



# AI Search for Agricultural Planning and Control



## Innovation Challenge December 2024

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*Developed by:*

**Adriano Godoy**

**Danillo Silva**

**Demerson Polli**

**Rodica Vacariu**

# Summary of content

- **Project Overview:** Development of a search engine for agriculture using a Large Language Model (LLM) and Azure services.
- **Team Members:** Roles of team members in back-end and front-end development, project planning, and integration.
- **Key Features:**
  - Functional search engine utilizing LLM for processing queries.
  - Data sourced from Brazil, supporting queries in Portuguese and English.
  - Integration of various Azure services (OpenAI, Cosmos DB, Content Moderator, Speech to Text, Custom Vision).
- **Language Extensibility:** Future support for additional languages based on database capabilities.
- **CI/CD and Azure DevOps:** Status of CI/CD implementation and version control using GitHub.
- **Responsible AI:** Implementation of Azure Content Moderator and ethical standards in AI usage.
- **Innovation and Future Development:** Potential enhancements like advanced query processing, additional data sources, and report generation.
- **Research Overview:** Focus on soybean cultivation, pest management, and environmental impacts.
- **Key Findings:** Insights on pest management complexity, environmental effects on soybean growth, and soil health practices.
- **Conclusion:** Emphasis on the project's foundational role in creating a powerful search engine for agricultural insights.





## Overview

This project aims to develop a robust search engine powered by a Large Language Model (LLM).

The application integrates various Azure services to enhance user interaction and provide accurate search results based on user queries. Currently, the implementation focuses on leveraging LLM capabilities to retrieve and generate relevant information efficiently.





## Key Features

**Functional Search Engine:** The application operates as a search engine, utilizing LLM to process user queries and return relevant results from a vast database of information.

**Data Source:** The project utilizes a data source from Brazil, allowing users to ask questions exclusively in Portuguese. Responses from OpenAI can be provided in both Portuguese and English, ensuring bilingual support.

**Integration of Azure Services:** The project employs a variety of Azure services to enhance functionality, including:

**Azure OpenAI:** For generating human-like responses and understanding user queries.

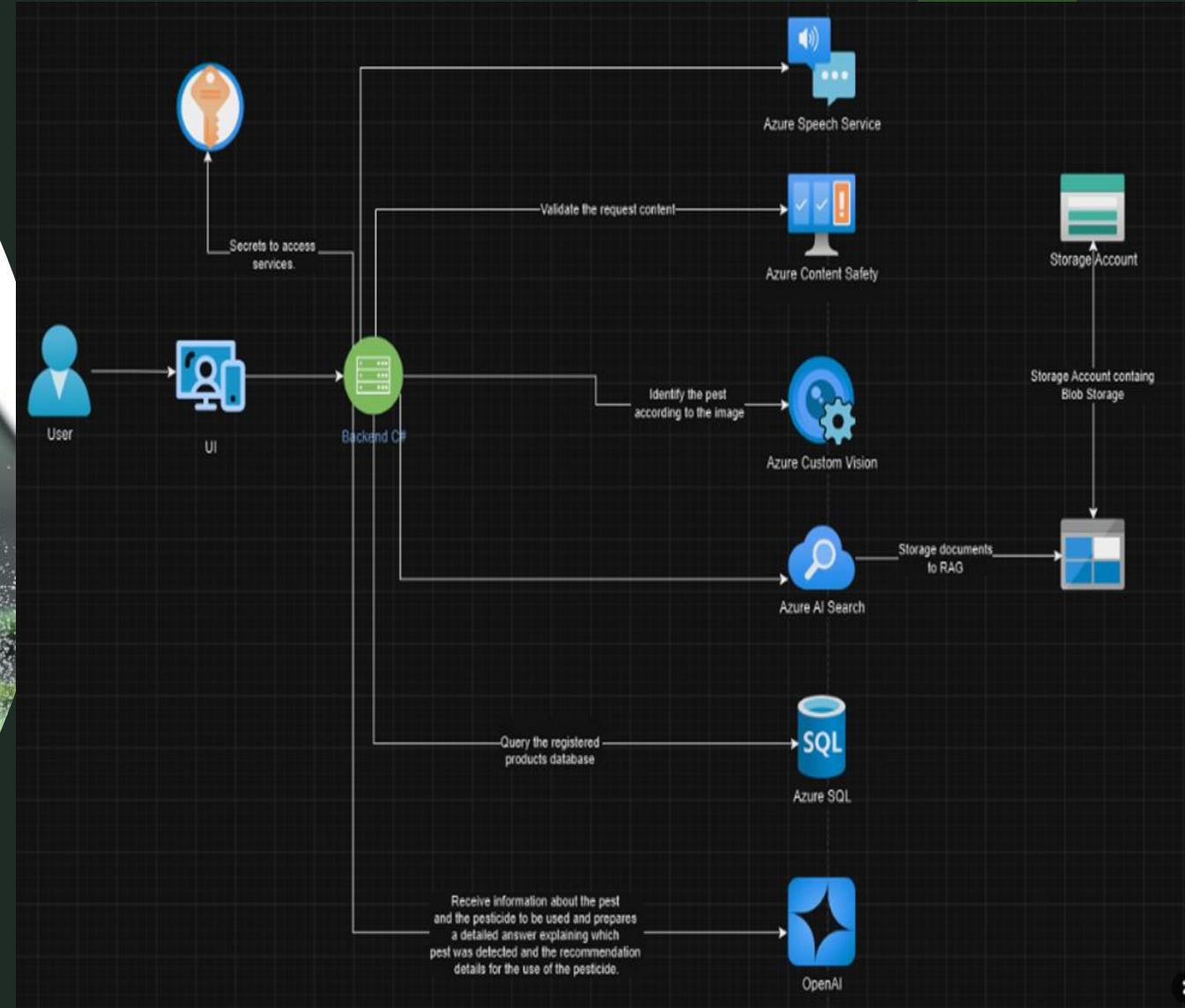
**Azure Cosmos DB:** To store and manage large datasets efficiently.

