MEF4CAP

Monitoring and Evaluation Frameworks for the Common Agricultural Policy

**Deliverable D2.3**

# Identified new technological opportunities from collaboration with EU projects and initiatives

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| **Contributors** | Sokratis Kaprelis (Neuropublic), Tomaso Ceccarelli (WR), Marcel van Asseldonk (WR), Alberto Gutierrez García (Itacyl), Ifigeneia Tsioutsia (AGRO APPS PC), Trevor Donnellan (Teagasc) |
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## Executive summary

MEF4CAP is a H2020 project with the main purpose of delivering an innovation agenda and roadmap for future monitoring of EU agriculture Policy. The Common Agricultural Policy (CAP) post 2020 is targeted towards a wider range of objectives covering broader domains such as social, environmental, and economic sustainability in agriculture and rural areas. This fact implies that new data sources are required to measure the effects and performance of the Policy. Up to date, the main information sources in order to monitor and verify how well the CAP objectives have been reached are the applications by farmers for CAP payments (through the Integrated Administration and Control System - IACS) and retrieved data from national statistical agencies (e.g. Eurostat and the Farm Accountancy Data Network - FADN).

Given the new policy needs, an increase in the number and type of indicators is expected. New indicators have been identified, developed, and tested to adapt to the new policy needs. More data will be required to adequately measure sustainability; therefore, it is vital to consider whether it is possible to utilise existing data sources more efficiently, avoiding duplication and potentially allowing scope for collection of new types of data, e.g., measuring of social sustainability and well-being. To make the future system cost-effective and limit the administrative burden on farmers, future monitoring and evaluation of the CAP will depend on a framework that is grounded in digitalisation, following the trends occurring in the agriculture sector. To this end, digital data from advanced data capturing methods – mainly ICT based mechanisms - will become essential.

WP2 of the MEF4CAP project focuses on Information and Communications Technological (ICT) developments in relation to the agricultural sector. The main objective is to review and assess current and new technologies that are widely utilised or provide a potential benefit for data capturing and processing directly or indirectly related with the new CAP monitoring and evaluation objectives. There are various ongoing efforts in the ICT domain in the context of agriculture, sometimes occurring in parallel, aiming to solve common challenges. The work of WP2 aims to support the identification and categorisation of technological solutions and trends with a clear potential or even a proven track record that can be exploited for addressing the data needs of the monitoring and evaluation frameworks for the agricultural and related policies.

This deliverable, D2.3 “Identified new technological opportunities from collaboration with EU projects and initiatives”, is the second deliverable of WP2 and documents the work conducted in the context of Task 2.2 “Continuous monitoring and collaboration with EU projects and initiatives to review and assess new technological opportunities”. The scope of this document is to identify emerging ICT solutions and methodologies that can be potentially useful and that can be directly or indirectly exploited towards the digitisation of monitoring and evaluation frameworks for the future CAP. This work was done at an early stage of the project, through the establishment of collaboration channels with the most prominent EU projects in this domain.

As it will be evident, in the content of this deliverable the research initiatives that were selected for direct communication were either directly related with the use of technological opportunities in support of current and future CAP objectives (e.g., CAP monitoring including

 

support to area-based payments) or relevant with generic agricultural data sharing, particularly focusing on interoperability of digital agricultural technologies. The selected projects are considered as pioneering in the domain of agricultural data sharing and some of them are aiming to directly address the needs of CAP monitoring and evaluation. Their outcomes can be considered as a steppingstone towards the more generilised implementation of ICT based data collection capable to address the needs of additional application domains of agricultural sector.

To document this, all the results of the liaison activities are presented and the most advanced technological approaches currently in the research and development phase are evaluated. The recorded outcomes from these initiatives will be combined with outcomes from deliverable D2.1 "Landscape of agri-food ICT technologies within EU" in order to compose D2.2 "Best practices on the adoption of ICT agricultural technological solutions".

The final list of core projects with established collaboration activities is as follows:

- H2020 DEMETER project
- H2020 ENVISION project
- FaST project
- Open IACS project
- H2020 MIND STEP project
- H2020 DIONE project
- H2020 NIVA project

In addition to the established collaboration activities and aiming to further investigate ongoing research activities, relevant with a wider scope of CAP objectives, a thorough review of ongoing research efforts was conducted focusing on the utilisation of ICT mechanism (sensors and information systems) in support of livestock management with a particular focus on animal welfare. Outcomes of this analysis are provided in a specific section. In most of the cases, the researched technologies are not considering support of CAP monitoring and evaluation as their direct objective, however there is great potential towards this direction through further exploitation of the generated datasets as ground-truth evidence of the applied practices.

In a similar manner, a review of ongoing research initiatives on Satellite based Earth Observation was conducted, mostly operated under the umbrella of ESA (European Space Agency) and the outcomes of this analysis are provided in a specific section.

A more detailed analysis on the usefulness of the presented information sources is performed in the context of WP3. WP2 Deliverables will be utilised as input by WP3 "Current systems and future pathways" to confront promising ICT developments with data needs for an enhanced monitoring and evaluation framework, functional to the future and reformed CAP.

 

**List of abbreviations**

API - Application Programming Interface

CAP - Common Agriculture Policy

CSA - Coordination and Support Actions

CSV - Comma-Separated Values

DG-AGRI - Directorate-General for Agriculture and Rural Development

EC - European Commission

EO - Earth Observation

EU - European Union

FADN - Farm Accountancy Data Network

FDIS - Field Data Information System

FMIS - Farm Management Information System

GAEC - Good Agricultural and Environmental Conditions

HPC - High Performance Computing

IACS - Integrated Administration and Control System

ICT - Information and Communication Technologies

IDM - Individual Decision Making

IoT - Internet of Things

LOD - Linked Open Data

LPIS - Land Parcel Identification System

MS - Member States

NDVI - Normalised Difference Vegetation Index

OTSCs - On-The-Spot-Checks

PA - Paying Agency

RS - Remote Sensing

SAR - Synthetic Aperture Radar

SMR - statutory management requirements

TRL - Technology Readiness Level

UAVs - Unmanned Aerial Vehicles

 

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# 1. Objectives and overview

**Objectives**

MEF4CAP is a H2020 project with the main purpose of delivering an innovation agenda and roadmap for future monitoring of the EU agriculture Policy. The Common Agricultural Policy (CAP) post 2020 is targeted towards a wider range of objectives covering broader domains – agriculture, sustainability, agri-environmental and food security among others. This fact implies that new data sources are required to measure the effects and performance of the Policy. Performance is the key idea in the new monitoring and evaluation framework of the CAP. At the same time, new technological developments, are enhancing the capability of providing, retrieving and integrating new data sources that are called to achieve those new data requirements. MEF4CAP brings together the expected needs for assessing the performance of the future Policy and the newest technological solutions to address those requirements.

WP2 of the MEF4CAP focuses on reviewing and analysing ICT Developments within the agricultural sector. The main objective of this work package is to review and assess current and new technologies that are widely utilised or provide a potential benefit for data capturing and data processing in support of agri-food monitoring and evaluation objectives. The analysis conducted within this work package will allow the identification and categorisation of technological solutions and trends with a clear potential or even a proven success record that can be exploited for addressing the data needs of the monitoring and evaluation frameworks for the new agricultural and related policies.

The main contribution of this deliverable D2.3 “Identified new technological opportunities from collaboration with EU projects and initiatives”, is to review and document on-going ICT related approaches and efforts in the context of monitoring and evaluation of the future CAP. This work is realised in the context of Task 2.2 “Continuous monitoring and collaboration with EU projects and initiatives to review and assess new technological opportunities”. Within this task, collaboration activities have been established with selected H2020 ongoing projects and other initiatives. Through a number of collaboration sessions we aimed to extract and record up-to-date technological developments in the agri-food sector that are currently under research and development.

D2.3 has the form of a living document with the aim to capture the outcomes of this liaison work resulting from the collaboration activities realised with EU projects and other related initiatives. All the related actions were recorded, including the preparation communications with the targeted projects, the rationale justifying the establishment of the collaboration, detailed minutes of the collaboration meetings, etc. All these information items are available to MEF4CAP partners for further analysis if necessary.

Next steps include the combined analysis of D2.1 and D2.3 in order to identify the final outcomes on best practices and lessons learned with regards to the utilisation of ICT technological solutions for the agri-food domain in the EU and how these solutions can support future CAP monitoring and evaluation frameworks. This work will be documented in Deliverable D2.2 “Best practices on the adoption of ICT agricultural technological solutions”.

WP2 deliverables will also be utilised as input to WP3 “Current systems and future pathways” to complementarily analyse technological offerings and data demands of future monitoring

 

and evaluation systems. The outcomes of this analysis will be recorded in D.3.2. “Potential of current systems and ICT developments for future data needs”.

**Overview**

Section 1 presents the objectives and an overview of this deliverable.

Section 2 introduces this deliverable and describes the overall rational of the conducted research.

Section 3 contains profile information of the core collaboration targets

Section 4 contains the analysis of the realised liaison activities and the key technical outcomes.

Section 5 provides a review of recent research initiatives on technologies for livestock management and animal welfare

Section 6 provides a review of recent research initiatives on satellite-based Earth Observation relevant to CAP monitoring and evaluation objectives

Section 7 provides the conclusions of this work.

 

# 2. Introduction

The CAP is reformed in the light of new societal challenges approximately every seven years. The new CAP, which starts in 2023, aims to foster a sustainable and competitive agricultural sector that can support the livelihoods of farmers and provide healthy and sustainable food for society, as well as vibrant rural areas[1]. The changes are based on evidence-based decision making which in turn implies the need for evaluations based on harmonised data and indicators. The European Commission (EC) has set up the Performance Monitoring and Evaluation Framework (the former CMEF, which is now known as the PMEF) to assess the performance of the CAP. The PMEF is a set of rules, procedures and indicators to evaluate the CAP. The PMEF provides key information on CAP implementation and supports the verification process of how well objectives have been reached. In order to evaluate the implementation of CAP objectives, it is necessary to collect data related to relevant indicators[2]. Currently the main data sources are:

- Applications by farmers for CAP payments Integrated Administration and Control System[3] (IACS)
- Data from national statistical agencies, Eurostat and the Farm Accountancy Data Network[4] (FADN).

Given the new policy needs, an increase in the number and type of indicators is expected. New indicators have been identified, developed and tested to adapt to these new policy needs. More data will be required to adequately measure for example sustainability and well-being; therefore, it is vital to consider whether it is possible to utilise existing data sources more efficiently, avoiding duplication and potentially allowing scope for collection of new types of data. In order to make the future system cost effective and limit the administrative burden on farmers, future monitoring and evaluation of the CAP will depend on a framework that is grounded in the trend of digitalisation. To this end, digital data from advanced data capturing methods – mainly ICT based mechanisms - will become essential.

At the same time there is an ongoing trend where innovative ICT solutions are being adopted in support of everyday farm operations. Consequently, there is a wide range of data flows from and to farms, part of them being relevant to policy evaluation and monitoring. A future monitoring system should make optimal use of these different sources of data and modern ICT based data capturing systems. As part of its ongoing aim to simplify and modernise the EU's CAP, the European Commission (EC) is already adopting new rules that allow a range of modern technologies to be used when carrying out checks for area-based CAP payments. These include the possibility to completely replace physical checks on farms (On-The-Spot-Checks, OTSC) with a system of automated cross checks based on Earth Observation data products (EO) (e.g. with the use of satellite data), in combination with Internet of Things (IoT) and other digital

[1] https://ec.europa.eu/info/food-farming-fisheries/key-policies/common-agricultural-policy/new-cap-2023-27_en
[2] https://agridata.ec.europa.eu/extensions/DataPortal/cmef_indicators.html
[3] https://ec.europa.eu/info/food-farming-fisheries/key-policies/common-agricultural-policy/financing-cap/financial-assurance/managing-payments_en
[4] https://ec.europa.eu/info/food-farming-fisheries/farming/facts-and-figures/farms-farming-and-innovation/structures-and-economics/economics/fadn_en

 

technologies (Freire et al., 2019). The development of such automated monitoring systems is expected to reduce the number of OTSCs, fulfilling the EC commitment to modernise and simplify the IACS processes within the CAP framework. Each EU member state paying agency has been responsible for at least 5% of the physical OTSCs, which is both time-consuming and expensive (Navarro et al., 2021).

There are various challenges that need to be addressed towards the integration of the various technological solutions. For example, Earth Observation (EO) technologies are the key for large scale monitoring solutions. However, they still can't perform adequately in respect to small area parcels (<1ha) that for example dominantly characterise the holdings of farmers in South-East Europe. In addition, their performance is affected by weather parameters e.g., cloud coverage, which is often the case at North European countries. Additional challenges with regards to the exploitation of agricultural data streams from innovative sources are related with the data sharing regulatory environment, including issues like data ownership, data privacy, and data secrecy. Another crucial issue halting the exploitation of existing data flows to a maximum extent is the technical and semantic interoperability of systems as well as the heterogeneity in terms of data models and data exchange mechanisms.

The MEF4CAP project – in the context of WP2 – aims to create an inventory of ICT based solutions that demonstrate strong potential toward the further digitalisation of agricultural sector and that can contribute to CAP monitoring and evaluation mechanisms. Towards this scope, a series of liaison activities have been initiated with related projects, initiatives, and organisations. The overall objective of the collaboration activities is to capture relevant agricultural technological developments that are still on an early stage but have the potential to be adopted on large scale in the years to come.

Summarising, Task 2.1 performed a thorough state of the art review mainly of already published scientific articles and technical reports on agricultural technologies that are already in use across the EU. Task 2.2 aims to capture technological developments that are not yet widely deployed or that still are under research and development. To this end, a series of direct interactions with the selected EU projects and organisations were realised aiming to identify if and how their outcomes can directly or indirectly be exploited towards the digitisation of monitoring and evaluation frameworks for the future CAP. In addition, and in order to provide a more complete overview of the ongoing research activities on areas relevant to CAP monitoring and evaluation, the review is extended in recording developments on the use of ICT technologies for the needs of livestock management considering animal welfare. In a similar manner, recent development on satellite-based Earth Observation research outcomes on EU level are reviewed.

 

# 3. Collaboration targets

From an early stage and during the description of work preparation of the MEF4CAP action an initial list was created with targeted EU projects that were considered as the most prominent in providing significant outcomes towards the digitisation of monitoring and evaluation frameworks for the future CAP. During the Task 2.2 execution, this initial list was revised and all MEF4CAP partners were asked to contribute with their knowledge on significant ongoing efforts that are of interest for MEF4CAP project objectives. MEF4CAP partners proposed potential targets along with the respective rationale for establishing the collaboration channel. Given that D2.3 is a living document and that it was made available to all partners on the MEF4CAP project's file sharing repository, the document was also utilised for collaboratively recording the potential liaison targets and the ongoing liaison activities. After various iterations and revisions that took place with the exchange of emails and virtual meetings, the final list of initiatives and projects that MEF4CAP project targeted for collaboration is presented in table 1. The table contains the name of the initiative, a short description of the initiative focusing on parts that are related with MEF4CAP's objectives, the project partner that proposed the collaboration and details on the collaboration status.

*Table 1. Targeted initiatives for liaison with MEF4CAP project*

| **Initiative name** | **Short descriptions** | **MEF4CAP partner** | **Collaboration status** |
|---|---|---|---|
| H2020 DEMETER<br><br>Building an Interoperable, Data-Driven, Innovative & Sustainable European Agri-Food Sector | The H2020 DEMETER (https://h2020-demeter.eu/) is a large-scale project deployed in 18 countries, 15 of which are EU Member States. The project will analyse data obtained from a wide range of actors (production sectors and systems) to provide an integrated interoperable data model enabling optimal resource management in the European agri-food sector.<br>More specifically, the project focuses on interoperability across data, platforms, services, applications and online intelligence, as well as human knowledge tailored to the needs of the agri-food sector. To this end, the DEMETER project released the initial version of the Agricultural Information Model (AIM) which aims to be a common data model and to enable semantic interoperability between DEMETER and existing agri-food systems and ontologies.<br><br>IA - Innovation Action<br><br>Start Date: 1 September 2019<br>End Date: 28 February 2023 | NP | **Established-** Meeting took place on 24/05/2021 |
| H2020 ATLAS | The H2020-Atlas (https://www.atlas-h2020.eu/) is a sister project with DEMETER having as main objective to address the lack of data interoperability in agriculture by combining the use of agricultural | Agroapps | The collaboration didn't take place. There is |

 

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| Agricultural Interoperability and Analysis System | equipment with sensor systems and data analysis. The project will address the lack of data interoperability in agriculture by combining the use of agricultural equipment with sensor systems and data analysis. The ATLAS platform aims to deliver a service offering hardware and software interoperability using data from sensors to demonstrate the benefits of digital agriculture in a wide range of sectors affecting modern agriculture.<br><br>IA - Innovation action<br><br>Start Date: 1 October 2019<br>End Date: 31 March 2023 | | an overlap with the sister project H2020-DEMETER |
| H2020 ENVISION<br><br>Monitoring of Environmental Practices for Sustainable Agriculture Supported by Earth Observation | The H2020 - ENVISION project (https://envision-h2020.eu/) contributes in the achievement of CAP's environmental objectives, offering the tools for the continuous, large scale and uninterrupted monitoring of farm management activities with regards to sustainability.<br>The project will design a toolbox to monitor service of sustainable agricultural practices all year round. It will use in situ, open data and historical information as well as data made available by the Global Earth Observation System of Systems (GEOSS) and Copernicus, which builds on a constellation of satellites making frequent daily observations. This information will be used to develop cultivated crop type maps and to monitor soil organic carbon, vegetation status and crop growth. The toolbox will be tested and validated in a preoperational environment by potential future customers of its products and services.<br>These tools reinforce the monitoring of environmental and climate-friendly agricultural practices stemming from EU policy ensuring that the agricultural activities do not severely impact the climate and nature.<br><br>IA - Innovation action<br><br>Start Date: 1 September 2020<br>End Date: 31 August 2023 | Agroapps | **Established-** Meeting on 4/6/2021 |
| OGC | The Open Geospatial Consortium (OGC) is an international consortium of more than 500 businesses, government agencies, research organisations, and universities driven to make geospatial (location) | NP | The collaboration didn't take place as OGC participates in |

 

