Research and Innovation Action
HORIZON-CL6-2021-FARM2FORK-01
TOPIC: HORIZON-CL6-2021-FARM2FORK-01-18

NESTLER
oNe hEalth SusTainabiLity partnership between EU-AFRICA for food sEcuRity

Deliverable D4.2
NESTLER frontend implementation of GIS services

Authors	D. Bellos (CEO), A. Bagltatzi (CEO), D. Sykas (CEO)
Nature	*Demonstrator*
Dissemination	*PU*
Version	*1.0*
Status	*Final*
Delivery Date (DoA)	*M24*
Actual Delivery Date	*30/09/2024*

Keywords	*Dissemination, Communication, Activities*
Abstract	*This document outlines the NESTLER consortium's Dissemination and Communication activities during the first 18 months of the project. It presents the participation in events, the organization of workshops, the publications and communication activities over the social media and website of the project*

Funded by the European Union under Grant Agreement no.101060762

DISCLAIMER

	Participant organisation name	Short	Country
01	SYNELIXIS SOLUTIONS S.A.	SYN	EL
02	CloudEO AG	CEO	DE
03	RINIGARD DOO ZA USLUGE	RINI	HR
04	EBOS TECHNOLOGIES LIMITED	eBOS	CY
05	STICHTING IDH SUSTAINABLE TRADE INITIATIVE	IDH	NL
06	ZANASI ALESSANDRO SRL	Z&P	IT
07	AGRIX TECH SARL	AGRI	CM
08	CONSERVATION THROUGH PUBLIC HEALTH	CTPH	UG
09	THE INTERNATIONAL CENTRE OF INSECT PHYSIOLOGY AND ECOLOGY LBG	ICIPE	KE
10	ETHIOPIAN INSTITUTE OF AGRICULTURAL RESEARCH	EIAR	ET
11	RWANDA AGRICULTURE AND ANIMAL RESOURCES DEVELOPMENT BOARD	RAB	RW
12	INTERNATIONAL INSTITUTE OF TROPICAL AGRICULTURE	IITA	NG
13	MANA BIOSYSTEMS LIMITED	MANA	UK
14	UNIVERSITY COLLEGE LONDON	UCL	UK
15	RINISOFT LTD	RINIS	BG

ACKNOWLEDGEMENT

This document is a deliverable of NESTLER project. This project has received funding from the European Union's Horizon Research and innovation programme under grant agreement № 101060762.
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 that may be made of the information it contains.

Document History

Version	Date	Contributor(s)	Description
V0.1	15.09.2024	CEO	Initial Version
V0.2	26.09.2024	IDH, RAB	Internal review
V0.3	27.09.2025	CEO	Updated version
V0.4	28.09.2024	SYN	Quality review
V1.0	30.09.2024	SYN	Final Review and Submission

Document Reviewers

Date	Reviewer's name	Affiliation
26.09.2024	Prof Eniola Fabusoro	IDH
26.09.2024	Dr Pascal Nyabinwa	RAB

Table of Contents

List of Figures 5
List of Tables 6
Definitions, Acronyms and Abbreviations 7
Executive Summary 8
1. Introduction 9
2. Intuitive Design of NESTLER Dashboard 10
2.1. Requirements and Purpose 10
2.1.1. Project requirements 10
2.1.2. User requirements 10
2.2. Visualization components 12
2.3. Dashboard Pages and Design 13
2.3.1. Pages and content 13
2.3.2. Colour palette and font 13
3. Frontend Implementation 15
3.1. Technologies used 15
3.2. URL 16
3.3. Connection of frontend with backend 16
3.3.1. Matching frontend functionality with backend API 16
3.3.2. Connection with MinIO 17
3.4. Dashboard functionalities and pages 17
3.4.1. Elements and functionalities 17
3.4.2. Implementation of pages 22
4. Conclusion 29
5. Annex 1 – Use Case Mapping 30
6. Annex 2 - Questions to Pilot Leaders 31

List of Figures

Figure 1: : NESTLER Dashboard pages template design 13

Figure 2: Main technologies, libraries and their versioning used for the frontend of the NESTLER Dashboard and its elements. 16

Figure 3: Locust alert example. 18

Figure 4: User input form for pest infestation alert. 18

Figure 5: Interactive map for pest outbreak forecast. 19

Figure 6: Satellite view over a site with the specific date selection from the user, and daily land surface temperature elements. 20

Figure 7: Dashboard element for crop yield quality estimation 21

Figure 8: Dashboard element for crop yield quality estimation 21

Figure 9:One Health' landing page and its elements. 23

Figure 10: The Pilot 1 - Use Case 1 page of the NESTLER dashboard and its elements. 24

Figure 11: Pilot 2 page of the NESTLER dashboard and its elements. 25

Figure 12: The Pilot 3 - Use Case 1 page of the NESTLER dashboard and its elements. 26

Figure 13: The Pilot 3 - Use Case 2 page of the NESTLER dashboard and its elements. 26

Figure 14: The Pilot 5 - Use Case 1 page of the NESTLER dashboard and its elements. 27

Figure 15: The Pilot 6 page of the NESTLER dashboard and its elements. 28

List of Tables

Table 1: Mapping of data source types, corresponding information for inclusion in the NESTLER dashboard, and actions taken by pilot owners to determine their visualization requirements. 11

Table 2: Association of the selected dashboard components with relevant content and functionalities..............12

Table 3: Colour palette used for the NESTLER Dashboard. 14

Table 4: Dashboard data and their NESTLER API endpoints 16

Definitions, Acronyms and Abbreviations

ACR	Acronym
DoA	Description of Action
ToC	Table of Content
WP	Work Package
WPL	Work Package Lead
GIS	Geographic Information Science
API	Application Programming Interface
ID	Identity Document
CSS	Cascading Style Sheets

Executive Summary

This document provides an overview of the design, development, and implementation of the NESTLER dashboard, aimed at facilitating One Health data visualization and analysis. The report begins by outlining the project and user requirements, which serve as the foundation for the intuitive design of the dashboard. It then delves into the visualization components, layout, and design choices, ensuring that the dashboard meets the needs of diverse users.

The frontend implementation section presents the technologies used, the integration of frontend and backend functionalities, and the specific elements and pages developed. Key considerations include seamless connection with backend APIs and efficient data handling using MinIO. The document concludes with a summary of achievements and future development plans, ensuring the NESTLER dashboard continues to evolve and support the project's goals effectively.

1. Introduction

The NESTLER project aims to develop a robust WebGIS dashboard that supports the One Health approach by enabling effective visualization and analysis of health-related data. This document builds upon previous deliverables and provides an in-depth account of the design and development process undertaken during the first phase of the project.

Section 2 covers the intuitive design of the dashboard, starting with a detailed analysis of both project-specific and user-specific requirements. It then explores the visualization components that form the core of the dashboard, followed by a discussion on the design of dashboard pages, including choices of colour palettes and font. Section 3 focuses on the frontend implementation, describing the technologies employed, the integration of frontend and backend systems with code examples, and the development of various dashboard functionalities.

The document concludes (Section 4) with a summary of findings and outlines the next steps in the dashboard's development, reinforcing the commitment to creating a versatile tool that meets the evolving needs of the NESTLER project and its stakeholders.

2. Intuitive Design of NESTLER Dashboard

2.1. Requirements and Purpose

The objective of the NESTLER Dashboard implementation lies on three different axes:

- the first is **to develop an intuitive visualization toolkit that allows for the interaction of end-users with relevant information generated from the platform**. Visualization increases efficiency by allowing users to quickly access and interpret information, which is particularly helpful when dealing with large datasets, as is the case of NESTLER datasets that will be analysed in the next chapters.

- The second pillar is **to visualize information that is user-centric and will provide different modality of information sources**. In this way, the dashboard will significantly improve the user experience by presenting data in an easy-to-understand, visually appealing format, allowing users to quickly grasp insights. This ease of use also enhances decision-making, as interactive tools make it simpler to analyze complex data, empowering users to make more informed choices based on clear patterns and relevant information.

- Lastly, the third axis is **to formalize application programming interfaces (APIs) which will be used to interface with external platform services that are currently operational**. This formalization will ensure a reliable framework of interaction among frontend, backend, and any external services that are required to be integrated into the NESTLER system, for example, to ingest latest captured data from the NESTLER sensors.

2.1.1. Project requirements

The design of the NESTLER dashboard has been implemented taking into consideration the project objective SO7, namely the “Implementation and integration of data analytics tools and NESTLER visualization dashboard”. Specifically, and according to the Grant Agreement, the dashboard will:

- *“incorporate recent innovations in front-end technologies and integrate software services for visualising GIS systems”*
- *“offer accurate mapping of information sources collected from several sources to be plotted on the geographical maps for evaluating risk assessments, and potentially model the impact of health outbreaks”*
- *“facilitate communication across the stakeholders for the effective development of public health policy frameworks”.*

2.1.2. User requirements

CEO throughout the first 3 months of the project compiled two documents for the definition of the dashboard visualization requirements from the end user perspective. These documents were entitled “Use Case Mapping” and “Questions to Pilot Leaders”. After the preparation and composition of the documents, they were shared with the NESTLER pilot leaders, who were asked to fill them out, and thus gather the exact user requirements distinctively for each NESTLER pilot use case, in order to proceed with the dashboard design.