**Azure Content Moderator:** To ensure that the content returned adheres to community standards and guidelines.

**Azure Speech to Text:** To allow voice-based queries, enhancing accessibility.

**Azure Custom Vision:** For image recognition capabilities, enabling users to search using images.

## Workflow Diagram



## Language Extensibility

Future Capabilities: The project can be extended to support additional languages, including English and others, provided that appropriate data is stored in the database. This adaptability allows for broader application across different countries and linguistic demographics.

## CI/CD and Azure DevOps

Implementation Status: Due to time constraints, we did not have the opportunity to implement Continuous Integration and Continuous Deployment (CI/CD) practices or utilize Azure DevOps for this project.

Understanding of Software Lifecycle: Despite the lack of CI/CD implementation, the team possesses a solid understanding of the entire software development lifecycle. We have adhered to best practices throughout the development process.

**Version Control:** We utilized GitHub repositories for version control, ensuring effective collaboration and tracking of changes.

## Responsible AI

We emphasize responsible AI practices by implementing Azure Content Moderator on user inputs and providing disclaimers on outputs. This ensures ethical standards are maintained and potential risks associated with AI usage are mitigated.



## Innovation and Future Development:

While the current implementation serves as a functional search engine, there is significant potential for further innovation. Future enhancements could include:

**Advanced Query Processing:** Implementing more sophisticated algorithms for understanding user intent and context.

**Integration of Additional Data Sources:** Expanding the search capabilities by integrating external databases and APIs.

**Report Generation:** Developing features that allow users to generate reports based on search results, particularly in fields like agriculture, where data-driven insights are crucial.

**Validation of the use of technology in compliance with laws.**

The project was developed based on a **Strategic Agronomic Planning** program, which is informed by the research conducted by **Foundation researchers**. This program focuses on selecting the most effective inputs for optimizing crop production.

# HOW IT WORKS

## HOW?

1.



You will provide information detailed information about each plot of your crop, so that may we know yours property.



2.



The researchers will analyze the information and formulate strategies initials.

3.



Through meetings in person, we will plan together strategies, actions and inputs for crops soy, corn or integration crop-livestock.

4.



You will receive a full program with high degree of detail, indicating all the strategies and inputs for the Harvest and the Safrinha.



# Application Interface

Leveraging Technology and Data Analytics for Optimal Resource Management and Increased Crop Yield.



