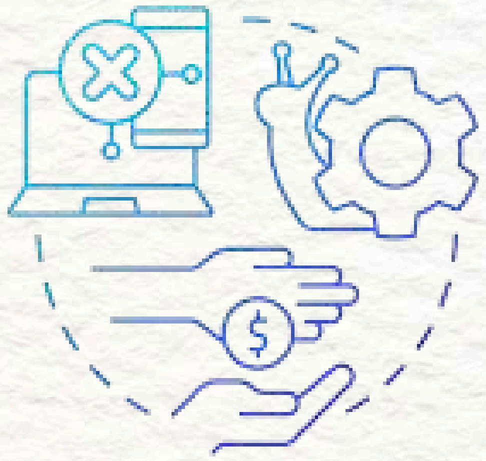
Introduction

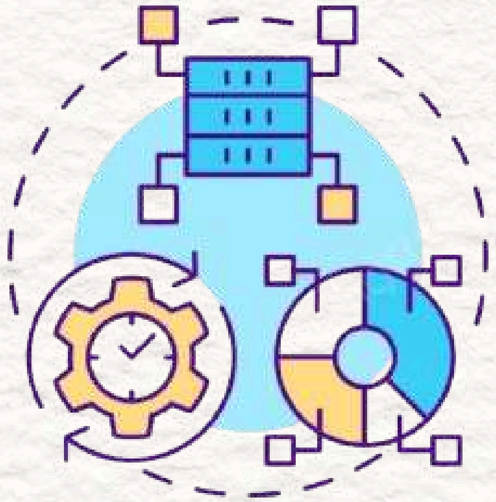
- Agriculture today faces numerous challenges, especially among small and medium-sized farms.
  - increasing climate variability
  - inefficient use of resources
  - lack of access to modern technological tools.



- Existing smart farming solutions are:
  - fragmented
  - expensive
  - too complex for widespread adoption

Introduction

- GrowSync, a cost-effective and scalable IoT system
- It is designed to support precision agriculture through intelligent automation and real-time data monitoring.
- Integrates a multi-layered architecture comprising sensors, microcontrollers, cloud services, actuators, and a mobile application.
- Flutter enables farmers to remotely view real-time data, receive alerts, adjust system parameters, and automate schedules



Literature Review

1

Hardware

- DHT22 for accurate temperature/humidity monitoring (Devanand et al., 2020)
- MQ135 for air quality detection (Agarwal, 2022)
- LSPH01 sensor for soil pH and moisture (Dragino Technology, 2025)
- PIR (HC-SR501) sensor used for detecting motion (GrowSync System, 2025)

Widely adopted for:

- energy efficiency, reliability and ease of integration with microcontrollers.

2

Cloud Platform

- Agroview utilizes machine learning to process UAV imagery and sensor data, enabling advanced analysis. (Soussi, 2023)
- Crop health mapping, CO_2 monitoring, and soil condition assessment.
- Agroview offers superior scalability, analytical capabilities, and support for large-scale farming operations compared to generic platforms.

Literature Review

3

Mobile Application

- Flutter supports real-time interface updates, cross-platform compatibility and a rich set of customizable UI components.
- Flutter is ideal for building interactive, sensor-driven apps for IoT applications in agriculture due to its hot reload capability and embedded device support. (Grace, 2025)

4

Communication Protocols

- ZigBee and LoRaWAN were chosen for local sensor networks.
- Low power consumption and long-range capabilities. (Avşar and Mowla, 2022)
- MQTT over Wi-Fi with TLS encryption is adopted for cloud communication.
- Ensure secure and reliable data transfer, aligning with best practices in secure IoT system design.

Why did we build GrowSync?

Problem Statement

1

Struggle with maintaining optimal environmental conditions like soil pH, temperature, humidity and air quality in order to maximize crop yield and ensure sustainability

2

Fragmented, expensive and difficult to scale, which causes poor adoption in developing countries

3

Lack of real-time insights and automation in agriculture also causes an increase in manual labour, resource wastage and inconsistent agricultural productivity

Problem Statement

1

Environmental Instability in Farming

Problem: Farmers struggle to maintain optimal growing conditions for crops.

- Soil pH, temperature, humidity, and air quality often fluctuate.
- Manual monitoring is time-consuming and inconsistent.
- Poor control over the environment leads to lower crop yields and sustainability issues.
- Sensitive crops are especially vulnerable to small changes.

Problem Statement

2

Inaccessible & Fragmented Technology

Problem: Smart farming solutions are often expensive and hard to scale.

- Many existing systems are fragmented (not integrated)
- High cost and complexity limit adoption in developing regions.
- Lack of modular or open-source solutions increases dependency on vendors.
- Farmers need affordable and scalable systems tailored to local needs.

Problem Statement

3

Lack of Real-Time Insights & Automation

Problem: Manual farming leads to inefficiency and resource waste.

- Delayed responses to environmental changes lead to crop damage.
- Heavy reliance on labor increases cost and effort.
- Water, fertilizer, and energy are often overused.
- Inconsistent productivity due to lack of precision farming.

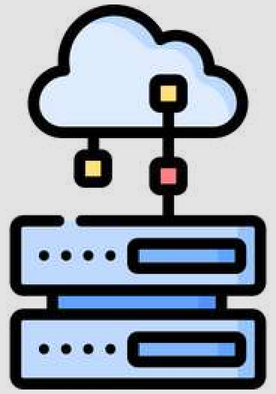
Objectives

1

Develop a multi-layer IoT architecture incorporate real-time sensing, data transmissions, cloud analytics, and automated actuation.

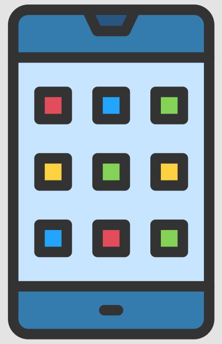
2

Leverage cloud platforms such as AWS and Agroview for secure data storage, trend visualization, and support ML-based forecasting for informed decision-making.



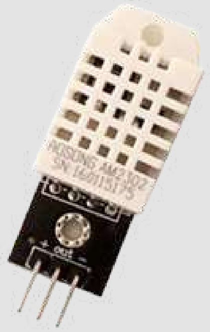
3

Develop a user-friendly mobile application using Flutter for remote monitoring and farm operations from anywhere, anytime.



Hardware Components

LSP01 LoRaWAN Soil pH Sensor



DHT22 Temperature and Humidity Sensor

MQ135 Gas Sensor

HC-SR501 Infrared Sensor

ESP32 Wi-Fi Module

LCD Display

Piezoelectric Buzzer

JT-180A Submersible Water Pump

JFC-1 Solenoid Valve

Software Platform

Cloud Platform: Agroview

- AI-powered cloud platform built on AWS.
- Integrated with:

1. Amazon S3 – processed outputs storage
2. AWS IoT Core – real-time sensor data collection
3. Amazon RDS – structured farm data management
4. AWS Timestream – time-series data storage

- Enables automated decision-making, high scalability and real-time insight for precision farming.

Mobile App Development Framework: Flutter

- Google-developed cross-platform framework using Dart.
- Supports hot reload and real-time UI updates for sensor data.
- Works on iOS, Android, web and embedded systems.
- Ideal for building interactive, real-time and sensor-driven farm apps.

Methodology

3 Communication Protocols

- ZigBee, LoRaWAN for sensor data (short to long range).
- MQTT (ESP32 ↔ Cloud)
- HTTPS (Cloud ↔ Mobile App).

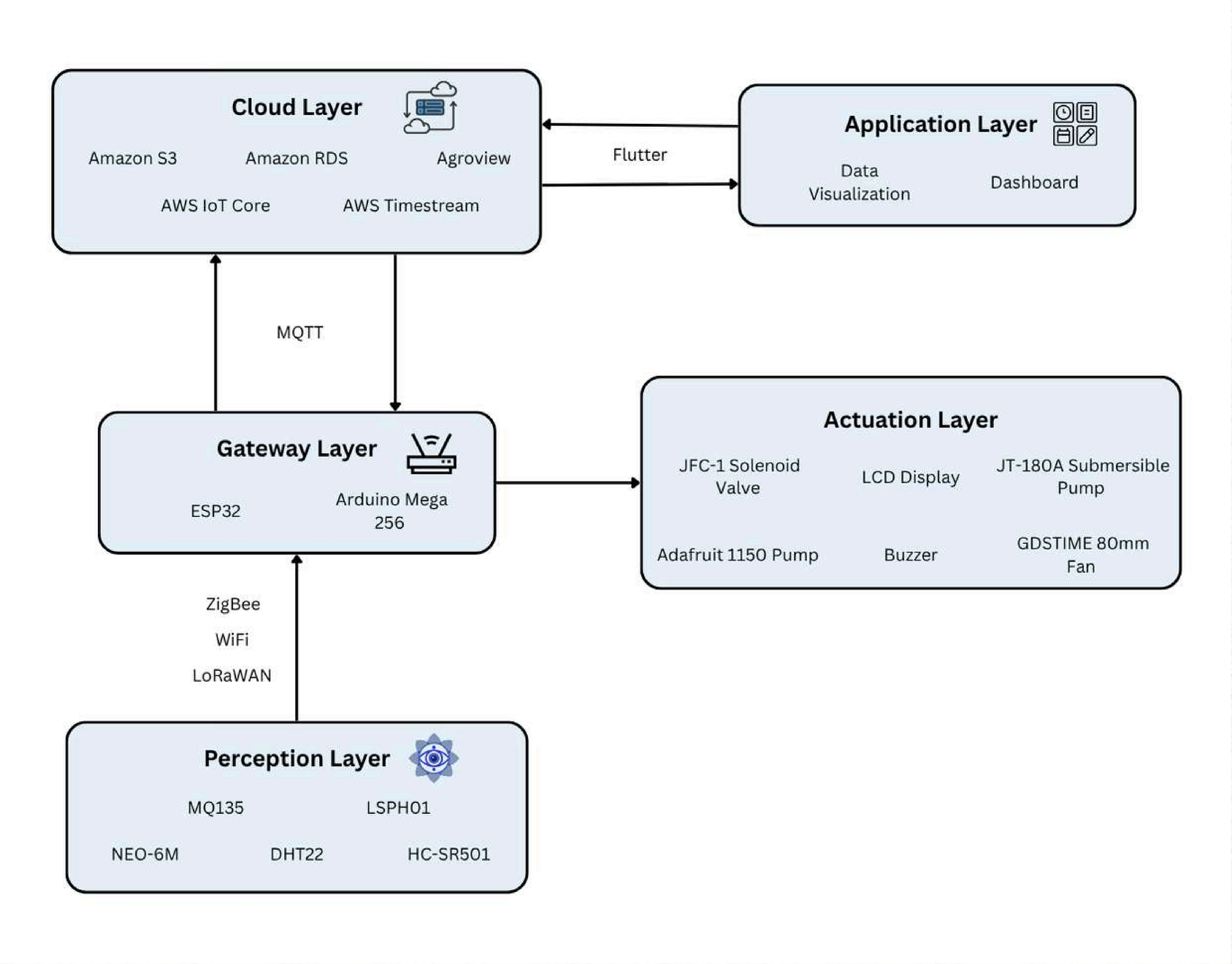
4 Data Management

- Time-series sensor data in Amazon Timestream.
- Logs in Amazon S3, system settings in Amazon RDS.
- Data is encrypted at rest (AES-256) and in transit (AES-128/AES-256/TLS).