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| | information and services FAIR - Findable, Accessible, Interoperable, and Reusable.<br><br>OGC Agriculture Domain Working Group (DWG) https://www.ogc.org/projects/groups/agriculturedwg<br><br>The purpose of this Working Group is to:<br>• Provide a forum for discussion and documentation of interoperability requirements for a given information or user community.<br>• Provide a forum to discuss and recommend document actions related to Interoperability Program Reports.<br>• Develop Change Request proposals (CR's) for existing OGC Standards.<br>• Develop engineering reports with the intent to seek for approval by the TC for release of these documents as OGC White Papers, Discussion Papers or Best Practices Papers.<br>• Provide a forum for development of concepts relating to testbed, pilot, and interoperability experiment activities in the agricultural domain<br>• Host informational presentations and discussions about the use of adopted OGC Standards in the agricultural market. | | DEMETER project. OGC representatives participated in collaboration meeting with DEMETER |
| Joint Research Centre - JRC | JRC/CBM is a set of scripts to perform monitoring on agricultural parcels with Sentinel 1 & 2 developed by JRC in support to Member States implementing Checks by Monitoring. It is an alternative to ESA SEN4CAP and is maintained by JRC Geo-CAP team (https://github.com/ec-jrc/cbm). | ITACyL | This meeting didn't take place. Discussion topics are covered from collaboration meeting with FaST |
| DG AGRI, DG DEFIS, DG DIGIT "FaST- Farm Sustainability Tool" | Supported by the European Commission's DG Agriculture and Rural Development (DG AGRI), the Defence Industry and Space (DG DEFIS) and by the EU ISA2 Programme (DG DIGIT), the FaST digital service platform (https://fastplatform.eu/) will make available capabilities for agriculture, environment and sustainability to EU farmers, Member State Paying Agencies, farm advisors and developers of digital solutions.<br>The FaST platform solutions aims to take advantage of Europe's space capabilities – Copernicus and Galileo - to help farmers sustainably manage their holdings. Through a core service ensuring the minimum functionality described in the Regulation, the solution will ensure that farmers will be supported digitally in | ITACyL | **Established-** Meeting on 6/7/2021 |

 

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| | their farm management and compliance requirements regarding nutrient management and further sustainability objectives. The Farm Sustainability Tool (FaST) would integrate relevant legal obligations and return publicly-held data, including space data, as useful information to the farmers, while supporting two-way communication with public authorities and the integration of digital solutions in the field.<br>FaST will help lay the foundations of a comprehensive digital ecosystem for sustainable farm and land management in Europe. It will support farmers in their administrative decision-making processes, for farm profitability and environmental sustainability. At the same time, it will provide a reliable on-farm landing spot for digital solution developers (including satellite-based solutions) and service providers. It will reduce administrative burdens for farmers and Paying Agencies, and streamline communication between the farmers and public authorities.<br><br>Start Date of FaST phase 2: June 2021<br>End Date of FaST phase 2: May 2022 | | |
| INEA - Open IACS<br><br>Open LOD platform based on HPC capabilities for Integrated Administration of Common Agriculture Policy | Open IACS (https://open-iacs.eu/) is a project is funded by the EC through the Executive Agency for Innovation and Networks (INEA). Project partners are a group of Paying Agencies, research experts and an HPC group with high experience. Open IACS general objective is to support the generation, aggregation and cross-border reuse of open datasets, increase the capabilities of HPC (High Performance Computing) and the data capabilities of the European data infrastructure, and promote the use of HPC and data across borders in the public interest.<br>The project will provide a true and open community platform for sharing solutions in the IACS domain though the Linked Open Data (LOD) paradigm. Open IACS infrastructure will facilitate the end-user access to HPC capabilities by means of automated management of service level agreement that assure the appropriate planning and allocation of resources among the HPCs hosting and the possibility to assign jobs seamlessly to the different providers included in Open IACS's HPC infrastructure.<br><br>Start Date: 1 September 2019<br>End Date: 31 August 2022 | NP | **Established-** Meeting on 9/7/2021 |

 

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| H2020<br>MIND STEP<br><br>Modelling Individual Decisions to Support the European Policies Related to Agriculture | MIND STEP (https://mind-step.eu/) is a European research project aiming to improve exploitation of available agricultural and biophysical data. The project will make use of agricultural and biophysical data and include individual decision making (IDM) unity in new and existing policy models for impact assessments. Using agricultural statistics and big datasets, the new IDM models will be estimated and calibrated, drawing on established economic and evolving machine learning techniques.<br>The overall ambition of MIND STEP is to support public decision making in agricultural, rural, environmental and climate policies, taking into account the behaviour of individual decision-making units in agriculture and the rural society.<br><br>The MIND STEP specific objectives are:<br>• to develop a highly modular and customisable suite of Individual Decision Making (IDM) models focusing on behaviour of individual agents in the agricultural sector to better analyse impacts of policies,<br>• to develop linkages between the new IDM models and current models used at the European Commission to improve the consistency and to broaden the scope of the analysis of policies,<br>• to develop an integrated data framework to support analysis and monitoring of policies related to agriculture,<br>• to apply the MIND STEP model toolbox to analyse regional and national policies and selected EU CAP reform options and global events affecting the IDM farming unit, working together with policymakers, farmers and other stakeholders,<br>• to safeguard the governance and future exploitation of the MIND STEP model toolbox.<br><br>RIA - Research and Innovation action<br><br>Start Date: 1 September 2019<br>End Date: 31 December 2023 | WUR | **Established-** Meeting on 10/9/2021 |
| H2020 DIONE<br><br>Advanced monitoring for modernising CAP | The EU-funded DIONE project (https://dione-project.eu/) offers a unique fusion of innovative technologies that improves the workflow of agricultural monitoring. DIONE project is developing a direct payment controlling toolbox for Paying Agencies to abide by the modernised CAP regulations, involving novel techniques that will improve the | NP | **Established-** Meeting on 29/9/2021 |

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| | capabilities of satellite technology while integrating various data sources (drones, soil sensors and mobile applications). At the same time, a machine learning-based system developed on a regional or national scale will evaluate the monitored parameters to form evidence-based conclusions regarding eventual environmental impacts on an entire region.<br><br>IA - Innovation action<br><br>Start Date: 1 January 2020<br>End Date: 30 June 2022 | | |
| H2020 NIVA<br><br>New IACS Vision in Action | NIVA project (https://www.niva4cap.eu/) delivers a suite of digital solutions, e-tools, standards and good practices for e-governance and initiates an innovation ecosystem to support further development of IACS that will facilitate data and information flows.<br>The monitoring systems that are developed within NIVA are making use of remotely sensed, farm-level and field-level data.<br>NIVA aims to modernise IACS by making efficient use of digital solutions and e-tools, by creating reliable methodologies and harmonised data sets for monitoring agricultural performance while reducing administrative burden for farmers, Paying Agencies and other stakeholders.<br><br>This overall objective is made operational through a number of specific objectives:<br>• Integrate and reuse IACS evolutions based on open standards and common services<br>• Build on farmers' acceptance of the Smart Monitoring methodology<br>• Reduce the gap between current use and potential broader use of IACS data<br>• Create a permanent exchange platform for discussion and exchange<br><br>IA - Innovation action<br><br>Start Date: 1 June 2019<br>End Date: 31 May 2022 (likely to be extended for 6 months) | WUR (WENR) | **Established-** Various MEF4CAP partners (WUR, NP, ITACyL) also participate in NIVA project.<br><br>A first set of results from NIVA are directly mediated to MEF4CAP through these partners.<br><br>Further collaboration actions and transfer of results from NIVA project will be realized. |

As a first step and in order to establish a communication channel, an invitation-to-collaboration email was send to representatives of each targeted project. The letter is available in Annex A. After a positive reply, a doodle poll was set up in order to identify a common accepted date. A proposed agenda was specified and send by MEF4CAP representatives to the meeting

 

participants. In general, collaboration meetings were held online (due to COVID-19 restrictions) and organised to have a duration of approximately one hour.

All meetings were organised and realised based on the following schedule/agenda:

- Introduction of participants
- Agenda presentation
- Short presentation of MEF4CAP and objectives - rationale for this meeting
- Short presentation of the invited project's objectives
- Presentation and Q&A on selected topics that the invited project members elaborates on and that are of interest for MEF4CAP project's objectives
- Open discussion
- Closing of the meeting

After the completion of the meeting, detailed minutes where extracted and made available through the living document to all MEF4CAP participants.

 

# 4. Liaison activities' outcomes

This section presents an analysis of the currently available results from the targeted projects that are of interest for the MEF4CAP objectives. The outcomes of each project reported here are derived from two main sources:

a) Review of already published results. The main sources of information are published deliverables, information available at project's website, and presentations (slides) available from various public events.

b) Analysis of the meeting minutes recorded during the sessions (on-line meetings) organised with the MEF4CAP project.

Besides the analysis of these two sources of information, a short summary of outcomes is provided for each project, including also the relevance of the project's objectives with MEF4CAP and the potential for future collaboration activities.

## 4.1 H2020 DEMETER project

The call took place on the 24th of May 2021 at 11:00 CEST with 14 attendees representing MEF4CAP and H2020 DEMETER projects and lasted approximately one hour and a half.

The meeting Agenda was:

- Introduction
- Presentation of MEF4CAP (10 minutes)
- Presentation of DEMETER (10 minutes)
- Semantic interoperability & Data sharing (30 minutes)

With indicative discussion topics:

  - DEMETER's data and system interoperability mechanisms
  - Field Sensors
  - Farm Calendars
  - Adoption perspectives and challenges

The call started with a quick introduction of all attendees followed by a brief presentation of the two projects respectively. Following are some relevant slides from the presentations.

 

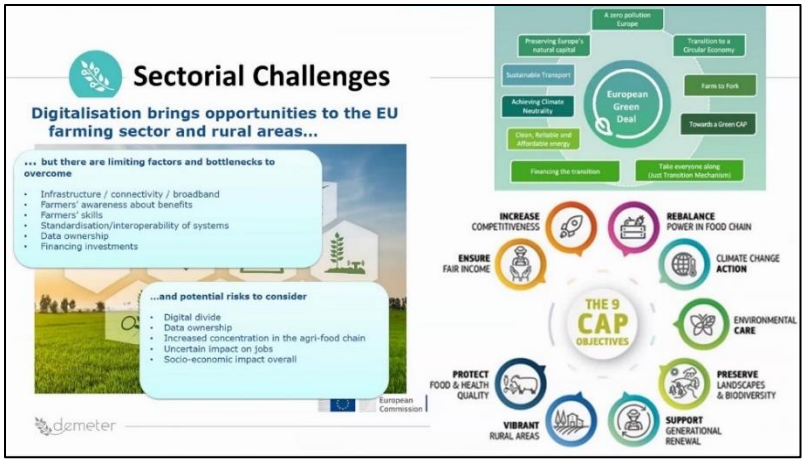


*Figure 1. DEMETER's sectorial challenges regarding the new CAP*

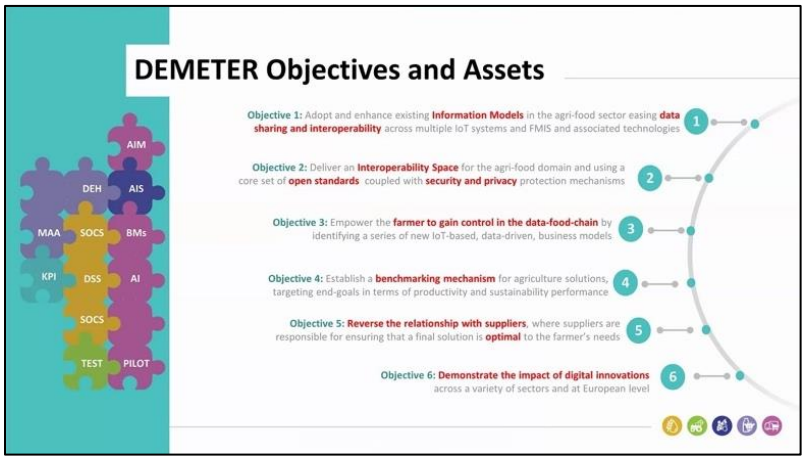


*Figure 2. DEMETER's objectives and assets*

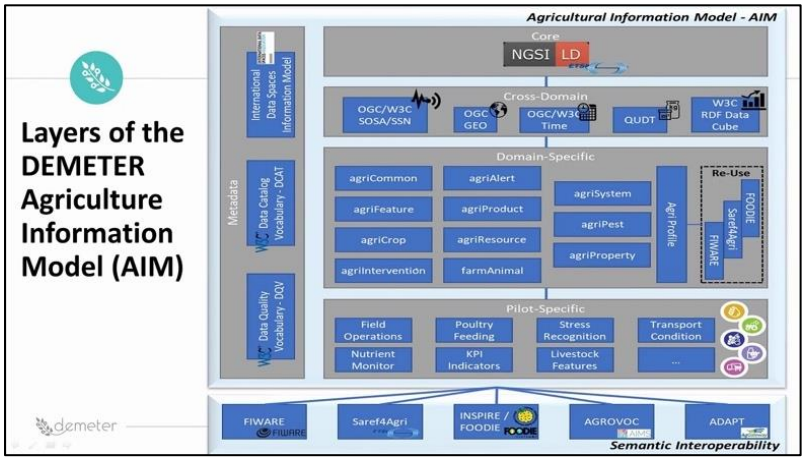


*Figure 3. Layers of the DEMETER Agriculture Information Model (AIM)*

 

After the completion of the presentation session, the discussion focused on DEMETER's approach on the topics of semantic interoperability and data sharing in the agri/tech-food sector. The productive discussion between participants led to examining DEMETER's potential to support semantic interoperability needs for the digitisation of monitoring and evaluation frameworks for the future CAP.

**Key technical outcomes:**

The H2020 DEMETER (https://h2020-demeter.eu/) project is a large-scale deployment of farmer-driven, interoperable smart farming-IoT based platforms, delivered through a series of 20 pilots across 18 countries (15 EU Member States). Involving 60 partners, DEMETER adopts a multi-actor approach across the value chain, with 25 deployment sites, 6,000 farmers and over 38,000 devices and sensors being deployed.

DEMETER aims to facilitate the further adoption of advanced technologies (IoT, AI, EO, Decision Support) in order to increase performance in multiple aspects of farming operations. 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.

Until today only two deliverables are publicly available from the DEMETER project: "D3.1 DEMETER reference architecture - Release 1[5]" and "D2.1 Common data models and semantic interoperability mechanisms[6]". Deliverable D3.1 presents a conceptual Reference Architecture facilitating data sharing in heterogeneous ecosystems of agricultural technologies. According to D3.1, in order to implement this Reference Architecture several key technologies need to be developed. The most crucial of these is the common data models which make the DEMETER Agricultural Information Model (AIM) and which enable semantic interoperability between DEMETER and existing agri-food systems and ontologies. AIM's specification is available at Deliverable 2.1.

[5] https://h2020-demeter.eu/wp-content/uploads/2020/10/D3.1-DEMETER-reference-architecture_v1.0.pdf
[6] https://h2020-demeter.eu/wp-content/uploads/2020/10/DEMETER_D21_final.pdf

 

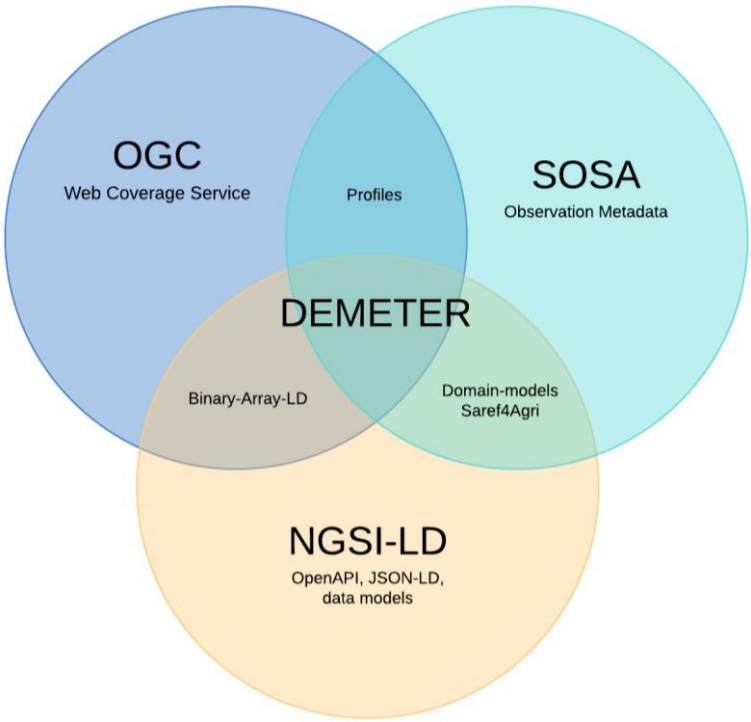


*Figure 4. Reuse of existing standards towards semantic interoperability by H2020-DEMETER project*

According to D2.1, AIM adopts a modular approach and is based on a rich set of related standards or dominant solutions. AIM distinguishes between four main parts, each with a different role: the AIM core metamodel, which builds on and extends the NGSI-LD meta-modelling approach; the AIM cross-domain ontology, i.e., the set of generic models that aim at providing common definitions for not necessarily tied to the agri-food sector and at avoiding conflicting or redundant definitions of the same classes at the domain-specific layer; the AIM domain-specific ontologies that model information related to all domains linked to the agri-food section, such as crops, animals, agricultural products, as well as farms and farmers just to mention a few of the most important concepts included in these ontologies; and finally, the AIM metadata schema that aims to represent and capture any metadata that may be required by DEMETER. DEMETER AIM aims to support interoperability with regards to several existing standards and dominant agri-food data modelling approaches (such as NGSI-LD and FIWARE, Saref4Agri, ADAPT, INSPIRE and FOODIE, AGROVOC and EO data) detailing the semantic mapping of these to AIM (figure 5).

With regards to DEMETER's pilots, it is of interest for MEF4CAP the pilots that are experimenting and evaluating technologies that support the automated recording of farming practices. These technologies demonstrate the potential of in-situ data collection that can also be utilised for improving the recording and reporting of applied inputs (e.g. fertilisers, pesticides) towards a more optimised CAP indicators' monitoring methodology. Such a pilot is "PILOT 2.2 Automated Documentation of Arable Crop Farming Processes[7]", however no results are yet published from any pilot of DEMETER project.

[7] https://h2020-demeter.eu/pilots-overview/pilot-cluster-two/automated-documentation-of-arable-crop-farming-processes/

 

Based on the **MEF4CAP - DEMETER session,** the following outcomes are identified:

The DEMETER project focuses on systems and data interoperability for the various digital solutions of the agriculture sector through the use of semantic and syntactic interoperability mechanisms. The DEMETER project introduces the Agricultural Information Model (AIM) which aims to reuse upper-level ontologies in a complementary manner with domain specific ontologies. The DEMETER's approach allows to bridge the gaps that occur through the use of different -sometimes parallel- standards that "pop up" and are applicable to different application domains. The AIM is a "living model" that allows to integrate new terms and ontologies that are currently missing in order to extend the range of standards and models that they are compatible with. This approach affects the sustainability of the model as it is extensible and flexible so that it can be adapted and reused in the future even after the lifetime of the project. In addition, the persistent identification of the ontology provides a permanent way of identifying the ontologies concepts making them independent and beyond the project's lifetime.

As it is already stated, DEMETER project realises a number of pilots where various technologies are implemented. One of the pilots that is of interest for the MEF4CAP's objectives focuses on pesticides applications and their automated documentation in the context of CAP monitoring. There is keen political interest in the use of pesticides and the Farm-to-Fork strategy has specific ambitions to reduce the pesticide use. In addition, statistics offices do collect data on pesticide use but it is a huge administrative burden for farmers. There are also doubts about the quality of the provided data from the farmers. The tested technological approach is promising but there are various weak spots that are identified. For example, it is difficult to record and cross-check what the farmer has actually in the tank with the spraying liquid.

