**TERMS OF REFERENCE**

**Consultancy services for**

**the development of an Early Warning System (EWS)**

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# Background

## The Purchaser

### 1.1.1 Overview of the Agency’s Legal Basis, Organizational Role, and Core Objectives

Romania has received a loan from the International Bank for Reconstruction and Development (IBRD) to support the implementation of the Rural Pollution Prevention and Reduction Project (RAPID Project). This initiative aims to mitigate environmental challenges in rural areas by promoting sustainable agricultural practices and ensuring the protection of natural resources. The Loan 9505-RO, ratified through Law no. 332/2023 on November 7, 2023, became effective on December 13, 2023, with a closing date of June 30, 2028.

The National Phytosanitary Authority (ANF), through the Project Management Unit (PMU RAPID), is responsible for implementing the Early Warning and Forecast Bulletin System (EWS) as part of this project. ANF is the national authority responsible for phytosanitary risk management, plant protection regulations, and pest and disease monitoring in Romania. The agency ensures compliance with national and EU regulations regarding plant health, coordinating actions to prevent and control phytosanitary threats.

The EWS shall serve as a digital platform for automating the forecasting, issuing, and dissemination of phytosanitary bulletins and warnings to farmers and local authorities. By integrating weather data, pests/diseases information, and geospatial information, the system will enhance efficiency, accuracy, and coordination in plant protection, supporting sustainable agricultural practices and regulatory enforcement.

### Overview of the Stakeholders

The successful implementation and operation of the EWS will involve multiple stakeholders, each playing a distinct role in the system’s deployment, management, and utilization.

Primary Stakeholders

* ANF and Regional Phytosanitary Units – As the main beneficiary, ANF and its regional offices shall use the EWS to generate warning bulletins, improve risk forecasting, and ensure regulatory compliance in phytosanitary protection.
* Farmers – The system shall provide real-time alerts and recommendations via mobile notifications, emails, and web-based dashboards, enabling farmers to make informed decisions on pest and disease control.
* Local Authorities (Town Halls) – Town halls shall utilize EWS bulletins to coordinate local pest control measures and ensure compliance with national phytosanitary policies.

**Secondary Stakeholders**

* ANF IT Department – Ensures the maintenance, security, and integration of EWS with existing systems such as PESTEXPERT.
* Compliance and Quality Assurance Teams – Monitor system regulatory compliance, data integrity, and traceability, ensuring adherence to phytosanitary standards.
* Management and Decision-Makers – Oversee project implementation, budget approval, and system performance evaluation to ensure alignment with ANF’s strategic objectives.
* The Consultant – The designated service provider responsible for developing, deploying, and maintaining the EWS in compliance with contractual and regulatory requirements.

External Stakeholders

* Regulatory Authorities – Ensure the EWS complies with national and EU regulations regarding phytosanitary risk management and sustainable agriculture.
* Other Institutional Partners – Institutions that collaborate with ANF through a Memorandum of Understanding and have access to EWS bulletins through a dedicated API.
* Consultants and Partners – Provide software, infrastructure, and technical support for EWS deployment and long-term sustainability.

The Purchaser is the Ministry of Environment, Waters and Forests through the PMU RAPID.

The Consultant of the EWS shall be selected, based on the present Terms of Reference.

## 1.2 Definition of terms

***Table 1 – Acronyms used throughout the Terms of Reference***

|  |  |
| --- | --- |
| Term | Description |
| ANF | National Phytosanitary Agency (Agenția Națională Fitosanitară), the main beneficiary of the system. |
| PMU | Project Management Unit established within ANF to oversee the implementation of the Early Warning and Forecast Bulletin System. |
| ANM | National Meteorological Administration (Administrația Națională de Meteorologie), providing weather data and forecasts relevant to the system. |
| APIA | Agency for Payments and Intervention in Agriculture (Agenția de Plăți și Intervenție pentru Agricultură), which may integrate data for agricultural support. |
| LAU | Local Administrative Unit |
| FIN | Farmer Identification Number at APIA |
| PESTEXPERT | Refers to the existing database system currently implemented at ANF for managing pest-related data. |
| PPP | Plant Protection Products, referring to the regulated chemical products used in agricultural pest control. |
| Bulletin | Refers to the forecast and warning bulletins issued by the system to inform farmers of potential risks. |
| EWS | Early Warning System, referring to the software application for forecasts and bulletins regarding agricultural pests and diseases. |
| EWS Mobile App | The mobile application provid users with access to early warning bulletins, forecasts, and real-time alerts in a user-friendly format. |
| The Project | Referring to the development and implementation of the Early Warning and Forecast Bulletin System. |
| The Contract | Referring to the contract signed with the selected Economic Operator (Services Provider/Consultant). |
| The Consultant | Refers to an individual entity or a joint venture partnership of two or more entities collaborating under a formal agreement to fulfill contractual obligations. In a joint venture, members share responsibilities, resources, risks, and outcomes to deliver the agreed-upon services. |
| The Client (interchangeably also called Client) | The term refers to the organization or entity responsible for initiating, managing, and overseeing a procurement process, such as the acquisition of goods, services, or works. In this case, the **Client is the Ministry of Environment, Waters and Forests through the RAPID Project Management Unit**. |
| Training Plan | Referring to the structured plan to train ANF personnel on how to use the EWS effectively. |

# 2. Objectives of the assignment

## 2.1 Overview of Current Business Objectives, Procedures, and Processes

The National Phytosanitary Authority (ANF) is responsible for monitoring, forecasting, and mitigating pest and disease risks through the issuance of timely and accurate warning bulletins. Thus, all technical activities shall be under technical coordination assured by ANF, while the contractual provisions shall remain under the supervision and coordination by UMP RAPID.

Currently, the Plant Protection and Phytosanitary Quarantine Office manages this process manually, following these steps:

***Table 2 – Current steps for bulletin drafting, validation and distribution***

|  |  |  |
| --- | --- | --- |
| **Step** | **Action** | **Details** |
| 1 | Obtain Weather Data | Weather data is retrieved manually from the ANM, without any automated data integration. |
| 2 | Consult the PESTEXPERT Database | Staff accesses the PESTEXPERT Database, managed by ANF, to identify at least three recommended plant protection products (PPP) for the identified risks. |
| 3 | Analyze Scientific Documentation | Paper-based resources, such as "Prognoza în Protecția Plantelor" by Savescu Aurel and Rafaila Constantin and "Dăunătorii Plantelor Cultivate de la A la Z" by Mihai Talmaciu, are used to identify pests/diseases and their environmental occurrence conditions. |
| 4 | Combine Data Sources | Information from weather forecasts, PESTEXPERT, and scientific documentation is consolidated manually to prepare the bulletin. |
| 5 | Draft, Validate, and Distribute the Bulletin | The bulletin is manually prepared, reviewed for accuracy by ANF’s field reporters, uploaded to ANF’s website, and distributed to farmers and other stakeholders (such as townhalls) via email or other manual channels. |

These processes face significant challenges, including delays, inconsistencies, and limited scalability due to the reliance on disconnected, manual workflows.

The current workflow is visually described in the following diagram:

A diagram of a flowchart

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**Fig. 1 – Current business and information workflow for issuing and dissemination of bulletins at ANF level**

## 2.2 Overview of Changes in Objectives, Procedures, and Processes

The Early Warning and Forecast Bulletin System (EWS) aims to overhaul the current manual processes, bringing automation and integration to key functions, such as:

1. **Automated Data Retrieval**

Integrates weather data other datasets from ANM, including soil moisture, sunlight duration, cloud cover, temperature, rainfall, wind speed, and air humidity. These datasets provide critical environmental conditions required to assess pest and disease risks.

1. **Dynamic Database Connectivity**

Establishes direct integration with the PESTEXPERT database to automate the issuing of alerts based on pests/diseases occurrence probabilities, and selection of recommended plant protection products (PPPs), ensuring data consistency and efficiency in pest management.

1. **Digital Resource Access**

Insert scientific data as extracted/provided from specialized literature by the ANF into the pest-weather mapping database to map pest and disease appearance to specific weather factors. This data establishes correlations between weather conditions (e.g., temperature, humidity, and soil moisture, etc.) and pests/diseases, enabling precise forecasting and tailored recommendations.

1. **Streamlined Data Integration**

Automates the matching of weather conditions from ANM, pests/diseases lifecycle data from scientific literature, and PPP recommendations from PESTEXPERT. ANF should have the opportunity to validate the alerts and recommendations, before their public disclosure and dissemination. The data integration ensures that bulletins are validated and precisely tailored to specific risks of pests/diseases.

1. **Spatial Context with Geospatial Data Integration**

Incorporates geospatial data from relevant external sources to geographically contextualize pest and disease occurrence probabilities, enabling localized and accurate recommendations for interested agricultural stakeholders.

1. **Enhanced Scalability**

Utilizes advanced automation, data integration, and geographic contextualization to meet the increasing demand for accurate and timely pests and disease alerts, ensuring ANF's ability to finetune and scale operations efficiently.

# 3. Scope of the Services

## 3.0 Deliverables and Implementation Framework

The Consultant is expected to deliver the following outputs:

1. **Custom-Designed Early Warning System (EWS), including:**
   * Developing and implementing a tailored EWS solution designed specifically to address the operational needs of ANF.
   * Delivering a software system that shall include both a web-based application for centralized access by ANF personnel and stakeholders, and a mobile application for farmers and local authorities, ensuring real-time access to alerts, bulletins, and localized recommendations.
   * Automating the pests/diseases occurrence probabilities calculation, based on weather data, crops and phenological phases (BBCH), and other relevant factors
   * Ensuring full compliance with applicable national and EU regulations, particularly those governing sustainable agricultural practices.
2. **Complete Source Code for EWS:**
   * Provide UMP RAPID and ANF with the complete source code of the EWS, ensuring future-proof customization, scalability, and updates.
   * Allow UMP RAPID and ANF with the capability to modify and expand the system in response to evolving operational and regulatory needs.
3. **Cloud Infrastructure design and implementation:**

* Collaborate with ANF to size and design the IaaS-based (virtual-machine) cloud environment in which the EWS will run. The cloud environment must be equivalent or compatible **with the ADR Government Private Cloud (based on Microsoft Azure Stack Hub).**
* The Beneficiary will select and contract the cloud provider; the Bidder’s role is limited to defining the technical parameters (CPU, RAM, storage, network, security controls, etc.) required by the EWS and verifying compatibility with ADR’s Governmental Cloud standards.
* Prepare a comprehensive “License Register” in the technical offer. For every third-party or platform component needed to install, configure, operate, and maintain the EWS in the cloud, list: product name, edition/version, metric (core, user, VM, etc.), quantity, and term.
* All licenses shall be procured and owned by the Beneficiary; pricing is not requested, only the exhaustive list.
* **The Consultant shall Install and commission—**within the Beneficiary-provided cloud environment—all third-party components listed in the Consultant’s Technical Offer (e.g., database engines, web/application servers, middleware, monitoring tools, etc.**), then install, configure, and place the Early Warning System into full production operation, ensuring conformity with every functional and non-functional requirement set out in these Terms of Reference.**
* Integrate, as needed, the cloud-based EWS with the existing on-premises Identity Provider (IdP) system – the B2C from Azure**,** which already supports role-based authentication and authorization for other ANF software systems. This integration should ensure compatibility for user management, secure authentication, and uninterrupted access across all connected systems. Additionally, the EWS shall integrate with the ANF's email infrastructure, enabling functionalities such as alerts and notifications through existing channels.

The integration process will prioritize a smooth transition with minimal disruption to current operations. It must maintain robust security measures, ensure compliance with GDPR and other relevant regulations, and facilitate unified, secure user experience for all stakeholders interacting with the EWS.

1. **Expert Consultancy in pests/diseases occurrence probability calculations:**
   * Integrate a predictive algorithm to calculate pests/diseases occurrence probabilities, ensuring timely and validated outputs.
   * Ensure compliance with EU and national legislation and guidance documents through efficient data governance and adherence to phytosanitary rules.
   * Collaborate with ANF to establish workflows and data management practices that align with best practices in pest/diseases risk assessment and environmental sustainability.
2. **Comprehensive System and Solution Documentation:**
   * Develop and deliver detailed system documentation.
   * Provide comprehensive user manuals for various roles within ANF to facilitate effective EWS system usage and maintenance.
   * Include installation, configuration, and troubleshooting guides to ensure smooth implementation and ongoing support.

6. **Training Sessions and Support Materials:**

* + Provide comprehensive training, including practical sessions (on-job training), for ANF personnel to enhance their knowledge of the EWS.
  + Provide efficient training materials, including step-by-step guides, use case demonstrations, and interactive workshops.
  + Focus on ensuring a smooth transition from manual workflows to the automated and integrated EWS environment.

**7. Maintenance, Support, and Warranty Services:**

* Provide at least 24 months of maintenance and support for the EWS, addressing any technical issues, updates, or system enhancements.
* Offer at least 2-year warranty covering fixes, updates, or performance optimizations to ensure the system operates as intended post-deployment.
* Support ANF in incorporating evolving operational needs, such as adjusting the pest-weather mapping table, expanding user bases, or enhancing functionalities, as requests by ANF

**Pilot and Full Deployment Phases:**

The implementation of the Early Warning System (EWS) shall be carried out in two distinct phases:

**Phase 1: Pilot Deployment**

In **Phase 1**, the EWS shall focus on specific crops (e.g., wheat, corn, sunflowers), particular phenological phases, and targeted regions (e.g., certain counties or LAUs based on geographic criteria). This focused deployment shall enable ANF to test the system’s functions, including real-time data integration, pests/diseases occurrence probability calculations, bulletin drafting, validation and dissemination. Local stakeholders, including ANF staff and farmers, should interact with the system during this phase and provide feedback to improve it.

**Phase 2: Full Nationwide Deployment**

Following the pilot's success, **Phase 2** will expand the EWS to include all major crops and agricultural regions across Romania. This phase should increase the system's data processing capabilities and ensure its reliability for nationwide operations. The system shall provide localized risk analysis, timely alerts, and actionable recommendations for farmers and stakeholders, improving pest and pests/diseases occurrence calculations, thus preparing ANF staff and users to utilize the fully operational system.

**Phase 3: Implementation and Approval Criteria**

Phase II of the Early Warning System (EWS) implementation shall commence only after the successful acceptance and formal approval of the Pilot Phase.

**Deviations and Alternative Solutions:**

***Any deviation/alternative solution from/for the technical requirements may be accepted by the Client based on arguments clearly presented in the progress reports by the Consultant, with prior approval/ request by the Beneficiary, in case the effort (needed working days) is not less than initially estimated as compared with the initial solution.***

The Consultant shall be responsible for the **full** development, deployment, and operationalization of the EWS in the cloud environment, including:

* Elaboration of business analysis reports, to be further approved by the Beneficiary.
* Software development according to the technical specifications in these ToR, and approved business analysis reports.
* Elaboration of internal testing reports based on business scenarios agreed with the Beneficiaries, to be further approved by the Beneficiary.
* Timely Execution – Deliver all project activities on schedule, in accordance with the conditions of these ToR.
* Resource Planning – Allocate sufficient personnel, infrastructure, and tools to meet project objectives.
* System Updates and Maintenance – Implement all updates, modifications, and performance enhancements required for the system, during the support and maintenance period
* Compliance with Best Practices – Ensure adherence to legal, contractual, and industry best practices.
* Expert Contributions – Assign qualified personnel and specialists to achieve project milestones.
* Personnel Identification – Provide ANF with a list of key experts in the bidding stage, and a list of non-key experts at the start of the contract
* Collaboration – Work closely with ANF staff to ensure effective implementation and regulatory compliance.

## 3.1 Business Requirements to Be Met by the System

The Early Warning System (EWS) aims to replace manual workflows with a digitized and integrated platform, including a mobile application. This system shall enable ANF to deliver accurate and timely early warning bulletins, which include pests/diseases occurrence probabilities for crops, as well as the recommended measures that farmers should take.

The EWS shall integrate various functionalities to streamline operational processes. These functionalities shall include automated data retrieval from ANM, geospatial data of farmers’ agricultural parcels and crops from APIA (for enrolled APIA farmers), and an advanced predictive algorithm for calculating pests/diseases occurrence probabilities. The system shall facilitate real-time dissemination of EWS bulletins to stakeholders via digital channels, providing localized and actionable recommendations.

The EWS system shall benefit from a modular and scalable architecture enabling integration, advanced analytics, and compliance with national and EU and national legislation.

The expected business and information flow of the EWS system is presented in the diagram below:

A diagram of a company

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Fig 2. - Expected business and information flow of the EWS system

The EWS is expected to include, as necessary, and without being limited to, the following core modules:

***Table 3 – Expected EWS modules***

|  |  |
| --- | --- |
| **Module** | **Description** |
| **System Administration and Configuration Module** | Manages user roles, permissions, and system configurations. Controls integrations with external systems, ensuring data accuracy. Logs changes and actions for transparency and compliance. Manages alerts for internal system users. |
| **Quality Assurance and Bulletin Drafting Module** | Retrieves and processes weather, crop and parcel data, as well as PPP data. Manages the pest-weather data table. Allows for automated bulletin drafting based on weather data, pest-weather mapping table, historical data, recommended PPPs, crop and parcel data. Allows for manual bulletin drafting irrespective of pest/disease prediction outputs. Allows manual review and editing before issuing the bulletin. |
| **Historical Data Module** | Stores and archives pest/disease occurrence and corresponding geospatial and weather data. Enables trend analysis and predictive modeling. Ensures secure data retrieval by manual search (based on various parameters) and API functions. |
| **Bulletin Dissemination and Notification Module** | Distributes validated bulletins via email, and mobile notifications. Targets stakeholders based on geospatial and user data. Provides a web-based portal for accessing bulletins.  Offers a secure, token-based API for external stakeholders (e.g., institutions which have signed a Memorandum of Understanding with ANF) to retrieve bulletins. |
| **Mobile Application Module** | Delivers real-time alerts and bulletins to farmers. Integrates geospatial data for localized risk analysis. Supports offline access and user feedback submission. |
| **Audit and Compliance Monitoring Module** | Tracks all user actions and system changes. Ensures compliance with data integrity and security policies. Provides reports for audits and regulatory oversight. |
| **Reporting Module** | Generates reports on pest/diseases calculated occurrence probabilities, trends, filtered and grouped by various weather and geolocation parameters. Generate reports on system performance. Supports geospatial visualizations and data exports. Enables role-based access to customizable reports. |

The interaction between these modules regarding the inputs and outputs generated by each of them is presented in the diagram below:

A diagram of a diagram

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**Fig. 3 – EWS Modules Relationship Diagram**

The proposed functionalities and requirements for the EWS modules are detailed in the next chapters of these ToR, and shall be refined in collaboration with stakeholders during the analysis phase.

### **3.1.1 Key Users of the Early Warning System (EWS)**

User roles in the Early Warning System (EWS) shall be managed through a centralized role-based access control (RBAC) system that should define which functionalities and modules each user can access based on their assigned role. Permissions are granted at the level of individual modules—such as, bulletin drafting, bulletin dissemination, or reporting—and ensure that each user interacts only with the components relevant to their responsibilities.

User rights grant read/edit/write operations on EWS modules’ functionalities. At this point, it is expected that the following user roles be implemented:

***Table 4 – Expected user roles***

| **No.** | **Abbreviation** | **Role in EWS** | **Description** |
| --- | --- | --- | --- |
| 1 | SA | System Administrator | Manages user roles, system configurations, and integration of external data sources like PESTEXPERT ANM, APIA. |
| 2 | DA | Data Analyst | Validates and processes incoming data from APIA, ANM and PESTEXPERT database; Ensures data quality for pests/diseases occurrence probability calculation; drafts EWS bulletins, validates them and sends them to the Bulletin Dissemination Module, archives past pests/disease occurrence probabilities through the Historical Data Management Module |
| 3 | FR | Field Reporter | Collects and inputs localized pest/disease outbreak YES/NO feedback into the system |
| 4 | CM | Communications Manager | Manages dissemination of alerts / bulletins, and notifications via email, and mobile apps; customizes alert templates for stakeholders |
| 5 | FA | Farmer (Beneficiary) | Receives alerts and recommendations through the EWS bulletin regarding pests/diseases occurrence probabilities; takes proactive measures to mitigate pest/disease occurrence risks. |
| 6 | LAU | Local Authority (LAU) | Receives email alerts with EWS bulletins to coordinate regional pest/disease control measures, ensuring compliance with regional agricultural practices. |

**Important Note:**

The user roles outlined in the table represent the **minimal roles** necessary for the effective operation of the Early Warning System (EWS). These roles should serve as a foundational structure but must not limit the flexibility of the system to accommodate additional roles.

* **Role Customization:** The system should allow the creation of new user roles as needed, based on the specific resources, workflows, and operational requirements that may evolve over time.
* **Dynamic Role Management:** The role management feature should support customization of permissions and responsibilities to align with new workflows, expanded functionalities, or integration of additional datasets.

### **3.1.2 System Administration and Configuration Module**

**Purpose**

The System Administration and Configuration Module is a central component of the Early Warning System (EWS) that provides tools for managing system setup, customization, user administration, and ongoing configuration. The module shall ensure secure, scalable, and efficient operation while maintaining compliance with organizational policies and regulatory requirements.

**Core Features**

#### **3.1.2.1 User Administration**

##### **3.1.2.1.1 User roles and permissions**

To ensure secure, flexible, and role-based access across the EWS platform, the System Administration and Configuration Module shall enable System Administrators to define and manage user roles, assign fine-grained permissions, and control access to specific functions within each EWS system module. Each module shall expose a set of configurable and include view, create, update, delete actions that can be selectively granted to roles, ensuring precise access control aligned with operational needs.

Roles within the system should be designed to be flexible and adaptive, allowing for dynamic adjustments as workflows or organizational needs evolve. System administrators should be able to modify roles to accommodate new responsibilities or operational changes, ensuring that the system remains aligned with current requirements.

To ensure transparency and accountability, all changes to roles and permissions should be logged in the system's audit trail. This should include details such as:

* + - timestamps
    - the user who initiated the change
    - modifications

##### **3.1.2.1.2 User registration and management**

The system shall implement a structured registration process through which users are created, grouped into teams based on organizational structure or operational roles, and assigned predefined roles with associated permissions.

This process should support the classification of EWS users, facilitate modular access control, and ensure the collection of essential user information. User accounts shall be synchronized with the ANF’s Identity Provider (IdP) to maintain consistency across systems.

At this point, the key attributes of registered users should contain fields such as:

* + assigned role
  + email address
  + team affiliation,
  + organizational unit
  + manager

Other fields may be added to the user form or synchronized from ANF’s IdP, as requested by ANF.

#### **3.1.2.2 Integration Management**

System Administrators shall configure and manage integrations with external systems, ensuring continuing data flow and operational consistency across interconnected platforms. This capability shall enable administrators to establish, monitor, and maintain integrations tailored to the specific requirements of the Early Warning System (EWS).

Each integration should be defined and customized through a series of configurable attributes. The system should provide a clear identifier for the external system being connected, such as PESTEXPERT for PPP data, ANM for weather datasets, or APIA for geospatial parcel-specific information. The Integration type should specify the nature of the connection (e.g data upload, API integration, direct database connection). System administrators should further configure API Keys and other access credentials to ensure secure communication with the external platforms.

At this moment, from the integration standpoint, it is expected that the EWS system should at least:

* retrieve data from ANM, APIA and PESTEXPERT
* provide EWS bulletins to external stakeholders, based on an API implemented in the Bulletin Dissemination and Notification Module.

The System Administrator should be able test the integration connection parameters, fetch sample data from the source (for incoming connection), and validate its format before saving integration settings for the EWS system.

