MAKERERE UNIVERSITY

COLLEGE OF COMPUTING AND INFORMATION SCIENCES

DEPARTMENT OF NETWORKS

User Manual for Smart Cloud-Based Soil Advisor

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User Manual (User Interface and Operations)

About This Manual

This manual serves as a comprehensive guide for using the Smart Cloud-Based Soil Advisor system. It is designed for farmers, agricultural extension officers, and system administrators who intend to use the system for monitoring soil health and receiving tailored crop recommendations.

It outlines the hardware setup, system architecture, connectivity, dashboard usage, maintenance guidelines, and troubleshooting steps. This manual covers everything from powering the sensors to navigating the web interface and interpreting data.

Project GitHub Repository: https://github.com/HarrisonMoses/BSE25-28-CBSA

Blog Link: https://fyp-blog.onrender.com/

Thingspeak API: https://api.thingspeak.com/channels/2912443/feeds.json?api_key=7SEG1UOO84U6C6QF

1. Getting Started

1.1 Sign in to Your Account

To access the platform:

- Open the application and navigate to the **Sign in** page.
- Enter your **Username** and **Password**.
- Optionally, check the **Remember me** box to save your login details.
- Click the green **SIGN IN** button.
- If you forget your password, click **Forget password?** to reset it.

- New user? Click Sign up to create an account.

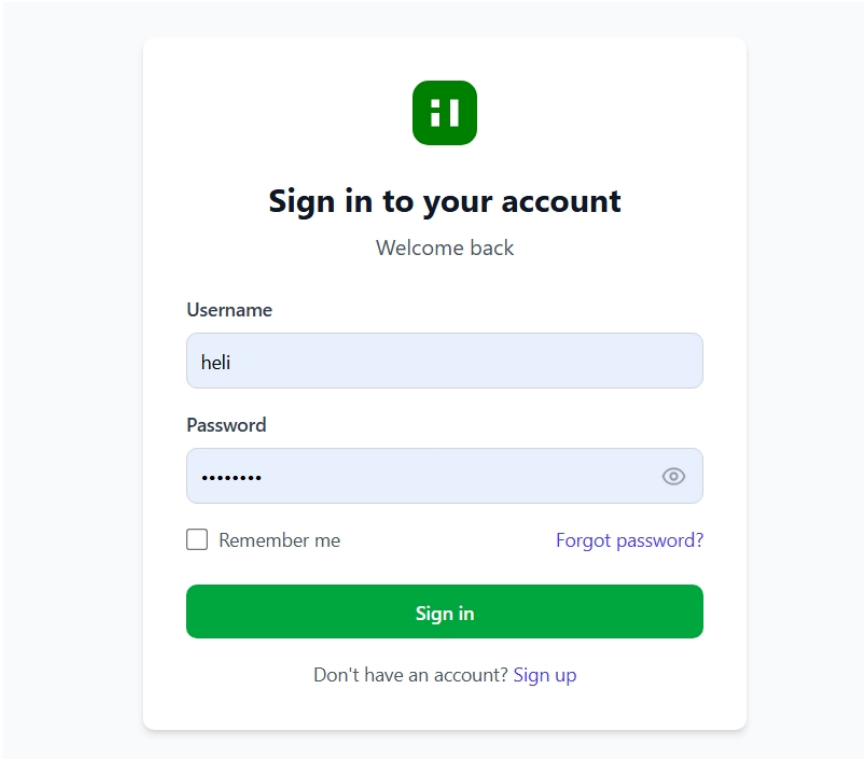

Figure 0.1: Sign In Screen

1.2 Create a New Account

To create an account:

- Navigate to the **Create Your Account** page.
- Fill in the following fields:
    - **Username**: Choose a unique username (e.g., @eric123).
    - **Email Address**: Enter your email.
    - **Phone Number**: Provide your contact number.
    - **Password**: Create a secure password.
    - **Confirm Password**: Re-enter your password to confirm.
- Click the green **CREATE ACCOUNT** button.
- Already have an account? Click **LOGIN** to sign in.