**Demeter project's outcomes that are of interest for MEF4CAP are mainly related with data and system interoperability of agricultural solutions but also with regards to the agricultural technologies that are introduced or tested within DEMETER's pilots. Interoperability is considered as a prerequisite for facilitating farm-level data sharing from the various operational ICT systems that support farmers on everyday tasks. Further interactions and exchange of results will be realised with DEMETER when the respective deliverables of interest will be publicly available. However, DEMETER project is not considered as a project that is directly related with CAP monitoring technologies/solutions.**

## 4.2 H2020 ENVISION project

The call took place on the 4th of June 2021 at 14:00 CEST with 12 attendees representing MEF4CAP and H2020 ENVISION projects and lasted approximately one hour.

The meeting Agenda was:

- Introduction
- Presentation of MEF4CAP (10 minutes)
- Presentation of ENVISION (10 minutes)
- Elaboration on ENVISION's Data Products in support of future CAP data needs (20 minutes)

 

- How ENVISION handles key challenges on agricultural data collection (20 minutes)

  <u>With indicative discussion topics:</u>

  - Integration of heterogeneous data and Semantic interoperability
  - Data ownership
  - Diverse maturity level on applied agri-technologies
  - Future steps

The call started with a quick introduction of all attendees followed by a brief presentation of the two projects' objectives respectively. Following are some relevant slides from the presentations.

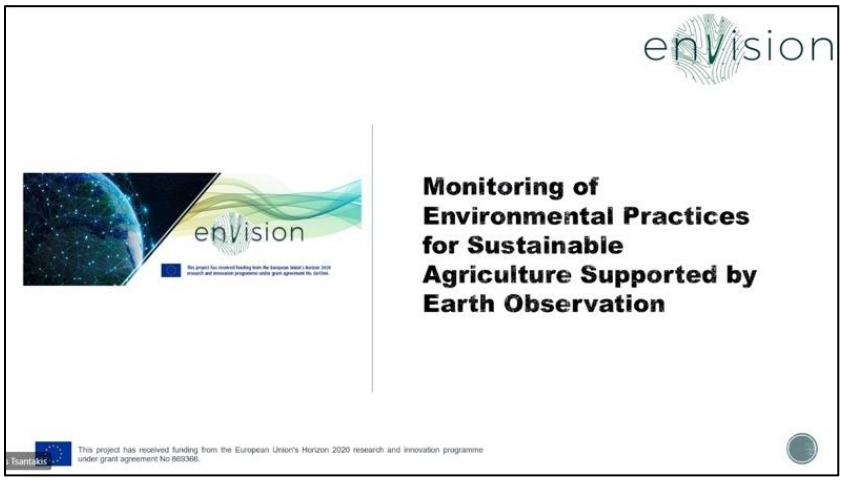


*Figure 5. ENVISION's aim*

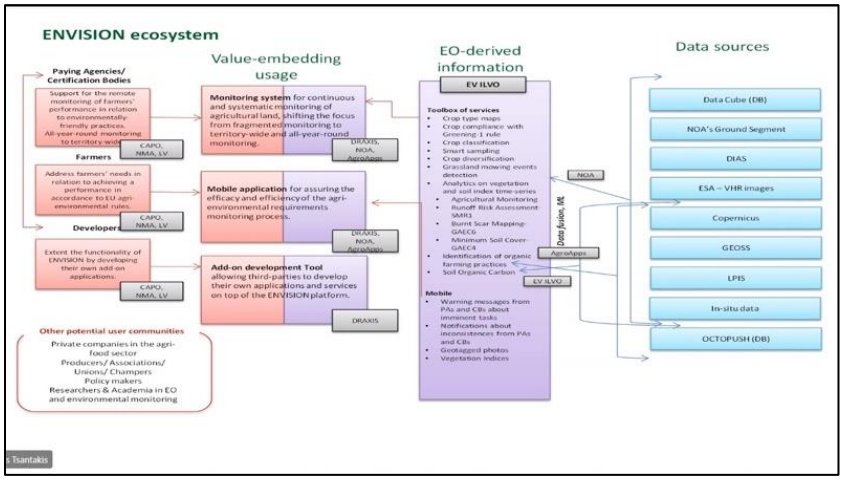


*Figure 6. ENVISION's ecosystem*

 

After the completion of the presentation session, the discussion focused on ENVISION's approach on Data Products in support of the future CAP data needs as well as how ENVISION project handles key challenges regarding the issue of agricultural data collection.

**Key technical outcomes:**

ENVISION project develops and tests innovative tools for the continuous, large scale and uninterrupted monitoring of farm management activities with regards to sustainability, in compliance with the CAP's agri-environmental objectives. The developed tools are integrating data from the following sources: In-Situ Data, Databases, Copernicus EO data, while the targeted data products are related with: Cultivated Crop Type Maps, Soil Organic Carbon, Organic Farming, Grassland Mowing/Ploughing, Soil Erosion. The developed services are targeting the following type of users: Paying Agencies (Web platform), Certification Bodies (Web platform), Farmers (Mobile App), Third-Party developers (Add-on Development tools).

ENVISION has published "D4.1 Architecture and Services Specifications report[8]" which provides the specifications of the tools that are under development by this project. Based on this deliverable, a short summary of the tools that are in relation with MEF4CAP's objectives follows.

**Service: Cultivated Crop type Maps.** The Cultivated Crop Type Maps is an Earth Observation (EO) crop classification module that exploits satellite data along with the usage of Machine Learning techniques in order to provide products related to the validation of the declared crop type by a farmer. In addition, it provides the knowledge of the compliance with certain environmental rules such as Greening requirements. Thus, it can be used from the Paying Agencies as a tool to enhance the process of checking the declarations of the farmers at the time of declarations, but also to assist via smart sampling of parcel to be checked during the validation process (OTSCs). This can be achieved as the service that informs the PAs about the parcels that have a high probability of being wrongly declared.

The Crop Diversification Service exploits the Land Parcel Information System (LPIS) and the declarations of the farmers. Thus, it will monitor crop types included in the aforementioned files and it will make a merge of crop types if the exhaustive process cannot distinguish between two or more of them. As a result, the predicted crop type of each declared parcel will be generated along with a percentage of prediction's confidence and it will be used as indicator for the declaration process. Last but not least, taking into account last year's farmers declarations, this service will be able to point out possible Land Use/Land Cover (LULC) changes, if they exist.

- **Targeted users: Paying agencies**. The service will provide them with continuous information about the crop type of each parcel. The first classification process will take place early in the year in a higher level giving the potential for the agencies to check the validity of the declaration. Then, multiple executions of the service will produce results in a lower level for each declared crop type. Thus, it can assist the Paying Agencies in decision-making as it allows them to make targeted inspections of parcels in shorter time periods so to validate the declared crop type.

[8] https://envision-h2020.eu/wp-content/uploads/2021/04/D4.1-Architecture-and-Services-Specifications-report.pdf

 

- **Input data** - The input data required are EO data and Paying Agencies' data to derive crop information:
    - Satellite: Sentinel-2 L2A, Sentinel-1
    - Products: Spectral bands, backscattering coefficients, coherence (if needed), Vegetation Indices (VIs)
    - Paying agencies: Declared Crop Type, Validated Crop type, Polygon data
- **Output data** - The service will provide:
    - Crop type maps as a shape file over the registered parcels early in the year grouped in a higher class
    - Crop type maps as a shapefile over the registered parcels in a predefined frequency
    - Compliance information as a shape file over the registered parcels in a predefined frequency

**Service: Grassland Mowing Events Detection**. This service will provide a fully automated identification of Grassland Events module, with a view to assist in the valid and on-time identification of main events taking place in grasslands, such as mowing and grazing (if possible). The service will contribute into the direct supervision of the Paying Agencies of the compliancy of grasslands farmers to the respective regulation of pilot countries regulations and indication of possible declination from them. Given that, PAs will be able to organise and realise more accurate field visit campaigns to more specific locations pinpointed from that service and as a result will drive into the reduction of the inspections cost.

- **Targeted users:**
    - **Paying Agencies**: The service will provide them with continuous information regarding grassland activity of each parcel. This will give PAs the ability to monitor abrupt changes into the field's canopy though the entire cultivation period and track the main events taking place and the respective time-periods. Moreover, given the specific regulations applied from each country, grassland mowing events detection micro-service can assist the PAs in the faster and better identification of farmers' compliance.
    - **Policy Makers**: The service will assist policy makers in taking the best decision on planning the more suitable number of grassland events allowed during the entire cultivation period and to analyse the potential of grassland maintenance.
- **Input data** - The input data required are EO data and Paying Agencies data to derive grassland mowing events detection:
    - Satellite: Sentinel-1, Sentinel-2 L2A, VHR
    - Products: Spectral bands, backscattering coefficients, coherence coefficients, Vegetation Indices (Vis), FAPAR, LAI

 

- Paying Agencies: masked grassland crop type maps, polygon data, mowing regulations for the specific AOI

- **Output data** - Events Map (shapefile) of grassland mowing detection per parcel encapsulating all the extracted information regarding the detected events, their confidence levels and their compliance into the respective mowing regulations.

**Service: Analytics on Vegetation and Soil Index Time-series (AVSIT).** The service aims at providing vegetation and soil indices, along with geospatial analytics such as growth trends, change detection, phenological metrics, soil specific indicators, static indicators with respect to rainfall erosivity and soil erodibility, cover management factor for soil erosion, Natura2000 areas hotspot detection, Burnt Scar Mapping and Runoff Risk assessment for the reduction of water pollution in Nitrate Vulnerable Areas. The final set of subservices remains to be defined after the processing of user requirements.

- **Targeted users:**
  - Paying agencies. The service will provide them with continuous information regarding the parcels cultivation phases and the respective compliance of the current CAP policies. Multiple executions during the entire cultivation period and visualisations of the service will give them a clearer picture of the current farmers' activity. In parallel, the provision of the respective confidence levels will assist them in decision-making as it allows them to make more accurate field inspections (through RS or OTSC) and reduce the cost of field campaigns.
  - Policy Makers. In the dawn of a new POST 2020 CAP, this service can be a valuable supportive tool on the design of new area-specific cross-compliance policies. Policy makers can use this service as a second hand in order to define new regulations focusing on the topical characteristics and specifications of the inspected regions.

- **Input data:** (i) Satellite: Sentinel-1, Sentinel-2 L2A, (ii) Products: Spectral bands, backscattering coefficients, coherence coefficients, Vegetation Indices (Vis), (iii) Auxiliary Shapefiles: e.g LPIS, Agricultural Practices Descriptions, hydrographic networks, Natura2000 regions, etc.

- **Output data**: The service will provide either in file format (GeoTIFF, Shapefile) or via a RESTful API the following: Vegetation Indices, Soil Indices, Maps and Analytics (Phenological Metrics, Growth trends, Change Detection et cetera).

**Service: Identification of organic farming practices.** Plants cultivated under organic and conventional farming principles present bio-chemico-physical differences that can be detectable by satellite imagery, especially during the vegetative and reproductive growth stages. The identification of organic farming practices service will benefit from these differences to discriminate between organic and non-organic (conventional) crops. The logic behind the service is to identify distinct patterns characterising the growth and evolution of organic and conventional crops during the growing season, through the use of both high

 

resolution optical and radar satellite images depicting the phenological status of the cultivated parcels. This service aims to provide a fully-automated Organic crop identification service, which aims at identifying whether a particular crop type declared as organic is classified as such, based on a traffic light system. The service will contribute to replace direct and guide on-field checks for priority control and will result in the reduction of inspections costs and of the Certification Bodies (CBs) administrative burden, thus ensuring targeted and efficient controls and faster delivery of payments/organic certifications to farmers. The service will exploit a number of EO derived indicators and tools to ensure effective monitoring of the crop condition variability and phenological stages, in both space and time**.**

- **Input data:** The input data required are EO data to derive VIs and CBs data to derive crop information.
  - Satellite: Sentinel-2 L2A/Sentinel-1 (EO data)
  - Products: Spectral bands, backscattering coefficients, VIs, Phenology Analytics (Predictor Features)
  - Certification Bodies: Crop Type, Sowing Date, Polygon Data (In Situ Data by the farmer), Farmer's declaration of the cultivation method
- **Output data**: The service will provide maps of decision on the cultivated practices and whether these are organic or conventional over a registered parcel by the end of the growing period or within the growing period, updated every time satellite images are available (Sentinel-2 or Sentinel-1). The product is accompanied with a legend showing the values of "organic", "non-organic", "not classified" (when the decision's accuracy is lower than an acceptable value).

**Service: Soil Organic Carbon (SOC) monitoring.** The SOC service aims to: Deliver Verified top-soil (0-10 cm) qualitative Soil Organic Carbon estimations, Visualise SOC spatial variability at parcel, area, and regional level, and to Support the further collection of SOC measurement data, as a way to improve the SOC model and to validate its results. The service will be used to monitoring CAP's soil requirements (in terms of soil organic carbon) and support the maintenance of soil organic matter level relative to the current and future CAP requirements. End-users may use service results to get insights and information on tillage, drainage, and overall agricultural management practices.

**Input data:**

- SOC Carbon images (Maps) presenting topsoil SOC values at high spatial resolution (10-30 meters)
- LPIS data
- Administration boundaries

**Output data**:

- Synthetic bare soil layer obtained by Sentinel-2 time series (10 m resolution) formatted as Multilayer Raster (GeoTIFF)

 

- SOC content for croplands (10 m resolution) formatted as Raster GeoTIFF
- Average SOC content for each agricultural parcel (including other statistics) formatted as Shapefile

Based on the **MEF4CAP - ENVISION session,** the following additional outcomes are identified:

All services by the ENVISION project are mainly based on EO data products. However, EO is not an efficient approach when handling small agricultural parcels which is the case for many EU Member States located in the south east area (such as Greece, Cyprus, South Italy). This issue is also acknowledged by ENVISION project as all traditional crop classification techniques do not seem to work in Cyprus that has extremely small parcels. Something different is needed in such situations and they are specifically exploring that. In order to address this issue a pixel-based approach or a semi-pixel-based approach as well as buffers are utilised. In addition, ENVISION is also exploring the shift from the traditional machine learning classification approaches utilised by the majority of EO based CAP monitoring projects (e.g. Vector Machines) to more efficient approaches like convolutional neuro-networks. ENVISION also aims to exploit and augment the Sentinel time series by using the Paying Agency's owned very high-resolution data received from the JRC project.

Regarding satellite data and the purchasing of satellite images of higher resolution, ENVISION members consider that these data will definitely play a role in the immediate future. This makes sense because Sentinel images have zero cost but do not resolve 100% of the problems. On the other hand, the monitoring, inspection and controlling of the CAP is substantial. Reducing cost is feasible by allocating financial resources in order the Member States to have access to proprietary and commercial data as well.

In addition, geotagged photos recorded by farmers are already playing an important role in many Member States and they are going to play a key role in future. However, there are many still unresolved issues with the use of UAVs and high resolution images. For example, in project CALISTO a proof of concept pilot is realised using geotagged photos, street level images and UAV images for the monitoring of the paying agencies. The first results showed that UAVs demonstrate limited capabilities due to legal framework, weather conditions, limited flight time, logistics, etc.

With regards to agricultural activity detection, the use of satellite data are currently offering various promising approaches but there are still issues to be resolved. More specifically, grazing in particular is very hard to be detected because it has to do with observing where the animals have passed through. It is not like having a uniform change in the land over the fields. Grassland grazing has very low TRL in comparison with grassland mowing that is operationally used by quite a few paying agencies. Satellite data can also be used for the identification of illegal stubble burning.

**MEF4CAP and ENVISION projects are investigating many topics of common interest. ENVISION project is currently in the process of developing ICT tools specifically for addressing the various challenges towards current and future CAP monitoring. The main information sources that ENVISION tools are exploiting are EO data products. ENVISION project doesn't focus on the various agricultural ICT solutions that provide farm level in-**

 

**situ information (e.g. data logs from machinery, FMIS, farmers' digital calendar). ENVISION is considered by MEF4CAP as one of the most related projects with regards to CAP monitoring and the respective outcomes will be continuously monitored.**

## 4.3 FaST project

The call took place on the 6th of July 2021 at 13:00 CEST with 11 attendees representing MEF4CAP and FaST projects and lasted approximately three quarters.

The meeting Agenda was:

- Introduction
- Short presentation of MEF4CAP's objectives (10 minutes)
- Presentation of FaST project objectives and achievements so far (15 minutes)
- Presentation of FaST tools (15 minutes)

With indicative discussion topics:

  - Challenges that are not currently addressed by FaST - future plans
  - Current adaptation by farmers, operational use of FaST tools - first impressions
  - Next steps for FaST

The call started with a quick introduction of all attendees followed by a brief presentation of the two projects' objectives respectively. Indicative slides from the presentations and other material follow.

 

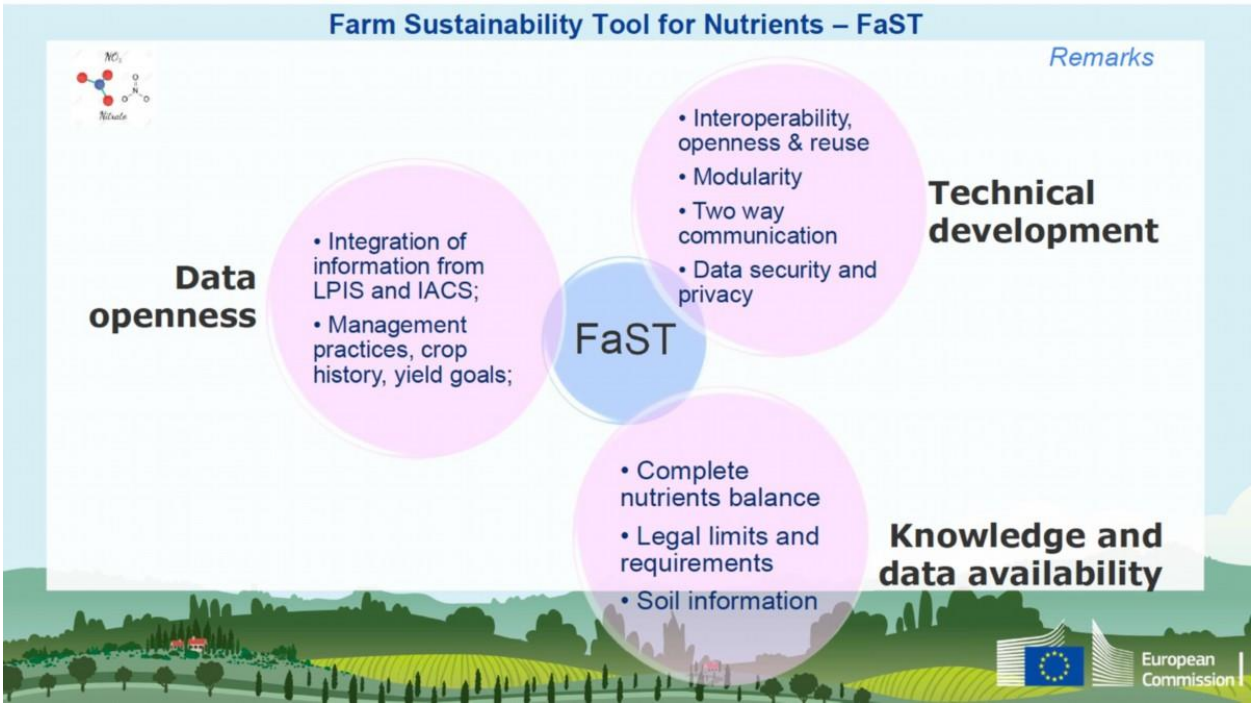


*Figure 7. Elements and functionalities of FaST*


*Figure 8. The FaST tool mobile application*

 

After the completion of the presentations session, the discussion focused on FaST's achievements so far and the project's produced tools such as the FaST mobile application.