The purpose and general content of each of the aforementioned documents are described below.

Document 1: Use case mapping

Before the initial design of the dashboard, a mapping of each use case was implemented, based on the NESTLER D5.1: NESTLER 1st phase pilot demonstrations readiness. Information such as country, type of farming, objectives, and key benefits were all gathered to start working on the requirements per use case. An essential parameter include the size and type of farm, for example, a crop field, a chicken house, or a pond. Such information determines the nature of visualization e.g. a crop field, if the boundaries are known, can be visualized on a map either as an area feature, or as a point feature. A chicken house can be visualized as a point feature, whereas a pond, either as a point or area feature, depending on its size.

Moreover, all the available and under development of NESTLER datasets and service outputs were gathered according to D3.1: Remote Sensing technologies and multi-modal data aggregation protocols. The goal of this step was to define, and cross-correlate which datasets are essential and which service outputs are meaningful for visualization per use case.

All the requested information is summarized in the table below:

Table 1: Mapping of data source types, corresponding information for inclusion in the NESTLER dashboard, and actions taken by pilot owners to determine their visualization requirements.

Category	Information	Action
General information	• Pilot • Pilot ID • Country • Type of farming • Objectives • Key Benefits of Pilot • Location/Area	Prefilled based on submitted deliverable. Applied to all use cases.
Data Visualization	• Map • Image • Video • Audio • Tabular data (e.g. sensors) • Other (e.g. input by user)	Selection of data visualization preferences per use case
Services	• Weather Impact Assessment • Livestock Wellbeing • Insect Population • Crop Yield Quality (sensor-based) • Crop Yield Quality (satellite-based) • Economic risk assessment	Selection of relevant services per use case

Annex 1 includes the spreadsheet where an overview of the data visualization and services requirements has been summarized per use case.

Document 2: Questions to Pilot Leaders

The goal of this questionnaire was to understand the actual needs for data visualization of each pilot and/or use case. It gathered key questions for pilot leaders, aiming to define the data visualization requirements for NESTLER's webGIS and web application. It also included requests for specific location details for each pilot/use case, such as plot and pond coordinates, where necessary.

All questions were collected, collated, and synthesized from the following NESTLER submitted deliverables:

- NESTLER D3.1: Remote Sensing technologies and multi-modal data aggregation protocols
- NESTLER D5.1: NESTLER 1st phase pilot demonstrations readiness

The available answers of the pilot leaders can be found in Annex 2.

2.2. Visualization components

Taking the above project and user requirements into account, several features have been selected as the visualization components of the dashboard.

Table 2: Association of the selected dashboard components with relevant content and functionalities

NESTLER Dashboard Component	Content and Functionalities
Pilots' generic information	• Country and location • Pilot leader and NESTLER partners • Short description • Objectives
User input	Dependent on pilot: • Selection of e.g. plot for relevant visualization in dashboard • Data input option as specified in D5.1 (e.g. planting methods, flowering, fruit set time, etc) • Pest infestation type (for crops) • Disease type (for livestock, aquaculture, insect)
WebGIS	• Map viewer • Zoom in/out, pan, etc • Interactiveness: relevant graphs and pop-up info on-click
Data	• IoT/Sensor measurements for environmental, weather, and water variables. • Static imagery, video, and audio files (links to content). • Locations of crop fields, ponds, stations, etc

Services' output	Dependent on service output data format: • Maps (interactive or static) • Indicators • Graphs • Tables

2.3. Dashboard Pages and Design

2.3.1. Pages and content

The NESTLER Dashboard will serve as the central hub for the entire platform, featuring seven key pages: one dedicated to "One Health" and six individual pages for each of the NESTLER Pilots. This structure was chosen to provide users with clear updates on the status of each pilot, supporting both user engagement and dissemination efforts. The "One Health" page consolidates data from various sources, including station measurements and alerts from the NESTLER Pilots, and presents them on interactive maps for risk assessment evaluations and health outbreak modeling.

A template design of the pages is illustrated in the figure below. Generally, the left side of the page offers an overview of the respective webpage, including key information such as pilot objectives, specific use case goals, location (both as text and displayed on an interactive Web GIS), and the lead partner. On the right side, a flexible dashboard is featured, containing various blocks with diverse types of information specific to each use case. As each use case has unique objectives and visualization requirements, the content of these blocks varies accordingly.

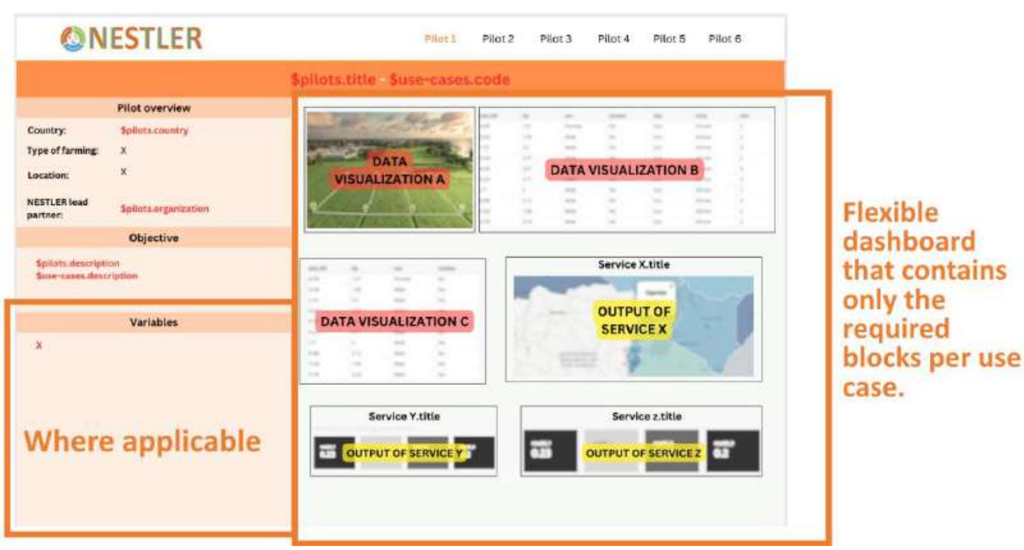

Figure 1: NESTLER Dashboard pages template design

2.3.2. Colour palette and font

The colours of the primary and secondary elements on the NESTLER dashboard, along with the background and block colours, align with the NESTLER website's colour palette. These are outlined in the table below:

Table 3: Colour palette used for the NESTLER Dashboard.

Usage	Colour	HEX Code
Main	Orange	#DB6E1B
Secondary I	Medium Orange	#FFCDAF
Secondary II	Light Orange	#FFEDE2
Background	Grey	#F9F9F9
Blocks	White	#FFFFFF

The same applies to the font used throughout the dashboard. The chosen font is Montserrat.

3. Frontend Implementation

3.1. Technologies used

The NESTLER dashboard leverages the latest advancements in frontend technologies and integrates software services for GIS visualization. Python and Shiny were used for the development of the dashboard functionalities. Shiny utilizes a reactive execution engine to minimize unnecessary re-rendering, ensuring outputs are only updated when upstream components change. This approach supports a range of applications, from simple dashboards to complex web apps. By automatically managing app state, Shiny eliminates the need for manual state handling, allowing developers to focus on insights rather than execution. Built on the modern Python web stack with Starlette and asyncio, Shiny provides robust support for CSS and JavaScript customization, enabling rich and interactive user experiences.

For the development of graphs, Matplotlib and Seaborn are used. Matplotlib is versatile and highly customizable, making it ideal for a wide range of visualizations with full control over plot details. It integrates well with various environments and supports many plot types. Seaborn, built on Matplotlib, simplifies complex plotting tasks, offering enhanced aesthetics and easy-to-use functions for statistical visualizations. It's especially suited for quickly creating appealing plots with minimal code.

The Web GIS features are implemented using GeoServer and Leaflet, a JavaScript library. GeoServer is a powerful tool for managing and publishing large-scale geospatial data, supporting multiple formats, and adhering to OGC standards. It allows efficient data sharing and extensive map customization. Leaflet is a lightweight, user-friendly JavaScript library for creating fast, interactive web maps. It offers easy integration with map services and a rich plugin ecosystem for enhanced features. Together, GeoServer and Leaflet provide a robust solution for geospatial data management and interactive visualization.

numpy==1.26.4
pandas==2.2.1
requests==2.31.0
uvicorn==0.29.0
starlette==0.37.2
matplotlib==3.8.4
seaborn==0.13.2
shiny==0.9.0
ipyleaflet==0.19.1
shinywidgets==0.3.2
ipywidgets==7.6.5

Figure 2: Main technologies, libraries and their versioning used for the frontend of the NESTLER Dashboard and its elements.

3.2. URL

The NESTLER Dashboard can be found at the following link: https://dashboard.platform.nestler-project.eu/.

It is noted that for security reasons the URL is not publicly available. Access is restricted and requires whitelisting to ensure authorized use only.

3.3. Connection of frontend with backend

The frontend received data directly from https://api.platform.nestler-project.eu/core/api/v1 (NESTLER CORE API). This connection is established using a Bearer Token.

