



## Manual and Content of the Modules and Submodules of the SOLANA Platform

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This work has been developed since 2023 through ongoing collaboration between the National Federation of Potato Producers (FEDEPAPA) and the National Potato Promotion Fund (FNFP) (Bogotá, Colombia), together with the National University of Colombia – Bogotá Campus, Faculty of Agricultural Sciences, Laboratory of Agrocomputing and Epidemiological Analysis (Building 500, Lab 227). We extend our gratitude to the Colombian potato sector, represented by the FNFP and administered by FEDEPAPA, for its financial support and commitment to promoting research and technological development in potato production.

The SOLANA platform, version 1.0, has been conceived as a user-friendly, open-access tool tailored to the specific needs of farmers and technical assistants. SOLANA will be managed directly by the sector, ensuring that its functionalities evolve in accordance with local requirements and production realities. Through the integration, visualization, and analytical use of agronomic, climatic, and phytosanitary information, SOLANA aims to optimize decision-making, support evidence-based management, and strengthen the technological capacity of Colombia's potato production sector.

### 1. Authentication Screen

The access link to the platform, [go2cloud-fedeppapaas.web.app](http://go2cloud-fedeppapaas.web.app), redirects users to the authentication screen (Figure 1A). New users must register by creating a *Username*, providing an *Email Address*, and creating and confirming a *Password*, after which they are automatically registered (Figure 1B). Once registered, users can log in using their username and password. Additionally, a password recovery option is available in case access is lost (Figure 1C).



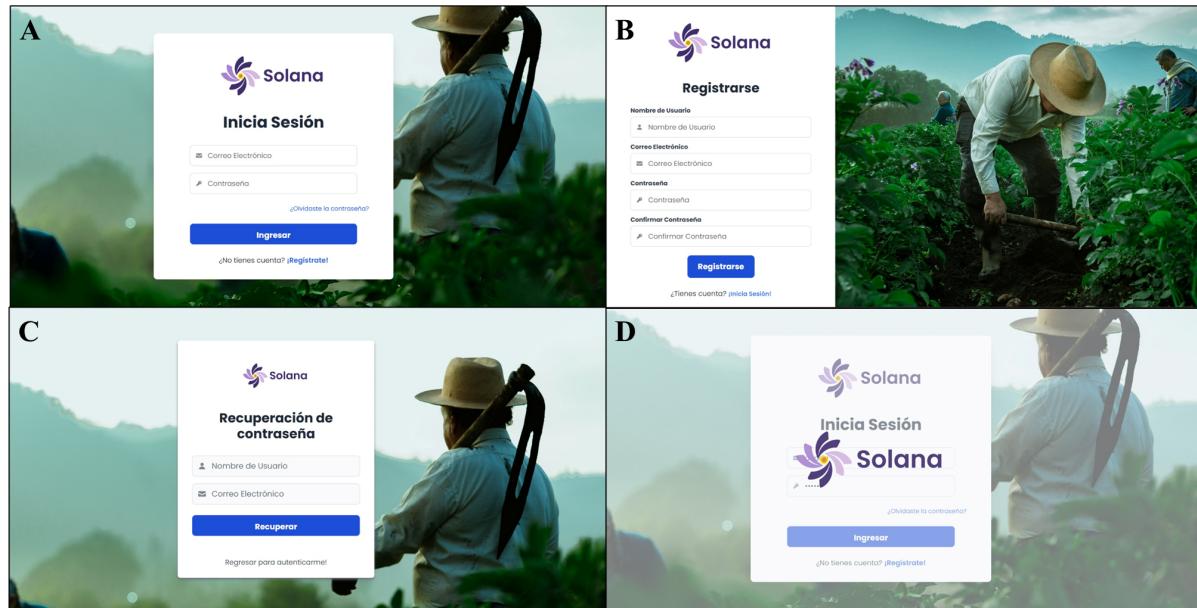


Figure 1. Visualization of the SOLANA platform registration panel. A: Initial view after accessing the login URL. B: New user registration screen. C: Password recovery screen for already registered users. D: Display scheme of the SOLANA logo shown during screen transitions.