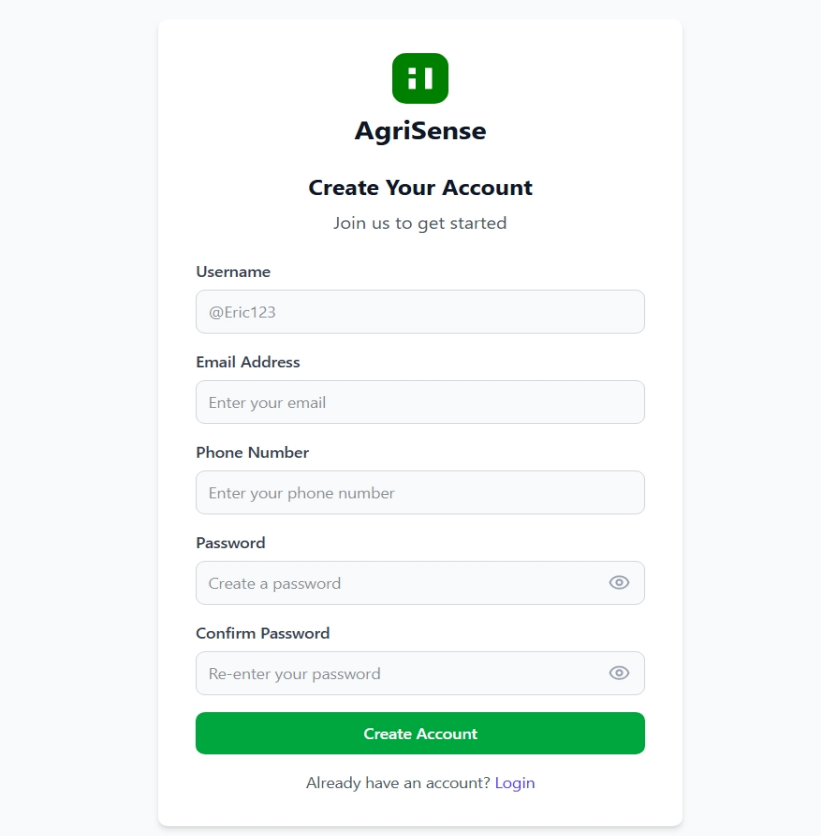

Figure 0.2: Register Screen

2. Managing Farms

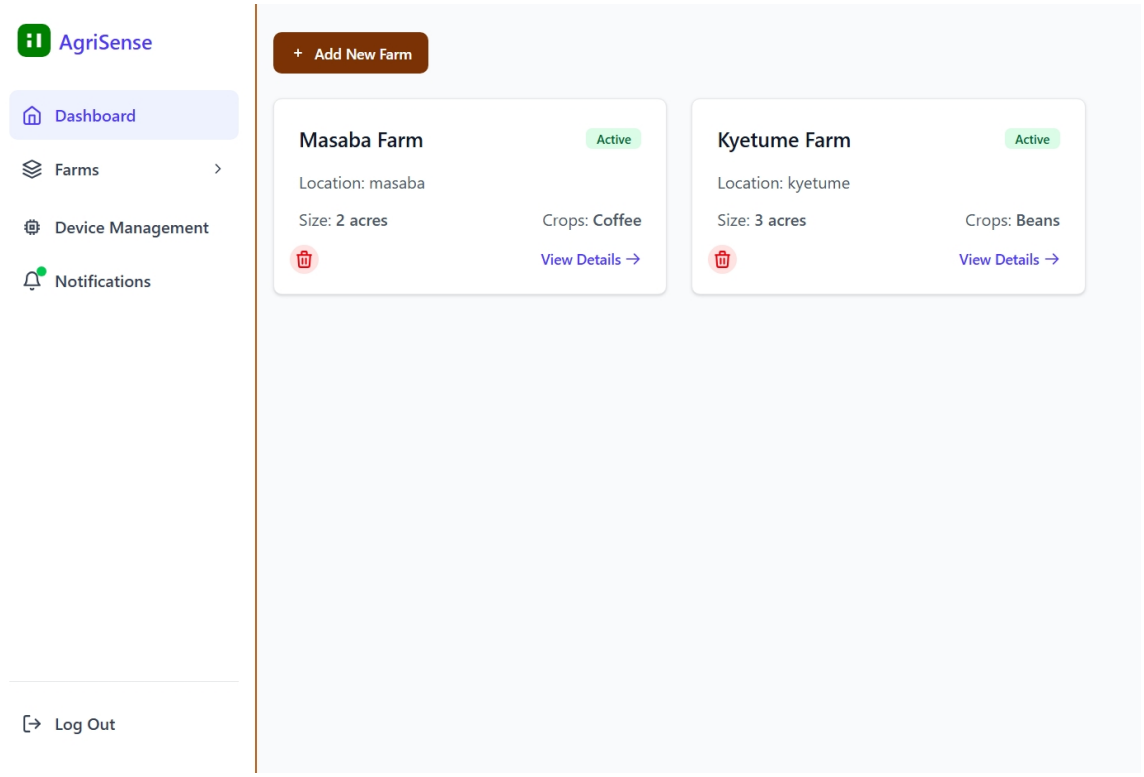

Figure 0.1: Farm Dashboard Screen

2.1 Add a New Farm

To add a farm:

- From the **Farms** section, click the brown **+ Add New Farm** button.
- In the pop-up window, enter:
    - **Farm Name**: Name your farm (e.g., Masaba Farm).
    - **Location**: Specify the farm's location (e.g., masaba).
    - **Size (acres)**: Enter the farm size in acres (e.g., 2 acres).

- Click the green Save Farm button to save, or Cancel to discard.