The saved integration connection parameters shall be used by EWS for retrieving for in bulletin data (e.g. weather, parcel specific data and PPP’s) in its operational mode.

#### **3.1.2.3 Notification and Alert Configuration**

The **Notification and Alert Configuration** functionality within the Early Warning System (EWS) is designed to generate alerts exclusively based on parameters received from external sources, primarily the National Meteorological Administration (ANM).

These alerts should be targeted at internal system users, such as data analysts (DA), communication managers (CM) or system administrators and do not extend to end-users such as farmers or town halls.

The alerts shall be automatically triggered when incoming data from ANM exceeds predefined thresholds configured in the system — for example, temperature ranges, humidity levels, or precipitation values associated with specific pest or disease emergence patterns.

The alerts shall be delivered via email to the designated internal users and shall include detailed contextual information such as the exceeded thresholds, affected regions, relevant weather parameters, and the timestamp of the triggering event,

#### **3.1.2.4 System settings**

The module shall include a secure interface for configuring core functional and technical settings of the EWS platform. System Administrators shall be able to manage parameters such as cache policies, session timeouts, system time zone, web access settings (e.g., IP whitelisting, allowed domains), API usage limits, and log file paths.

These configurations shall be applied globally and affect system performance, access behavior, and interoperability. All changes shall be versioned and recorded in the audit trial for traceability and compliance purposes.

Considering that the EWS System will operate on the cloud compatible with the Governmental cloud, additional configurations may need to be set based on the cloud's infrastructure. All configuration settings will be finalized during the project's analysis phase.

### **3.1.3 Quality Assurance and Bulletin drafting module.**

#### **3.1.3.1 Purpose**

The Quality Assurance and Bulleting Drafting module is an essential component of the Early Warning System (EWS). It ensures that all incoming data is accurate, consistent, and suitable for predictive analysis and bulletin generation.

Within this module, weather data retrieved from the National Meteorological Administration (ANM), shall be processed (including the data that became historical) to be used by the predictive algorithm

The retrieval and processing of weather data from the National Meteorological Administration (ANM) follows an agreed Memorandum of Understanding with the National Phytosanitary Authority (ANF), to ensure data accuracy, consistency, and alignment with phytosanitary forecasting requirements.

The module shall generate draft bulletins at ANM georeferenced grid level (typically 7kmx7km land blocks) for all crops, and all possible stakeholders. Simultaneously, for the use of farmers registered at APIA, bulletins shall be generated for the geospatial referenced parcels and crop data from APIA. The data on parcels and crops shall be ensured by APIA, for the APIA registered farmers.

The module also includes a centralized management system for the pest-weather mapping table. The database table of the module shall include the weather thresholds linked with potential pests/diseases for specific crops, with respect of their phenological stages (BBCH stages), thus creating a foundation for precise pests/diseases occurrence probability calculation.

According to the received ANM georeferenced weather data the algorithm shall be able to generate pests/diseases occurrence probabilities. At this stage, the module should be linked with the PESTEXPERT database, thus providing further recommendation on the use of PPPs. The ANF staff, based on the automated issued draft bulletins, should be able to, according to their expert judgement (scientific analysis, field-analysis, etc.), validate the draft bulletins, edit the generated bulletin or issue extra bulletins, irrespective of the automated data / module analysis.

Any anomalies or inconsistencies identified during validations shall be escalated to Data Analysts / to the Consultant. The Consultant shall adjust the thresholds or any algorithm parameter, thus ensuring the module is optimized.

The bulletins shall be finalized using predefined templates, to be further disseminated to farmers, authorities, and other stakeholders through (registered) email and mobile application, ensuring timely delivery of information.

The farmers with declared parcels and crops at APIA, shall have access to bulletins accustomed at the level of their parcels and crops.

In addition to its validation and mapping functionalities, the module shall include comprehensive error-handling mechanisms, historical data integration, and audit capabilities. Historical data integration shall allow the module to cross-reference real-time inputs with past trends, enhancing the reliability of forecasts and providing a foundation for long-term trend analysis.

#### **3.1.3.2 Core features**

##### **3.1.3.2.1 - Weather data retrieval**

Weather data consists of 24 hours weather data forecast, generated daily by the ANM, and should be retrieved through an FTP account provided by ANM

The weather data provided by ANM is grid-based, meaning it corresponds to predefined geographical coordinates, rather than individual agricultural parcels. These data are delivered in GRIB2 format and represents weather conditions over a 7x7 km georeferenced grid for the following 24h (with one-hour granulometry), covering the entire Romanian territory.

During the bulletin generation process, these data are validated and mapped to APIA georeferenced parcels (including their location in LAU) and their declared crops, (ensuring the bulletin will be associated with relevant parcels and crops belonging to farmers registered at APIA).

Weather data, as received from the National Meteorological Administration (ANM), shall be retrieved, transformed, stored and processed, as needed, into average values over pest- or disease-specific periods, ensuring, through the predictive algorithm, that the alerts shall reflect the relevant weather conditions for each potential pest / disease outbreak scenario.

The following weather data shall be fetched from ANM:

***Table 5 – ANM weather data***

|  |  |
| --- | --- |
| ANM Weather parameters | Data Format |
| Temperature | 2 meter air temperature in °K |
| Soil Temperature | Soil temperature, multilayer, in °K |
| Air humidity | 2m Relative Humidity in % |
| Soil moisture - Column-integrated Soil Moisture (multilayers) | Soil Moisture (multilayers) in % |
| Total Precipitation | mm/day |
| Wind speed and direction | Wind speed and direction at 10m, m/s – U and V vectors |
| Solar radiation - Downward direct short wave radiation flux at surface | W/m2 |
| Snow depth | meters |
| Total Cloud Cover | in % |

Weather data may be subject to a transformation process prior to integration into the system's analytical workflows. This transformation shall ensure structural alignment with the standardized format defined by the pest-weather mapping table. Adjustments may include unit normalization (e.g., converting temperature from Kelvin to Celsius), temporal aggregation (e.g., hourly to daily averages), or any other transformation, as resulted during the analysis phase of the project.

Timestamps should be adjusted to a uniform UTC format to ensure temporal consistency across all datasets.

###### **3.*1*.*3*.*2*.1*.1* APIA geolocation data retrieval**

Data from APIA shall be retrieved once per year, in shape of geolocation data files, regarding farmers parcels` information, including their location at LAU level and their declared crops. Data shall be anonymized (but shall include farmer identification number (FIN), as registered at APIA). Thus, once the APIA enrolled farmers download and install the mobile application, the system shall automatically provide access to the farmers to alerts at the level of their parcels and for their specific crops, through their FIN.

The data should be fetched from an FTP account set-up by APIA. Technical details shall be established during the analysis phase.

###### **3.*1*.*3*.*2*.*1.2* Transformation into means over pest/disease-specific periods**

Once the daily weather data is transformed and stored, the system shall perform an average of specific weather parameters spanning periods of time (e.g. 72h,120h), depending on the pest/ disease being targeted. The length of the period varies depending on the lifecycle of the pest or disease and shall be configured by the Consultant at ANF’s request, for each pest/disease in relation to all crops and phenological phases, based on the information available in the pest-weather mapping table.

The averages shall be calculated from weather data retrieved from ANM and stored over the preceding days.

The average values shall be stored, along with the calculation date timestamp, and then fed directly into the predictive algorithm, enabling matching between weather conditions and pest or disease occurrence probabilities.

##### **3.1.3.2.2 - Pest-Weather Mapping Table Management**

**The Pest-Weather Mapping Table** establishes the relationship between validated weather data, crop phenological stages (BBCH stages), and potential pest or disease occurrence probabilities. This centralized table serves as a foundational tool for aligning weather conditions with scientifically supported predictions of pest and disease activity.

The Pest-Weather Mapping Table ensures that the weather data provided by the National Meteorological Administration (ANM) are mapped to specific crops and BBCH stages, creating a reliable framework for pest and disease occurrence probabilities. The Consultant should perform, along the contract, implementations of regular updates and validations, at the request of the ANF, thus ensuring the table reflects up-to-date environmental conditions, scientific standards, and operational requirements, or to include any calibration request, as needed.

**Data management**

The Pest-Weather Mapping Table integrates validated weather parameters with crops and their BBCH stages to capture the critical relationships that influence pest and disease occurrence probabilities. This table acts as a centralized repository, serving as the primary source for linking weather data to crops and their phenological stages.

Some of the weather data received from ANM may need to be processed and transformed, so it can match the format of the pest-weather mapping table fields.

The table below includes pest-weather table fields, corresponding weather data from ANM, and potential transformations.

Further refinements of the table fields and transformation needs shall be conducted in the analysis phase, so that all incoming data can be properly validated, saved and fed into the predictive algorithm, yielding proper scientific results.

***Table 6 – Pest-weather mapping table and corresponding ANM weather data***

| **Pest-Weather mapping table field** | **Description** | **Corresponding weather data parameter (ANM)** | **Potential Transformation Needs** |
| --- | --- | --- | --- |
| **Crop Type** | Name of the crop (e.g., wheat, corn, sunflower). | N/A | No transformation required |
| **BBCH Stage** | The phenological stage of the crop (e.g., flowering, ripening). | N/A | No transformation required |
| **Air Temperature (°C)** | Optimal temperature range for pest/disease occurrence. | GRIB2 - 2 metre temperature in °K | Extraction from GRIB2 and conversion to °C |
| **Soil Temperature (°C)** | Soil temperature thresholds favoring pest/disease emergence. | GRIB2 - Soil Temperature (multilayer model) | Extraction from GRIB2 and mapping to soil depths |
| **Humidity (% RH)** | Range of air humidity levels promoting pest/disease activity. | GRIB2 - 2m Relative Humidity; Specific Humidity | Conversion from absolute to relative humidity if needed |
| **Soil Moisture (% SM)** | Soil moisture percentage that may favor pest/disease activity. | GRIB2 - Column-integrated Soil Moisture (multilayers) | Interpolation for specific soil depths |
| **Precipitation (mm)** | Thresholds of rainfall that may suppress or promote pest/disease development. | GRIB2 - Total Precipitation | Summation over a 24-hour period |
| **Wind Speed (km/h)** | Wind speed ranges influencing pest/disease spread. | GRIB2 - 10 metre U and V wind components | Vector calculation from U/V components |
| **Solar Radiation / S**unlight duration **(h)** | H  Hours of sunlight required for pest/disease development. | GRIB2 - Downward direct short wave radiation flux at surface | Threshold calculations for solar exposure and count sunlight duration |
| **Snow Cover (cm)** | Snow cover depth affecting overwintering pests or diseases. | GRIB2 - Snow depth | Transformation from m to cm |
| **Cloud Cover (h)** | Cloudy conditions promoting fungal diseases or inhibiting pest activity. | GRIB2 - Total Cloud Cover | Conversion from percentage to cloud cover categories and count the specific number of cloudy hours during one day |
| **Pest/Disease Name** | The pest or disease associated with the crop and conditions. | N/A | N/A |

[6.1.3 - **Annex 1.1.3 – Pest-Weather Mapping table**](#_6.1.3_-_ANNEX) serves as a starting point for populating the pest-weather mapping table. The data shall be reviewed and revised by ANF before and after system implementation, to ensure alignment with operational requirements and scientific standards. The Consultant may need to add other columns to the table, as requested by ANF, regarding crops, weather and/or pests/diseases (such as the EPPO code, for unique identification and integration with PESTEXPERT). During business analysis or along the Contract implementation, ANF may request use of other crop, weather and pest/disease data, or application of other transformations

It is the responsibility of the Consultant, based on the data received from ANF, to populate the pest-weather mapping table with all necessary information for accurate pest/disease prediction.

The Consultant is also responsible for modifying/refining the pest-weather mapping table following the Pilot phase completion and, possibly, during the support phase, as requested by the ANF.

**Editable Fields**

To ensure adaptability and maintain data integrity, the system shall enable authorized users (e.g., Data Analysts) to modify specific fields within the table:

* **Weather data thresholds** - Threshold ranges for parameters such as temperature, soil moisture, precipitation, and other weather factors to align with the latest scientific research.
* **Crop and BBCH Stage** = Users can add or adjust mappings between crops, weather data and their corresponding BBCH growth stages based on data from the [6.1.1 - ***ANNEX 1.1.3 - BBCH Official Data Annex***](#_6.1.1_-_ANNEX)

Each modification shall be automatically recorded in the system’s audit log, capturing details such as the user ID, timestamp, previous values, and updated entries.

**Version Control**

The table employs version control mechanisms to track every modification:

* Archiving Changes - Stores all updates with timestamps, user IDs, and descriptions of adjustments.
* Rollback Capability - Allows users to revert to previous versions if inconsistencies are identified.

**Parameter Weights**

Each weather parameter from the pest-weather mapping table shall be assigned with a weight, to reflect its relative importance in determining pest and disease occurrence probabilities. These weights are specific to each crop, BBCH stage, and pest/disease, and are carefully tailored to prioritize the factors most influential for a given scenario. This ensures that critical parameters such as temperature and humidity receive greater emphasis in the table’s mappings, while secondary factors contribute to refining the predictions.

A sample weight table is represented below:

***Table 7 – Sample weight table***

| **Parameter** | **Weight (Example Range)** | **Importance** |
| --- | --- | --- |
| Air Temperature | High (0.7 – 1.0) | Often a primary driver, influencing pest activity and disease progression. |
| Soil Temperature | Medium (0.4 – 0.6) | Essential for soil-borne pests and diseases; depends on the pest lifecycle. |
| Humidity | High (0.7 – 1.0) | Plays a critical role in fungal diseases and pest development. |
| Soil Moisture | Medium (0.4 – 0.6) | Key for diseases reliant on wet conditions or pests with water-dependent lifecycles. |
| Precipitation | LowMedium (0.3 – 0.5) | Affects pest/disease spread, suppression, or promotion, depending on the lifecycle. |
| Wind Speed | Low (0.1 – 0.3) | Influences pest dispersal and spore movement, but typically secondary. |
| Solar Radiation | Low (0.1 – 0.3) | Influences certain diseases and pests requiring specific sunlight conditions. |
| Snow Cover | Medium (0.4 – 0.6) | Determines overwintering conditions for some pests and diseases. |
| Cloud Cover | Low-Medium (0.3 – 0.5) | Promotes fungal growth under suitable humidity and temperature conditions. |

**The exact weights shall be established during the business analysis phase, as provided by ANF.**

**✅ Notes:**

* **Weights** are variable and can be fine-tuned during the **analysis phase** based on the targeted pest or disease model.
* The **range values** represent the **relative influence** of each parameter on pest/disease occurrence (e.g., *High* parameters strongly affect predictions, *low* parameters have minor effects).
* Final weights may be adjusted based on the analysis of the historical data of past pests/disease predictions by the Consultant, throughout support phase.

##### **3.1.3.2.3 - Predictive Algorithm**

The Predictive Algorithm represents the logic behind EWS’s capability to deliver accurate pest and disease occurrence probabilities. This process should integrate weather, geospatial, and crop data, pest-weather mapping table information and specific weights of the used weather parameters

The algorithm should typically consist of the following stages:

***Table 8 – Predictive algorithm stages***

|  |  |
| --- | --- |
| **Stage** | **Tasks** |
| Data input | Select averaged weather data (ANM grid-based forecasts), geospatial data (APIA - crop types, parcel boundaries), and specific historical pest assessments. |
| Risk Identification & Probability Calculation | Compare selected weather data against the Pest-Weather Mapping Table.  Assign probability scores for each pest/disease based on how specific weather factors fall into the applicable pest/disease range, and on their specific weights in determining the outcome |
| Validation and probability mitigation against historical pest/disease occurrence probabilities data | Adjust probability scores, if past records indicate discrepancies, as requested by ANF |
| Decision Support & draft bulletin generation | Draft pest/disease occurrence probabilities bulletins, including probability scores, affected crops, and recommended treatments (PPPs). Allow manual expert validation/adjustments before official dissemination. |

Overall, this process is predominantly algorithmic, with only the assignment and adjustment of parameter weights and adjustment/approval of bulletin content necessitating expert manual input.

**Probability Calculations:**

The probability calculations within the predictive algorithm are based on the relative influence of various weather parameters on pest and disease risk on concurrency, and their match within the specific range established in the weather-pest mapping table. Each parameter should contribute to the overall prediction, reflecting its importance in specific pest or disease scenarios.

A sample table showcasing how weather data, crop types and their BBCH stages, generate pest/disease probabilities in presented in [6.1.2 - ANNEX 1.1.3 – Example Output Table of the Predictive Algorithm](#_6.1.2_-_ANNEX)

**Note: These considerations are minimal and will be finalized during the implementation phase in collaboration with ANF's professional staff. The final approach will be customized to meet the specific operational and scientific needs of the Early Warning System (EWS).**

##### **3.1.3.2.4 - PESTEXPERT data integration**

The PESTEXPERT Data integration functionality retrieves PPP data from the PESTEXPERT database and integrates it into the Early Warning System (EWS) draft bulletin.

Selection of PPP data is built on a two-key matching system—EPPO code as the primary key and pest name as the secondary key—ensuring identification of pests or diseases.

Following the prediction of a particular pest/disease for a given crop, the system will pull data referring to a 3(three) PPPs applicable for that pest/disease prevention.

The system should fetch data from PESTEXPERT to include, as a minimum the following fields: PPP name, Hazard Phrase, Precautionary Statements, Minimum/Maximum dosage, Application Method, Pre-Harvest interval

This extracted information will be automatically inserted by the EWS into the draft bulletin.

If a specific pest or disease has no corresponding Plant Protection Product (PPP) listed in the PESTEXPERT database, the system must handle this scenario by applying predefined fallback strategies. These may include manual insertion of required PPPs within the content of the bulletin.

Since PESTEXPERT runs inside ANF’s infrastructure, ANF shall offer access to PESTEXPERT database.

Technical integration details and applicable PESTEXPERT required fields to be included in the bulletin, shall be established during the analysis phase.

##### **3.1.3.2.4 - Bulletin Drafting and Validation**

The Bulletin Drafting and Validation functionality focuses on consolidating validated data and producing actionable pest and disease forecasts in a standardized format. All input data has already undergone validation in earlier stages, ensuring accuracy and compliance by the time it is integrated into the bulletin.

**Bulletin drafting**

The bulletin preparation process is typically initiated when the computed probability of a pest or disease occurrence surpasses a manually predefined threshold, ensuring that forecasts are data-driven and minimize false alerts.

After the execution of the predictive algorithm, the system should highlight calculated pest/disease probabilities and suggest bulletin drafting when predefined thresholds are met. However, authorized users must have the ability to manually draft a bulletin at any time, regardless of system-generated probabilities, ensuring flexibility for expert assessments, regulatory needs, or exceptional circumstances not fully captured by automated predictions.

**Data Consolidation**

The first step involves integrating all validated datasets into a predefined bulletin template, ensuring consistency and clarity. Below are the main data categories of information included in the bulletin, which include:

***Table 9 – Bulletin content***

| **Data** | **Content Integrated into the Bulletin** |
| --- | --- |
| Weather and crop | Summarized air and soil temperatures, precipitation, humidity, and other parameters affecting pest activity  Crop and BBCH information |
| Geospatial Data | LAU containing ANM grid block, other possible georeferential information, as requested |
| Algorithm Outputs | Probabilities of pest or disease occurrences |
| Recommendation | recommended PPPs, along with PPP usage guidelines,  Pest lifecycle stages, geographic distribution and other relevant data (manually inserted) |

The bulletin template should organize data into clearly defined sections, and contain at least the following sections :

***Table 10 – Bulletin template sections***

| **Section** | **Content** |
| --- | --- |
| Header | Region, date, target crops, and BBCH stages. |
| Weather Overview | Key weather and soil parameters influencing pest and disease risks. |
| Risk Forecast | Pest and disease probabilities, along with key environmental triggers. |
| Recommendations | Specific pest management strategies, including PPPs  Guidance on regulatory and safety standards for recommended actions.  (The information shall be filled out either automatically, from PESTEXPERT database, or through manual input) |

**Bulletin validation**

Before finalization, the Data Analyst conducts a manual revision of the bulletin to ensure its accuracy, completeness, and compliance with predefined standards. This review includes verifying that all integrated data—such as weather conditions, pest occurrence probabilities, geospatial references, and recommended PPPs—are correctly populated and scientifically sound. The Data Analyst ensures that the computed risk assessments align with expected patterns and that all recommendations comply with regulatory guidelines. If any inconsistencies or missing data are identified, the Data Analyst makes necessary corrections directly before approving the bulletin for dissemination.

### **3.1.4 Historical Data Module**

**Purpose**

The Historical Data Management Module (HDMM) is designed to provide comprehensive archiving, retrieval, and analysis capabilities for past pests / diseases occurrences probabilities, and corresponding crops, BBCH, weather data parameters and their respective parameter weights used in the predictive algorithm. By maintaining a structured and accessible repository of historical datasets, the module shall support pests/diseases outbreak trend analysis.

**Core Features**

#### **3.1.4.1 - Predictive Algorithm Output storage**

To refine predictive algorithms and facilitate comparisons, the system shall store all historical pest/disease occurrence probability calculations from the EWS along with their input data (e.g., weather, crop, BBCH, parameter weights). This process shall help analyze trends and improve calculation accuracy over time.

Historical Results stored datasets should include fields such as :

***Table 11 – Historical dataset fields***

| **Fields** | **Description** |
| --- | --- |
| **Weather Data** | ANM weather data used for pests/diseases occurrence probability calculation, at the time of algorithm execution |
| **Crop Type** | Crop for which the predicitve algorithm has yielded the pests/diseases occurrence probability |
| **BBCH** | Phenological growth stage of the crop |
| **Parameters Weights** | The weather parameters’ weights at the time of algorithm execution |
| **Pest/Disease Probability** | Predicitive algorithm’s output probability of pest or disease occurrence for comparison and trend analysis. |
| **Timestamp** | The timestamp, at the moment of algorithm execution |

Data archiving processes shall ensure that all datasets are securely stored and accessible while maintaining historical accuracy and compatibility with analytical tools. Data shall enter the archive after being validated by the Data Analyst (when the bulletin has been issued) and screened by the **Field Reporter**, ensuring its quality and relevance.

If data is not screened by the **Field Reporter** within a configurable timeframe, it shall automatically be archived, to prevent delays in the system’s workflow.

Additional metadata such as the username of the Data Analyst (responsible for validating the bulletin), the username of the Field Reporter (who confirmed or rejected the pest/disease prediction), and relevant geospatial references (e.g., ANM grid identifiers, LAU codes) should also be stored alongside each historical data entry to ensure full traceability and contextual accuracy.

#### **3.1.4.2 Data Retrieval**

The data retrieval process shall allow flexible and precise access to historical information. With advanced search capabilities, EWS users (based on their access rights) shall be able to filter datasets by parameters such as date range, geographic location (LAUs or counties), crop type, pest or disease name, and specific weather parameters (included in the pest-weather mapping table). This ensures that users such as field reporters and data analysts be able to find and extract the information they need.

The data retrieval shall benefit from advanced search capabilities, api integration and role based access control, as highlighted in the table below :

***Table 12 - Key Attributes of Data Retrieval***

| **Attribute Name** | **Description** |
| --- | --- |
| Advanced Search Capabilities | Enables users to search for and retrieve datasets using a wide range of filters, including: |
|  | - Date Range: Search data from a specific time period. |
|  | - Geographic Location: Retrieve data by LAU, county, parcel, or latitude/longitude coordinates. |
|  | - Crop Type: Filter by the crop associated with the dataset (e.g., wheat, corn, sunflower). |
|  | - Pest/Disease Name: Search by specific pests or diseases names or EPPO code |
|  | - Weather data: Query data based on pest-weather mapping table weather fields |
| API Integration | Provides programmatic access to datasets for integration with external systems: |
|  | - Supports RESTful APIs for real-time and batch data access. |
| Role-Based Access Control | Ensures that only authorized users can access specific datasets, adhering to ANF’s security protocols: |
|  | - User Roles: Access permissions are defined based on roles (e.g., Data Analyst, Field Reporter). |
|  | - Audit Logging: Tracks all retrieval activities for compliance and accountability. |

#### **3.1.4.3 - Trend analysis**

The trend analysis functionality shall provide the Early Warning System (EWS) with the ability to identify patterns and analyze pests/ disease occurrence probabilities, which have been calculated in the past.