3.3.1. Matching frontend functionality with backend API

During the launching of the frontend application, there is an initialization phase which creates the configuration file. This configuration file contains all the required information to build the dynamic User Interface (UI) of the frontend. Below you may find specific API calls that are used for the initialization phase:

Table 4: Dashboard data and their NESTLER API endpoints

Description	API Endpoint
Pilot Metadata	https://api.platform.nestler-project.eu/generic/api/v1/pilots
Use Case Metadata	https://api.platform.nestler-project.eu/generic/api/v1/pilots/{PILOT_ID}/use-cases/
Complexes Metadata	https://api.platform.nestler-project.eu/core/api/v1/complexes/

Sensors Metadata	https://api.platform.nestler-project.eu/core/api/v1/sensors/?parcel={PARCEL_ID}
Measurements (data from sensors)	https://api.platform.nestler-project.eu/core/api/v1/sensors/{SENSOR_ID}/measurements/

Please visit API endpoint page for more information regarding responses https://api.platform.nestler-project.eu/core/api/v1/swagger/.

Some Python example calls for obtaining sensor measurements from a pilot site installation:

```
endpoint = f'https://api.platform.nestlerproject.eu/core/api/v1/sensors/{sensor["id"]}/measurements/'

headers = { 'content-type': 'application/json', 'Authorization': f'Bearer {cfg["CORE_API_TOKEN"]}' }

measurements = requests.get(endpoint, headers=headers).json()
```

3.3.2. Connection with MinIO

MinIO is accessed using CORE API under the /assets endpoint. Likewise, a Bearer token is required to request media files. For each Use case in each pilot, a request is made using a unique combination of pilot_id and usecase_id and if media exist (videos or images) they are rendered into the webpage. The endpoint of the media files and, in general, assets for a specific pilot and use case is the following:

https://api.platform.nestler-project.eu/core/api/v1/assets/?use_case={USECASE_ID}&pilot={PILOT_ID}'

A Python example where this endpoint is used is as follows:

```
endpoint = f' https://api.platform.nestler-
project.eu/core/api/v1/assets/?use_case={USECASE_ID}&pilot={PILOT_ID}'

headers = { 'content-type': 'application/json', 'Authorization': f'Bearer {cfg["CORE_API_TOKEN"]}' }

media = requests.get(endpoint, headers=headers).json()
```

3.4. Dashboard functionalities and pages

3.4.1. Elements and functionalities

Up to now, the following functionalities have been developed:

User input

Certain dashboard pages require user input to enhance functionality. For instance, in Pilot 1, users are prompted to enter data such as planting methods, flowering dates, and harvest periods. Similarly, on the One Health page, users can log infestation alerts to generate forecasts and infestation maps. To facilitate this, forms have been integrated into the relevant dashboard pages, allowing users to input necessary data, which will later be displayed in a table format for easy access and analysis.

Interactive map for pest infestation alert

This WebGIS component is a user-friendly tool that displays information on pest outbreaks within specific project areas through an interactive map. It allows users to easily identify infestations by highlighting affected regions. For example, as shown in the figure below, a plot in Nigeria displays a locust alert, while other locations remain pest-free. The map consolidates data from multiple sources, including the NESTLER API, pilot-owner submissions, and a dedicated form on the same page (Figure X). Users can input details such as the type of pest, infestation coordinates, and the date, which are then uploaded into the NESTLER database for seamless tracking and management.

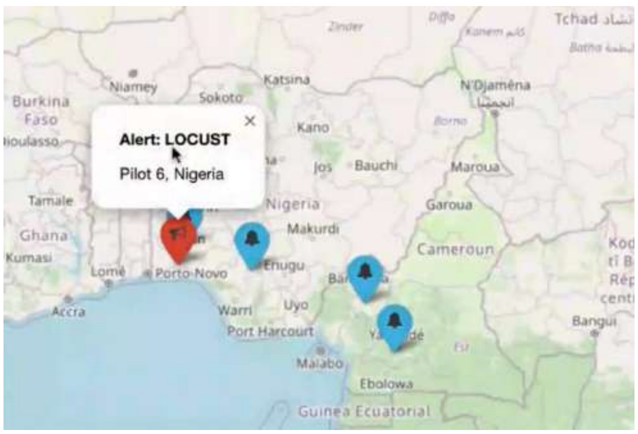

Figure 3: Locust alert example.

Figure 4: User input form for pest infestation alert.

Interactive map for pest infestation forecast

When a new alert is added to the NESTLER database, an algorithm is triggered to simulate a pest outbreak prediction. The results are displayed in a georeferenced video format on an interactive Web GIS interface. Users can seamlessly interact with the map using controls like zoom in, zoom out, play, pause, and pan for smooth navigation and analysis.

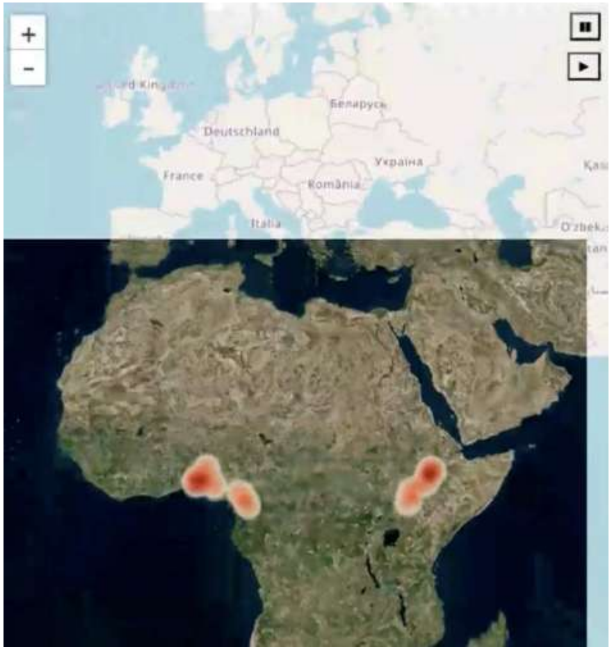

Figure 5: Interactive map for pest outbreak forecast.

Pilot overview, objectives, and interactive map for pilot/use case location

These three elements are included in every pilot page. They consist of the introduction to each pilot and use case, by showing the location and general information of the site and pilot. The pilot overview element includes information such as the site and country where the pilot/use case takes place, as well as the pilot leader. The pilot objectives element presents the goals of the specific pilot/use case, while the geographical location of the respective site is shown within an interactive map; it allows users to explore the site in realtime, offering features like zoom, and pan for easy navigation.

Satellite view and Land Surface Temperature over the pilot/use case site

Satellite view and satellite-based land surface temperature WMS layers have been integrated through a web GIS to provide a high-resolution aerial perspective of the current situation over the broader area of the site, with a daily update. This tool allows users to visually explore and analyze the terrain and/or the land surface temperature, offering daily insights into the site's environment and layout from a satellite perspective. To change the date, a user-friendly calendar option has been added for the user.

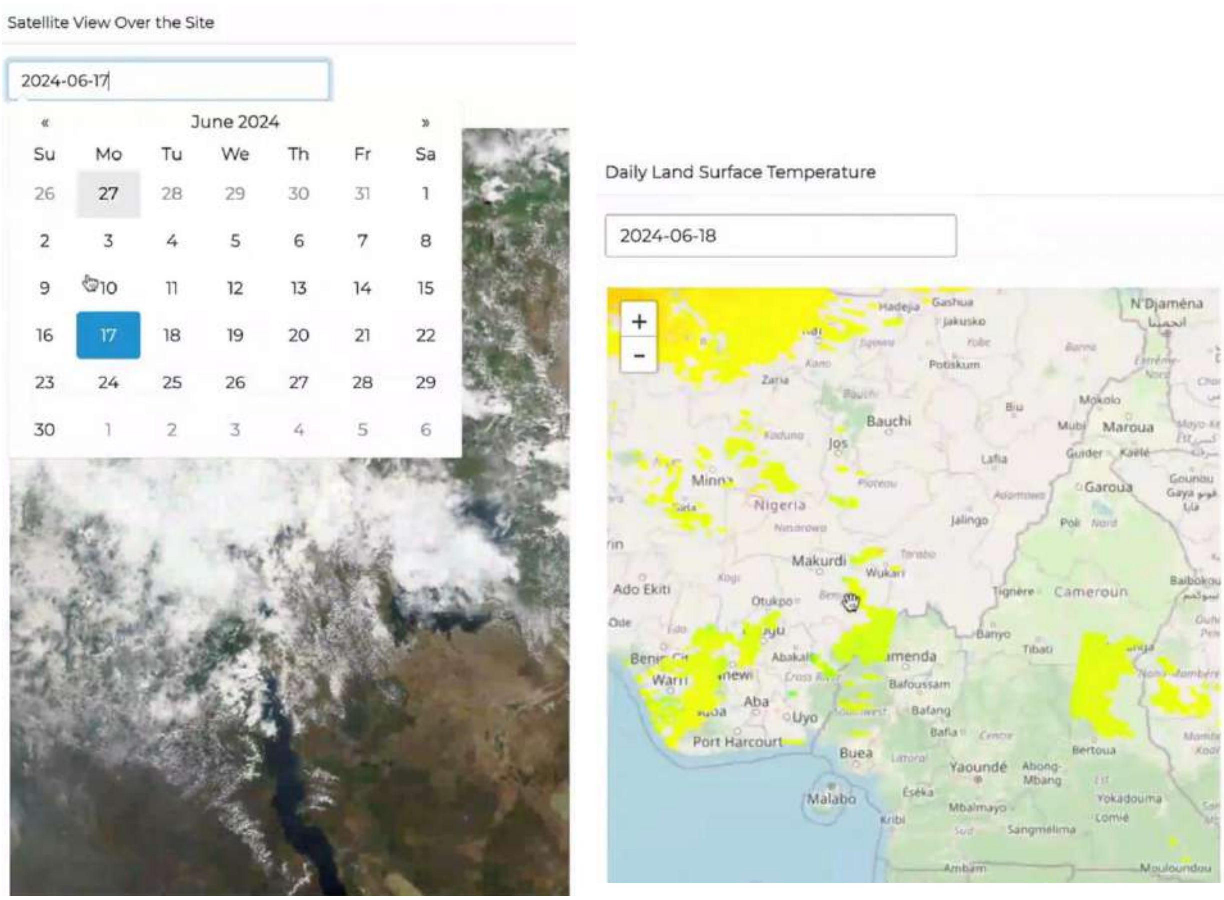

Figure 6: Satellite view over a site with the specific date selection from the user, and daily land surface temperature elements.

