "lamenessFalsePositiveRate":"",
      "lamenessPrecision":"",
      "lamenessAccuracy":"",
      "mastitisTruePositiveRate":"",
      "mastitisFalsePositiveRate":"",
      "mastitisPrecision":"",
      "mastitisAccuracy":"",
      "ketosisTruePositiveRate":"",
      "ketosisFalsePositiveRate":"",
      "ketosisPrecision":"",
      "ketosisAccuracy":""
    },
    {
```

```
      "@id": "urn:demeter:72d9fb43-53f8-4ec8-a33c-fa931360259a",
      "@type": "HealthPrediction",
      "identifier": "2",
      "description": "Health Prediction collection of observations1",
      "hasMember": [{ "@id": "urn:demeter:ObservationCollection/1a"}, { "@id": "urn:demeter:ObservationCollection/2a" } ,{ "@id":
"urn:demeter:ObservationCollection/3a" } ],
      "hasFeatureOfInterest": { "@id": "urn:demeter:animal1" },
       "predictionMetric":{ "@id": "urn:demeter:predictionMetric1" }
    },
    {
      "@id": "urn:demeter:ObservationCollection/1a",
      "@type": "ObservationCollection",
      "description": "Individual properties collection1",
      "hasMember": [{ "@id": "urn:demeter:ObservationI/1a"}, { "@id": "urn:demeter:ObservationI/2a" } ,{ "@id":
"urn:demeter:ObservationI/3a" }, { "@id": "urn:demeter:ObservationI/4a"}, { "@id": "urn:demeter:ObservationI/5a" } ,{ "@id":
"urn:demeter:ObservationI/6a" }, { "@id": "urn:demeter:ObservationI/7a"}, { "@id": "urn:demeter:ObservationI/8a" } ,{ "@id":
"urn:demeter:ObservationI/9a" }, { "@id": "urn:demeter:ObservationI/10a"}, { "@id": "urn:demeter:ObservationI/11a" } ,{ "@id":
"urn:demeter:ObservationI/12a" }, { "@id": "urn:demeter:ObservationI/13a"}, { "@id": "urn:demeter:ObservationI/14a" }, { "@id":
"urn:demeter:ObservationI/15a" } ],
      "resultTime": "2018-02-01T12:36:12Z"
    },
    {
      "@id": "urn:demeter:ObservationCollection/2a",
      "@type": "ObservationCollection",
      "description": "Conductivity properties collection1",
      "hasMember": [{ "@id": "urn:demeter:ObservationC/1a"}, { "@id": "urn:demeter:ObservationC/2a" } ,{ "@id":
"urn:demeter:ObservationC/3a" } ],
      "observedProperty": { "@id": "http://foodie-cloud.com/model/foodie#electricConductivity"}
    },
    {
      "@id": "urn:demeter:ObservationCollection/3a",
      "@type": "ObservationCollection",
      "description": "Activity properties collection1",
      "hasMember": [{ "@id": "urn:demeter:ObservationA/1a"}, { "@id": "urn:demeter:ObservationA/2a" }, { "@id":
"urn:demeter:ObservationA/3a" } ],
      "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#animalActivity"}
    },
    {
      "@id": "urn:demeter:ObservationI/1a",
      "@type": "Observation",
      "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#pedometer"} ,
      "hasResult": [{ "@type": "QuantityValue", "numericValue": "514", "unit": {"@id": "qudt-unit:xyz"} }]
```

```
    },
    {
      "@id": "urn:demeter:ObservationI/2a",
      "@type": "Observation",
      "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#MID"} ,
      "hasResult": [{ "@type": "QuantityValue", "numericValue": "319", "unit": {"@id": "qudt-unit:xyz"} }]
    },
    {
      "@id": "urn:demeter:ObservationI/3a",
      "@type": "Observation",
      "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#lactations"} ,
      "hasResult": [{ "@type": "QuantityValue", "numericValue": "4", "unit": {"@id": "qudt-unit:xyz"} }]
    },
    {
      "@id": "urn:demeter:ObservationI/4a",
      "@type": "Observation",
      "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#dailyProduction"} ,
      "hasResult": [{ "@type": "QuantityValue", "numericValue": "39.25", "unit": {"@id": "qudt-unit:xyz"} }]
    },
    {
      "@id": "urn:demeter:ObservationI/5a",
      "@type": "Observation",
      "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#averageDailyProduction"} ,
      "hasResult": [{ "@type": "QuantityValue", "numericValue": "33.54", "unit": {"@id": "qudt-unit:xyz"} }]
    },
    {
      "@id": "urn:demeter:ObservationI/6a",
      "@type": "Observation",
      "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#fat"} ,
      "hasResult": [{ "@type": "QuantityValue", "numericValue": "3.57", "unit": {"@id": "qudt-unit:xyz"} }]
    },
    {
      "@id": "urn:demeter:ObservationI/7a",
      "@type": "Observation",
      "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#protein"} ,
      "hasResult": [{ "@type": "QuantityValue", "numericValue": "3.09", "unit": {"@id": "qudt-unit:xyz"} }]
    },
    {
      "@id": "urn:demeter:ObservationI/8a",
      "@type": "Observation",
      "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#fatProteinRatio"} ,
      "hasResult": [{ "@type": "QuantityValue", "numericValue": "1.16", "unit": {"@id": "qudt-unit:xyz"} }]
```

```
    },
    {
      "@id": "urn:demeter:ObservationI/9a",
      "@type": "Observation",
      "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#totalDailyLying"} ,
      "hasResult": [{ "@type": "QuantityValue", "numericValue": "649", "unit": {"@id": "qudt-unit:xyz"} }]
    },
    {
      "@id": "urn:demeter:ObservationI/10a",
      "@type": "Observation",
      "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#actualLameness"} ,
      "hasResult": {}
    },
    {
      "@id": "urn:demeter:ObservationI/11a",
      "@type": "Observation",
      "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#predictedLameness"} ,
      "hasResult": {"@id": "https://w3id.org/demeter/agri/ext/livestockFeature#healthStatus-Healthy" }
    },
    {
      "@id": "urn:demeter:ObservationI/12a",
      "@type": "Observation",
      "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#actualKetosis"} ,
      "hasResult": {}
    },
    {
      "@id": "urn:demeter:ObservationI/13a",
      "@type": "Observation",
      "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#predictedKetosis"} ,
      "hasResult": {"@id": "https://w3id.org/demeter/agri/ext/livestockFeature#healthStatus-Sick" }
    },
    {
      "@id": "urn:demeter:ObservationI/14a",
      "@type": "Observation",
      "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#actualMastitis"} ,
      "hasResult": {}
    },
    {
      "@id": "urn:demeter:ObservationI/15a",
      "@type": "Observation",
      "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#predictedMastitis"} ,
      "hasResult": {"@id": "https://w3id.org/demeter/agri/ext/livestockFeature#healthStatus-Sick" }
```

