SMART LAND

"Your Digital Agricultural Assistant"

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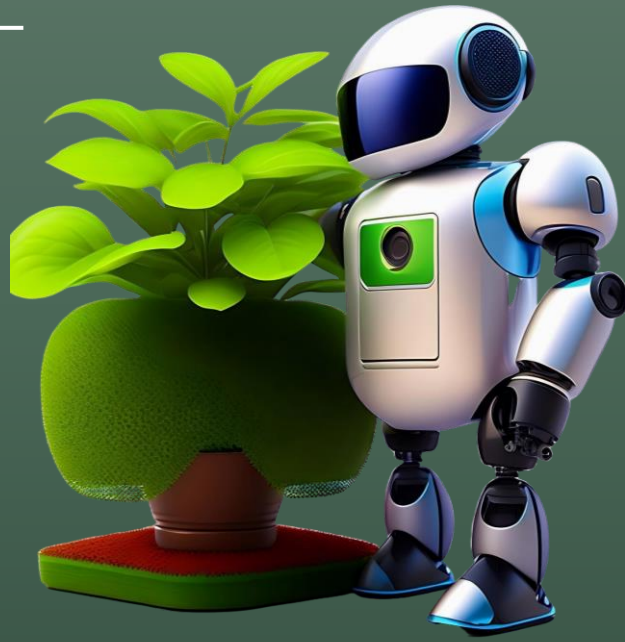


INTRODUCTION

Smart land

mobile app designed to assist farmers and agricultural engineers.
It uses artificial intelligence to simplify agricultural decision-making and provide accurate, accessible information.

Why?

- Provide instant farming support through an AI chatbot.
- Check soil fertility and offer smart agricultural advice.
- Make expert knowledge easily accessible via a simple mobile app.
- Reduce reliance on traditional help and improve decision-making.

Problem and Solution

Problem

Many farmers, especially in rural areas, lack access to reliable agricultural advice. Decisions about soil, fertilizers, and crops are often made without expert guidance, reducing productivity.

Why it matter

Agriculture is vital to our economy. Empowering farmers improves crop yield and sustainability. There's a gap between traditional farming and smart technology—Smart Land bridges that gap

Solution

- Offers a bilingual agricultural chatbot (Arabic & English)
- Provides a soil fertility analyzer using ML
- Delivers a simple, offline-friendly interface
- Includes a central knowledge base tailored for farmers

OUR GOALS

Soil Fertility Analysis

Use machine learning to check soil values (e.g., nitrogen, phosphorus, pH) and predict fertility level.

Better Decisions

Share educational content and best practices to help users farm smarter.

Accessible Knowledge

Provide agricultural help to farmers in remote areas who can’t easily reach experts.

Reduce Dependency

Help users rely less on traditional agricultural extension services by offering smart, personal support.

Easy Mobile Use

Ensure the app is user-friendly and includes a searchable knowledge base of crops,
fertilizers, and pesticides.

AI Chatbot Support

Build a chatbot that answers questions in Arabic and English about soil, crops, fertilizers, and irrigation.