## 2. Main Dashboard

After registration, the user can access the platform and is redirected to the Main Dashboard. This screen displays a welcome message alongside the platform logo and provides access to the corresponding modules (Figure 2A and 2B). In the upper-right corner, a control panel displays user account information, module filtering options, and a logout function. Users can select any of the modules to visualize the corresponding informational variables derived from the integrated database. An update is currently being implemented for the pre-existing modules, both in the underlying code structure and in the user interface, as part of the improvements included in SOLANA version 1.0.



**A**

¡Bienvenido!

A la plataforma de modelado de papa en las regiones productoras de papa (*Solanum tuberosum*).

Podrás encontrar módulos como: Modelación de variables climáticas, aspectos agronómicos y de manejo, registros fitosanitarios, propiedades físico-químicas del suelo y tendencias actuales académicas.

Haz click sobre los modulos para acceder a ellos.

Registro exitoso!

Usuario registrado con éxito!

OK

Módulo Registro Fitosanitario

Módulo Propiedades FisicoQuímicas del Suelo

Módulo Tendencias Académicas y Búsquedas en Línea

**B**

¡Bienvenido!

A la plataforma de modelado de papa en las regiones productoras de papa (*Solanum tuberosum*).

Podrás encontrar módulos como: Modelación de clima, variables climáticas, aspectos agronómicos y de manejo, registros fitosanitarios, propiedades físico-químicas del suelo y tendencias actuales académicas.

Haz click sobre los modulos para acceder a ellos.

Módulo de Pronóstico de Clima

Módulo de Variables Climáticas

Módulo Registro Fitosanitario

Módulo Propiedades FisicoQuímicas del Suelo

Módulo Tendencias Académicas y Búsquedas en Línea

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**Figure 2. Visualization of the Main Dashboard showing all submodules of the SOLANA platform.**

### 3. SOLANA Platform Modules

#### a. Climate Module

The climate section of the platform is currently divided into two components climate forecast and climate variables. To enhance accessibility and data interpretation, these components will be merged into a single Climate Module, organized into two sections: *Historical Climate* and *Climate Forecast*.

Historical Climate (Figure 3A1): This section includes key climatic variables such as precipitation, relative humidity, maximum, mean, and minimum temperatures, and wind speed.



Users can visualize the average historical trends of each variable by month (*View History*) to analyze climatic patterns and seasonality. Additionally, the platform allows the display of climatic conditions for the months preceding the selected date (*View Climate*), providing recent contextual data. When hovering over a graph, an interactive tooltip displays the exact numerical value to facilitate precise visualization and interpretation.

**Climate Forecast (Figure 3B1):** This section is powered by climate forecasts from IDEAM, offering projections up to six months beyond the current month. It consists of two main components: a graphical representation of precipitation and temperature for the selected period (monthly values) and a table summarizing the projected climatic risk associated with drought or excessive rainfall. For each risk condition, the platform provides management recommendations, such as irrigation scheduling or drainage network design. In months without risk alerts, users are referred to the historical section to review the normal climatic behavior for that period.

Previously, a separate climatic variables module was established to display reference parameters according to the climatic clusters (Figure 3C1). In the updated version, this functionality is integrated within the unified Climate Module to ensure consistency and improved user experience.

