Smart Farming

Project for Monitoring the Environment conditions of crop field and predicting Onset of pathogen attack on crops/plants.

FACULTY – ZIA ABBAS
TA – ZAINAB RAZA
TEAM – RVHV

<u>Team Members:</u>

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Motivation

Growing Food Demand:

Global population growth requires a 70% increase in food production by 2050, making precision farming is essential for sustainable agriculture.

Environmental Impact Reduction :

Excessive pesticide use harms ecosystems. Our project tries to minimise environmental pollution and preserve biodiversity.

Economic Efficiency:

Early detection of pathogens prevents widespread crop loss, reducing pesticide and labour costs for farmers.

Reducing Food Waste:

Minimising crop loss from pathogens directly reduces food waste and enhances food security.

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Adapting to Climate Change:

Real-time sensor data helps farmers respond to climate-induced diseases, enhancing resilience and sustainability.

Scalable and Sustainability :

The system can be implemented on farms of any size, adapting to various crops and regions.
Precision farming reduces the environmental impact of agriculture by limiting the overuse of chemicals, protecting ecosystems and promoting sustainable practices.

Integration with Smart Farming:

Sensors and data analytics provide farmers with instant feedback, allowing timely adjustments to crop management, improving farm efficiency and reducing risks.

COMPONENTS REQUIRED:

1. Microcontroller (ESP32)
2. DHT22
3. SGP 30
4. LDR
5. Capacitive Soil Moisture Sensor
6. MQ135
7. Relay Module
8. 12V Mini Submersible Water Pump + pipe

USE CASE OF EACH COMPONENT
1)ESP32(MICROCONTROLLER): THE ESP32 IS A LOW-POWER MICROCONTROLLER WITH BUILT-IN WI-FI AND BLUETOOTH.

2) DHT22 (TEMPERATURE AND HUMIDITY SENSOR): DHT22 USES A THERMISTOR FOR TEMPERATURE MEASUREMENT AND A CAPACITIVE HUMIDITY SENSOR TO MEASURE RELATIVE HUMIDITY.

3) SGP30 (VOC AND CO2 SENSOR): **THE SGP30 SENSOR DETECTS VOCS (VOLATILE ORGANIC COMPOUNDS) AND CO2 EQUIVALENTS USING A METAL OXIDE GAS SENSOR.**

4) LDR (LIGHT DEPENDENT RESISTOR): **THE LDR GIVES LIGHT INTENSITY VALUES BY CHANGING ITS RESISTANCE BASED ON THE INTENSITY OF LIGHT.**

5) RESISTIVE SOIL MOISTURE SENSOR: A RESISTIVE SOIL MOISTURE SENSOR WORKS BY MEASURING THE ELECTRICAL RESISTANCE BETWEEN TWO CONDUCTIVE PROBES INSERTED INTO THE SOIL.

6) Relay Module(5V): A 5V RELAY MODULE ALLOWS A LOW-POWER CONTROL SIGNAL FROM A MICROCONTROLLER (LIKE ARDUINO) TO SWITCH HIGH-POWER DEVICES ON AND OFF.

7)WATER PUMP(12V DC): A **DC WATER PUMP** IS A COMPACT, ENERGY-EFFICIENT DEVICE THAT USES **DIRECT CURRENT (DC)** ELECTRICITY TO TRANSFER WATER FROM ONE PLACE TO ANOTHER.

OVERALL USE CASE:
THE SYSTEM INTEGRATES SENSORS TO MONITOR KEY ENVIRONMENTAL AND PLANT-SPECIFIC PARAMETERS (TEMPERATURE, HUMIDITY, VOCS, SOIL MOISTURE, CO_2) WITH AN **ESP32** MICROCONTROLLER FOR DATA PROCESSING. ACTUATORS RESPOND BY ADJUSTING CONDITIONS OR APPLYING TREATMENTS. THIS SETUP ENABLES **EARLY PATHOGEN DETECTION**, **CONTROLLED PESTICIDE USE**, AND **EFFICIENT RESOURCE MANAGEMENT**, REDUCING WASTE AND ENVIRONMENTAL IMPACT WHILE ENHANCING CROP HEALTH AND YIELD.

IoT-Based Plant Stress Detection System Overview:

1. **Observation**: IoT sensors detect environmental and plant-specific parameters (e.g., VOCs, soil moisture, temperature) for real-time plant stress monitoring.

2.**Data Transmission**: Sensor data is sent to ThingSpeak using MQTT for efficient, real-time updates over low-bandwidth networks.