Technologies

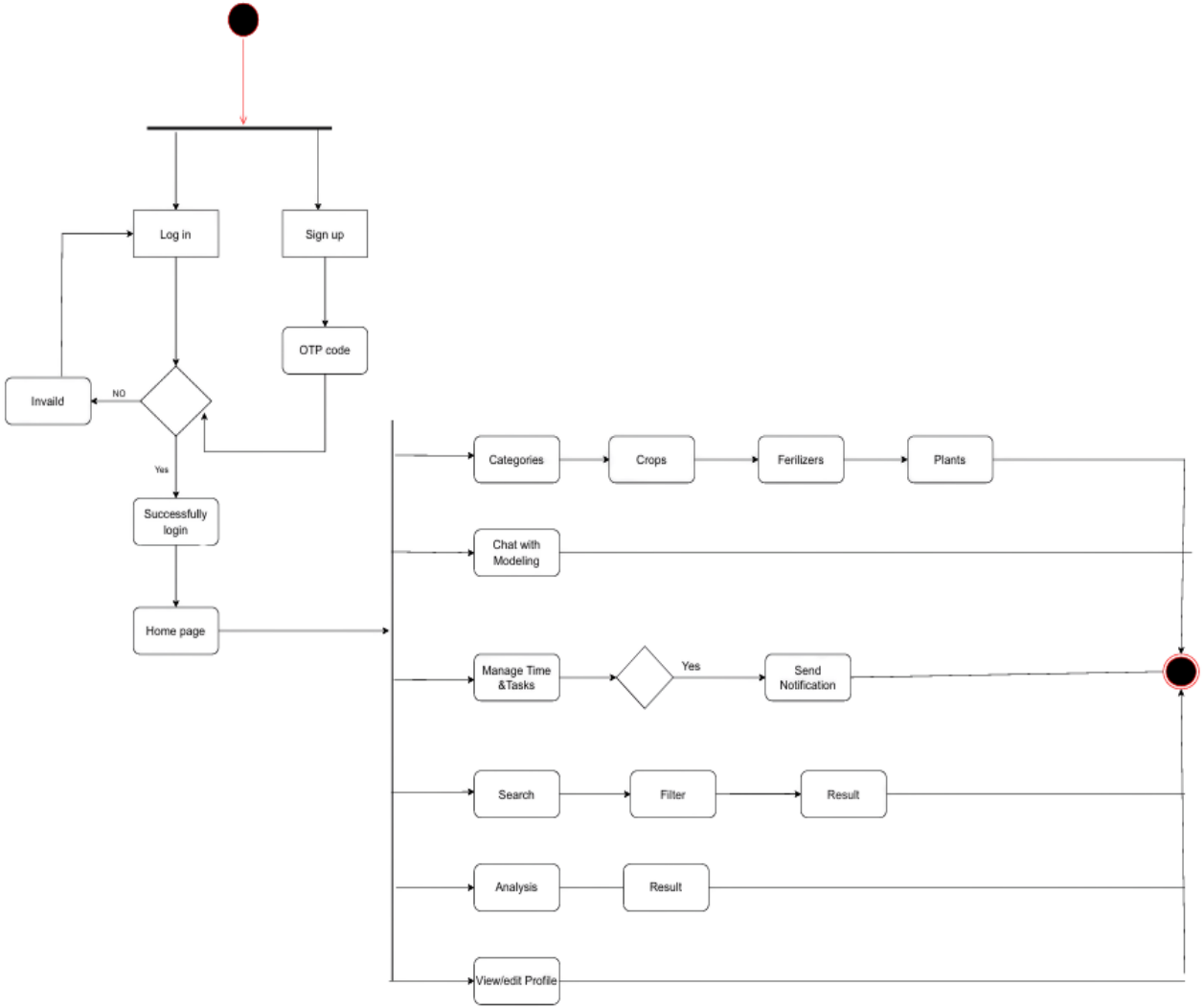
Frontend:
Flutter (Dart)
Responsive Mobile UI

Backend:
ASP.NET Core
FastAPI (Python)

Database:
SQL Server
Entity Framework (ORM)

AI Integration:
LLAMA 3 (Meta)
LoRA Configration
Gradio Interface

Others:
Figma (UI Design)
Ngrok (API Tunneling)
Postman (API Testing)