```
    },
    {
      "@id": "urn:demeter:ObservationC/1a",
      "@type": "Observation",
      "hasResult": [{ "@type": "QuantityValue", "numericValue": "11.3", "unit": {"@id": "qudt-unit:xyz"} }],
      "resultTime": "2018-02-01T10:36:12Z"
    },
    {
      "@id": "urn:demeter:ObservationC/2a",
      "@type": "Observation",
      "hasResult": [{ "@type": "QuantityValue", "numericValue": "10.7", "unit": {"@id": "qudt-unit:xyz"} }],
      "resultTime": "2018-02-01T11:36:12Z"
    },
    {
      "@id": "urn:demeter:ObservationC/3a",
      "@type": "Observation",
      "hasResult": [{ "@type": "QuantityValue", "numericValue": "10.6", "unit": {"@id": "qudt-unit:xyz"} }],
      "resultTime": "2018-02-01T18:36:12Z"
    },
    {
      "@id": "urn:demeter:ObservationA/1a",
      "@type": "Observation",
      "hasResult": [{ "@type": "QuantityValue", "numericValue": "242", "unit": {"@id": "qudt-unit:xyz"} }],
      "resultTime": "2018-02-01T10:36:12Z"
    },
    {
      "@id": "urn:demeter:ObservationA/2a",
      "@type": "Observation",
      "hasResult": [{ "@type": "QuantityValue", "numericValue": "216", "unit": {"@id": "qudt-unit:xyz"} }],
      "resultTime": "2018-02-01T11:36:12Z"
    },
    {
      "@id": "urn:demeter:ObservationA/3a",
      "@type": "Observation",
      "hasResult": [{ "@type": "QuantityValue", "numericValue": "98", "unit": {"@id": "qudt-unit:xyz"} }],
      "resultTime": "2018-02-01T18:36:12Z"
    }
]
}
```

C.7.2. Component 4.G.2 Poultry Well Being

AIM Model - Input


```
{
    "@context": [
        "https://w3id.org/demeter/agri-context.jsonld",
        "https://w3id.org/demeter/agri/ext/poultryFeeding-context.jsonld",
        "https://w3id.org/demeter/agri/ext/stressRecognition-context.jsonld"
    ],
    "@graph":[
        {
            "@id": "urn:demeter:device",
            "@type": "Device",
            "animalRawSound": "https://link.sound",
            "extractedFeaturesFromSound": "Set of characteristics extracted as numerical float data.",
            "airTemperature": 23.5,
            "airHumidity": 80.2,
            "airFlow": 50.0,
            "lightIntensity": 99.6,
            "airCO2": 16.3,
            "powerLoses": 1
        },
        {
            "@id": "urn:demeter:flock",
            "@type": "AnimalGroup",
            "identifier": "88acd214-f633-4db7-9560-0ca69abc1a4a",
            "animalSpecies": "Chicken",
            "flockAverageAge": "1"
        }
    ]
}
```


AIM Model - Output


```
{
    "@context": [
        "https://w3id.org/demeter/agri-context.jsonld",
        "https://w3id.org/demeter/agri/ext/poultryFeeding-context.jsonld",
        "https://w3id.org/demeter/agri/ext/stressRecognition-context.jsonld"
    ],
    "@graph":[
        {
```

```
            "@id": "urn:demeter:flock",
            "@type": "AnimalGroup",
            "identifier": "88acd214-f633-4db7-9560-0ca69abc1a4a",
            "animalSpecies": "Chicken",
            "flockAverageAge": "1"
        },
        {
            "@id": "urn:demeter:stress",
            "@type": "StressOrPressure",
            "stressLevel": "abnormal",
            "safetyInstructions": "check flock"
        }
    ]
}
```


C.8. DSS AREA: 4.H - Traceability

C.8.1. Component 4.H.1 Milk Quality Prediction

AIM Model - Input - Training


```
{
  "@context": [
    "https://w3id.org/demeter/agri-context.jsonld",
    "https://w3id.org/demeter/agri/ext/livestockFeature-context.jsonld",
       {
      "qudt-unit": "http://qudt.org/vocab/unit/"
    }
   ],
   "@graph": [
          {
            "@id": "urn:demeter:milkproduct1",
            "@type": "MilkProduct",
            "productName": "Latte Maccarese",
            "productType": "Raw"
          },
                              {
                               "@id": "urn:demeter:predictionMetric1",
                               "@type": "PredictionMetric",
                               "rawTruePositiveRate":"",
                               "rawFalsePositiveRate":"",
```

```
                              "rawPrecision":"",
                              "rawAccuracy":"",
                              "processedTruePositiveRate":"",
                              "processedFalsePositiveRate":"",
                              "processedPrecision":"",
                              "processedAccuracy":""
                              },
          {
            "@id": "urn:demeter:72d9fb43-53f8-4ec8-a33c-fa931360259a",
            "@type": "MilkQualityPrediction",
            "description": "Milk Quality collection of observations1",
            "hasMember": [{ "@id": "urn:demeter:ObservationI/1a"}, { "@id":           "urn:demeter:ObservationI/2a" } ,{ "@id":
"urn:demeter:ObservationI/3a" }, { "@id": "urn:demeter:ObservationI/4a"}, { "@id": "urn:demeter:ObservationI/5a" } ,{ "@id":
"urn:demeter:ObservationI/6a" }, { "@id": "urn:demeter:ObservationI/7a"}, { "@id": "urn:demeter:ObservationI/8a" } ,{ "@id":
"urn:demeter:ObservationI/9a" }, { "@id": "urn:demeter:ObservationI/10a"}, { "@id": "urn:demeter:ObservationI/11a" } ],
            "resultTime": "2018-02-01T12:36:12Z",
            "hasFeatureOfInterest": { "@id": "urn:demeter:milkproduct1" },
                               "predictionMetric":{ "@id": "urn:demeter:predictionMetric1" }
          },
          {
            "@id": "urn:demeter:ObservationI/1a",
            "@type": "Observation",
            "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#aciditySH"} ,
            "hasResult": [{ "@type": "QuantityValue", "numericValue": "6.61", "unit": {"@id": "qudt-unit:xyz"} }]
          },
          {
               "@id": "urn:demeter:ObservationI/2a",
            "@type": "Observation",
            "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#casein"} ,
            "hasResult": [{ "@type": "QuantityValue", "numericValue": "2.52", "unit": {"@id": "qudt-unit:xyz"} }]
          },
          {
               "@id": "urn:demeter:ObservationI/3a",
            "@type": "Observation",
            "observedProperty": { "@id": "http://qudt.org/vocab/quantitykind/density"} ,
            "hasResult": [{ "@type": "QuantityValue", "numericValue": "1030", "unit": {"@id": "qudt-unit:xyz"} }]
          },
          {
               "@id": "urn:demeter:ObservationI/4a",
            "@type": "Observation",
            "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#fat"} ,
            "hasResult": [{ "@type": "QuantityValue", "numericValue": "4.93", "unit": {"@id": "qudt-unit:xyz"} }]
```

