

AGR.AI

What is agr.ai?

In the agricultural sector, the efficient management of natural resources and proper crop planning are critical challenges. Adverse weather conditions, such as drought or storms, along with soil quality deterioration due to incorrect crop rotation, can negatively affect production, lead to economic losses, and hinder long-term sustainability. Currently, many farmers lack advanced tools to monitor and manage these factors, resulting in inefficient decisions that increase operational costs and reduce productivity.

In response to this issue, our project aims to develop software that offers comprehensive solutions for intelligent agricultural management. This system will enable farmers and rural managers to perform an initial diagnosis of their land, using advanced data to predict future production and necessary maintenance. Based on continuous monitoring of soil nutrient levels through a historical record of satellite images, the software will provide recommendations to optimize crop rotation, ensuring that a proper balance of soil nutrients is maintained.

Additionally, the system will integrate advanced weather forecasting, enabling the prevention of climatic disasters such as droughts or storms, helping to reduce risk and mitigate the impact of these situations on agricultural production. The ability to manage resources and budgets more accurately will also lead to a significant reduction in operational costs, increasing the profitability and sustainability of agricultural activities.

This comprehensive approach not only provides tools to assess and monitor the current state of crops but also enables strategic future planning, helping farmers make informed decisions and reduce costs, ensuring more efficient and resilient agriculture in the face of climate challenges.

Problem or need

Modern agriculture faces a series of critical challenges related to the efficient management of crops, the prediction of climate disasters, and the sustainable use of soil resources. The lack of access to advanced tools that provide real-time information and the ability to perform accurate diagnostics of agricultural conditions puts many farmers at a disadvantage, especially in rural areas with limited connectivity access.

1. Difficulties in Accessing Real-Time Information

One of the biggest problems is the lack of stable connectivity in rural areas, which prevents farmers from efficiently monitoring the conditions of their land and crop changes in real time. This exposes them to unexpected risks such as droughts, storms, or variations in soil nutrients, often resulting in significant economic losses. Implementing a connectivity solution like Starlink (a high-speed satellite internet system) would solve this issue by providing access to a constant monitoring network capable of collecting real-time data from anywhere in the world. In this way, farmers would have access to critical information that would enable them to make immediate decisions to mitigate risks.

2. Technology Accessibility to Farmers

Another major challenge is how to reach farmers and make this technology accessible. Many producers, especially in more remote or resource-limited areas, lack familiarity with advanced technological tools, which could pose a barrier to adopting a digital solution. It is essential to create an user-friendly and accessible system, accompanied by an appropriate training process, to ensure that farmers can efficiently use the software and gain the expected benefits. Additionally, a dissemination strategy must be designed to connect this software with the needs of small and medium-sized producers.

3. Data Collection and Processing

An effective diagnosis requires the ability to retrieve accurate and up-to-date data on soil conditions, climate, and crop rotation. However, one challenge is how to capture this data efficiently without disrupting the daily activities of farmers. A viable solution would be to implement a system of simple forms that allow farmers to input key information about their land and crops, complemented by data obtained from satellite imagery and real-time weather monitoring. In this way, the software can integrate user-provided information with data from external sources, generating a comprehensive and personalized analysis.

Solution to this problem

To address the challenges of modern agriculture, we propose an innovative solution based on Artificial Intelligence (AI) that will enable farmers to perform predictive diagnostics of their crops with a six-month projection. Using both regular and infrared satellite images, along with other key variables, the system will provide critical information for resource management, crop planning, and climate disaster prevention.

1. Prompt Engineering for 6-Month Crop Diagnosis

The central system is a specialized AI that analyzes data from satellite images and other sources to generate a diagnosis of the crop situation for a six-month period. This predictive diagnosis will provide information on:

- Estimated crop yield based on current and past soil and climate conditions.
- Crop rotation recommendations to maximize soil nutrients and enhance long-term sustainability.
- Weather predictions that will allow anticipation of adverse events such as droughts or storms, helping to mitigate risks and prevent losses.