**AgroAssistent App**

Image URL: <https://bugwoodcloud.org/images/1536x1024/1453261.jpg>

**Registered Products**

Enter pest name: **Anticarsia gemmatalis**

**Get Registered Products**

ID	Registration Number	Commercial Brand	Class	Crop	Pest Scientific Name	Pest Common Name
276	5124	Acedemar	Insecticida	Soja	Anticarsia gemmatalis	"La
279	36618	Acefato CCAB 750 SP	Insecticida	Soja	Anticarsia gemmatalis	"La
289	26024	Acefato CCAB 950 SG	Insecticida	Soja	Anticarsia gemmatalis	"La
304	16024	Acefato Max Nortox	Insecticida	Soja	Anticarsia gemmatalis	"La
307	18907	Acefato Nortox	Insecticida	Soja	Anticarsia gemmatalis	"La
317	412	Acefato Sumitomo 750 SP	Insecticida	Soja	Anticarsia gemmatalis	"La
320	8311	Acehero	Insecticida	Soja	Anticarsia gemmatalis	"La
364	12317	Atrix 750 SP	Insecticida	Soja	Anticarsia gemmatalis	"La
404	26422	Aggresso	Acaricida/Insecticida	Soja	Anticarsia gemmatalis	"La
444	24522	Agroban	Acaricida/Insecticida	Soja	Anticarsia gemmatalis	"La

**POST /classify\_pest\_file**

**Parameters**

No parameters

**Request body**

**file** \* required  
 IMAGEM\_3\_FRU...s-as-situacoes.jpg  
 string(\$binary)

**Execute** **Clear**

**Responses**

**Curl**

```
curl -X 'POST' \
  'https://localhost:7064/classify_pest_file' \
  -H 'accept: */*' \
  -H 'Content-Type: multipart/form-data' \
  -F 'file=@IMAGEM_3_FRU...s-as-situacoes.jpg;type=image/jpeg'
```

**Request URL**

[https://localhost:7064/classify\\_pest\\_file](https://localhost:7064/classify_pest_file)

**Server response**

Code	Details
200	<b>Response body</b> <pre>{   "result": "For controlling Lagarta militar (Spodoptera sp.) on soybeans, you can follow these guidelines:\n\n- **Application Rate**: Use 150 - 200 mL/ha.\n- **Maximum Applications**: Up to 2 applications.\n- **Timing**: Inspect periodically and spray when the first larvae are observed.\n- **Treatment Conditions**: Use the higher dose in cases of high pest pressure.\n- **Application Volume**: Apply in 200 L/ha.\n- **Reapplication**: Reapply after 7 days if reinfestation occurs.\n\nMake sure to monitor your crops closely for the best results! \n\n(source: Bula_EMGOTOL_PLENO_S_1_6.02.2024.pdf)",   "observation": "The recommendation can only be made by a qualified professional. An agronomic prescription must be issued. The information is researched and the response generated by generative AI and it is necessary to verify at the source whether the information is accurate.",   "pestClassification": "Lagarta militar (Spodoptera sp.)" }</pre> <div style="float: right;"> <a href="#">Download</a> </div> <b>Response headers</b> <pre>access-control-allow-origin: * content-type: application/json; charset=utf-8 date: Fri, 28 Dec 2024 05:42:14 GMT server: Kestrel</pre>

**Responses**

Code	Description	Links
200	OK	No links

**hackaton-microsoft-agro** 1.0 OAS 3.0

<https://localhost:7044/swagger/v1/swagger.json>

## hackaton-microsoft-agro

**GET /health**

**POST /classify\_pest**

**Parameters**

Name	Description
url * required string (query)	https://th.bing.com/th/id/OIP.n_kue-moilybxrY

**Execute** **Clear**

### Responses

**Curl**

```
curl -X 'POST' \
'https://localhost:7044/classify_pest?url=https%3A%2F%2Fth.bing.com%2Fth%2Fid%2FOIP.n_kue-moilybxrY&X-C2VwHaEBK3Frk3D1X2GpIdX3DImgDetMain' \
-H 'accept: */*' \
-d ''
```

**Request URL**

```
https://localhost:7044/classify_pest?url=https%3A%2F%2Fth.bing.com%2Fth%2Fid%2FOIP.n_kue-moilybxrY&X-C2VwHaEBK3Frk3D1X2GpIdX3DImgDetMain
```