```
        },
        {
            "@id": "urn:demeter:ObservationI/5a",
          "@type": "Observation",
          "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#protein"} ,
          "hasResult": [{ "@type": "QuantityValue", "numericValue": "3.31", "unit": {"@id": "qudt-unit:xyz"} }]
        },
        {
            "@id": "urn:demeter:ObservationI/6a",
          "@type": "Observation",
          "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#freezingPointMC"} ,
          "hasResult": [{ "@type": "QuantityValue", "numericValue": "-553.17", "unit": {"@id": "qudt-unit:xyz"} }]
        },
        {
            "@id": "urn:demeter:ObservationI/7a",
          "@type": "Observation",
          "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#lactose"} ,
          "hasResult": [{ "@type": "QuantityValue", "numericValue": "4.79", "unit": {"@id": "qudt-unit:xyz"} }]
        },
        {
            "@id": "urn:demeter:ObservationI/8a",
          "@type": "Observation",
          "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#SNF"} ,
          "hasResult": [{ "@type": "QuantityValue", "numericValue": "8.87", "unit": {"@id": "qudt-unit:xyz"} }]
        },
        {
            "@id": "urn:demeter:ObservationI/9a",
          "@type": "Observation",
          "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#urea"} ,
          "hasResult": [{ "@type": "QuantityValue", "numericValue": "403.84", "unit": {"@id": "qudt-unit:xyz"} }]
        },
        {
            "@id": "urn:demeter:ObservationI/10a",
          "@type": "Observation",
          "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#actualQuality"} ,
          "hasResult": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#qualityValue-High"}
        },
        {
            "@id": "urn:demeter:ObservationI/11a",
          "@type": "Observation",
          "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#predictedQuality"} ,
          "hasResult": { }
```

```
        }
    ]
}
```

AIM Model -- Output - Training


```
{
  "@context": [
    "https://w3id.org/demeter/agri-context.jsonld",
    "https://w3id.org/demeter/agri/ext/livestockFeature-context.jsonld",
       {
      "qudt-unit": "http://qudt.org/vocab/unit/"
    }
   ],
   "@graph": [
          {
            "@id": "urn:demeter:milkproduct1",
            "@type": "MilkProduct",
            "productName": "Latte Maccarese",
            "productType": "Raw"
          },
                            {
                             "@id": "urn:demeter:predictionMetric1",
                             "@type": "PredictionMetric",
                             "rawTruePositiveRate":"87.2",
                             "rawFalsePositiveRate":"5.74",
                             "rawPrecision":"89.57",
                             "rawAccuracy":"94.45",
                             "processedTruePositiveRate":"85.73",
                             "processedFalsePositiveRate":"5.77",
                             "processedPrecision":"93.52",
                             "processedAccuracy":"95.51"
                            },
          {
            "@id": "urn:demeter:72d9fb43-53f8-4ec8-a33c-fa931360259a",
            "@type": "MilkQualityPrediction",
            "description": "Milk Quality collection of observations1",
            "hasMember":   [{   "@id":   "urn:demeter:ObservationI/1a"},   {   "@id":   "urn:demeter:ObservationI/2a"   }   ,{   "@id":
"urn:demeter:ObservationI/3a"   },   {   "@id":   "urn:demeter:ObservationI/4a"},   {   "@id":   "urn:demeter:ObservationI/5a"   }   ,{   "@id":
"urn:demeter:ObservationI/6a"   },   {   "@id":   "urn:demeter:ObservationI/7a"},   {   "@id":   "urn:demeter:ObservationI/8a"   }   ,{   "@id":
"urn:demeter:ObservationI/9a" }, { "@id": "urn:demeter:ObservationI/10a"}, { "@id": "urn:demeter:ObservationI/11a" } ],
```

```
            "resultTime": "2018-02-01T12:36:12Z",
            "hasFeatureOfInterest": { "@id": "urn:demeter:milkproduct1" },
                                  "predictionMetric":{ "@id": "urn:demeter:predictionMetric1" }
          },
          {
            "@id": "urn:demeter:ObservationI/1a",
            "@type": "Observation",
            "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#aciditySH"} ,
            "hasResult": [{ "@type": "QuantityValue", "numericValue": "6.61", "unit": {"@id": "qudt-unit:xyz"} }]
          },
          {
               "@id": "urn:demeter:ObservationI/2a",
            "@type": "Observation",
            "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#casein"} ,
            "hasResult": [{ "@type": "QuantityValue", "numericValue": "2.52", "unit": {"@id": "qudt-unit:xyz"} }]
          },
          {
               "@id": "urn:demeter:ObservationI/3a",
            "@type": "Observation",
            "observedProperty": { "@id": "http://qudt.org/vocab/quantitykind/density"} ,
            "hasResult": [{ "@type": "QuantityValue", "numericValue": "1030", "unit": {"@id": "qudt-unit:xyz"} }]
          },
          {
               "@id": "urn:demeter:ObservationI/4a",
            "@type": "Observation",
            "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#fat"} ,
            "hasResult": [{ "@type": "QuantityValue", "numericValue": "4.93", "unit": {"@id": "qudt-unit:xyz"} }]
          },
          {
               "@id": "urn:demeter:ObservationI/5a",
            "@type": "Observation",
            "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#protein"} ,
            "hasResult": [{ "@type": "QuantityValue", "numericValue": "3.31", "unit": {"@id": "qudt-unit:xyz"} }]
          },
          {
               "@id": "urn:demeter:ObservationI/6a",
            "@type": "Observation",
            "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#freezingPointMC"} ,
            "hasResult": [{ "@type": "QuantityValue", "numericValue": "-553.17", "unit": {"@id": "qudt-unit:xyz"} }]
          },
          {
               "@id": "urn:demeter:ObservationI/7a",
```