2. Specialized Prompts and Satellite Data

The core of the system is a specialized prompt that allows the AI to interpret satellite images (both regular and infrared). Regular images provide a detailed view of the visible condition of the crops, while infrared images enable the measurement of the Normalized Difference Vegetation Index (NDVI), which is a crucial indicator of plant health, soil quality, and water content in crops.

This satellite data will enable the AI to:

- Detect areas with low yield or specific intervention needs.
- Analyze the crop history and its patterns over time, identifying potential future issues such as nutrient loss.
- Predict irrigation and fertilization needs, optimizing resources to reduce costs.

3. Simple Interaction and Data Retrieval

To make the solution accessible and practical for farmers, the system will include intuitive forms where users can input key information about their land, such as crop type, planting dates, and other relevant characteristics. This information will be complemented by satellite data to provide a comprehensive and personalized analysis.

The system will allow to:

- Collect and centralize information on soil conditions and crops.
- Generate specific recommendations for each farmer based on their particular conditions.
- Update the diagnosis in real time as weather or terrain conditions change, keeping the information always relevant.

This solution provides a powerful tool for intelligent agricultural management, helping farmers anticipate problems and make data-driven decisions to improve productivity, reduce costs, and ensure the long-term sustainability of their crops.



Technical development

Resources Used

To implement an efficient solution based on artificial intelligence and satellite image analysis, it is essential to have a set of resources that allows collecting and processing the necessary information. Below are the key resources that the project uses to generate accurate diagnostics and make predictions about the condition of the crops in the medium term.

1. Satellite Imagery and Drones

- **Satellite Images:** They are essential for the constant monitoring of crops on a large scale. These images provide an overall and accurate view of the condition of agricultural lands, detect growth patterns, identify problem areas, and assess crop behavior.
- **Drones:** They provide detailed images of specific areas, allowing for more localized and real-time analysis. Drones can be used in situations where plant-level detail is crucial for identifying specific issues, such as localized pests or diseases.

2. Infrared Imaging

They play a key role in the soil moisture analysis, as they allow for the measurement of soil humidity. This is especially useful for identifying areas where crops are experiencing water stress (either a lack or an excess of water), thus optimizing the use of irrigation systems. By evaluating the distribution of moisture, water waste can be avoided and irrigation efficiency improved, ensuring that crops receive the appropriate amount of water.

3. Thermal Imaging

They allow for the detection of subtle changes in plant behavior that may be related to the onset of diseases. Through these images, it is possible to identify anomalies in leaf or soil temperature that indicate the presence of biological stress or deficiencies. This facilitates early disease detection, enabling the farmer to take action before the crops are severely affected.

4. Actual Images

They are used to identify issues such as water stress, nutrient deficiencies, pests, and diseases in crops. By combining these images with the analysis of other variables, a more comprehensive diagnosis of the overall condition of the land and crops can be obtained, helping to make more informed decisions about the necessary interventions.

5. Meteorological Data

This information is essential for predicting weather events that may affect crop growth, such as droughts, heavy rains or storms. By combining this data with the diagnostics generated by the AI, farmers can anticipate and mitigate the impact of adverse weather conditions, helping to protect crops from significant damages.

6. Demography and Environmental Resources

This analysis is relevant for understanding the socioeconomic context of agricultural regions and optimizing resource distribution. Additionally, factors such as air and soil pollution, water availability, and interactions with local fauna and flora directly affect agricultural productivity. The system takes these elements into account to generate more accurate predictions and adjust recommendations for each specific case.