**Server response**

Code	Details				
200	<b>Response body</b> <pre>{ "result": "For controlling the soybean stink bug (<i>Eusucharus heros</i>), consider the following:\n- **Dosage**: Apply 200 mL/ha.\n- **Applications**: Maximum of 2 applications.\n- **Timing**: Inspect the crop regularly and apply treatment at the first signs of infestation when you find 2 to 4 stink bugs per sampling.\n- **Application**: If reinfestation occurs, resupply the treatment but not before a 7-day interval.\n- **Notes**: Make sure to use higher doses in cases of high pest population or favorable climatic conditions for bug development.\n\n[Source: Bula_ONGEO PLENO 5_16.02.2024_4.pdf]\n\n**Observation**: The recommendation can only be made by a qualified professional. An agronomic prescription must be issued. The information is researched and the response generated by generating AI and it is necessary to verify at the source whether the information is accurate.",\n"pestClassification": "Percevejo da soja (<i>Eusucharus heros</i>)" }</pre> <p><b>Download</b></p> <b>Response headers</b> <pre>access-control-allow-origin: * content-type: application/json; charset=utf-8 date: Fri, 29 Dec 2024 05:48:42 GMT server: Kestrel</pre> <p><b>Responses</b></p> <table border="1"><thead><tr><th>Code</th><th>Description</th></tr></thead><tbody><tr><td>200</td><td>OK</td></tr></tbody></table> <p><b>Links</b></p>	Code	Description	200	OK
Code	Description				
200	OK				

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```

The screenshot shows the Microsoft Visual Studio IDE interface. On the left, the Solution Explorer displays a project structure for 'HACKATHON-MICROSOFT-AGRO' containing files like 'api\_client.py', 'app.py', 'html\_templates.py', 'prompt\_templates.py', and 'utils.py'. The code editor window shows Python code for a 'local\_multimodal\_ai\_chat\_main\_demo' module, which includes functions for classifying images, pests, and generating recommendations. The terminal window at the bottom shows command-line output in PowerShell (PS) for running the application. The status bar indicates the application is now ready to be viewed in Streamlit.

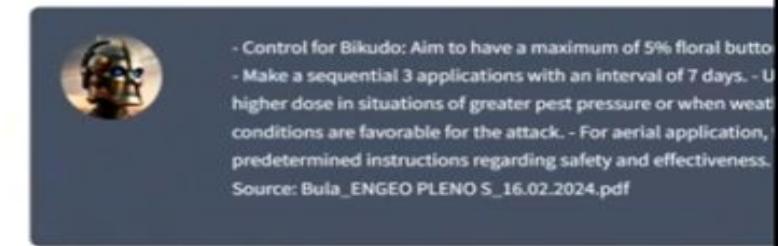
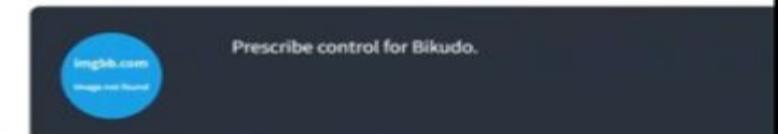
## AI Search for Agricultural Planning and Control in Brazil

Type your message here.

Text is a URL of an image

Send

Chat History:



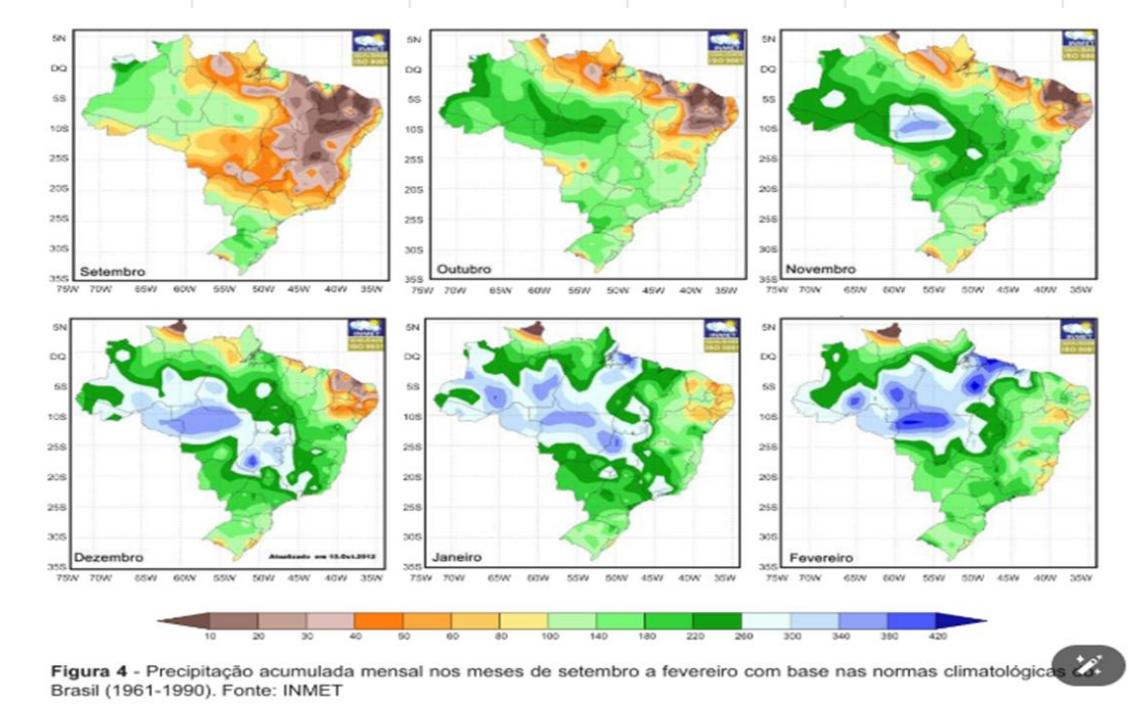
Regions exhibit significant variations in temperature, rainfall, day length, and other environmental factors, all of which influence plant behavior and crop production. Additionally, the timing of planting periods plays a crucial role in determining plant yield. Given the