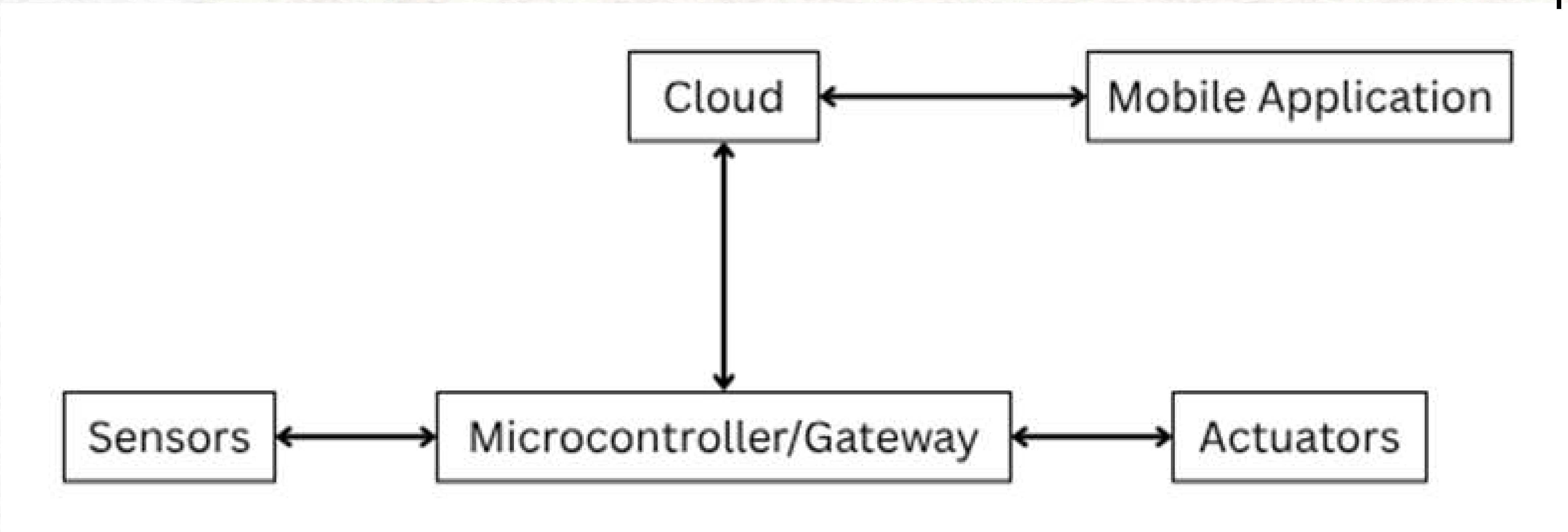
5 Mobile App Functionality

- Real-time monitoring.
- Manual & scheduled control.
- Alerts & daily/weekly reports.
- Customization by crop type and user roles.

Architecture Diagram



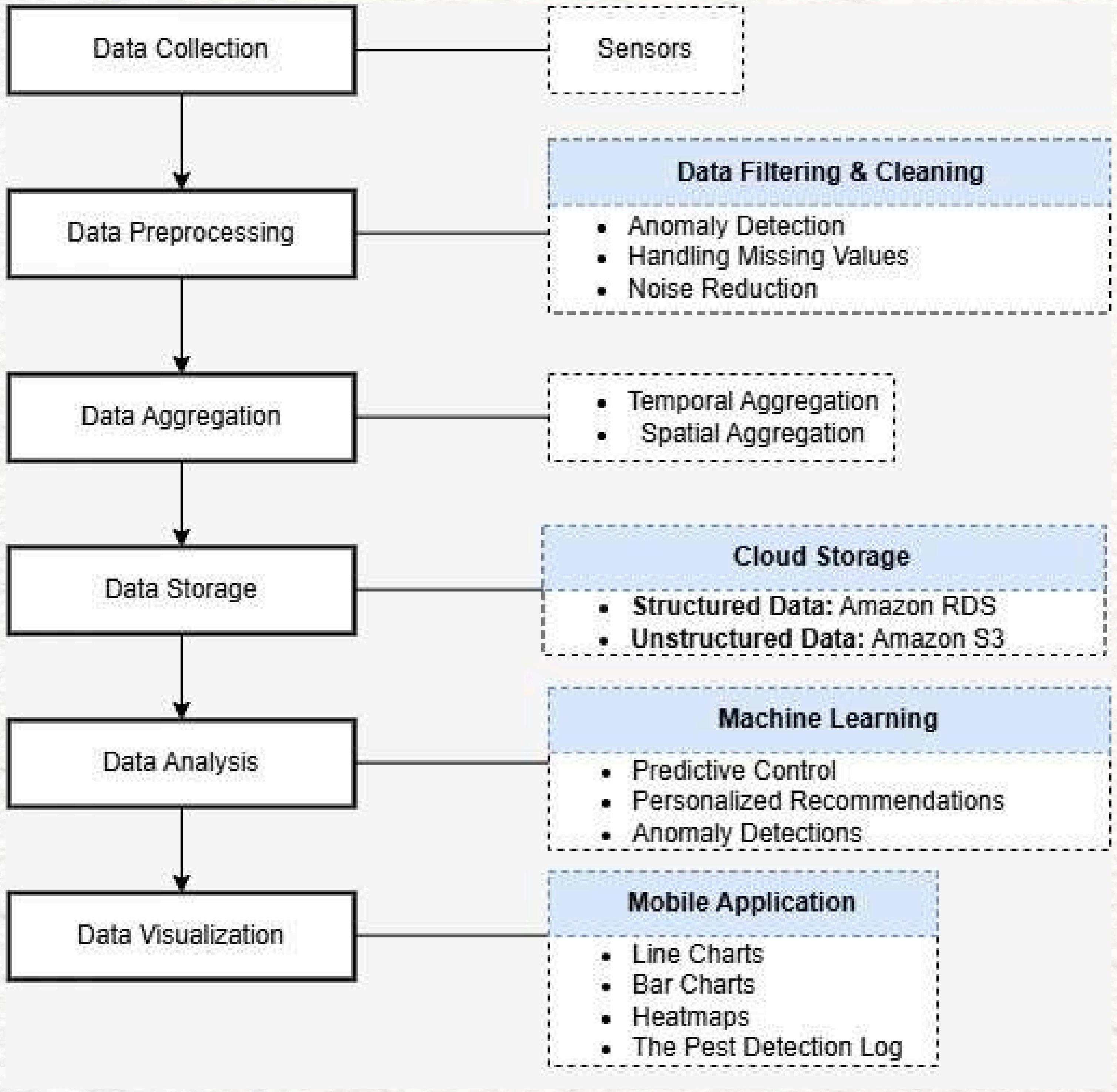
Data Transmission Pathways



Transmission Pathways

1. **Sensors, Actuators and Microcontrollers**
   - Short Range: ZigBee
   - Medium Range: ZigBee Mesh
   - Long Range: LoRaWAN
2. **Gateway and Cloud**
   - MQTT over WiFi
3. **Cloud and Mobile Application**
   - HTTPS over WiFi

Flowchart for Data Processing & Analysis



1. **Data Collection:** Sensors
2. **Data Preprocessing:** Data Filtering & Cleaning
3. **Data Aggregation:** Temporal & Spatial Aggregation
4. **Data Storage:** Cloud Storage - Amazon RDS & S3
5. **Data Analysis:** Machine Learning
6. **Data Visualization:** Mobile App with Charts & Logs

Results & Findings

Wokwi

error code: 524

IoT Agriculture - Wokwi ESP32, STM32, Arduino Simulator

Run IoT and embedded projects in your browser: ESP32, STM32, Arduino, Pi Pico, and more. No installation required!