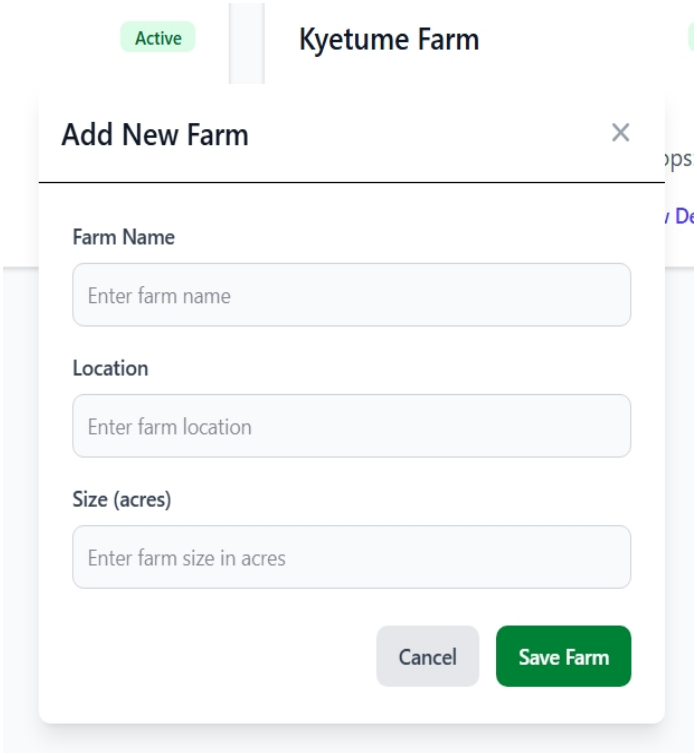

Figure 0.2: Add Farm Screen

2.2 View Farm Details

In the **Farms** section, you'll see a list of farms (e.g., Masaba Farm, Kyetume Farm).

Each farm card displays:

- Farm name, location, size, and crops.
- Status (e.g., Active).

Click **View Details** to see more information about a farm.

To delete a farm, click the red trash icon.

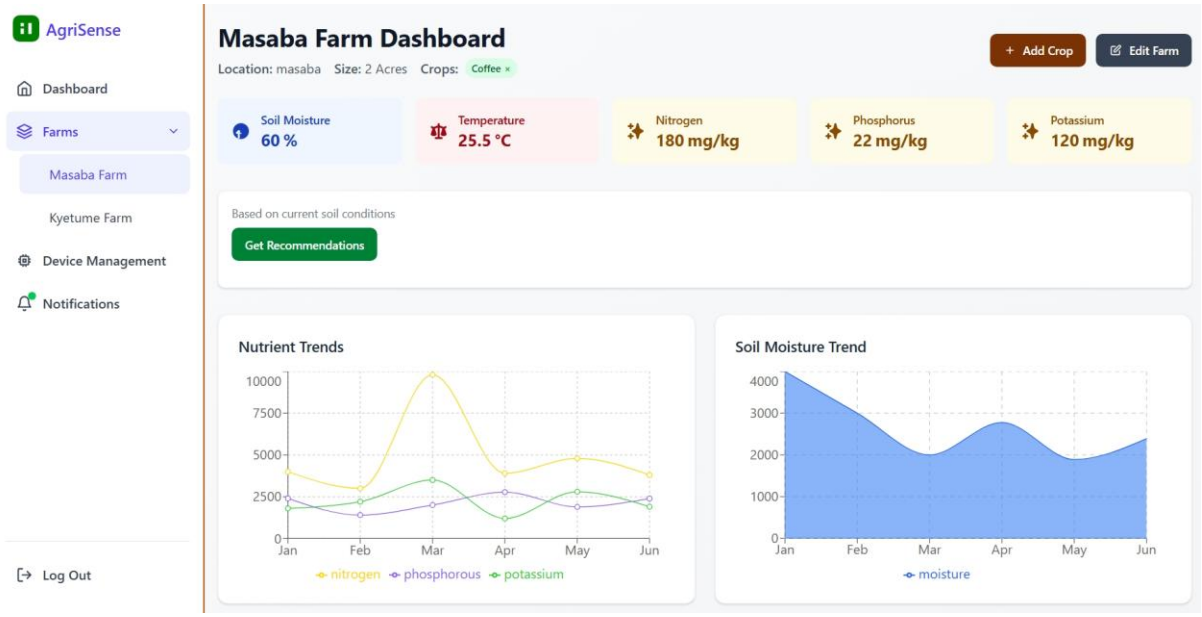

Figure 0.3: View Farm Details Screen

2.3 Edit a Farm

- From the farm dashboard (e.g., Masaba Farm Dashboard), click the **Edit Farm** button.
- Update the farm details as needed and save the changes.

