NASA SPACE APPS CHALLENGE

Local event: Xalapa

Challenge:

Leveraging Earth Observation Data for Informed Agricultural Decision-Making

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Introduction

Climate change is impacting a sector that is fundamental to global food security: agriculture. Prolonged droughts, rising water levels, and flash floods are putting crops and agricultural systems at risk, as well as leading to biodiversity loss and changing weather patterns. All these problems combined create a global emergency. In order to combat this, it is necessary to develop adaptation and mitigation strategies to ensure the safety and quality of crops.

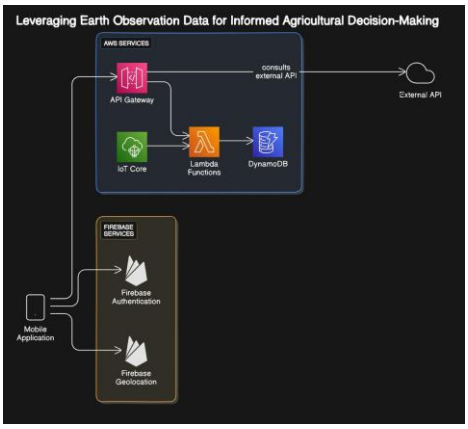
I. Problem statement

1.1 Problem definition

Farmers face a deluge of water-related challenges due to unpredictable weather, pests, and diseases. These factors can significantly impact crop health, farmers' profits, and food security. Depending upon the geography, many farmers may face droughts, floods or both at the same time.

1.2 Proposed solution

We are creating an IoT that, by collecting data through hardware and/or data obtained from datasets and APIs, processes and notifies farmers about natural disasters such as droughts, floods, and other important meteorological data through a mobile app. This will enable them to have high-quality crops. Additionally, it will provide other tools such as expert advice, forums for farmers to interact, pest alerts, and other relevant problems in their zone, as well as recommendations. (Picture 1)



Picture 1

The user will have three options to choose from based on their interests, needs, and opportunities. The first, which is the most comprehensive, requires internet access and, based on data collected from the **Sensor module (Shield Root)** and a **transmitter-emitter module (Shield Root Collector)** along with real-time weather data and other data processed by the API, will provide the user with alerts, recommendations, and access to sensor information through a **mobile app (Crop Shield)**. The second option also requires internet access but, compared with the first, does not have the Shield Root, so it will only receive data of the weather and surroundings. The third option offers the user an offline alternative, where Shield Root will continuously take measurements and send data to the API regularly. However, since it cannot be compared with real-time data, it will be stored until the user can access to a network and receive feedback, while also storing meteorological data for the following months to prepare the user for potential natural disasters.

Data collection through hardware will be done using a sensor module that will measure atmospheric pressure, soil and environmental humidity, temperature, and pH. The pH sensor will also allow us to measure macronutrients in the soil. This data will be sent to the server, which will collect and process it along with data from databases to connect it to Crop Shield and perform the tasks.

1.3 Objetives

General Objective:

To assist farmers in cultivating and harvesting their crops without any setbacks or inconveniences, using a tool that is accessible to all, regardless of their economy or consistent internet access.

Specific Objectives:

- To prevent farmers from experiencing any type of loss, whether it is economic loss due to investments in necessary materials or crop loss.

- To improve the quality and condition of crops, whether they are intended for sale and need to be competitive with other sellers' products or are for the farmers' own consumption.

II. Theorical framework

Climate change is a global phenomenon that alters weather patterns in most regions of the world, affecting various sectors, including agriculture. Changes in temperature and soil conditions involve multiple challenges, impacting everything from production to distribution of the products.

Direct Impacts:

Direct impacts are very noticeable and occurs almost immediately. Some of the most common examples are:

- Increased temperatures: Heat waves and rising temperatures can cause heat stress in plants, which can affect crop growth and even lead to complete crop failure.
- Changing rainfall patterns: Changes in precipitation patterns can have two opposite consequences: prolonged droughts or more intense rainfall, which directly affects water availability. Prolonged precipitation can also lead to an increase in bodies of water.
- Natural disasters.

Indirect Impacts:

Are those who going to take more time to notice them.

- Desertification: Desertification of fertile lands, although it is not an immediate problem, is one of the biggest issues as it reduces areas available for crop cultivation.
- Spread of pests and diseases: Human activities, food trade, and temperature changes conducive to humidity, make easier for pests to proliferate and migrate.
- Biodiversity loss: Biodiversity loss is one of the biggest problems of climate change. The transformation of terrestrial and marine ecosystems has caused a great loss of species that means non pollination of plants or extinction.