WokwiMakes

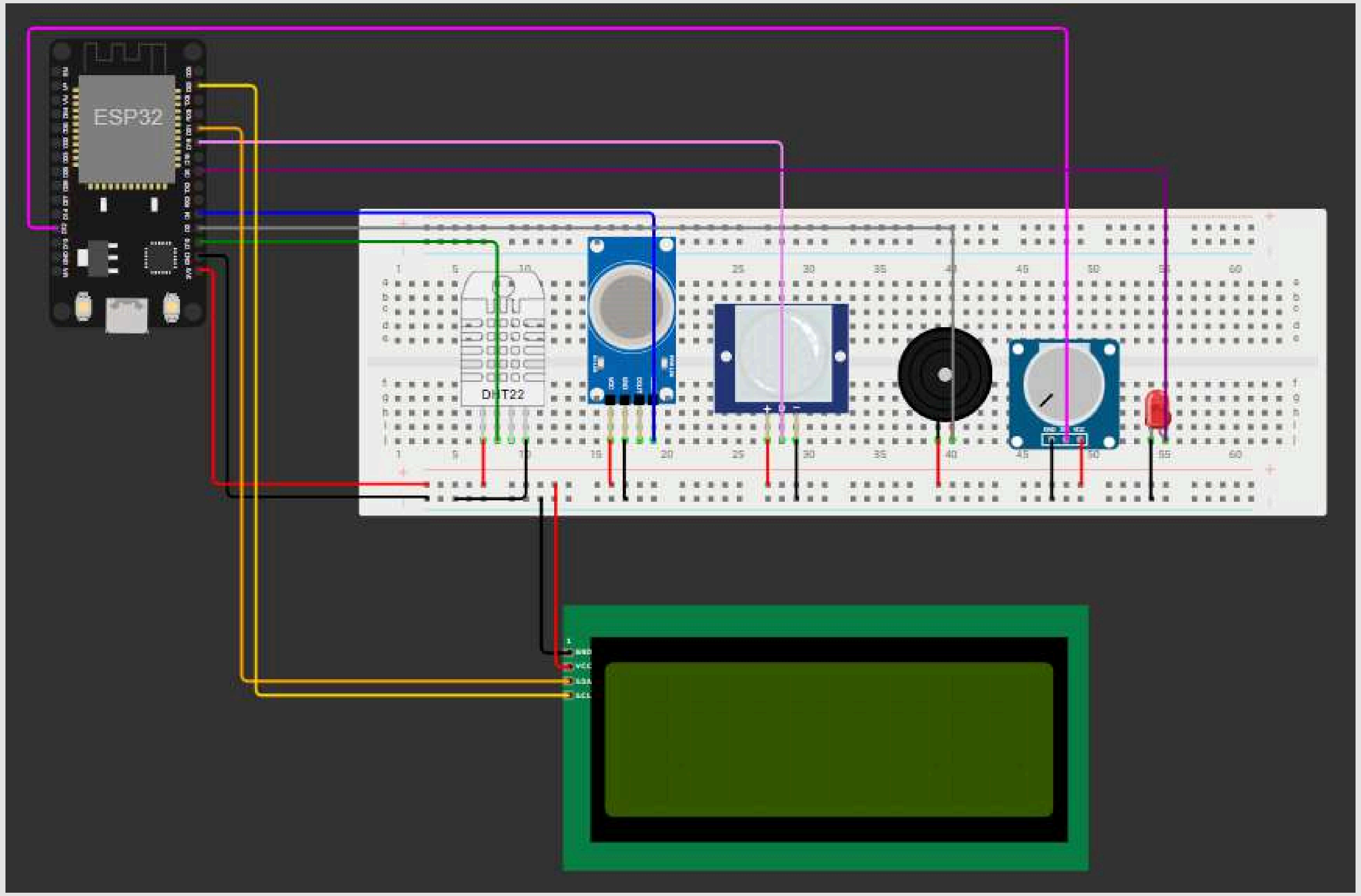
Google Colab

Google Colab

google.com

Results & Findings

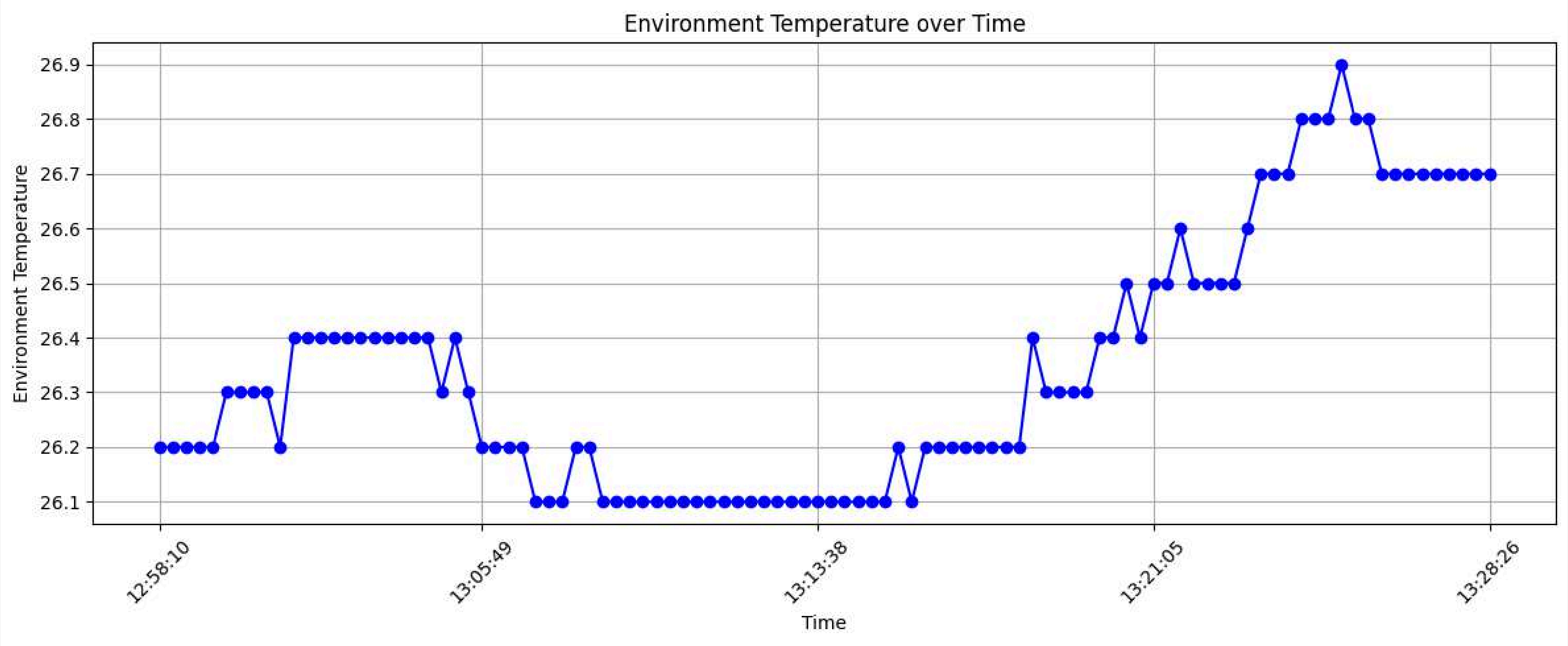
Wokwi



Results & Findings

Google Colab

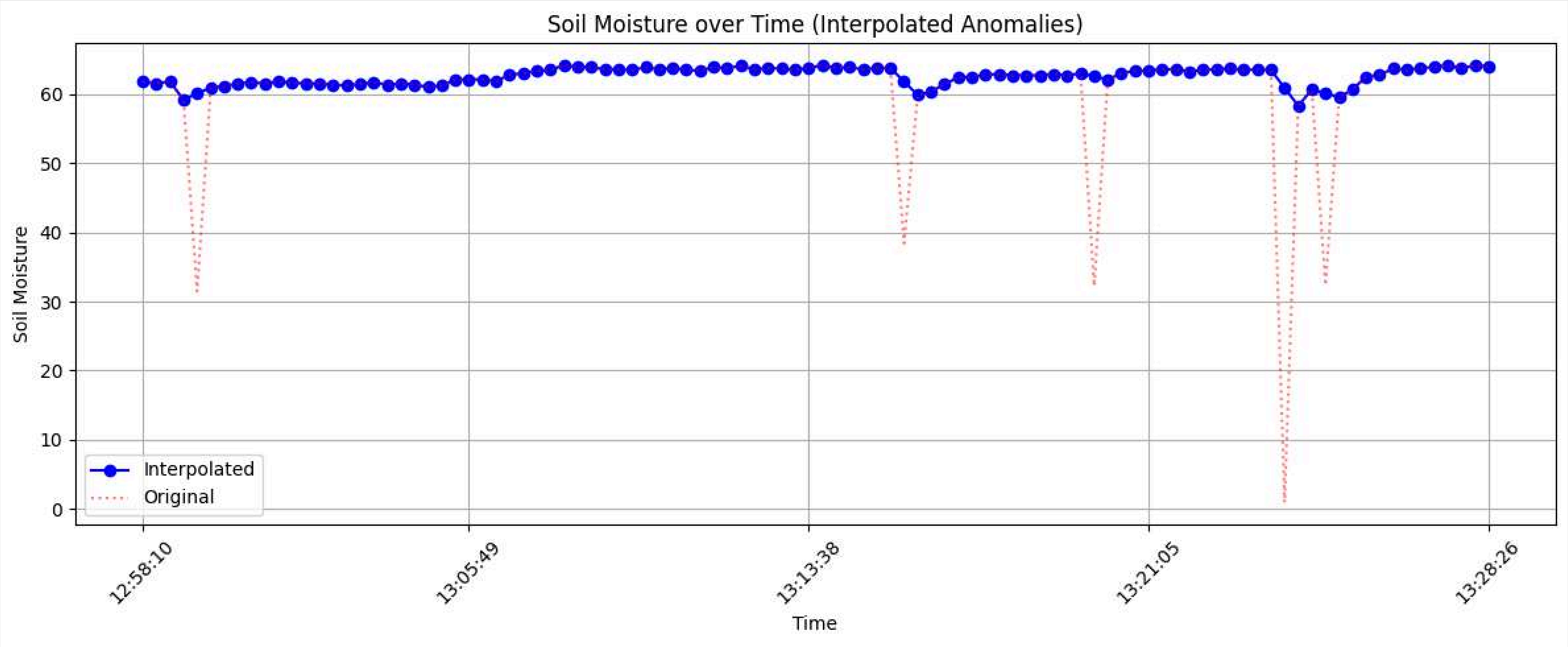
Visualization of Sensor Data



Results & Findings

Google Colab

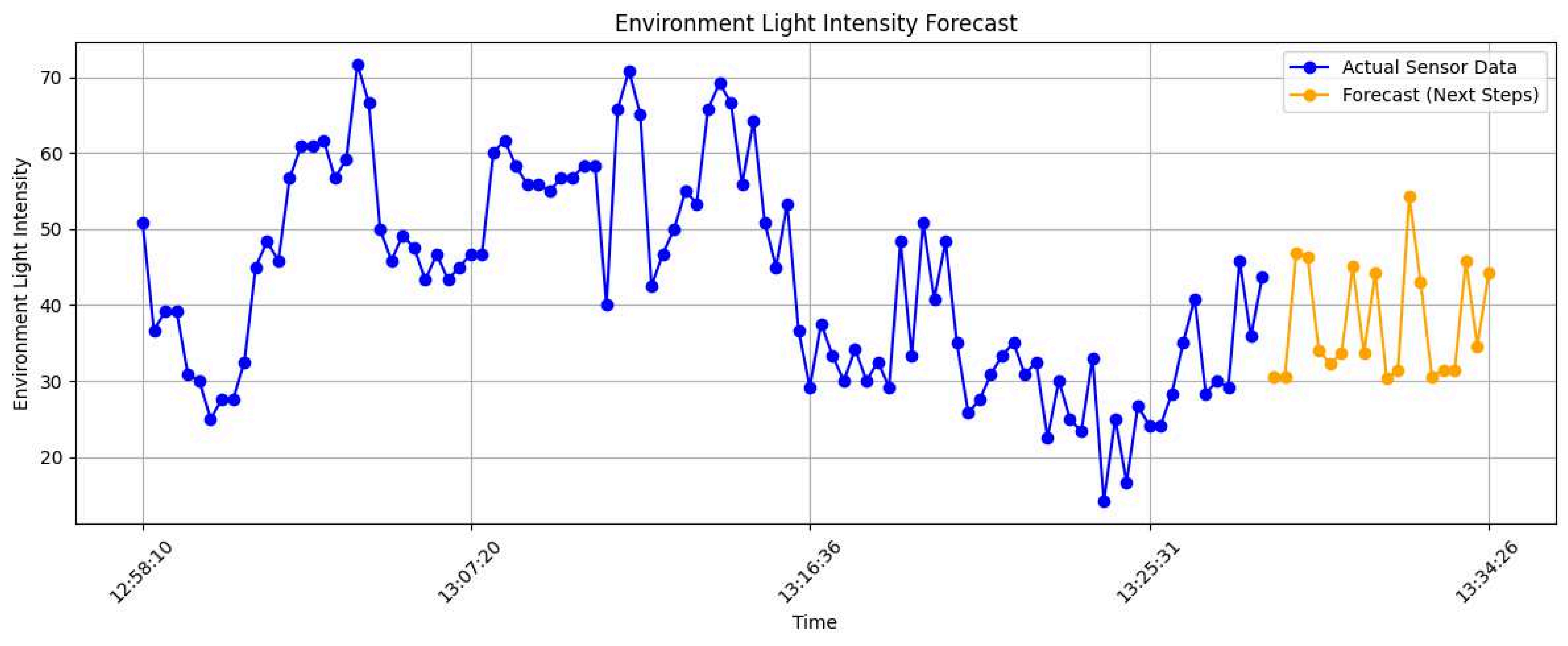
Interpolation of Abnormal Values



Results & Findings

Google Colab

Forecasting of Sensor Data



Results & Findings

Google Colab

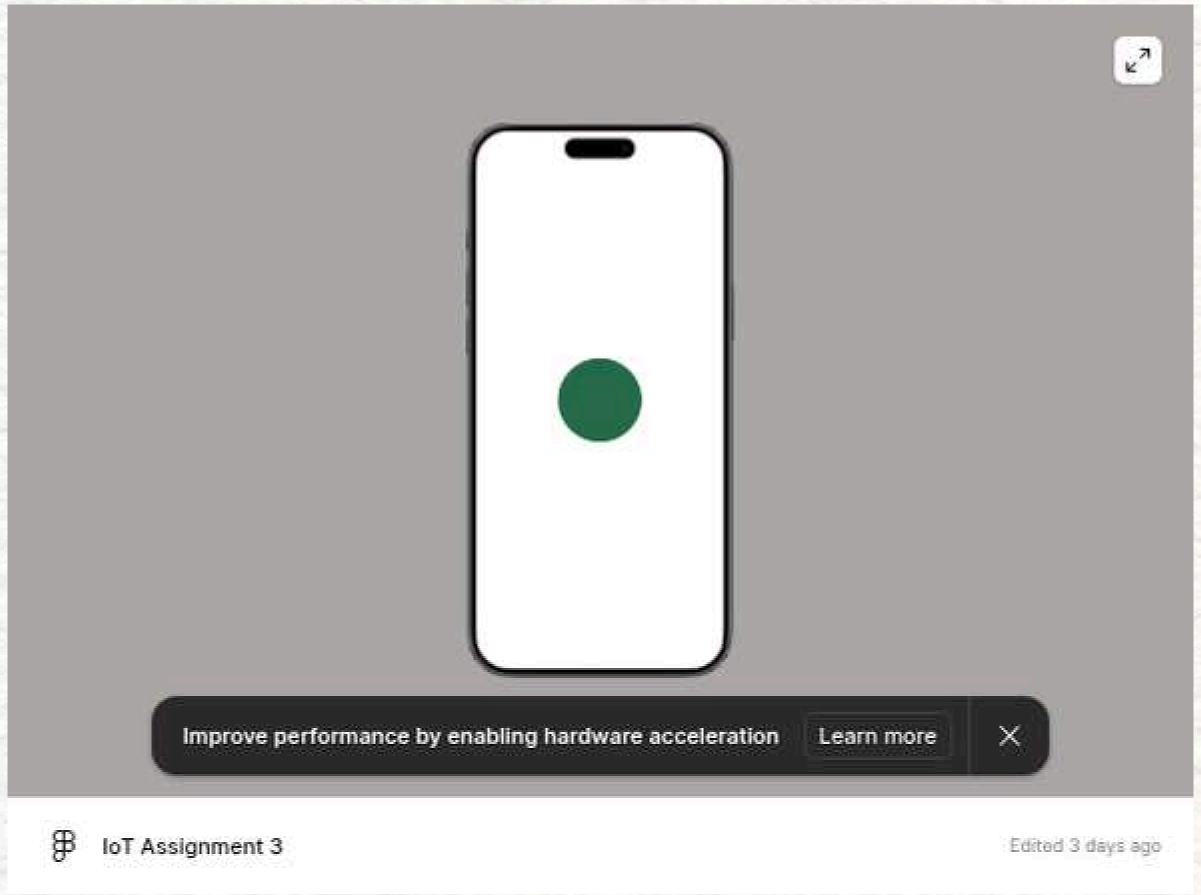