3. Managing Devices

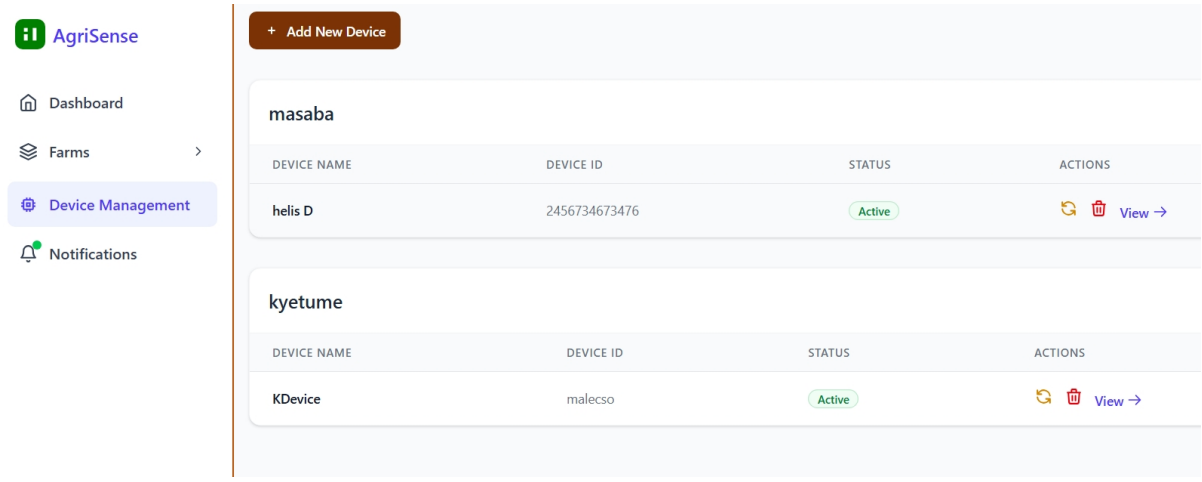

Figure 0.1: Device Management Screen

3.1 Add a New Device

To add a device to a farm:

- From the **Device Management** section, click the brown **+ Add New Device** button.
- In the pop-up window, enter:
    - **Device Name**: Name your device (e.g., helis D).
    - **Device ID**: Enter the unique device ID (e.g., 2456734673476).
    - **Select Farm**: Choose a farm from the dropdown (e.g., masaba).
- Click the green **Register Device** button to save, or **Cancel** to discard.

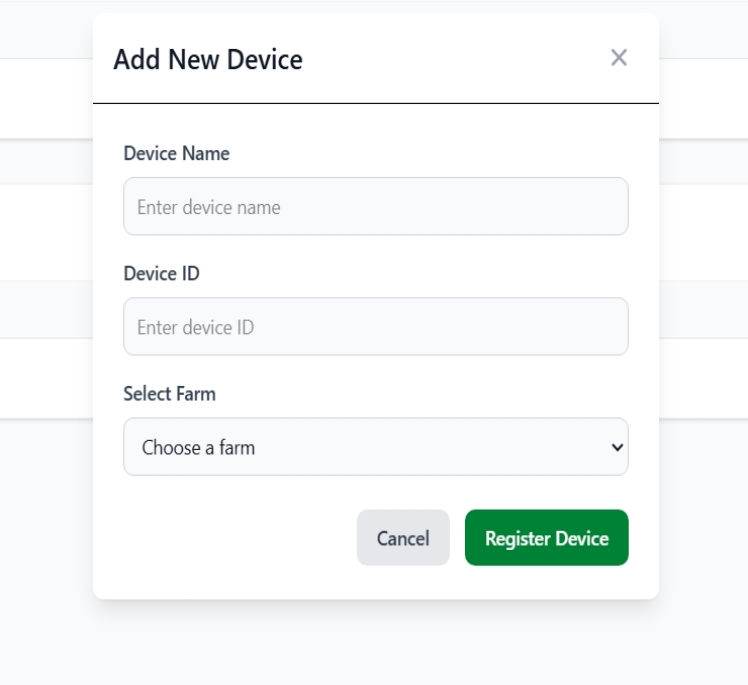

Figure 0.2: Add Device Screen

3.2 View Device Details

- In the **Device Management** section, devices are listed under their respective farms.
- Each device entry shows:
    - Device Name (e.g., helis D).
    - Device ID (e.g., 2456734673476).
    - Status (e.g., Active).

- Click **View** to see device details, or use the red trash icon to delete a device.

4. Monitoring Farm Conditions

4.1 Farm Dashboard

The farm dashboard provides a snapshot of soil conditions for a selected farm (e.g., Masaba Farm Dashboard):

- **Soil Moisture**: Displays the current soil moisture percentage (e.g., 60%).
- **Temperature**: Shows the current temperature (e.g., 25.5°C).
- **Nutrient Levels**: Displays levels of Nitrogen (e.g., 180 mg/kg), Phosphorus (e.g., 22 mg/kg), and Potassium (e.g., 120 mg/kg).
- **Trends**:
    - **Nutrient Trends**: A line graph showing Nitrogen, Phosphorus, and Potassium levels over time (e.g., Jan to Jun).
    - **Soil Moisture Trend**: A graph showing soil moisture levels over time (e.g., Jan to Jun).