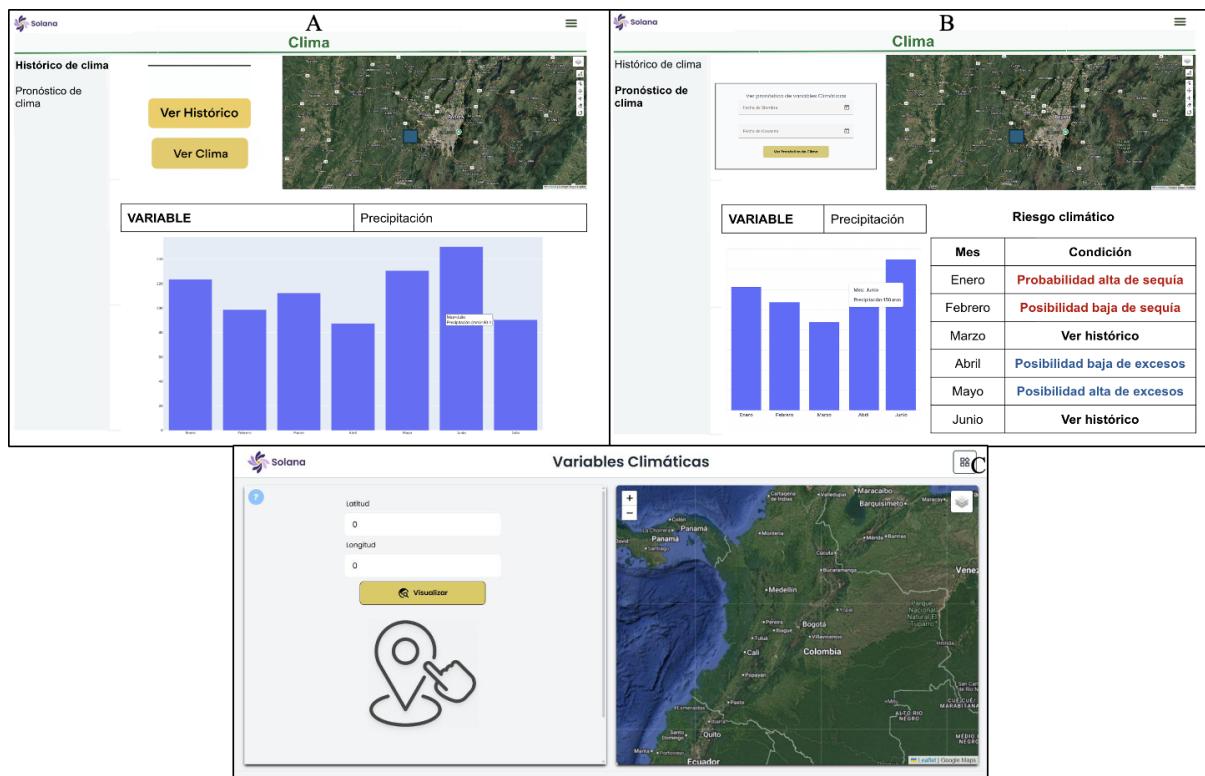


Figure 3. Climate Module of the SOLANA platform. 3a1. Historical climate section of the Climate Module in the SOLANA platform. 3b1. Climate forecast section of the Climate



Module in the SOLANA platform. 3c1. Climatic variables section displaying reference parameters by cluster in the SOLANA platform.