Crop Yield Prediction Based on User Input

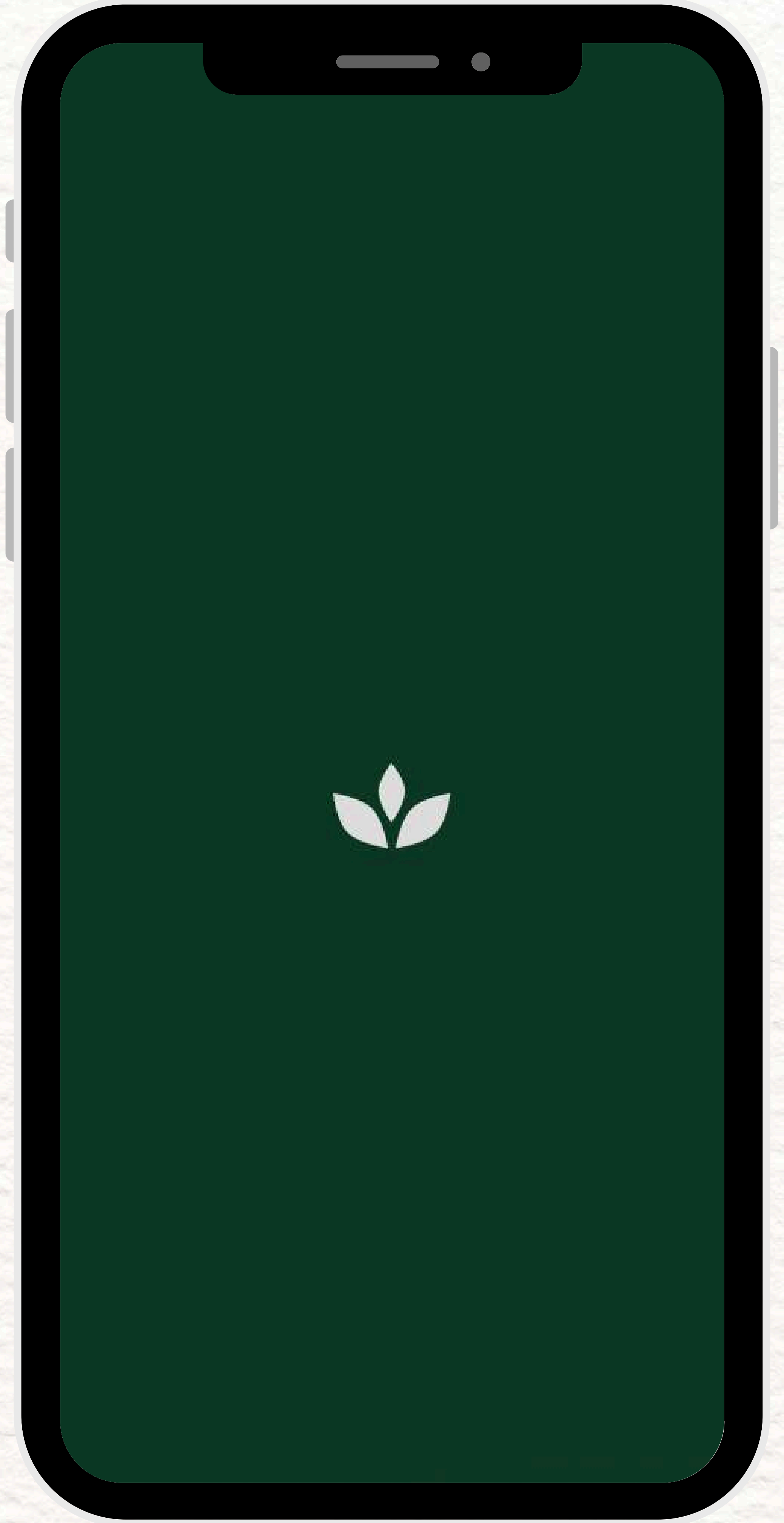
```
=========================================
|         CROP YIELD PREDICTOR          |
=========================================

Please enter the following details:

🌧️  Rainfall (mm): 10000
🌡️  Temperature (°C): 25
🌾  Fertilizer Used? (1 = Yes, 0 = No): 1
🚿  Irrigation Used? (1 = Yes, 0 = No): 1

🧮 Predicting crop yield...

-----------------------------------------
🌱 Predicted Crop Yield: 53.17 tonnes/ha
-----------------------------------------
```