**Key technical outcomes:** The FaST[9] v1.0 has already been released and tested to Andalucia, Castilla y Leon, Estonia and Piemonte as a mobile application that embarks the following features in a user-friendly interface:

- Maps overlaying farm data on GIS layers
- Copernicus/Sentinel imagery: RGB+NDVI
- Campaign management with import of IACS/GSAA farmer data
- Fertilisation recommendation
- Geo-tagged photos
- Two-way communications
- Basic weather/climate

The FaST Stage 2 project has been initiated in order to expand the reach of the platform to the farmers of: Wallonia (Belgium), Bulgaria, Greece, Romania, and Slovakia with the support of the respective Paying Agencies. The second stage is expected to be completed by the end of May 2022.

The platform also provides an Administration Portal, where the Paying Agency can access the regional data, configuration and user profiles and a secured API mechanism to remotely connect to the data store.

The vision is for the FaST tool to become a world-leading platform for the generation and re-use of solutions for sustainable and competitive agriculture based on space data (Copernicus and Galileo) and other public and private datasets. The modular platform - when it will be fully developed - aims to support EU agriculture and the CAP by also enabling the use of solutions based on machine learning applied to image recognition, as well as the use and reuse of IoT data, various public sector data as well as user generated data.

According to FaST documentation[10] and in relation to future CAP implementation, this tool will be capable to support the following entities:

- **Farmers**

Farmers will download and upload data from/to the FaST platform and be proposed value-added agri-services that will be displayed right into the FaST application and web portal. The FaST platform will be interfaced with the administrative databases: the farmer's data will be readily available without needed to re-input them.

- **National and Regional CAP agencies**

The largest part of the EU CAP budget is managed and controlled through IACS in Member States, aiming to safeguard the CAP financials and supporting the farmers. The IACS is implemented at national and regional level through the Paying Agencies of each EU Member State. In the post-2020 CAP reform, Member States will be responsible, through their Paying Agencies, for providing a Farm Sustainability Tool to their farmers (GAEC5). At the same time,

[9] https://fastplatform.eu/
[10] https://fastplatform.eu/whyfast

 

satellite EO is seen to take an increasing role in the overall implementation of the CAP, from compliance with legal obligations to the implementation of targeted climate and environment measures. With the FaST, PA will register compliance with GAEC 5 and possibly with further SMRs and GAECs[11]. As the FaST platform will provide access to libraries of code, the tool will be customised by Paying Agencies, to offer additional functionalities or to adapt to Member States specificities. Paying Agencies will also use the tool to communicate directly with the farmers (on CAP declaration campaign for example). It should be noted that this feature is not yet developed.

In addition the tool will support National and Regional CAP agencies in the following domains:

- **Environmental monitoring**

Support to monitoring certain environmental parameters (soil quality, air pollution, nitrogen rate, water quality, etc.). Particular benefit to Nitrogen Vulnerable Zones.

- **Compliance**

Relevant advice that is within the parameters of the CAP, ensuring that farmers who follow this advice both are compliant with the CAP and have a record proving this fact.

- **Increased two-way communication**

Rapid sharing of critical information for farmers, such as warnings on declarations, changes in policies, etc. Farmers can also rapidly reach MA/PAs to inform them of any issues when the need arises.

- **Economies of Scale**

Pooling of resources by many Member States on FaST leads to significantly higher value than individual Member States. Democratic access to these resources levels the playing field across the EU.

- **Digitalisation**

Laying the foundations for digitalisation would be a boon to rural development efforts and small holders by introducing them to new technology. Offering users a portfolio of digital services, allowing them to derive value in ways most relevant to their circumstance.

With regards to integration with national/local IACS, the following process is specified[12]:

In order to provide data access to the farmer, FaST connects to the regional/national IACS system (or equivalent farm registry), where the data of the farmer is stored. This data is usually derived from the GSAA (geospatial aid application) of the farmer from the previous year. The data that FaST will need to be able to propose services to the farmer only includes agricultural data: parcel geometries (polygons), previous crops and varieties. The datasets are "pulled" into FaST but never pushed back into the IACS system. Once the data are inside FaST, the farmer has the possibility to edit it in FaST without any impact to his IACS/GSAA data.

[11] A full list of GAECs is available here: https://marswiki.jrc.ec.europa.eu/wikicap/index.php/Good_Agricultural_and_Environmental_Conditions_(GAEC)
[12] https://gitlab.com/fastplatform/docs/-/blob/master/journey_doc/journey_doc.md

 

Based on the **MEF4CAP - FaST session** the following additional outcomes are identified:

The FaST platform integrates data from multiple sources such as Earth Observation data (i.e. satellite imagery and navigation) and climate providers' APIs and is operational for both farmers and public authorities. In addition it integrates the following "static" information[13]:

- Soil data: necessary to provide default soil information to users and to be used as default values in the fertilization algorithms
- Surface waters and water courses: necessary for display, to compute constraints and nitrogen limitations that depend on water body proximity
- Nitrate Vulnerables Zones: necessary for display, to compute constraints and nitrogen limitations that depend on being within an NVZ
- Natura2000 areas: mostly for display and to comute constraints
- List of plant species and varieties: this is the list of crop that will be used by all users in your region/country. This list can be different from the IACS crop nomenclature or from the way crops are described within your fertilization algorithm: however, in both cases, you will need to provide a mapping table between each nomenclature.
- List of fertilizer products: if your fertilization algorithm produces actual fertilizer product recommendations (in addition to chemical element recommendation, such as N, P & K), then you should provide a base list of fertilizer products, either organic or mineral
- Legal limits for nitrogen and conditions that apply to each limit, such as crop yield or NVZ

As it is stated, these data sources are considered as "static" because they are not expected to change often and do not depend on user input. It does not mean that they will be fixed forever.

The platform currently supports nutrients/fertilisation advice and management but in the future it will also support water management sources as well as other environmental data. More specifically, the platform supports nitrate management advice which is aligned with the specific policy applied till today and in line with the paying authorities.

Regarding data standards, the platform uses the ALISE standard. They use the dual spatial vocabulary which is maintained by the joint Research Centre of the Commission and the core elements of this vocabulary are extended with more specific and relevant ones for the FaST platform.

As far as privacy issues are concerned, they are obliged to implement privacy regulations on their performed activities. A key issue is that the farmers' explicit consent is needed for the data that is to be shared. No personal data is shared from farmers except for the initial information they provide. It should be added as well that no country has access to others' country data and the same happens to regional level and between Paying Agencies as well (i.e. each group has its own set of data).

**FaST is considered as highly related with MEF4CAP's objectives. The use of tools like FaST that are designed to be utilised by individual farmers in order to both provide data to regional agencies but also for the farmers to receive advice (e.g. fertilisation) is of high importance towards the realisation of mutualisation-of-resources vision. FaST tool is**

[13] https://gitlab.com/fastplatform/docs/-/blob/master/journey_doc/journey_doc.md#integration-of-static-data-sources

 

**already in use in a number of countries, however there are still no clear outcomes with regards to farmer's adoption (e.g. number of farmers that are utilising the tool, data volumes exchanged, efficiency of using the app from the farmers' perspective but also from the PAs). It must also be noted that not all the designed features are yet implemented and tested (e.g. provision of data by the farmers to regional agencies). These outcomes would be of high importance for evaluating the FaST's tool approach. Both projects agreed to continuous collaboration with further exchange of information and results.**

## 4.4 Open IACS project

The call took place on the 9th of July 2021 at 13:00 CEST with 11 attendees representing MEF4CAP and Open IACS projects and lasted approximately 50 minutes.

The meeting Agenda was:

- Introduction
- Short presentation of MEF4CAP's objectives (10 minutes)
- Short presentation of Open IACS's objectives – achievements so far (15 minutes)
- Data sharing in the context of Future CAP - Open IACS's approach (20 minutes)

With indicative discussion topics:

  - Which data types/information items are considered as useful for IACS?
  - How IACS can access and use these data? Technical/Semantic interoperability.
  - How "Open IACS" project handles farmer's data ownership? Farmer's reluctance to share data?
  - ICT solutions for Landscape Monitoring
  - Any other issues

The call started with a quick introduction of all attendees followed by a brief presentation of the two projects' objectives respectively. Following are some relevant slides from the presentations.

 

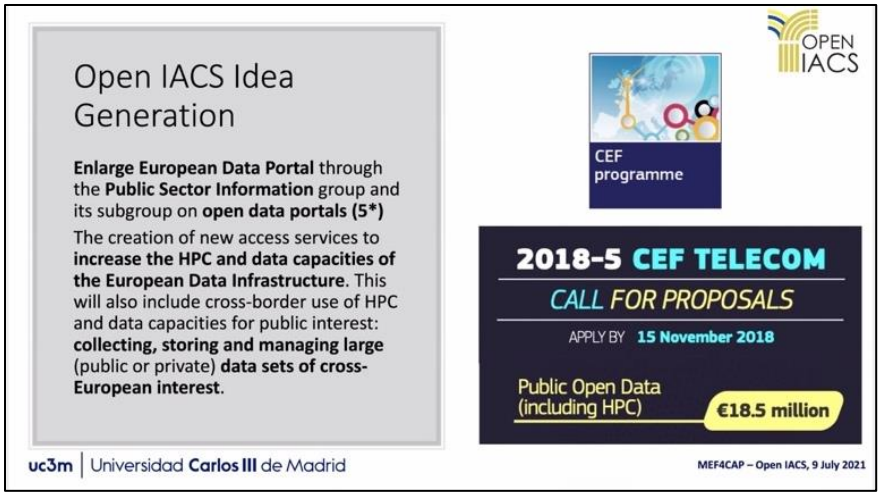


*Figure 9. Open IACS's Idea Generation*

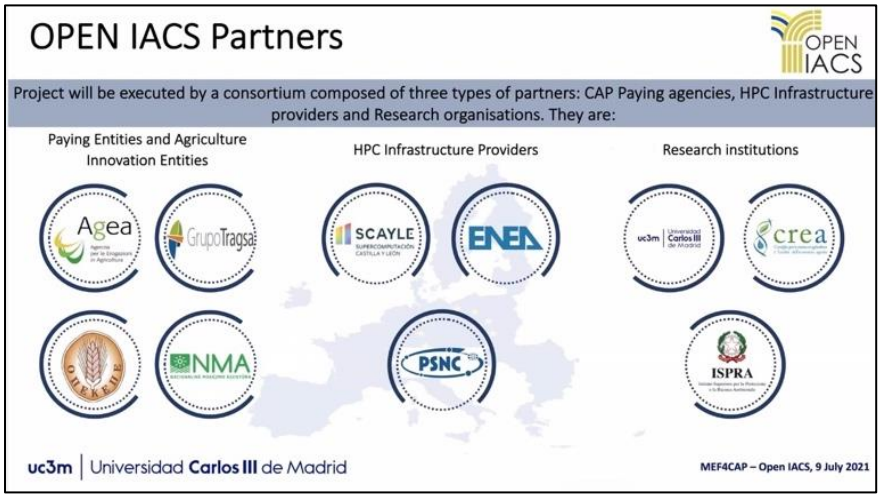


*Figure 10. Open IACS's project partners*

 

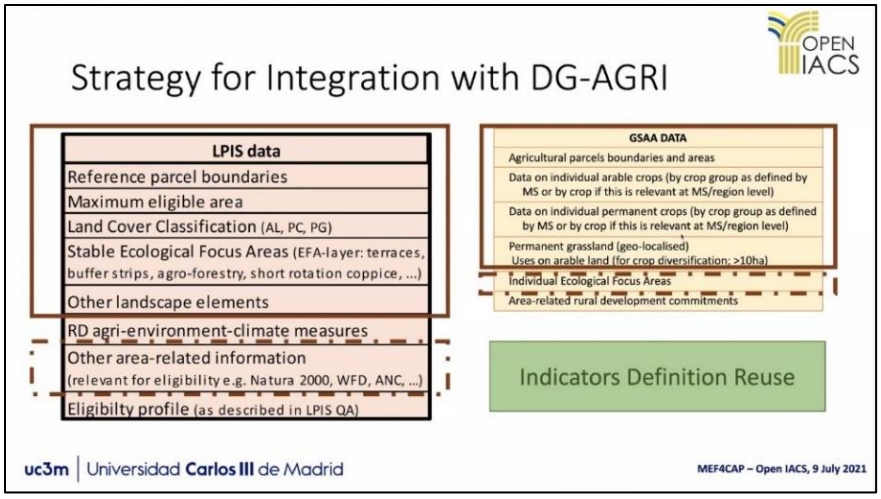


*Figure 11. Open IACS's strategy for Integration with DG-AGRI*

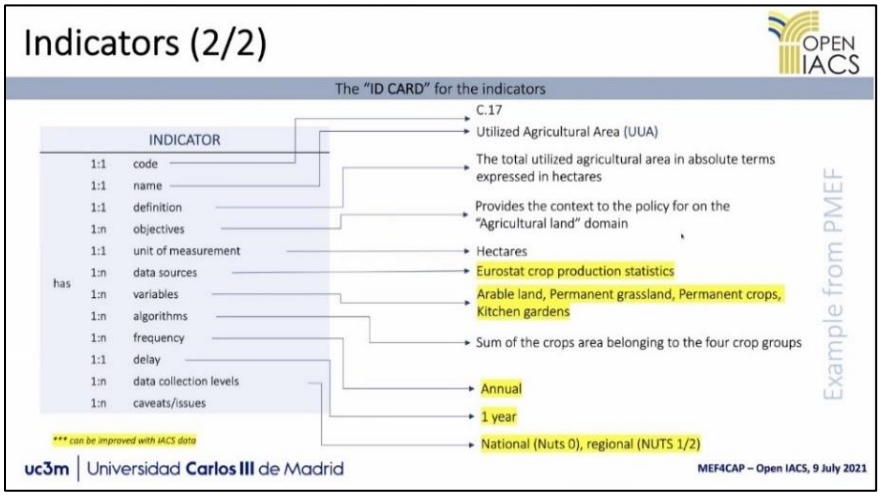


*Figure 12. Open IACS's "ID CARD" for the indicators*

After the completion of the presentation session, the discussion focused on Open IACS's achievements, how they handle issues of Technical/Semantic interoperability and farmer's data ownership, their view regarding ICT solutions for landscape monitoring as well as the produced project results.

**Key technical outcomes:**

The main technical goal of Open IACS project is the creation of a common infrastructure for agri-environmental governance of the CAP. In doing so, the action will provide an open community platform for sharing solutions in the IACS domain for the CAP through the Linked Open Data paradigm. This will include generic services to facilitate end-user access to HPC capabilities by managing different HPC providers via a technological architecture that processes service level agreements to seamlessly assign jobs to the different providers involved in Open IACS infrastructure.

 

More specifically, Open IACS project aims to:

- Design a network of interoperable Linked Open Data (LOD) End-points considering information for Agri-environmental management of IACS policies.
- Implement the common agri-environmental LOD infrastructure for IACS policy management by means of increasing HPC capabilities.
- Demonstrate the usefulness of this infrastructure through its application in different scenarios.

The project has not publicly published any deliverables with results yet.

Based on the **MEF4CAP - Open IACS** the following additional outcomes are identified:

Open IACS project is collaborating directly with paying agencies. They have defined a data model (ontology) in order to address heterogeneity of information modelling that is introduced by the use of different data sources. Open IACS representatives stated that within the project, farmers do not provide directly any information because they do not have yet such obligations (e.g. on providing information on nutrients utilised to their cultivation). One of the features that Open IACS implements is to support the integration of applied inputs by the farmer as it will be mandatory in the new CAP (e.g. retrieving information from FMIS regarding nutrients, seeds, fertilisers). All these information items are planned to be integrated but are not included in the current version of the Open IACS.

Open IACS's data models are planned to be open to the general public. The relevant information will be available to the whole community directly from the end points but APIs will be provided in order to access information in a more meaningful way. This information will be managed directly by the Paying Agencies allowing them to submit regularly snapshots to the EU data portal. The information services will be transferred to them since they have signed a post-project commitment to maintain the infrastructure provided.

As it was stated by the Open IACS, EC's official position/requirement is that the various initiatives need to confront with the INSPIRE data model (ontology) when collecting and publishing open data with regards to the agricultural sector. In addition, it is foreseen that paying agencies' interest will increase as soon as there are evidences on the power of the combination/integration of different data sources in a simple way.

Open IACS project is not currently addressing the issue of how the various Farm Management Information Systems are able to connect and provide their datasets to the paying agencies. For example, farms are not giving to Open IACS information regarding good practices, other activities or nutrients because the supported communications are from the Paying Agencies to the farmers. However, in the coming years it is envisioned that the information system will have such possibility.

Open IACS project has already specified a data model (ontology) for describing data collections referring to LPIS and farmers declarations which is based on the JRC IACS model. As a starting point, they did a transformation into their ontology and based on that they were able to make the transformation from LPIS data to linked data.

 

Open IACS is not currently addressing the issue of data ownership and issues like who owns the data and how data are reused. In order to remove complexity from the project, the commitment was to publish only information owned by the Paying Agencies. That is why they are using IACS systems as a starting point. In the coming years, nutrients, fertilisers and seeds will be part of the IACS system due to the new reporting obligations. Paying Agencies will continue to be the owners of these information.

It must be stated that there is no official document by Open IACS project and only references are made in relevant presentations, meetings and events.

**Open IACS is considered as highly related with MEF4CAP's objectives and future collaboration actions will be realised. Available documentation on Open-IACS objectives and current outcomes are limited and this fact doesn't allow the direct monitoring of project's results.**

## 4.5 H2020 MIND STEP project

The first collaboration session took place on the 10th of September 2021 at 14:00 CEST with 10 attendees representing MEF4CAP and MIND STEP projects and lasted approximately 1 hour.

The meeting Agenda was:

- Introduction
- Short presentation of MEF4CAP's objectives (10 minutes)
- Short presentation of MIND STEP's objectives – achievements so far (10 minutes)

With indicative discussion topics:

  - Elaborate on the integrated data framework for policy monitoring developed by MIND STEP
  - What data sources and data type are integrated and how? How the generalisation from farm level to regional level is realised?
  - Which are the targeted policy indicators
  - Elaborate on MIND STEP model toolbox. What is the scope and how do they operate the various tools/algorithms?

The call started with a quick introduction of all attendees followed by a brief but concise presentation of the two projects' descriptions and objectives respectively. Following are some relevant slides from the presentations.