##### **3.1.4.3.1 Analytics dashboard**

The module shall provide interactive dashboards with visual representations of current pests/diseases probabilities, alongside historical data for specific crops and their respective BBCH stages, helping to identify trends and assess risks effectively.

The EWS dashboard should support the analysis of historical pest and disease occurrence data through the following features:

• **Pest Outbreak Trends** – Graphs displaying the frequency and intensity of past outbreaks (past calculated pests/diseases occurrence probability above a certain threshold) across different regions and time periods.

• **Weather Pattern Visualizations** – Charts presenting historical weather data from ANM, including all relevant parameters (e.g., temperature, humidity, rainfall, wind).

• **Risk Assessment Summaries** – Maps and graphs showing the calculated probabilities of pest or disease occurrences, with breakdowns by LAU, crop type, and BBCH growth stage.

• **Geospatial and Temporal Filtering** – Tools to filter data by region (e.g. : county or LAU level), crop type, pest or disease, and time interval, to identify specific outbreak scenarios.

• **Comparative Analysis** – The ability to overlay pest/disease occurrence data with corresponding weather and crop information to reveal patterns and anomalies.

• **Custom Visualization Options** – Options to customize views and outputs for reporting, such as exporting filtered datasets or generating focused risk summaries.

##### **3.1.4.3.2 Weather parameter correlation**

The interactive dashboard shall include a section dedicated to analyzing past pest and disease occurrence probability calculations, specifically in relation to the weather parameter weights used by the predictive algorithm. This section should present the results of a parameter weights analysis algorithm, evaluating potential weather parameters' weights derived from pest/disease occurrence probabilities in historical data. This shall help refine the predictive algorithm by adjusting weather parameter weights based on evidence.

***Table 13 – Parameter weights analysis algorithm (input, method, outputs)***

|  |  |  |
| --- | --- | --- |
| **Input Data** | **Analysis Method** | **Outputs** |
| - Historical and real-time datasets, including weather parameters (e.g., temperature, humidity, precipitation), crop types, BBCH growth stages, and calculated pest/disease occurrence probabilities.  - Predefined weather parameter weights, initially configured based on expert judgment and scientific literature.  - YES/NO validation feedback from Field Reporters. | - Applies correlation metrics such as Pearson (for linear relationships), and Spearman (for monotonic relationships) to assess the strength of association between input variables and validated pest/disease presence.  - Compares computed correlations with existing weights to identify inconsistencies or reinforcement.  - Flags parameters with strong influence on historical outbreak patterns, suggesting areas where predictive weights may need adjustment. | - A ranked list of weather parameters, based on correlation strength with past outbreak data, to support the re-evaluation of model inputs.  - Graphical outputs including scatterplots, heatmaps, and trend graphs that visualize relationships and patterns.  - Alerts or recommendations when current parameter weights significantly diverge from historical correlation evidence. |

This functionality should serve as a decision-support mechanism for ANF and the Consultant for adjusting weather parameters weights.

The revision of the weather parameters’ weights shall be operated by the Consultant, at ANF’s request, during implementation, support and maintenance of EWS, at ANF’s request

### **3.1.5 Bulletin Dissemination and Notification Module**

The **Bulletin Dissemination and Notification Module** shall facilitate the efficient and timely delivery of forecast bulletins and alerts generated by the EWS.

The primary role of this module is to disseminate validated bulletins to relevant stakeholders, ensuring the information is accessible, actionable, and delivered through appropriate channels.

Dissemination and notification shall be triggered upon bulletin validation and issue by the data analyst.

**Core Features**

#### **3.1.5.1 Bulletin Web Access Portal**

The Bulletin Web Access Portal functionality shall provide stakeholders with a centralized, geospatially enhanced platform for accessing alerts and forecast bulletins through a web-based portal.

Core Functionalities

**Geospatial Dashboard Overview**

The web portal should feature an interactive dashboard displaying current bulletins and alerts on a geospatial map. Users should be able to visualize affected regions, overlay weather conditions (e.g., temperature, precipitation, humidity and other relevant weather parameters from ANM), and select zone based on ANM grid data, LAU and/or FIN (for APIA enrolled farmers).

The map must integrate with the EWS backend and be powered by GIS technology (e.g., Mapbox, Leaflet, or similar) to ensure fast rendering, responsive interaction, and real-time synchronization with the underlying datasets.

The map should allow users to quickly :

 Zoom and pan across regions of interest at national, county, and parcel levels.

 Click on specific areas or markers to access detailed **information** from the associated bulletin, including pest/disease type, affected crops, meteorological triggers, and recommended actions.

**Advanced Search and Filtering**

Users should quickly locate relevant bulletins by applying filters such as:

* + Date range (historical or upcoming risk periods)
  + Geographical scope (county, LAU, FIN)
  + Pests/Disease (selecting the the pests/diseases and/or the respective occurrence probabilities)
  + Crops

Each bulletin should be linked to the specific geospatial area it affects (e.g – county, selections of LAU, parcel for APIA enrolled farmers), allowing users to access localized insights:

* + APIA enrolled farmers shall view parcel-specific risk levels, by inserting their FIN
  + Authorities shall assess regional trends, supporting targeted interventions.

**Multi-Device Compatibility**

The portal shall be optimized for desktops, laptops, and tablets, ensuring accessibility across different screen sizes, operating systems and browsers. The geospatial map shall remain responsive across all devices for real-time analysis.

All bulletin access portal functionalities shall be refined during the analysis phase.

**Access and User Registration**

The features of the Bulletin Web Access Portal should be publicly accessible by default for general viewing of pests/diseases alerts. However, access to personalized information—such FIN filtering or parcel-specific risk dashboards shall require user registration.

Users seeking access to personal APIA-linked data should sign up by providing a valid email address.

The web access portal shall support integration with the ROeID authentication system, enabling users to securely authenticate using their official digital identity credentials in compliance with national standards.

Upon signing up, the user shall be able to configure, at a minimum:

* Their APIA parcel data by inserting its FIN
* Notification preferences based on crop, BBCH, location (selection of LAUs, county, etc)

#### **3.1.5.2 Distribution via Email**

The module shall ensure that bulletins are sent securely and efficiently to recipients via email, for registered Bulletin Web Access Portal users and other recipients (manually added by the authorized EWS users).

Email delivery shall be automated and shall use predefined templates to distribute notifications directly to stakeholders’ email addresses.

All email communications shall follow strict security protocols and adhere to applicable legal frameworks, including the General Data Protection Regulation (GDPR) and relevant national data privacy laws.

EWS should address the following key issues:

* TLS encryption for all emails in transit to prevent interception
* Role-based access controls ensure that only authorized system components can trigger or access email delivery
* Data minimization - emails include only essential, non-sensitive personal data
* Consent-based communication – Signed up users and other recipients must explicitly agree to receive bulletins during registration
* Furthermore, the system must provide recipients with a straightforward mechanism to opt-out of receiving future bulletins at any time. Each notification email shall include a clearly visible unsubscribe link or instructions, allowing users to easily withdraw their consent if they no longer wish to receive communications. Upon opting out, their preferences will be promptly updated in the system, and they will be excluded from subsequent email distributions, in full compliance with data privacy requirements.

**Scalable Email Distribution**

EWS may need to handle a high volume of emails sent to thousands of recipients. In this case, the system shall be integrated with a dedicated email delivery service capable of handling bulk messaging with high deliverability rates. The system should send bulk emails using:

* Transactional email services such as SendGrid, Amazon SES, or Mailgun
* Segmentation and Batching - Emails should be sent in intelligently managed batches based on region, crop type, or other relevant bulletin information, optimizing throughput and reducing the risk of throttling
* Asynchronous Queues – The system shall be integrated with messaging queues (e.g., RabbitMQ, Azure Queue Storage) ensures bulletins are processed and sent without affecting application performance

**Recipient list management**

Recipients should be added, edited or deleted in the manual list, providing the possibility to send customized emails to interested stakeholders, particularly town halls.

The recipient form should include several attributes such as name, email address, a selection of geolocational areas of interest (e.g selection of LAUs, county, etc), a selection of crops and other relevant information, to be determined. All attributes shall be defined during the analysis phase.

**Email Templates**

Authorized users (e.g communication managers) shall manage predefined templates that standardize the structure and content of emails. These templates should support dynamic fields, such as region and bulletin details (crop, pests/diseases occurrence probabilities, necessary action, etc), ensuring recipients receive clear and actionable information.

The bulletin should be attached to the email, in PDF format.

The **Distribution via Email** feature involves key attributes to ensure targeted, secure, and efficient bulletin delivery to the appropriate recipients, while maintaining data integrity and flexibility for certain stakeholder groups.

The email distribution feature shall include storage and archiving capability, ensuring that all sent emails are securely saved and can be accessed at any time. These archived emails are organized in a manner similar to an **INBOX**, allowing users to easily consult past communications.

A comprehensive filtering system should be integrated, enabling users to search and sort emails based on key criteria, such as recipient name, geolocation area of interest, delivery status (Sent, Failed, Pending), and date. This functionality ensures that stakeholders can review historical notifications, track communication logs, and maintain a complete record of bulletin dissemination activities, promoting transparency and operational efficiency.

All functionalities of distribution via email shall be refined during analysis phase

#### 3.1.5.3 Push Notifications through the EWS Mobile Application

The **Push Notifications through the EWS Mobile Application** feature enables the timely and efficient dissemination of geographically targeted bulletins and alerts directly to stakeholders’ mobile devices. The module ensures secure, real-time delivery of notifications The mobile application provides interactive access to notifications and enables users to act promptly based on the information received.

Push notifications in the EWS mobile app shall be managed via Firebase Cloud Messaging (FCM) for Android and Apple Push Notification Service (APNS) for iOS, ensuring direct and secure message delivery without requiring integration with the Play Store or Apple Store. Device tokens are registered and stored in the EWS backend, allowing alerts to be sent based on geospatial filters such as APIA parcel locations and ANM weather data.

**Core Functionalities**

1. **Real-Time Alerts**

The module delivers notifications instantly upon the approval of bulletins, ensuring stakeholders receive timely updates.

* **Geographic Targeting**: Notifications are tailored based on the recipient’s parcel location for enrolled APIA farmers, who have uploaded their FIN into the mobile application. Farmers who are not enrolled in APIA may receive alerts for specific LAUs or counties
* **Interactive Content**: Notifications include metadata such as bulletin ID, crop, pest/disease probability, and a direct link to view the full bulletin within the mobile app.

***Table 14 – Push notification key attributes***

| **Attribute** | **Description** |
| --- | --- |
| **User ID** | Unique identifier for linking notifications to individual users. |
| **Device Token** | Identifies the recipient's mobile device for secure and accurate push notification delivery. |
| **Geographical Relevance** | Links notifications to APIA parcel data for enrolled farmers or LAU for town halls and other recipients |
| **Notification Timestamp** | Records the exact time the notification was delivered to the recipient's device. |
| **Read Status** | Tracks whether a notification has been viewed or acknowledged by the user. |

#### **3.1.5.4 External API Access for Validated Bulletins**

To support inter-institutional collaboration and data interoperability, the Bulletin Dissemination and Notification Module shall include a dedicated API access layer enabling authorized third-party institutions—specifically APIA and ANM—to securely retrieve validated warning bulletins issued by ANF.

This functionality is developed in alignment with the Memorandums of Understanding (MoUs) signed between ANF and other two institutions and will facilitate timely integration of bulletin data into their respective systems for further analysis, policy support, or agricultural advisory services.

Core Functionalities:

* Secure API Gateway: A RESTful API interface protected by token-based authentication (e.g., OAuth 2.0), ensuring only authorized access from APIA and ANM systems.
* Bulletin Query Parameters: Institutions will be able to query bulletins based on date, region, crop, and risk level.
* Metadata and Status: Each bulletin will include meta data of the bulletins such as timestamps of validation and dissemination, crop, pests/diseases and other relevant attributes
* Standardized Format - The retrieved bulletins shall be available in both JSON and PDF format
* Usage Logging and Monitoring - All external API access events will be recorded in the system’s audit (available for review in the Audit and Compliance Monitoring Module), including request timestamp, and retrieved bulletin IDs.

The integration parameters shall be managed at the level of the System Administrator within the System Administrator and Integration module – [Integration Management](#_1.1.2.3._Integration_Management)

### **3.1.6 - Mobile Application Module**

The **Mobile Application Module** shall be available for download on Google Play and the Apple App Store, offering farmers and stakeholders a convenient, real-time interface to access alerts, bulletins, and geospatial data tailored to their parcels or zones of interest. The app shall be designed to integrate with the Early Warning System (EWS) backend, ensuring real-time updates, data synchronization, and a user-friendly experience.

The Consultant shall be responsible for submitting the finalized mobile application to the **Google Play Store** and **Apple App Store**, ensuring full compliance with the respective platform guidelines to secure approval and availability for end users.

**Development Approach and Technologies**

The application should be developed using Flutter or a similar cross-platform framework, ensuring a consistent and high-performance experience on both Android and iOS. This approach allows for a single codebase, reducing development time and maintenance costs while ensuring native-like performance. The application shall communicate with the EWS backend through RESTful APIs or similar technology, providing secure and efficient data exchange. The backend shall reside in the cloud infrastructure, ensuring scalability, high availability, and compliance with GDPR and national security regulations.

Geospatial functionalities should be implemented using a solution compatible with large-scale weather datasets, such as Mapbox, Google Maps SDK, OpenStreetMaps, or a similar platform, ensuring interactive mapping, efficient weather data visualization, and integration of ANM’s and APIA geospatial data for precise localization of pests/diseases alerts

The application’s architecture shall follow the **Model-View-Controller (MVC)** or **Model-View-ViewModel (MVVM)** design patterns, ensuring separation of concerns for easier maintenance and enhanced scalability. Offline functionality will be implemented using local storage solutions like **SQLite**, **Hive**, or similar, allowing users to access recent notifications, bulletins, and settings even without an active internet connection. The design shall emphasize intuitive navigation and user-centric interfaces to ensure ease of use for all stakeholders.

**System Architecture and Security**

Real-time alerts and notifications shall be delivered using services such as Firebase Cloud Messaging (FCM), Apple Push Notification Service (APNS), or similar. Error tracking and analytics shall be supported by tools like Sentry, Google Analytics for Firebase, or similar, enabling continuous optimization of app performance and user experience.

**Core Functionalities of the EWS Mobile Application**

The EWS Mobile Application shall require user registration and authentication to access its functionalities. This approach enables secure, personalized access to pest and disease alerts, while ensuring compliance with GDPR and national data protection regulations.

**1) User Registration and Authentication**

**All users must create an account using a valid email address to access the application.**

**Functionalities:**

* User registration via email, with verification process.
* Optionally, the user should be able to register with their Gmail account
* All session data and access tokens are managed securely.
* The application shall support integration with the ROeID authentication system, enabling users to securely authenticate using their official digital identity credentials in compliance with national standards.

**2) FIN-Based Personalized Alerting**

The application shall allow APIA enrolled farmers to input their FIN and access alerts for their APIA-registered parcels.

**Functionalities:**

* Input and validation of the FIN after login.
* Automatic retrieval of parcel geometries and crop metadata from the APIA data imported into EWS.
* Display of user-specific parcels on the interactive map.
* Overlay of pest/disease alerts, weather data, and parcel crop.
* Link to full bulletins issued by the EWS for each alert.
* Secure handling of parcel metadata, with encryption in transit and storage.

**3) LAU-Based Alert Visualization**

Authenticated users may also view alerts based on selected Local Administrative Units (LAUs), allowing for regional filtering of diseases/pests alerts.

**Functionalities:**

* Search-and-select interface for LAU selection.
* Visualization of selected LAUs on the map as standardized GIS polygons.
* Real-time overlay of pests/diseases alerts, parcel crops.
* Tap-to-view bulletins with metadata: pest/disease type, timestamp, affected crops, and direct link to full bulletin.
* Option to save favorite LAUs to user profile.

**4) Data Privacy and Security**

* All user data (email, FIN, parcel info) is encrypted and securely stored.
* No personal data is shared with third parties.
* Access is governed by role-based permissions.
* GDPR compliance ensured via authentication, access control, and audit trail mechanisms.

**5) Offline Access to Critical Information**

The mobile application shall ensure continued usability in areas with limited or no internet connectivity by locally storing recent alerts, notifications, and essential geospatial data. This includes:

* Cached EWS bulletins and notifications for access without a network connection
* Locally saved parcel and LAU selections to support uninterrupted navigation and risk review in offline mode

Once internet connectivity is reestablished, the app automatically synchronizes with the EWS backend to retrieve the latest bulletins, update alerts, and ensure all user preferences and feedback are transmitted securely.

6) **Other key features of the mobile application**

***Table 15 – key features of the mobile application***

| **Category** | **Feature** | **Description** |
| --- | --- | --- |
| **Design** | Responsive UI | Consistent user experience across Android and iOS, optimized for mobile use. |
|  | Multilingual Support | At this moment the interface shall be available in Romanian. However, the application must support addition of other languages. |
| Security | Data Encryption | All data in transit and at rest is encrypted (TLS, AES-256). |
| **Personalization** | Parcel-Based  Alert Configuration | Enrolled APIA farmers can define alert preferences based on their registered APIA parcels, by inserting their FIN |
| **Reporting** | User Feedback  Submission | Users can report pest presence or give feedback on bulletins directly in app, which will be stored and used in the Reporting module |
|  | Activity Log Sync | User interactions and feedback are synced with backend for reporting/auditing. |

Note:

These features represent the minimum requirements for the application. Detailed specifications, additional functionalities, and potential refinements will be determined during the analysis phase, based on stakeholder input, technical feasibility, and system integration requirements.

### **3.1.7 - Audit and Compliance Monitoring Module**

**Purpose**

The Audit and Compliance Monitoring Module shall ensure accountability, transparency, and regulatory compliance within the Early Warning System (EWS). It shall track user actions, monitor system activity, and safeguard data integrity to support both operational needs and legal requirements.

**Core Features**

**1. Audit Trail**

The Audit Trail shall be the primary mechanism for ensuring accountability in EWS. The audit trail should capture every significant action performed in the system and allows administrators to search and filter by user, timestamp, action type, and affected component.

**Audit Trail for Key Modules**

Each audited module shall include a structured record of relevant activities. The following table provides the consolidated set of audit attributes used across the core components of the EWS:

***Table 16 – Audit attributes***

| **Attribute** | **Description** |
| --- | --- |
| Unique ID | Identifies each recorded action. |
| Timestamp | Logs the exact time of the action. |
| User Role & ID | Specifies the user and their role who performed the action. |
| Action Type | Describes the nature of the action (e.g., Create, Update, Retrieve). |
| Affected Module | Indicates which EWS module was involved (e.g., Reporting, Bulletin Drafting). |
| Affected Entity/Record | Indicates the type of entity that was modified (e.g., user role, report, email template, bulletin, etc.). |
| Change Summary | Summarizes what was changed, including old and new values if applicable. |
| IP Address | Captures the origin of the activity. |

This unified schema ensures consistent auditing across the following modules:

* System Administration and Configuration Module
* Quality Assurance and Bulletin Drafting Module
* Historical Data Management Module
* Bulletin Dissemination and Notification Module
* Reporting Module

**2. Configurable Alerts**

The system shall allow administrators to configure alerts for critical system events, in order to ensure timely response to both security and operational incidents. Each alert shall be categorized by type (e.g., Critical, Warning, Information) and linked to a specific triggering event, such as a failed login attempt, unauthorized data modification, or unexpected system downtime.

Alerts should include a defined priority level, which determines the urgency of the response and the visibility within the system’s monitoring interface. Additionally, system administrators shall be able to specify the target audience for each alert – the EWS users who receive these alerts, ensuring that relevant stakeholders are immediately notified based on their role and responsibilities.

The critical system events triggering these alerts shall be defined during the analysis phase.

**3. User Activity Reports**

User Activity Reports offer insights into how the system is being used by different roles. This functionality shall summarize user interactions, groups activities by role, and highlights anomalies, such as unauthorized access attempts or irregular data changes, ensuring accountability.

The system shall generate user activity reports that provide a concise overview of actions performed by each user, categorized by their assigned role (e.g., Filed Reporter, Data Analyst). These reports shall summarize system interactions within a defined timeframe and support the identification of usage patterns or unusual behavior. When irregularities have been detected—such as unauthorized access attempts or atypical data modifications, the system shall flag them as anomalies and include detailed descriptions of the events.

Each entry shall be time-stamped to allow precise tracking and support audit investigations or compliance reviews.

### **3.1.8 - Reporting Module**

The Reporting Module within the EWS shall be designed to enable advanced search capabilities across its data sources, including pests/diseases-related data, weather datasets, geospatial information, and user actions. Access to reports shall be governed by role-based permissions and aligned with regulatory and organizational policies. This module should support various types of reports with flexible grouping options (e.g., by period, location, or pest/diseases). This module should also enable the creation of pivot tables, charts, and geospatial visualizations for in-depth data analysis.

The reporting module shall also generate reports based on user feedback and submitted through the mobile application

At this stage, the following reports have been identified by ANF as being mandatory. However, throughout the analysis phase and later, during the full deployment phase, more reports shall be implemented by the Consultant, at ANF’s request. ANF may request that the Contractor implement up to 20 reports, aside from the mandatory reports listed in the table below.

