Research and Innovation Action
HORIZON-CL6-2022-GOVERNANCE-01
TOPIC: HORIZON-CL6-2022-GOVERNANCE-01-11

AgriDataValue

Smart Farm and Agri-environmental Big Data Value

Deliverable D6.11
Practice Abstract Volume 1

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Nature	Document
Dissemination	PU – Public
Version	V1.0
Status	Final
Delivery Date (DoA)	30/06/2024 (M17)
Actual Delivery Date	30/06/2024 (M17)

Keywords	Practice abstract, EIP-AGRI, Agricultural Data Space, Remote Sensing, Climate Monitoring, CAP
Abstract	This document is the first volume of the anticipated Practice Abstracts to be delivered throughout the duration of the project. In this first volume, the utilisation of remote sensing, climate monitoring, and machine learning in agricultural activities is captured.

Funded by the European Union under Grant Agreement no. 101086461

ACKNOWLEDGEMENT

The AgriDataValue project is funded by the European Union under Grant Agreement No. 101086461. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Research Executive Agency, while neither the European Union nor the granting authority can be held responsible for any use of this content.

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Document History

Version	Date	Contributor(s)	Description
V0.1	10/06/2024	A. Zacepins, I. Berzina (ZSA)	Document initialisation
V0.2	25/06/2024	G. Athanasiou, K. Railis, A. Skias, M. Perdikeas, (SYN)	Added two (2) practice abstracts.
V0.3	25/06/2024	A. Zacepins, I. Berzina (ZSA)	Added two (2) practice abstracts. Prepared for internal review.
V0.4	29/06/2024	A. Zacepins, I. Berzina (ZSA)	Addressed reviewers' comments. Submission candidate.
V1.0	30/06/2024	K. Railis, G. Athanasiou(SYN)	Document polishings. Final version.

Document Reviewers

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28/06/2024	I. Katris	TBA

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Definitions, Acronyms and Abbreviations

ADS	Agri-Environment Data Space
EIP-AGRI	European Innovation Partnerships for Agricultural Productivity and Sustainability
GAEC	Good Agricultural and Environment Conditions
ML	Machine Learning
NDVI	Normalised Difference Vegetation Index
PA	Practice Abstract
SMR	Statutory Management Requirements
TCI	Temperature Condition Index
VHI	Vegetation Health Index
WP	Work Package
WPL	Work Package Lead

Executive Summary

The document is the first volume of a series of Practice Abstracts that are going to be delivered throughout the duration of the project, as mandated by the European Innovation Partnerships for Agricultural Productivity and Sustainability. The next two volumes of practice abstracts are anticipated on M34 and M60, as D6.12 and D6.13 respectively.

The first volume of the Practice Abstracts focuses on the following topics:

- PA1: Accurate crop phenology and pest risk prediction utilising Machine Learning (ML)
- PA2: Green ambitions in the CAP and the conditionality system
- PA3: An eye from the sky: Earth observation for studying agricultural droughts and predicting extreme events
- PA4: Strengthening capacities for Agri-Environment Climate Monitoring and Informed Decision Support in smart farming

Due to the unavailability of the EIP-AGRI format for Horizon multi-actor projects 2021-2027, a classic document format was chosen, with the Practice Abstracts to be anticipated in the EIP-AGRI format as soon as it is available.

1 Introduction

This deliverable captures a series of Practice Abstracts (PA), produced in the context of WP6 – *Impact Creation & Outreach* of AgriDataValue project. The practice abstracts captured in this document compose the first volume of the abstracts that are going to be delivered throughout the duration of the project.

The purpose of the practice abstracts is to be finally submitted to the European Innovation Partnerships for Agricultural Productivity and Sustainability (EIP-AGRI) project database [1] in the common EIP-AGRI format, facilitating the flow of knowledge, as well as for dissemination purposes. EIP-AGRI has fostered synergies and complementarities between European Union's research policy and the Common Agricultural Policy's (CAP) rural development policy, a fact which highlights the importance of the practice abstracts under delivery.