 

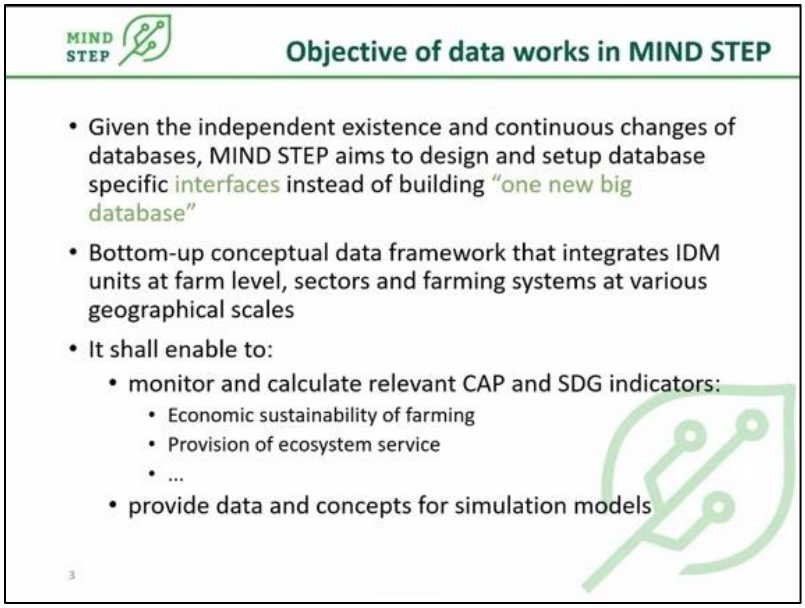


*Figure 13. MIND STEP's objective regarding data works*

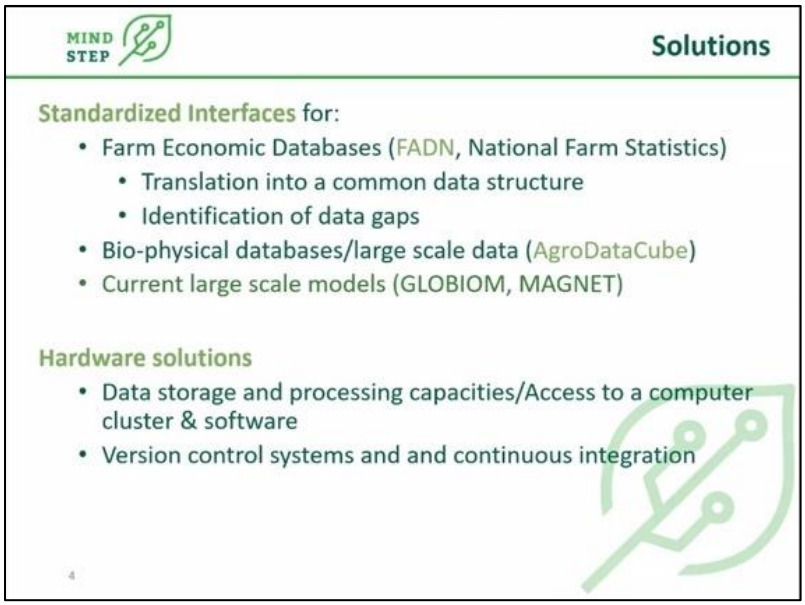


*Figure 14. MIND STEP's solutions*

 

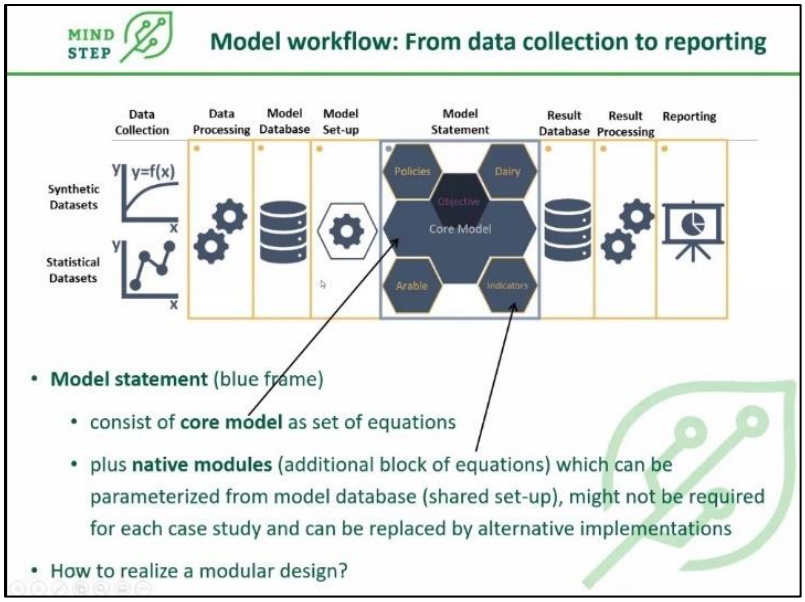


*Figure 15. MIND STEP's model workflow*

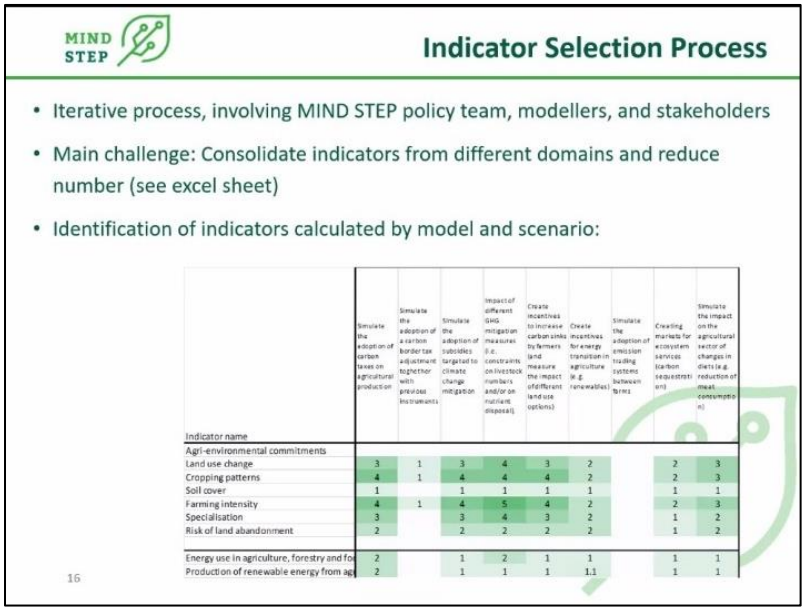


*Figure 16. MIND STEP's indicator selection process*

After the completion of the presentation session, the discussion focused on MIND STEP's achievements, the developed integrated data framework for policy monitoring, data handling issues (generalisation, integration) as well as the produced tools and solutions.

 

**Key technical outcomes:**

MIND STEP's project objectives[14] is to support public decision making in agricultural, rural, environmental and climate policies, taking into account the behaviour of individual decision-making units in agriculture and the rural society. MIND STEP aims to develop a highly modular and customisable suite of Individual Decision Making (IDM) models focusing on behaviour of individual agents in the agricultural sector to better analyse impacts of policies. In addition, the project aims to develop an integrated data framework to support analysis and monitoring of policies related to agriculture and to apply the MIND STEP model toolbox to analyse regional and national policies and selected EU CAP reform options.

MIND STEP aims to select, develop and release interfaces to access economic, bio-physical and data of existing models (like GlOBIOM or MAGNET) using state of the art ICT approaches, like REST API, R package distributions, and services based on Web Map Feature. In addition, it develops and applies methodologies to merge economic (full population and survey data) and biophysical data sets of high spatial and temporal resolution.

Currently only one deliverable is publicly available "D1.1 - Key policy questions for ex-ante Impact Assessment of EU Agricultural and Rural Policies[15]". A number of open access scientific articles are already published[16] which are mainly focusing on developing analytical frameworks for researching and evaluating issues like the adoption of digital agriculture technologies by farmers. For example, in the article entitled "Adoption and diffusion of digital farming technologies - integrating farm-level evidence and system interaction", a conceptual framework integrating farm-level evidence on adoption with a systemic perspective on technology diffusion is presented.

Based on the **MEF4CAP - MIND STEP session** the following additional outcomes are identified:

With regards to data collection, homogenisation and classification of agriculture activities the MIND STEP project uses standardised semantics and labelling schemes that are introduced by Eurostat. Location modelling is realised through the use of Nomenclature of Territorial Units for Statistics or NUTS[17]. NUTS is a geocode standard - developed and regulated by the EU - for referencing the subdivisions of countries for statistical purposes. It only covers the Member States of the EU in detail where for each EU member country, a hierarchy of three NUTS levels is established by Eurostat in agreement with each member state.

MIND STEP currently utilises aggregates of input data from FADN on regional bases, however integration of individual farm level data are among future plans. Data management system developed by MIND STEP is adaptable and able to integrate additional data sources. The project's aim is to integrate farm level in-situ data sources such as Earth Observation data products, data collected from sensors deployed at the farms or from connected farmer's digital calendar. Results though depend on the number of farms which have adopted new technologies and are willing to share their data to statistical organisations for processing. Results depend also on whether the relevant agri-tech companies are legally in position to

[14] https://mind-step.eu/why-mind-step
[15] https://mind-step.eu/assets/content/resources/deliverables/817566_D1.1-Deliverable_1.pdf
[16] https://mind-step.eu/resources
[17] https://ec.europa.eu/eurostat/web/regions-and-cities/overview

 

share data, whether farmers are willing to invest on new technologies and what types of farms are going to do that.

The proper use of biophysical data is of high importance for MIND STEP project not only for monitoring but also for modelling and ex ante assessment of policies (for example broad specific data such as distances between plots and farms in order to calculate costs or soil quality indicators for crop specific yields etc.). It appears though that linking parcel information to farms is not always possible and depends on the country and other parameters that vary.

**Both projects are researching means for new CAP indicators' monitoring. MIND STEP's outcomes can be considered that are more related with policy makers that need an assessment framework in order to evaluate the implementation of the designed policies. The collaboration between both projects will be further continued with the exchange of insights, deliverables and/or results in forthcoming meetings.**

## 4.6 H2020 DIONE project

The aforementioned call took place on the 29th of September 2021 at 11:00 CEST with 11 attendees representing MEF4CAP and DIONE projects and lasted approximately 1 hour.

The meeting Agenda was:

- Introduction
- Short presentation of MEF4CAP's objectives (10 minutes)
- Short presentation of DIONE's objectives – achievements so far (10 minutes)

With indicative discussion topics:

- Details on geotagged photos app. What is the potential of using this app for the needs of the new CAP monitoring?
- EO data products in support of agricultural practices monitoring. What are the practices that can be detected? How to handle issues like small farms and cloud coverage.
- How the integration of drones with EO is realised?
- How the connection and data-sharing with Paying Agencies (IACS) is realised? How the data modelling harmonisation issue is tackled?

The call started with a quick introduction of all attendees followed by a brief presentation of the two projects' objectives respectively. Following are some relevant slides from the presentations.

 

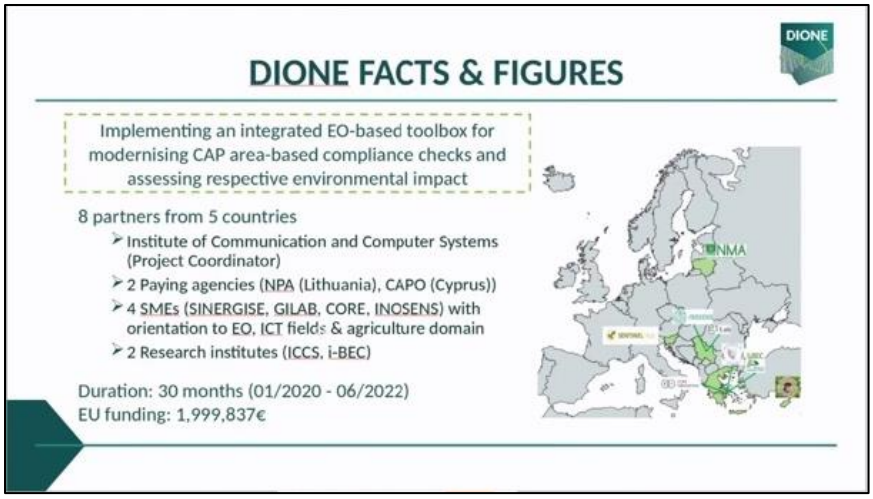


*Figure 17. DIONE's facts and figures*

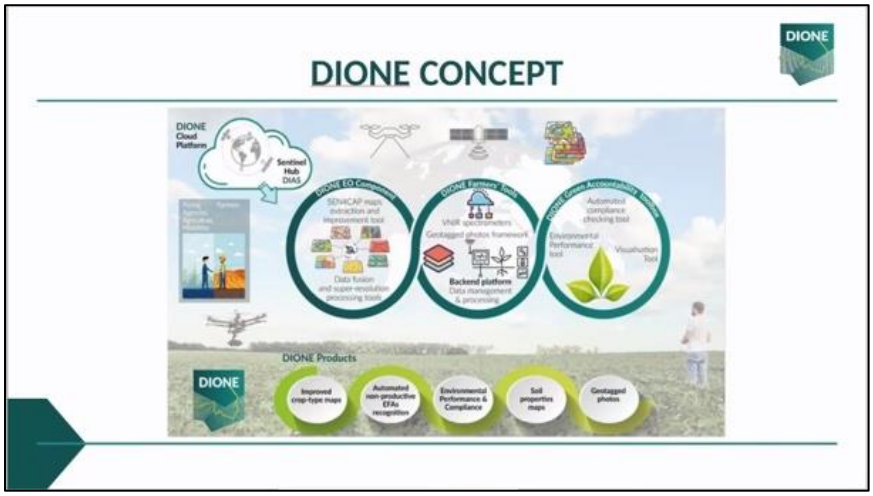


*Figure 18. DIONE's concept*

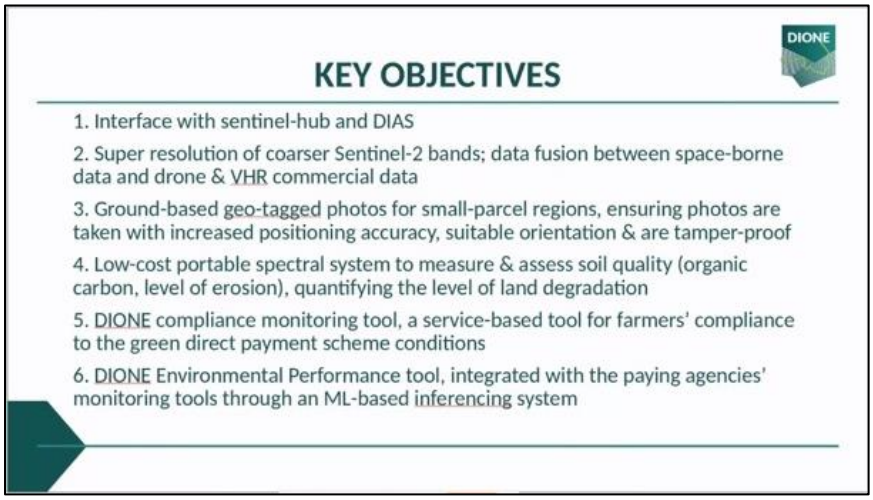


*Figure 19. DIONE's key objectives*

 

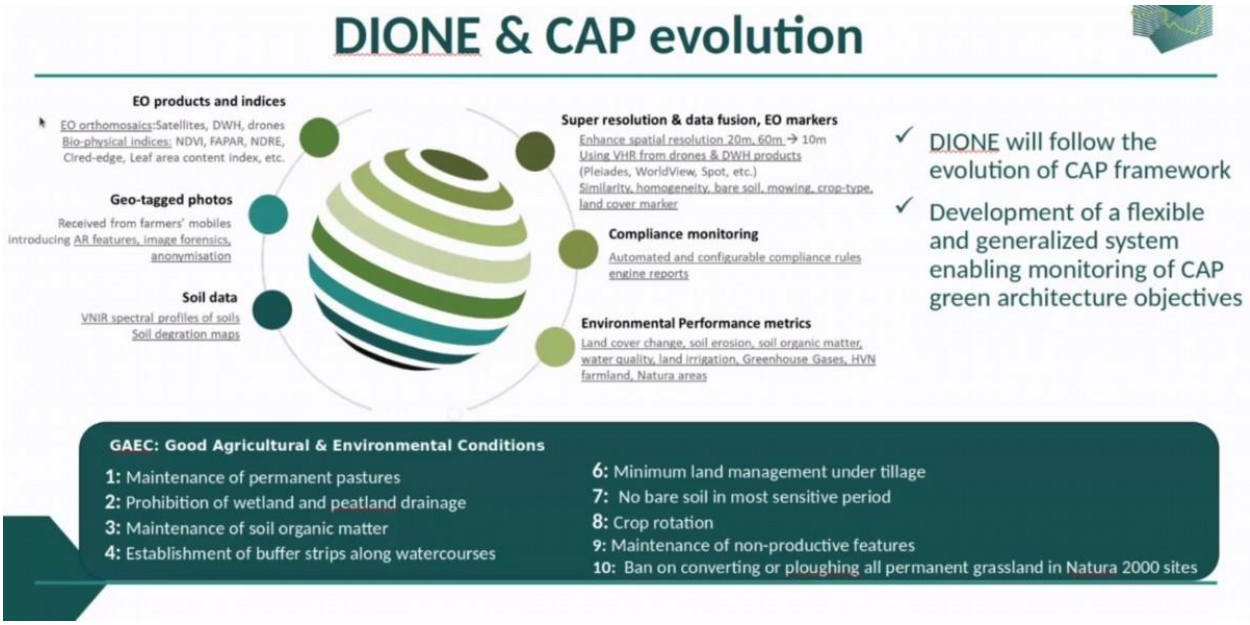


*Figure 20. DIONE's view for the CAP evolution*

After the completion of the presentations session, the discussion between participants focused on high level objectives of the DIONE's project and on the in-situ soil scanning system. Key partners of the project didn't participated in the session so it was not feasible to elaborate on the targeted topics.

**Key technical outcomes:**

DIONE project has published deliverable "D4.3: Implementation and development of systems; SSS, data processing and geo-tagged photos framework"[18] which provides the technical specification of the in-situ data gathering tools. Two of these tools are considered as highly related with MEF4CAP objectives:

a) The geo-tagged photos framework

b) The microelectromechanical systems (MEMS) soil quality monitoring sensor

The DIONE farmers' geotagged photos framework aims to complement the Earth Observation data sources with reliable ground-based information about agricultural parcels and thus facilitating CAP compliance monitoring. In this context, the framework comprises different components and technical innovations towards assisting and guiding users to capture efficiently representative photos of their parcels while adhering to current technical recommendations and ensuring the security, validity and reliability of the collected photos. The data collection process is supported by a mobile application (frontend) that exposes to the user all the related content about their parcels while enabling the conclusion of the process and the provision of the final photos to the Paying Agencies. In this context, various processes are

[18] https://dione-project.eu/wp-content/uploads/2021/08/DIONE_D4.3_V1.0_Implementation-and-development-of-systems_-SSS-data-processing-and-geo-tagged-photos-framework-alpha-versions-alpha-versio.pdf

 

employed so as to enable among other things the provision of the necessary instructions for farmers to reach a given parcel, the reception of notifications about tasks they need to undertake as well as directions regarding the process of capturing appropriately a photo of a given parcel.