7. Pest and Nutrient Deficiency History

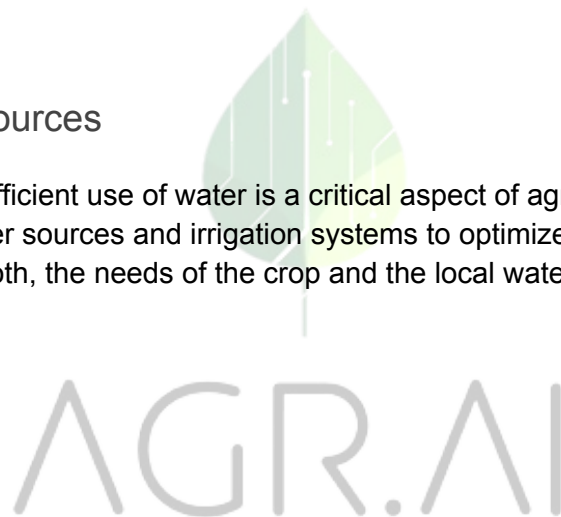
The use of historical data on the occurrence of pests and nutrient deficiencies in crops allows the identification of patterns and trends over time. With this information, the AI can anticipate the recurrence of these issues and recommend preventive measures, improving soil and crop health. The system also evaluates nutrient levels in the soil to suggest the appropriate use of fertilizers, enhancing soil quality and increasing long-term productivity.

8. Local Fauna and Flora

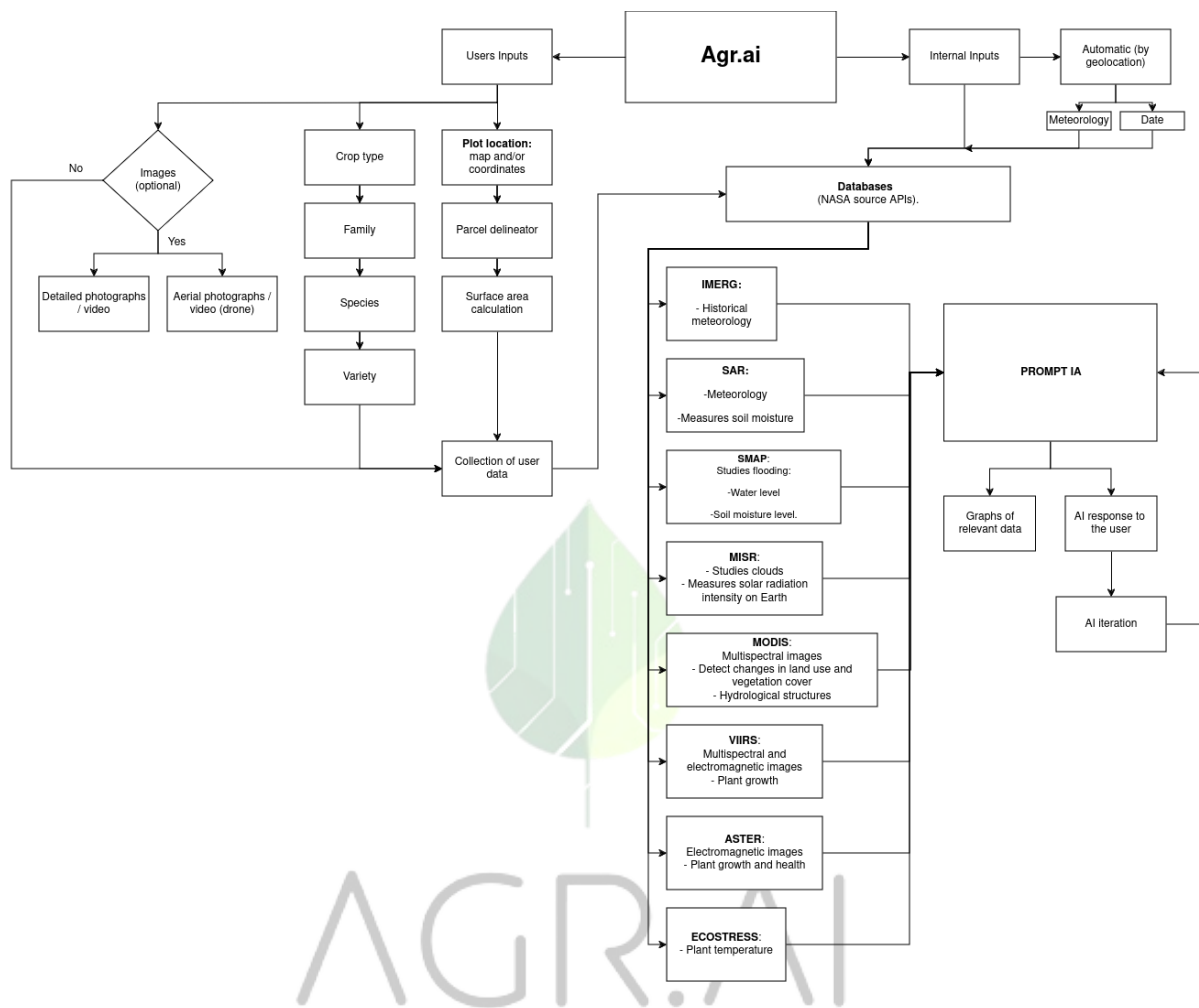
Monitoring the fauna and flora near crop areas is important for maintaining ecological balance, and ensuring that agricultural practices do not negatively impact the natural environment. Additionally, some species can be indicators of environmental health, providing valuable information for the sustainable management of resources.