Activity Diagram

User Functionality

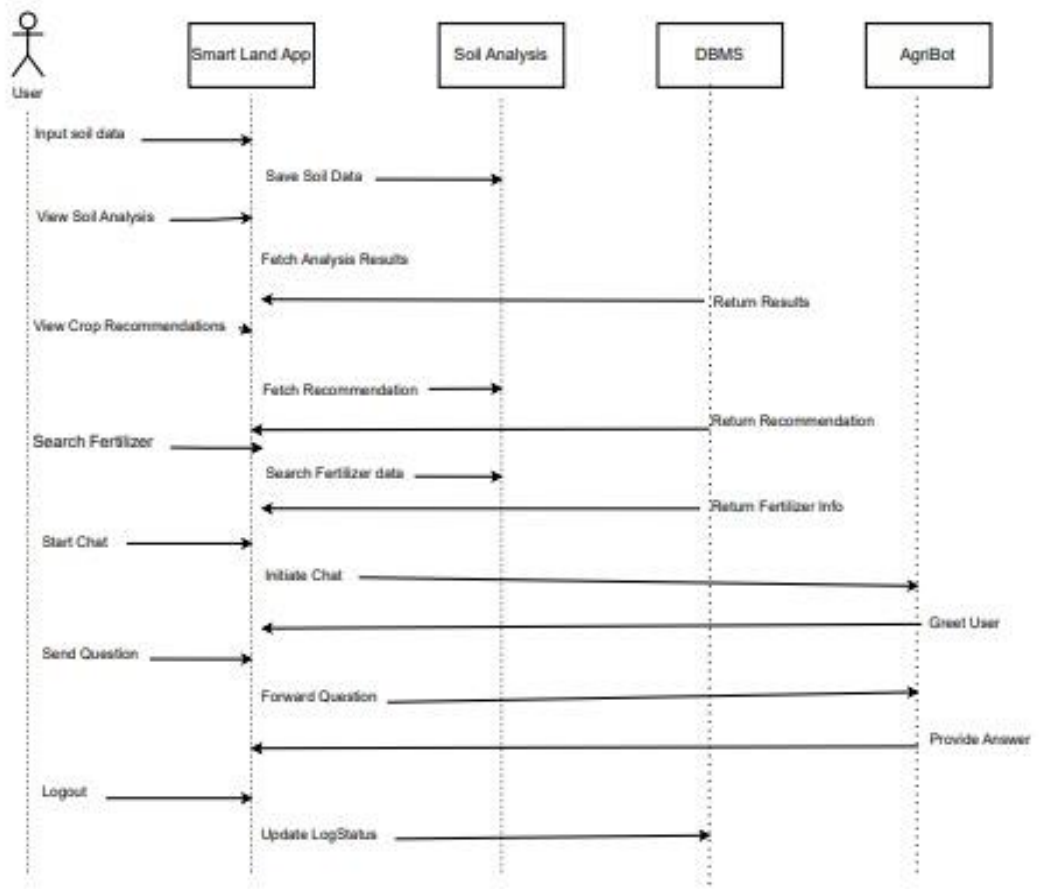
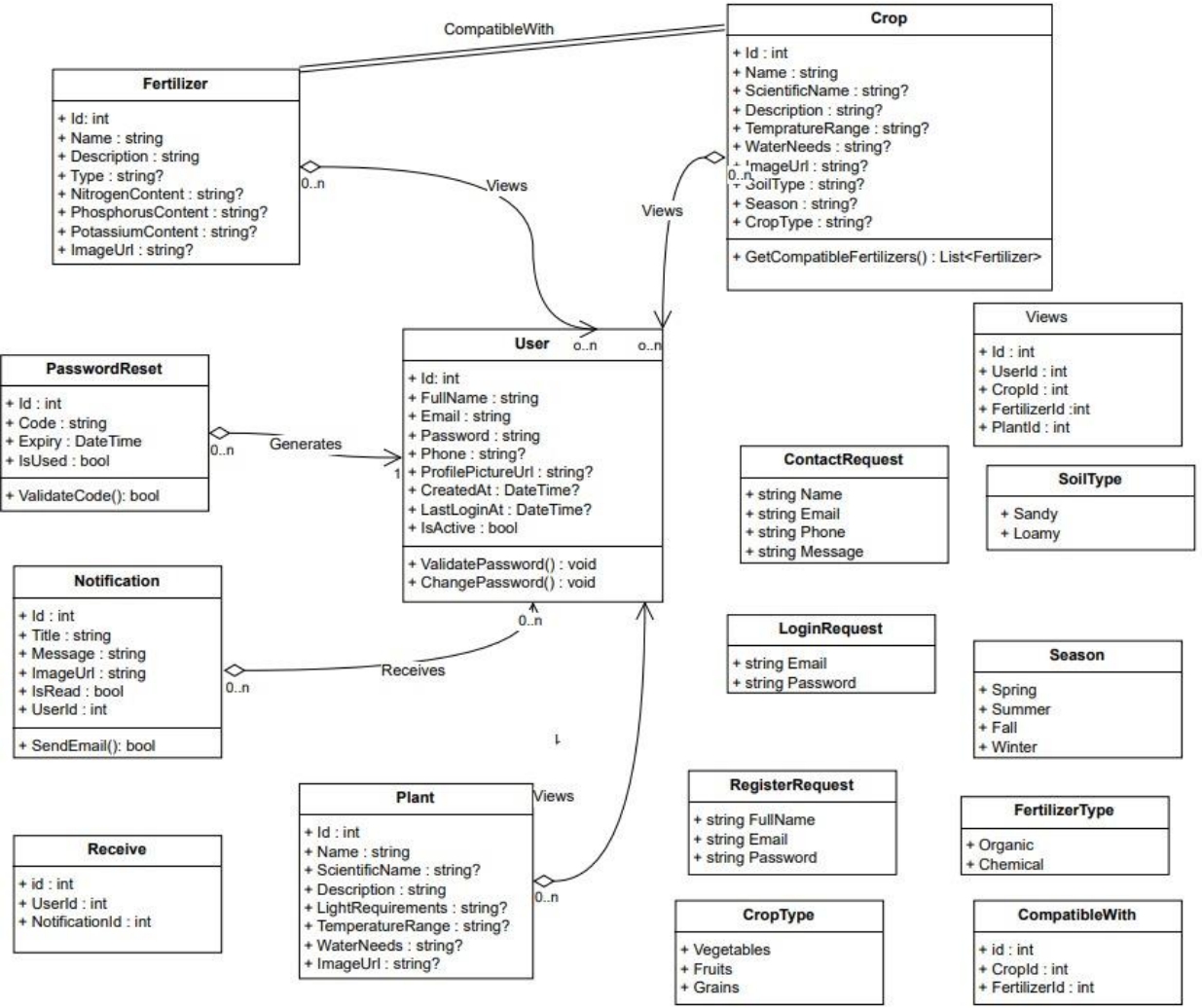