The app provides innovative features like the use of Augmented Reality in order to assist the user in capturing the appropriate photo. In addition, it provides offline mode of operation, navigation and geolocation mechanisms of increased accuracy, privacy protection for individuals.

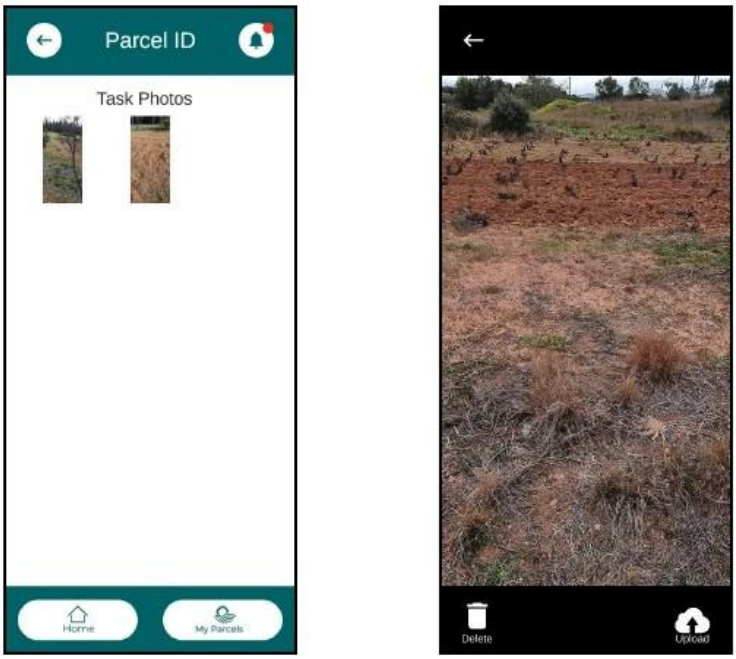


*Figure 21. A snapshot of DIONE[17]'s geotagged photo app.*

Based on the **MEF4CAP - DIONE session** the following additional outcomes are identified:

In the framework of DIONE project, a soil quality spectral sensor has been developed. The final user can be anyone but realistically this solution is addressed to agronomists, Paying Agencies and possibly clusters of farmers or farmers' organisations. This sensor is a small device that connects via Bluetooth to any smartphone. The device is placed on top of the soil and its function is to take snapshots. It records the spectral signature of the soil and based on these signatures, machine learning models can estimate with high accuracy some of the physico-chemical properties such as soil organic carbon, sand silt and clay, nitrogen content as well as calcium carbonate.

Accuracy, though, also depends on the completeness of the dataset since the machine learning model works better if it is feeded with lots of data. Although they already have a database with spectral signatures, their aim is to expand it in order to achieve better accuracy in results. The

 

described solution is able to produce fertilisation advice and its basic concept is to replace as much as possible the laboratory analyses which are time consuming and costly.

The core of the system is based on Sen4Cap project and it is run on a DIAS platform but the project aims to build on top of the Sen4Cap results and will try to improve the resolution maps for Sentinel-2 in order to derive even better results. Soil texture maps can also be produced with a reasonable good level of accuracy even if the soil quality spectral sensor is not used since legacy data can be exploited (from past soil data analyses).

Another solution that is being developed in the framework of DIONE project is the geo-tagged photos application. It is a specific platform where members of the Paying Agencies can log in. They select a specific point on the map to direct the farmer and the application then alerts the farmer that he needs to perform this action. The farmer navigates to that spot where he needs to take a photo (geo-tagged) and sends it back to the database. Then, the Paying Agency is informed accordingly that the picture has been captured at that specific spot. It is an application that is integrated in terms of the software on the APIs and is standalone. It has already been tested in real environment during August 2021 in the areas of Cyprus and Lithuania and results are under evaluation.

**Both MEF4CAP and DIONE projects are elaborating on the evolution of the CAP green framework and aim to find flexible mechanisms in order to enable successful monitoring and compliance checks. DIONE project provides both mechanisms for EO and in-situ based monitoring of information that are related with CAP indicators. DIONE is considered as highly related with MEF4CAP objectives and the collaboration between both projects will be further established with the exchange of insights, results as well as deliverables in forthcoming meetings.**

## 4.7 H2020 NIVA project

The overall objective of the innovation action entitled “New IACS Vision in Action” (NIVA) (https://www.niva4cap.eu/) is to modernise IACS by making efficient use of digital solutions and e-tools, by creating reliable methodologies and harmonised data sets for monitoring agricultural performance while reducing administrative burden for farmers, Paying Agencies and other stakeholders. The project started on June 2019 and it is expected to finish on May 2022 (likely to be extended for 6 months). As it is obvious NIVA project is highly related with MEF4CAP objectives and it has already delivered results on various domains on ICT developments for agriculture. Various MEF4CAP partners (WUR, NP, ITACyL) participate in the NIVA project, thus no collaboration call was needed to be established. Results and insights from the NIVA project are directly transferred through these partners.

 

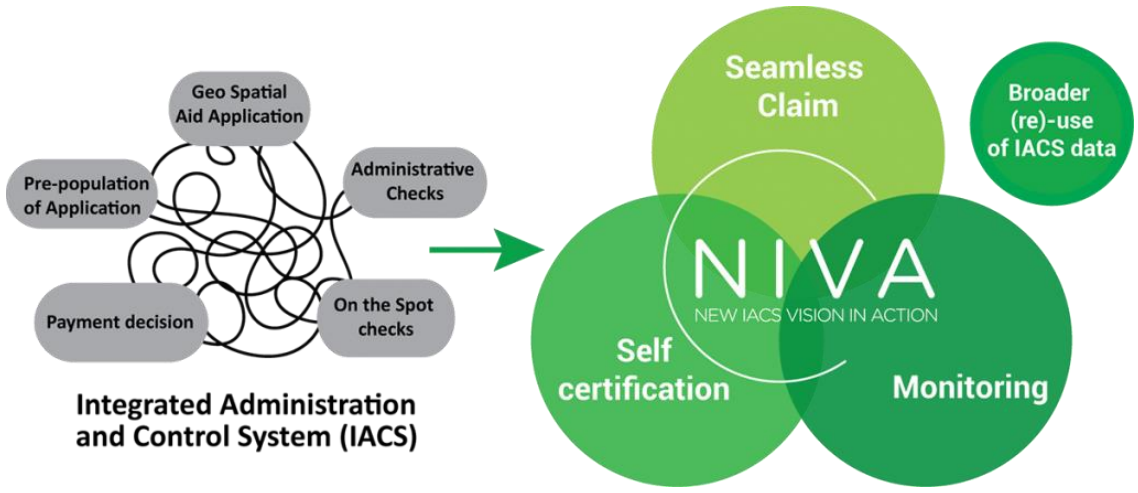


*Figure 22. A schematic representation of the IACS as it is now (left) and what is expected to change (simplify) by the newly introduced monitoring approach (right)*[19]

NIVA project mainly aims on introducing innovative and digitised solutions for PAs and the handling of subsidies. However, given that PAs and IACS are currently one of the main data sources for monitoring CAP indicators, the same innovative mechanisms are considered of high importance also for the MEF4CAP project and the related developments in ICT. To this end and for the needs of this deliverable, the most related with MEF4CAP and mature outcomes of the NIVA project are reported hereafter.

**Key technical outcomes:**

According to NIVA project two main categories of information sources (systems) are of key interest for the monitoring and evaluation of the future: Earth Observation data sources and digital solutions deployed and utilised on farm level (e.g. Farm Management Information Systems (FMIS)). On the same time both systems are still raising lots of difficulties towards their integration with existing IACS of the Paying Agencies. In NIVA's "D3.5 Recommendations for standardised connections between IACS and other applications"[20] thorough analysis is presented on how PAs (through their IACS) can benefit from integrating EO data products and data from FMIS. As it is stated, D3.5 aims to provide at least some common basic knowledge, enabling interested entities to be aware of the available data and of the potential exchange solution options with their advantages and drawbacks. Access to big volumes of EO data and derived products for the needs of IACS is still considered as a very complex topic while potential exchange of data between IACS and FMIS is even less researched and analysed.

**Use of EO for monitoring**

With regards to the utilisation of EO, the following main categories of data sources are identified:

- Sentinel-2 is a constellation with two twin satellites that acquire optical imagery at a spatial resolution of 10, 20 and 60 m. The average revisit frequency of the combined

[19] https://www.niva4cap.eu/project/
[20] https://www.niva4cap.eu/wp-content/uploads/2021/09/D3.5Recommendations-for-standardised-connections-between-IACS-and-other-applications_v1.0.pdf

 

constellation is 5 days. Sentinel 2 images are the best candidates for EO monitoring because they are optical images (easy for interpretation) with rich semantics, relatively good spatial resolution (up to 10 m) and because they are open data (freely available). In theory, they have a good revisit frequency however in practice there may be clouds in the sky making the images non exploitable. The cloud issue depends on geographic location; in Europe, clouds are generally more frequent in northern and central EU Member States or in mountainous areas. More detailed information about S2 may be found on: https://sentinel.esa.int/documents/247904/685211/Sentinel-2_User_Handbook.

- Sentinel-1 radar mission comprises of a constellation of two polar-orbiting satellites operating day and night and acquiring imagery regardless of the weather with a spatial resolution up to 5 and revisit frequency of 6 days. Sentinel-1 is performing Synthetic Aperture Radar (SAR) which means that the sensor emits its own energy, in the form of a signal (in a given band - interval of frequencies) and then records the amount of that energy reflected back (reflected backscatter) after interacting with the Earth. Radar can penetrate clouds and because of this, these data provide an advantage over optical/ imagery. Radar signatures require a lot pre-processing before they can be used as input for crop classification or any other EO monitoring process. The pre-processing consumes both data storage and computation power.

- NASAs Landsat-8 satellite sensor is an American Earth observation satellite developed by NASA and the U.S. Geological Survey (USGS). The spatial resolution is of 15m, 30m, and 100m depending on the type of captured image. Its revisit cycle (temporal resolution) is 16 days and the data is freely available. Landsat data is considered of high quality and very stable products as the Landsat satellite program is the longest continuous Earth imaging program in history. Since 1972, Landsat satellites have collected huge amounts of consistent spectral imagery.

- HHR-VHR imagery. In the NIVA context, HHR (High High Resolution) applies to ground pixel size less than 5 m and equal to or more than 1 m whereas VHR (Very High Resolution) applies to ground pixel size less than 1 m. These high-resolution images are available by commercial providers. These are usually tasked imagery, taking an image over a given area of interest on a specific day. HHR and VHR imagery are already by some Paying Agencies in EU. The images are provided to PAs by the European Commission during the Control with Remote sensing (CwRS) Campaign for specific acquisition windows for each agricultural control zone. That relates to the yearly CAP image acquisition work programme where each Member State requests the EU to obtain the satellite imagery for the controls via JRC. These images are traditionally used for the on the spot checks (OTSC) controls for Basic Payment Scheme / Single Area Basic Payment Scheme and crop diversification. This usually applies to a sample of around 5% of farmers to verify farmers' declarations and adherence to eligibility rules. Within the "New Area Monitoring System" some countries (e.g. Malta) use some HHR imagery for checking the small parcels as the spatial resolution Sentinel is not sufficient for concluding on the eligibility status (insufficient number of pixels falling entirely within the field boundaries). Use of VHR or HHR imagery might also be used for validation on sample areas as providing an independent source of data.

 

Regarding the definition of small parcels, NIVA's survey showed that the definition varies for each country (and PA) as the size of small fields ranges from 0.1-1ha. Also, it was reported that the polygon's (parcel) shape plays a significant role in characterising inconclusive small parcels. For example, various elongated, irregular or concave polygons may not be possible to be monitored based on EO due to their particular shape, even though they may extend a certain parcel size. As it is already stated, for tackling the small parcel issues, most PAs consider acquiring higher resolution satellite imagery from commercial providers (e.g., Planet, SPOT-6/7, and Worldview). Finally, it is stated that the issue of small parcels that can't be monitored using Sentinel data may be mitigated by applying the JRC guidelines that recommend to aggregate adjacent parcels with same declared crop or practice under FOI (Feature of Interest).

Two additional interesting points indicated by NIVA on the use of EO data for monitoring are the following:

a) EO monitoring is generally not using single date satellite images but temporal profiles and time series of observations for the same parcel.

b) Use of existing tools and specialised platforms for processing EO data. Downloading and processing raw images from the official ESA's Copernicus Open Access Hub repository (e.g. https://scihub.copernicus) is not an efficient approach as there are many restrictions (e.g. time-consuming process, requires large volumes of storage and processing power, no direct access to images that are older than 1 year). Proposed alternative solutions are to use of national portals that are providing Sentinel images (at least) on the national territory, usually working as mirrors of the ESA Hub, that may also provide pre-processed Sentinel images or additional satellite images of higher resolution. The other approach is the use of "Copernicus Data and Information Access Service[21]" (DIAS) that provide a centralised access to Copernicus data and information (including Sentinel images), as well as to processing tools.

More interesting results are expected to be extracted after the conclusion of various use cases that are still under development.

**Farm Management Information Systems for monitoring**

NIVA makes an evaluation on the use of FMISs as potential sources of ground truth evidence in the scope of new CAP monitoring. NIVA adapts the following definition for FMIS: "a planned system for the collecting, processing, storing and disseminating of data in the form of information needed to carry out the operations functions of the farm". The following indicative information items are usually handled by FMISs but also of interest for CAP monitoring:

- Information on agricultural land use: The parcel's area (e.g. in hectares) and location (e.g. polygon coordinates) is among the core information entities that are useful for IACS.
- Agricultural Inputs: The type, amount and time of applied inputs (e.g. pesticides, fertilisers, irrigation) at a parcel is among the most significant information items for IACS; it is expected to be required data for the CAP post-2020.

[21] https://www.copernicus.eu/en/access-data/dias

 

- Crop type and yield: The actual type of crop cultivated for a specific time period and the harvested yield is of interest by IACS.
- Applied agricultural practices – Planting, Harvesting, Mowing, Ploughing, etc.: This category includes the type of applied practice and the respective time period that are applied. The use of machinery data is also included within this category.
- Organic cultivation practices: This information item refers to whether a cultivation is treated with a manner approved for organic agricultural products or not.
- Livestock - Herd management: Total number of animals, type of animals, annual births/deaths, medicines utilised, animal feed utilised, etc.
- Livestock Pasture management: Conditions of pastures.
- Financial Inputs/Outputs: This refers to financial related information items (cost, amounts, etc.) related with purchased agricultural products (fuels, chemicals, seeds, equipment etc.) and their respective consumption/use. Also the potential income from selling the production is of interest.

Given that IACS act as a centralised repository of agricultural data NIVA also identifies datasets and information items that can be mediated by IACS to farmers (through their FMIS):

- IACS through the Land Parcel Identification System can provide to FMIS data on parcels geometries and unique identifiers through user friendly means of rendering.
- Information on registered animals in the context of livestock management.
- Aggregates on pesticides/fertilisers use for the area that the parcel is located.
- Pest infestation early warnings for the area that the parcel is located along with recommendations for pest management related actions.
- Carbon footprint performance for the area that the parcel is located.
- Soil quality and soil erosion for the area that the parcel is located.
- Other agricultural statistics (e.g. harvested yields, harvest dates, crop types) for the area that the parcel is located.)

More interesting results are expected to be extracted after the finalisation of NIVA's use cases that are still under development.

**NIVA project can be considered as one of the projects that aim to address the needs of future CAP monitoring in a holistic way. NIVA aims to evaluate current challenges and potential solutions for agricultural data sharing through semantic, syntactic and organisational interoperability mechanisms. On the same time develops a set of CAP monitoring tools that exploit both EO data products and in-situ sources (e.g. geotagged photo apps, integration from machinery and FMIS). These tools are currently under evaluation by PAs of multiple Member States of EU. NIVA project is currently in its final year of execution, so the outcomes of the various activities are continuously published. MEF4CAP plans to closely monitor and evaluate these outcomes.**

 

# 5. Livestock management and animal welfare

Innovative data driven technologies tailored to the needs of live-stock management are currently widely researched and, in some cases, already in production use. Among the core objectives of such approaches is to deploy data collection mechanisms (e.g., IoT sensing technologies), allowing real time monitoring of conditions where the animals live (e.g. stable) or graze (e.g. pastures), but also to track the activity/status of the herd. The generic objective is to optimise livestock management procedures and to assist in data-driven decision making of the applied interventions. On the same time, such technologies are generating datasets that can act as ground truth evidence of the applied animal treatment practices which can support CAP monitoring and evaluation. This section presents an overview of relevant and currently ongoing research activities.

## 5.1 DECIDE project

Funding Source: European Commission/H2020
Start Date: July 2021
Duration: 60 months
Website: https://decideproject.eu/

The project entitled “Data-driven control and prioritisation of non-EU-regulated contagious animal diseases” (DECIDE) aims to explore different approaches for data collection and data usage to support animal health. The project aims to harvest currently underused potential of existing datasets through innovative combinations of existing and new data types and streams.

Methods for the modeling, analysis, and interpretation of collected data are researched while decision support tools are implemented and utilised in practice. Within the overall DECIDE framework, these tools constitute the bridge between the “data-driven” models and the actual process of “decision making” by stakeholders involved with disease information, prevention, detection, and control in different capacities and at different population levels. In addition, the project aims to determine the economic and welfare burden of prevalent contagious production diseases and ensure prioritisation of control measures for reduction of further spread, cost effectiveness and increased welfare. Furthermore, DECIDE determines the stakeholders’ drivers, barriers, and willingness to share data and/or to implement and use data-driven decision tools for animal disease and animal welfare management. The project aims to utilise this knowledge to develop and evaluate informational material directed at stakeholders aiming to generalise the implemented practices.

The project’s use cases are focused on gastro-intestinal and respiratory tract infections of calves, pigs and poultry but also on specific pathogens related to growth reduction and mortality in salmonids. With regards to data analysis and modelling, the project builds mechanisms that provide early warning signals using multivariate and/or multi-level dynamic monitoring models that are generalisable to multiple cases. For example, an add-in into the control dashboard of a commercial automated milk feeder for calves has been developed which is capable to indicate a reduction of milk intake in the group and generate early warnings. The reduction is often related to infectious causes and farmer and veterinarian need to proceed with effective and efficient measures. In another use case, a decision support tool is developed for salmon producers to choose the best possible option for sea lice control in salmon given

 

the burden on disease, the effectiveness of treatment, the mortality after treatment and the welfare of the fish.