Prototype

Figma

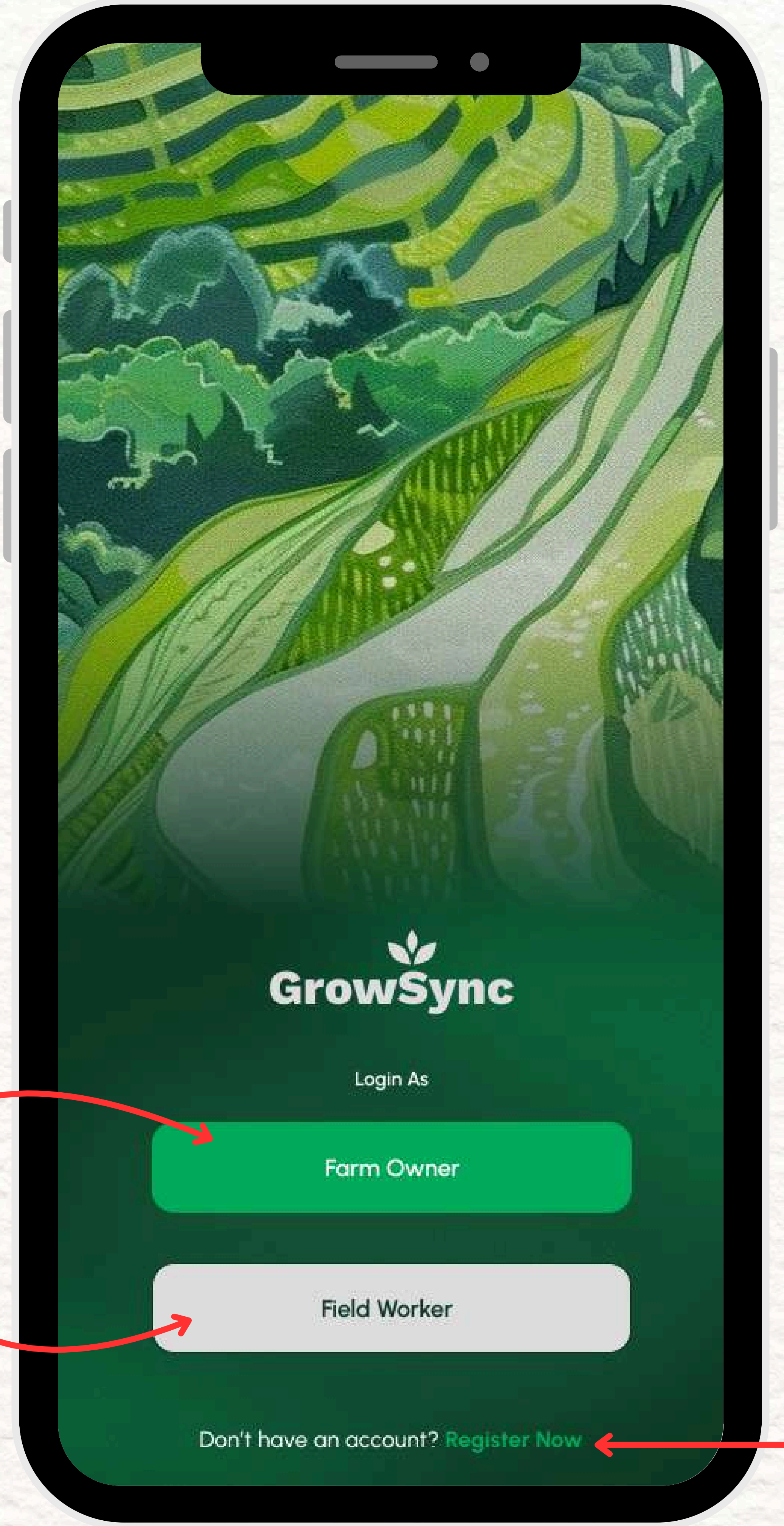
LIVE DEMO!