vast amount of information available, there is a substantial need to compile and organize this data into a comprehensive database. **Generative AI** can facilitate this process by enhancing search capabilities.

With the abundance of productivity research published globally, AI can comprehend context and deliver more relevant search results, making it easier to access the information needed for effective agronomic planning, or effective agronomic planning or effective agronomic

**Tabela 1** - Épocas de semeaduras de cultivares de soja na Região Centro-Sul do estado de Mato Grosso do Sul.  
Fonte: Adaptado de Pitol (2015).

Cultivar	Época de Plantio - Dia/Mês																											
	Setembro				Outubro				Novembro				Dezembro															
	20	26	01	06	11	16	21	26	01	06	11	16	21	26	01	06	11	16	21	26	01	06	11	16	21	26		
5D6215-IPRO	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a	a			
ADV4317-IPRO	25	30	05	10	15	20	25	30	05	10	15	20	25	30	05	10	15	20	25	30	05	10	15	20	25	30		
AS3610-IPRO																												
AS3680-IPRO																												
AS3730-IPRO																												
Estande: Altura:	aumenta diminui				menor maior				aumenta diminui																			
	<ul style="list-style-type: none"> <li><span style="color: green;">■</span> Período preferencial = alta produtividade + competitividade</li> <li><span style="color: yellow;">■</span> Período aceitável = boa produtividade</li> <li><span style="color: blue;">■</span> Período tolerado = média produtividade/risco de estiagem e doença</li> <li><span style="color: red;">■</span> Não recomendado = baixa profundidade/baixo porte/alto riscos com doenças e estiagem</li> </ul>																											



The following table illustrates the percentage of weed control achieved with various herbicides, a trend that is also applicable to fungi and insect management. For instance, one herbicide may provide 100% control of a particular pest while only managing to control 15% of another. Conversely, another option might achieve 80% control of both pests. Additionally, varying levels of pest infestation can further complicate these dynamics. Intensive pesticide use in certain regions has led to genetic selection issues, resulting in pests developing resistance. In this scenario, only the most resilient pests survive, exacerbating the problem.

Tratamento	Dias Após a Aplicação				
	14	21	28	35	42
Testemunha	0,0 C	0,0 C	0,0 D	0,0 D	0,0 E
Boral 500 SC® (500)	89,2 A	77,6 B	51,2 C	31,6 C	20,0 D
Classic® (80)	81,4 B	76,0 B	60,0 C	39,0 C	22,4 D
Classic® (100)	94,6 A	77,6 B	71,0 B	60,0 B	41,6 C
Classic® (120)	97,0 A	79,0 B	73,0 B	60,0 B	40,0 C
Flumyzin 500® (200)	98,0 A	78,0 B	72,0 B	54,0 B	36,6 C
Pivot® (1000)	93,6 A	82,6 B	55,4 C	41,0 C	32,0 C
Imazaquim Nortox® (1000)	93,0 A	91,0 A	83,0 A	72,0 A	63,0 B
Sencor 480® (1000)	96,0 A	92,0 A	84,6 A	68,0 B	68,4 B
Sencor 480® (2000)	94,0 A	92,0 A	86,2 A	82,0 A	78,0 A
Spider® (30)	92,6 A	88,0 A	86,2 A	77,0 A	72,0 A
Spider® (42)	95,4 A	95,0 A	92,0 A	85,0 A	74,0 A
Teste F	214,14**	81,95**	96,28**	30,77**	59,54**
CV (%)	4,87	8,08	8,42	17,75	15,97

Tabela 7.1. Eficiência de alguns herbicidas\* aplicados em PPI, pré e pós-emergência, para o controle de plantas daninhas da cultura da soja em solos de Cerrado. Dados compilados da tabela da Comissão de Plantas Daninhas da Região Central do Brasil, 2003.