In addition, it also develops disease specific mechanistic models to simulate pathogen spread and syndrome occurrence. Warning systems are based on both the actual data monitored (e.g., using thresholds) but also on mechanistic models (e.g., inference algorithms). Finally, the project is researching mechanisms for diseases' prioritisation and control measures for policy and research agenda's considering that better control of endemic infectious diseases is an important pillar of sustainable animal production. Given that the project is still on its first year, there are no concrete outcomes published yet.

Summary of data sources utilised: milk feeder quantity sensors, animal tracking, fish farming sensors.

## 5.2 CLEARFARM

Funding Source: European Commission/H2020
Start Date: October 2019
Duration: 48 months
Website: https://www.clearfarm.eu/

The EU-funded ClearFarm project aims to develop methods for animal welfare assessment in livestock production. The project focuses on technologies relevant to Precision Livestock Farming (PLF) aiming to increase animal welfare in the whole production chain of dairy cows and pigs. It also co-designs, develops and validates a platform capable to inform both farmers and consumers to assist their decision-making.

In the context of PLF, several sensors (collars, RDIF tags, microphones, environmental sensors) are placed on animals and farms collecting a wide range of variables. A cloud-based software data platform collects a wide range of data related to animal behavior, physical and mental health, environmental impact, and productivity. Through algorithmic processing of these data collections, data products are generated that provide to producers and consumers easy to understand indicators on animal welfare status. Users of the platform will be able to see the updated information on the status of the animals, with an emphasis on early-warning signals that can help them to react to threats more rapidly. The animal welfare information will be integrated in food's labelling in order to provide clear, transparent, and updated information to pork and milk consumers.

The project has already published results starting from an evaluation of sensor technologies for welfare assessment of dairy cattle (Stygar, 2021) and on the potential of extracted feeding patterns to assess generic animal welfare (Bus, 2021). It also attempts to exploit higher level knowledge, through inference processes applied on data collections, aiming for example to identify the relation between play behavior and growth rate in piglets across weaning (Larsen, 2021). With regards to policy monitoring and evaluation, ClearFarm project analyses the potential for data-driven and animal-based welfare assessment in the context of European quality schemes (Stygar, 2022).

Summary of data sources utilised: smart collars, RDIF tags, microphones, environmental sensors

 

## 5.3 PPILOW

Funding Source: European Commission/H2020
Start Date: September 2019
Duration: 60 months
Website: https://www.ppilow.eu/

The project entitled "Poultry and Pig Low-input and Organic production systems' Welfare" (PPILOW) aims to co-construct solutions to improve the welfare of poultry and pigs reared in organic and low-input outdoor production systems. Essentially, PPILOW project develops a smartphone based self-assessment tool aiming to improve pig and poultry welfare on farm and designed to be utilised by the farmers wanting to assess the welfare of their animals on-farm. The app can also be used by technicians, vets, and consultants. It is co-built with several stakeholders and practitioners from different countries. It is focused on animal-based indicators, categorised into the four welfare principles (good housing, good feeding, good health, and appropriate behavior). The application has separate assessments for pregnant sows, farrowing sows with piglets, grower pigs, finisher pigs and the loading process. The results of the assessment can be found on the PIGLOW website (https://www.piglow.eu/) along with a set of questionnaires that have been designed to support animal welfare self-assessment.

The application also supports the extraction of information about average scores/answers for all welfare indicators and automated advice with risk factors for each indicator. In second phase, a benchmarking tool allows the farmer to see how well the farm scores in comparison to other farms. The welfare radar emphasises the scores for some of the most important welfare aspects. The results can be discussed with a vet in order to enhance the welfare of the livestock.

Summary of data sources utilised: self-assessed smartphone application

## 5.4 HealthyLivestock

Funding Source: European Commission/H2020 (the European part only)
Start Date: September 2018
Duration: 60 months
Website: https://healthylivestock.net/

HealthyLivestock is an ongoing research programme aiming to study the contribution of enhanced animal health and welfare on reducing the need to use antimicrobials in pigs and poultry.

It quantifies the main factors associated with prevention of disease spread on farms through housing or management and establishes performance indicators to assess them. It studies ways to improve the ability of animals to withstand or deal with pathogen challenges through welfare improvements which reduce stress or through nutritional measures' improvement to the balance of gut microbiota or probiotics. The project aims to develop, validate, and deploy an automated behaviour and live weight analysis system that enables trait-specific monitoring

 

for early detection of both generic health challenges and specific diseases. Early detection investigates ways of applying Precision Livestock Farming techniques to develop tools for early detection of health problems, both generic and specific, such as digestive and respiratory diseases. It is structured into three tasks that study how automated monitoring, with a variety of sensors, identifies individuals or groups in need of treatment. For example, a machine vision system for early detection and prediction of sick birds has been developed and tested using a trained model tailored to broiler chickens (Okinda, 2019). Finally, the project validates all the potential solutions by identifying the most promising technical and management practices to reduce the need for antimicrobials, based on practical feasibility, societal acceptance and economic viability.

Summary of data sources utilised: connected feeders, connected drinkers, automatic weighing stations, RFID ear tags, data entry.

## 5.5 Geronimo

Funding Source: European Commission/H2020
Start Date: June 2021
Duration: 60 months
Website: https://www.geronimo-h2020.eu/

GEroNIMO project's aim is to research functional regions in the DNA of some domesticated animals (pig and chicken), including elements that regulate gene transcription under different conditions. Additionally, the project focuses on exploring how the genome is altered by environmental cues through epigenetic mechanisms that modify how available the DNA is for gene expression. The methods are mostly computational (algorithmic). A Hackathon will take place as an important event for brainstorming on the use of new genomic technology in animal breeding. The results of the project aim to improve animal welfare and sustainability to reduce resource usage and contribute to more efficient livestock production. The results may lead to recommendations to decision-makers all over Europe.

Summary of data sources utilised: analytical/numerical/scientific approach.

## 5.6 Code: Re-Farm

Funding Source: European Commission/H2020
Start Date: May 2021
Duration: 30 months
Website: https://coderefarm.eu/

The Code: Re-Farm (Consumer-driven demands to reframe farming systems) research project focus on poultry and goat production systems with the goal of understanding the links between husbandry systems and intrinsic quality of derived products. The study covers 3 different production lines for the poultry industry: 1. Broilers, 2. Egg laying hens, 3. Dual purpose production lines. For each line, 2 different husbandry systems are investigated: a) Intensive (not for the dual purpose, since it is not currently applicable), b) Extensive. For the goat industry, one production line (milk production) will be investigated, focusing on breeds with: 1) High and 2) Medium milk production potential. For each breed, 2 different husbandry systems will be studied: a) Intensive, b) Extensive.

 

Based on analysis of input from relevant project partners and wider stakeholder groups in the business ecosystem, the project will explore future challenges in existing farming systems and their accompanying value chain. This includes an assessment to understand the changing demand side, as well as investigating changes on the supply side. It will also establish an inventory of contemporary and new business models to address these future challenges. The results of this analysis will be used to develop new business models that fit sustainable, consumer-demand-compatible business, including reframing of value chains and ecosystem management systems. Thus, the project aims at adding value to high quality livestock products, through data-based (exploiting also pilot results) demonstration. The alternative business models will be evaluated on viability, financial and environmental sustainability. This will inform planned targeted interventions according to products' life cycle, industry capabilities and sustainable potential for goat and poultry farming.

Several different novel tools will be developed for milk analysis, eggs analysis, preclinical mastitis detection, microbiome analysis, automated animal health & welfare assessment and gas analysis.

Finally, a Product Intelligent Analytics Platform will be developed, for quality monitoring and management of goat and poultry products. It will facilitate data gathering, visualisation and analysis. The Code: Re-farm tools will be able to directly transmit analysis' results to the platform, where also other data will be fused (from conventional analysis, food traceability information, animal tags). The platform will include an AI-based Semi-Empirical Recommendation Engine for supporting accurate decisions based on Fuzzy Logic. The platform itself will also facilitate the tracing of the entire Product Lifecycle Roadmap.

Summary of data sources utilised: product lifecycle Monitoring, laboratory techniques.

## 5.7 Grazing4AgroEcology

Funding Source: European Commission/HORIZON-CSA\HORIZON-AG
Start Date: September 2022
Duration: 42 months

The full title of Grazing4AgroEcology (G4AE) is "European Network to promote grazing and to support grazing-based farms on their economic and ecologic performances as well as on animal welfare" and it is a thematic network focusing on grazing farmers. It is based on the idea that grazing-based production systems have the proven potential to produce high quality food, to be beneficial to the competitiveness of farmers and animal welfare, as well as for other ecosystem services and are widely appreciated by the society. However, for many reasons, grazing is generally declining in Europe, which is a threat for many ecosystem services. G4AE has 18 partners including farmers' organisations, extension services, education, and research in eight countries (France, Germany, Ireland, Italy, The Netherlands, Portugal, Romania, and Sweden) and its main objective is to enable the capture and implementation of best-practices and innovations to promote grazing for agroecology. G4AE will innovate the grazing sector by strengthening the capacity of farmers to understand more objectively their own agroecological performance through an integrated self-assessment and by triggering farmers to strive for innovation and boost digitalisation.

Summary of data sources utilised: self-assessment

 

## 5.8 Conclusions on livestock management technologies

This section presented ongoing research actions that are realised in EU and are utilising ICT technologies in support of livestock management, having among their key objectives monitoring, evaluation, and improvement of animal welfare. The range of available technologies is now capable to address the needs of various livestock production types under different context facilitating the realisation of the "Precision Livestock Farming" concept.

From a technical perspective, data collection mechanisms are getting easier to be deployed/controlled and more robust in the challenging livestock operational environments. IoT based sensing technologies are capable to implement extended data collection on the status of the animals and to feed data-driven decision-making algorithms providing early warnings that can assist more rapid reactions to potential threats.

As it is common in almost all of IoT projects, data collections are often under-exploited, hence there is still great potential but also challenges on further utilising the collected datasets that support the needs of livestock farmers and the policy monitoring and evaluation.

Among the key objectives under research is the specification of indicators that reflect animal wellness and the specification of the respective data collection and processing methods for calculating the indicators.

With regards to CAP monitoring and evaluation, the collected datasets are a valuable source of ground truth evidence that can contribute towards sustainable livestock farming. The presented ICT technologies can provide evidence on the type and population of animals, their environmental conditions of living, and their overall welfare. Among the reviewed research initiatives, the DECIDE project aims to address policy research agenda considering mechanisms for diseases prioritisation and control measures. One of the key challenges is that in most of the cases, the various mechanisms that are researched are not considering the sharing of data and calculated outcomes among their key requirements. Data and system interoperability are key parameters toward the further exploitation of livestock management system in support of CAP monitoring and evaluation needs.

 

# 6. Satellite based Earth Observation

This section presents an overview of currently ongoing or recently completed research activities in the field of satellite based Earth Observation (EO) which are directly related with CAP monitoring and evaluation or, in a more generic manner, relevant with agricultural-production. The reviewed initiatives are realised under the framework of the European Space Agency (ESA) and complements the EO research outcomes presented in section 4.

## 6.1 Sen4CAP – Sentinels for Common Agricultural Policy

Funding Source: ESA
Start Date: July 2017
Duration: 30 months + Extension framework
Website: http://esa-sen4cap.org

The Sen4CAP project aims at providing to the European and national stakeholders of the European Common Agricultural Policy (CAP) validated algorithms, products, workflows, and best practices for agriculture monitoring relevant for the management of the CAP. Special attention has been given to provide evidence on how Sentinel-1 and Sentinel-2 derived information can support its modernisation and simplification.

The project has been setup by ESA and has been developed in close collaboration with DG-Agri, DG-JRC, DG-Grow and in particular with 6 selected national Paying Agencies. Demonstrations and use cases have been contacted in the context of the Paying Agency operations up to national scale, addressing a range of monitoring aspects in the IACS cycle, including the greening measures of the CAP.

The SEN4CAP main objectives are:

- To identify and specify EO products and services suitable to increase the efficiency, traceability as well as reducing the costs of the IACS.
- To develop Algorithm Theoretical Basis Documents along with open-source code for agricultural EO products based on Sentinel-1 & -2 responding to the user requirements.
- To demonstrate and validate the developed agricultural EO products up to national scale.
- To provide evidence for the utility of Sentinel products within IACS procedures at EU and national level for a range of national and regional Paying Agencies representative for the heterogeneous agricultural practices, landscape and climate within the EU, as well as to identify the associated limits and conditions of applications.
- To prepare and facilitate the transfer of developed EO products and services to the PAs including capacity building and demonstrating cloud computing capabilities.

During the first phase, fast-track prototype products were generated with the objective of providing early evidence to the Steering group of the benefits of the Sentinels for improving the CAP management in preparation of the CAP reform.

During the second phase (16 months), the full value of the developed EO products and processing system were assessed through a national-scale demonstration that was carried out in the operational environment of the engaged Paying Agencies.

 

After the original 30 months period, an open call added new use cases to the project, whilst the open-source software has been frequently updated, and webinars have regularly been organised. Collaborations with other research projects (like ENVISION, NIVA, etc.) have always been a key element in advancing integration and effectiveness.

The full use case selection aimed at being a good balance between the current CAP management, based on the current legislation, the administrative and on-the-spot checks performed by the PAs, and the need to anticipate what could be relevant and feasible for the new monitoring approach.

## 6.2 SEN4STAT – Sentinels for Agricultural Statistics

Funding Source: ESA
Start Date: 2019
Duration: 30 months
Website: https://www.esa-sen4stat.org/

Agricultural monitoring at national scale is a prerequisite for assessing and analysing the agricultural resources by mandated authorities, usually the agricultural National Statistical Offices (NSOs). NSOs collect in general national agricultural monitoring data by farm and household surveys. Recognising the limitations of the current agricultural data collection in developing, emerging as well as in industrialised countries, key international bodies and UN agencies aim to improve and enhance the current practices in agriculture data collection.

For a successful uptake of EO information by agricultural NSOs, specific steps in remote sensing must be achieved in terms of additional information products, methodological development and support for effective integration in their operational workflows and reporting obligations.

The SEN4STAT project aims to develop and demonstrate agricultural Earth Observation (EO) products and workflows based on the Sentinel missions of the European Union (EU) Copernicus program which support the agricultural statistics and can be integrated in the National Statistical Offices environment. In this context and to raise the awareness of NSOs for EO as well as to lower the technical entry barrier, a set of activities have been identified by the SEN4STAT project:

- Engage and develop together with NSOs dedicated applications and workflows to integrate EO agricultural information in their operations.
- Identify and specify EO products and services suitable to increase the efficiency and temporal-spatial coverage of national agricultural statistics.
- Develop data analytical tools for combining national statistical data sets, including household surveys, with satellite observations and derived EO information.
- Develop algorithms along with open-source code for agricultural EO products based on Sentinel-1 & -2 responding to the user requirements.
- Demonstrate and validate the developed products for agricultural statistics at national scale.
- Prepare and facilitate the transfer of developed EO products and services to the NSO including capacity building and demonstrating cloud computing capabilities.

 

Six use case subjects have been considered with the SEN4STAT NSOs pilot which are displayed in the following diagram.

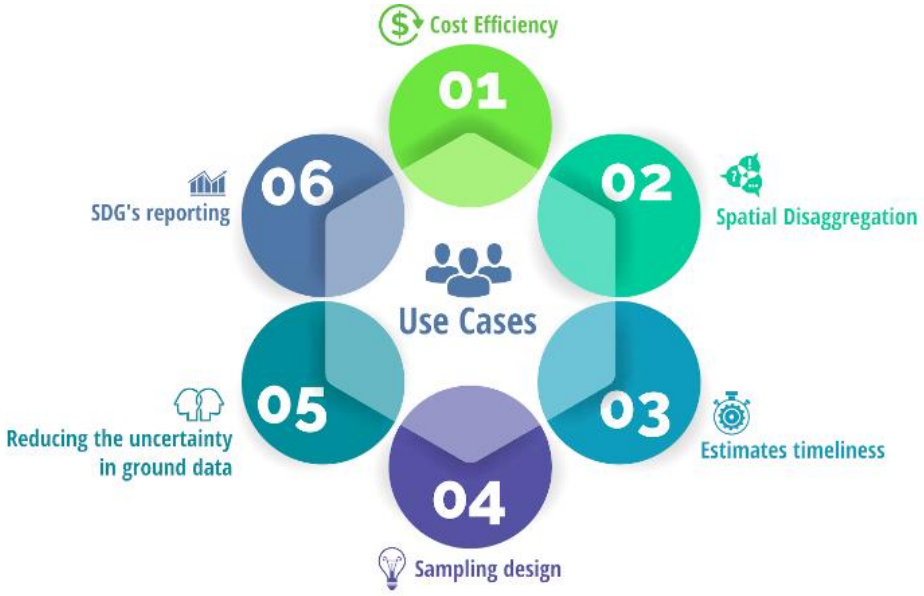


*Figure 23. SEN4STAT pilots relevant with National Statistical Offices*

In more details:

- The "cost-efficiency" use case will evaluate if and how EO data can contribute to reduce the cost of the survey by reducing the sampling size and/or increasing the efficiency by reducing the sampling error.
- The "spatial disaggregation" use case will rely on EO data to allow statistics disaggregation at small administrative areas (e.g. province, county) and therefore improve the statistics granularity.
- The "timeliness" use case will show how EO data can be useful to forecast statistics and provide early estimates before the end of the season or just after, thus being less consolidated but more timely than official statistics which are often available late after the end of the campaign. The provision of seasonal - instead of annual - estimates could also be part of this use case for countries which have several successive crops and which have the adequate ground data.
- The "sampling design" use case will assess how EO data can support the building of an area sampling frame (moving from LIST/POINT) and find the optimal samples size and segments size.
- The "data quality control" use case will implement procedures based on EO data to reduce the uncertainty in the ground database (data collection protocol & quality control procedure).
- The "SDG's reporting" use case will see how EO data can provide relevant information to support the reporting of specific indicators related to the SDG's 2 "Zero Hunger" and 6 "Clean Water and Sanitation"
- Overall, the research objectives of SEN4STAT are highly relevant with EU's CAP M&E framework, however the countries selected for piloting the developed services are mainly

 

non-European (Ecuador, Malawi, Tanzania, Senegal, with the exception of Spain) which may hinders the potential for adaptation in the EU context.

 

## 6.3 Aquafarm 2.0

Funding Source: ESA
Start Date: March 2020
Duration: N/A
Website: https://business.esa.int/projects/spacesense-soc

The project concept strongly builds on the knowledge of local stakeholders, in order to deliver advanced, and locally specific, crop monitoring services. Sentinel 2 satellite optical data (and Landsat 8) is the cornerstone of the system, allowing for remote crop monitoring.

The AquaFarm 2.0 crop monitoring service targets EU Common Agricultural Policy (CAP) requirements for Portuguese farmers as well as Agri-tech service providers. The service will integrate data from satellites (Sentinel 2 optical data and Landsat 8), meteorological models, measurements and plant growth models and in-situ data to provide facts and forecasts about crops and soil health.

The system will detect crop types and some agriculture practices using Sen2Agri and Sen4CAP software. AquaFarm 2.0 improves access to data and models (which have low maintenance costs and high durability when compared with intensive measurements based services) to support four identified users - retailers, farmers associations, ministries, and service providers - that all together help improve the agricultural value chain.