***Table 17 – Mandatory reports***

| **No.** | **Report title** | **Description** | **Key attributes** | **Frequence** |
| --- | --- | --- | --- | --- |
| 1 | Report on Pest/Diseases Incidences | Summarizes pest and disease occurrences by type, location, crop, BBCH stage, and frequency. | Pest/Disease Type, Region, Crop, BBCH Stage, Date, Frequency | Weekly |
| 2 | Report on Crop Incidences | Summarizes crop-specific pest and disease impact across regions (counties, LAUs) and timeframes. | Crop Type, Region, Pests/Diseases occurrence probability, Date, Affected Area, Frequency | Weekly/ Monthly/ Yearly |
| 3 | Report on Weather Trends | Summarizes historical and recent weather data relevant to pest/disease forecasting models. | Date, Region, Temperature, Humidity, Rainfall, Wind, Solar Hours | Weekly / Monthly |
| 4 | Report on Geospatial Alerts | Tracks issued alerts mapped to LAUs and affected crops. | Alert ID, LAU, Crop, Pests/Diseases occurrence probability, Recommendations | Daily / Weekly |
| 5 | Report on Forecast Accuracy | Evaluates the accuracy of EWS predictions by comparing forecasted vs. observed events. | Forecast Date, Region, Predicted Risk, Yes/No feedback from field reporter | Monthly / Quarterly |
| 6 | Report on Notifications | Summarizes alert notifications sent via mobile applications and email, including delivery status. | Notification ID, Channel, Recipient Type, Status, Timestamp | Weekly / Monthly |
| 7 | Report on User Activity | Logs user interactions for auditing, grouped by module and user role. | User ID, Role, Action Type, Timestamp, Module | Daily / Weekly / Monthly |
| 8 | Report on System Performance | Monitors backend and frontend system performance metrics. | Date, API Throughput, Latency, Error Rate, Uptime | Monthly / Quarterly |
| 9 | Report on PPP Recommendations included in bulletins | Summarizes PPPs fetched from PESTEXPERT, and inserted as recommendations for into issued bulletins | Crop, Pest/Disease, Recommended PPPs, Application Guidelines | Weekly / Monthly / As Needed |
| 10 | Report on Alert Workflow | Tracks the lifecycle of alerts, from creation to resolution. | Alert ID, Creation Date, Status, Last Update, Assigned User | Weekly |
| 11 | Report on Risk Levels by Region | Analyzes pest/disease risk levels at regional level (county, selection of counties) for supported crops. | Region, Crop, Risk Index, BBCH Stage | Weekly / Monthly |
| 12 | Report on Historical Data Trends | Provides aggregated historical trends for past diseases/pests occurrence probabilities and their corresponding historical weather data | Period of time, Region, Crop, Pest/Disease, Weather Parameters | Quarterly / Annually |
| 13 | Report on Feedback Received | Summarizes user feedback submitted through the EWS platform or mobile app. | User ID, Feedback Type,Message, Timestamp | Monthly |
| 14 | Comparison Report on Pest and Disease Trends | Compares pest and disease dynamics across years and regions. | Pest/Disease, Year, Region, Frequency | Quarterly / Annually |
| 15 | Comparison Report on Crop Incidences by Zone | Compares incidence rates for crops across different zones and years. | Crop, Region (e.g., county, selection of LAUs), Year, Incidence Rate | Quarterly / Annually |
| 16 | Comparison Report on Pest/Disease Frequency Across Years | Analyzes how frequently specific pests/diseases have emerged over time. | Pest/Disease, occurrence probability, Region (county, selection of counties), Frequency, Year | Quarterly / Annually |

The report module should include key features such as**:**

1. Role-Based Access Control - Each report type is accessible only to authorized roles (e.g., farmers, administrators, analysts).
2. Interactive Dashboards - Users can view data in dynamic visualizations such as maps and pivot charts.
3. The Reporting Module shall include a customizable template engine that empowers users to design and generate reports based on specific analytical needs. Users shall have access to a user-friendly interface for selecting data fields from available EWS datasets—such as pests/diseases, occurrence probabilities, weather parameters, geospatial information, or bulletin dissemination logs—and apply a wide range of filtering and grouping conditions. Logical operators (AND, OR, NOR, XOR) should be supported to allow the construction of advanced queries, enabling complex correlations between variables. Filters may include, but are not limited to, date ranges, regions (e.g: counties, selection of LAUs), crop types, occurrence probability thresholds, severity levels, or user roles. The report templates shall be saved and reused as needed, promoting consistency in recurring analyses. Once configured, templates can be executed on-demand or scheduled, generating outputs in multiple formats (e.g., Excel, PDF, GeoJSON) depending on user roles and permissions.
4. Export Options: Supports exporting reports in PDF, Excel, CSV, and geospatial formats (e.g., GeoJSON).
5. Scheduled Reporting: Enables automated report generation at predefined intervals.

**Implementation requirements:**

* Reports should use the same data structure as the EWS system, so that all information is accurate and consistent. They should also follow ANF’s internal procedures and legal rules, making sure the reports are both useful for daily work and compliant with regulations.
* The reports should ensure integration with EWS core modules, allowing real-time insights to support decision-making and operational efficiency.

## 3.2 Functional Performance Requirements of the System

### **3.2.1 - General Functional Requirements**

#### **3.2.1.1 User and Access Management**

The EWS system shall comply with the following requirements:

* Role-Based Access Control: Provide granular access management through roles and permissions integrated with ANF’s Identity Provider (IdP), ensuring system administrators can assign and manage user-specific permissions for accessing modules like PESTEXPERT integration, geospatial data, and weather datasets.
* User Groups and Permissions - Allow administrators to create and manage user groups, such as Data Analysts, Field Reporters, and Communications Managers, and assign permissions tailored to their roles within the EWS.
* Unlimited Network Access: Ensure the system is accessible to an unlimited number of authorized ANF users

#### **3.2.1.2 Usability**

The EWS system shall comply with the following requirements:

* Consistent Interface - Maintain uniform behavior and design across all modules, including the mobile application, web access portal, to ensure a user experience and reduce the learning curve for stakeholders interacting with the EWS.
* Intuitive Design - Design a user-friendly interface optimized for both web and mobile platforms, supporting efficient task execution, navigation, and real-time access to critical alerts and bulletins on the go.
* Error Handling - Provide clear error messages across all platforms, including the mobile app. Ensure server logs and debugging support are accessible to administrators for quick issue resolution.
* Notifications of errors should be visible within the mobile application when applicable.
* Data Sorting - Include multi-column sorting features for data tables across both the web and mobile interfaces, with optimized designs for smaller screen sizes to ensure usability when interacting with workflows, alerts, and master data.
* Keyboard Shortcuts: Enable system-wide shortcuts for users or quick-access buttons for mobile users to optimize usability and task completion.
* Customizable UI - Allow interface customization to meet user preferences and regulatory standards, with additional mobile-specific features like personalized dashboards and notification filtering.

#### **3.2.1.3 Modular Structure and Interoperability**

The EWS system shall comply with the following requirements:

* Provide web-based architecture for all modules except the Mobile Application Module, which will be a stand-alone mobile application for Android and iOS operating systems
* Modular Architecture- Design modular components to enable seamless integration between functional areas and future scalability.
* Interoperability Standards: Ensure compatibility with external data sources and systems, such as PESTEXPERT, APIA, and ANM.
* Independent Operations - Allow modules to operate independently while sharing data as required.
* Detailed API Documentation - Provide comprehensive API documentation for future integrations.
* Audit Trails - Maintain comprehensive logs of user activities and system changes.

#### **3.2.1.4 Access and Extensibility**

* Unlimited Accessibility: Support unlimited access for users within ANF’s network.
* License-Free Operation: Avoid additional licensing requirements post-development, ensure there are no hidden licensing fees to be supported by the Beneficiary.

#### **3.2.1.5 Cloud-Based Infrastructure Requirements**

* Cloud Compatibility: Design the system for cloud deployment, ensuring scalability and reliability.
* Elastic Resource Allocation - Utilize elastic cloud capabilities to accommodate fluctuations in usage.
* Data Security - Implement GDPR-compliant encryption and access controls.
* Backup and Disaster Recovery - Include automated backups and failover mechanisms to ensure data availability.
* Performance Monitoring - Provide tools for tracking resource utilization and system performance.

### **3.2.2 - Home Page Functional Requirements**

Users shall access the Early Warning System (EWS) via a secure web-based portal. Authentication will be managed through ANF’s existing Identity Provider (IdP), ensuring single sign-on (SSO) and role-based access control. Upon successful login, each user shall be automatically directed to the home page, which serves as the central interface for monitoring tasks, alerts, and data relevant to their role.

The home page of the Early Warning System (EWS) should serve all user roles by providing a personalized overview of relevant activities, tasks, and alerts. Each user should have quick access to ongoing tasks, historical data, and upcoming events associated with their responsibilities.

* The home page shall feature an integrated dashboard displaying key insights sourced from the Reporting Module and Historical Data Management Module. This includes geospatial risk maps (highlighting pests/diseases occurrence), summary charts, and reports. Data should be updated dynamically to reflect real-time system status and role-specific insights.
* Alerts shall be embedded within the dashboard, prioritized and categorized based on their relevance to the user’s role. Alerts shall be sourced from the Audit and Compliance Monitoring Module and System Administration and Configuration module
* Task management components should provide a clear overview of critical actions, such as bulletin dissemination tasks, alerts, or pending bulletin approvals. This information should be synchronized with the Audit and Compliance Monitoring Module and the Bulletin Dissemination and Notification Module.
* A calendar view shall help users anticipate future actions such as scheduled data updates, planned sampling campaigns, or bulletin release workflows, ensuring timely preparation and coordination.
* Quick access tools should allow users to navigate directly to key modules, including the Historical Data Management Module, the Reporting Module, and the Bulletin Dissemination and Notification Module. A “Recent Activities” panel should summarize user actions performed in the past 48 hours to enhance transparency and personal accountability.
* The home page shall support customizable interactive widgets, enabling users to tailor their interface layout. Widgets may include tools for report generation, data validation summaries, and geospatial visualizations.
* The default interface language shall be Romanian, ensuring compliance with operational guidelines and facilitating adoption by national and regional users.
* All elements of the home page, including widgets, dashboards, alerts, and content—shall be dynamically filtered by user role (e.g., System Administrator, Data Analyst, Field Reporter) to ensure users interact only with tools and information relevant to their designated functions.
* The design, layout, and functionality of the home page must be reviewed and formally approved by the Beneficiary during the analysis phase, to ensure full alignment with operational expectations and user workflows.

### **3.2.3 - Functional Requirements for System Administration and Configuration Module**

The System Administration and Configuration Module shall provide, as needed, and without being limited to, the foundational capabilities necessary to manage users, roles, permissions, integrations, validation logic, and alerts within the Early Warning System (EWS). All functionalities must be secure, auditable, and configurable, ensuring full compliance with ANF’s internal procedures and regulatory obligations.

**1. User Administration**

* The system MUST enable users with the “System Administrator” role to manage core entities such as Roles, permissions, and teams/groups.
* The system MUST synchronize user identity attributes (e.g., email address, organizational unit, role, manager) with the ANF Identity Provider (IdP).
* The system MUST implement a structured registration workflow to classify users and assign permissions aligned with predefined roles (e.g., System Administrator, Data Analyst, Field Reporter).
* Each user record MUST include audit trail attributes capturing timestamps, changes made, and the initiating user.
* The system MUST allow administrators to view and manage user metadata.

**2. Role and Permission Management**

* The system MUST allow creation, updating, and deletion of roles, each with a unique ID, name, and description.
* Permissions MUST be granular, defining actions such as read, write, update, and delete across specific modules
* All modifications to roles and permissions MUST be recorded in a complete audit trail including timestamps, changed fields, and user IDs.

**3. Integration Management**

* The system MUST support configuration and management of connections with external data sources such as PESTEXPERT, APIA, and ANM
* Each integration MUST include attributes such as integration name, type (API, file, database), API keys, access credentials, and synchronization schedules.
* The system MUST support real-time and scheduled synchronization modes.

**4. Integration monitoring**

* The system MUST provide administrators with real-time dashboards for monitoring active integrations.
* Synchronization logs MUST include event types (e.g., success, failure), data volumes, timestamps, and any detected anomalies.
* The system MUST track and visualize integration health metrics such as error rates, last sync time, and uptime status.

**5. Notification and Alert Configuration**

* The system MUST support template-based configuration for internal system notifications targeted at roles such as Data Analyst, Communications Manager, and System Administrator.
* Alerts MUST be generated based on parameters received from external sources such as ANM and matched against predefined thresholds.
* Notifications MUST include a priority level (e.g., Critical, Warning, Information) and a target role.
* Notification templates and rules MUST be stored, versioned, and testable before deployment.

1. **System configuration**

* The system MUST provide a secure interface accessible only to users with the "System Administrator" role for configuring global system settings.
* The system MUST allow administrators to define and update cache policies, including cache duration, refresh intervals.
* The system MUST allow configuration of session timeouts, including maximum idle time and forced logout after a specified period of inactivity.
* The system MUST support setting the default system time zone, which shall apply uniformly across all timestamps in logs, notifications, and reports.
* The system MUST enable configuration of web access rules, including IP whitelisting, domain restrictions.
* The system MUST allow administrators to set API usage limits per user or IP.
* The system MUST automatically record all system configuration changes in the audit trail, including user ID, timestamp, and before/after values.

### 3.2.4 - Functional Requirements for the Quality Assurance and Bulletin Drafting Module

The Quality Assurance and Bulletin Drafting Module shall ensure the scientific validity, operational consistency, and timely generation of pest and disease forecast bulletins within the Early Warning System (EWS). The module must integrate weather data, crops and geospatial inputs, the predictive algorithm, pest-weather mapping logic, and expert validation workflows to support evidence-based phytosanitary alerts.

**1. Weather Data Retrieval and Processing**

* The system MUST retrieve daily grid-based weather forecasts (GRIB2 format) from the ANM FTP server.
* Retrieved data MUST cover all ANM-defined 7x7 km grid cells across Romania and include hourly values for the next 24 hours.
* The system MUST convert and standardize the raw GRIB2 data into structured formats (e.g., JSON or XML) for internal processing.
* Timestamp normalization MUST be applied to ensure all weather records follow a consistent UTC time reference.
* The system MUST aggregate hourly values into averages across pest/disease-specific windows (e.g., 72h, 120h), storing both the results and calculation timestamps for further analysis.

**2. Integration of APIA Geolocation and Crop Data**

* The system MUST support annual retrieval of parcel-level crop declarations from APIA via a secured FTP account.
* Retrieved parcel data MUST include anonymized farmer IDs (FIN), declared crops, and LAU-level geolocation metadata.
* The system MUST associate ANM grid cells with APIA parcels to enable crop-specific forecasting at parcel level.
* FIN-based access MUST be implemented in the mobile app to deliver parcel-specific alerts to registered farmers.

**3. Pest-Weather Mapping Table Management**

* The system MUST maintain a centralized Pest-Weather Mapping Table linking validated weather thresholds to pest and disease occurrence probabilities per crop and BBCH stage.
* Editable fields MUST include:
  + Crop type
  + BBCH stage
  + Weather parameter thresholds
  + Parameter weights
  + Associated pests/diseases
* The system MUST log all updates, including user ID, timestamp, and change history.
* The module MUST support version control and rollback functionality for the mapping table.
* Weights for each weather parameter MUST be configurable and reflect their relative contribution to pest/disease prediction.
* Weather data transformations (e.g., °K to °C, wind vector calculations) MUST be supported to align with pest-disease forecasting standards.

**4. Predictive Algorithm and Probability Calculation**

* The system MUST integrate weather, crops, and pest-weather mapping table data to compute pest/disease occurrence probabilities.
* Probability scores MUST be weighted based on parameter importance (as defined in the pest-weather mapping table).
* Draft bulletins MUST be automatically triggered when pest/disease probability scores exceed predefined thresholds.
* Manual override functionality MUST be provided to allow authorized users to initiate bulletin generation independently of automated triggers**.**

**5. PESTEXPERT Integration for PPP Recommendations**

* The system MUST retrieve PPP recommendations from the PESTEXPERT database using EPPO codes and pest names as primary keys.
* Retrieved fields MUST include:
  + PPP name
  + Hazard and precautionary statements
  + Min/Max dosage
  + Application method
  + Pre-harvest interval
* If no PPP is found, the system MUST allow manual input of recommendation details in the draft bulletin**.**
* Technical integration parameters with PESTEXPERT MUST be finalized during the analysis phase.

**6. Bulletin Drafting, Validation, and Approval**

* The system MUST consolidate weather summaries, crop and BBCH data, geolocation info, pest probability outputs, and PPP recommendations into a structured bulletin template.
* The system MUST allow users to create and delete Bulletin templates and edit them
* Bulletin sections MUST include:
  + Header (region, date, crops, BBCH)
  + Weather overview
  + Pest/disease forecast
  + Recommendations and safety guidance
* Manual editing of draft bulletins MUST be available before approval.
* A Data Analyst MUST review, validate, and approve each bulletin prior to dissemination.
* Data Analysts MUST be able to manually draft, validate and issue a warning bulletin, according to their expert judgement, irrespective of the output of the predictive algorithm.
* The system MUST record bulletin drafting and validation actions in an audit log.
* All bulletins must be saved in PDF format and stored along identification metadata (e.g – issue date, crop, LAU, county, etc) for future access.

### **3.2.5 - Functional Requirements for the Historical Data Management Module**

**1. Data Archiving**

• The system MUST archive all validated datasets along with relevant metadata, including timestamps, user IDs, and geospatial references (e.g., LAU codes or ANM grid identifiers).

• The system MUST automatically archive datasets if they are not reviewed by Field Reporters within a configurable timeframe.

• The system MUST support multiple export formats such as JSON, CSV, and GeoJSON to ensure compatibility with external analysis and reporting tools.

• Archived datasets MUST include both raw and processed data, including weather, geospatial information, pest and disease occurrence probabilities, and Field Reporter validation feedback (Yes/No).

1. **Data Retrieval**

* The system MUST support advanced search functionality to retrieve archived datasets using filters such as date range, geographic location, crop type, pest or disease name, and weather parameters.
* The system MUST expose APIs to allow programmatic access to datasets by authorized systems or tools.
* Role-based access control MUST be enforced to ensure that only authorized users can access sensitive or restricted datasets.
* All data retrieval activities MUST be logged with details such as timestamp, user ID, and reference to the retrieved dataset, to support traceability and compliance.

1. **Trend Analysis**

* The system MUST provide interactive dashboards that display trend visualizations, including historical pest outbreaks and weather patterns.
* The system MUST enable users to apply filters and customize dashboard views by selecting region, crop, pest or disease type, and time period.
* The system MUST implement a parameter weights analysis algorithm that calculates statistical correlations between weather parameters and pest/disease occurrence probabilities, based on validated historical datasets and field-reported observations.

**4. Performance and Scalability**

• The system MUST process and archive datasets for all regions of Romania within 5 minutes of data submission.

• Data retrieval operations MUST support at least 8,000 concurrent users without performance degradation.

• The system MUST handle up to 6 TB of archived data annually while maintaining quick response times for search and retrieval.

**5. Integration with Other Modules**

• The system MUST be integrated with the Reporting Module to provide data for trend analysis and compliance reporting.

### **3.2.6 - Functional Requirements for the Bulletin Dissemination and Notification Module**

The Bulletin Dissemination and Notification Module is responsible for securely and efficiently delivering validated bulletins and alerts generated by the Early Warning System (EWS). Dissemination must occur only after bulletin validation and shall support multiple delivery channels, including a web-based access portal, automated emails, and push notifications through the EWS mobile application.

1. **Bulletin Web Access Portal**

* The system MUST provide a web-based portal for viewing bulletins and alerts, integrated with interactive geospatial map.
* The portal MUST support overlaying bulletins and weather data on the map, allowing users to visualize affected areas using ANM grid data, LAU codes, or parcels linked to FIN, for enrolled APIA farmers.
* The portal MUST support advanced filtering by:
  + Date range
  + Geographic location (county, LAU, or FIN)
  + Crop type
  + Pest or disease and associated probabilities
* The portal MUST allow public access to general alerts and restricted access to parcel-specific information for registered users.
* Registered users MUST be able to configure:
  + Their FIN for accessing personalized parcel-level bulletins
  + Crop and region preferences
  + Notification preferences
* The portal MUST be compatible with desktops, laptops, and tablets, ensuring responsive geospatial tools on all supported screen sizes across all modern browsers (Chrome, Mozilla, etc)
* The portal should include a section for user feedback, which can be utilized in the reporting module.

2. **Distribution via Email**

* The system MUST enable automated email distribution of validated bulletins to registered users and manually added recipients.
* Email delivery MUST be secured using TLS encryption and adhere to GDPR and national data protection regulations.
* The system MUST support:
  + Role-based access controls for triggering email distribution
  + Consent-based communication (e.g., explicit opt-in at registration)
  + Dynamic email templates with fields for region, crop, pests/diseases, risk level, and recommended actions
  + PDF attachments containing the full bulletin
* Emails MUST be segmented and batched intelligently by region, crop, or risk level to support scalable delivery, if needed
* The system MUST integrate with bulk email services (e.g., SendGrid, Amazon SES) and asynchronous processing queues (e.g., RabbitMQ) to support high-volume, reliable delivery, id needed
* Recipient lists MUST be manageable by authorized users and include attributes such as:
  + Name
  + Email address
  + Geolocational area of interest (e.g., LAU)
  + Crop preferences
* All sent emails MUST be archived with status (Sent, Failed, Pending), date, and recipient metadata.
* A searchable and filterable archive interface MUST allow authorized users to consult historical delivery logs.

3. **Push Notifications via Mobile Application**

* The system MUST deliver real-time push notifications through the EWS mobile app upon bulletin approval.
* Push notifications MUST be targeted based on:
  + FIN-linked APIA parcel locations (for enrolled farmers)
  + LAU or county for other user groups (e.g., town halls)
* Notifications MUST include metadata such as:
  + Bulletin ID
  + Crop, BBCH and pest/disease risk probability
  + Direct link to full bulletin in the mobile app
* Device tokens MUST be securely stored in the EWS backend, associated with unique user IDs.
* The system MUST use Firebase Cloud Messaging (FCM) and Apple Push Notification Service (APNS) to deliver messages across Android and iOS devices.
* Notification logs MUST include:
  + Timestamp of delivery
  + Read status
  + Geospatial relevance of the alert

4. **General Requirements for all dissemination channels**

* Dissemination MUST be triggered only after bulletin validation is completed and approved by authorized personnel.
* The system MUST support centralized configuration of notification templates and user preferences across all dissemination channels.
* The system MUST log and archive all dissemination events for auditability and performance tracking.
* Dissemination logic and interface elements MUST be reviewed and finalized during the analysis phase in collaboration with ANF.

### **3.2.7 - Functional Requirements for the Mobile Application Module**

The Mobile Application Module shall enable real-time access to EWS alerts, bulletins, and geospatial data for farmers and stakeholders through an Android and iOS-compatible interface. The app must be secure, responsive, and fully integrated with the EWS backend for data synchronization and personalized user experiences.

**1. User Registration and Authentication**

* The mobile app MUST require user registration via a valid email address.
* Optional integration with Gmail authentication MUST be supported.
* The system MUST manage user sessions and access tokens securely, using encrypted transmission and storage.
* Only authenticated users MUST have access to parcel-specific or LAU-based data.

**2. FIN-Based Personalized Alerting**

* The app MUST allow APIA-registered farmers to input their FIN and receive pest/disease alerts specific to their registered parcels.
* Upon FIN validation, the system MUST retrieve associated parcel geometries and crop metadata.
* The app MUST:
  + Display these parcels on an interactive map
  + Overlay pest/disease alerts and relevant weather indicators
  + Provide direct access to full bulletins relevant to each alert
* All parcel data MUST be encrypted in transit and at rest.

**3. LAU-based Alert Visualization**

* Authenticated users MUST be able to filter alerts by selecting one or more Local Administrative Units (LAUs).
* The app MUST:
  + Provide a search-and-select interface for LAU selection
  + Visualize LAUs as GIS polygons on the map
  + Display real-time overlays for pest/disease alerts, weather, and affected crops
  + Provide tap-to-view access to bulletins with metadata (pest, crop, timestamp)
  + Allow saving of preferred LAUs in user profiles

**4. Offline Access to Critical Information**

* The app MUST support offline access to:
  + Recently received bulletins and notifications
  + FIN - related parcels or LAU selections
* Once online, the app MUST automatically synchronize:
  + Alerts
  + Bulletins
  + User preferences and feedback

**5. Data Privacy and Security**

* All user-related data (e.g., email, FIN, parcel info) MUST be encrypted using TLS and AES-256 standards.
* No personal data MUST be shared with third parties.
* Role-based access controls MUST restrict data visibility and app functionality.
* The app MUST comply with GDPR through clear consent mechanisms, access auditing, and secure storage.

**6. Real-Time Notification Delivery**

* The system MUST use Firebase Cloud Messaging (FCM) and Apple Push Notification Service (APNS) to deliver alerts in real time.
* Notification targeting MUST be based on:
  + FIN for APIA parcels
  + LAU for general users
* Notifications MUST include:
  + Bulletin ID
  + Crop
  + Pest/disease probabilities
  + Link to the full bulletin
* Notification delivery MUST be logged with timestamps, user ID, and read status.

**7. Geospatial Integration and Visualization**

* The mobile app MUST integrate with a mapping SDK (e.g., Mapbox, Google Maps SDK, or OpenStreetMaps) to display:
  + Parcels
  + LAUs
  + Pest/disease overlays
* The geospatial system MUST support layering weather data from ANM for contextual risk visualization.