9. Water Resources

The availability and efficient use of water is a critical aspect of agriculture. The solution employs data on water sources and irrigation systems to optimize the use of this resource, taking into account both, the needs of the crop and the local water conditions.



Application flow



Agr.ai works as follows:

When a user registers, they provide a series of data (location of the plot, either on a map or in coordinates, which delineates the plot and calculates the available surface area). The user also inputs information about the types of crops, family, variety, and species to which they belong. Finally, to achieve greater precision in queries to the AI, it is recommended that the user provide images, either by capturing photos with a drone or through detailed real images. After this data collection, all this information goes into a database, where all the necessary APIs and resources are gathered to ensure the highest possible accuracy.

At this point, where data is entered, it is also important to note that the AI receives internal inputs automatically to consider factors such as the date, meteorology, and other elements that can be obtained without requiring human interaction.

It is crucial to emphasize that these databases containing a large number of APIs, resources, etc., can also obtain information from the following satellites (each in a specific way, although in most cases via APIs):

- **IMERG:** Provides historical meteorology and precipitation data worldwide, with new information available every day.
- **SAR:** Capable of obtaining information in rain, day, night, or any other situation thanks to infrared waves that penetrate clouds. This is useful for obtaining soil moisture.
- **SMAP:** Gather information on water levels to study and predict flooding. It also measures soil moisture, making it a great complement to SAR for these parameters.
- **MISR:** Captures photographs of solar radiation intensity on Earth.
- **MODIS:** This satellite collects multispectral images used to detect changes in land use and vegetation cover, plant health, and hydrological structures, among other things.
- **VIIRS:** Focuses on collecting data on digital growth through multispectral images.
- **ASTER:** Provides electromagnetic images to determine surface temperature.
- **ECOSTRESS:** This satellite measures plant temperature, addressing the issue that higher temperatures indicate lower soil moisture levels.

Once we understand all the parameters, resources, and information we need to use, we move on to the AI's operational phase. In our case, the AI receives all the information discussed earlier, checks the latest news, historical data, and any necessary information to achieve the highest accuracy with a minimal margin of error.

All of this, along with the context the user provides when sending a message and images that can clarify the situation for our AI, enables the AI to have all the graphs (shown at the end in the mockup) updated with the best available data. This way, the user can have a personalized experience tailored to their specific case whenever they wish.

Logically, if the user is not satisfied with their response, they can iterate with the AI as many times as needed until they find the answer that best fits their needs.

AI explains:

The AI runs on a Meta model, Llama 3 80B. We chose this model because it provides the best responses and has the quickest processing time. To adapt it to our project, we employed two techniques: RAG and Prompt Engineering.

The first technique, RAG (Retrieval-Augmented Generation), allows us to input any type of data (APIs, databases, general documents, etc.). This has enabled us to utilize all the resources compiled from NASA's website, ensuring we have all the necessary knowledge to address any issues that arise without any problems. Additionally, we have conducted extensive training, rigorously testing this AI.