## 6.4 SenZitall

Funding Source: ESA
Start Date: November 2019
Duration: initially 2 years – Ongoing (expected end: June 2023)
Website: https://business.esa.int/projects/senzitall

The main objectives of the SenZitall service is to provide a reliable and flexible wireless sensor network (WSN) system that can be deployed in urban as well as harsh and remote environments. This type of performing WSN, coupled together with the SenZitall spatial decision support system (SDSS), provides near-real time (NRT) simulations of pest population dynamics and associated risk. Such simulations are now more commonly used and completely integrated in our society with new applications developed on a regular basis. One of those new application areas is Integrated Pest Management (IPM). Population dynamics forecasting models can provide great capability enhancement to combat pests in a sustainable way by proactively controlling them before they become a problem. This requires precise and NRT meteorological data, which sensor networks can provide.

 

However, although sensor networks are already widely used in many techno-environmental settings, and this number will only continue to increase with the rise of IoT, most existing WSN systems still rely on the availability of a power grid and Wi-Fi or cellular communication networks, which are widely available in and around populated areas. Pest management, on the other hand, requires surveillance in remote areas where a local network and power supply are not present. Satellite communication (SATCOM) provides a solution to the current limitations insuring no data loss and a continual stream that feeds into the pest population dynamics and disease models.

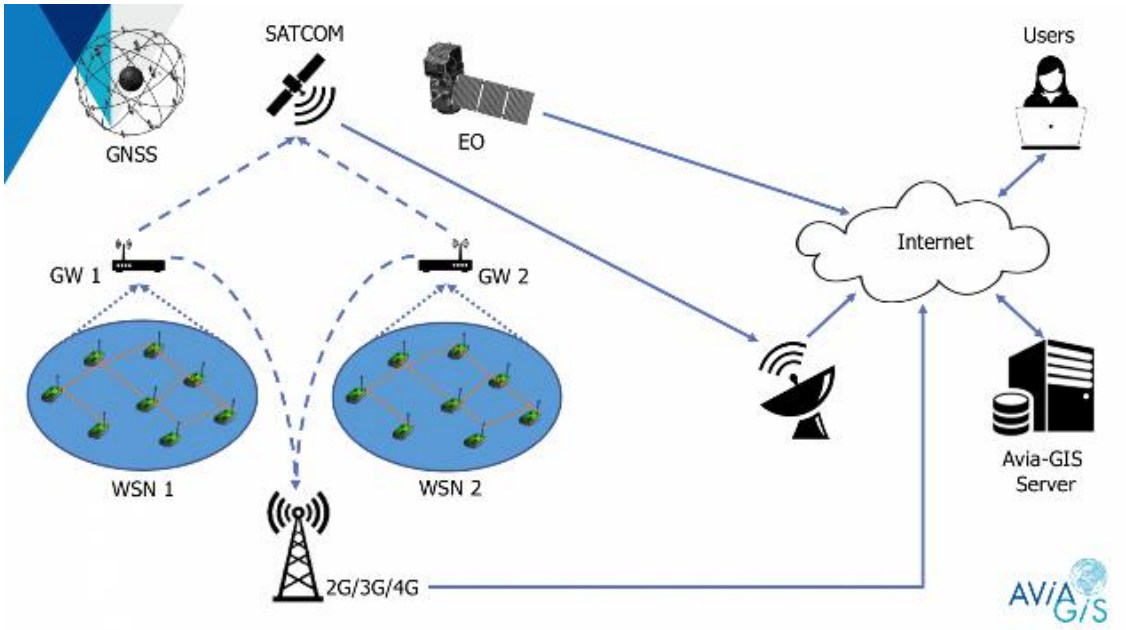


*Figure 24. SenZitall's approach on integrating EO with WSN*

The key customers' segments targeted by SenZitall are horticultural sector, mainly interested in a) frost protection systems, b) monitoring of fruit growth throughout the season and c) pest management. Targeted cultivations are pears, apples and cherries in Europe and Olives in the Mediterranean.

With regards to the pest control sector, the main interest is in Integrated Pest Management solutions, pest population dynamics and disease risk.

The targeted focus markets are: Hospitality in the Tropics and Urban Pest Control in France which can be divided into two main groups: a) Mosquito IPM in tropical, high-end luxury game reserves in RSA b) Urban pest control in Europe.

The factory testing of the system and service components was successfully concluded in May 2021. Additional SenZitall pilot demonstration activities are planned for July-December 2022 at selected locations in: Belgium, Turkey, South Africa, and Guadeloupe, French overseas territories in the Caribbean.

 

## 6.5 Forest Carbon Monitoring

Funding Source: ESA
Start Date: July 2021
Duration: 24 months
Website: https://www.forestcarbonplatform.org/

The Forest Carbon Monitoring project implements a prototype of a cost-efficient monitoring and accounting platform for forest carbon stock based on satellite remote sensing approaches supported by in-situ datasets. A single platform that is open and commonly shared will enable the quantification of carbon with comparable results worldwide. This will help policy-makers shape better decisions based on highly accurate data. It will also support policy implementation on national and international levels through improved reporting and verification capabilities.

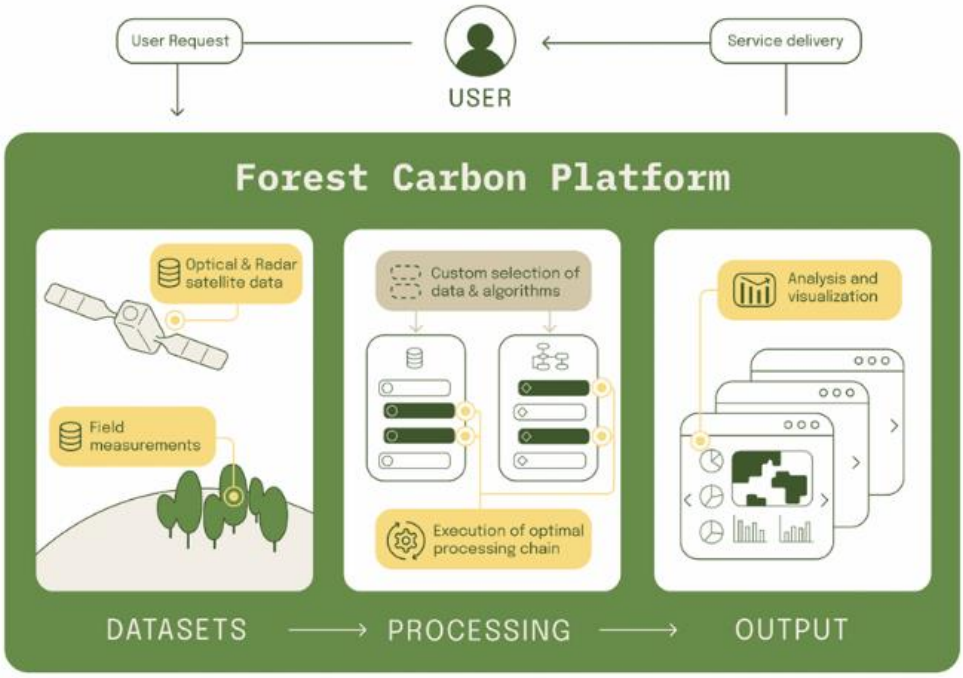


*Figure 25. The "Forest Carbon Monitoring" approach*

The monitoring system will be built on the Forestry TEP[22] cloud-processing platform, forming a foundation for operational forest carbon services. These services will enable reliable Measuring, Reporting and Verification (MRV) processes for forest carbon, following the IPCC Good Practice Guidance (GPG) and guidelines that are further defined in the Methods and Guidelines Document (MGD) of the Global Forest Observation Initiative (GFOI). Demonstration and validation of the developed services will start on January 2023. System piloting through demonstration cases will include local cases aimed for private companies, regional to national

[22] https://f-tep.com/

 

cases for administrative agencies and a European wide demonstration for international agencies.

## 6.6 Soil Signal

Funding Source: ESA
Start Date: 2021
Duration: N/A
Website: https://business.esa.int/projects/soilsignal

SoilSignal aims to provide an agricultural monitoring service for farmers by using Earth Observation and state-of-the-art machine learning tools. SoilSignal's main objective is to provide a decision support tool for soil health including measuring, predicting and providing irrigation and fertiliser recommendations.

Currently, crop management decisions including water and fertiliser are based on either local ground samples collected on a regular basis during the growing season or using generalised agronomic models that provide limited profit opportunities for growers.

SoilSignal is deployed on Deep Planet (https://www.deepplanet.ai/) existing AI platform and web portal that provides highly accurate predictions and effective prescription. Users are able to monitor their farms, to optimise their irrigation and fertiliser management as well as to increase their yield. Regular monitoring, specific recommendations, work order management system and digital agronomist help farmers to take corrective actions in order to improve outcomes and reduce costs, including the replacement of expensive ground sensors.

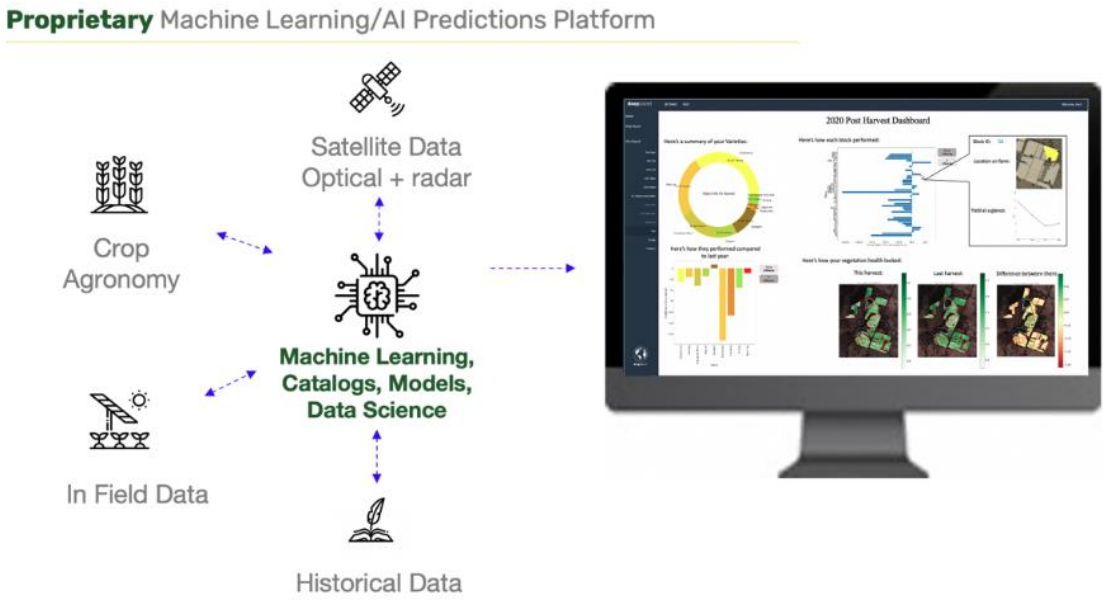


*Figure 26. Soil Signal's approach on soil health monitoring*

 

## 6.7 Conclusions on ESA EO research projects

The above EO based projects are indicative of the trend towards offering to a wide range of stakeholders' information, tools, and advice in order to optimise their decision-making processes, reduce administrative burden, improve transparency, maximise benefits, and protect the environment. Monitoring and evaluation are key elements in their methodologies, although not always directly related to the CAP. Research tries to exploit more and more data sources, combining traditional with advanced types, whilst developing ICT technologies to overcome challenges related to the rural environment.

All the above approaches are promising, but there is a lack of efficient coordination, especially about how the achieved results of these research projects could be adapted for addressing targeted challenges on a horizontal manner also including the needs of CAP monitoring and evaluation. Each project focuses on its own data, stakeholders, and challenges without an explicit connection to a general framework.

For example, in most of these research initiatives there is a need of creating datasets of ground truth evidence that will assist the training of knowledge extraction algorithms of satellite observations, thus avoiding the costly process of in-situ sampling. Algorithms' performance is highly related to the quality of the training data-sets and a collaboration of this task would be beneficial for all the research initiatives. In addition, most commonly, projects face issues about the data privacy concerns and the robustness of the data flows while they try to improve standardization processes and foster the involvement of the various stakeholders.

 

# 7. Conclusions

This deliverable provides a detailed overview of the established liaison connections of MEF4CAP project with the most prominent EU projects focusing on ICT solutions and methodologies in the agri-food domain. All liaison activities' key outcomes are presented in order to assess the more advanced technological approaches that are under research and development. The final list of projects and initiatives that collaboration channel have been established is the following:

- H2020 DEMETER project
- H2020 ENVISION project
- FaST project
- Open IACS project
- H2020 MIND STEP project
- H2020 DIONE project
- H2020 NIVA project

The conducted analysis of the current results for each project is based on two main sources:

a) Review of already published results. The main sources of information are published deliverables, information available at project's website, and presentations (slides) available from various public events.

b) Analysis of the meeting minutes recorded during the sessions (on-line meetings) organised with the MEF4CAP project.

Within this deliverable and for each project a short summary of outcomes is provided, including also the relevance of the project's objectives with the MEF4CAP, the project's direct or indirect relation with CAP monitoring and evaluation, and the potential for future collaboration activities.

In the analysis conducted in D2.1 "Landscape of agri-food ICT technologies within EU" the following categories of technologies and ICT solutions have been identified as relevant and with a potential to have a significant role in future CAP monitoring:

- Telecommunication technologies
- Field sensors
- Farm Management Information Systems
- Agricultural machinery
- Satellite based Earth Observation & Remote sensing services
- Livestock management technologies
- Pasture management technologies
- Platforms for financial information exchange
- Agricultural data models and data sharing strategies

In table 2, a mapping is presented between the MEF4CAP's technological areas of interests and the potential of contribution by the conducted projects.

 

*Table 2. Technological opportunities*

| Initiative name | Technological opportunities of interest | Further Synergies |
|---|---|---|
| DEMETER | Telecom technologies, Field sensors, Farm Management Information systems, Agricultural machinery, Agricultural data models and data sharing strategies | MEF4CAP will further analyse DEMETER's outcomes on data and system interoperability for digital agriculture solutions.<br>MEF4CAP will monitor outcomes from DEMETER's individual use cases/pilots especially those that are related with automated recording of agricultural practices. |
| ENVISION | Satellite based Earth Observation & Remote sensing services, Pasture management technologies | ENVISION is considered by MEF4CAP as one of the most related projects with regards to future CAP monitoring. Most of the ENVISION's specified solutions are still under development. Follow up collaboration actions will be realised the following months in order to collect and evaluate the respective outcomes. |
| FaST | Satellite based Earth Observation & Remote sensing services, Farm Management Information Systems, | FaST is considered as highly related with MEF4CAP's objectives. FaST tool is already in use in a number of countries, however there are still no clear outcomes with regards to farmer's adoption and that not all the designed features are yet implemented and tested. MEF4CAP will proceed with follow up collaboration actions in order to collect more outcomes on this project. |
| Open IACS | Agricultural data models and data sharing strategies | Open IACS aims to offer next generation services focusing especially on data interoperability for national/regional Paying Agencies in EU. Available documentation on Open-IACS objectives and current outcomes are limited and this fact doesn't allow the direct monitoring of project's results. Additional collaboration and results exchange actions will be realized. |
| MIND STEP | Platforms for financial information exchange, Agricultural data models and data sharing strategies | MIND STEP aims to develop a highly modular and customisable Decision Making models aiming to better analyse impacts of policies (CAP). MIND STEP integrates various data sources and develops and applies methodologies to merge economic and biophysical data sets of spatial and temporal resolution.<br>MEF4CAP will continue the collaboration activities with MIND-STEP aiming to get more insights on the integration of - CAP related-economics data sources and on how to achieve an advanced exploitation of information sources like FADN. |

 

| | | |
|---|---|---|
| DIONE | Satellite based Earth Observation & Remote sensing services, Field sensors | Both MEF4CAP and DIONE projects are focusing on the evolution of the CAP and aim to find flexible mechanisms in order to enable successful monitoring and compliance checks.<br>DIONE elaborates on mechanisms for EO and in-situ based monitoring.<br>Collaboration with DIONE will continue in order to get more detailed evaluation results on the tested technologies – especially the MEMS soil quality monitoring sensor and the geo-tagged photos app. |
| NIVA | Satellite based Earth Observation & Remote sensing services, Field sensors, Farm Management Information systems, Agricultural machinery, Pasture management technologies, Agricultural data models and data sharing strategies, | NIVA project addresses the needs of future CAP monitoring in a holistic way. The monitoring tools and methodologies that have been developed and currently are under evaluation in NIVA are of high importance and directly related with MEF4CAP. MEF4CAP plans to closely monitor and evaluate these outcomes and to ogranise follow up meetings with NIVA representatives. |

The next round of collaboration activities will be realised through the sharing of MEF4CAPs outcomes documented in reports and deliverables. In addition, a series of national workshops are planned where results from MEF4CAP's demonstration cases (WP4) will be presented. In these workshops representatives from research initiatives with established collaboration channels will be invited and feedback on the presented results will be collected. A final round of collaboration interactions will be realised with regards to WP6- Synthesis and road map.

 

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# Annex

## Annex A – Invitation letter for collaboration

*"Dear _____ project representatives,*

*The purpose of this email is to declare the parties' shared willingness to initiate collaboration among Innovation Action "_____" and Coordination and Support Action (CSA) "MEF4CAP-Monitoring and Evaluation Frameworks for the Common Agricultural Policy (101000662)".*

*MEF4CAP (https://www.mef4cap.eu/), which is funded under the topic "FNR-02-2020: Developing long-term monitoring and evaluation frameworks for the Common Agricultural Policy", focuses on the development of methods and performance indicators for the effective Monitoring and Evaluation (M&E) of the policies applied in the context of the future Common Agricultural Policy (CAP).*

*The MEF4CAP project is designed to draw on the insights and perspectives of all relevant stakeholders to identify best practices, ensure the inclusion of all relevant developments and to discuss the potential of widening their application.*

*Based on collected information, MEF4CAP will identify future pathways through which the novel policy data needs can be addressed, using different technological and methodological approaches. MEF4CAP will make an inventory of future data needs for M&E, describe the current developments in ICT and data capturing techniques and assess the technological readiness of these solutions. Finally, the project will deliver a roadmap for future monitoring, where the needs of different stakeholders are met, and the potential of different approaches is fully and optimally exploited.*

*In the context of the requested cooperation among the two initiatives we invite to share with us the related outcomes e.g. deliverables, demonstration actions, workshops. On behalf of MEF4CAP we are also declare our willingness to proceed with the organisation of joint initiatives.*

*In addition, the following actions will be required by your side:*

*a) Provide your experts opinion by replying on a set of questions that will be send to you by MEF4CAP*

*b) If necessary, to participate in at least one conference call with MEF4CAP representatives in order to further elaborate on yours organisation/project recent outcomes on the topics of interest for the MEF4CAP project.*

*To better facilitate the liaison among the two projects, please indicate a person (name and email) that will act as contact point.*

*Looking forward for your reply,*

*(MEF4CAP representative) "*

 