Figure 3.4 – User Functionality



Class Diagram

Backend

- Developed using C# and ASP.NET Core Web API.
- Provides RESTful APIs for:
  - User management
  - Agricultural data processing
  - System interaction
- Follows a modular, clean architecture with database-mapped models.
- Designed for future scalability (AI, analytics, 3rd-party APIs).
- Main Features:
  - Secure user authentication & authorization
  - Password reset functionality
  - Gmail OTP verification
  - Notification management

End Point

Auth

POST	/api/Auth/register
POST	/api/Auth/login
POST	/api/Auth/forgot-password
POST	/api/Auth/verify-code
POST	/api/Auth/reset-password
GET	/api/Auth/profile
POST	/api/Auth/upload-profile-image
PUT	/api/Auth/update-profile

Notifications

GET	/api/Notifications

Plants

GET	/api/Plants
GET	/api/Plants/{id}

Search

GET	/api/Search
GET	/api/Search/filter

CombinedEntities

GET	/api/CombinedEntities

Contact

POST	/api/Contact

Crops

GET	/api/Crops
GET	/api/Crops/{id}

Fertilizers

GET	/api/Fertilizers

Soil Fertility Classification

- **Data Source:** Collected from FAO (Food and Agriculture Organization).
- **Data Structure:** Each row = one soil sample, columns = chemical features.
- **Input Features:**
  - **Macro Elements:** N, P, K
  - **Soil Chemistry:** pH, EC, OC, S
  - **Micronutrients:** Zn, Fe, Cu, Mn, B

- **Algorithm Used:** Random Forest
  - Chosen for **high accuracy** and resistance to **overfitting**
  - Combines multiple decision trees for better generalization
- **Model Accuracy:**
  - Achieved **95% accuracy** on test data
  - Evaluated using **Accuracy** and **Confusion Matrix**
  - Effectively classifies soil as **high fertile or middle fertile low fertile** , making it suitable for real-world use

Argi-ChatBot

Llama-3.1-8B-Instruct

- LLAMA 3 is an open-source AI model from Meta, trained on conversations to understand and respond like a human.
- We used the lightweight Instruct-8B version to build a smart agricultural assistant that answers farmers' questions intelligently.

Argi-ChatBot

Data Gathering & Preprocess

Quantization of Model

LORA Configurations

Model Training

Testing

Model Loss

Model Deployment

Argi-ChatBot

Data Processing

The Llama3 Instruct requires the data to be in a suitable format for training and inference before the usage of the model

```
<|begin_of_text|><|start_header_id|>user<|end_header_id|>

Hello!<|eot_id|><|start_header_id|>assistant<|end_header_id|>
```

Quantization of Model

the LLAMA 3 model was quantized using the bitsandbytes library. Quantization significantly reduces memory usage and computational load by converting model weights to 4-bit precision, allowing the model to fit within the limited resources available

Argi-ChatBot

LORA Adapters:

LORA is Parameter Efficient Fine tuning technique which adds layers to the frozen model original layers thus indicating which layers should be focused on and retrained for the specific case , this way fine tuning Pre_trained LLMs is working better