On the other hand, we have implemented Prompt Engineering. This involves providing a prompt to the AI so it can assume a specific role. For example, in this case: "Assume your role as an agronomist with over 20 years of experience, considering [Crop type]...". This technique also allows for the inclusion of inputs, meaning data provided by the user or

various resources. With this, we can further customize the output that the user receives while harnessing the full potential of the previous technique linked to the base potential of Llama 3.

All of this ensures that the user has a completely personalized experience.

Algorithm use case

In this section, we will address the functionality of the specialized prompt designed for the artificial intelligence used in our agricultural project. This prompt enables interaction between the user and the system, facilitating the input of relevant data and the retrieval of accurate diagnostics regarding the condition of the crops. Next, we will detail how this prompt is structured and used to maximize its effectiveness in agricultural decision-making.

1. User prompt

"My crop has some unusual bite marks on the leaves. I also noticed, after reading the newspaper, that there's a plague of grasshoppers, locusts, and crickets nearby. I'd like to get solutions as quickly as possible to control this. Additionally, I'm still having the water issues I mentioned earlier. By the way, if you can give me an estimation of what I can harvest in the next 6 months, that would be even better."

2. How the algorithm works – Prompt engineering

It acts as an agricultural engineer specializing in the evaluation and optimization of crops. The objective is to assess the state of an olive crop in the Guadalhorce Valley (Málaga, Andalusia, Spain) and propose solutions to potential problems based on the information I provide. Here are the relevant data you should analyze:

Data provided by the user:

- **Type of crop:** Olive trees
- **Vegetation color:** Apparently normal
- **Crop condition:** Flowering stage
- **Visible problems in the field:** Insect bites on leaves and branches. A large number of grasshoppers, locusts, and crickets were found.
- **Real-time images:** [Provided by the user]

Data obtained from APIs and other external resources:

- **Weather data:** [Weather API: temperature forecast, precipitation in the next 7 days]
- **Soil data:** [Soil API: pH, soil moisture, available nutrients]
- **Satellite images:** [Satellite images API: NDVI, variation in vegetation health]
- **Pest history in the region:** [Pest API: detected insects, recent diseases]
- **Available water resources:** [Water resources API: available water volume, water stress]

3. Objective of the analysis:

- Evaluate the condition of the crop based on the combination of data provided by the user and data obtained from the APIs.
- Detect possible problems such as pests, diseases, or nutrient deficiencies.
- Provide solutions that the farmer can implement immediately.
- Estimate the harvest yield in the next 6 months based on weather forecasts and the current health of the crop.
- If necessary, suggest techniques to improve soil or water use, as well as methods for pest or disease control.
- Real-time images: Analyze the drone images provided by the user to elaborate the response.

AI RESPONSE

We will proceed with the evaluation of the olive cultivation in Guadalhorce Valley based on the data provided:

Crop Status Analysis

Vegetation Condition: Real-time images and observations indicate normal vegetation color, which suggests that the olive trees are in a healthy state in terms of their foliar development. The flowering stage is key to production yield, as it determines future fruit formation.

Visible Problems: The presence of bites on leaves and branches, as well as a large number of grasshoppers, locusts, and crickets, suggests a pest problem that may affect the crop's productivity.

Data obtained from APIs:

- **Climate (Climate API):** Forecast of moderate temperatures, with the possibility of light rain in the next 7 days. This weather is favorable for flowering, but attention should be paid to potential sudden temperature drops, which could have negative effects.

- **Soil (Soil API):** Moderate pH between 6.5 and 7, with adequate but slightly limited soil moisture, and low nitrogen levels. This may indicate the need for nitrogen fertilization to support growth during this crucial flowering phase.
- **Satellite Images (NDVI API):** NDVI values are consistent with healthy vegetation, although there is a slight variation in some areas of the olive grove. This may be associated with pest distribution or small patches of water stress.
- **Pest History (Pest API):** Recent outbreaks of locusts and grasshoppers have been detected in the region, which is consistent with field observations.
- **Water Resources (Water Resources API):** The available water volumes are sufficient for the crop's current needs, although water stress may increase if irrigation is not well managed in the upcoming months, especially with the arrival of warmer temperatures.