III. Project development

3.1 Initial phase

During this stage, the team focused on identifying and defining all aspects that we considered key of the challenge. We began by reading the characteristics and critical requirements for the project, as well as the corresponding documentation provided. Additionally, we conducted a very general investigation into some concepts that we considered basic to be able to develop this project in the best possible way and to be able to propose the first ideas.

3.2 Planning phase

To kick off this phase, we began by defining all the general aspects of the project, going through different stages such as the objectives. We asked ourselves questions like "Who do we want to help? and how are we going to do it?"

Having identified our target population, which in this case are farmers, we pointed out the major problems they would face. We categorized them into **climate-related issues** (droughts, floods, hurricanes, etc.), **soil-related problems** (pH levels, macronutrients, humidity) and in a future, look for pest infestations (insects, animals, microorganisms).

We classified these problems based on if they were human-caused or natural, controllable or uncontrollable, and how we would measure them.

Subsequently, we categorized the types of users we would have in the application. We concluded that they would be those who already have crops and those who want to plant something new or start from scratch.

Once we had gathered all this data, we began to consider how we would provide assistance. We decided to use the server application that had been previously discussed to reach all users who required it.

Finally, we sketched out a design and feature list for the application, outlining the order and expected functionality of each section.

3.3 Design and experimentation phase

This phase was one of the most challenging as, due to time concerns, it couldn't be very extensive. At the beginning of it, we researched the sensors that were going to be used and discarded those that did not fit the needs or costs envisioned for the project. Similarly, we reviewed the databases and resources provided by NASA to determine which ones would be useful for the challenge.

While designing and simulating the Shield Root, we encountered several problems, such as communication between the unit and the server. This was due to some sensors that did not allow the correct execution of this action, so we had to find new alternatives to fit the needs we had proposed, but with new alternatives.

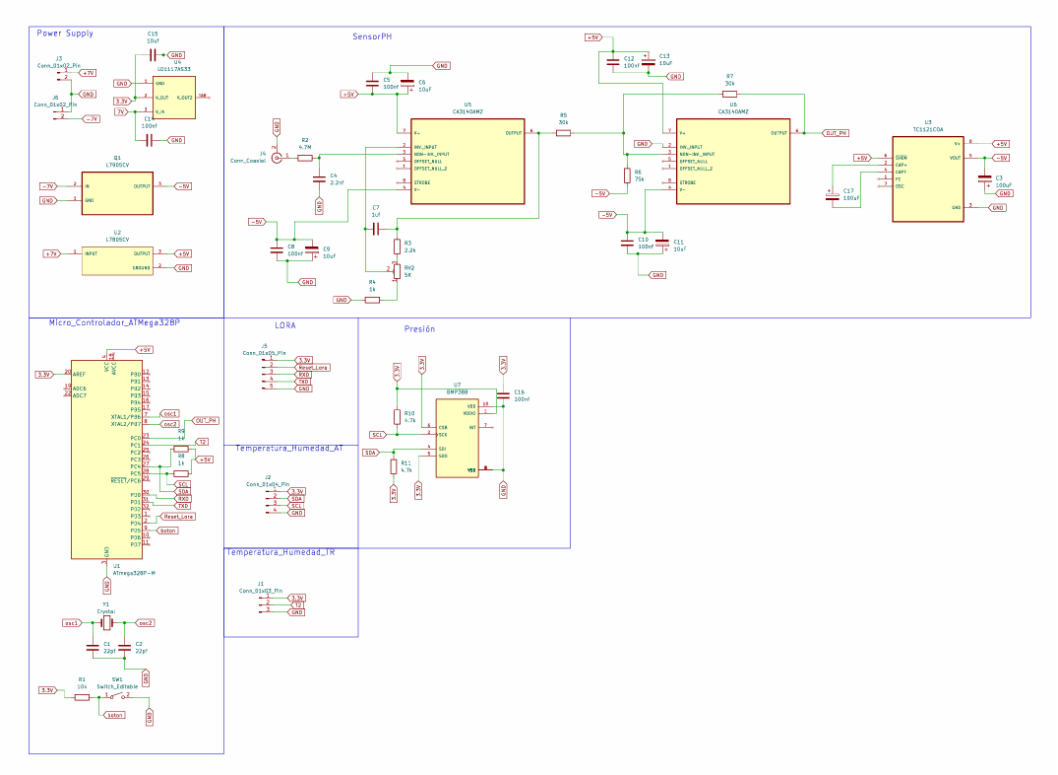
On the application side, we didn't really have any significant issues, other than some coding errors that were resolved very quickly and some issues to open the file of the app.