Sensor graphs

Sensor graphs provide real-time visualizations of data collected from the NESTLER sensors installed at the use case sites. These graphs allow users to easily monitor and analyze key metrics such as air temperature, air humidity, and solar radiation level, offering clear insights into environmental conditions and sensor performance over time. The showed metrics are selected for each use case based on the requirements provided by the pilot leaders.

Crop yield quality estimation

The Crop Yield Quality Estimation is a web GIS element showing the WMS Layer of the satellite-based crop yield estimation service, as derived from GeoServer. Its functionality is to display monthly-based data on crop yield quality, and to provide users with an interactive map to assess and monitor agricultural performance, offering valuable insights into yield potential and productivity across different regions.

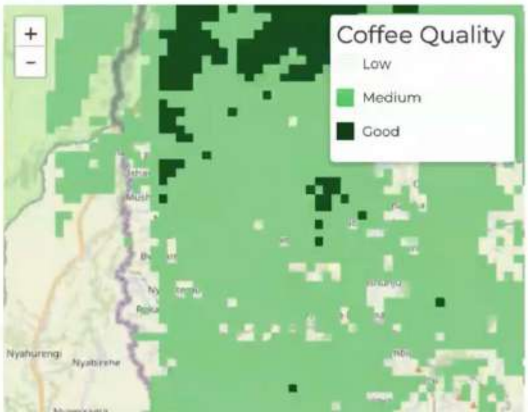

Figure 7: Dashboard element for crop yield quality estimation

Latest video and image footage from the site

This element offers the latest visual updates, showcasing recent videos and images captured at project locations. This feature enables users to monitor site conditions and activities, providing a dynamic and engaging way to stay informed about ongoing developments.

Health status

The Health Status presents the outcome of the pest detection NESTLER algorithm for fish and poultry, providing insights into the well-being of pilots' livestock. This feature enables users to monitor their health status and assess overall conditions, as generated from the uploaded video and image footage, ensuring effective management and care of fish and poultry populations. All media files are retrieved from MinIO through the NESTLER CORE API.

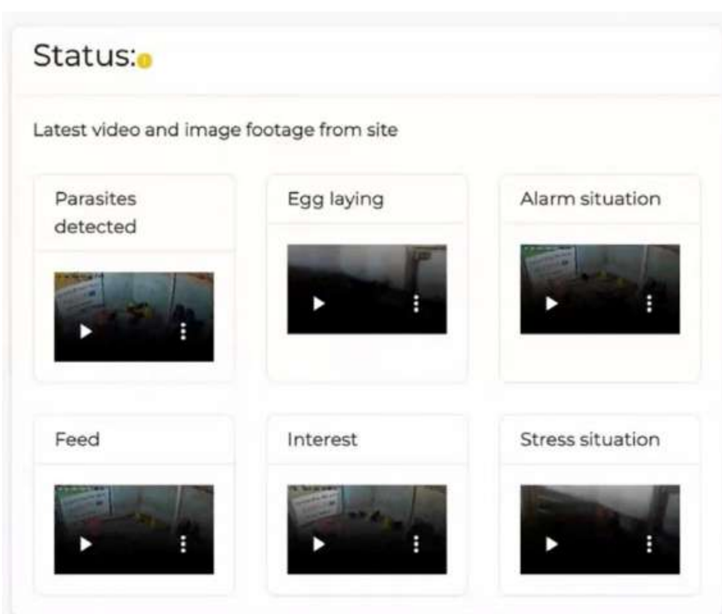

Figure 8: Dashboard element for crop yield quality estimation

Interactive map for current weather and weather forecast

An interactive map for current weather conditions and weather forecasts offers real-time updates over the broader area of the pilot sites. Users can easily explore features such as temperature, precipitation, and wind patterns, providing essential information for decision-making and planning based on the latest weather data.

3.4.2. Implementation of pages

Landing page – One Health

When users first enter, they land on the "One Health" page of the dashboard. There, they can see an overview of the pilot locations, presented visually on a static map and in a detailed table that includes information about the organization and country, among others. As users scroll down, they find a general description of One Health and how the NESTLER project aligns with its goals. One of the main objectives of the project is to identify pest locations and run simulations to minimize the impact of pest diseases over a larger area. To this end, the interactive map for pest infestation alert is placed on this page, for the display of mapped pilot locations along with any alert types. This feature allows users to view the latest pest detection status in pilot areas. An algorithm in the NESTLER system will run simulations based on user input, playing them as a video loop. Currently, the map input is done manually, but eventually, users will be able to submit information through a form by selecting the pest, date, and location, or through the NESTLER service output. Additionally, there is a Web GIS visualization for current weather and weather forecasts, where users can see the forecast for specific locations.

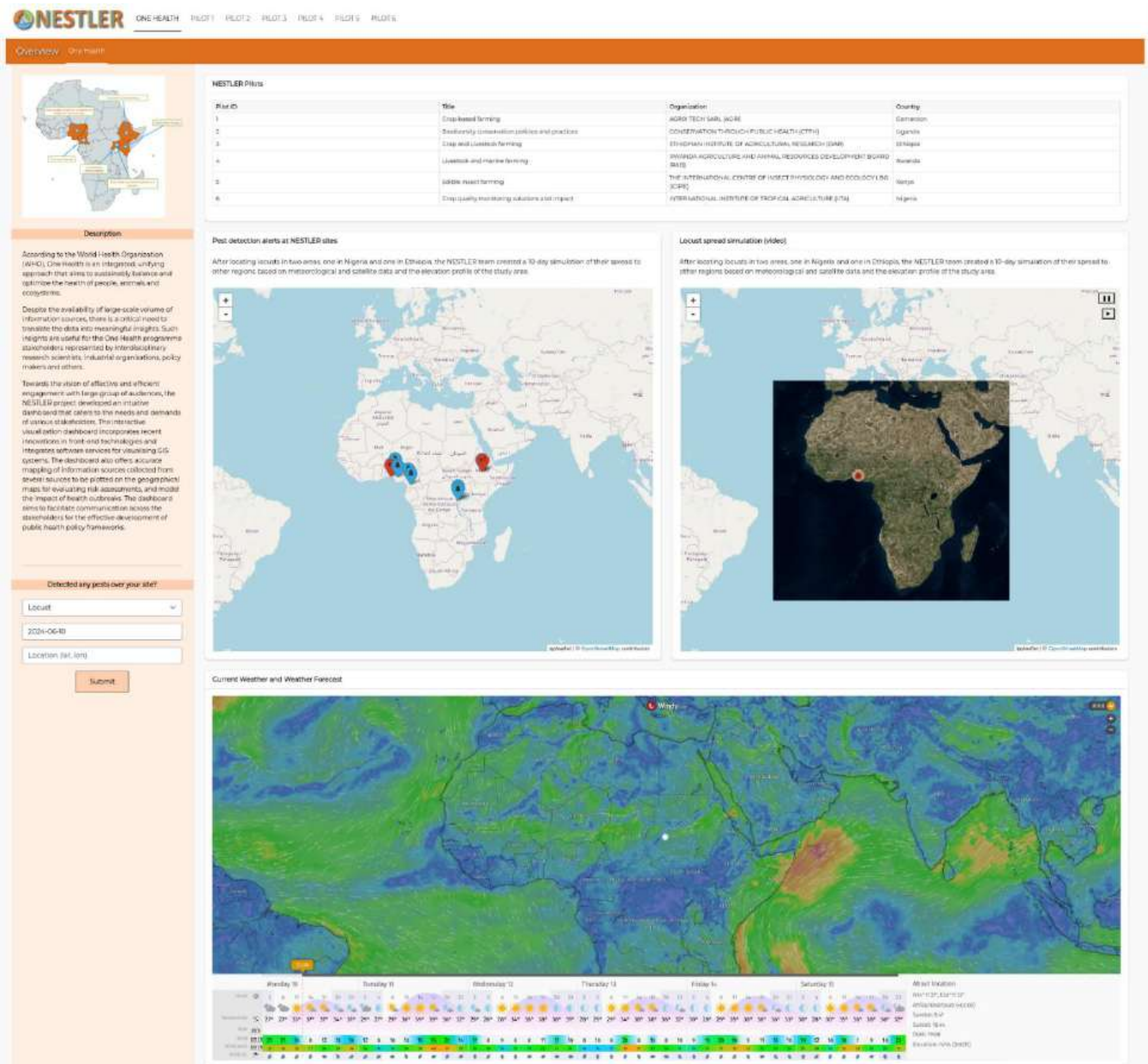

Figure 9:One Health' landing page and its elements.