4. Problem Evaluation

- **Pests:**
The main problem identified is the infestation of grasshoppers, locusts, and crickets, which are damaging the foliage and branches. These insects can weaken the crop, affect photosynthesis, and reduce fruit production.
- **Nutrients:**
There is a nitrogen deficiency in the soil which, if not corrected, could limit the crop's growth and health, affecting fruit development.
- **Variations in Vegetation Health:**
Although the overall condition is good, satellite images show slight variations in certain areas, which could be related to the presence of pests or problems with water and nutrient distribution.

5. Proposed Solutions

- **Pest Control:**
Implement a biological control program to reduce the population of grasshoppers, locusts, and crickets using natural predators or traps. Specific insecticides can also be used if the problem escalates.
Constantly monitor the field using drones or satellite systems to detect potential increases in insect populations.

- **Fertilization:**

Apply slow-release nitrogen-rich fertilizers to ensure that the plants receive the necessary nutrients during fruit development.

Reinforce with foliar applications of micronutrients, such as iron and zinc, to improve the overall health of the crop.

- **Irrigation Management:**

Carry out moderate and consistent irrigation, taking advantage of the available water, especially in areas showing water stress in satellite images.

Optimize the drip irrigation system to ensure uniform water distribution.

6. Yield Estimation

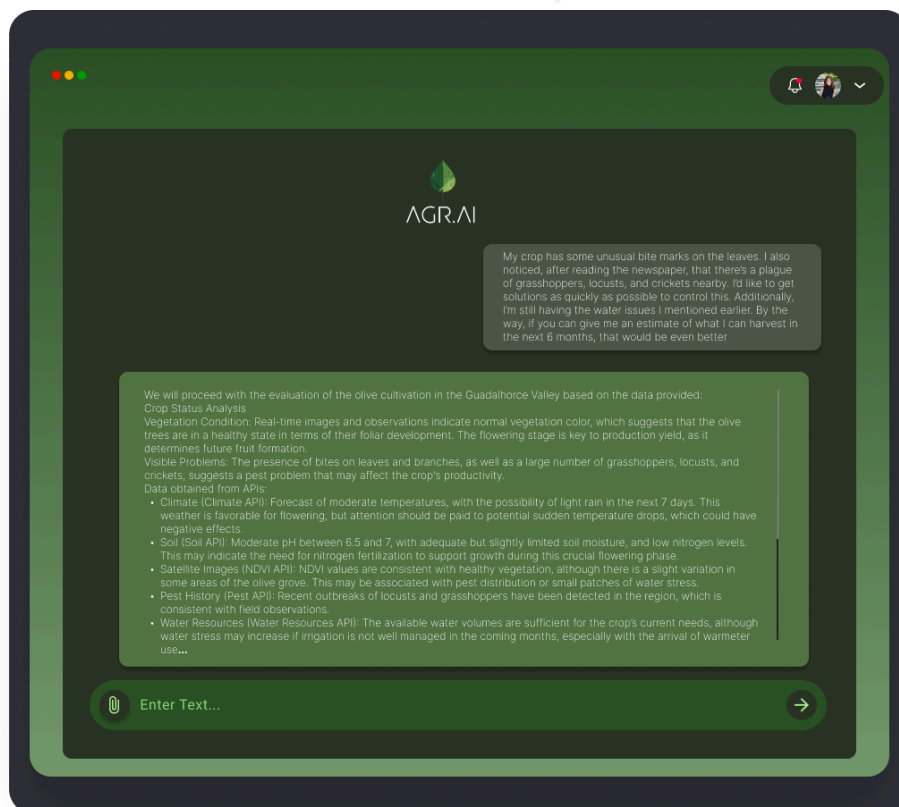
Based on climate forecasts, the current crop condition, and the proposed corrective measures, a moderate-high yield is estimated if the pest problem is efficiently controlled and an adequate fertilization is applied. Production is expected to be within normal levels for the region, with a possible 10-15% reduction if pests or nutrients are not properly managed.