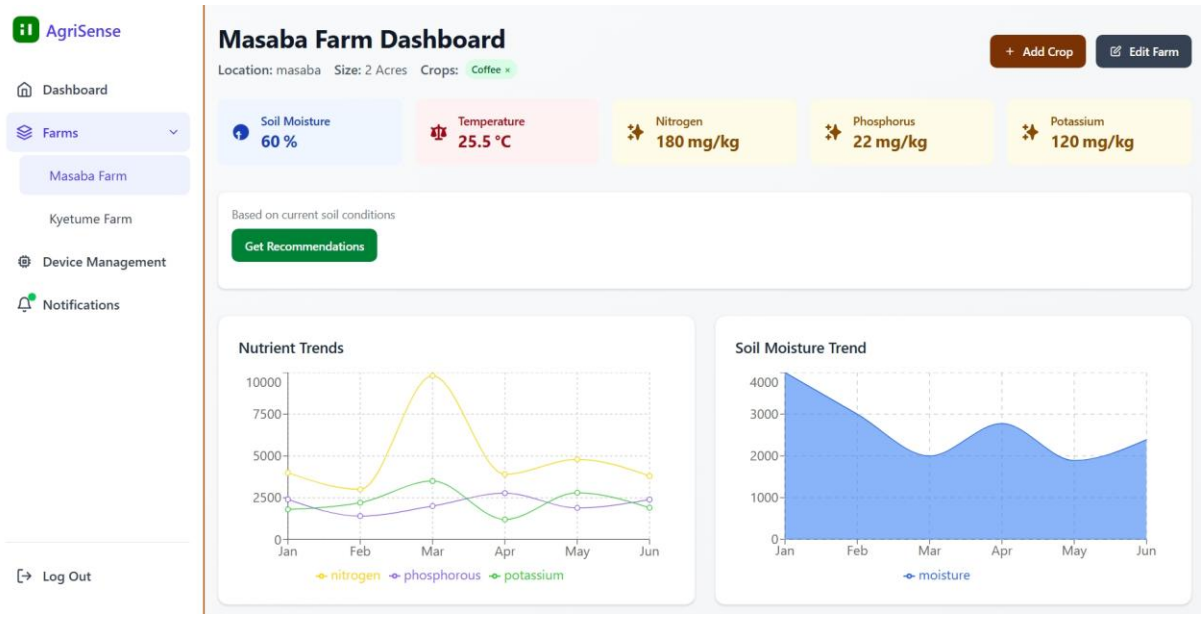

Figure 0.1: Farm Dashboard Screen

4.2 Crop Recommendations

- Based on current soil conditions, the dashboard suggests suitable crops (e.g., Tomatoes, Corn, Lettuce, Peppers).
- Click **Get Recommendations** to view more details.

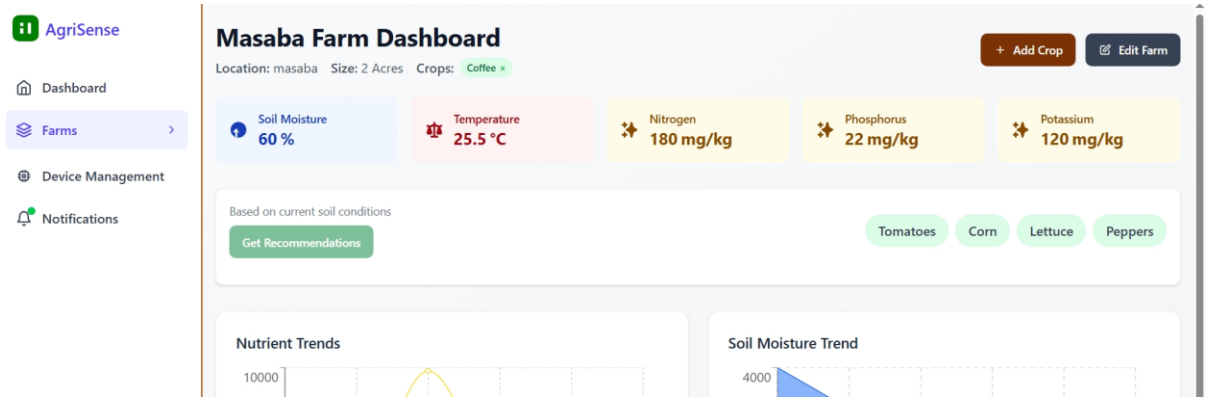

Figure 0.2: Crop Recommendations Screen

4.3 Add a New Crop

To add a crop to a farm:

- From the farm dashboard, click the brown **+ Add Crop** button.
- In the pop-up window, select a crop from the dropdown (e.g., Coffee).
- Click the red **Add Crop** button to save, or **Cancel** to discard.
- Added crops are displayed on the dashboard (e.g., Crops: Coffee).