Landing Page

GrowSync

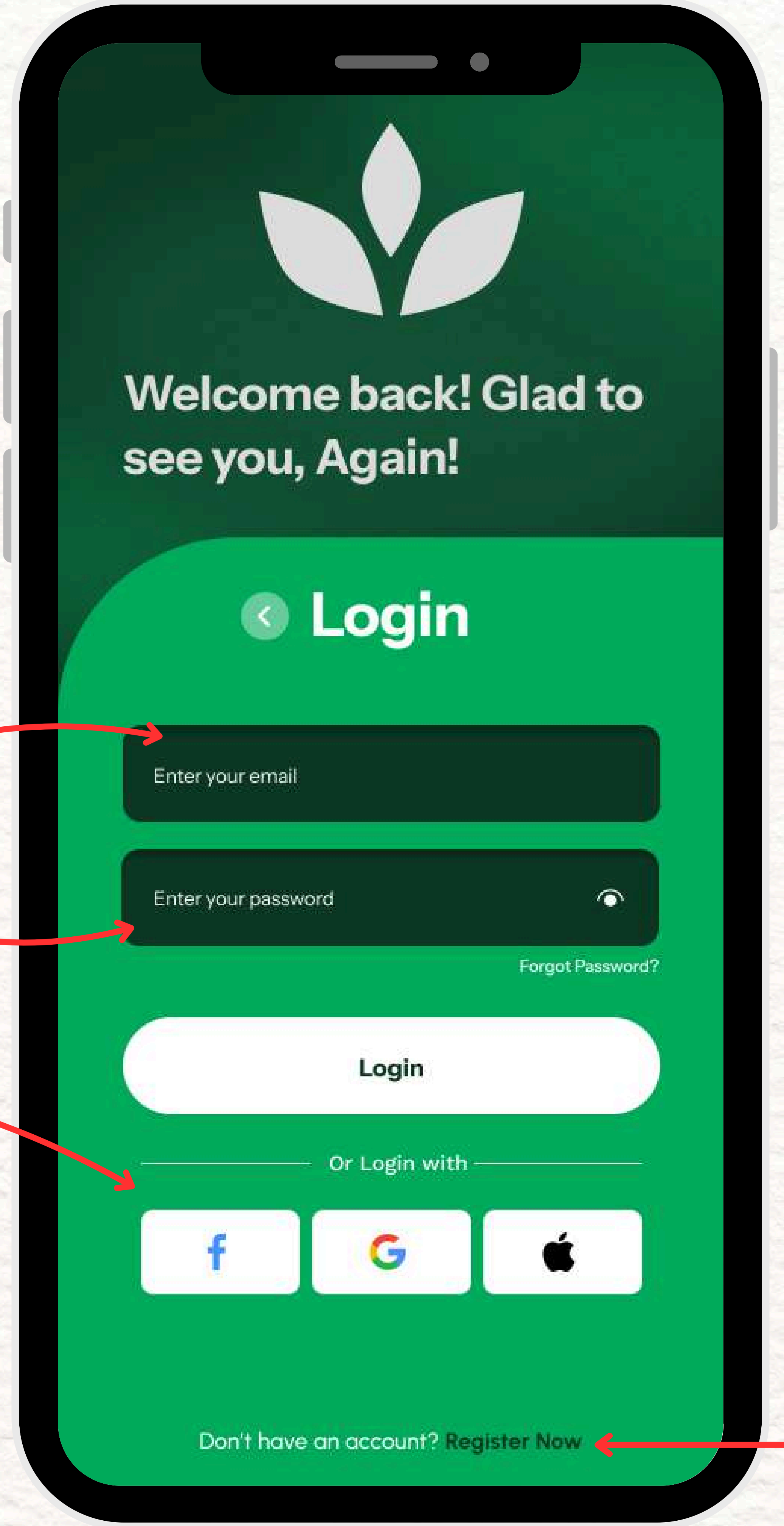


Registered users can login as

Unregistered users can

Login Page

GrowSync



Registered Users are required to enter

OR

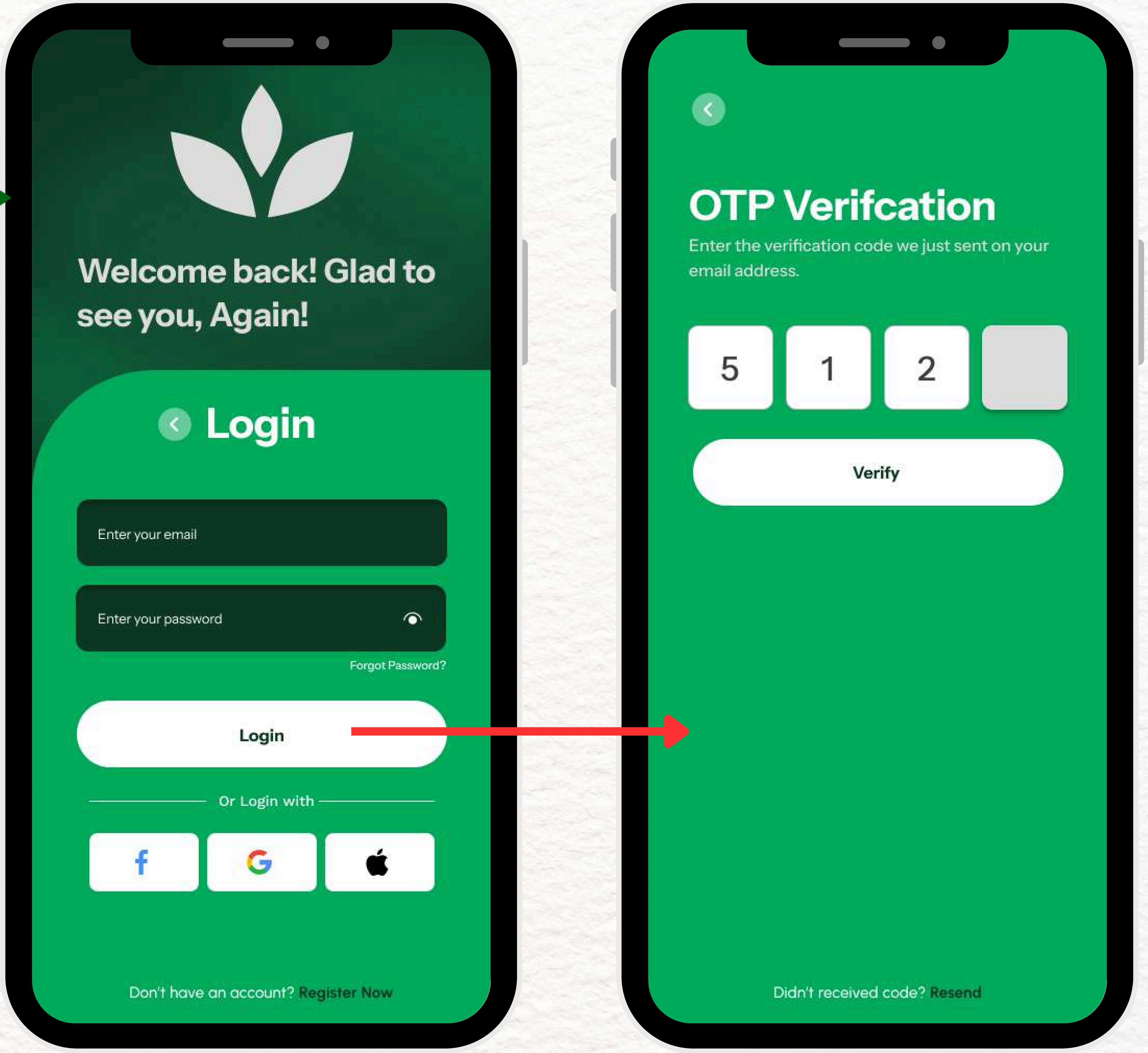
Login using

Unregistered users can

OTP Verification

GrowSync

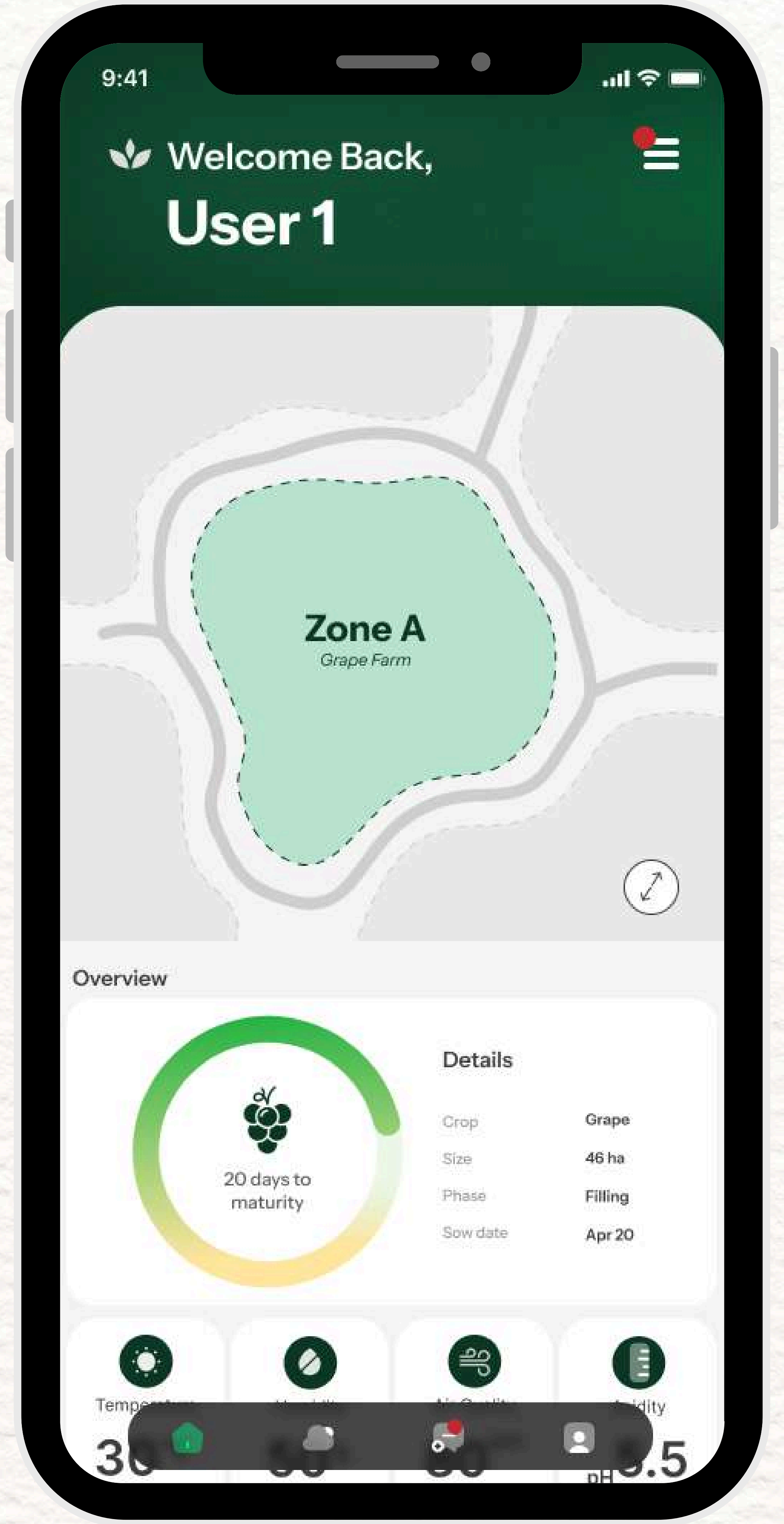
As part of our security measurements, when Users click Login they will have to verify their login via OTP code



Home Page

GrowSync

After the verification process, users will be brough to the home page



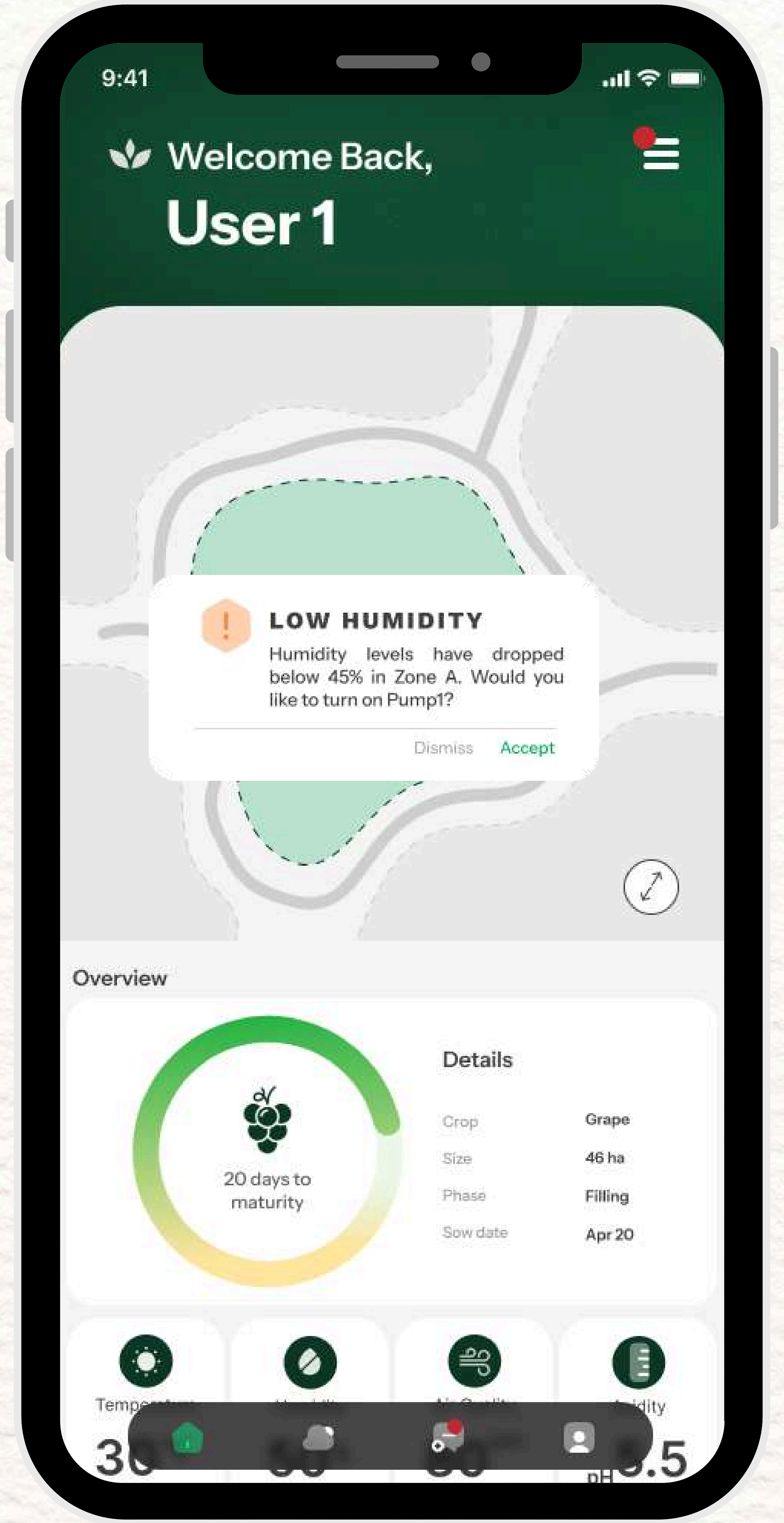
Functions

- Map of the farm
- Overview of the crop details
- Overview of sensor details
- Weather Forecast
- Growth Chart

Alerts

GrowSync

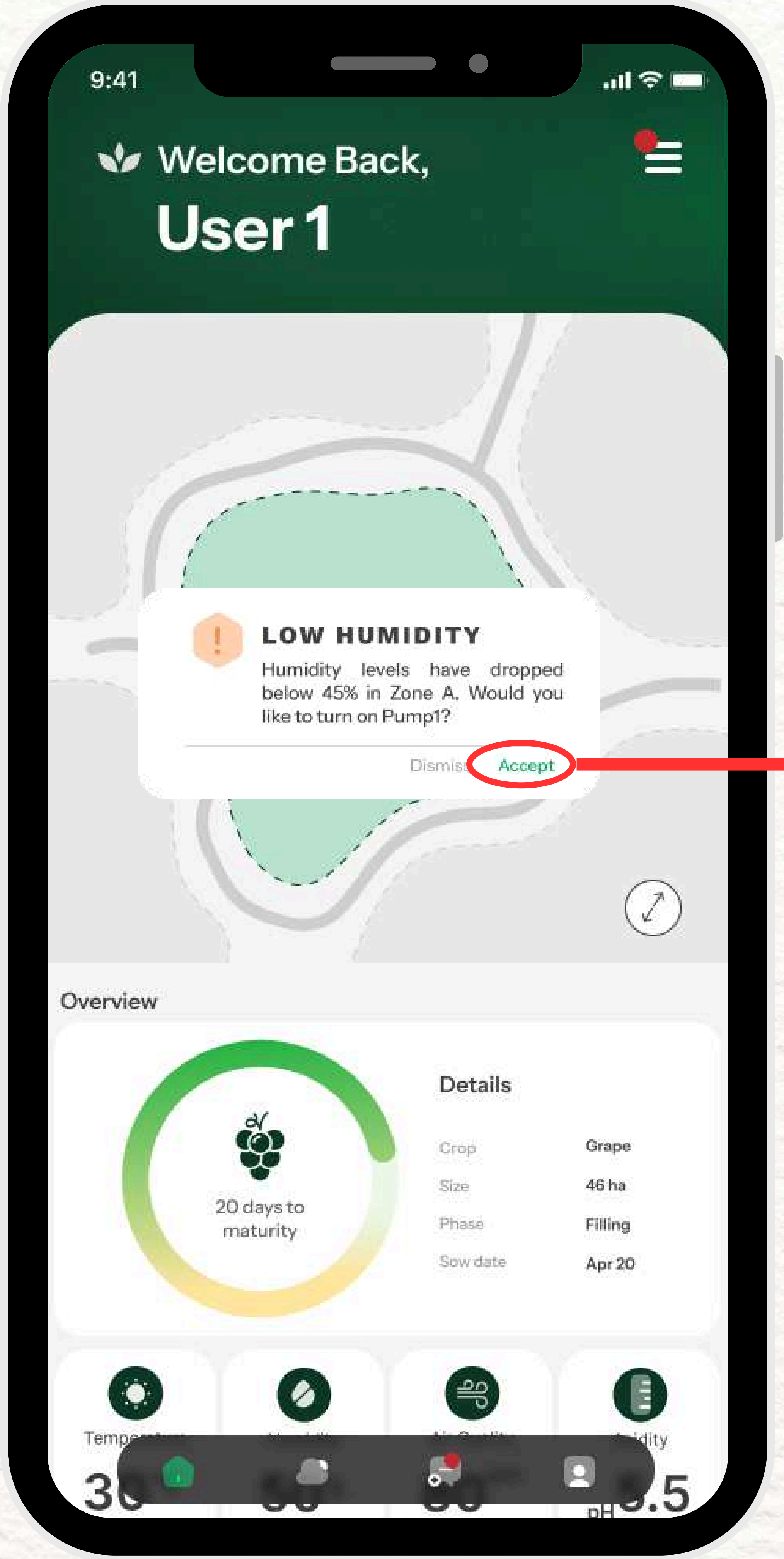
Alerts will pop up on the screen, users will have the choice of choosing to “accept or “dismiss”