```
            "@type": "Observation",
            "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#lactose"} ,
            "hasResult": [{ "@type": "QuantityValue", "numericValue": "4.79", "unit": {"@id": "qudt-unit:xyz"} }]
          },
          {
               "@id": "urn:demeter:ObservationI/8a",
            "@type": "Observation",
            "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#SNF"} ,
            "hasResult": [{ "@type": "QuantityValue", "numericValue": "8.87", "unit": {"@id": "qudt-unit:xyz"} }]
          },
          {
               "@id": "urn:demeter:ObservationI/9a",
            "@type": "Observation",
            "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#urea"} ,
            "hasResult": [{ "@type": "QuantityValue", "numericValue": "403.84", "unit": {"@id": "qudt-unit:xyz"} }]
          },
          {
               "@id": "urn:demeter:ObservationI/10a",
            "@type": "Observation",
            "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#actualQuality"} ,
            "hasResult": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#qualityValue-High"}
          },
          {
               "@id": "urn:demeter:ObservationI/11a",
            "@type": "Observation",
            "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#predictedQuality"} ,
            "hasResult": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#qualityValue-High"}
          }
     ]
}
```


AIM Model -- Input - Prediction


```
{
  "@context": [
    "https://w3id.org/demeter/agri-context.jsonld",
    "https://w3id.org/demeter/agri/ext/livestockFeature-context.jsonld",
       {
      "qudt-unit": "http://qudt.org/vocab/unit/"
    }
```

```
],
"@graph": [
        {
          "@id": "urn:demeter:milkproduct1",
          "@type": "MilkProduct",
          "productName": "Latte Maccarese",
          "productType": "Raw"
        },
                          {
                           "@id": "urn:demeter:predictionMetric1",
                           "@type": "PredictionMetric",
                           "rawTruePositiveRate":"",
                           "rawFalsePositiveRate":"",
                           "rawPrecision":"",
                           "rawAccuracy":"",
                           "processedTruePositiveRate":"",
                           "processedFalsePositiveRate":"",
                           "processedPrecision":"",
                           "processedAccuracy":""
                          },
        {
          "@id": "urn:demeter:72d9fb43-53f8-4ec8-a33c-fa931360259a",
          "@type": "MilkQualityPrediction",
          "description": "Milk Quality collection of observations1",
          "hasMember":   [{   "@id":   "urn:demeter:ObservationI/1a"},   {   "@id":   "urn:demeter:ObservationI/2a"   }   ,{   "@id":
"urn:demeter:ObservationI/3a"  },  {  "@id":  "urn:demeter:ObservationI/4a"},  {  "@id":  "urn:demeter:ObservationI/5a"  }  ,{  "@id":
"urn:demeter:ObservationI/6a"  },  {  "@id":  "urn:demeter:ObservationI/7a"},  {  "@id":  "urn:demeter:ObservationI/8a"  }  ,{  "@id":
"urn:demeter:ObservationI/9a" }, { "@id": "urn:demeter:ObservationI/10a"}, { "@id": "urn:demeter:ObservationI/11a" } ],
          "resultTime": "2018-02-01T12:36:12Z",
          "hasFeatureOfInterest": { "@id": "urn:demeter:milkproduct1" },
                           "predictionMetric":{ "@id": "urn:demeter:predictionMetric1" }
        },
        {
          "@id": "urn:demeter:ObservationI/1a",
          "@type": "Observation",
          "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#aciditySH"} ,
          "hasResult": [{ "@type": "QuantityValue", "numericValue": "6.61", "unit": {"@id": "qudt-unit:xyz"} }]
        },
        {
             "@id": "urn:demeter:ObservationI/2a",
          "@type": "Observation",
          "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#casein"} ,
```

```
            "hasResult": [{ "@type": "QuantityValue", "numericValue": "2.52", "unit": {"@id": "qudt-unit:xyz"} }]
          },
          {
               "@id": "urn:demeter:ObservationI/3a",
            "@type": "Observation",
            "observedProperty": { "@id": "http://qudt.org/vocab/quantitykind/density"} ,
            "hasResult": [{ "@type": "QuantityValue", "numericValue": "1030", "unit": {"@id": "qudt-unit:xyz"} }]
          },
          {
               "@id": "urn:demeter:ObservationI/4a",
            "@type": "Observation",
            "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#fat"} ,
            "hasResult": [{ "@type": "QuantityValue", "numericValue": "4.93", "unit": {"@id": "qudt-unit:xyz"} }]
          },
          {
               "@id": "urn:demeter:ObservationI/5a",
            "@type": "Observation",
            "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#protein"} ,
            "hasResult": [{ "@type": "QuantityValue", "numericValue": "3.31", "unit": {"@id": "qudt-unit:xyz"} }]
          },
          {
               "@id": "urn:demeter:ObservationI/6a",
            "@type": "Observation",
            "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#freezingPointMC"} ,
            "hasResult": [{ "@type": "QuantityValue", "numericValue": "-553.17", "unit": {"@id": "qudt-unit:xyz"} }]
          },
          {
               "@id": "urn:demeter:ObservationI/7a",
            "@type": "Observation",
            "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#lactose"} ,
            "hasResult": [{ "@type": "QuantityValue", "numericValue": "4.79", "unit": {"@id": "qudt-unit:xyz"} }]
          },
          {
               "@id": "urn:demeter:ObservationI/8a",
            "@type": "Observation",
            "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#SNF"} ,
            "hasResult": [{ "@type": "QuantityValue", "numericValue": "8.87", "unit": {"@id": "qudt-unit:xyz"} }]
          },
          {
               "@id": "urn:demeter:ObservationI/9a",
            "@type": "Observation",
            "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#urea"} ,
```

```
            "hasResult": [{ "@type": "QuantityValue", "numericValue": "403.84", "unit": {"@id": "qudt-unit:xyz"} }]
          },
          {
               "@id": "urn:demeter:ObservationI/10a",
            "@type": "Observation",
            "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#actualQuality"} ,
            "hasResult": {}
          },
          {
               "@id": "urn:demeter:ObservationI/11a",
            "@type": "Observation",
            "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#predictedQuality"} ,
            "hasResult": {}
          }
     ]
}
```


AIM Model - Output - Prediction


```
{
  "@context": [
    "https://w3id.org/demeter/agri-context.jsonld",
    "https://w3id.org/demeter/agri/ext/livestockFeature-context.jsonld",
       {
      "qudt-unit": "http://qudt.org/vocab/unit/"
    }
   ],
   "@graph": [
          {
            "@id": "urn:demeter:milkproduct1",
            "@type": "MilkProduct",
            "productName": "Latte Maccarese",
            "productType": "Raw"
          },
                              {
                                "@id": "urn:demeter:predictionMetric1",
                                "@type": "PredictionMetric",
                                "rawTruePositiveRate":"",
                                "rawFalsePositiveRate":"",
                                "rawPrecision":"",
```