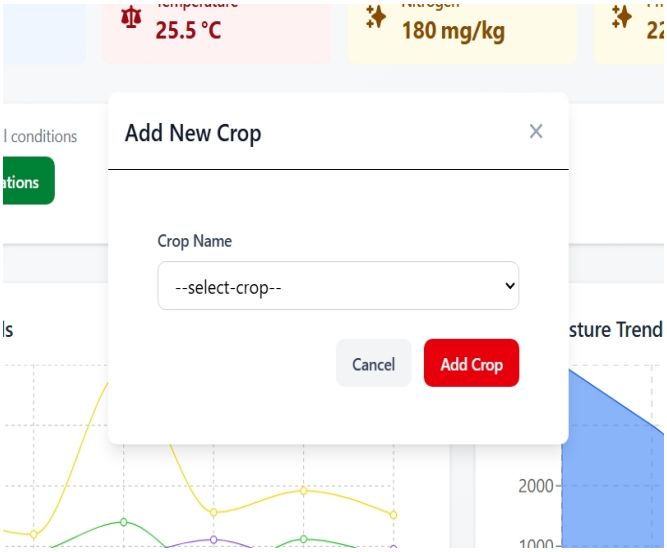

Figure 0.3: Add Crops Screen

5. Notifications

5.1 View Notifications

- Navigate to the **Notifications** section.
- Notifications alert you to important updates, such as:
    - Potassium levels being outside the optimal range for a crop (e.g., 120 ppm, above the optimal 95 ppm for Maize).
- Click **Mark all as read** to clear unread notifications.

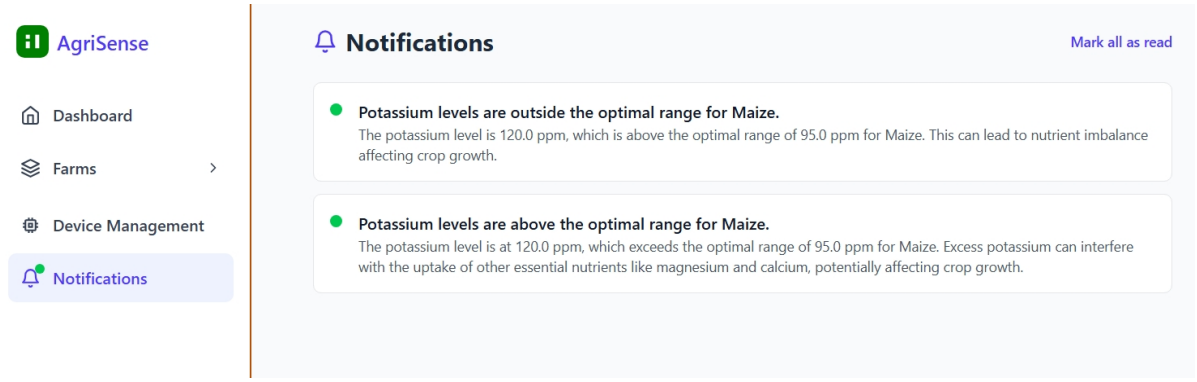

Figure 0.1: Notification Screen

6. Logging Out

To log out, click the **Logout** button at the bottom of the sidebar.

6.1 System Overview

The Smart Cloud-Based Soil Advisor is an integrated IoT system that collects real-time soil nutrient and environmental data using sensors and sends it to a cloud platform (ThingSpeak). The backend receives the data from the thingspeak api, processes it and formats the data to

displays actionable insights on a web dashboard.

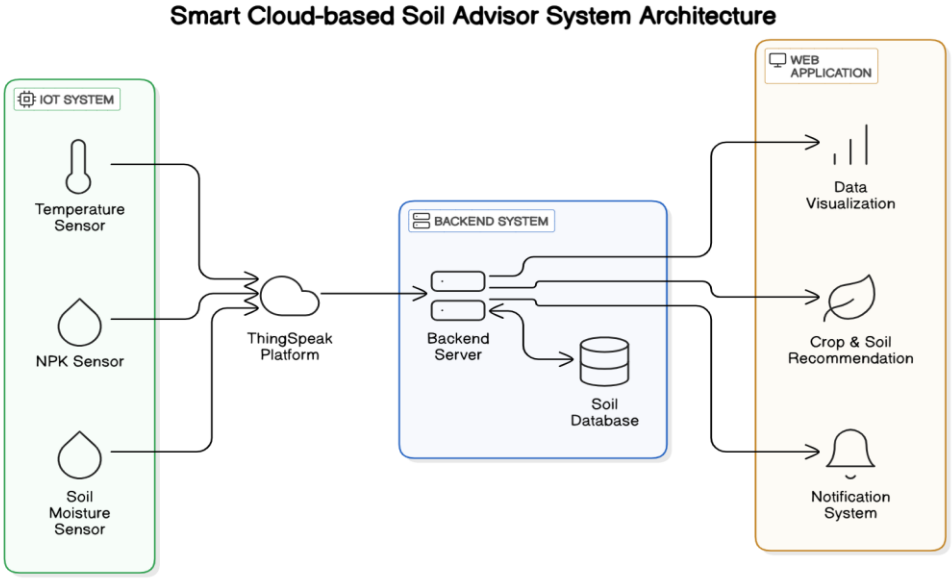

Figure 0.1: System Architecture Diagram

Key Components:

- **IoT Sensor Node:** Measures soil moisture, temperature, and nutrient (NPK) levels.
- **Gateway (ESP32):** Receives sensor data and uploads to the cloud.
- **ThingSpeak Platform:** Stores and visualizes real-time data.
- **Backend Server & Database:** Processes data, stores historical readings.
- **Web Interface:** Displays insights, provides recommendations and alerts to users.