Pilot 1

Pilot 1 has two use cases, so for each use case, a dedicated tab has been added. For Pilot 1's crop-based farming use case, there is a daily land surface temperature layer where users can select different dates and interact with the map to get an overview of their area. Sensor data graphs are also available, showing parameters requested by the pilot leader. Users can input information about crops through a form, adding specifics such as plot details, date, planting methods, fertilizer applications, and yield per total cost. The second use case for Pilot 1 follows the same structure, with maps, pilot overviews, specific objectives, forms, and sensor graphs.

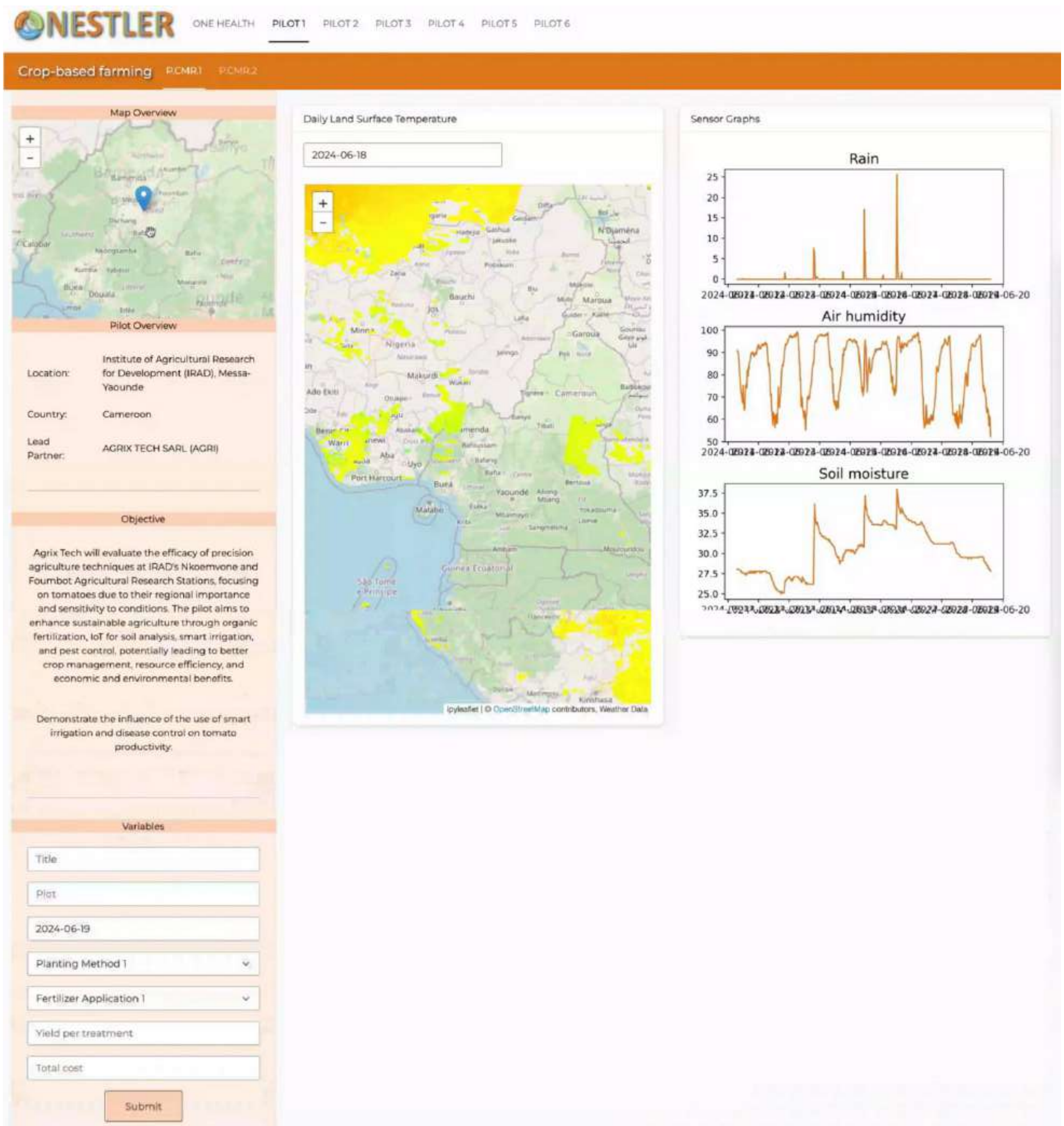

Figure 10: The Pilot 1 - Use Case 1 page of the NESTLER dashboard and its elements.

Pilot 2

Moving on to Pilot 2, users can see a map overview of the pilot location and general information about the specific use case. Features include sensor graphs, a satellite view of the location on a daily basis, and at the bottom, crop yield quality estimation for coffee plantations, the output of a NESTLER service that runs in the background.

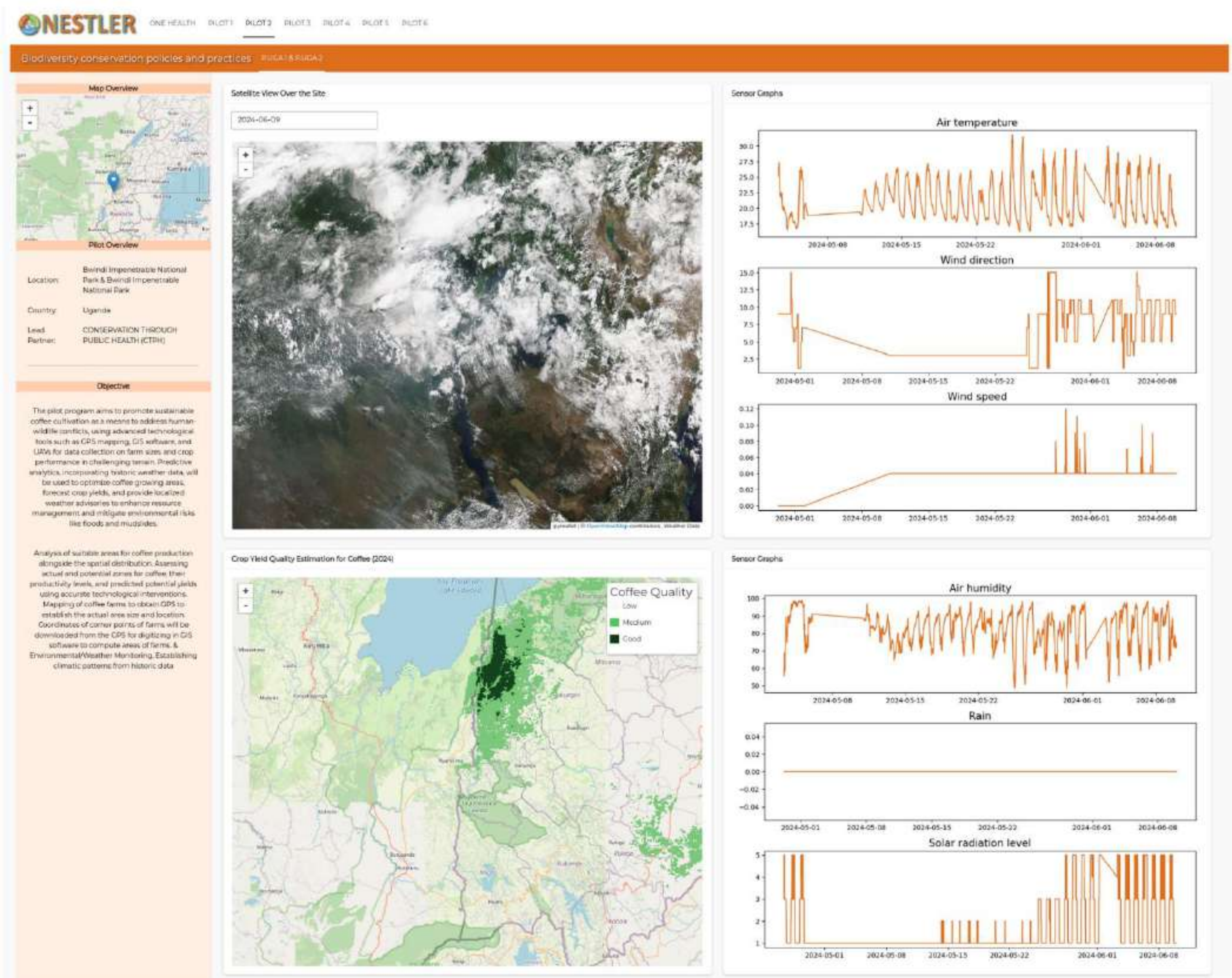

Figure 11: Pilot 2 page of the NESTLER dashboard and its elements.