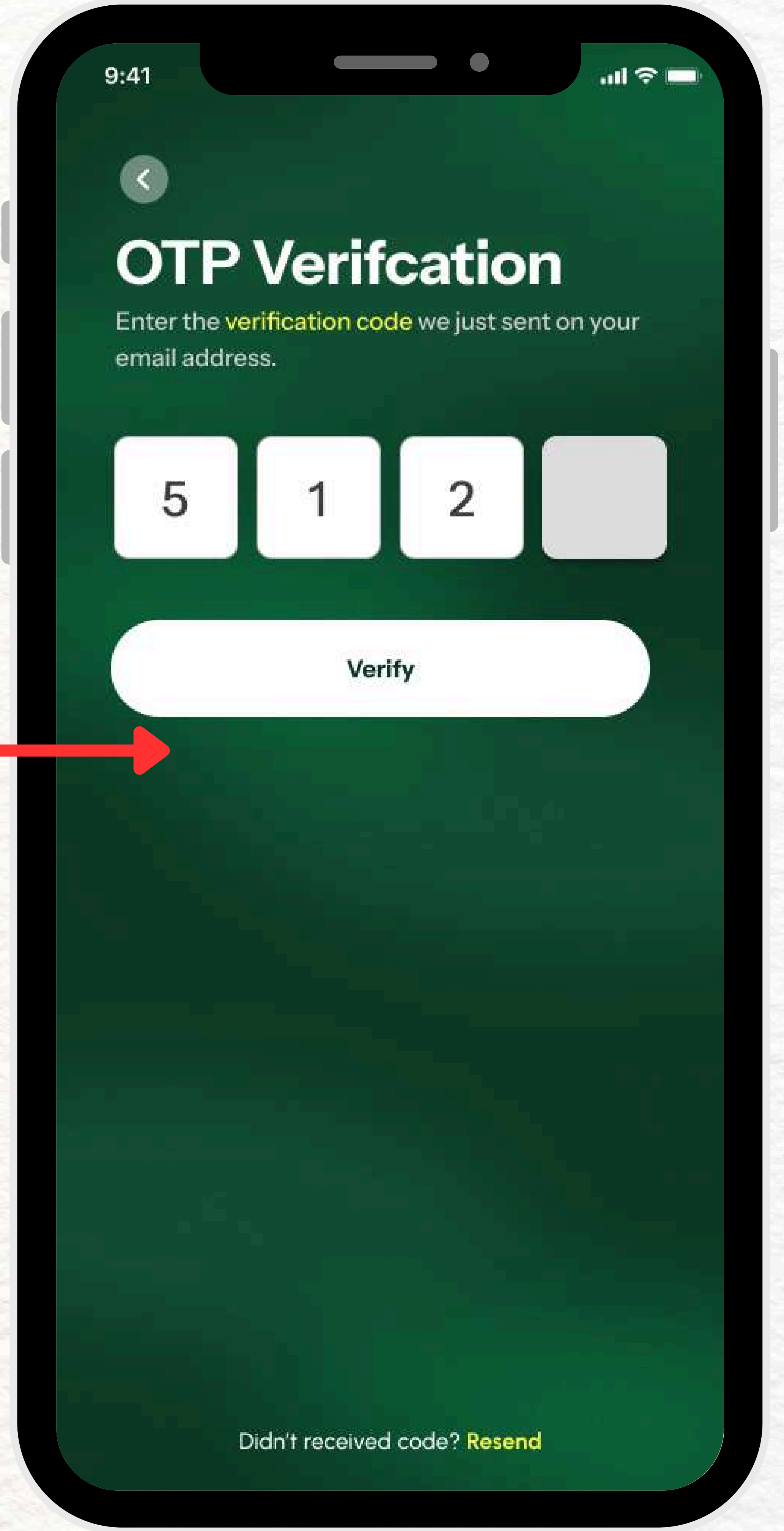


Alerts – OTP

GrowSync

Upon accepting, users will be brought to a OTP authentication for verification again.