3.4 Closing phase

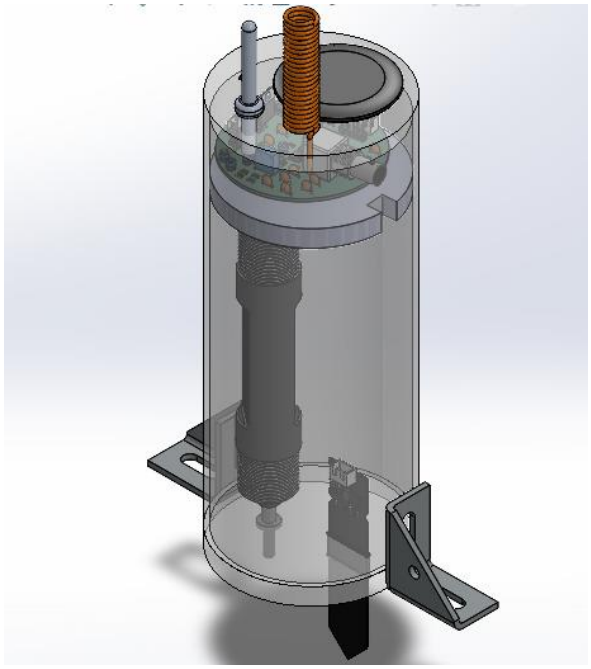
In this phase, the simulation of the three elements of our project were brought together (Picture 2-8): the application, the server, and the Integrated Measurement Unit. Initially, we encountered some problems with the communication and control between the parts, as the methodology to be followed varied depending on whether the user had continuous internet access.

Once these issues were resolved, we did not encounter any more significant obstacles.

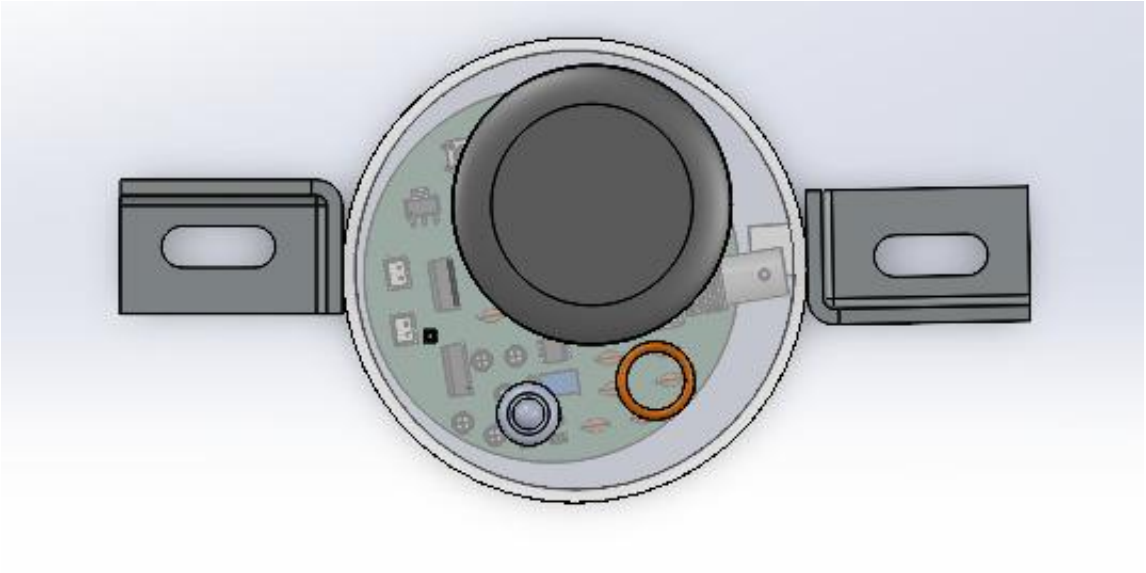
Picture 1. Crop Shield App Sign-Up Screen Simulation