**8. Backend and System Architecture**

* The app MUST be developed using Flutter or a similar cross-platform framework for Android and iOS.
* The backend MUST reside within the cloud environment and comply with national security and GDPR standards.
* The app MUST interact with the backend using secure RESTful APIs.
* Design patterns such as MVC or MVVM MUST be used to promote maintainability and scalability.

**9. Additional Functionalities and Features**

* The mobile application must provide a responsive user interface, ensuring a consistent and intuitive experience across both Android and iOS devices. It shall also support multilingual capabilities, with Romanian as the default language and the possibility to add additional language options based on user preferences.
* The users MUST have the ability to configure their alert preferences based on specific crops, registered parcels, and regions. The application will also provide advanced filtering options, allowing users to receive only those notifications that are relevant to their selected crop types, counties, LAUs, or FIN codes.
* The application must include a feedback feature that allows users to report pest occurrences or submit comments regarding bulletins directly through the interface. Additionally, all user activity and submitted feedback will be automatically synchronized with the EWS backend, supporting audit trails and continuous system improvement.

### 3.2.8 - Functional Requirements for the Audit and Compliance Monitoring Module

**1. Comprehensive Audit Trail**

• The system MUST record every user action performed within the system, capturing details such as timestamps, user IDs, roles, IP addresses, and the affected modules or datasets.

• The system MUST allow administrators to search, filter, and export audit records based on specific criteria such as date, user role, or action type.

• Audit trails MUST include detailed logs for all core modules (e.g., System Administration and Configuration, Reporting, Historical Data Module, and Quality Assurance and Bulletin Drafting) to ensure accountability and traceability.

**2. User Activity Monitoring and Reporting**

• The system MUST generate user activity reports summarizing interactions by role, time frame, and module.

• The system MUST highlight anomalies such as unauthorized access attempts, irregular data changes, or failed authentication events.

• Reports MUST be exportable in multiple formats (e.g., PDF, Excel) and configurable by administrators.

**3. Configurable Alerts for Compliance Events**

• Administrators MUST be able to configure alerts for critical compliance events such as failed authentication attempts, or significant configuration changes.

• Alerts MUST include details on the triggering event, priority level (e.g., Information, Warning, Critical), and the intended recipient roles.

• Alerts MUST be logged and included in periodic compliance reports for audit purposes.

**4. Role-Based Access Control for Audit Functions**

• Access to audit logs and compliance tools MUST be restricted based on user roles to protect sensitive information.

• All role changes MUST be logged to ensure accountability for access adjustments.

**5. Scalability and Long-Term Data Retention**

• The system MUST scale to handle up to 1 million audit records annually, ensuring no degradation in search and retrieval performance.

• Audit data MUST be retained for a minimum of 5 years, with archival mechanisms for older records.

• Archived records MUST remain accessible for legal or operational reviews while adhering to data protection regulations.

**6. Compliance with Regulatory Standards**

• The system MUST adhere to GDPR and national data protection laws, ensuring secure handling of sensitive user and system data.

• Audit logs MUST be encrypted at rest and in transit using industry-standard encryption protocols (e.g., AES-256, TLS).

• The system MUST allow export of audit logs for external regulatory or legal reviews.

### **3.2.9 - Functional Requirements for the Reporting Module**

**1. Comprehensive Reporting Framework**

* The system MUST enable the generation of reports across all data sources, including pest /diseases data, weather datasets, geospatial information, and user actions.
* The Reporting Module must collect and process user-submitted feedback from the mobile application
* Reports MUST support flexible grouping by parameters such as region (e.g : selection of LAUs, county, etc), time period, or pests/diseases, crops, BBCH, etc.
* The system MUST log all report generation activities, including timestamps, user roles, and report details, to maintain accountability.

1. **Customizable Report Templates**

• The system MUST allow users to design and save report templates tailored to specific needs.

• Templates MUST support advanced customization options, such as parameter selection, layout configuration, and inclusion of visual elements like charts or maps.

• Users MUST have access to predefined templates for common reporting scenarios (e.g., pests/diseases probabilities for a particular crop and BBCH).

1. **Data Export and Distribution**

• Reports MUST be exportable in multiple formats, including PDF, Excel, and CSV, for seamless use across external platforms.

• The system MUST support automated distribution of reports via email

• The system MUST provide secure access to generated reports through a web-based portal for authorized stakeholders.

1. **Role-Based Access Control for Reports**

• Access to reporting features MUST be restricted based on user roles, ensuring data confidentiality.

• The system MUST allow administrators to configure role-based permissions for creating, accessing, and modifying reports.

• All role changes related to report permissions MUST be logged for auditing purposes.

1. **Integration with EWS Modules**

* The system MUST integrate with the **Historical Data Management Module** to retrieve archived datasets, enabling long-term trend analysis and seasonal comparisons.
* The system MUST integrate with the **Bulletin Dissemination and Notification Module** to access dissemination logs, recipient information, and delivery statuses, ensuring complete traceability in reporting outputs.
* The system MUST be integrated with the **Quality Assurance and Bulletin Drafting Module**, allowing reporting on pest/disease occurrence probabilities and bulletin approval timelines
* The system MUST be integrated with the **Audit and Compliance Monitoring Module** to incorporate user activity logs
* The system MUST interface with the Mobile Application Module to gather data on push notification delivery and user interaction analytics, supporting evaluation of stakeholder engagement at the regional level.

1. **Real-Time and Scheduled Reporting**

• The system MUST allow users to generate real-time reports, ensuring immediate insights based on current data.

• Scheduled reporting MUST enable automated generation and delivery of reports at predefined intervals.

• The system MUST ensure reports are dynamically updated with the latest data at the time of generation.

1. **Scalability and Performance**

• The system MUST scale to support the generation of up to 1,000 complex reports daily without performance degradation.

• Report generation and export MUST complete within 10 seconds for datasets with up to 100,000 entries.

• The system MUST maintain high performance during peak usage periods, ensuring uninterrupted reporting operations.

1. **Visualization and Interactive Dashboards**

• The system MUST include interactive dashboards to provide visual insights such as trend graphs, heatmaps, and pivot charts.

• Dashboards MUST allow users to filter and customize data views by location, pest/diseas, crop and BBCH, time interval, etc.

• Users MUST have access to geospatial visualizations for mapping pests/diseases occurrence probabilities and weather parameters.

1. **Compliance and Security**

• The system MUST adhere to GDPR and national data protection laws, ensuring secure handling of sensitive data.

**3.3. Technical Specifications**

**3.3.0 General Technical Requirements**

**3.3.0.1 System Development and Evolution**

The Consultant shall deliver a custom-developed Early Warning System (EWS), consisting of a web-based platform and a mobile application. The EWS shall be either built from scratch or customized from Commercial Off-The-Shelf (COTS) software.

The software development should not fully rely on artificial intelligence (AI) or machine learning (ML) models. AI programming solutions may be used, but limited at the:

* Code completion and suggestions: AI-powered tools like code editors with AI assistants can suggest completions, fixes, or improvements for code.
* Bug detection and fixing: AI can help identify bugs or vulnerabilities in code and suggest fixes.
* Code optimization: AI can assist in optimizing code for performance, readability, or other criteria.

This approach shall ensure the system remains deterministic, explainable, and verifiable.

Incidental use of AI in development tools (e.g., code completion) is acceptable if it does not compromise solution integrity or introduce dependencies.

**Use of Open-Source Technologies**

Technologies used in the development of the EWS may include open-source components only if:

* They are encapsulated within COTS products or frameworks, or
* The Consultant provides explicit assurances regarding support, maintenance, and compliance with security and licensing policies throughout the project lifecycle (including both development and maintenance phases).

All open-source components should:

* Include usage logging for transparency and traceability
* Be thoroughly vetted to meet organizational and regulatory standards
* Be fully documented to ensure system sustainability, long-term reliability, and clarity of dependencies

**3.3.0.2 Technology Requirements for EWS Implementation**

Early Warning System (EWS) shall be developed using a modern, scalable, and secure technology, capable of supporting complex data flows, high-availability services, and continuous integration with external platforms. This section outlines the key technical requirements necessary to ensure that the system is reliable, extensible, and compliant with both national and European standards.

The EWS system should be developed using contemporary development practices and technologies, incorporating microservices or modular architecture, cloud-native capabilities, and advanced data processing mechanisms. It must also support secure and efficient communication with third-party systems such as APIA, ANM, and PESTEXPERT, while ensuring full adherence to cybersecurity and data protection regulations.

The Consultant should adhere to the following development principles:

**Scalable Architecture & Modern Technologies**

* Support for microservices architecture or a modular monolith approach
* Use of modern programming languages such as Python, Java, Go, Node.js
* Scalable database solutions (SQL or NoSQL), capable of handling large datasets for pests/diseases, weather, and geospatial information datasets

**Version Control & Continuous Deployment**

* Utilize version control systems (GitHub, GitLab) with a clear branching strategy
* Implement Continuous Integration/Continuous Deployment (CI/CD) pipelines
* Support Docker-based distribution for consistent deployments across environments

**Security & Compliance**

* Authentication and authorization via OAuth 2.0 with support for Role-Based Access Control (RBAC) and Attribute-Based Access Control (ABAC)
* Protection mechanisms against common vulnerabilities (SQL Injection, Cross-Site Scripting (XSS), Cross-Site Request Forgery (CSRF))
* Full compliance with GDPR and ISO 27001 data security standards
* Automated vulnerability scanning integrated into development workflows

**Integration & Extensibility**

* RESTful APIs, file upload and/or database connections for external integrations (e.g., with PESTEXPERT, APIA, ANM)
* Availability of administrative interfaces (CLI/UI) for configuration and customization

**Testing & Code Quality**

* Automated unit, integration, and end-to-end tests with enforced coverage thresholds
* Use of performance benchmarking tools to ensure responsiveness under peak loads
* Regular code reviews to maintain quality and consistency

**Premium Support & Maintenance**

The Consultant must offer a Service Level Agreement (SLA) commitment, to ensure timely issue resolution. For the terms of the SLA, refer to [6.1.4 - ANNEX 2.0 - Technical Support and Help Desk Services](#_6.1.4_-_ANNEX)

The Consultant must deliver comprehensive technical documentation covering architecture, deployment, and troubleshooting

**3.3.0.3 Core Technical requirements**

The EWS system should comply with the following core technical requirements

* Centralized Database - A unified and centralized database that should store all organizational data, including weather, geospatial, crop, BBCH, pests/diseases datasets. The database should allow for secure data entry, modification, and deletion, ensuring consistency across the application.
* Unified Access Point - a single access point to all system features and datasets through a web-based portal and a mobile application. Both web-based portal and mobile application should support secure user authentication and intuitive navigation.
* Error Logging and Audit Trail - The system should log detailed error messages and maintain a comprehensive audit trail for all operations. This should include user actions, data modifications, and integration activities. The audit trail should comply with regulatory requirements, ensuring full traceability and accountability.
* Role-Based Security and User Authentication - an efficient Single Sign-On (SSO) mechanism integrated with ANF’s existing Identity Provider (IdP). Access controls should follow a role-based security model, assigning permissions based on predefined user roles (e.g., System Administrator, Data Analyst, Farmer).
* Scalability and Flexibility - The system should support scalability to accommodate increased user demand and data volume, particularly during seasonal peaks.
* Data Standardization – The EWS should be able to standardize data formats for all processed data (e.g., JSON, GeoJSON, CSV) for integration and analysis.
* Bulletin Management and Dissemination - Automate the drafting, validation, and dissemination of bulletins through predefined templates. Notifications should be delivered via multiple channels including web portal, email, and mobile push notifications.
* Real-Time and Offline Access - Ensure real-time data processing and synchronization across all modules. Provide offline capabilities for mobile application users, enabling access to cached data and notifications in areas with limited connectivity.
* Geospatial and Analytical Features - interactive geospatial tools to support localized risk analysis (through computed pests/diseases occurrence probabilities). The EWS should support trend analysis and predictive modeling for pests/disease occurrence probabilities, utilizing historical and real-time data.

**3.3.0.4 Maintainability and User-Friendly Design**

* The system must be easily maintainable, with structured documentation, modular design, and clear workflows to support future updates by ANF or third-party developers.
* Both the web portal and mobile application interfaces must be intuitive and user-centric, ensuring accessibility for all stakeholders.

**3.3.0.5 Expected Operational Standards**

* Concurrent Users: Support at least 8,000 concurrent users without performance degradation.
* Data Throughput: Handle large-scale data processing (6 TB of data annually) efficiently.

**3.3.1 Computing Hardware Specifications and system security**

The Consultant must design, setup, and configure fully web cloud-based IT architecture, based on virtual machines (IaaS), that should be compatible with the Governmental Cloud, complying with the requirements of these ToR, and ensuring integration with the Beneficiary’s existing systems, including PESTEXPERT, APIA, and ANM.

**3.3.1.1 Disaster recovery, back-up, security and performance standards**

The system shall implement disaster recovery and business continuity mechanisms. Critical services—such as pest and disease data processing—must be recoverable within a maximum recovery time objective (RTO) of 1 hour.

Regular, automated backup protocols to ensure data integrity and reliable accessibility for geospatial, weather, and pests/diseases occurrence probabilities datasets.

The backups must support version control and ensure compliance with operational workflows.

The Early Warning System (EWS) shall be designed and deployed to meet operational, security, and performance standards, including:

• **High Availability**: Configured for the high availability of EWS modules, with a minimum uptime of 99.5% to support real-time processing and bulletin dissemination.

• **GDPR Compliance**: Full adherence to GDPR regulations and other national data

privacy standards to ensure the secure handling of sensitive user and agricultural data.

• **Private Network Access**: Restrict access to a private network, ensuring the EWS is accessible only by authorized ANF personnel and integrated systems.

• **Scalable Data Processing**: Configured to efficiently manage anticipated data volumes, including processing weather data from ANM, geospatial data from APIA for 1 million parcels, and pest lifecycle analytics from PESTEXPERT. The system must handle a 50% increase in data volume during seasonal peaks without degradation of performance.

**3.3.1.2 Integration requirements and documentation**

The Bidder should provide a comprehensive and detailed specification of all resources required to operate the proposed Early Warning System (EWS) in the cloud environment. This should include documentation on resource allocation, integration processes, and disaster recovery protocols.

For reference, the current ANF infrastructure includes:

• The PESTEXPERT database serving as the central repository for data on Plant Protection Products (PPPs), including information on authorized substances, target pests and crops, recommended application methods, safety classifications, and regulatory metadata.

• An existing Identity Provider (IdP) system integrated with PESTEXPERT and other software systems in the ANF infrastructure, which provides secure authentication and role-based access control for ANF’s systems.

The Consultant must ensure that the cloud infrastructure integrates with these components and provides a scalable and centralized platform to manage current and future needs.

**3.3.2 Software specifications**

This section outlines the essential software components that must be delivered by the Consultant as part of the Early Warning System (EWS) implementation. These components are designed to support the system's efficient operation, scalability, and compliance with the National Phytosanitary Authority's (ANF) objectives and regulations.

**Early Warning System Core Software**

* The core software component of the Early Warning System (EWS) shall be developed and delivered by the Consultant in two distinct phases—**Pilot** and **Final Deployment**—in accordance with the functional, non-functional, and technical specifications outlined in these ToR, and based on the business requirements established in the analysis phase.
* The source code of the EWS, along with all functionalities and supporting documentation created or elaborated by the Consultant under this Contract, shall become the property of the Beneficiary (ANF) to ensure long-term adaptability, scalability, and compliance with operational needs. The complete source code, alongside all supporting documentation developed under this contract, shall become the property of ANF to ensure long-term adaptability and compliance.

The following tables describe the main scopes, deliverables and key objectives of the two Pilot and Full Deployment phases, in accordance with previous chapters

**Phase 1: Pilot phase**

***Table 18 – Pilot phase scopes***

| Aspect | Details |
| --- | --- |
| Scope | - Implement all functional modules as specified in the ToR.  - Focus on key crops (e.g., wheat, corn, sunflowers).  - Target limited geographic regions (e.g.: counties, selection of LAUs)  - Ensure full deployment of predictive algorithm, bulletin drafting and validation, notification dissemination, reporting, and system administration functionalities.  - Launch a fully functional mobile application, following specifications from this ToR and analysis phase. |
| Key Objectives | - Validate forecasting models using real-time data and historical datasets.  - Collect and integrate feedback from users (farmers, ANF staff) to improve system accuracy.  - Test system interoperability with PESTEXPERT, ANM, and APIA datasets to ensure proper data exchange and processing.  - Assess system performance under realistic data loads and concurrent user activity scenarios. |
| Deliverables | - Fully functional pilot version of the EWS, covering all modules and features installed in a fully configured cloud environment, using the acquired software licenses proposed by the bidder.  - Reports and dashboards tailored for pilot deployment and performance analysis.  - Comprehensive documentation, including pilot system setup, user guides, and feedback integration procedures.  - Training sessions for ANF personnel and stakeholders on system usage, data interpretation, and integration workflows. |
| Duration | 10 months, subject to feedback-driven iterations and refinements identified during the pilot phase. |

**Phase 2: Full Deployment**

***Table 19 – Full deployment scopes***

| **Aspect** | **Details** |
| --- | --- |
| **Scope** | - Expand EWS to nationwide coverage for all major crops and regions. |
|  | - Integrate additional software development following user feedback during pilot stabilization feedback |
|  | - Update system documentation and user manuals, to reflect all changes. |
| **Key Objectives** | - Ensure system scalability to handle nationwide operations with 8,000 concurrent users. |
|  | - Provide real-time alerts and forecasts to all stakeholders. |
|  | - Achieve compliance with national and EU regulations on security and data privacy. |
|  | - Finalize workflows for system operation, maintenance, and long-term scalability. |
| **Deliverables** | - Fully operational EWS with all modules and nationwide coverage. |
|  | - Nationwide mobile application deployment with optimized features. |
|  | - Comprehensive training programs for ANF staff and end-users. |
|  | - Updated usage manuals, system documentation, including source code and installation guides. |
|  | - Maintenance and support framework for at least 24 months post-deployment. |
| **Duration** | 6 months following the successful pilot phase evaluation and approval. |

**System Software**

* The system software must fully support the integration and operation of the Early Warning System (EWS) in a Governmental cloud compatible environment.
* Scalability

The system must be automatically scaled to accommodate an increasing number of users, growing data volumes, and expanding operations without manual intervention.

* Authentication and Security:
  + Support for integration with cloud identity management systems to enable Single Sign-On (SSO) for secure authentication.
  + All data at rest and in transit must be encrypted using industry-standard protocols (e.g., TLS, AES-256).
  + Implement cloud-native security features, such as Role-Based Access Control (RBAC) and Identity and Access Management (IAM), to enforce secure access, as required by ANF, and in compliance with the Governmental cloud technical standards.
* Monitoring and Performance:
  + Integrate cloud-based monitoring tools to ensure the EWS consistently operates at optimal performance levels.
  + Provide tools for administrators to track system health, resource utilization, and response times.

**3.3.3 System Management, Administration, and Security Specifications**

#### **3.3.3.1 Technical Management and Troubleshooting**

The EWS must include features for monitoring system health, managing configurations, and resolving technical issues in real time. These features shall ensure uninterrupted functionality and optimal performance, even during peak usage periods.

**System Health Monitoring** – EWS should provide administrators with real-time dashboards of insights into server performance, database status, and connectivity with external systems like PESTEXPERT and ANM. Alerts shall be triggered for critical issues, such as database capacity nearing its limit or failed data integrations. By offering an intuitive overview of system operations, administrators should proactively address potential bottlenecks and avoid disruptions.

**2.4.2 Security**

The EWS must ensure confidentiality, integrity, and availability of sensitive data, including pests/diseases occurrence probabilities, weather data, and geospatial information. The system shall incorporate advanced security measures to mitigate risks and ensure compliance with GDPR and other regulatory frameworks. These measures should include :

* **End-to-End Data Protection**: All data transmitted between the EWS and external systems, shall be encrypted using industry standards like TLS. At rest, sensitive datasets—including parcel-specific geospatial data and user activity logs—will be secured using AES-256 encryption.
* **Access Control and Multi-Factor Authentication (MFA)**: The EWS shall enforce the principle of least privilege, ensuring users can access only the data and functionalities necessary for their roles. MFA will be mandatory for administrative accounts and users handling sensitive datasets, providing an additional layer of security against unauthorized access.
* **Threat Detection and Response**: Real-time monitoring tools shall identify and alert administrators to unauthorized access attempts, unusual activity patterns, or vulnerabilities. The system will also include automated responses, such as account locking for repeated failed login attempts.
* **Regulatory Compliance and Security Logging**: The EWS shall maintain detailed logs of all security events. These logs include user IDs, timestamps, and event descriptions, enabling thorough reviews during audits or investigations.

**3.3.4 Service Specifications**

The Consultant must undertake the following activities as part of the project scope:

* Conduct an in-depth analysis of the ANF's pest and disease monitoring workflows, geospatial data requirements, and weather data integration processes. This includes reviewing current regulatory, legal, and institutional frameworks relevant to the EWS.
* Review all existing documentation provided by the Beneficiary, including details on pest and disease lifecycles, crop-specific risks, and geospatial mapping standards.
* Perform a detailed analysis of functional and non-functional specifications to define technical requirements, ensure compliance, and align deliverables with the operational needs of the EWS.
* Design, develop, and deploy the EWS with modular components including data integration, forecasting, notification, and reporting modules. Ensure these modules function as part of a scalable system.
* Test the developed system rigorously to meet defined performance, security, and operational standards. Provide well-documented test scenarios for User Acceptance Testing (UAT) along with support throughout the testing phase.
* Install and configure IT infrastructure necessary for the EWS, within the cloud infrastructure, ensuring interoperability with ANF's current systems like PESTEXPERT, APIA, and ANM.
* Provide comprehensive user manuals, system specifications, and maintenance documentation in Romanian.

#### **3.3.4.1 Current Identity and Mailbox System**

* The EWS must support Single Sign-On (SSO) to ensure centralized identity and access management. This functionality allows authentication across all EWS modules and reduces administrative overhead.
* Integration with the ANF’s existing identity system must allow role-based access control. This ensures users access only the data and functionality necessary for their roles, such as pest forecasts or geospatial data analysis.
* The system shall integrate with ANF’s email system, for managing bulletin dissemination.

#### **3.3.4.2 Existing Monitoring IT System (PESTEXPERT, APIA, and ANM)**

* The EWS must enable data exchange with PESTEXPERT, APIA, and ANM. This includes retrieval of weather data from ANM, crops, parcel information (through FINS for APIA enrolled farmers), as well as PPPs and other PPP metadata from PESTEXPERT
* Integration processes should follow secure communication protocols:
  + Data exchange, established during analysis, may use HTTPS or FTP(S) based on system compatibility and agreements between ANF, APIA, and ANM.
  + Token-based authentication shall be used where applicable to safeguard data exchanges.
  + Validation of JSON payloads to ensure compliance with EWS data standards.
* Automated logging of data exchanges shall:
  + Provide full traceability of interactions with PESTEXPERT, APIA, and ANM.
  + Ensure accountability during audits.
  + Support both operational needs and regulatory compliance requirements.

**3.3.5 Documentation and Intellectual Property Requirements**

The Consultant is required to provide comprehensive documentation for the Early Warning System (EWS), ensuring effective usage, installation, maintenance, and administration. The documentation must cover all essential aspects related to the system and include the following:

* User Manuals
* Installation Manual
* Maintenance Manuals
* Software Design Document (SDD)
* Software Requirements Specification (SRS)
* IT Architecture Document

Additionally, the Consultant must deliver:

* Internal test reports
* Security reports
* Administration and architecture documents, as applicable
* Commented source code

All documentation must be provided in Romanian and submitted to the National Phytosanitary Authority (ANF) for technical approval.