Nome comum Nome científico	Bentazon	Bentazon+Acifluorfen	Chlorimuron-ethyl	Clethodim	Cloransulam-methyl	Diclosulam	Dimethenamide	Fenoxaprop-p-ethyl+Clethodim	Fluazifop-p-butyl	Flumetsulam	Flumioxazin PRE	Fomesafen	Fomesafen+Fluazifop <sup>a</sup>	Haloxypf-R, éster metílico	Imazaquin <sup>b</sup>	Imazethapyr	Lactofen	Metolachlor <sup>c</sup>	Metrubuzin	Oxasulfuron	Propaquizafop	Sethoxydim	Tepraloxydin	Trifluralin			
Apaga-fogo <i>Alternathera tenella</i>	T -	S	T -	-	S -	T	S	S S	-	-	S S S	-	S	-	-	T	-	-	-	-	-	-	-	-			
Caruru <i>Amaranthus viridis</i>	T	S	S	T -	S S -	T	S -	S -	-	S -	S -	S S	-	T	-	S	-	-	-	-	-	-	-	-			
Carrapicho-rasteiro <i>Acanthospermum australe</i>	M	M	S	T	S S M -	T	S -	M M -	S	S M T	M -	-	T	-	T	-	T	-	T	-	-	-	-	-			
Mentrasto <i>Ageratum conyzoides</i>	S	S	S	T -	S S -	T	S	S S S	-	S M S -	S S	-	T	-	T	-	T	-	T	-	-	-	-	-			
Picão-preto <i>Bidens pilosa</i>	S	S	S	T	S S M -	T	S -	S S -	S	S S S S S S	-	T	-	T	-	T	-	T	-	-	-	-	-	-			
Falsa-serralha <i>Emilia sonchifolia</i>	M -	S	T -	-	-	-	-	S -	-	M M S -	M -	-	T	-	T	-	-	-	-	-	-	-	-	-			
Erva-de-touro <i>Tridax procumbens</i>	S	S	S	T	S S -	-	T	S	S S S	-	M -	S -	-	-	T	-	-	-	-	-	-	-	-	-			
Trapoeira <i>Commelina benghalensis</i>	S	S	S	T	M M S -	-	-	M M -	M S S S M -	-	T	-	T	-	T	-	T	-	T	-	-	-	-	-			
Cordas-de-viola <i>Ipomoea grandifolia</i>	S	S	S	T	S S T -	-	T	M -	S S -	M S M -	M -	-	T	-	T	-	T	-	T	-	-	-	-	-	-		
Erva-de-santa-luzia <i>Chamaesyce hirta</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Leiteiro <i>Euphorbia heterophylla</i>	T	S -	T	M M T -	M M -	S S -	S <sup>1</sup>	S -	-	T	-	-	T	-	T	-	T	-	T	-	-	-	-	-	-		
Desmodium <i>Desmodium tortuosum</i>	T -	S	T	M M T -	-	-	S T -	-	T	T	T	S S S -	T	-	T	-	T	-	T	-	-	-	-	-	-		
Fedegoso <i>Senna obtusifolia</i>	T -	S <sup>2</sup>	T	T T M -	T S -	T -	-	T	-	-	-	-	-	T	-	T	-	T	-	T	-	-	-	-	-		
Cheirosa <i>Hypoxis suaveolens</i>	T	S	S <sup>3</sup>	T -	-	S -	T	S	S S S	-	M S S -	M S -	T	-	T	-	T	-	T	-	-	-	-	-	-		
Guanxuma <i>Sida rhombifolia</i>	S	S -	T	S S T -	T S -	-	-	S S -	S S -	S S -	-	T	-	T	-	T	-	T	-	T	-	-	-	-	-		
Beldroega <i>Portulaca oleracea</i>	S -	S	T -	-	S -	T -	-	S -	-	S S S -	S -	-	T	-	M	-	T	-	M	-	-	-	-	-	-	-	
Poia-branca <i>Richardia brasiliensis</i>	-	-	M	T -	-	-	-	T S -	M S -	S M -	-	S M -	-	T	-	T	-	T	-	-	-	-	-	-	-	-	
Erva-quente <i>Spermacoce latifolia</i>	-	-	-	-	-	-	-	S -	-	-	-	S -	-	-	-	S	-	-	-	-	-	-	-	-	-	-	-
Joá-de-capote <i>Nicandra physaloides</i>	S	S	M <sup>2</sup>	T -	-	S -	T T	S S S	-	M S -	-	S	-	S	-	T	-	T	-	T	-	-	-	-	-	-	
Maria pretinha <i>Solanum americanum</i>	-	-	T	T -	-	-	T -	-	-	-	S S S S T -	-	T	-	T	-	T	-	T	-	-	-	-	-	-	-	-