### b. Soil Module

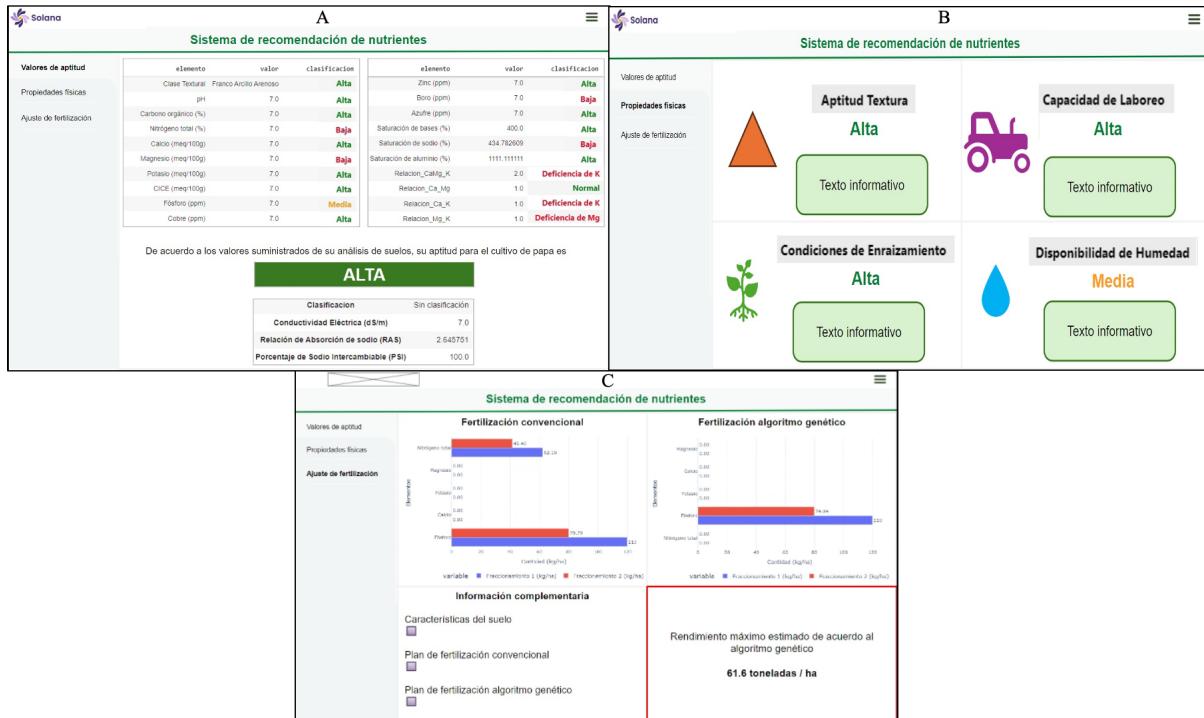
This module is composed of three main sections: Suitability Values, Physical Properties, and Fertilization Adjustment. It is powered by user-provided information derived from soil analyses conducted in each production plot.

**-Suitability Values (Figure 4A):** This section allows users to input soil analysis results. Each variable is assigned a suitability score represented by a traffic-light color scale (green, yellow, red), based on suitability thresholds established by FEDEPAPA. This provides an initial assessment of the soil's potential for potato production. If the soil is classified as suboptimal or improvements are desired, the platform links to other modules that provide specific management recommendations.

**-Physical Properties (Figure 4B):** This section highlights key physical soil parameters influencing crop development. Four main soil properties are analyzed texture, workability, rooting conditions, and moisture availability. Based on previously entered data, the system determines soil texture and its relationship with agronomic performance, presenting corresponding management recommendations for each parameter.

**-Fertilization Adjustment (Figure 4C):** This section estimates the nutrient requirements necessary to correct deficiencies identified in the suitability analysis. It compares two fertilization approaches: a Conventional Model and an Optimized Model based on a genetic algorithm trained on previous datasets. The output includes nutrient quantities (kg/ha) for each fraction, allowing users to compare total nutrient demands and estimated maximum yield potential. Additionally, the system can display the projected increase in yield under the optimized model, acknowledging that other environmental or management factors may influence the final outcome.





**Figure 4. Soil Module of the SOLANA platform.** **4a.** Soil suitability section of the Nutrient Recommendation System module in the SOLANA platform. **4b.** Physical soil properties section of the Nutrient Recommendation System module in the SOLANA platform. **4c.** Fertilization adjustment section of the Nutrient Recommendation System module in the SOLANA platform.

### c. Agronomic and Crop Management Module

This module includes three main sections: **Production Parameters**, **Forecasting Models**, and the **SUBSTOR Model**. It is fed by the previous module (Nutrient Recommendation System), which provides soil analysis data, as well as by historical records from the database.