#### **3.3.5.1 General Requirements**

* All documentation must be submitted electronically in both Microsoft Word and Adobe Acrobat PDF formats.
* Documentation will be uploaded to the DevOps repository maintained by the Consultant.
* Version control must be applied, with the latest version corresponding to the current production-ready application version.
* No version of the system may be deployed to production without the associated documentation being completed and approved.
* Final documentation must be electronically signed with a qualified digital certificate.

#### **3.3.5.2 Intellectual Property Requirements**

* All software developments created under this project, including source code, algorithms, and user interfaces, will remain the property of Beneficiary (ANF).
* All reports, data, instructions, plans, statistics, databases, software, and other materials developed during the project will be the exclusive property of ANF.
* The Consultant must not retain copies of any materials or use them for purposes outside the contract without prior written approval from ANF.
* ANF will hold all intellectual property rights, including copyright, to the results and materials produced under this contract. These rights may be used, published, assigned, or transferred by ANF without limitation.

#### **3.3.5.3 User Manuals**

User manuals must describe how to use the EWS for various roles, including but not limited to:

* System Administrator (SA)
* Data Analyst (DA)
* Field Reporter (FR)
* Communications Manager (CM)
* Farmer (FA)
* Local Authority (LA)

Each manual must include step-by-step instructions (with text and graphics) for performing specific tasks within the system.

#### **3.3.5.4 Installation Manual**

The installation manual must provide detailed step-by-step instructions for installing and configuring the EWS. It must include all necessary scripts, programs, and resources required for successful deployment. Separate instructions must be provided for:

* Hardware components (if case)
* Cloud set-up environment
* Software components

#### **3.3.5.5 Maintenance Manual**

The maintenance manual must outline actions required during the maintenance period, including:

* Monitoring system performance
* Identifying and resolving potential issues
* System updates (hardware, firmware, and software)
* Regular backups

It must document procedures for:

* Backup and recovery
* Database maintenance
* Monitoring (performance, security, logs)
* Deployment of updates and optimizations
* User management

Additionally, the Consultant must provide a knowledge transfer plan for ANF technical staff, covering software module administration, source code modification, and system configuration.

#### **3.3.5.6 Software Requirements Specification (SRS)**

The SRS must detail all functional and non-functional requirements of the EWS, including:

* **Functional Requirements:** Description of core functionalities such as data integration, bulletin generation, and alert management.
* **Non-Functional Requirements:** Performance, security, scalability, and availability metrics.
* **User Requirements:** Interaction scenarios for all roles.
* **Interfaces:** Integration points with PESTEXPERT, ANM, and APIA systems.
* **Data Requirements:** Specifications for input formats, validation, and storage.
* **Compliance:** Alignment with national and EU standards.
* **Acceptance Criteria:** Conditions for successful delivery.

#### **3.3.5.7 Software Design Document (SDD)**

The SDD must provide technical documentation on the system’s internal structure, including:

* Data models and database designs
* UML diagrams (static and dynamic)
* Use case models
* Error codebook
* Optimization and performance strategies

#### **3.3.5.8 IT Architecture Document**

This document must provide a detailed overview of the EWS infrastructure, emphasizing its cloud-based deployment. The document must include:

1. **Cloud Infrastructure Diagrams -** detailing resources and interconnections.
2. **Integration with On-Premises Systems -** ensuring compatibility with ANF’s existing IT infrastructure.
3. **Production and Test Environment Descriptions - d**etailed setups for these environments.
4. **Containerization Details -** Description of Kubernetes clusters or similar technologies.
5. **Data Protection and Compliance -** Strategies for data security, GDPR compliance, and disaster recovery.

## 3.4 Training and Training Materials

The Consultant must provide a complete set of training materials in Romanian, designed to support the effective onboarding and continuous use of the Early Warning System (EWS) by all user roles (e.g., System Administrators, Data Analysts, Field Reporters, Communications Managers). These materials shall be tailored to reflect the system functionalities as defined in these ToR and further refined during the analysis phase.

The training package should include, at a minimum:

* User Guides (PDF format):
* Role-specific manuals covering the step-by-step usage of each EWS module
* Detailed explanations of system workflows and all EWS modules
* Screenshots and annotated diagrams to guide users through key interfaces
* Instructions for handling edge cases (e.g., editing pest-weather mappings, managing temporary integrations)
* Video Tutorials:
  + Recorded instructional videos (screen recordings with Romanian voiceover or subtitles) demonstrating core workflows
  + Module-by-module walkthroughs, including configuration, data entry, dashboard use, and report generation
  + Scenario-based examples (e.g., how a data analyst validates a bulletin, how a farmer accesses alerts via the mobile app)
* FAQs and Troubleshooting Guides:
  + A compiled list of frequently asked questions for each module, covering both technical and functional aspects
  + Solutions to common issues encountered during login, bulletin review, parcel visualization (via FIN insertion), and mobile application common errors
  + Contact information or escalation paths for unresolved technical support issues
* Quick Reference Sheets (QRS):
  + One-page printable guides summarizing key actions for each role (e.g., publishing a bulletin, registering a new user)

**Access and Distribution**:

* All materials should be made available in both digital (downloadable from the ANF portal) and printable formats
* Where applicable, the content MUST be accessible within the EWS user interface (e.g., help buttons, tooltips linking to relevant guide sections)
* The Consultant MUST update the training materials as the system evolves during implementation, ensuring that documentation reflects the latest functional changes or enhancements introduced in the system. Final versions of all materials shall be reviewed and approved by the Beneficiary prior to user training sessions or rollout.
* Each session must include practical exercises tailored to specific operational needs, such as managing pest risk alerts or generating custom reports.

**Training sessions**

The Consultant should conduct training sessions with ANF’s stakeholders, comprising of :

* Special on-the-job training program, conducted for 10 county-level ANF offices, consisting of a structured presentation followed by a dedicated Q&A session. Each training session shall span over 2(two) working days and shall be delivered in person. The representatives from additional ANF county offices will be invited to participate remotely, ensuring broad institutional coverage and knowledge transfer across the organization.
* 5 online training seminars (4 hours per seminar), targeting broader stakeholder groups within ANF. These online sessions shall be scheduled as per project needs or at ANF’s request.

## 3.5 Technical Support and Maintenance

### **3.5.1 Warranty Service**

* The Consultant must provide, at a minimum, a two-year warranty (24 months) period starting from the full deployment of the EWS system. This includes preventive and corrective maintenance to ensure system reliability and performance, as well as the cloud-based infrastructure on which the system will operate.
* A dedicated service desk must be established for incident reporting and resolution during the warranty period. The service desk platform must support logging, prioritization, and tracking of issues.

For detailed information regarding technical support and Help Desk services, including response times, incident prioritization, and responsibilities, please refer to [***section 6.1.4 – ANNEX 2.0 - Technical Support and Help Desk Services***](#_6.4_-_ANNEX)

### **3.5.2 Preventive Maintenance**

* The Consultant must perform regular EWS performance reviews to prevent potential issues. This includes monitoring system logs, updating algorithms, and proposing optimizations for pest forecasting accuracy.
* System health checks, conducted quarterly, must include testing of data integrations, notification delivery systems, and forecasting modules. Findings and recommendations must be documented and shared with the Beneficiary.

**3.6. Testing and Quality Assurance Requirements**

**3.6.1 Inspections**

**3.6.1 Inspections before delivery**

Development Process: The Consultant must provide information on the development process to be used to deliver EWS, including:

* + - * Development team structure and organization,
      * Development methodology and process lifecycle,
      * Code Review process,
      * Source code Management,
      * Continuous Integration Plan,
      * Tools and Techniques to be used,
      * Test plan

**3.6.2 Pre-commissioning Tests**

The Consultant must provide documentation related to the integration testing, including:

* Technical details on integration methodology for each external system,
* Testing approach,
* Test data,
* Test procedure,
* Test results report.

In addition to the testing documentation, the Consultant **must** plan and execute the following proposed tests in alignment with the technical requirements, specifically addressing performance and security tests as mentioned in current chapter :

**3.6.2.1 System Integration test**

* Test: Verify the integration of the EWS system with other external systems
* Condition: The cloud environment must support integration between EWS and external databases, file sources and APIs.
* Success Criteria: Data exchange between EWS and external systems should occur smoothly with minimal latency. Error handling should be robust in case of communication failures.

**3.6.2.2 Cloud Environment Tests**

**3.6.2.2.1 Cloud Infrastructure Validation**

* + **Test:** Verify that the cloud infrastructure meets the performance and security requirements defined in the system specifications.
  + **Condition:** The cloud environment must be configured according to the specifications (e.g., virtual machines, storage, network configurations).
  + **Success Criteria:** The infrastructure components should pass initial validation tests, including availability, scalability, and redundancy features. The cloud environment must be capable of supporting expected workloads without degradation in performance.

**3.6.2.2.2 Scalability Testing**

* + **Test:** Simulate increasing data volumes and concurrent user access to test the system's scalability within the cloud environment.
  + **Condition:** Scale up the cloud resources (e.g., compute power, storage) to handle different loads, such as peak traffic and large data processing tasks.
  + **Success Criteria:** The system should handle the increased load without issues such as system slowdowns, crashes, or data loss, demonstrating that the cloud environment can scale horizontally and vertically.

**3.6.2.2.3 Performance Testing**

* + **Test:** Measure system performance under stress conditions, including load and latency tests.
  + **Condition:** Test with various numbers of concurrent users and workloads (e.g., large data uploads or batch processes).
  + **Success Criteria:** Response times must remain within acceptable limits as defined in the non-functional requirements. For example, response times for user requests should not exceed 2 seconds, and system throughput should be adequate under maximum expected load.

**3.6.2.2.4 Disaster Recovery Testing**

* + **Test:** Test cloud system's disaster recovery capabilities, including backup and recovery procedures for data and application components.
  + **Condition:** Simulate a failure scenario, such as data corruption or cloud service outage.
  + **Success Criteria:** The system should restore to operational status within the specified recovery time objective (RTO) and recovery point objective (RPO). Data should be recovered without loss, and the application should be functional after recovery.

**3.6.2.2.5 Data Security and Encryption Testing**

* + **Test:** Verify that data is securely transmitted and stored, following the security protocols defined in the project specifications.
  + **Condition:** Ensure that encryption is implemented for data at rest and in transit, and that proper access controls are enforced.
  + **Success Criteria:** Data should remain protected with encryption mechanisms during all stages (e.g., data storage, retrieval, transfer), and unauthorized access attempts should be blocked and logged appropriately. Security audits should be passed with no major vulnerabilities.

**3.6.2.2.6 Cloud Service Availability Testing**

* + **Test:** Test the cloud service uptime and availability under different conditions, such as load and maintenance periods.
  + **Condition:** Ensure that the cloud provider guarantees a minimum availability percentage (e.g., 99.5%) and that it meets under various conditions.
  + **Success Criteria:** The system should remain available and operational with minimal downtime. Any downtime or interruptions should not exceed the defined Service Level Agreement (SLA) thresholds.

**3.6.2.2.7 Backup and Data Retention Testing**

* + **Test:** Verify that the backup and data retention processes function correctly in the cloud environment.
  + **Condition:** Test scheduled backups, data retrieval, and retention policies as defined in the system requirements.
  + **Success Criteria:** Data backups should be successfully created and stored according to schedule. The recovery process should be efficient, and data retention policies should be enforced.

**3.6.2.2.8 Cloud Conditions Terms**

* Cloud Service Configuration: Before executing tests, the system must be configured to meet the technical requirements outlined in section 3.3.1 - Computing Hardware Specifications for EWS hosting and finalized in collaboration with the ANF’s IT experts during the analysis phase.
* **Load and Stress Conditions:** Simulate high load, peak usage, and stress conditions such as a surge in concurrent users and large data processing tasks that may affect cloud environment.
* Security Compliance: Ensure that the cloud environment meets regulatory security standards (e.g., GDPR) and internal security policies for handling sensitive agricultural and pest monitoring data.

**3.6.2.2.9 Cloud Success Criteria**

* **Performance Metrics:** All performance tests must meet the agreed-upon response times, throughput, and system performance targets defined in the system specifications.
* **Scalability:** The system should scale without service degradation, ensuring no bottlenecks or crashes during load increases.
* **Availability:** Cloud services should be operational and available as per the agreed-upon SLA (99,5%). Unplanned downtime should be minimized and adhere to the acceptable limits.
* **Data Integrity:** No data should be lost or corrupted during backup, migration, or recovery processes.
* **Security Compliance:** All security tests should pass, confirming that data encryption, access controls, and other security mechanisms are properly implemented and secure.

**3.6.2.3 User Access and Authentication Test**

* **Test:** Test the user authentication and authorization mechanisms in the cloud environment, such as Single Sign-On (SSO), two-factor authentication, and role-based access control.
* **Condition:** Ensure that all user roles and permissions are correctly configured, and access control mechanisms are implemented.
* **Success Criteria:** Users should only be able to access data and functionality as allowed by their roles. Unauthorized users should be unable to access sensitive data or critical functionality.

**3.6.3 Operational acceptance Tests**

To ensure that the Early Warning System (EWS) meets all required standards of quality, performance, security, and usability, the Consultant shall design and execute a comprehensive validation approach, covering every critical phase of system delivery. This section outlines the key activities and deliverables that will govern the assurance of system quality, including quality planning, functional and non-functional testing, security verification, and final user validation. The Consultant is responsible for ensuring that each phase is thoroughly documented, executed according to best practices, and aligned with the specific needs and operational expectations of the Beneficiary. Throughout this process, the Consultant should also support ANF personnel involved in testing and validation phases.

**3.6.3.1 Quality Assurance Plan**

The Consultant shall prepare Quality Assurance Plan in accordance with the requirements of the project, as outlined in these ToR, for the monitoring of the quality of system development. The Project Quality Assurance Plan shall include:

* the standards and procedures applied for each phase.
* the input and output criteria for each phase.
* the verification, test and validation activities to be carried out.
* the planning of the verification, test and validation activities to be carried out including schedules, resources and approval processes.
* specific responsibilities of the quality activities.

The following elements should be addressed:

* project is properly organized, with an appropriate life cycle.
* development team members have defined tasks and responsibilities.
* documentation plans are implemented.
* documentation contains what is specified in the current ToR
* documentation and coding standards are followed.
* standards, practices and conventions are adhered to
* metric data is collected and used to improve products and processes.
* reviews and audits take place and are properly conducted.
* tests are specified and rigorously carried out.
* problems are recorded and tracked.
* projects use appropriate tools, techniques and methods.
* software is stored in controlled libraries.
* software is stored safely and securely.
* software from external suppliers meets applicable standards.
* proper records are kept of all activities.
* staff are properly trained.
* risks to the project are minimized.

**3.6.3.2 Functional Tests**

During the development, the Consultant is required to provide documentation for testing EWS functions including:

* List of all functional tests,
* Testing scripts,
* Testing data,
* Testing methodology (manual tests, automated tests, etc.) and tools,
* Test results report.

**3.6.3.3 Performance Tests**

Under heavy load conditions, the system may experience performance challenges. To address this, the Consultant is expected to conduct stress and performance testing and provide comprehensive test reports. These performance tests must be conducted on the agreed-upon cloud infrastructure.

Tests must confirm that the system performs as required in non-functional requirements. The Consultant must provide the following:

* Testing methodology and tools,
* Test scripts,
* Test data,
* Test results report.

Important: In addition to providing the testing documentation, the Consultant may conduct performance tests, as required by ANF, to ensure the EWS operates as intended. These tests may be performed, for instance, following the setup and configuration of the cloud environment, as well as after the pilot or full deployment of the EWS in the cloud environment.

**3.6.3.4 Security Tests**

Security is a major concern of all web applications, especially those publicly available through the Internet. The Consultant is required to perform isolated penetration tests covers hosting environment and custom-developed software (EWS). The Consultant must provide the following:

* Test methodology and tools,
* Test scripts with technical details,
* Test data,
* Final security tests report.

Condition: The cloud environment tests have been executed and successfully passed, and the EWS solution has been fully deployed in the specified cloud environment.

Success Criteria: The EWS solution must demonstrate compliance with security standards by successfully mitigating at least the OWASP22 Top 10 risks, including:

* Injection,
* Broken Authentication,
* Sensitive Data Exposure,
* XXE,
* Broken Access Control,
* XSS,
* Insecure deserialization,
* Using components with known vulnerabilities,
* Insufficient logging & monitoring.

Important: As with performance tests, these tests may need to be conducted multiple times, such as following the setup and configuration of the cloud environment and after the partial or full deployment of the EWS in the cloud environment.

**3.6.3.5 User Acceptance Test**

The User Acceptance Test (UAT) serves as the final checkpoint to ensure that the delivered EWS solution meets the Beneficiary's business requirements and operational needs before formal acceptance. UAT is a collaborative process involving end-users who will utilize the system in real-world scenarios, with full support and guidance from the Consultant to ensure smooth execution.

**Execution Approach** implies:

* **Preparation Phase:**
  + The UAT process is based on detailed specifications and business requirements defined during the analysis phase
  + The Consultant shall be responsible for developing the UAT plan in collaboration with ANF’s designated team. This plan will clearly define test objectives, detailed test cases(scenarios), success criteria, and the roles and responsibilities of all parties involved. The Beneficiary must approve the UAT plan before testing begins.
  + The Consultant provides necessary documentation, training, and tools to support UAT activities.
* **Testing Environment Setup:**
  + The testing environment mimics the actual operational setup, ensuring realistic scenarios.
  + The Consultant shall ensure that the system is configured correctly and ready for user testing, including any required data, workflows, and configurations.
* **User Involvement:**
  + Actual system users, who represent the Beneficiary’s operational teams, shall perform the tests to validate business workflows and functions.
  + The testing process shall perform typical tasks, edge cases, and scenarios that align with day-to-day operations and exceptions.
* **Consultant’s Support:**
  + The Consultant remains available to provide hands-on guidance, answer questions, and address any issues encountered during the UAT.
  + Quick resolutions to minor issues ensure that testing remains on schedule.

**Delivery expected results:**

* Real-World Validation: The UAT shall focus on replicating the Beneficiary's real-world business processes, ensuring that the EWS supports ANF’s envisioned workflows.
* **Feedback Mechanism:** Any identified discrepancies, bugs, or suggestions for improvement are logged and communicated to the Consultant for resolution.
* Compliance:  
  The UAT must ensure that EWS complies with all business and functional requirements outlined in these ToR, encompassing performance, reliability, usability, and alignment with EWS-specific compliance standards.

# 4 Team Composition & Qualification Requirements for the Key Experts (and any other requirements which will be used for evaluating the Key Experts under Data Sheet 21.1 of the ITC)

**4.1 Required Expert Profiles**

The Bidder is expected to present a team capable of successfully implementing the EWS System, according to the requirements outlined in the Terms of Reference and within the specified timeline. The team must consist of at least 5 key experts and should also comprise at least 12 non-key experts. The key experts shall comply with the following qualifications and experience requirements:

***Table 20 - Key Experts, qualification and experience***

| Role | Count | Qualifications and experience |
| --- | --- | --- |
| Project Manager | 1 | University degree (minimum Bachelor's) in computer science, software engineering, information technology, or in engineering with specialization or proven experience in IT project management. At least 3 years of experience in managing contracts or projects, preferably in the fields of agriculture, rural development, or environmental monitoring. Demonstrated success in developing and delivering **at least two** systems of similar complexity.  Proven experience in coordinating multidisciplinary teams, managing risk, and ensuring timely delivery of complex software and IT infrastructure projects in the public sector. |
| Senior Business Analyst | 1 | University degree (minimum Bachelor's) in computer science, information systems, software engineering, business administration, or economics. With a minimum of 3 years of experience in analyzing business processes and defining software requirements for digital transformation project. Experience in gathering and documenting complex business requirements for at least two systems of similar complexity, ensuring alignment between business needs and technical solutions.  Proven ability to document workflows, identify optimization opportunities, and translate user needs into functional and non-functional system requirements. |
| Technical Lead | 1 | University degree (minimum Bachelor's) in computer science, software engineering, information technology, or electronics and telecommunications.  Over 5 years of hands-on experience in software development, with a strong understanding of modern coding practices and technologies.  With over 3 years of team leadership experience and at least one project implementing large-scale IT systems (e.g for 1,000+ users or multiple locations), including database and API integration. |
| Senior Developers | 1 | University degree (minimum Bachelor's) in computer science, software engineering, or information technology.  A minimum of 3 years of experience in software development.  Proven experience with technologies such as .NET/PHP/Java Python/Node.js or equivalent, mobile development technologies (e.g Flutter, React Native or equivalent), and cloud platforms such as Azure/AWS or equivalent.  Experience in developing frontend and backend components, APIs, mobile application development, and cloud integration shall be considered a plus.  Participation in at least two large-scale IT projects (e.g., for at least 1,000 users or under use in multiple locations), preferably involving geospatial data, data validation workflows, or agricultural systems shall also be considered and advantage. |
| Phytosanitary Compliance Expert | 1 | University degree (minimum Bachelor's) in agricultural sciences, plant protection, horticulture, biology, or environmental sciences. At least 3 years of professional experience in the field of plant protection/ phytosanitary legislation/ pest monitoring. Participation in at least one EU or nationally funded project related to crop health risk management or forecasting systems. Proven knowledge of the regulatory framework for PPPs (Plant Protection Products), including national and EU legislation (e.g., EPPO standards, cross-compliance schemes), and practical experience in pest lifecycle analysis, pests/diseases occurrence probability evaluation |

It is expected that the non-key experts included by the bidder in the project team should implement the following main indicative tasks, as shown below:

***Table 21 - Non-Key Experts and their main indicative tasks***

| Role | Count | Main indicative tasks |
| --- | --- | --- |
| Senior Developers | 3 | Develop and maintain core system functionalities, including APIs, geospatial data processing, and user interface design. |
| Senior Business Analyst | 1 | Supports documentation, workflow mapping, and requirement validation. Assists in process optimization and usability assessments. |
| Solution and Infrastructure Architect | 1 | Designs and manages cloud, hybrid, and on-premises infrastructure to ensure high availability, security, and compliance  Develops the technical structure of the EWS, ensuring alignment with business needs and infrastructure requirements. |
| Compliance & Data Governance Officer | 1 | |  | | --- | |  |  |  | | --- | | Ensures GDPR compliance, cybersecurity, and regulatory adherence. Manages audit, documentation, and regulatory reporting. | |
| Testing and Quality Assurance Specialists | 3 | Conducts unit testing, integration testing, and user acceptance testing (UAT) to identify, document, and track bugs for resolution, guaranteeing a stable and robust system. Collaborates with Business Analysts to create comprehensive test scenarios and maintain detailed test documentation. Partners closely with senior developers to streamline bug-fixing efforts and improve overall system performance. |
| Integration Specialist | 1 | |  | | --- | |  |  |  | | --- | | Manages system integrations with external platforms (PESTEXPERT, APIA, ANM). Ensures data synchronization and workflow automation. | |
| Trainers | 2 | Delivers comprehensive training to end-users on the effective use of the EWS, ensuring proficiency and maximizing system utilization. Develops detailed **training materials**, conducts engaging sessions, and provides ongoing support to users. Works closely with stakeholders to tailor training programs to specific needs and ensure alignment with organizational goals and best practices. |

# 5 Reporting Requirements and Time Schedule for Deliverables

The project is expected to be last 16-month, comprising a timeline that ensures a structured and phased implementation of the Early Warning System (EWS), covering analysis, development, testing, deployment, and operational stabilization, with all key milestones aligned to achieve full system readiness within 16 months from kick-off. The implementation of the **Early Warning System (EWS)** is expected to fit within the **16-month timeline**. The bidder should include in its offer a proposed timeline, detailing the phases, milestones, and key activities to demonstrate alignment with the expected project schedule.