```
                                "rawAccuracy":"",
                                "processedTruePositiveRate":"",
                                "processedFalsePositiveRate":"",
                                "processedPrecision":"",
                                "processedAccuracy":""
                              },
          {
            "@id": "urn:demeter:72d9fb43-53f8-4ec8-a33c-fa931360259a",
            "@type": "MilkQualityPrediction",
            "description": "Milk Quality collection of observations1",
            "hasMember":    [{    "@id":    "urn:demeter:ObservationI/1a"},    {    "@id":    "urn:demeter:ObservationI/2a"    }    ,{    "@id":
"urn:demeter:ObservationI/3a"   },  {   "@id":   "urn:demeter:ObservationI/4a"},  {   "@id":   "urn:demeter:ObservationI/5a"   }   ,{   "@id":
"urn:demeter:ObservationI/6a"   },  {   "@id":   "urn:demeter:ObservationI/7a"},  {   "@id":   "urn:demeter:ObservationI/8a"   }   ,{   "@id":
"urn:demeter:ObservationI/9a" }, { "@id": "urn:demeter:ObservationI/10a"}, { "@id": "urn:demeter:ObservationI/11a" } ],
            "resultTime": "2018-02-01T12:36:12Z",
            "hasFeatureOfInterest": { "@id": "urn:demeter:milkproduct1" },
                                "predictionMetric":{ "@id": "urn:demeter:predictionMetric1" }
          },
          {
            "@id": "urn:demeter:ObservationI/1a",
            "@type": "Observation",
            "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#aciditySH"} ,
            "hasResult": [{ "@type": "QuantityValue", "numericValue": "6.61", "unit": {"@id": "qudt-unit:xyz"} }]
          },
          {
               "@id": "urn:demeter:ObservationI/2a",
            "@type": "Observation",
            "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#casein"} ,
            "hasResult": [{ "@type": "QuantityValue", "numericValue": "2.52", "unit": {"@id": "qudt-unit:xyz"} }]
          },
          {
               "@id": "urn:demeter:ObservationI/3a",
            "@type": "Observation",
            "observedProperty": { "@id": "http://qudt.org/vocab/quantitykind/density"} ,
            "hasResult": [{ "@type": "QuantityValue", "numericValue": "1030", "unit": {"@id": "qudt-unit:xyz"} }]
          },
          {
               "@id": "urn:demeter:ObservationI/4a",
            "@type": "Observation",
            "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#fat"} ,
            "hasResult": [{ "@type": "QuantityValue", "numericValue": "4.93", "unit": {"@id": "qudt-unit:xyz"} }]
          },
```

```
{
    "@id": "urn:demeter:ObservationI/5a",
  "@type": "Observation",
  "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#protein"} ,
  "hasResult": [{ "@type": "QuantityValue", "numericValue": "3.31", "unit": {"@id": "qudt-unit:xyz"} }]
},
{
    "@id": "urn:demeter:ObservationI/6a",
  "@type": "Observation",
  "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#freezingPointMC"} ,
  "hasResult": [{ "@type": "QuantityValue", "numericValue": "-553.17", "unit": {"@id": "qudt-unit:xyz"} }]
},
{
    "@id": "urn:demeter:ObservationI/7a",
  "@type": "Observation",
  "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#lactose"} ,
  "hasResult": [{ "@type": "QuantityValue", "numericValue": "4.79", "unit": {"@id": "qudt-unit:xyz"} }]
},
{
    "@id": "urn:demeter:ObservationI/8a",
  "@type": "Observation",
  "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#SNF"} ,
  "hasResult": [{ "@type": "QuantityValue", "numericValue": "8.87", "unit": {"@id": "qudt-unit:xyz"} }]
},
{
    "@id": "urn:demeter:ObservationI/9a",
  "@type": "Observation",
  "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#urea"} ,
  "hasResult": [{ "@type": "QuantityValue", "numericValue": "403.84", "unit": {"@id": "qudt-unit:xyz"} }]
},
{
    "@id": "urn:demeter:ObservationI/10a",
  "@type": "Observation",
  "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#actualQuality"} ,
  "hasResult": {}
},
{
    "@id": "urn:demeter:ObservationI/11a",
  "@type": "Observation",
  "observedProperty": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#predictedQuality"} ,
  "hasResult": { "@id": "https://w3id.org/demeter/agri/ext/livestockFeature#qualityValue-High"}
}
```

```
    ]
}
```

C.8.2. Component 4.H.2 Transport Condition

AIM Model - Input


```
{
    "@context": [
        "https://w3id.org/demeter/agri-context.jsonld",
        "https://w3id.org/demeter/agri/ext/transportCondition-context.jsonld"
    ],
    "@graph": [
        {
            "@id": "urn:demeter:producer",
            "@type": "Producer",
            "identifier": "b72312bb-17a0-4684-b92e-673fe4c1d06c",
            "certificates": "Poulty certificate"
        },
        {
            "@id": "urn:demeter:poultryProduct",
            "@type": "PoultryProduct",
            "placeOfProduction": {
                "@id": "urn:demeter:placeOfProduction",
                "@type": "Point",
                "name": "Sinkovic",
                "lat": "45.267136",
                "long": "19.833549"
            },
            "mhr": "vaccinated, no medical treatment",
            "poultryType": "Hybrid"
        },
        {
            "@id": "urn:demeter:transport",
            "@type": "Transport",
            "transportCondition": "Good"
        }
    ]
}
```

AIM Model - Output


```
{
    "@context": [
        "https://w3id.org/demeter/agri-context.jsonld",
        "https://w3id.org/demeter/agri/ext/transportCondition-context.jsonld"
    ],
    "@id": "urn:demeter:transport",
    "@type": "Transport",
    "packageId": "0ccd0e4c-bebe-4f85-8b47-86c40cbc7343",
    "transportCondition": "1"
}
```


C.8.3. Component 4.H.3 Field Book and FaST

AIM Model - Input


```
{
    "@context": [
        "https://w3id.org/demeter/agri-context.jsonld"
    ],
    "@graph": [
        {
            "@id": "urn:demeter:AgriFarm:5eeb76ccb8f8fe627be2b690",
            "@type": "AgriFarm",
            "name": "Almond trees farm in Cartagena, Spain",
            "hasAgriParcel": [
                {
                    "@id": "urn:demeter:AgriParcel:5eeb76ccb8f8fe627be2b690",
                    "@type": "AgriParcel",
                    "name": "Almond trees",
                    "hasGeometry": {
                        "@id": "urn: demeter:AgriFarm:geo:1",
                        "@type": "Point",
                        "asWKT": "POINT(38.59436666 -0.87921111 496)"
                    },
                    "area": 9000,
                    "numberOfPlants": 270,
                    "distanceInRow": 5.5,
                    "distanceBetweenRows": 6.0,
                    "hasAgriCrop": {
                        "@id": "urn:demeter:AgriCrop:1",
                        "@type": "AgriCrop",
```