## AI Search for Agricultural Planning and Control

Image URL:  
<https://inaturalist-open-data.s3.amazonaws.com/photos/57930130/large.jpeg>



Classification:

```

    {
      "result": [
        "- For controlling **Percevejo da soja (Euschistus heros)**, use:
          - **Dosage**: 200 mL/ha
          - **Number of Applications**: Maximum of 2 applications
          - **Timing**: Inspect the crop periodically and apply when 2 to 4 bugs are found per sampling.
          - **Reapplication**: If reinfestation occurs, reapply but not before 7 days.

        (Source: Bula_ENGEOL PLENO S_16.02.2024.pdf)
        "observation":
          "The recommendation can only be made by a qualified professional. An agronomic prescription must be issued. The information is researched and the response generated by generative AI and it is necessary to verify at the source whether the information is accurate."
        "pestClassification": "Percevejo da soja (Euschistus heros)"
      ]
    }
  
```

## Registered Products

Enter pest name:



# Management and Soil Fertility for the Crop

## Military

<sup>1</sup>Douglas de Castilho Gitti  
<sup>2</sup>Renato Roscoe  
<sup>3</sup>Lucas de Almeida Rised

### Introduction

Proper soil fertility management is an essential condition for the success of soybean crops. Diagnosing the soil's ability to supply nutrients to plants and planning appropriate fertilizer management strategies are important challenges for achieving high productivity and profitability.

Soybean is the most important crop in terms of planted area and profitability for rural producers in Mato Grosso do Sul. Planted on around two million hectares in the state, it is the main crop for most production systems, including integrated ones.

Fertilizer costs make up the largest portion of soybean production costs, representing 25% of the total cost or 36% of the crop cost (Richetti, 2012). In addition to their high cost share, fertilizers are production factors with a strong influence on productivity. Therefore, their correct use

can mean the difference between profit or loss.

The proper use of fertilizers involves what has been called "4C Management", which seeks to define the right source, in the right dose, applied at the right time and in the right location (Casarin & Stipp, 2009). These are the foundations of Good Practices for the Efficient Use of Fertilizers (BPUFs), which aim to provide adequate conditions for the balanced supply of nutrients to crops, while minimizing losses (Casarin & Stipp, 2013).

The first challenge is to properly diagnose nutrient deficiencies or excesses, which is done through soil and leaf analysis, assessments of nutrient balances (inputs and outputs), sensors to assess leaf color or chlorophyll levels, or even visual diagnosis of deficiency symptoms. Once the diagnosis is made,

The application encompasses various tasks related to agricultural planning in compliance with Brazilian regulations. Currently, it is developed using Python and C#, integrating an AI language model to assist farmers in creating effective agricultural plans and managing their crops

A comprehensive database will be established to store Brazilian regulations, dosage limits, and restrictions on pesticide use, which will serve as a resource for the AI language model. This model will be enriched with data tables containing information on seeds, fungicides, herbicides, pesticide efficacy, and soil fertility recommendations derived from both historical documentation and recent reports across different regions.

Additionally, the application features a computer vision model capable of identifying insect infestations and diseases through image analysis. This information is utilized by the language model to recommend effective pesticides that comply with Brazilian standards for pest control.

Furthermore, all searches will provide sources for verification and include warnings regarding the limitations of AI, ensuring users are well-informed.