This document includes the following practice abstracts:

- PA1: Accurate crop phenology and pest risk prediction utilising Machine Learning (ML)
- PA2: Green ambitions in the CAP and the conditionality system
- PA3: An eye from the sky: Earth observation for studying agricultural droughts and predicting extreme events
- PA4: Strengthening capacities for Agri-Environment Climate Monitoring and Informed Decision Support in smart farming

Due to the unavailability of the EIP-AGRI format for Horizon 2021-2027 multi-actor projects, the PAs have been collected in a regular document. When the appropriate common EIP-AGRI format becomes available, the PAs are going to be submitted as expected.

[1] https://eu-cap-network.ec.europa.eu/projects_en

1.1 PA1: Accurate crop phenology and pest risk prediction utilising Machine Learning (ML)

The constant adjustment of agricultural practices is an essential step to ensure that both the quantity and quality of agricultural production are maintained (or improved), while minimizing environmental impact, particularly on the soil. At the same time, it is essential for agricultural operations to remain economically sustainable. One of the agricultural activities with the greatest environmental and economic impact is the use of *phytosanitary products to control pests*, such as fungi or insects. Limiting their application to instances where they are strictly necessary enhances the sustainability of agricultural operations. To achieve this, treatments must be administered during the specific times and crop phenological stages when they will be most effective, and only if there is a genuine risk of infection or plant damage.

In the literature, there are already developed models for predicting the phenological evolution of plants and the risk of diseases. These models are based on linking field observations of the phenological crop states or of the presence of pests, with meteorological data, such as the daily and average temperature and the environmental humidity. These models can be calibrated to adjust to the characteristics of a particular space, which requires precise meteorological observations and, above all, field observations, which makes their application by farmers in general difficult.

In recent years, advancements in data capturing, processing, and visualisation technologies have enabled the development of more sophisticated models for predicting phenology and disease risk. These models, created by multidisciplinary teams, utilize diverse data sources to make accurate plot-level predictions while remaining general enough to be applicable across various geographical regions. Many of these models apply Big Data and Artificial Intelligence/Machine Learning (AI/ML) technologies to process data from agrometeorological stations, weather forecasts, multispectral satellite images (Sentinel 2), or, among other data sources, from field observations. However, most of these models are still limited to specific geographical areas. One of the reasons for this limitation is the lack of datasets of field observations. AgriDataValue utilises Internet of Things (IoT) sensors' data, drones with visual and hyperspectral cameras and satellite data to train ML models in predicting the accurate crop phenology and pest risk, while proposing actions that lower irrigation water, fertilizing and spraying.

Further development of these models will allow farmers to optimize the use of phytosanitary products, reducing their environmental impact and improving the economic sustainability of their holdings. The developments will also allow them to make better decisions about the timing of harvests, which will improve the quality and marketability of their products.

Figure 1: Synelixis SynField in-situ IoT sensors

Figure 2: Eastern moth caterpillar, a bug affecting peach trees

1.2 PA2 – Green ambitions in the CAP and the conditionality system

For the period 2023-27, the common agricultural policy (CAP) is built around ten key objectives. Focused on social, environmental and economic goals, these objectives are the basis upon which EU countries designed their CAP Strategic Plans. The objectives are: a) to ensure a fair income for farmers; b) to increase competitiveness; c) to improve the position of farmers in the food chain; d) climate change action; e) environmental care; f) to preserve landscapes and biodiversity; g) to support generational renewal; h) vibrant rural areas; i) to protect food and health quality; j) fostering knowledge and innovation.