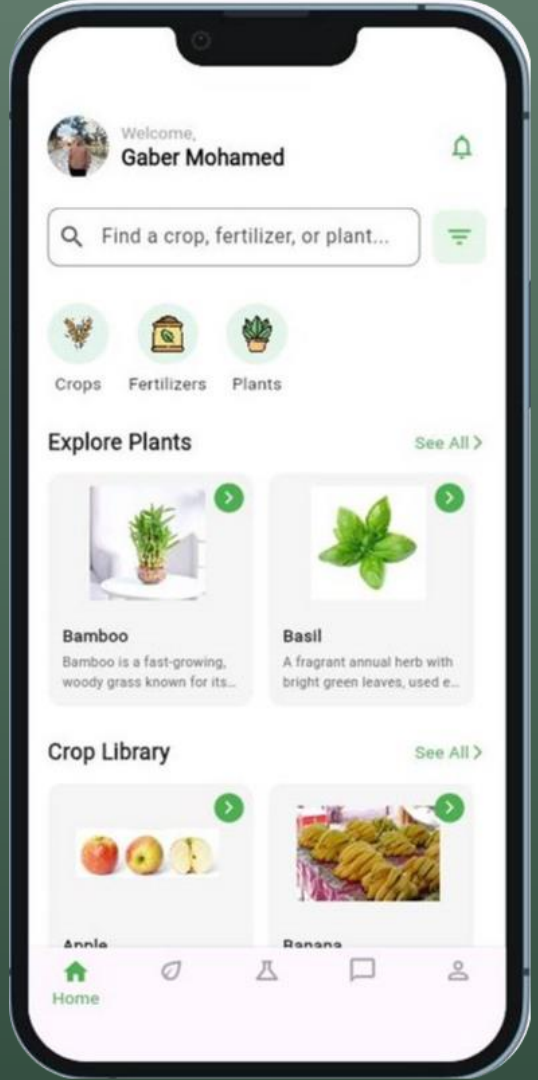
100	2.146000
110	1.736800
120	1.364900

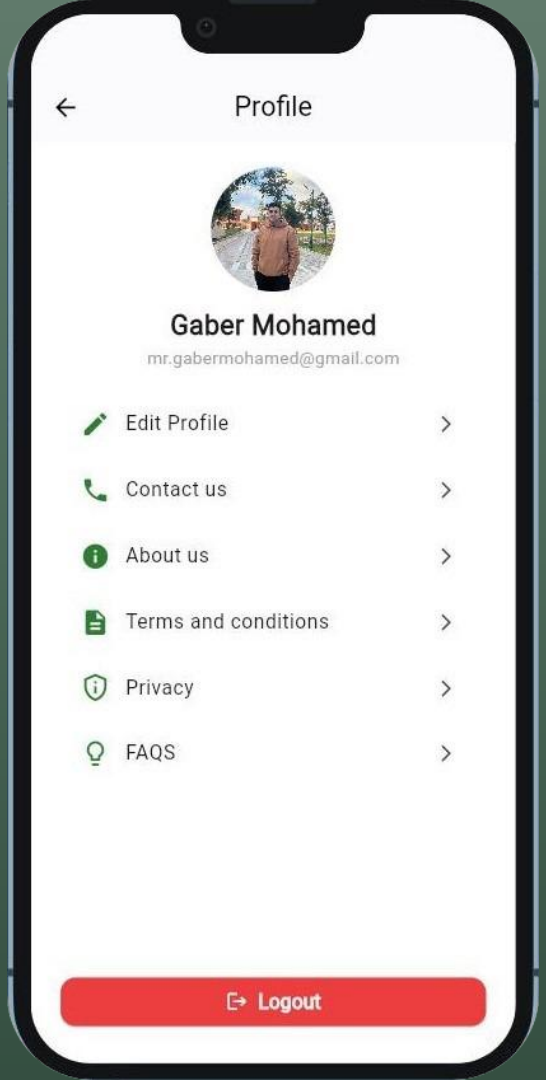
Model Training :

The Model was trained for 2 epochs (considering the RAM of the hardware and) using PyTorch framework and SFT Trainer , obtaining a loss of 1.7 , learning rate = 1e-5,
batch size =4