Pilots 3, 4 and 5

Pilots 3 and 4 focus on crop and livestock farming, while Pilot 5 has a third use case that involves insect farming. Since the content and visualization requirements of the respective use cases is equivalent, the design of the respective pages was also chosen to be the same. A new feature for the crop and livestock farming use cases is the block showing the status of the farm based on video and image footage from the site, derived from the NESTLER database. Users can view videos in full screen to see, for example the exact moment when an anomaly in the behaviour of poultry or fish is detected, e.g due to parasites. The algorithm will update the farm status based on this input. Insect farming use case page includes station measurements, and satellite-based land surface temperature layers for daily monitoring. Weather information over the pilot sites and the broader area is visualized at the bottom of the dashboard for all pages.

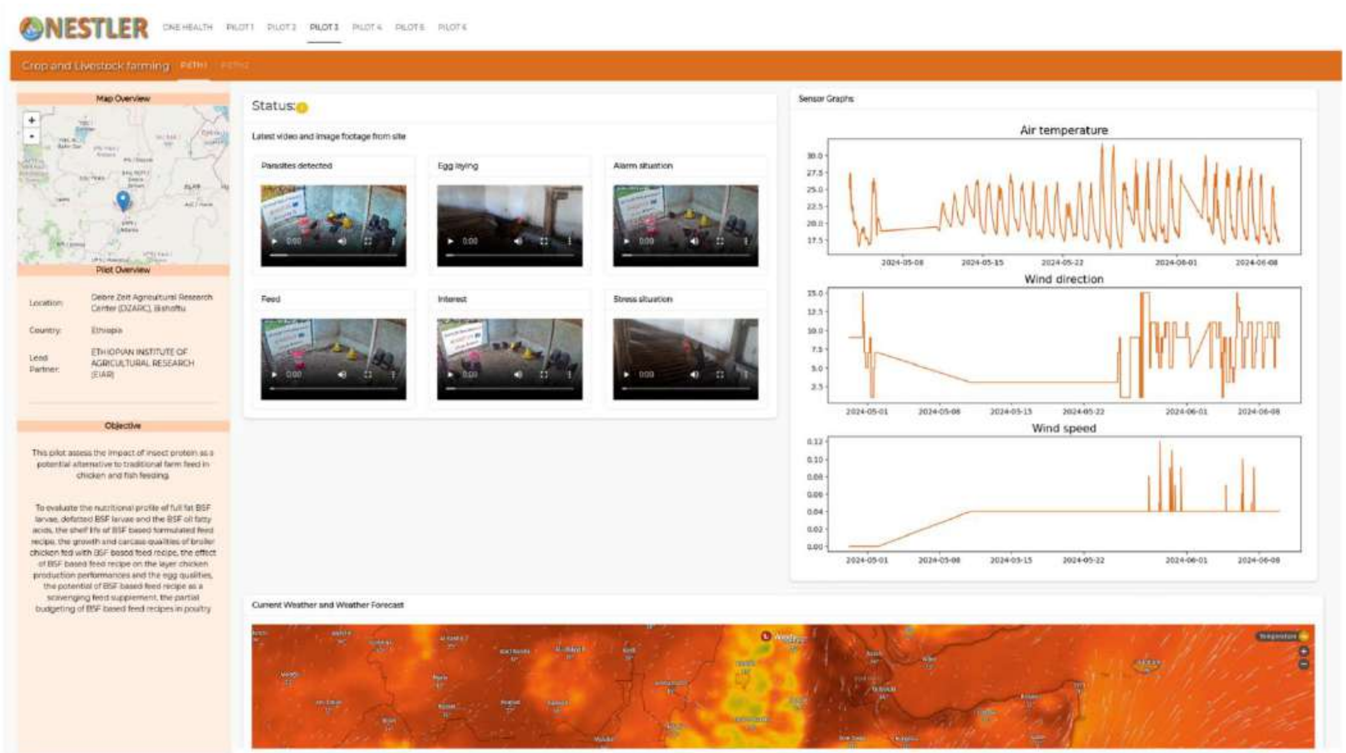

Figure 12: The Pilot 3 - Use Case 1 page of the NESTLER dashboard and its elements.

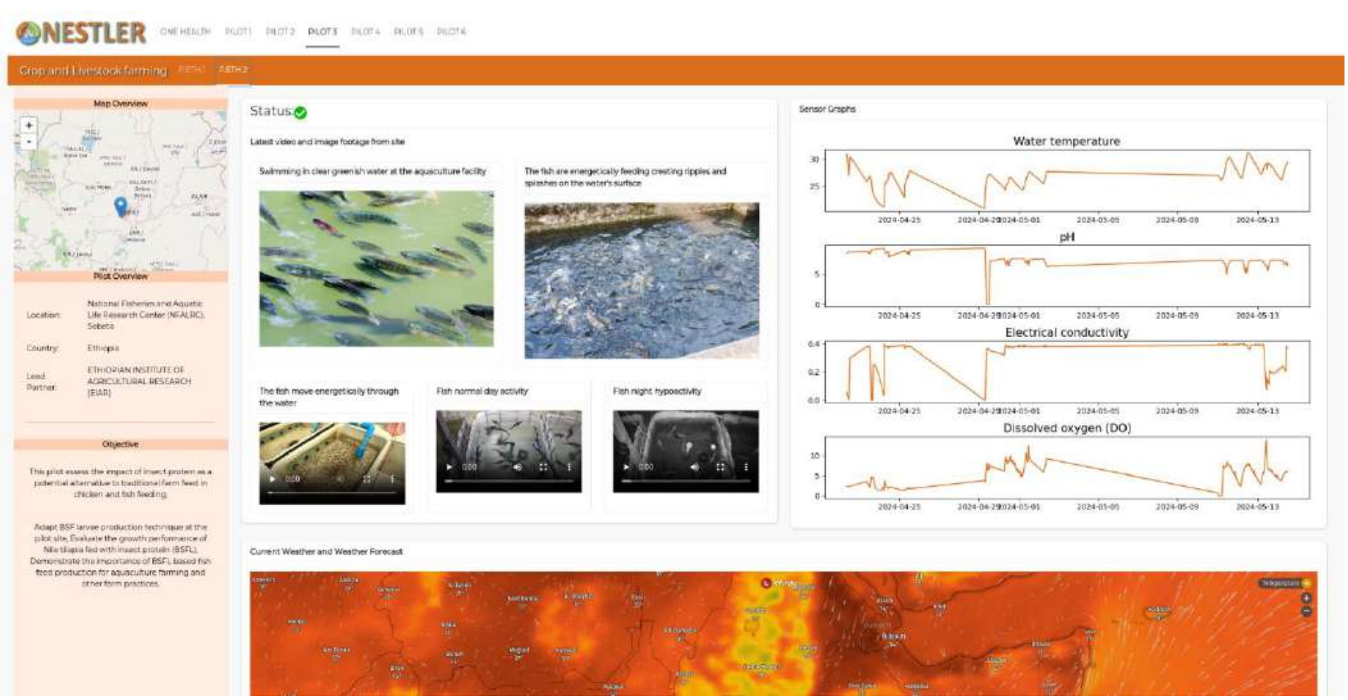

Figure 13: The Pilot 3 - Use Case 2 page of the NESTLER dashboard and its elements.