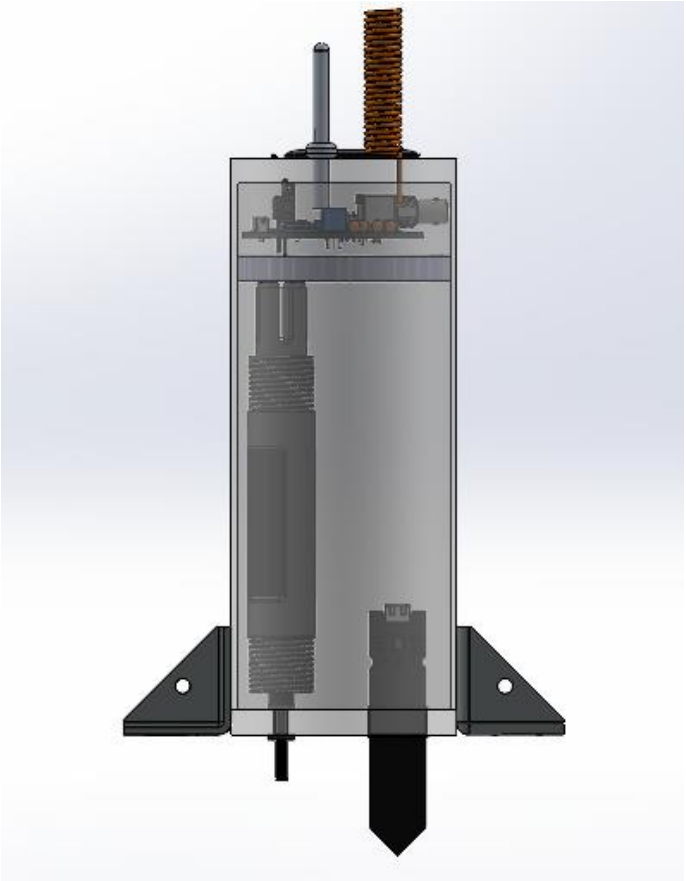
Picture 2. Shield Root Schematic



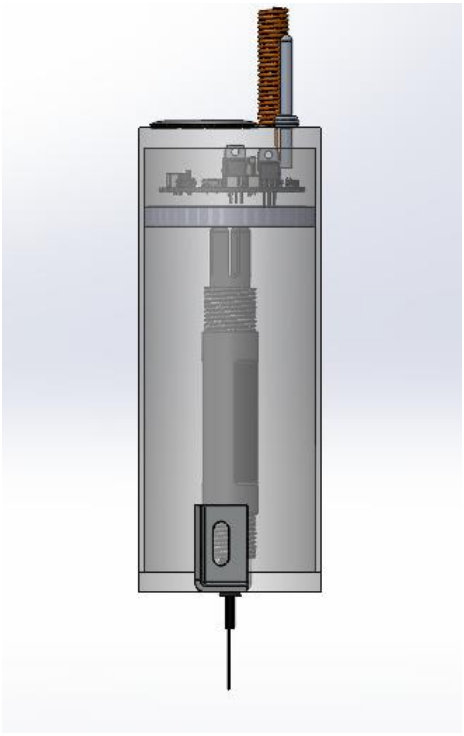
Picture 3. Shield Root Design Simulation