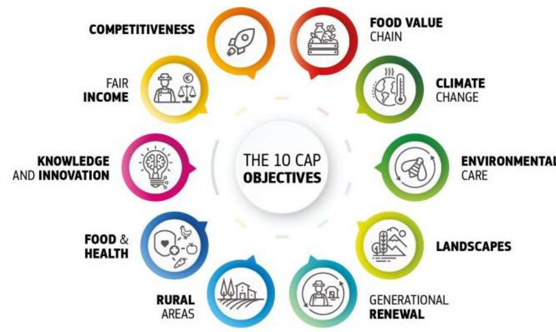

Figure 3: CAP 2023-2027 Objectives

Within the framework of the Common Agriculture Policy (CAP), farmers must comply with certain environmental and climate standards, which form the conditionality system, reflect increased ecological ambitions and consistently contribute to the fulfilment of the objectives of the European Green Deal. Therefore, conditionality plays an important role in increasing the sustainability of European agriculture within the context of CAP. The specific objectives regarding the environment and climate, according to art. 6 (1) of Regulation (EU) No 2115/2021 on CAP Strategic Plans aim at mitigating climate change and adapting to it, a sustainable development and efficient management of natural resources (water, soil, air) and conservation of biodiversity and landscape elements.

Compliance with the rules on conditionality is mandatory for farmers who receive decoupled direct payments, coupled direct payments, compensatory payments through interventions for rural development (environmental and climate commitments, natural constraints or other constraints specific to certain areas, maintaining forested areas) on the entire agricultural holding and throughout the calendar year in question. Conditionality rules include statutory management requirements (SMRs) and good agricultural and environment conditions (GAEC) standards relating to climate and environment, public and plant health and animal welfare.

The way in which the conditionality rules contribute to the specific environmental and climate objectives set out in Regulation (EU) No 2115/2021 is to mitigate the effects of climate change and adapt to it – art. 6(1)(d):

- GAEC 1 – Maintenance of permanent grassland based on a proportional ratio between permanent grassland and agricultural area at national level compared to the reference year 2018. The maximum reduction is 5% compared to the reference year.
- GAEC 2 – Protection of wetlands and peatlands
- GAEC 3 – Prohibition of burning stubble, dry vegetation and plant debris on arable land
- GAEC 4 – Creation of buffer strips (protection strips) along watercourses
- GAEC 5 – Earthworks management, reducing the risk of soil degradation and erosion, including consideration of slope
- GAEC 6 – Minimum ground cover to avoid bare ground during the most sensitive periods
- GAEC 7 – Crop rotation on arable land, excluding crops growing under water
- GAEC 8 – The minimum percentage of the agricultural area dedicated to non-productive areas or elements; Maintenance of landscape elements; Prohibition of cutting hedges and trees during the period of reproduction and growth of birds; Measures to avoid invasive plant species
- GAEC 9 – Prohibition of conversion or ploughing of permanent grassland designated as ecologically sensitive permanent grassland within the perimeter of Natura 2000 sites

1.3 PA3 – An eye from the sky: Earth observation for studying agricultural droughts and predicting extreme events

Remote sensing indicators are crucial for identifying and assessing agricultural droughts because they can provide extensive and timely information across large geographical areas. These indicators, derived from satellite imagery and sensor data, provide an aerial perspective on vegetation health, moisture content, and temperature variations, all of which are crucial for assessing agricultural conditions. They enable a deeper understanding of vegetation dynamics, allowing for the early detection of stress in crops and vegetation cover. By capturing essential parameters, remote sensing indicators enable the monitoring of changes in vegetation vigor and its response to moisture stress or temperature fluctuations.

Conversely, climatic models are essential for understanding and predicting the potential impacts of climate change on agriculture. They provide valuable insights crucial for sustainable food production. These predictions are indispensable for anticipating shifts in growing seasons, identifying regions at risk of extreme weather events, and assessing changes in water availability. Farmers, policymakers, and researchers can use this information to develop adaptive strategies, optimize crop selection, and implement resilient farming practices. With their capacity to give insights from the future, corresponding decision making, and implementation of proactive and reactive measures equally is ensured.