**-Production Parameters (Figure 5A):** This section aims to visualize production trends based on previously recorded data. It includes yield statistics categorized by department, municipality, production semester, harvest month, and variety, allowing users to identify regional and temporal performance patterns. Additionally, it will incorporate annual yield variation analyses to highlight temporal changes. A dropdown menu will enable users to select and display a single graph at a time, avoiding visual overload and improving interpretability.

**-Forecasting Models (Figure 5B):** This section allows users to select the production semester and forecasting model. The climatic cluster will be automatically determined according to the initially defined polygon. The module includes model evaluation metrics and provides recommendations for model replacement if performance is suboptimal. On the right side,

reference values for potential yield are displayed according to the semester and climatic cluster. Complementary management strategies for fertilization adjustments will be suggested if discrepancies arise between soil analysis results and model projections. These recommendations can be displayed as pop-up text or through downloadable documents.

**-SUBSTOR Model (Figure 5C):** This section requires user input, including sowing date, recording date, department, municipality, variety, and planting density. It also integrates data from the climate forecast module to simulate crop growth and estimate yield under different scenarios. The model helps users identify optimal planting dates and densities for improved production planning. A notification will remind users that simulated yields represent potential maxima derived from pre-trained models and do not account for adverse conditions such as climatic events, pests, or diseases, which may influence actual field performance.