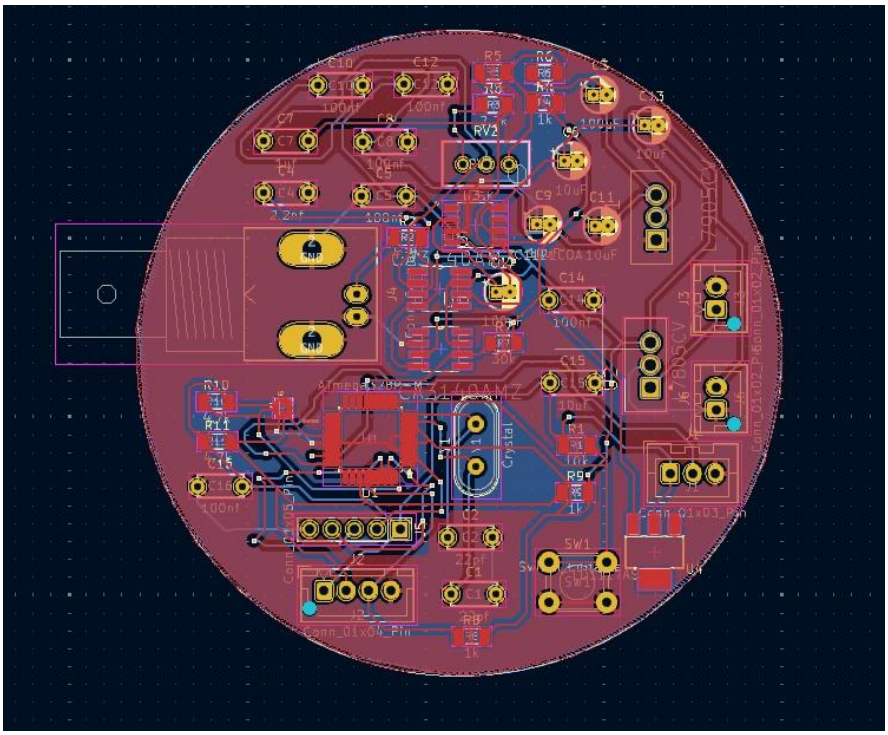
Picture 4. Shield Root top view



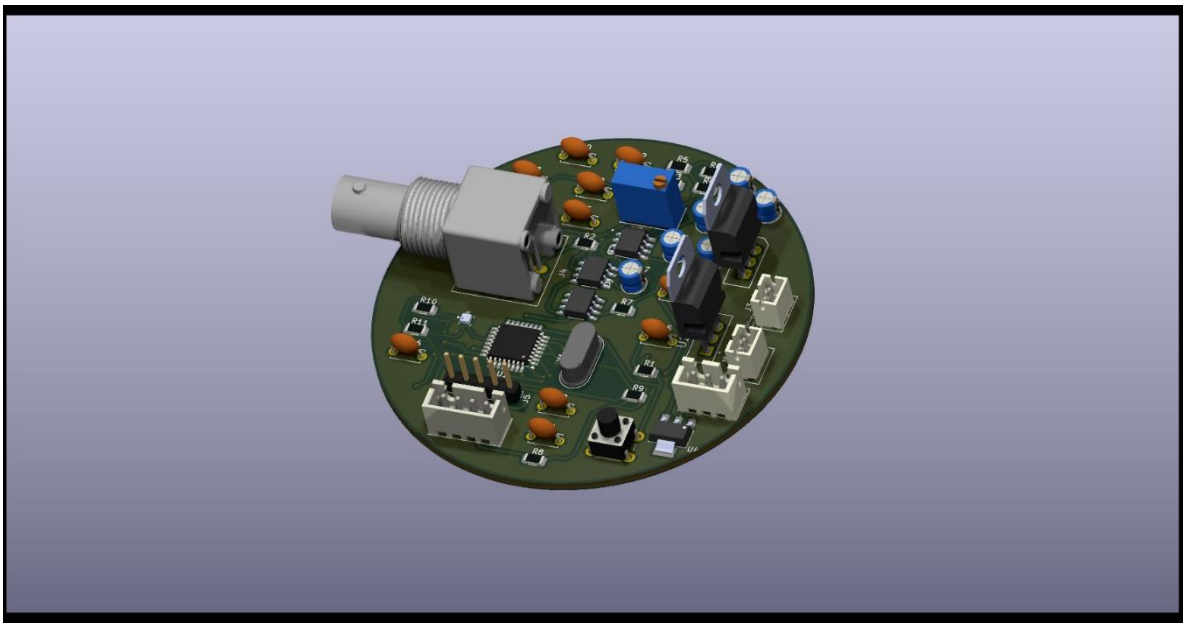
Picture 5. Shield Root front view



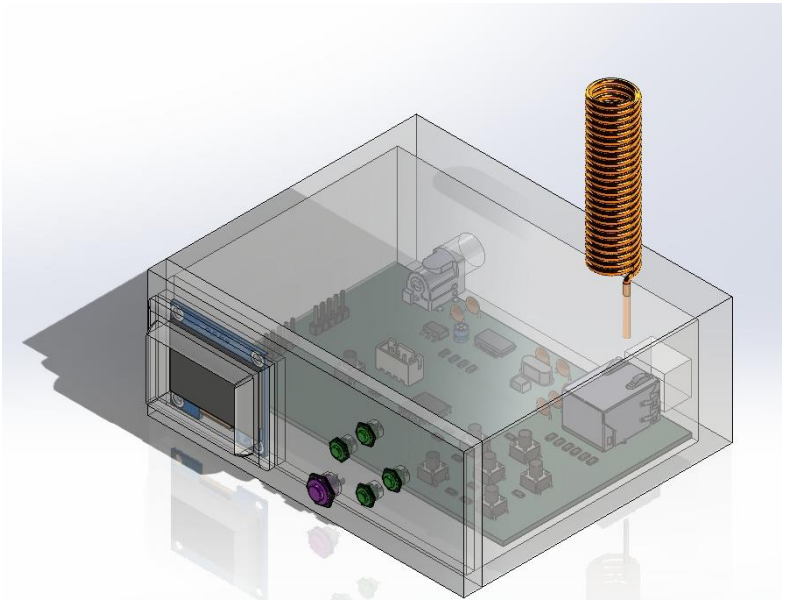
Picture 6. Shield Root lateral view



Picture 6. Shield Root PCB



Picture 7. Shield Root 3D Simulation



Picture 8. Shield Root Collector’s 3D design

IV. Conclusion

This project represents a shift towards digital transformation in agriculture. By providing farmers with data-driven tools, we lay the groundwork for a more sustainable, efficient, and climate-resilient agriculture. We expect this project to ensure food security, improve farmers' incomes, and help the agricultural population enhance their livelihoods.

We believe that it is necessary to continue researching and developing tools to combat climate change, as it is a problem that will not go away in the coming years, and we will need to be able to adapt and take action to neutralize its effects.

For more and technical information about our project please check out our GitHub repository:
https://github.com/YiyoChimal/NASA_Space_Apps_2024_Mecha_Cintli.git

Bibliography

- BASF. (2024, 30 julio). *Cambio climático y agricultura: cuál es el impacto | BASF México*. Recuperado 5 de octubre de 2024, de https://agriculture.basf.com/mx/es/contenidos-de-agricultura/cambio-climatico-y-agricultura-cual-es-el-impacto
- *Biodiversidad: nuestra defensa natural más fuerte contra el cambio climático*. (s. f.). Naciones Unidas. Recuperado 5 de octubre de 2024, de https://www.un.org/es/climatechange/science/climate-issues/biodiversity#:~:text=El%20cambio%20clim%C3%A1tico%20ha%20transformado%20los%20ecosistemas%20marinos%2C,a%20las%20primeras%20extinciones%20provocadas%20por%20el%20clima.