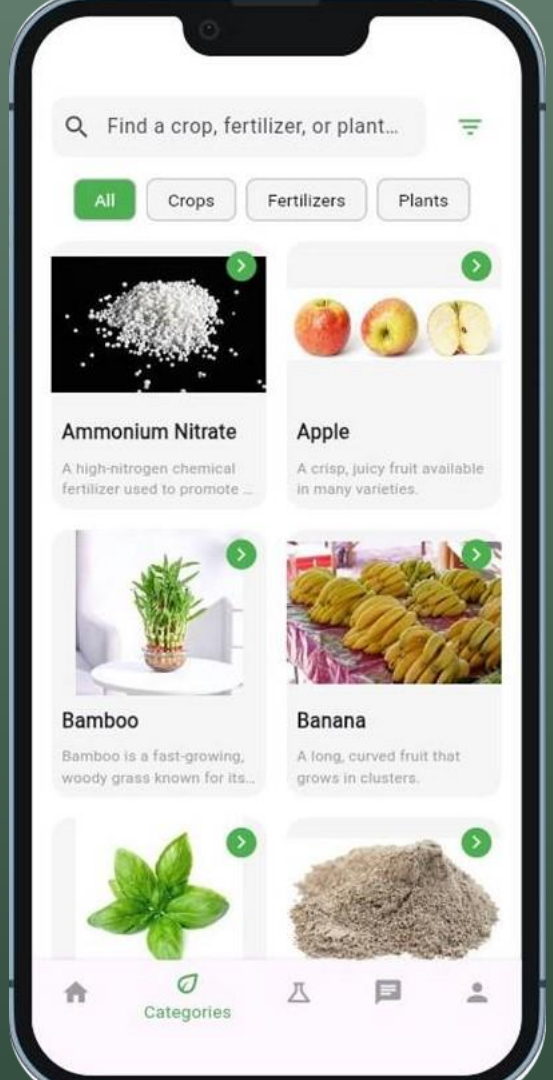
Home

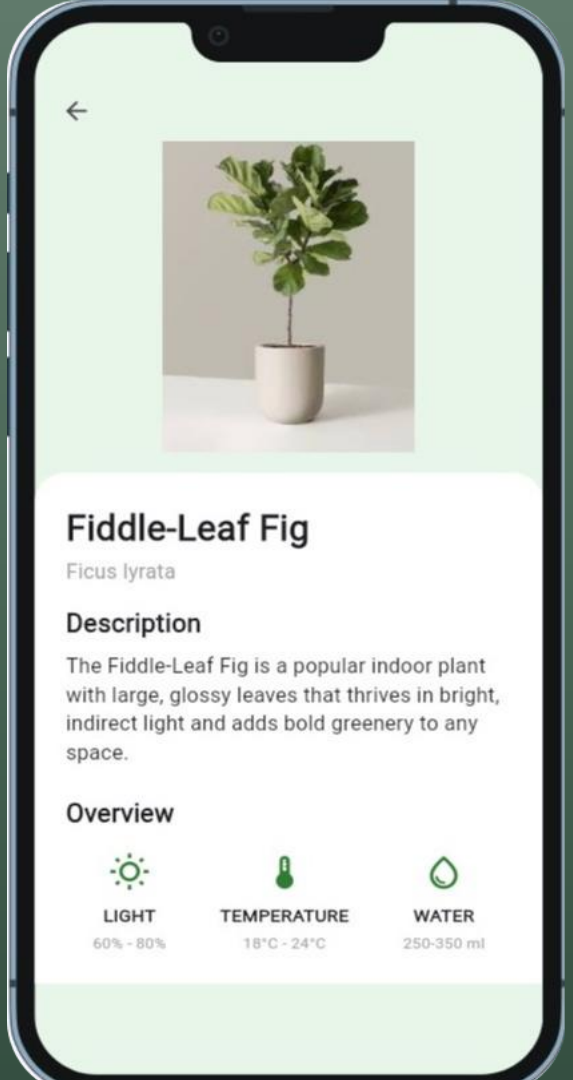
Profile



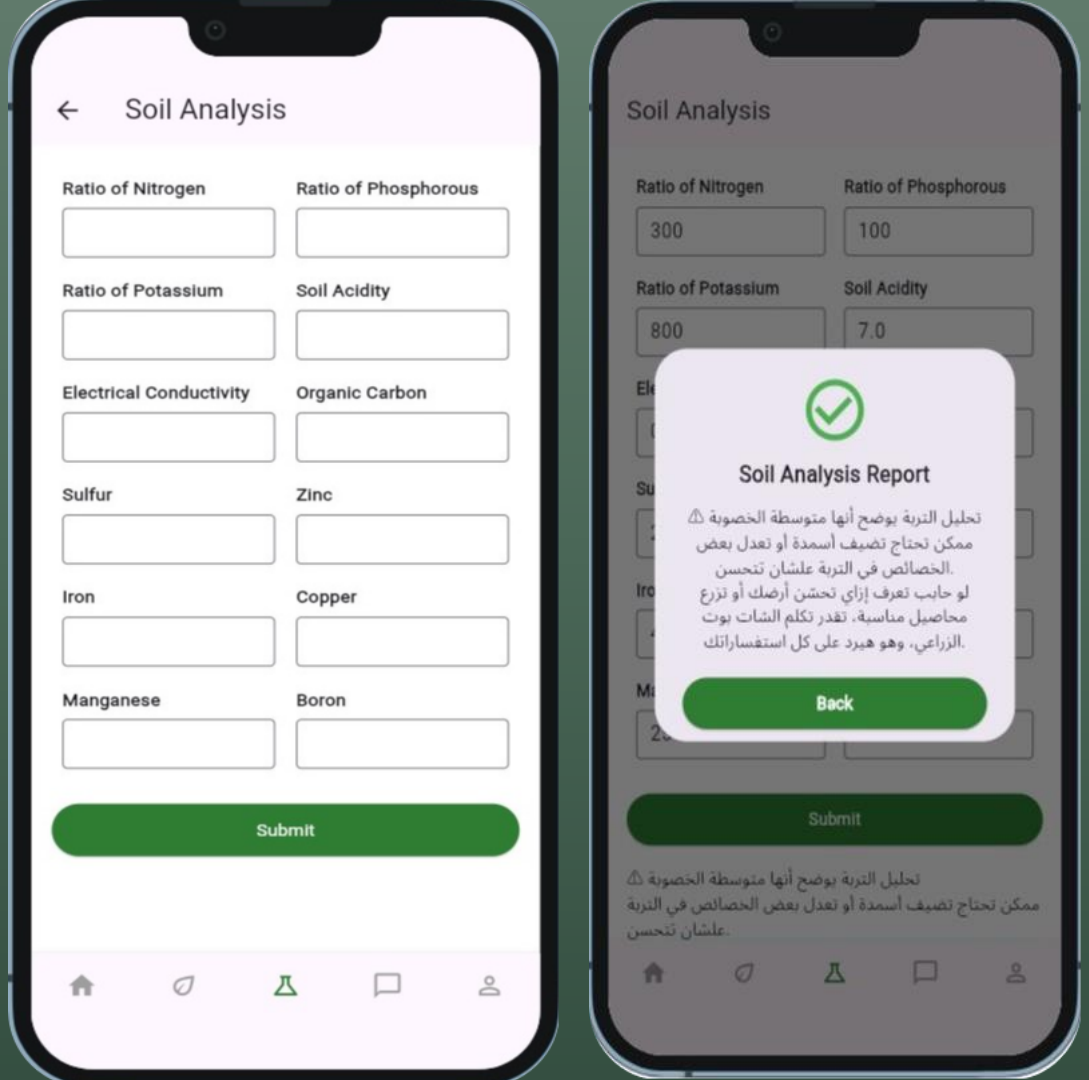


Categories


Find a crop, fertilizer, or plant...
All
Crops
Fertilizers
Plants
Ammonium Nitrate
A high-nitrogen chemical fertilizer used to promote ...
Apple
A crisp, juicy fruit available in many varieties.
Bamboo
Bamboo is a fast-growing, woody grass known for its...
Banana
A long, curved fruit that grows in clusters.
Categories


Fiddle-Leaf Fig
Ficus lyrata
Description
The Fiddle-Leaf Fig is a popular indoor plant with large, glossy leaves that thrives in bright, indirect light and adds bold greenery to any space.
Overview
LIGHT
60% - 80%
TEMPERATURE
18°C - 24°C
WATER
250-350 ml

Soil Analyzer screens



Chat Bot Screen

Conclusion

- This project presents a smart agricultural assistant using a fine-tuned LLaMA 3 model to offer real-time, bilingual support.
- It improves decision-making by combining AI-driven chatbot advice with soil analysis tools, making expert guidance accessible to farmers.

Future work

- focus on enhancing accessibility through voice support, offline functionality, and multilingual capabilities.
- It also aims to expand data coverage, improve security, and integrate with agricultural databases while adding features like analytics and gamification.