```
                    "plantDiameter": 0.236,
                    "plantType": "woody",
                    "cropCoefficient": 0.15,
                    "maxWaterConductivity": 4
                },
                "hasAgriSoil": {
                    "@id": "urn:demeter:AgriSoil:1",
                    "@type": "AgriSoil",
                    "percolatingEficiency": 0.9
                },
                "hasAgriWater": {
                    "@id": "urn:demeter:AgriWater:1",
                    "@type": "AgriWater",
                    "irrigationType": "drip",
                    "waterConductivity": 1
                },
                "hasDevice": [
                   {"@id": "urn:demeter:temperature:5f85693cf8fe8723e0814710:5f85693cf8fe8723e0814700"},
                    {"@id": "urn:demeter:humidity:5f85693cf8fe8723e0814710:5f85693cf8fe8723e0814703"},
                    {"@id": "urn:demeter:windspeed:5f85693cf8fe8723e0814710:5f85693cf8fe8723e081470c"},
                    {"@id": "urn:demeter:sunradiation:5f85693cf8fe8723e0814710:5f85693cf8fe8723e0814709"},
                   {"@id": "urn:demeter:precipitation:5f85693cf8fe8723e0814710:5f85693cf8fe8723e0814706"}
                ]
            }
        ]
    }
   ]
}
```

C.9. DSS AREA: 4.I - Benchmarking

All the Benchmarking components share the same output DSS based on:

- featureofInterest: the target of the benchmarking; can be a farm or a technology.
- KpiIndicator: the description of the indicators.
- KpiIndicatorValue: the value of the indicator for the featureOfInterest.

AIM Model - Output


```
{
  "@context": [
    "https://w3id.org/demeter/agri-context.jsonld",
    "https://w3id.org/demeter/agri/ext/kpiIndicator-context.jsonld",
    {
      "qudt-unit": "http://qudt.org/vocab/unit/"
    }
  ],
  "@graph": [
    {
      "@id": "urn:demeter:tech:agricolus_water_dss",
      "@type": "Farm",
      "description": "Agricolus Water DSS"
    },
    {
      "@id": "https://w3id.org/demeter/agri/ext/kpiIndicator#waterEfficency",
      "@type": "KpiIndicator",
      "schema.name": "Water Efficiency",
      "sector": {
        "@id": "https://w3id.org/demeter/agri/ext/kpiIndicator#sectorScheme-Agronomic"
      }
    },
    {
      "@id": "https://w3id.org/demeter/agri/ext/kpiIndicator#averageYield",
      "@type": "KpiIndicator",
      "schema.name": "Average Yield",
      "sector": {
        "@id": "https://w3id.org/demeter/agri/ext/kpiIndicator#sectorScheme-Agronomic"
      }
    },
    {
```