7. Additional Recommendations

- Consider the use of soil sensors to monitor moisture and nutrients in real-time.
- Plan preventive treatments before pests reach critical levels.
- Constantly monitor the local climate to prevent problems related to thermal stress during the next months of crop development.

Overall, the key to maintaining good yield will be integrated pest and nutrient management, along with efficient water use.

Mockup



Impact and benefits

The implementation of a predictive agricultural diagnostic system based on artificial intelligence (AI) has the potential to significantly transform the agricultural sector. This impact can be divided into several key aspects:

1. Resource Optimisation

AI technology would enable farmers to use essential resources such as water, fertilizers, and pesticides more efficiently. By analyzing satellite data and predicting crop needs, the system can reduce unnecessary input usage and ensure that they are applied only when truly needed, which not only reduces costs but also minimizes waste and environmental impact.

This would result in:

- Lower production costs by using fewer inputs and improving efficiency.
- Environmental sustainability by reducing the excessive use of chemicals and water.
- Higher profitability for farmers, who will be able to increase their profit margins.

2. Improving Productivity

The ability to anticipate crop needs and weather conditions through six-month diagnostics allows farmers to make informed decisions, thereby increasing agricultural productivity. By receiving recommendations based on the analysis of satellite images and key variables, farmers can proactively adjust their practices, optimizing:

- Crop rotation, ensuring better use of soil nutrients and preventing overexploitation of the land.
- Irrigation and fertilization, applying only what is necessary at the right times to maximize yield.
- Harvest planning, allowing farmers to prepare for adverse weather conditions and minimize losses.

With this technology, a significant increase in agricultural yields and improved product quality is expected, which will strengthen the sector at both national and international levels.

3. Risk Prevention and Mitigation

One of the most impressive aspects of the solution is its ability to predict climate disasters such as droughts, floods or storms, which are one of the main causes of losses in the agricultural sector. With this information, farmers can:

- **Taking preventive measures:** Adjusting planting and harvesting times or preparing irrigation infrastructure and crop protection before adverse weather conditions occur.
- **Reducing financial risk:** By minimizing losses caused by natural disasters, farmers improve their economic security and protect their income.

This capacity for anticipation not only benefits farmers at the individual level but also strengthens food security and the resilience of the agricultural sector against extreme weather phenomenon, which is crucial in the context of climate change.

4. Sustainability and Environmental Conservation

The system not only enhances agricultural productivity but also promotes more sustainable farming practices. By optimizing resource use and minimizing the environmental impact of traditional agricultural practices, this technology:

- Protects local ecosystems by reducing soil overexploitation and the use of chemicals that contaminate water and affect biodiversity.
- Conserves natural resources, such as water, which is a scarce commodity in many regions.
- Contributes to the fight against climate change by making more efficient use of agricultural inputs and reducing the carbon footprint of farming operations.

By combining sustainability and productivity, this solution has the potential to change the perception of agriculture, making it more resilient and environmentally friendly, which is increasingly valued by both, governments and consumers.

5. Farmer Empowerment

The accessibility of this technology through simple and intuitive interfaces allows farmers from any technological level to benefit from advanced data analysis without the need for deep technical knowledge. This fosters technological inclusion in rural areas, empowering farmers to:

- Make data-driven decisions that were previously unavailable to them.
- Improve long-term planning and have greater control over their productions.
- Access relevant and personalized information about their crops, facilitating the adoption of more modern and efficient agricultural practices.

This impact is particularly important in regions where access to advanced technologies is limited, as it democratizes the use of artificial intelligence in one of the most traditional sectors that is vulnerable to climate change.

6. Competitiveness of the Agricultural Sector

By implementing advanced prediction technologies, the agricultural sector can position itself as a more competitive player in the global market. The ability to anticipate market needs and ensure higher-quality crops allows producers to:

- Better respond to demand and offer products with higher added value.
- Reduce risks and increase profit margins, thereby improving competitiveness in both local and international markets.
- Attract investments and drive the development of new technologies related to agriculture, such as smart irrigation solutions or agricultural drones, creating a more robust technological ecosystem around the sector.