7. Hardware Setup

7.1. Capacitive Soil Moisture Sensor

Purpose: Measures soil water content.

Voltage: 3.3V–5.5V

Output: Analog (1.2V–3.0V)

Connection: Arduino Nano analog pin A0.

Setup Steps:

i. Connect VCC to 3.3V on Arduino Nano, GND to GND.

ii. Connect OUT to A0 on Arduino Nano.
iii. Insert the probe into the soil (up to the marked line).
iv. Power on the Arduino and check readings via Serial Monitor (expected: 100-200).

Note: Keep the sensor's electronics dry.

7.2. DS18B20 Waterproof Temperature Sensor

Purpose: Measures soil temperature.
Range: -55°C to +125°C.
Libraries: DallasTemperature, OneWire.
Pull-up Resistor: 4.7kΩ (DATA to VCC).
Connection: Digital pin D2 on Arduino Nano.

Setup Steps:

i. Install DallasTemperature and OneWire libraries in Arduino IDE.
ii. Connect VCC to 5V, GND to GND, DATA to D2 on Arduino Nano.
iii. Add a 4.7kΩ resistor between DATA and VCC.
iv. Place the probe in soil (5–10 cm deep).
v. Upload a test sketch and check Serial Monitor (expected: 20–30°C).

Note: Ensure the probe's waterproof seal is intact.

7.3. Soil NPK Sensor

Purpose: Measures Nitrogen, Phosphorus, Potassium.
Connection: Modbus RS485 via MAX485 module to Arduino.
Voltage: 9V–24V
Resolution: 1 mg/kg.

Setup Steps:

i. Connect NPK sensor's A and B to MAX485 A and B.
ii. Wire MAX485: VCC to 5V, GND to GND, RO to RX (pin 0), DI to TX (pin 1), RE/DE to D3 on Arduino Nano.
iii. Power the NPK sensor with 12V; connect GND to Arduino GND.

iv. Insert the probe into soil (10–15 cm deep).
v. Install ModbusMaster library, upload a test sketch, and check Serial Monitor (expected: N: 100–200, P: 20–50, K: 80–150 mg/kg).

Note: Use a stable 12V power supply.

7.4. NRF24L01 Wireless Module

Purpose: Sends sensor data wirelessly to the ESP32 gateway. **Frequency**: 2.4GHz.

Setup Steps:

i. **Arduino Nano (Sensor Node)**: Connect VCC to 3.3V, GND to GND, CE to D7, CSN to D8, SCK to D13, MOSI to D11, MISO to D12.
ii. **ESP32 (Gateway)**: Connect VCC to 3.3V, GND to GND, CE to GPIO 4, CSN to GPIO 5, SCK to GPIO 18, MOSI to GPIO 23, MISO to GPIO 19.
iii. Install RF24 library, upload test sketches to both devices (same channel/address).
iv. Check Serial Monitor on ESP32 for received data (expected: moisture, temp, NPK values).

Note: Use 3.3V power for NRF24L01 to avoid damage.

7.5. ESP32 Gateway

Purpose: Receives data via NRF24L01 and uploads to ThingSpeak using Wi-Fi.

Setup Steps:

i. Connect NRF24L01 to ESP32 (as above).
ii. Add Wi-Fi credentials and ThingSpeak API key to the sketch.
iii. Install ESP32 board, WiFi, and ThingSpeak libraries in Arduino IDE.
iv. Upload the sketch to ESP32.
v. Check Serial Monitor (115200 baud) for Wi-Fi connection and data upload (expected: “Uploaded to ThingSpeak”).

Note: Ensure a stable USB power source for the ESP32.