```
      "@type": "KpiIndicatorValue",
      "hasFeatureOfInterest": {
        "@id": "urn:demeter:tech:agricolus_water_dss"
      },
      "hasResult": [
        {
          "@type": "QuantityValue",
          "numericValue": 320.0,
          "unit": {
            "@id": "qudt-unit:Millimeter"
          }
        }
      ],
      "observedProperty": {
        "@id": "https://w3id.org/demeter/agri/ext/kpiIndicator#averageIrrigation"
      },
      "referenceValue": 400.0,
      "resultTime": "2021-01-01T00:00:00+00:00"
    },
    {
      "@type": "KpiIndicatorValue",
      "hasFeatureOfInterest": {
        "@id": "urn:demeter:tech:agricolus_water_dss"
      },
      "hasResult": [
        {
          "@type": "QuantityValue",
          "numericValue": 8.1,
          "unit": {
            "@id": "demeter:Tonne-Per-Hectare"
          }
        }
      ],
      "observedProperty": {
        "@id": "https://w3id.org/demeter/agri/ext/kpiIndicator#averageYield"
      },
      "referenceValue": 7.0,
      "resultTime": "2021-01-01T00:00:00+00:00"
    }
  ]
}
```

Annex D DIHIWARE technology description

The SOCS is based on the DIHIWARE, a solution developed by the MIDIH H2020 EU project (http://midih.eu) and currently in use in many ecosystems in Europe. The DIHIWARE offers a complete collaboration environment inspired by Enterprise Social Software. It supports both “Access to” and “Collaborate with” services, providing access to the latest knowledge and expertise and pulling teams together and providing a fertile ground for experimentation.

The knowledge-driven services, complemented by the collaborative and innovation side of the Platform, will create a virtual environment where beneficiaries can not only match assets and needs, but they can collaborate together towards joint innovations.

The DIHIWARE is the core building block on top of which specific DEMETER customisations (environment customisation, catalogue designing and dedicated user journeys) and new developments are being drawn up, with the help of the consortium, carrying out an in-depth study of the objectives that can be achieved through the use of the Platform and the DEMETER ecosystem offer.

The DIHIWARE Platform is an integrated system leveraging on knowledge-driven services that, next to a Catalogues Management System, and harmonised with the collaborative side of the Platform are able to create an environment where providers and consumers of digital technologies related to AI development and adoption cannot just matching assets and needs, but they can collaborate to boost innovation.

The Platform is based on different Open-Source components, integrated and distributed as Docker images, using a winning modular approach able to simply the deployment procedure and guarantee the possibility to have custom-tailored solutions suitable for the variegated environments.

The DIHIWARE customisation capabilities, next to a concrete adoption plan of the Platform, enables the delivery of specific tailored environments, based on selected DIHIWARE modules and in line with the stakeholders needs and requirements.

D.1. Architecture

The DIHIWARE Innovation and Collaboration Platform is an integrated environment made of the following main systems: Collaboration Portal (CP) and Catalogues Management System (CMS). Each system provides a specific function and complements the functionality of the other. The platform is also equipped with a component dealing with the users centralised authentication (Identity Manager).

The collaboration portal is the main entry point for users: it enables open collaboration, online community building and management as well as access to knowledge. The CMS provides functionalities related to the back-end management, structure, and storage of the catalogues as well as the front-end interface (integrated within the collaboration portal) allowing users to interact with them (e.g., view, filter and select).

The high-level decomposition is shown in Figure 106 and each system (including its core technologies and functionalities) is described in more details in the following sub-sections.

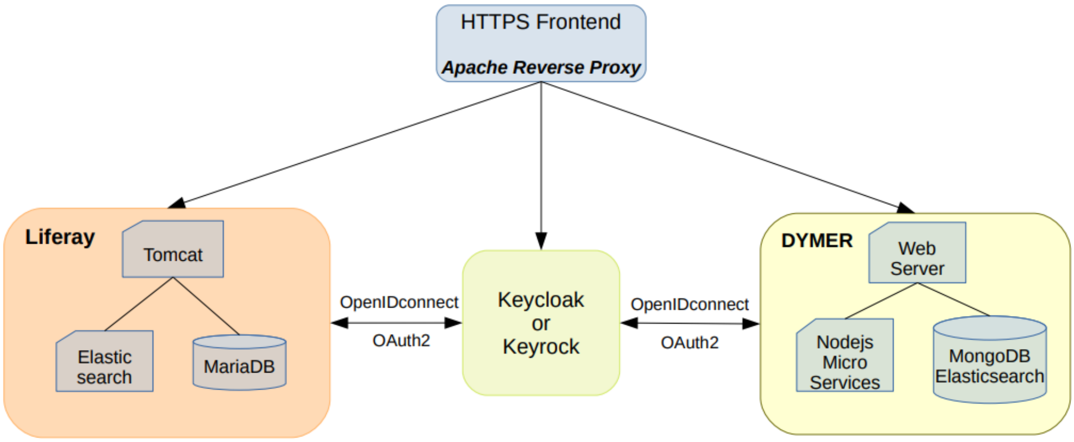


Figure 106: DIHIWARE Platform Architecture

D.2. Background modules and technologies

D.2.1. The Collaboration portal

The Collaboration Portal (CP) is the main subsystem, offering tools for knowledge management, social activity next to collaboration and innovation capabilities. It links users, processes, resources, and acts a powerful knowledge hub. Most of common community members will access only to this module.

The main purpose of the portal is to use its features to connect companies, people, information, and resources (also coming from the other bridged subsystems) in a collaborative space where it is possible to turn conversations and ideas into projects.

The suite of integrated and interconnected solutions of the platform aims to support efficiency, visibility, and collaboration processes. The Collaboration portal, in fact, enables and supports the development, integration and delivery of knowledge sharing and collaboration services based on social networking, collective intelligence, collaboration, sharing, transparency and self-empowerment.

The final aim of any collaborative platform is to support knowledge sharing in a multi-actor scenario. To this extend, the developed collaboration platform involves primitives for human socio-business activities and collaboration, including idea management, open innovation, and cross-enterprise social networks.

The Collaboration Portal is grounded on Liferay[14] the has been selected since it is a widely used Open-Source and state-of-the-art Content Management System. Liferay Portal is a free and Open-Source enterprise portal software product written in Java. Liferay includes a built-in web content management system allowing users to build websites and portals as an assembly of themes, pages, modules/widgets, and a common navigation.

[14] http://www.liferay.com/

D.2.2. The Catalogue Management System

The Catalogues Management System is the subsystem of the DIHIWARE that handles the resources organisation and cataloguing, being configured according to the platform instance requirements.

The Catalogue Management System acts as a new way of managing information, where the use of taxonomies and the power of metadata enable the organisation of product and services besides their dynamic modelling and visualisation.

The system offers a single access point for users leveraging on already existing information in different organisations by creating a federation of catalogues for a scalable system (data blending).

The Catalogue Management System is the main pillar of the one-stop-shop business model enabled by the platform that focuses on the value of the honest brokering. Therefore, the platform allows the construction and the management of a showcase of structured data coming from various sources.

The Catalogue Management System relies on **DYMER** (DYnamic Information ModElling & Rendering) which is a WCM (Web Content Management) completely developed by ENGINEERING within the MIDIH Project. It consists of two main components: Dymer-Core and Dymer-Viewer.

Dymer-Core is based on micro-service architectural style with an approach to developing a single application as a suite of small services, each running in its own process and communicating with lightweight mechanisms using HTTP/REST protocols alongside JSON.

Each micro-service is born with a specific role and among the main ones we can identify three:

- Service-Model allows dynamic modelling of data and metadata inherent to the products and services offered.
- Service-Template allows the generation of graphic templates that can be used in the display of products and services using logic-less templates.
- Service-Entities manage the storage and use of the product and services.

These micro-services are developed using the Express.js web application framework (for Node.js), released as free and open-source software under the MIT License. It is designed for building web applications and APIs.

The information is stored in NoSQL Database (MongoDB, Elasticsearch) that provides high performance, high availability, and automatic scaling. Service-Entities use Elasticsearch that is a distributed, Open-Source search and analytics engine for all types of data (including textual, numerical, geospatial, structured, and unstructured) that are stored in JSON format.

DYMER makes use of two JavaScript libraries, dymer.viewer.js and dymer.map.js, in order to visualise resources in list, map and data table mode.

The JavaScript libraries are capable of communicating with DYMER API enabling CRUD (create, read, update and delete) operations on the entities not only in DYMER but also in every external web portal.

DYMER is able to import data from external sources (from JSON files, Excel files and/or API services displaying data) and it can serve as a bridge to visualise external data thanks to DYMER RESTful APIs.

Interaction with the Dymer-Core takes place through the Dymer-Viewer, which is a fast, small and feature-rich JavaScript library. Thanks to this library it is possible to interact with the platform facilitating the use of data by offering a single search point and displaying the results in special graphic templates.