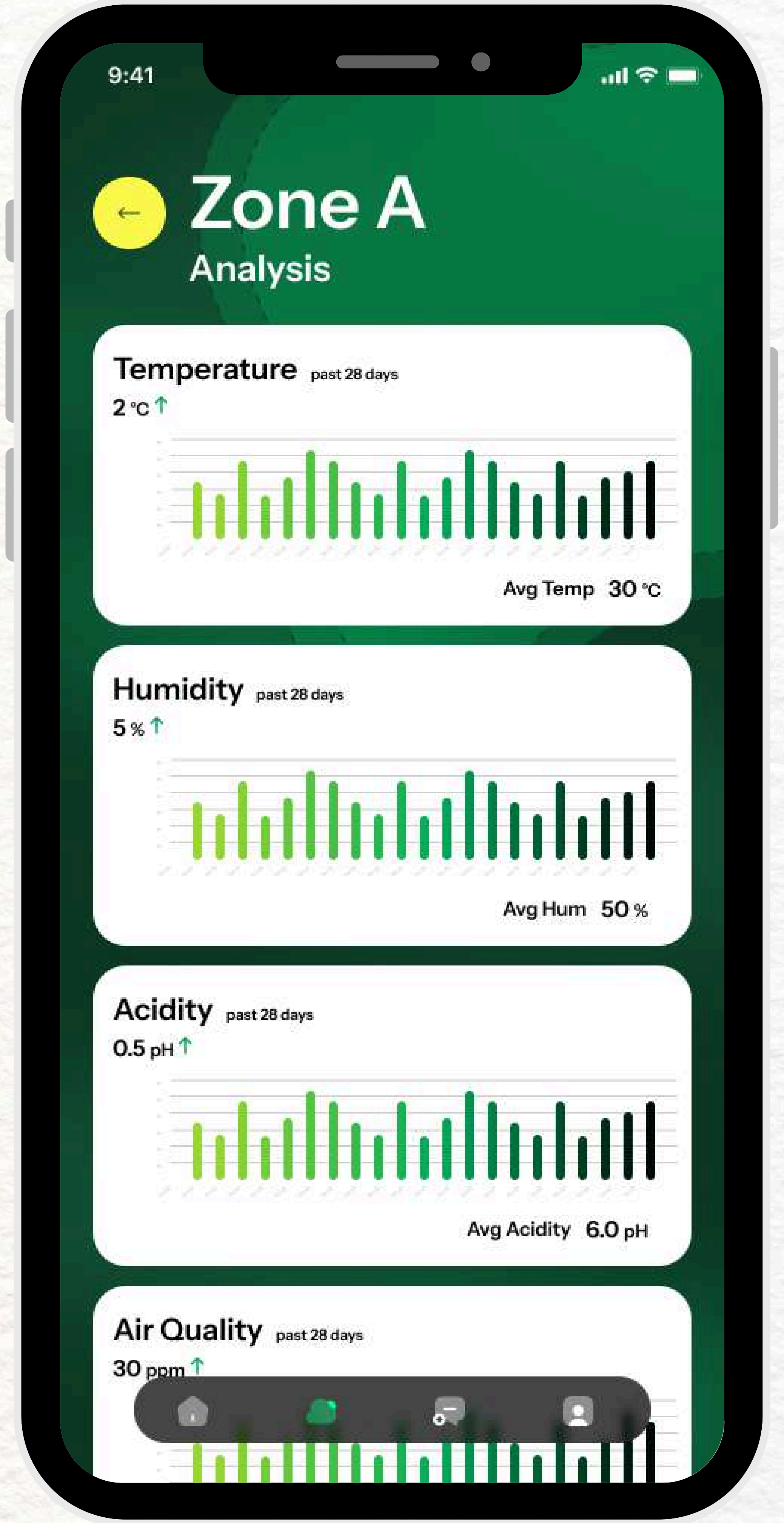




Zones Analysis

GrowSync

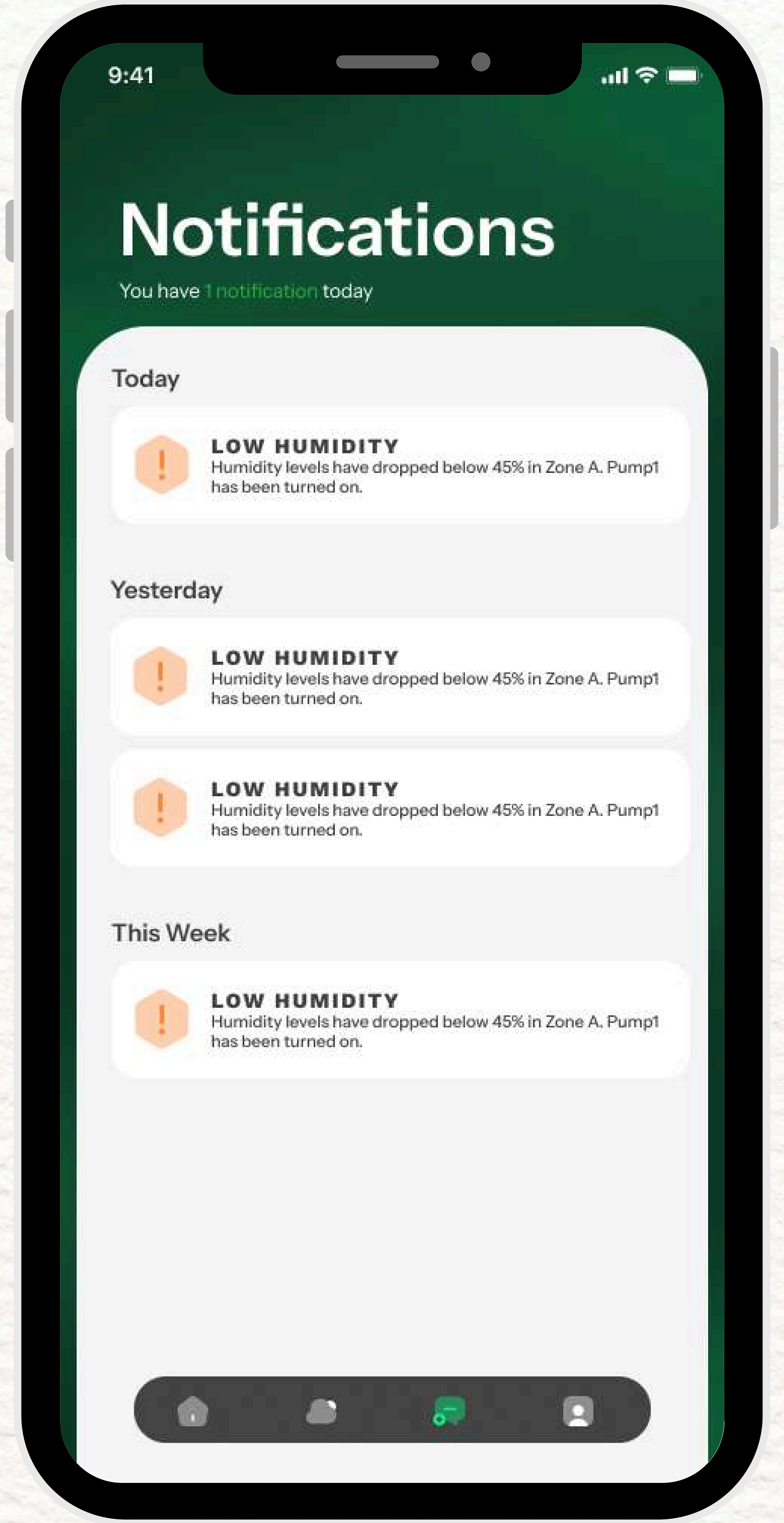
Our Machine Learning data analytics will be displayed in this page.



Notifications Page

GrowSync

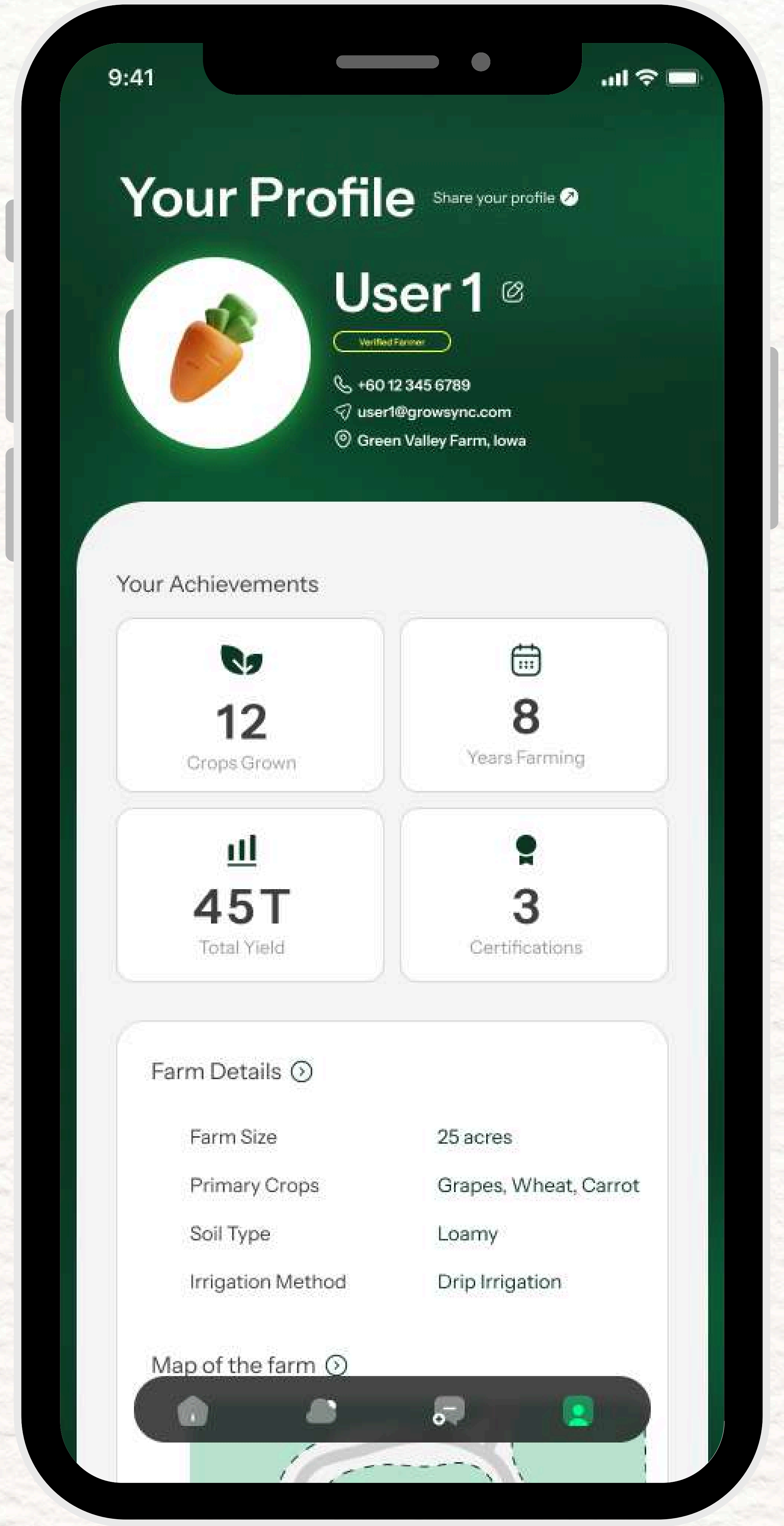
Users can view their past notifications in this page



Profile Page

GrowSync

Users can view their overall profile in this page



Discussion

Limitations

1

Limited Contextual Awareness in Automation

Current automation is based on fixed rules and thresholds; it does not adapt to changing environmental or economic contexts.

2

No Edge-Level Collaborative Intelligence

Edge devices operate in isolation, lacking collective intelligence across different zones or greenhouses.

3

Centralized Cloud Dependency

Relying heavily on cloud platforms introduces latency and makes the system vulnerable to downtime or internet outages.

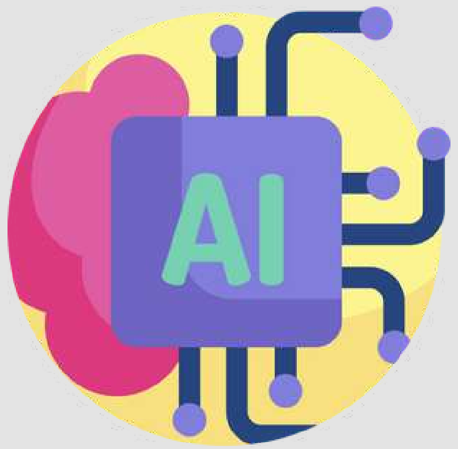
Limitation and Suggestion

Limitation 1

Lack of Context-Aware Decision-Making

Future Work Suggestions

- Integrate external APIs (weather forecast, electricity pricing, crop cycles).
- Implement contextual AI models that adapt to changing conditions.
- Enable dynamic threshold adjustment and predictive recommendations.



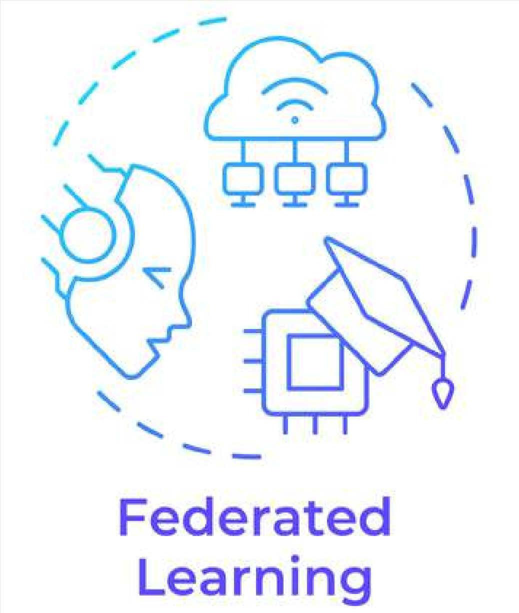
Limitation and Suggestion

Limitation 2

Lack of Swarm Intelligence or Multi-Device Collaboration

Future Work Suggestions

- Use federated learning for distributed model training across nodes.
- Implement multi-agent communication between zones.
- Enable proactive zone-based risk alerts (e.g., pest or fungus detection).



Limitation and Suggestion

Limitation 3

Overdependence on Centralized Cloud Increases Latency and Risk

Future Work Suggestions

- Adopt hybrid cloud-edge architecture.
- Run TinyML models locally for critical decisions (e.g., irrigation, fan control).
- Use local storage buffers (e.g., SQLite) for offline operation.

Conclusion

In conclusion, GrowSync offers a smart, scalable, and affordable solution to modern agriculture challenges. By automating environmental control, enabling real-time monitoring, and supporting data-driven decisions, GrowSync helps farmers improve crop health, reduce resource waste, and boost productivity. With future enhancements like context-aware intelligence and edge collaboration, GrowSync aims to drive the next wave of innovation in sustainable farming.

GrowSync

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Does Anyone Have Any Questions?

Thank you