## 5.1 Phases and subphases of the project

Below are the expected phases and subphases of the project. The bidder shall consider these phases as minimal requirements and structure their offer accordingly:

### P1. Planning and Analysis

**P1.1 Project Kick-Off and Stakeholder Alignment**

**Objective:** Project kick-off by aligning stakeholders, finalizing project logistics, and identifying potential risks.

**Key Activities:**

* Organize a **Kick-Off Meeting** to introduce the project participants from both the Consultant and Beneficiary sides.
* Present the **Project Initiation Document (PID)**, including:
  + Initial project plan, logistic organization, and methodology.
  + Key project objectives, deliverables, and timelines.
  + Risk identification and mitigation strategies.
* Agreement between participants on the following points:
  + **Roles and Responsibilities**: Clarify key roles for both parties and their corresponding authority.
  + **Communication Plan**: Define communication protocols to ensure collaboration.
  + **Document Exchange Protocol**: Set up secure and structured methods for sharing project-related documents.
  + **Deliverable Acceptance Steps**: Agree on the criteria and process for accepting deliverables.
  + **Reporting Procedures**: Establish periodic progress reporting mechanisms.
  + **Risk Mitigation Plan**: Outline potential implementation risks and strategies for mitigation.

**P1.2 Business Process Analysis and Requirements Gathering (Pilot Phase)**

**Objective:** Conduct an in-depth analysis of EWS business requirements, functional specifications, and technical infrastructure to design an optimal solution for the Pilot Phase.  
**Key Activities:**

* Review available documentation and identify business, functional, and technical requirements.
* Focus on integration points with existing systems like **PESTEXPERT**, **APIA**, and **ANM**.
* Analyze the following requirements:
  + **Business Processes**: Map workflows to automate existing manual processes.
  + **Functional and Non-Functional Needs**: Specify performance, scalability, and usability requirements.
  + **Software and Hardware Specifications**: Determine the technical resources required for the EWS infrastructure.
* Collaborate with Beneficiary stakeholders to clarify and refine system specifications.
* Develop a comprehensive **Project Plan**, covering:
  + Development methodology, change management, testing, and deployment strategies.
  + Quality Assurance Plan, including:
    - Methods to ensure compliance with **GDPR standards**.
    - Validation and acceptance criteria for deliverables.

**P1.3 Technical Infrastructure Planning and Design (Pilot Phase)**

**Objective:**

Plan and design a secure, scalable, and cloud-based infrastructure tailored for EWS requirements.  
**Key Activities:**

* Evaluate the Beneficiary’s existing infrastructure, focusing on:
  + **Integration with PESTEXPERT, ANF identity provider and/or other ANF systems.**
  + Current networking, hardware, and software configurations.
* Design the Cloud Infrastructure with a focus on scalability and efficiency:
  + Develop IT Architecture Documentation, including containerized solutions for IaaS model.
  + Ensure centralized management to reduce the Beneficiary's need to handle updates manually.
* Document and address technical requirements for integration with external systems (ANM, APIA, PESTEXPERT).
* Collaborate with the Beneficiary’s technical team to finalize infrastructure configurations.
* Address interoperability requirements, focusing on:
  + Secure authentication and role-based access control.
  + Data exchange with ANM, APIA and PESTEXPERT
  + Deployment of EWS (pilot and final version) in the cloud environment

### **P2. Design and Development (Pilot)**

**P2.1 System Administration and Configuration Module**

Objective:

The goal of this sub-phase is to develop the module responsible for managing system configurations, user administration, and integrations, ensuring secure, scalable, and efficient operations across the Early Warning System (EWS).

Description:  
During this phase, the Consultant shall design and implement the System Administration and Configuration Module, focusing on role-based access control to manage user roles, permissions, and responsibilities effectively. The system should enable administrators to create and customize user groups, assign granular permissions for accessing specific modules, and maintain secure authentication synchronized with ANF’s Identity Provider (IdP).

Additionally, the Consultant shall develop system configuration functionalities to facilitate integrations (data exchange ) with external systems such as PESTEXPERT, ANM, APIA and other external EWS stakeholders (based on methods such as API, FTP(S) access, or direct database connection)

The functionalities shall benefit from detailed audit trails for tracking synchronization events, user activities, and system changes, ensuring accountability and compliance with regulatory standards. Administrators shall have access to dashboards that provide real-time insights into integration statuses, data quality, and any detected anomalies.

**P2.2 – Development of the Quality Assurance and Bulletin Drafting Module**

Objective:

To develop and deliver a fully integrated module that ensures the scientific validation of weather and geospatial data, supports pest and disease occurrence probability calculations, through a rule-based predictive algorithm, and enables the generation of customizable, structured bulletins for expert review and dissemination.

**Description**:

During this sub-phase, the Consultant will implement the Quality Assurance and Bulletin Drafting Module as a core analytical and decision-support component of the EWS. The system shall retrieve and process daily weather data from ANM (in GRIB2 format), transforming it into standardized values) and aggregating them into pest-specific timeframes (e.g., 72h, 120h averages). Concurrently, APIA parcel and crop data will be integrated to enable parcel-level targeting of forecasts and alerts.

A centralized Pest-Weather Mapping Table shall be configured and populated based on input from ANF and scientific standards, linking validated weather parameters to crop phenological stages (BBCH) and pest/disease occurrence thresholds. The Consultant shall implement version control, parameter weighting, and audit trail functionalities for this table.

The predictive algorithm shall be developed to calculate pest and disease probabilities based on weather data, crop stage, and mapping rules. The system shall also integrate with the PESTEXPERT database to automatically retrieve PPP recommendations based on EPPO codes and/or pests/diseases name.

The Consultant shall design a flexible bulletin drafting engine with predefined templates, which should auto-populate with validated bulletin data (pests/diseases occurrence probabilities, crop, BBCH, PPPs and other data) and allow for manual editing by ANF experts. A built-in review and approval workflow shall allow Data Analysts or other authorized roles to validate, modify, and approve bulletins before release.

Phase completion should result in:

1. A fully functional Quality Assurance and Bulletin Drafting Module integrated with:
   * ANM (weather data),
   * APIA (parcel and crop data),
   * PESTEXPERT (PPP recommendations).
2. A configurable Pest-Weather Mapping Table with editable thresholds, BBCH stages, parameter weights, version control, and audit logging.
3. A predictive algorithm for pest/disease probability calculation with support for historical data adjustment and rule-based logic.
4. Predefined and customizable bulletin templates supporting both automatic and manual input, tailored to crop, region, and pest context.
5. Review and approval workflows for validation of bulletins before dissemination.
6. Documentation covering module functionality, configuration of mapping rules, algorithm logic, and bulletin lifecycle management.

**P2.3 Historical Data Management Module Development**

Objective:  
The aim of this sub-phase is to design and implement a module for archiving and managing validated pests/diseases probability calculations and their respective weather datasets.

Description:  
The Historical Data Management Module shall securely archive the validated datasets, ensuring that all data remains accessible and organized. The Consultant shall develop functionalities for managing multiple data formats, including JSON, GeoJSON, and CSV, to enable compatibility with various analytical and visualization tools.

This module shall also include advanced search and retrieval capabilities, enabling stakeholders to query datasets using filters such as date range, crop type, pest name, and weather parameters. This shall empower users, from data analysts to field officers, to quickly extract relevant information and make data-driven decisions. Additionally, API integration will allow programmatic access to archived datasets, supporting integration with external systems and tools.

To ensure system-wide consistency, workflows for archiving and retrieving datasets will be documented.

At this stage, all technical specification detailed at Section 1.1.4 - Historical Data Module and Section 1.2.4 – Functional requirements of the Historical Module shall be implemented.

**P2.4 Bulletin Dissemination Module Development**

**Objective:**To implement a comprehensive dissemination module that ensures timely, targeted, and secure delivery of validated bulletins and alerts through a multi-channel communication strategy, including a public web portal, automated email distribution, and mobile push notifications.

**Description:**In this sub-phase, the Consultant shall develop and configure the Bulletin Dissemination and Notification Module, which is responsible for ensuring that all bulletins generated and validated through the EWS are delivered efficiently to relevant stakeholders**.**

The system shall include the development of a Bulletin Web Access Portal with geospatial visualization capabilities. This portal should provide users with a centralized interface to view current and historical bulletins. It will support advanced filtering options by crop, pest, location (county, LAU, FIN), and date range, and will be optimized for multiple device types (desktop, tablet, etc.) and their respective browser versions. Public access to general alerts will be enabled by default, while personalized bulletin access (e.g., parcel-specific alerts based on FIN) will require secure user registration and configuration**.**

In parallel, the Consultant will implement secure email distribution features. This includes automated delivery of bulletins (in PDF format) to registered users and manually managed recipient lists (e.g., town halls). The email component will support:

* Predefined and customizable templates with dynamic fields (e.g., region, crop, pests/diseases occurrence probabilities)
* Bulk delivery via integrated transactional email services
* Intelligent batching and queue management for performance optimization
* Logging, archiving, and filtering of all sent communications
* GDPR-compliant user consent mechanisms and role-based access control

Additionally, the module shall include real-time Push Notification functionality via the EWS mobile application. Notifications shall be sent using Firebase Cloud Messaging (FCM) and Apple Push Notification Service (APNS) to users who have registered their devices. Alerts shall be geospatially targeted based on either APIA parcel locations (via FIN) or LAU selection. Each notification shall carry metadata (e.g., bulletin ID, crop, risk score, direct link) and support interaction tracking (delivery timestamp, read status).

Phase completion should result in:

1. A fully functional Bulletin Dissemination and Notification Module with integrated support for:
   * Web-based access with geospatial bulletin display and advanced filtering
   * Automated email dissemination using secure, scalable infrastructure
   * Mobile push notifications with geospatial targeting
2. A public bulletin web access portal with support for user registration, personalized dashboards, and multi-device compatibility
3. Configurable email templates, batch delivery logic, and recipient list management features
4. Integrated push notification service with device token registration, delivery tracking, and offline alert support
5. Technical documentation covering dissemination workflows, communication templates, user registration flows, and security controls

**P2.5 Mobile Application Module Development**

Objective:  
To design, develop, and deploy a cross-platform mobile application that provides farmers and other stakeholders with real-time access to alerts, forecast bulletins, and geospatial risk data, personalized to their registered parcels or selected administrative areas.

Description:  
During this sub-phase, the Consultant shall implement the Mobile Application Module, ensuring full integration with the EWS backend and delivering a responsive, intuitive, and secure user experience on both Android and iOS platforms. The mobile application shall be developed using a cross-platform framework such as Flutter and will be made available through the Google Play Store and Apple App Store, following official platform requirements.

The mobile application shall allow users to register with an email address (or optionally via Gmail), authenticate securely, and configure alert preferences. APIA-registered farmers should be able to input their FIN to receive parcel-specific alerts and view associated crop and risk data overlaid on an interactive geospatial map. Users who are not APIA-registered will be able to subscribe to alerts by selecting specific Local Administrative Units (LAUs).

The application should also support:

* Real-time alerts via push notifications (using FCM/APNS)
* Offline access to recently stored bulletins, alerts, and maps
* Multilingual support (with Romanian as the default)
* Full compliance with GDPR and national cybersecurity standards

Additional features include a user feedback form for pest/disease reporting, customizable notification filters (by crop, region, FIN), and synchronization of all user actions and preferences with the backend for auditing and continuous improvement.

P2. 5 stage completion should result in :

1. A fully functional mobile application (Android & iOS) integrated with the EWS backend via secure RESTful APIs, with functionalities such as :
   * FIN-based personalized alerting system for APIA-enrolled farmers, with support for parcel geometry visualization and crop-specific bulletins.
   * LAU-based alert access and filtering features for general users.
   * Secure user registration, authentication, and session management system.
   * Push notification infrastructure for real-time alerts, including delivery tracking and read status.
   * Offline access functionality for cached bulletins, alerts, and map layers.
   * User feedback submission feature and activity log synchronization with the backend.
2. Publication of the application in both the Google Play Store and Apple App Store, ensuring full compliance with technical and regulatory guidelines.
3. Documentation covering application architecture, user workflows, data security controls, and deployment procedures.

**P2.6 Audit and Compliance Monitoring Module Development**

**Objective:**  
The purpose of this sub-phase is to develop a module that ensures accountability, regulatory compliance, and system integrity by tracking user activities, monitoring data changes, and identifying potential anomalies.

**Description:**The Audit and Compliance Monitoring Module shall be designed to provide a comprehensive audit trail of all system activities, ensuring that every action taken within the EWS is logged, traceable, and reviewable. This includes tracking user actions, data modifications, and system configuration changes, supporting operational transparency and security.

A key component of the module will be the configuration of audit trails for all EWS modules. These audit logs will capture essential metadata such as timestamps, user IDs, affected records, and system actions, allowing administrators to review historical changes and generate compliance reports.

To enhance system security, the module should also implement configurable alerts that notify administrators of critical events, such as failed authentication attempts, unauthorized data modifications, or anomalies detected in forecasting outputs. These alerts will help maintain the integrity of the EWS by enabling real-time monitoring and rapid response to potential threats or compliance violations.

**P2.7 Reporting Module Development**

**Objective**:  
To implement a comprehensive, role-based reporting module that enables ANF and EWS users to generate, customize, schedule, and analyze operational, geospatial, and scientific data related to pest risks, weather patterns, alert dissemination, system performance, and user activity.

**Description**:

In this sub-phase, the Consultant shall design and develop the EWS Reporting Module, focusing on flexibility, advanced filtering capabilities, and full integration with core data sources, including weather data from ANM, geospatial and crop data from APIA, PPP recommendations from PESTEXPERT, and user interaction logs from the system’s backend.

The module should support a wide range of predefined reports identified by ANF, including pests/diseases occurrence probabilities grouped by crop and BBCH, geospatial alert trends, accuracy evaluations, notification delivery tracking, recommended PPP, system performance, and user activity logs. Reports will be available with different grouping options (e.g., time period, region, pest/disease ) and will serve the informational needs of both operational and analytical stakeholders.

The system shall also include a custom report template engine. This feature will allow authorized users to define their own reports by selecting fields from available EWS datasets, applying logical filters (e.g., AND, OR, XOR), and generating dynamic outputs. Reports will be exportable in various formats such as PDF, Excel, CSV, and GeoJSON.

Incorporated interactive dashboards should enhance the usability of reports, offering real-time charts, pivot tables, and geospatial visualizations. Reports can be scheduled at predefined intervals (e.g., weekly, monthly) or generated on demand. Access to reports and template creation features will be restricted based on user roles, ensuring compliance with organizational policies and data sensitivity levels.

P2.7 phase completion should result in :

1. A fully functional Reporting Module integrated with the EWS core system and external data sources (ANM, APIA, PESTEXPERT).
2. Implementation of all mandatory reports listed by ANF, including configuration of grouping, frequency, and output parameters.
3. A customizable report template engine, allowing dynamic query creation, logic-based filters, and reusable templates.
4. Interactive dashboards with support for pivot tables, trend charts, and geospatial data layers.
5. Export functionalities for PDF and Excel.
6. Scheduled reporting functionality with calendar-based configuration and notification of completed exports.
7. Documentation covering the report builder interface, dashboard tools, permissions management, and configuration of scheduled reports.

### **P3. Testing and Validation**

**Important:** Until the Beneficiary’s cloud environment is fully operational (by the end of **P3.2 Cloud Environment Setup and Configuration**), the Consultant will conduct internal testing within their own development cloud environment. These internal tests will ensure that all EWS services and modules are properly configured and functional before deployment in the Beneficiary’s infrastructure.

Once the ANF’s test environment is ready and approved, the Consultant will deploy EWS into this environment and conduct further validation testing.

During this phase, the Consultant will prepare all necessary **testing documentation**, including **user manuals for the EWS system** and **module-specific test plans**. The Consultant shall conduct iterative testing, document results, and adjust the system as needed. Retesting will be performed until EWS meets all specified requirements.

Note 1: The Consultant MUST ensure that all User Acceptance Testing (UAT) scenarios follow all the functionalities of the EWS modules, as detailed in section [3.1 – Business Requirements to be Met by the System](#_3.1_Business_Requirements)

Note 2**:** The Consultant shall collaborate with the Beneficiary to develop UAT test cases based on the functional and technical requirements established in previous phases and in accordance to all EWS modules functionalities, as described in these ToR. The testing process shall verify key system functionalities, data integrity, and user interfaces. Any discrepancies identified during testing will be documented, and the Consultant will make necessary adjustments before retesting. All testing activities will be planned, documented, and tracked, ensuring full transparency for both parties.

**Sub-phase Descriptions**

| **Sub-phase** | **Description** |
| --- | --- |
| **P3.1 Internal Testing - External System Integration** | The Consultant will conduct internal testing and evaluation of the EWS integration with external systems, including PESTEXPERT, APIA, and ANM. This phase shall ensure that EWS retrieves and processes external data correctly, meeting the integration requirements The focus will be on verifying data exchange, ensuring correct formatting, validation, and system stability. Beneficiary personnel participation is required. |
| **P3.2 Internal Testing - Historical Data Management Module** | This sub-phase shall validate the Historical Data Management Module to ensure accurate data archiving, retrieval, and version control. The Consultant shall verify that historical pest, weather, and geospatial datasets are correctly stored and accessible through advanced filtering (e.g., date, crop type, location). This phase shall ensure compliance with technical specifications outlined in P2.3 (Historical Data Management Module Development). Beneficiary personnel participation is required. |
| **P3.3 Internal Testing – Quality assurance and Bulletin Drafting Module** | The Consultant shall conduct testing of the Quality Assurance and Bulletin Drafting Module, ensuring that bulletins are generated accurately based on validated datasets. The focus should be on validating template functionality, pest-weather mapping table administration, and workflows as outlined in P2.2 (Quality Assurance and Bulletin Drafting Module Development). Beneficiary personnel participation is required. |
| **P3.4 Internal Testing - Bulletin Dissemination and Notification Module** | **Testing of the Bulletin Dissemination Module to validate email and push notification delivery mechanisms** for distributing pest and disease alerts. The Consultant shall verify that stakeholders (e.g., farmers, authorities) receive bulletins via email and can visualize them in the Bulletin Web Access Portal. This phase shall also confirm bulletin archiving and retrieval functionalities as per P2.4 (Bulletin Dissemination Module Development). Beneficiary personnel participation is required. The Consultant Authorized Compliance Officer must be present. |
| **P3.5 Internal Testing - Mobile Application Module** | The Consultant shall validate the Mobile Application Module, focusing on real-time access to bulletins, geospatial data integration, and offline capabilities. This phase will ensure that the mobile application functions as intended on both Android and iOS platforms, meeting the usability and security requirements defined in P2.5 (Mobile Application Module Development). Beneficiary personnel participation is optional. |
| **P3.6 Internal Testing - System Administration and Configuration and Audit and Compliance modules** | **P4.6 – Internal Testing: System Administration and Configuration Module & Audit and**  Intensive testing of –*System Administration and Configuration* and he Audit and Compliance Monitoring module. All functionalities described in ToR – in chapters 1.1.2 and 1.1.7, and corresponding functional requirements shall be tested.  Testing scenarios shall include, among others:   * Validation of user role assignment and permission configurations based on predefined profiles (e.g., Administrator, Data Analyst, Field Reporter). * Verification of authentication workflows and Single Sign-On (SSO) integration with ANF’s Identity Provider (IdP), ensuring secure and reliable access to the EWS platform. * Assessment of audit trail functionalities, including the logging of user actions (e.g., login attempts, data modifications, configuration changes), with accurate timestamping and user identifiers. * Review of compliance mechanisms to confirm alignment with ANF’s internal IT security policies and applicable regulations (e.g., GDPR, ISO 27001). |
| **P3.7 Internal Testing - Reporting Module** | The Consultant shall validate the **Reporting Module**, ensuring that **customized reports** (e.g., pest/disease occurrence probabilities) can be generated and exported in multiple formats (PDF, Excel). Testing will confirm that role-based access controls restrict report visibility appropriately. All other tests should align with specification from **P2.7 (Reporting Module Development)**. |
| **P3.8 Internal Functional, Integration, and Interoperability Testing** | Comprehensive functional, integration, and interoperability testing across all EWS modules. This phase will confirm that system workflows operate as expected, ensuring smooth interaction between different components (e.g., bulletin generation, historical data retrieval, real-time mobile notifications). Testing will ensure compliance with the technical specifications outlined in previous design phases. |
| **P3.9 Completion of System and UAT Documentation** | The Consultant will compile all necessary testing and validation documentation, including system architecture reports, UAT test cases, and module-specific test results. This documentation will be used to finalize the User Acceptance Testing (UAT) phase and prepare the system for deployment. |
| **P3.10 Validate Compliance with National and EU Regulations** | The Consultant will ensure that the EWS meets all regulatory compliance requirements, including data integrity, security, and auditability standards. The system’s audit trail, user authentication mechanisms, and data protection measures will be assessed for compliance with national and EU policies. |
| **P3.11 Complete User Acceptance Testing (UAT)** | **The Consultant will conduct full UAT testing in collaboration with the Beneficiary, validating that EWS meets all functional, technical, security, and performance requirements. End users will test real-world scenarios, including data workflows, external system integrations, and notification mechanisms. All test results will be documented, and any identified issues will be corrected before final system acceptance.** |

### **P4. Infrastructure Setup and EWS pilot deployment**

The Infrastructure Setup and Deployment phase ensures that the Early Warning System (EWS) is integrated into a secure, scalable cloud environment while maintaining compatibility with existing ANF systems. This phase will cover infrastructure assessment, cloud configuration, and pilot deployment, ensuring connectivity with external platforms such as PESTEXPERT, APIA, and ANM.

**P4.1 Assessment and Environment Preparation for Cloud Setup**

**Description:**

In this phase, the Consultant will conduct a comprehensive assessment of ANF's existing IT infrastructure to prepare for EWS integration within the cloud. This includes evaluating the current user and access management systems, ensuring compatibility with ANF's Identity Provider (IdP) and other authentication mechanisms. A full inventory of Active Directory objects (users, groups, and devices) shall be conducted to facilitate synchronization between ANF’s on-premises identity management and the cloud environment where EWS shall be deployed

Additionally, the Consultant will assess cloud resource requirements within the cloud. This involves estimating (adjusting the estimates included in the technical offer) the computing, storage, and network needs, ensuring scalability and compliance with national cloud security policies.

The assessment shall also cover network connectivity solutions, such as Virtual Private Network (VPN) configurations and secure API gateways, ensuring stable and secure connections between EWS and external data sources, including APIA for geospatial data and ANM for weather datasets. Special consideration shall be given to interoperability with ANF’s existing email and notification infrastructure, ensuring role-based communication between system users and stakeholders.

Upon completion, the cloud Infrastructure assessment report shall be reviewed and approved by ANF, ensuring alignment with the approved IT architecture documentation before proceeding to cloud configuration and system implementation.

**P4.2 Cloud Environment Setup and Configuration**

**Description:**

Following the cloud infrastructure assessment, the Consultant will set up and configure the cloud environment required to host the EWS platform. This setup will adhere to the approved IT architecture and cloud deployment strategy, ensuring compliance with ANF’s operational, security, and data governance standards.

The cloud environment shall be provisioned by the Beneficiary, based on the finalized computed, storage, and network resource assessments. The configuration will support integration with ANF’s existing systems, particularly PESTEXPERT for pest lifecycle data and APIA for geospatial parcel data. It will also include automated data backup and replication mechanisms, ensuring that critical datasets—such as historical pest occurrences, weather data, and system logs—are securely synchronized and maintained.