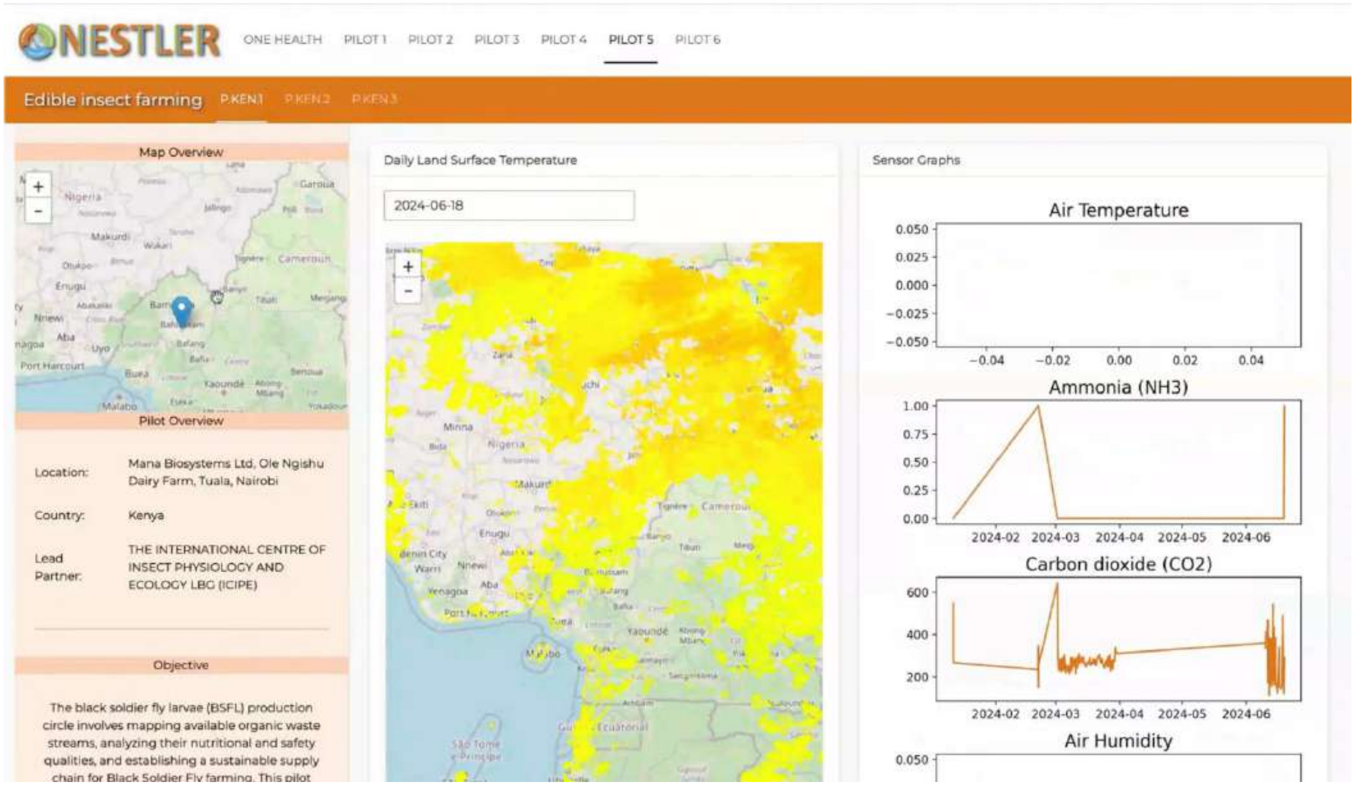

Figure 14: The Pilot 5 - Use Case 1 page of the NESTLER dashboard and its elements.

Pilot 6

Pilot 6 is dedicated to crop quality monitoring solutions and impact. The left side of the page shows the pilot overview and objectives, and a form for user input on specific plots has been added. All relevant blocks for this pilot are included, i.e. Satellite View over the Site, Sensor Graphs with the required metrics, and Current Weather and Weather Forecast.

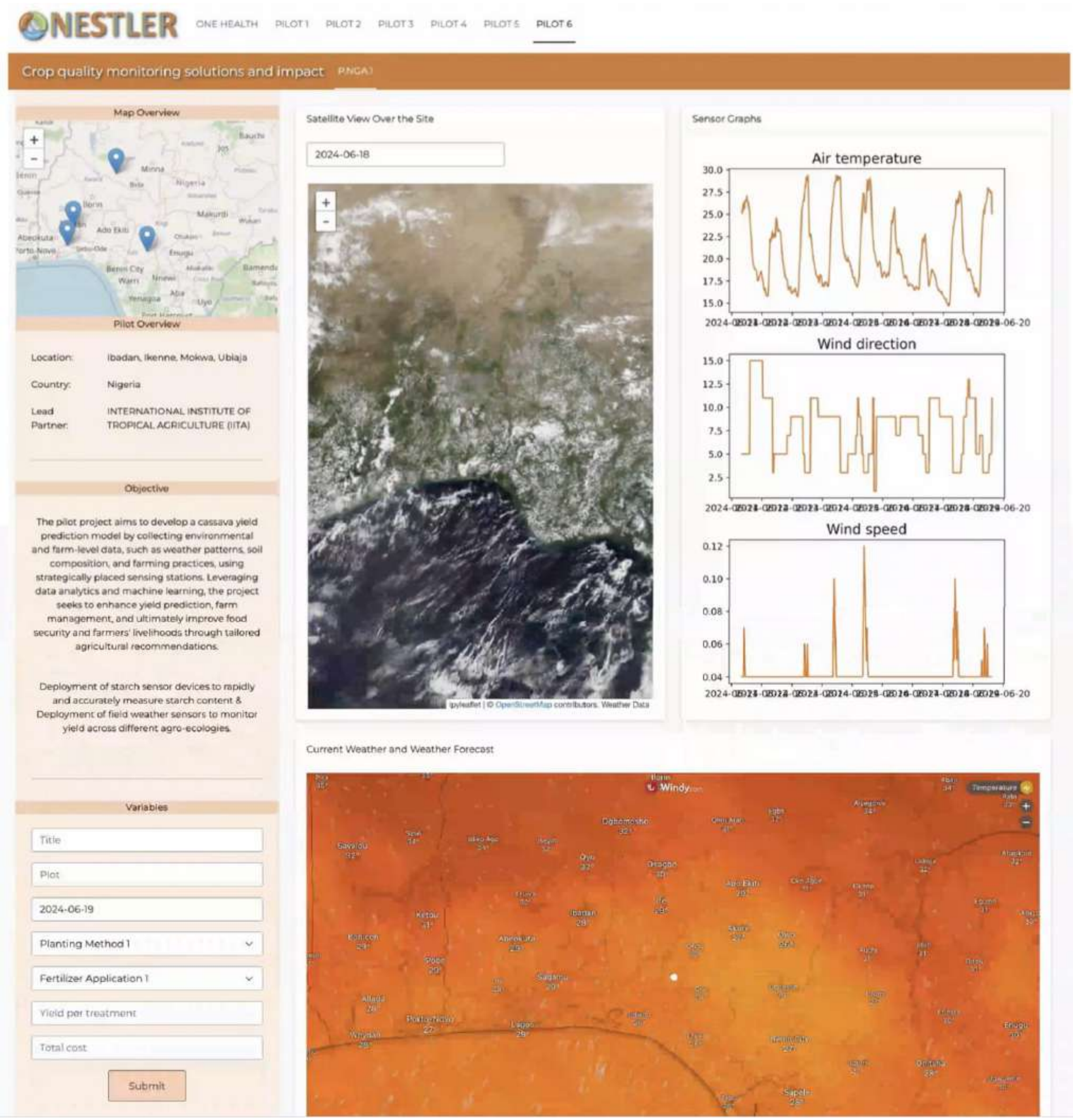

Figure 15: The Pilot 6 page of the NESTLER dashboard and its elements.

4. Conclusion

The development of the NESTLER dashboard marks a significant step forward in achieving the project's goals of supporting One Health through advanced data visualization and analysis tools. This document has provided a thorough account of the design and implementation process, from defining requirements to developing an intuitive user interface that integrates seamlessly with NESTLER backend system.

While substantial progress has been made in terms of visualization components and frontend implementation, the ongoing development will continue to refine and expand the dashboard's capabilities. Future efforts will focus on enhancing user experience, integrating additional data sources, and responding to feedback from pilot owners to ensure the dashboard remains a valuable asset for all stakeholders.

In conclusion, the work accomplished so far lays a strong foundation for the NESTLER dashboard. As development continues, the project team remains committed to evolving the dashboard to better serve the needs of the One Health community, ultimately contributing to improved health outcomes through better data visualization and analysis.

5. Annex 1 – Use Case Mapping

Pilot	Pilot ID	Type of farming	Location	Data Visualization						Relevant Services				
				Map	Image	Video	Audio	Tabular data (e.g. sensors)	Other (e.g. input by user)	Weather Impact Assessment	Livestock Wellbeing	Insect Population	Crop Yield Quality (sensor-based)	Economic risk assessment
Crop-based farming	P.CMR.1	Tomato	Area: 5000 m^2	✓	✓ (drone, mobile phone)			✓	✓				✓	
	P.CMR.2	Tomato	Area: 5000 m^2	✓	✓ (drone, mobile phone)			✓	✓				✓	
Biodiversity conservation policies and practices	P.UGA.1	Coffee	TBD	✓	✓ (drone, mobile phone)			✓		✓			✓	
	P.UGA.2	Coffee	TBD	✓	✓ (drone, mobile phone)			✓		✓				
Crop and Livestock farming	P.ETH.1	Chicken, broiler, layer, and dual	3 experimental chicken houses (25mx12m= divided in pens)		✓	✓	✓	✓			✓			
	P.ETH.2	Fish	10 fish tanks (180m2)		✓	✓	✓	✓			✓			
Livestock and marine farming	P. RWA.1	Chicken (Layers, Broilers, and dual-purpose)	Two experimental chicken houses (30m x 15m and 24m x 16 m) with divided pens ranging between 6m x 6m and 6m x 2m.		✓	✓	✓	✓			✓			
	P.RWA.2	Fish (Nile Tilapia)	pond (2250s.m)		✓	✓	✓	✓			✓			
Edible insect farming	P.KEN.1	Insects (Black soldier fly, mealworm, locust, crickets and African fruit beetle)	- Screenhouse (8m x 20m) for BSF and small concrete rooms ranging between 3m x 5m for other insects. - Experiments on different crop production systems	✓				✓				✓	✓	
	P.KEN.2	Broiler and layer chicken	12 experimental cubicles (1m x 3m) for hosting at least 8 birds					✓			✓			
	P.KEN.3	Potato, Bush bean & Indigenous vegetable (Amaranth)	Screenhouse (8m x 15m), Open field (1 ha of land)	✓				✓					✓	
Crop quality monitoring solutions and impact on food security	P.NGA.1	Cassava (other crops such as yam could be included)	TBD	✓				✓					✓	
	P.NGA.2	Cassava (other crops such as yam could be included)	4 ha	✓				✓					✓	

6. Annex 2 - Questions to Pilot Leaders

Pilot 1: Crop-based farming – Cameroon

Leader: AGRI

1. What elements/weather parameters are essential for you to monitor, e.g. daily? (Select all that apply)

- ○ Temperature
- ○ Rainfall
- ○ Humidity
- ○ Solar radiation
- ○ Soil moisture
- ○ Other: ....