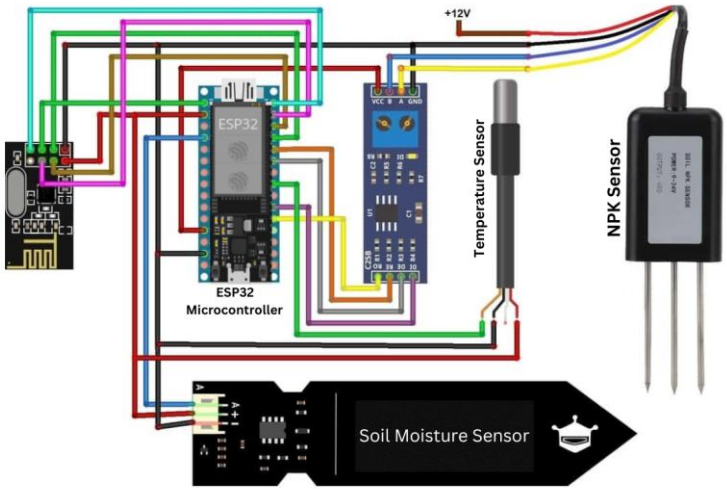

Figure 0.1: Sensor Node Circuit

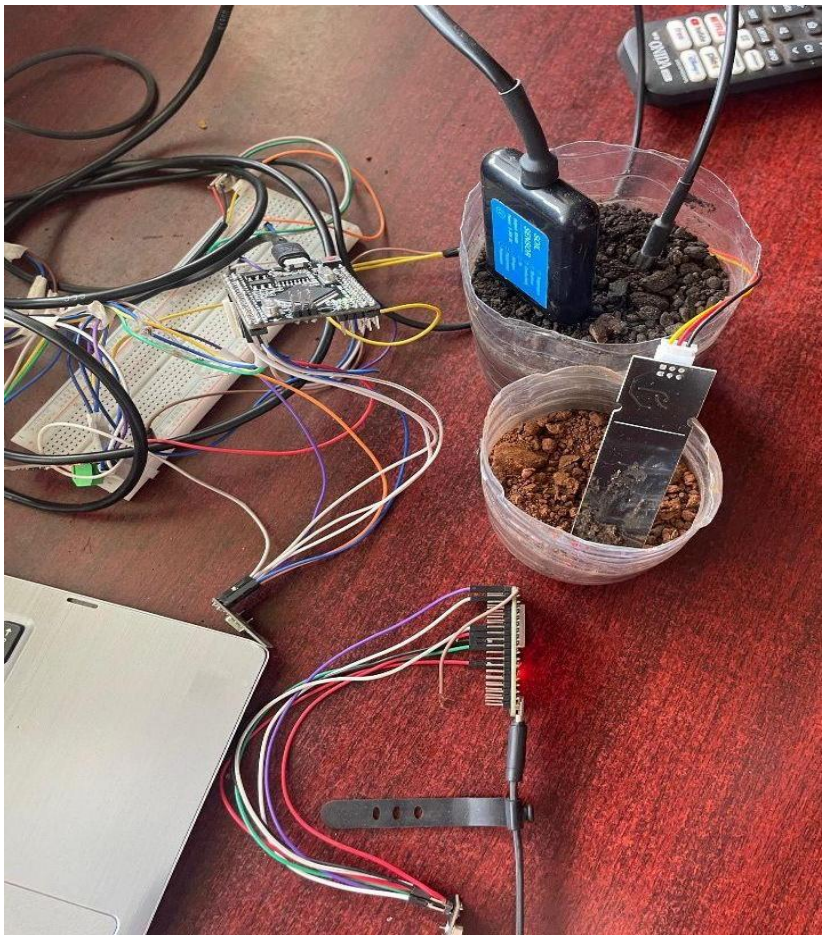

Figure 0.2: Real-life hardware setup of the Smart Cloud-Based Soil Advisor system, tested with a sample soil in a controlled environment, featuring sensors connected to the Arduino Nano and ESP32 gateway.

8. Firmware and Connectivity

8.1. Uploading Firmware

- Connect Arduino Nano and ESP32 to your PC via USB.
- Open Arduino IDE.
- Select the correct board and port for both the Arduino Nano and ESP32.
- Upload the sensor firmware (provided in GitHub repo).

8.2. Connecting to ThingSpeak

i. Go to ThingSpeak.com
ii. Create a channel and note your API key.
iii. Enter this key in the ESP32 firmware before uploading.

9. Maintenance & Calibration

- **Soil Moisture Sensor:** Clean sensor head monthly to avoid salt build-up.
- **NPK Sensor:** Recalibrate once every 6 months for accuracy.
- **Firmware Updates:** Check GitHub for the latest firmware.
- **Power Supply:** Ensure reliable power for uninterrupted data transmission.

10. Troubleshooting

*Table **Error! No text of specified style in document.**.1: Troubleshooting*

Issue	Possible Cause	Solution
No data on dashboard	ESP32 not connecting to Wi-Fi	Re-enter SSID and password in code
Sensor reads 0	Loose connection or faulty sensor	Check wiring, replace sensor if needed

ThingSpeak not updating	Wrong API key or quota exceeded	Verify API key, upgrade account

11. Frequently Asked Questions

Q1: Can the system work offline?

A: No, the ESP32 requires an internet connection to upload data to ThingSpeak.

Q2: How often is data sent to the cloud?

A: Data is sent every 60 minutes to reduce bandwidth and avoid sensory overload.

Q3: Can I integrate other sensors like EC?

A: Yes, as long as they communicate over I2C, UART, or analog, they can be added.

12. Safety

- Disconnect all power sources before wiring or making hardware changes.
- Handle NPK sensors carefully—excess moisture may affect calibration.
- Use protective gloves when handling soil samples or exposed circuitry.