In 2024, Brazil's agribusiness GDP is projected to reach R\$2.50 trillion (approximately \$415 billion), with R\$1.74 trillion (around \$290 billion) attributed to the agricultural sector and R\$759.82 billion from the livestock sector. According to the Brazilian Confederation of Agriculture and Livestock (CNA), agribusiness is expected to account for 21.8% of Brazil's GDP in 2024. This significant contribution underscores the vital role of agribusiness in the Brazilian economy, presenting a valuable opportunity for research and the development of applications aimed at enhancing productivity

## Assignments

Feature	When users	It should	So that
AI language chat to ask for information on agricultural planning.	Ask a question, the application may interpret this information to identify what the crop is, what kind of infestation there is in this crop and what is the planted area.	The application must return complete information for crop planning. Estimates of fertilizer consumption, agricultural pesticides, crop rotation, seeds appropriate for the region and propose the use of more efficient production technologies.	The application searches a SQL database and a vector database for information and restrictions of local legislation for suggestions. A report is presented in a front-end interface with all suggestions, restrictions and the sources consulted.
Identification of what kind of infestation the crop is suffering based on images of the plants leaves or of the insects that attacked the crop.	Uploads an image of a plant or of an insect.	Identify what type of disease or insect in the image can cause damage to the plant. Quantify through object detection the number of affected plants or number of pests per area to facilitate agronomic recommendations.	The application will identify what infestation the crop is suffering and limit the scope for the search of information. This operation is done by prompt engineering techniques.
Identification of pesticide efficiency based on research report.	Upload and PDF file with the research report.	Identify tables with efficiency data.	The application uses RAG (Retrieved-Augmented Generation) techniques to feed the language model with information about pesticide efficiency.
Identification of more productive seeds according to geographic location and publication of trial results for new cultivars.	Upload a PDF file with the historical documents about pesticides.	Identify productivity, disease resistance, best planting calendar, etc.	The application uses RAG (Retrieved-Augmented Generation) techniques to feed the language model with information about the cultivars.

# Conclusion

This project represents a foundational step towards creating a powerful search engine that leverages the capabilities of LLMs and Azure services. By focusing on responsible AI practices and exploring innovative features, we aim to provide users with valuable insights and enhance their search experience. Additionally, the extensibility of the project ensures that it can adapt to different languages and regions, broadening its impact and usability.

## Goals

High priority	Medium priority	Low priority
Train an Azure AI Vision model to identify the kinds of insects that may infest the crops.	Train an Azure AI Vision model to identify healthy and ill species in the crop.	Insert more images in the Azure Vision training dataset on kinds of insects.
Implement an Azure Document Intelligence model to collect data on research reports.	Implement an Azure Document Intelligence model to collect data on historical documents.	Insert more images in the Azure Vision training dataset on healthy and ill species.
Implement a language model to answer questions about agricultural planning based on information of crops, infestations, etc. given by the user.	Implement prompt engineering to limit the scope of the model based on images loaded and classified by the application.	
Include a RAG to the language model to incorporate information from recent research on pesticide efficiency.	Include a RAG to the language model to incorporate information from historical documents on pesticide efficiency.	
Implement a front-end interface for the application and improve the backend.		

## Research Overview

1. The theme of this literature review focuses on soybean cultivation, particularly in the context of agricultural practices, pest management, and the impact of environmental factors. The purpose is to synthesize existing research to understand the challenges and advancements in soybean production. This is significant as soybean is a major crop globally, contributing to food security and economic stability.

### Literature Analysis

- Theoretical Framework: This research is grounded in agroecology and integrated pest management. These frameworks emphasize sustainable agricultural practices that balance productivity with environmental health.

### Key Findings:

- Pest Management: The literature highlights the increasing complexity of pest management in soybean crops due to the emergence of herbicide-resistant weeds. Studies indicate that effective management requires a combination of cultural practices and herbicide applications.
- Environmental Impact: Research shows that climatic conditions significantly affect soybean growth phases. Optimal sowing times are crucial for maximizing yield and minimizing pest outbreaks.
- Soil Health: The importance of soil management practices, including the use of cover crops and crop rotation, is emphasized to enhance soil fertility and reduce pest pressures.
- Methodological Evaluation: Most studies utilize experimental designs with controlled variables to assess the effectiveness of various treatments. While these methods provide robust data, they often lack long-term ecological assessments, which are crucial for understanding sustainable practices.

### Research Gaps and Future Directions

- Research Gaps: There is a notable gap in longitudinal studies that examine the long-term effects of integrated pest management strategies on soybean yield and soil health. Additionally, the impact of climate change on pest dynamics in soybean production remains underexplored.
- Future Research Recommendations: Future research should focus on developing adaptive management strategies that consider climate variability. Incorporating farmer participatory approaches could enhance the relevance and applicability of findings.