To uphold data security and compliance with national regulations, the Consultant shall implement:

* Access control policies ensuring role-based permissions and secure authentication via ANF’s Identity Provider (IdP).
* Logging and monitoring systems, integrated with the Audit and Compliance Monitoring Module, to track system activities and detect anomalies.
* Backup and disaster recovery strategies, ensuring business continuity and regulatory compliance.

**P4.3 Pilot Deployment of EWS**

**Description:**

Once the cloud environment is operational, the Consultant will deploy the **EWS Pilot version**, ensuring full configuration and validation of system functionalities before rollout. This deployment shall consist of all EWS **modules**.

The **Pilot deployment** shall be deployed upon completion of the testing and validation phase, ensuring the EWS complies with all functionalities of these ToR.

### **P5. Training and Rollout**

The **Training and Rollout** phase ensures that all stakeholders are fully equipped to operate the Early Warning System (EWS) efficiently. This phase includes comprehensive training programs tailored to different user roles, along with the successful transition of EWS from the **Pilot Phase to full production use**. The training approach will combine **self-guided resources, structured training sessions, e-learning modules, and live demonstrations**, ensuring that all personnel can confidently navigate the system.

**P5.1 Staff Training and Education**

**All activities in P5.1 – Staff Training and education phase should comply with** [**3.4 – Training and Training materials**](#_3.4_Training_and)

**Description:**

In this sub-phase, the Consultant shall develop and deliver customized training sessions for the Beneficiary’s staff, ensuring they can efficiently use all EWS modules. Training will be structured based on different user roles, covering system administrators, data analysts, communications managers, field reporters, and mobile application users and all other roles defined in the system.

To facilitate effective learning, the Consultant will produce comprehensive training materials, including:

* User manuals and quick start guides for different modules.
* E-learning modules and video tutorials, ensuring accessibility for all users.
* Technical documentation for IT staff managing system configurations and integrations.

The training will cover key functionalities of each module, ensuring personnel understand:

* System navigation and operational workflows within EWS.
* Data validation processes, including integration with PESTEXPERT, APIA, and ANM.
* Role-based access control and security protocols for maintaining data integrity.

Additionally, the Consultant will ensure that all users are trained on security best practices, covering authentication, data protection, and compliance protocols. At the end of this sub-phase, the trained personnel will be able to operate the EWS independently, ensuring a smooth transition to full operational use.

**P5.2 Go-Live of Pilot Phase**

**Description:**  
The Go-Live of the Pilot Phase marks the transition of EWS from testing to operational deployment. This phase ensures that all EWS modules are fully functional and integrated with external systems, allowing real-time data collection, analysis, and notification dissemination.

Key activities include:

* Final system configuration and integration with external platforms (PESTEXPERT, APIA, ANM).
* Validation of data migration, ensuring all datasets are successfully transferred.
* Operational testing, verifying that the system functions as expected under real-world conditions.

The Consultant should deliver a **final report** summarizing:

* System setup, performance, and configurations.
* Final compliance report, certifying that EWS pilot meets regulatory and operational standards.

Following successful validation, the pilot system will transition into production, transferring system administration to the Beneficiary. This process will be accompanied by the formal **approval of the system, ensuring it enters the hypercare and stabilization phase.**

### **P6. Hypercare and Stabilization**

The **Hypercare and Stabilization** phase is a critical period following the **Go-Live of Pilot phase, ensuring** that the system is fully stabilized and optimized for long-term operational use. This phase includes **intensive monitoring, user support, system adjustments, and final optimizations**, ensuring adoption by all stakeholders. The goal is to address any immediate challenges, fine-tune system performance, and ensure that all components function as expected under real-world conditions.

**P6.1 Hypercare Period (Pilot Phase)**

**Description:**

In this sub-phase, the Consultant will provide intensive monitoring and support for the Pilot deployment of the EWS, ensuring that all modules function correctly and that users receive immediate assistance during the transition to full production use.

**Key activities during this phase include:**

* Intensive System Monitoring: For the first 8 weeks after Go-Live, the system will be closely observed to detect and resolve any performance, integration, or operational issues. Key indicators such as system uptime, data integrity, and response times will be continuously tracked.
* User Support and Troubleshooting - The Consultant shall provide real-time assistance to end-users, addressing any difficulties related to data access, system workflows, or integrations with external systems (e.g., PESTEXPERT, APIA, and ANM). A dedicated support team will be available to ensure minimal disruptions to daily operations.
* System Optimization - The system shall undergo continuous adjustments to enhance its speed, reliability, and scalability. This may involve modifying system configurations, database performance tuning, or refining notification settings to ensure optimal functionality.
* Issue Resolution and Bug Fixing - Any defects or inconsistencies identified during this period will be documented, prioritized, and resolved through system updates or patches. The Consultant will implement a structured approach to fixing errors without causing system downtime or regressions.
* User Feedback and Adjustments - The Consultant shall actively collect user feedback to assess the usability and effectiveness of the EWS modules. Necessary improvements to the user interface, notification settings, or data workflows will be implemented in collaboration with the Beneficiary during the P7 – Implement, Test and Validate Changes phase
* Knowledge Transfer and Documentation Updates - The Consultant will ensure that all system administration and operational knowledge is effectively transferred to the Beneficiary’s IT and operational teams. Training materials and user manuals will be updated based on system enhancements during this phase.
* Final System Stabilization - The objective of this phase is to ensure that the EWS is fully stabilized and operational. Once critical issues have been resolved and the system is functioning as expected, the EWS shall transition to normal operations, ready for broader deployment.
* During this phase, all application modules will be available for system users and stakeholders, but not operational from the production standpoint.

**P6.2 Full-Scale Deployment Preparation**

**Description:**  
Following the successful Pilot Go-Live and Hypercare period, the Consultant, in collaboration with the Beneficiary’s designated key personnel, will conduct a final review of the system’s readiness for full-scale deployment. This phase ensures that the system is fully optimized, scalable, and tailored to meet the operational needs of all targeted users before rolling out EWS across additional regions.

Key activities include:

* Finalizing System Configurations - The Consultant will review and adjust system settings to ensure that EWS is optimized for broader deployment. This includes fine-tuning geospatial data overlays, optimizing notification workflows, and refining data validation protocols.
* Operational Readiness Assessment - The system shall undergo final testing to confirm its ability to handle larger-scale operations, ensuring it can support increased data volumes, additional stakeholders, and extended geographic coverage.
* Support Structure Setup - The Consultant shall formalize user support strategies, ensuring that documentation, training materials, and help desk protocols are in place
* Defining Adaptations and Enhancements: Any additional requirements identified during the Hypercare period shall be documented, analyzed, as necessary to refine the system before the broader rollout.
* Finalizing the Full Deployment Plan - The Consultant shall develop a comprehensive rollout strategy, defining key milestones, deployment schedules, and resource allocation for full-scale implementation. This plan will outline the phased expansion of EWS, ensuring minimal disruption to ongoing operations.

### **P7. Implement, Test, and Validate Changes**

The **Implementation, Testing, and Validation** phase ensures that all **approved enhancements and refinements** identified during previous phases are integrated, tested, and validated to optimize the Early Warning System (EWS). This phase focuses on improving the **user experience, implementing functional updates, and validating compliance with technical and regulatory standards**.

**P7.1 Implement Approved Changes**

**Description:**  
Following the design improvements in P7.1, the Consultant will proceed with the implementation of approved changes, ensuring that they align with the Beneficiary’s operational needs while maintaining system stability. The focus will be on enhancing system functionalities without disrupting ongoing operations.

Key activities include:

* Updating the Quality Assurance and Bulletin Drafting Module, ensuring improved data validation processes.
* Refining historical data retrieval functionalities, optimizing search performance and filtering capabilities.
* Enhancing bulletin generation and dissemination workflows, ensuring seamless notification delivery.
* Adjusting reporting capabilities, improving the customization and export options available to users.

Throughout this phase, the Consultant shall work collaboratively with the Beneficiary to ensure that each update is properly integrated, tested, and validated before deployment.

**P7.2 Enhancements User Acceptance Testing (UAT) with Standard Compliance Validation**

**Description:**  
The final stage of this phase involves conducting a comprehensive round of User Acceptance Testing (UAT) to ensure that all enhancements meet business, technical, security, and performance requirements as outlined in the project documentation and feedback received from system users and stakeholders. The Consultant shall update the test plan to accommodate the newly developed EWS functionalities/adjustments.

Key testing activities may include:

* Validating the accuracy of pest forecasts and risk assessments, ensuring that the updated system processes and disseminates alerts correctly.
* Testing the revised reporting functionalities, confirming that reports are generated with correct parameters and formats.
* Ensuring mobile application stability, verifying real-time alerting and offline accessibility.
* Testing all other implemented system changes, as resulted from the Hypercare and Stabilization phase

Additionally, the Consultant’s Authorized Compliance Officer shall be responsible for certifying that the system adheres to regulatory compliance standards, ensuring that all updates meet national and EU data protection and security guidelines.

Furthermore, all technical and support, as well as training materials shall be adjusted and all **system users and stakeholders shall be updated with regard to system changes.**

### **P8. Full Deployment**

The Full Deployment phase marks the transition of the Early Warning System (EWS) from Pilot implementation to full-scale operational deployment. This phase ensures that EWS is fully operational across all designated user groups, including ANF staff -data analysts. field reporters, and system administrators while maintaining system stability, security, and compliance with operational requirements.

During this phase, the Consultant and the Beneficiary shall review the Pilot phase outcomes, adjust system configurations as needed, and ensure a structured expansion of EWS to all relevant users and stakeholders. The deployment shall be phased and carefully managed to minimize disruptions and ensure smooth adoption across all identified operational teams.

Given the complexity of data synchronization, system integrations, and user onboarding, it is anticipated that each new user group should require approximately 25 working days

**P8.1 System Expansion and User Onboarding**

**Description:**  
This sub-phase focuses on the structured expansion of EWS across all relevant operational groups, ensuring adoption, full system integration, and real-time data synchronization. The Consultant shall oversee the controlled onboarding of system users, ensuring they are properly trained, have access to relevant system functionalities, and can efficiently utilize EWS for risk forecasting, data validation, and reporting.

Key activities shall include:

* User Account Provisioning and Role Assignments – Ensuring all new users are registered in EWS, assigned appropriate access levels, and trained on their specific workflows.
* Data Synchronization and System Configuration – Finalizing historical data migration, live data feeds, and external system integrations (PESTEXPERT, APIA, ANM).
* Training and Support for New Users – Delivering structured onboarding sessions, including e-learning modules, user guides, and live Q&A sessions to ensure smooth adoption.
* Validation of Operational Workflows – Testing data validation, risk assessment, and reporting functionalities to confirm EWS aligns with real-world operational needs.

Each newly onboarded user group should undergo training, testing, and validation sessions to ensure a transition to full system use.

**P8.2 Final Validation and Operational Readiness**

Relevant Sections:

Description:  
Following the onboarding and system expansion in P8.1, the Consultant shall conduct a final validation phase to ensure full operational readiness of EWS. This should involve real-world scenario testing, stakeholder feedback collection, and final refinements to system configurations before transitioning EWS into standard operational use.

Key validation activities shall include:

* Ensuring bulletin dissemination workflows, verifying that notifications are properly generated and sent to relevant stakeholders.
* Confirming reporting accuracy and data integrity, ensuring that risk forecasts and analytics align with operational needs.
* Final security and compliance review, validating system access controls, audit logs, and data protection mechanisms should be fully functional.

At the end of this sub-phase, EWS shall be formally transitioned to full-scale operational use, with all user groups fully integrated and system workflows running as expected.

### **P9. Support & Maintenance**

The Support & Maintenance phase ensures that the Early Warning System (EWS) remains fully operational, secure, and adaptable throughout its lifecycle. During this period, the Consultant is responsible for providing comprehensive maintenance services, including corrective, preventive, adaptive, and perfective maintenance to address system issues, implement improvements, and accommodate changes in operational requirements.

Additionally, the Consultant shall oversee system updates, security enhancements, and compliance adjustments, ensuring that all modifications are properly documented to support future maintenance and troubleshooting.

**P9.1 Production Support and Maintenance**

The production support and maintenance phase shall be carried out by the Consultant over a period of at least 24 months, from the completion of phase 8.2. Throughout thisperiod, the Consultant shall provide technical and operational support to ensure EWS remains stable, scalable, and aligned with evolving user needs. Maintenance activities should be structured to cover:

* **Preventive Maintenance** – Proactively identifying and addressing potential issues to ensure system reliability.
* **Corrective Maintenance** – Fixing defects or performance bottlenecks detected through user reports or monitoring systems,
* **Adaptive Maintenance** – Implementing modifications required due to changes in regulations, user workflows, or external data integrations (including adjustments to the pest-weather mapping table, at ANF’s request)
* **Perfective Maintenance** – Enhancing system performance, security, and usability based on feedback and technological advancements.

Key activities shall include:

* Routine system monitoring, ensuring up time, data integrity, and workflow efficiency.
* Bug fixes and performance optimization, maintaining real-time synchronization with PESTEXPERT, APIA, and ANM.
* Security updates, ensuring that authentication, encryption, and data protection measures align with national and EU compliance standards.
* User support and training refreshers, addressing evolving system needs.
* Ongoing updates to system documentation, reflecting modifications, feature enhancements, and best practices.

**Deliverables:**

1. **Support and maintenance reports**, detailing system performance, bug resolutions, and applied enhancements.
2. **Updated security and compliance documentation**, ensuring adherence to evolving regulatory requirements.
3. **Revised user manuals and training materials**, reflecting changes made during the maintenance period.

## 5.2 Reports - Deliverables Overview

The following table outlines the project reports, key deliverables and expected timeline for the main project milestones, which must be documented through specific reports. Each report shall include key deliverables required to validate the successful completion of the respective implementation phase and must be submitted for review and approval by the Acceptance

***Table 22 – Milestones and Deliverables***

| **Milestone** | **Report No.** | **Report name** | **Purpose and key deliverables** | **Timeline** |
| --- | --- | --- | --- | --- |
| **Analysis Phase completion** | **R1** | **Analysis phase report** | This report marks the completion of the Planning and Analysis phase (M1 – M4).  Key deliverables :  **- Analysis phase report** containing :   * business process analysis, potential refinements of technical and business requirements of this ToR, * technical infrastructure planning and design. * security framework used, and EWS’ integration plans with external systems.   Additionally, the report should assess the estimated cloud resource requirements, including computed, storage, and network sizing. | **T0 + 3 months** (3 months from contract signing) |
| **Completion of Pilot Implementation and Deployment in cloud environment** | **R2** | **Pilot Implementation and Deployment report** | * This report documents the completion of the design, development of EWS pilot, and EWS pilot deployment phases (M3 – M10) in the cloud environment. The report marks the development and configuration of all EWS modules.   **Key deliverables**:   * test scenarios report proposed for EWS compliance verification * cloud configuration report * EWS pilot compliance verification report (all modules should comply with ToR’s requirements) * mobile application submission report * performance evaluation report (including stakeholders’ feedback) * training completion report (for the pilot) * internal testing reports (functional, performance, security and UAT) * source code for the EWS pilot * training manuals for the EWS pilot | **R1 +7 months**  (7 months from R1 approval) |
| **Final EWS Deployment and Operational Readiness** | **R3** | **Final EWS Deployment report** | This report shall confirm the successful full-scale deployment of the EWS for all users, regions and crops.  **Key deliverables**:   * updated source code. * updated training manuals. * updated test scenarios report proposed for EWS compliance verification * updated internal testing reports **(**functional, performance, security and UAT) **- to include** the adjustments or new functionalities of the EWS system. * final testing and acceptance report that should certify that the EWS system meets all functional, security, and performance requirements, as defined in these ToR. | **R2 + 6 months** (6 months from R2 approval |

1. ***T0 + X*** *means the report is due* ***X months after the contract signing date****.*

* ***R# + X*** *means the report is due* ***X months after the approval of the referenced report (R#)****.*

**Submission and Approval Process**

All reports must be delivered to both ANF and RAPID-PMU, in two original copies (one per entity), in Romanian, signed by the Consultant, along with electronic versions.

If revisions are required, the Consultant must **address modifications within 5 working days** (or an agreed-upon extended timeframe).

## 5.3 Cybersecurity risks

The Consultant shall:

* Include in each periodic progress report a dedicated section describing the status of compliance with cybersecurity risk management practices, along with any foreseeable risk mitigation measures that may be required.
* Immediately notify the Client of any cybersecurity risks that could impact the consulting services, deliverables, or underlying digital infrastructure associated with the contract.

These obligations are mandatory throughout the duration of the assignment and are intended to ensure transparency and early mitigation of potential security threats.

# Client’s Input and Counterpart Personnel

## 6.1 ANNEXES

The annexes mentioned in these ToRs are listed below.

### **6.1.1 - ANNEX 1.1.3 - BBCH Official Data Annex**



### **6.1.2 - ANNEX 1.1.3 - Example Output Table of the Predictive Algorithm**

**Example Output Table of the Predictive Algorithm**

The table below illustrates a sample output of the predictive algorithm, demonstrating how validated weather data, averaged over specific periods related to each pest or disease, is matched with crop types and BBCH stages. This matching process incorporates weather data from ANM to generate pest / disease occurrence probabilities.

| **Crop** | **BBCH Stage** | **Pest/Disease** | **Probability (%)** | **Contributing Factors (with Sample Weights)** |
| --- | --- | --- | --- | --- |
| **Wheat** | **Flowering** | **Ustilago tritici (Rust)** | **85%** | **- Air Temperature (30%): Favorable (15–25°C, averaged over pest-specific forecast period)**  **- Humidity (20%): High (>70%)**  **- Precipitation (10%): Moderate**  **- Soil Temperature (20%): Favorable (12–18°C)**  **- Soil Moisture (15%): Consistent (50–70%)**  **- Wind Speed (3%): Low (<10 km/h)**  **- Solar Radiation (5%): Sufficient (6–8 hours/day)**  **- Cloud Cover (2%): Moderate** |
| **Corn** | **Seedling** | **Tanymecus dilaticollis** | **75%** | **- Air Temperature (30%): Favorable (>20°C, averaged over pest-specific forecast period)**  **- Soil Moisture (15%): Low (<40%)**  **- Soil Temperature (20%): Optimal (>15°C)**  **- Humidity (20%): Low- Precipitation (10%): Minimal**  **- Wind Speed (3%): Moderate (5–10 km/h)**  **- Solar Radiation (5%): Sufficient (>8 hours/day)** |
| **Sunflower** | **Maturity** | **Sunflower Rust** | **65%** | **- Air Temperature (30%): Favorable (25–30°C, averaged over disease-specific forecast period)**  **- Humidity (20%): Moderate (50–70%)**  **- Precipitation (10%): Low**  **- Soil Temperature (20%): Consistent (20–25°C)**  **- Wind Speed (3%): Low (<10 km/h)**  **- Solar Radiation (5%): Sufficient (>6 hours/day)**  **- Cloud Cover (2%): High (>8 hours/day)** |
| **Potato** | **Vegetative** | **Potato Late Blight** | **90%** | **- Air Temperature (30%): Favorable (10–18°C, averaged over pathogen development period)**  **- Humidity (20%): Prolonged (>80%)**  **- Precipitation (10%): Moderate- Soil Moisture (15%): High (>70%)**  **- Soil Temperature (20%): Consistent (10–15°C)**  **- Wind Speed (3%): Minimal (<5 km/h)** |
| **Apple** | **Fruit Ripening** | **Apple Scab** | **80%** | **- Air Temperature (30%): Moderate (15–20°C, averaged over disease-specific forecast period)**  **- Humidity (20%): High (>85%)- Precipitation (10%): Sufficient**  **- Soil Temperature (20%): Consistent (12–18°C)**  **- Solar Radiation (5%): Low (<5 hours/day** |

**Key Considerations:**

* Weather data is averaged over durations tailored to the lifecycle of each pest or disease to ensure accurate probability assessments.
* Contributing factors include the weather data parameters, weighted according to their influence on pest and disease development.
* These parameters and weights will be finalized during the implementation phase in collaboration with ANF’s professional staff to ensure they align with operational needs and scientific standards.

**Note: This example table is indicative. Final factor weights, forecast averaging periods, and contributing parameters will be validated and customized during the project’s analysis and implementation phases.**

### **6.1.3 - ANNEX 1.1.3 – Pest-weather mapping table**



### **6.1.4 - ANNEX 2.0 - Technical Support and Help Desk Services**

1. Technical Support Services

Throughout the duration of the contract and the warranty period, the Consultant shall provide:

* Technical support for the administration and management of the Cloud infrastructure on which the system operates.
* Technical support for all delivered components and system modules, ensuring continuous and optimal functionality, including:
  + System Administration and Configuration Module
  + Quality Assurance and Bulletin Drafting Module
  + Historical Data Management Module
  + Bulletin Dissemination and Notification Module
  + Mobile Application Module
  + Audit and Compliance Monitoring Module
  + Reporting Module

2. Help Desk Services

The Consultant’s Help Desk support shall be provided for all functions of the EWS, including the modules developed and updated as part of this contract.

The Bidder shall include in its offer details regarding helpdesk support and the organizational methods of the helpdesk team. The contact point should be available according to the ANF’s working schedule, ensuring that any incident is promptly reported and addressed.

Incident notification shall be carried out through a service desk (incident management solution) provided by the Consultant. This solution should:

 Receive **and classify incidents** based on priority.

 Resolve **standard issues** directly.

 Escalate **complex issues** (e.g., system bugs, integration failures) to higher-level technical support within the Consultant's team.

The Consultant’s Help Desk service shall:

* Manage complaints registered in the service desk provided by the Consultant.
* Register incidents in a centralized manner and monitor their resolution until confirmation is received from the initial user reporting the problem.
* Ensure the efficient handling and resolution of incidents while maintaining clear communication with ANF’s support team.

3. Help Desk Team Responsibilities

The Consultant’s Help Desk team must ensure:

* Reception of incidents from ANF users through the service desk provided by the Consultant
* Classification and prioritization of incidents, if not already assigned by ANF.
* Identification of the source of the reported problem.
* Escalation of unresolved incidents to higher support levels when necessary.
* Resolution of incidents based on feedback received from advanced support levels.
* Notification of users regarding the resolution of reported incidents.
* Management of modification requests and forwarding them to higher levels when needed.
* Maintenance of an incident database.
* Generation of periodic activity reports regarding managed incidents.

1. Incident Priority Levels

ANF establishes the following maximum resolution times for the incidents:

| Priority Level | Severity | Maximum Resolution Time |
| --- | --- | --- |
| Priority 4 | Very Low | 24 hours |
| Priority 3 | Low | 16 hours |
| Priority 2 | Medium | 8 hours |
| Priority 1 | High | 4 hours |

5. Incident Classification and Evaluation

ANF reserves the right to classify incidents according to their priority level, and this classification is binding for the Consultant.

The Consultant cannot modify the priority level assigned by ANF.

The priority levels apply to all incidents recorded in the incident management solution provided by the Consultant. ANF reserves the right to evaluate resolution quality and compliance with service level agreements (SLAs) to ensure proper incident handling and system reliability.

## 6.2 Client’s input and responsibilities

ANF will oversee the implementation and management of the EWS by:

* Providing Information – Ensuring that all necessary data, reports, and regulatory guidelines are available for system development.
* Designating Points of Contact – Assigning personnel to interact with the Consultant, including:
  + Granting access to ANF systems and resources.
  + Appointing a contract manager for oversight.
  + Guidance for the preparation of the business analysis reports and their approval.
  + Overseeing internal developer testing and approval of the reports, and internal testing at the level of ANF leading to system acceptance at the level of ANF.

**Client’s (Project Management Unit - PMU RAPID) responsibilities:**

* Acceptance for payments – Processing contract payments as per agreed contractual terms.