- Cherlinka, V. (2023, 15 diciembre). Estrés térmico en plantas: causas y síntomas. *EOS Data Analytics*. Recuperado 5 de octubre de 2024, de https://eos.com/es/blog/estres-termico-en-plantas/#:~:text=El%20estr%C3%A9s%20t%C3%A9rmico%20es%20el%20efecto%20acumulativo%20de%20la%20intensidad
- EFECTOS DEL CAMBIO CLIMÁTICO SOBRE LA AGRICULTURA. (2017). En *Naciones Unidas Cepal*. Comisión Económica para América Latina y el Caribe. Recuperado 5 de octubre de 2024, de https://repositorio.cepal.org/server/api/core/bitstreams/3db22365-b69a-4ce2-bbcb-ffbf10b2f888/content
- *El cambio climático aumentará el riesgo de propagación de plagas, que ya destruyen un 40% de la producción de cultivos*. (2021, 2 junio). Naciones Unidas. Recuperado 5 de octubre de 2024, de https://news.un.org/es/story/2021/06/1492762#:~:text=El%20cambio%20clim%C3%A1tico%20aumentar%C3%A1%20el%20riesgo%20de%20propagaci%C3%B3n,internacional%20para%20prevenir%20la%20propagaci%C3%B3n%20de%20plagas%20
- Feldman, A. J. L., & Cortés, D. H. (2016). Cambio climático y agricultura: una revisión de la literatura con énfasis en América Latina. *El Trimestre Económico*, *83*(332), 459-496. https://doi.org/10.20430/ete.v83i332.231

- Revisión científica del impacto del cambio climático en las plagas de las plantas. (2021). En *FAO en nombre de la Secretaría de la CIPF eBooks*. https://doi.org/10.4060/cb4769es
- *Scientific review of the impact of climate change on plant pests*. (2021). Organización de las Naciones Unidas Para la Alimentación y la Agricultura. Recuperado 5 de octubre de 2024, de https://openknowledge.fao.org/items/8a6aa7fd-8e86-4c95-886a-ce52f1f6d01d
- Secretaria de Agricultura y Desarrollo Rural. (2015, 26 septiembre). *El cambio climático afecta al campo ¿cómo enfrentarlo?* gob.mx. Recuperado 5 de octubre de 2024, de https://www.gob.mx/agricultura/es/articulos/el-cambio-climatico-afecta-al-campo-como-enfrentarlo