There are several remote sensing and climate indicators, indicatively:

- The Temperature Condition Index (TCI) which captures vegetation responses to temperature shifts.
- The Vegetation Condition Index (VCI) which quantifies vegetation dynamics to reflect moisture changes.
- The Vegetation Health Index (VHI) - combines the Vegetation Condition Index (VCI) and the Temperature Condition Index (TCI) to evaluate both vegetation and temperature stress.
- The Normalised Difference Vegetation Index (NDVI) - is derived from Red and NIR bands, indicating vegetation presence based on spectral reflectance (intensity of red colour).

The combination of remote sensing with climate indicators is an essential approach for assessing agricultural drought. This integration revolutionizes the methods used to understand, monitor, and respond to environmental challenges. The adoption of these technologies provides policymakers, farmers, and stakeholders with a strong foundation for sustainable agricultural practices, ensuring resilience in the face of changing climate patterns. As society navigates the complex dynamics of climate change, the integration of remote sensing and climate indicators plays a crucial role in developing adaptive strategies and enhancing food security for future generations.

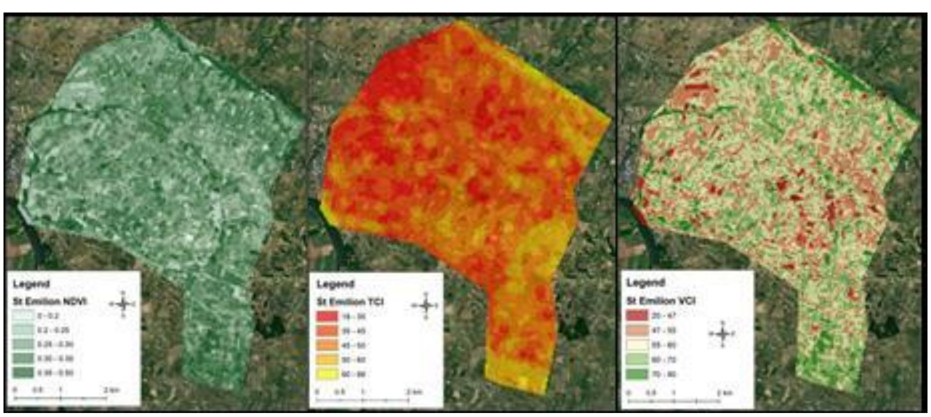

Figure 4: NDVI, TCI and VCI maps of Saint Emilion for summer 2023

1.4 PA4 – Strengthening capacities for Agri-Environment Climate Monitoring and Informed Decision Support in smart farming

AgriDataValue, a pioneering initiative in Smart Farming, focuses on several multidisciplinary branches in the sector of agriculture and recognizes the critical role of climate variability and change in affecting agricultural production, biodiversity, and food security. Through the integration of diverse agricultural data, including micro-climate measurements and projections (small and large scales), soil conditions, and pest developments, AgriDataValue seeks to provide farmers with actionable insights as adaptation strategies to extreme climate changes aiming for risk mitigation. The initiative also aims to achieve the key objectives outlined in the EU Common Agricultural Policy (CAP) strategy for the period 2023-2027.

To foster Agri-climate monitoring, AgriDataValue has selected and adopted a number of methodologies for potential application which are presented in the next figure.

Figure 5: Agri-climate monitoring methodologies

Moreover, implements a Decision-Support System (DSS) which on five main components which are: a) Climate data analysis, b) Climate projection models, including air temperature forecasting (small-scale and large-scale projections) c) Crop growth, Livestock, and Agro-economic models, including simulation of crop growth and livestock and estimating along with agro-economic reactions using the forecasted air temperature, d) Vulnerability analysis, including observation of the tendencies in climate and the change in its extreme conditions and analyzing vulnerabilities in the simulated and estimated results about the impact of climate change on agriculture and livestock and finally e) Decision support component, which provides to the user informed decision support as suggested adaptation strategies to climate impact on crops, soil, livestock, and biodiversity.