2. Do you (or any other NESTLER partner) develop(s) any crop yield algorithm/service based on the sensor/IoT data? If yes, please provide sample outputs and a short description of what it will include/show to SYN and/or CEO.

The Agrix Tech Application allows farmers to identify, treat and prevent plant diseases, particularly those of tomatoes. With this application, the farmer can easily fight against plant diseases and preserve the yield of these crops.

3. Regarding the user input on farm level, what will be the frequency or under what circumstances do you foresee doing that?

We work closely with some of our farmers. Some people come to the site to see what we do. We show them how to do soil analyses, how to apply organic fertilizer, how to transplant plants. At each new stage of the work, they are present. However, as we cannot involve all our farmers, we will popularize the results of this work to all our farmers after the experiment.

4. What kind of information derived from satellite data will be useful for you, e.g. crop yield indicator?

None

5. What are the coordinates of each plot (polygons)?

Field: Cameroon1. 5°29’49.2’’N 10°23’16.4’’E

Field: Cameroon 2. 3°43’19.3’’N 11°25’15.6’’E

6. Would it be useful for you to have all the above information in one place (webpage) for each use case (e.g. from installed sensors, algorithm output per plot, satellite-based crop yield indicators over broader area of plots, images from AGRI mobile app)?

Yes

Pilot 2: Biodiversity conservation policies and practices – Uganda

Leader: CTPH

1. When do you foresee installing the coffee fields, and when you do, which elements/ weather parameters will be essential for you to monitor, e.g. daily? (Select all that apply)

- Temperature
- Rainfall
- Humidity
- Solar radiation
- Soil moisture
- Other: ....
    - Wind-Direction,
    - Wind-Speed,
    - Ambient Relative

2. Do you (or any other NESTLER partner) develop(s) any weather impact assessment algorithm/service based on satellite data? If yes, please provide sample outputs and a short description of what they will include/show to SYN and/or CEO.

NO

3. What weather information derived from satellite data will be useful for you?

- Temperature
- Rainfall
- Humidity
- Solar radiation
- Soil moisture
- Other: ....
    - Wind-Direction,
    - Wind-Speed,
    - Ambient Relative

4. What kind of information derived from satellite data will be useful for you, e.g. crop productivity level indicator?

Monitoring weather patterns, tracking changes in the environment, mapping land use and vegetation, and assessing the impact of natural disasters on coffee farms

5. When you delimit the coffee fields, please provide the coordinates (polygons) of each one to SYN and/or CEO.

Latitude: *-0.98538921*
Longitude: *29.61336094*
Altitude: *1577.06298828125*

6. Would it be useful for you to have all the above information in one place (webpage) (e.g. from installed sensors, algorithm output, etc)?

Yes

Pilot 3: Crop and Livestock farming – Ethiopia

Leader: EIAR

1. Do you (or any other NESTLER partner) develop(s) the livestock wellbeing algorithm/ service based on IoT data? If yes, please provide sample outputs and a short description of what they will include/show to SYN and/or CEO.
   No,
2. Do you (or any other NESTLER partner) develop(s) the fish health monitoring algorithm/ service based on IoT data? If yes, please provide sample outputs and a short description of what they will include/show to SYN and/or CEO.
   No,

3. Which elements/parameters derived from the installed sensors are essential for you to monitor for poultry, e.g. daily? (Select all that apply)

- Temperature
- Ammonia
- Carbon dioxide
- Other: light intensity......................
- Coordinate for poultry pilot (P. EIAR.1)
  - 8.7655° N, 38.9978° E,
  - Altitude 1900 m.a.s.l.

4. Which elements/parameters derived from the installed sensors are essential for you to monitor for fish, e.g. daily? (Select all that apply)

- Temperature
- PH
- Conductivity

- DO
- Ammonia
- Other: ....
- Coordinate for fish pilot (P. EIAR.2)
    - $8^0$55’02’’ N, $38^0$38’10’’ E,
    - Altitude 2210m a.s.l.

5. Would it be useful for you to have all the above information in one place (webpage) for each use case?

Yes

Pilot 4: Livestock and marine farming – Rwanda

Leader: RAB

1. Do you (or any other NESTLER partner) develop(s) the livestock wellbeing algorithm/ service based on IoT data? If yes, please provide sample outputs and a short description of what they will include/show to SYN and/or CEO.
   No

2. Do you (or any other NESTLER partner) develop(s) the insect population algorithm/ service based on IoT data? If yes, please provide sample outputs and a short description of what they will include/show to SYN and/or CEO.
   No

3. Do you (or any other NESTLER partner) develop(s) the fish health monitoring algorithm/ service based on IoT data? If yes, please provide sample outputs and a short description of what they will include/show to SYN and/or CEO.
   No

4. What elements/parameters derived from the installed sensors are essential for you to monitor for poultry, e.g. daily? (Select all that apply)

- Temperature
- Ammonia
- Carbon dioxide
- Other: ......Relative humidity.................

5.What is the feedback of the RINISOFT poultry SW? Does the output include video sequences or photographs? What is the format?

6. What elements/parameters derived from the installed sensors are essential for you to monitor for fish, e.g. daily? (Select all that apply)

- Temperature
- PH
- Conductivity
- DO
- Ammonia
- Other: Oxidation reduction potential......................

7. What are the coordinates of each pond used in P.RWA.2 (points or polygons)?

P.RWA.1: 2°4’12’’S 29°4325’’E

P.RWA.2: 2°30’24’’S 29°36’36’’E

8. Would it be useful for you to have all the above information in one place (webpage) for each use case?

Yes

Pilot 5: Edible insect farming – Kenya

Leader: ICIPE

1. Do you (or any other NESTLER partner) develop(s) the livestock wellbeing algorithm/ service based on IoT data? If yes, please provide sample outputs and a short description of what they will include/show to SYN and/or CEO.

2. Do you (or any other NESTLER partner) develop(s) the insect population algorithm/ service based on IoT data? If yes, please provide sample outputs and a short description of what they will include/show to SYN and/or CEO.

3. Regarding the Linkages between waste production and farms geometries (orchestrated by MANA, ICIPE):

- what are the coordinates of the waste production points?
- what are the coordinates of the farms?
- Please provide the available linkages (geometries) to SYN and/or CEO
- How frequently will these be updated?

4. What elements/parameters derived from the installed sensors are essential for you to monitor for insect farming, e.g. daily? (Select all that apply)

- Temperature
- Ammonia
- Carbon dioxide
- PM1.0/2.5/10
- Other: ....

5. What elements/parameters derived from the installed sensors are essential for you to monitor for poultry farming, e.g. daily? (Select all that apply)

- Temperature
- Ammonia
- Carbon dioxide
- Other: ....

6. What elements (e.g. crop health, productivity, etc)/parameters (sensor variables, weather, etc) are essential for you to monitor for crops in P.KEN.3?

- Temperature
- Rainfall
- Humidity
- Solar radiation
- Soil moisture
- Other: ....

7. What are the coordinates of the crop fields used in P.KEN.3 (polygons)?

8. Would it be useful for you to have all the above information in one place (webpage) for each use case?

Pilot 6: Crop quality monitoring solutions and impact on food security – Nigeria

Leader: IITA

1. What elements/weather parameters are essential for you to monitor, e.g. daily?

- Temperature
- Rainfall
- Relative Humidity
- Solar radiation
- Soil moisture
- Wind direction/speed

- Other: ....

Minimum temperature (°C), maximum temperature (°C), temperature range (°C), precipitation (mm), relative humidity (%), wind speed (m/s), solar radiation (W/m2), surface soil wetness (%), root zone soil wetness (%), and profile soil moisture (%) for the whole crop growth cycle, i.e., from planting to harvesting of each field trial recorded on at least daily interval.

2. Do you (or any other NESTLER partner) develop(s) any crop yield algorithm/service based on the sensor/IoT data? If yes, please provide sample outputs and a short description of what they will include/show to SYN and/or CEO.

No. We will rely on NESTLER partners for this service

3. Regarding the user input on farm level, what will be the frequency or under what circumstances do you foresee doing that?

Growers will need to access the platform throughout the crop growing period, particularly before sowing the crop and at critical growth stages

4. What are the coordinates of the plots (polygons)?

The coordinates of the field trials where weather and soil sensors have been installed are:

Location (Latitude, Longitude)

Ibadan (7.5020243, 3.8946568)

Ubiaja (6.6705958, 6.3467802)

Ikenne (6.8548, 3.69633)

Mokwa (9.2394, 5.3103)

5. Regarding the historical yield data, where will these be stored, locally or ingested into the NESTLER database? If the latter, please provide a sample dataset to SYN.

The historical data is available at www.cassavabase.org but the data specific for the long term yield modeling can be shared directly with NESTLER-SYN. Please reach out to I.Rabbi@cgiar.org

6. Would it be useful for you to have all the above information in one place (webpage) for each use case (e.g. from installed sensors, algorithm output per plot, etc?

Yes