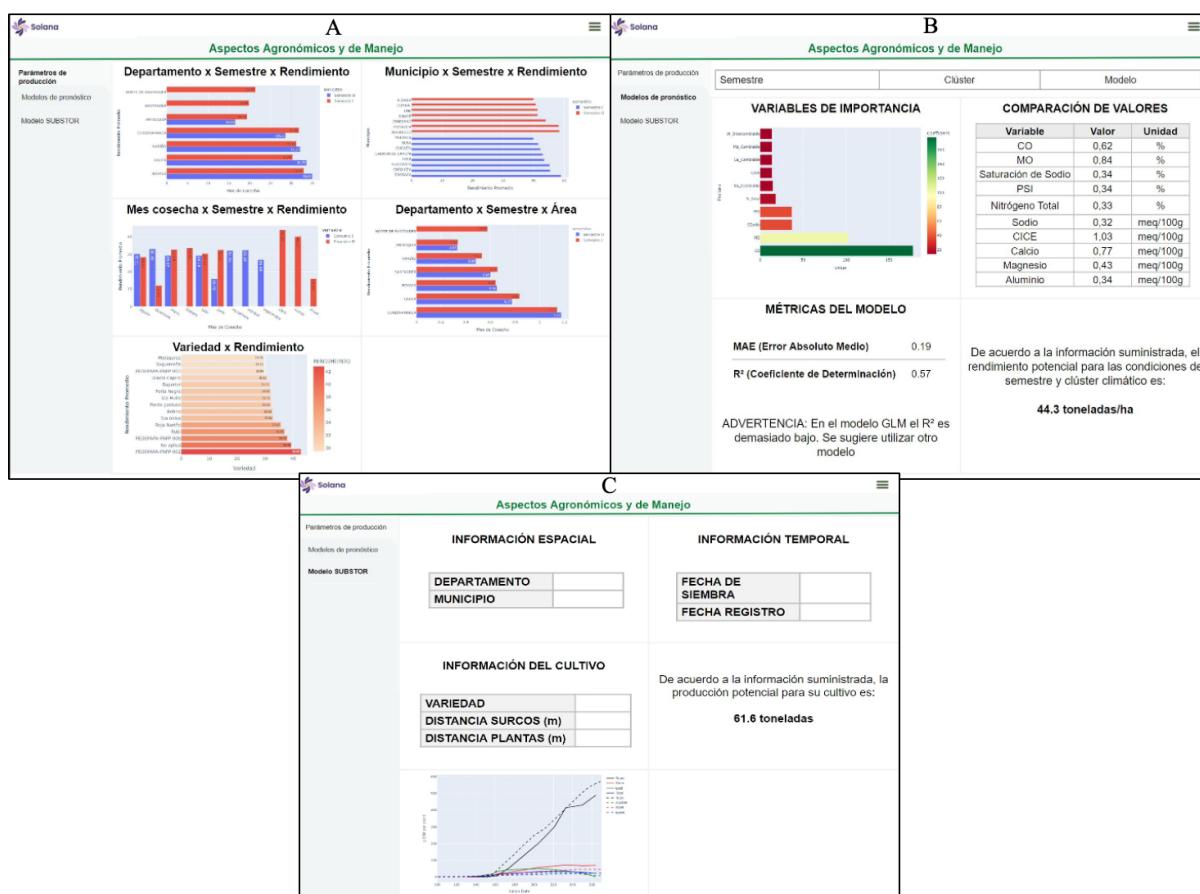


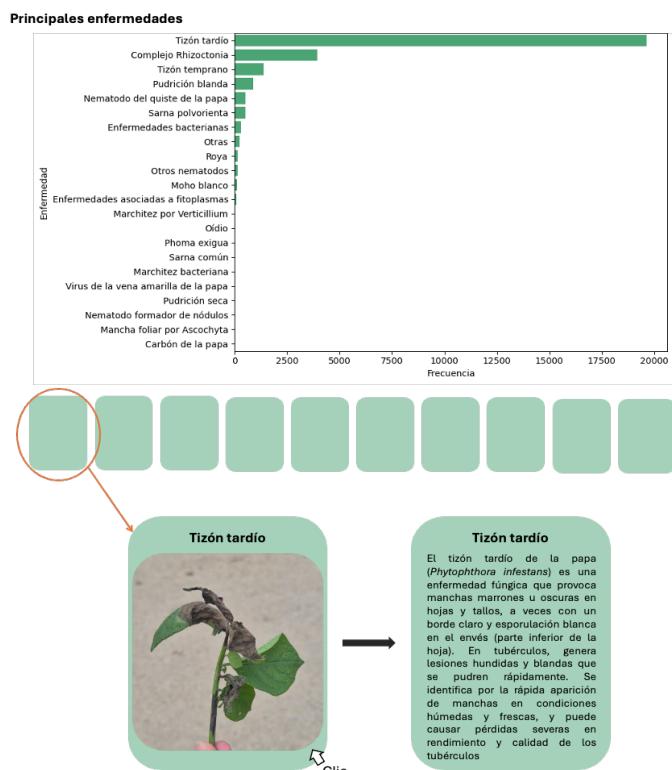
Figure 5. Crop Management Module. 5a. Production parameters section of the Agronomic and Crop Management module in the SOLANA platform. 5b. Forecasting models section of the Agronomic and Crop Management module in the SOLANA platform. 5c. SUBSTOR model section of the Agronomic and Crop Management module in the SOLANA platform.

#### d. Phytosanitary Module

Similar to the other modules, the **Phytosanitary Module** is organized into separate sections to facilitate data visualization and interpretation. The final interface and backend code are currently under development, focusing on three main processes:

- i) automating data cleaning through the creation of standardized dictionaries containing common names of targets in the database to improve user interpretation.
- ii) displaying statistical summaries of incidence and severity by disease, municipality, department, planting period, and variety.
- iii) dividing visualizations into three main categories — *Pests*, *Diseases*, and *Weeds*.

This module includes a bar chart that illustrates the frequency of reports for each phytosanitary problem recorded across all available data, enabling the identification of the most prevalent issues affecting potato crops in Colombia. Based on this analysis, the **ten most frequent problems** are selected for the development of individual technical sheets. Each sheet will include a reference image, common and scientific names, symptom descriptions, type of damage, and diagnostic criteria. If necessary, additional reference materials for other phytosanitary issues will be incorporated in future stages to broaden user awareness and improve field diagnosis capabilities. For illustration, Figure 6 presents an example applied to the *Diseases* category, which follows the same methodological framework used for the *Pests* and *Weeds* submodules.



**Figure 6. Phytosanitary Module of the SOLANA platform.**