Together with the DYMER viewer it is possible to use two components: the search algorithm and the filter function. The first one is designed to look for an element or to retrieve an element from any data structure stored in DYMER, whereas the second one helps the user to sort through a wide range of items and search for a specific value of one or more field/s within the data structure.

Annex E SOCS Data workshop

As part of task 7.2, a workshop was requested by WP4 to identify the specific data that would be needed to describe the main components within the SOCS platform after WP7 previously introduced an improved layout and design.

The goal of this workshop was to discover important aspects of SOCS components from different user perspectives. Having these differing views allowed for more conversation and more information in return. Overall, the workshop provided key information to enable the further development of the SOCS platform. Engineering (ENG), who participated in the workshop, will use the findings of this workshop to get a better understanding of the data models needed to improve components within the SOCS platform.

The preparation for this workshop included:

- Identifying the correct components.
- Designing a workshop to facilitate an open discussion.
- Inviting participants to give alternative views for the different type of stakeholders in the SOCS platform.

As the SOCS platform is designed to facilitate conversation between multiple stakeholder groups (farmers, IT providers, Software providers, Hardware providers, etc.) it was important to have multiple point of views on this.

The workshop was hosted on Mural, an online collaborative workspace that has been utilised for multiple workshops through the DEMETER project. Video and Audio communications were hosted through Zoom.

To encourage an open discussion during the workshop, there was no timer set on each exercise and once an exercise was completed, the participants then moved on to the next exercise.

In total the workshop included 6 similar exercises to discuss the components and their data structures. For a point of reference, the new design of SOCS was also displayed through screen share on the Zoom call.

The results are broken down into each exercise and listed below:

Organisations

The organisation component will be used to define each organisation within the SOCS platform. When a user creates a new organisation, they will be asked to include specific data including the data discovered during the workshop.

During the workshop discussion it was recommended that the organisation should focus on IT / Research organisations and that the Farm data would need a further discussion in its own exercise as extra information was needed.

The following data was discovered for the organisation component:

- Social Channels
- Address
- Location
- Post code

- Website
- Name
- Email Address
- Person of Interest
    - Discussion around this data concluded that it is a very important aspect to have for the farmer stakeholder group as it makes contacting an organisation more personal.
- Previous projects
- Publications in the area
- Business Description
- Type of Organisation (start-up, research institute, industry etc.)
- Domain of interest
    - Areas of expertise
    - Including: AR, AI, Machine Learning, MAA etc.
- Sectors
    - Arable Crops, Dairy, etc.

User data model

To use the SOCS platform, a user account is needed. To become a user certain data is needed to better define roles and interests.

The user in SOCS can be part of many different stakeholder groups including farm, Software providers, industry, and research. At the outset of this exercise, it was important to outline that different stakeholder groups will have different types of data associated with them, but also some common data type.

Common Attributes

- Name
- Location
    - Antonio gave a demo of the system at this point and provided an example of a map and geolocation data type that can be included for this.
- Email Address
- Social Media Channels
- Organisation (linked to organisation component)
- Role
- Phone Number
    - Ethan Cleary (IFA) noted that this would be important for the farming community as it is a main means of communication for a lot of farmers.

Farmer

The farmer model should include the following data along with points discussed in the farmer survey:

- Farm Type
- Farm Size

Software Developer

To differentiate software developers from other types of users **'area of expertise'** should be included.

IT Provider

An IT provider should include the **'type of technology'** that they provide as an important piece of data. Along with these data points, user skills would need to be included, which was covered in another exercise.

User Skills

Users will have skills as attributes assigned to them, these skills relate to categories and tags to make users more searchable through the SOCS platform.

User skills are an important data set that will differentiate user types based on their skillsets, this will be useful for searching for collaborators or organisations.

During the discussion it was noted that user skills will in fact be categories, which are covered in the next exercise in more detail.

It was also discussed that skill can be hierarchical, with some skills covering a large basis of other skills, examples are shown below. Common user skills noted:

- Project Management
    - Communication
- IT
    - IOT
    - AR
- Data Analytics
    - Big Data
- Livestock
- Animal Welfare
- Dairy

A link was drawn during the exercise to the categories exercise (Figure 107) to denote the important link between both exercises.

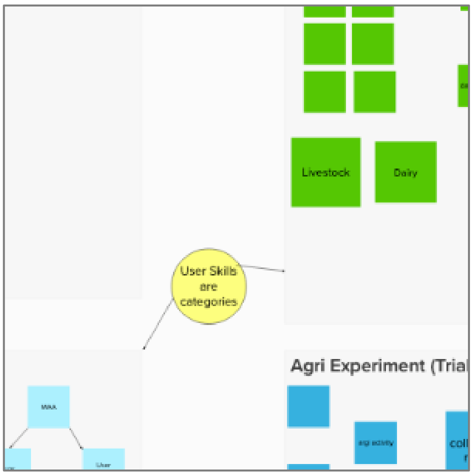


Figure 107: User skills and categories

Categories

Originally this exercise was called the 'tags' data model. Tags will be used to allow end users to easily search for users, documents, posts, trials, organisations, wikis, and blogs. During the discussion that took place it was explained that these tags are known within the SOCS system as predefined categories, which made it easier to understand their purpose. Again, these categories will be hierarchical in type and include the following examples from the exercise:

- Energy
- Irrigation
- Automation
- Management
- IoT
- Collaboration
- Pest Control
- Beekeeping
- Interoperability
- Yield
- Agri-tech
- Emissions
- Technology
    - AI
    - IOT
    - Etc.
- MAA
    - UX
    - User Adoption
- Data Privacy
- Dairy
- Arable Crops
- Precision farming
- Supply
- Livestock
- Fruit
- Vegetable

Topic/Post

The main interface and landing page of the SOCS platform holds the topics of discussion, these come in the form of blog posts, events, issues etc. that have been posted by the end users who will need to assign specific data elements to each topic. The discussed data that needs to be included in these is as follows:

- Post Type
    - Event
    - Blog
    - Issue / Problem
- Date
- Post content
- Title
- Author / User

- Hyperlinks (share button)
  - It was mentioned that not all post types would be shareable, but blog posts would be.
- Views
- Likes
- Upvotes
- Replies
- Best reply (Jump to)
- Tags (categories)
- As discussed in the previous exercise explanation

Agri Experiment (Trial)

An agri-experiment happens through collaboration on the SOCS system, this will involve multiple stakeholders and is an important aspect of the system. The following data was discovered through the exercise:

- Timescale
- Agri Activity
- Collaborators needed
- Collaborators involved
- Challenge it is based on
  - Situation before the trial
  - Problem to solve
- Resources needed
- Behaviour change
  - E.g., Water management
- Results (If completed)
- Title
- Tags / categories
- Type of Hardware & Software involved
- Participants
- Technology
- Standards
- Description
- Main Contact person
- Status
  - Not started / recruiting
  - Maturity level
  - Completed
    - Business model description
  - In progress
- Final Benefits
- Start Date
- End Date
- Results
- Standards

It was also discussed that a new role would need to be created to allow a user to update the status and progress on an agri-trial.

Farm Data

Farm data was an unplanned exercise and was developed as a need arising from the organisation exercise, it was noted that a farm data structure would be very different to an IT or research organisation. The following attributes were addressed through the exercise:

- Co-operative
    - Yes / no
- Location
- Willingness to take part in a trial
- Livestock
    - Kind
    - Amount
- Head / contact person
- Number of employees
- Type of agricultural activity
- Type of Agriculture
- Farm size
- Devices already enabled
    - IOT
- Hardware and software currently in use
- Part of trial
- Completed a trial

Interests

- Interests also links back to categories and tags as it can make a farm searchable based on a topic. This and willingness to participate in a trial were noted as being very important aspects of a farm component.

Linked Discussions

- Challenges
- Needs & concerns
- Tagged in challenges, blogs etc.