3.**Data Storage**: ThingSpeak securely stores historical environmental data for long-term analysis and pattern recognition.

4.**Data Retrieval**: Data is accessed via API keys through HTTP GET requests for real-time and historical analysis.

5.**Data Analysis**: AI and ML analyze trends to predict future conditions, visualized on a dashboard for actionable insights.

6.**Diagnostics**: Early detection of plant stress (e.g., pests, nutrient issues) through VOC and environmental pattern analysis.

7.**Precision Control**: Targeted interventions (e.g., localized pesticide use) optimize crop care, reducing resource waste and environmental impact.

THRESHOLD VALUES

1. Temperature (°C):
- Optimal range: 15°C to 35°C.
- Below 15°C: Plant metabolic activities slow down, leading to stunted growth.
- Above 35°C: Plants experience heat stress, causing wilting or reduced productivity.

2. Humidity (%):
- Optimal range: 30% to 100%.
- Below 30%: Excessive water loss occurs due to increased transpiration.
- Above 100%: Promotes fungal growth and increases susceptibility to diseases.

3. CO_2 Levels (ppm):
- Optimal range: 300 ppm to 1000 ppm.
- Below 300 ppm: Photosynthesis is impaired, reducing plant growth.
- Above 1000 ppm: Indicates poor air circulation, potentially causing plant stress.

4. Volatile Organic Compounds (VOCs) (ppb):
- Safe range: 0 ppb to 500 ppb.
- Above 500 ppb: Signals plant stress, often due to pathogens, pest infestations, or nutrient deficiencies.

5. Soil Moisture (%):
- Healthy range: 14.53% to 85.47%.
- Below 14.53%: Indicates drought-like conditions, limiting nutrient absorption.
- Above 85.47%: Suggests waterlogging, leading to root damage and oxygen deficiency.

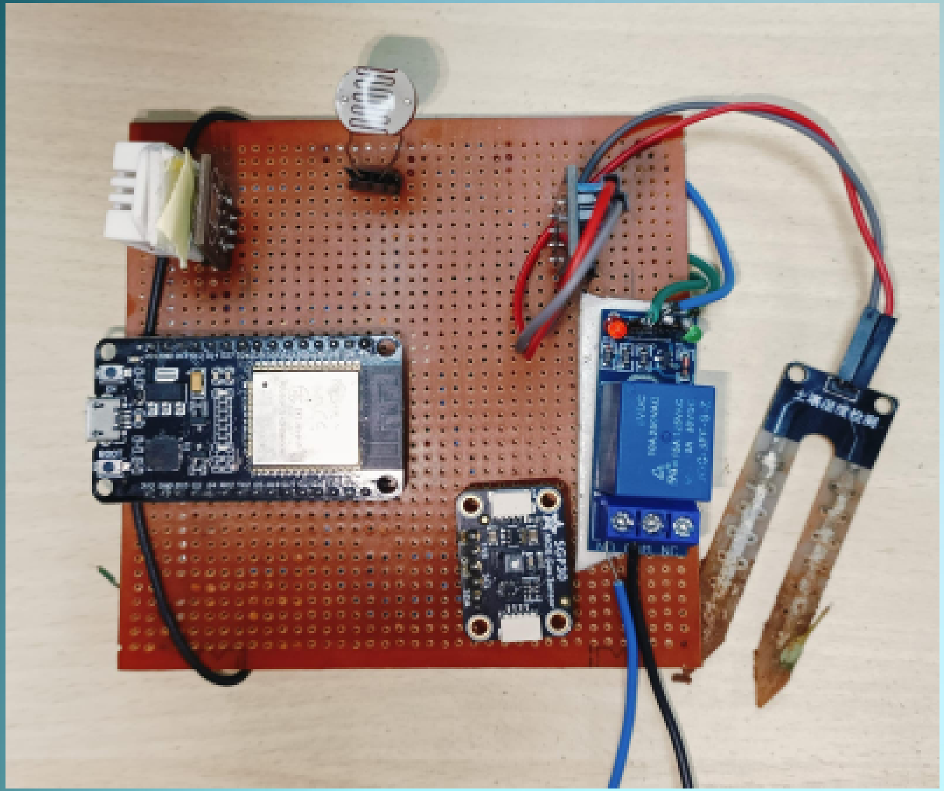
6. Light Intensity (%):
- Optimal range: 50% to 100%.
- Below 50%: Photosynthesis is inhibited, affecting plant growth.
- Above 100%: Causes heat stress or light damage to plants.

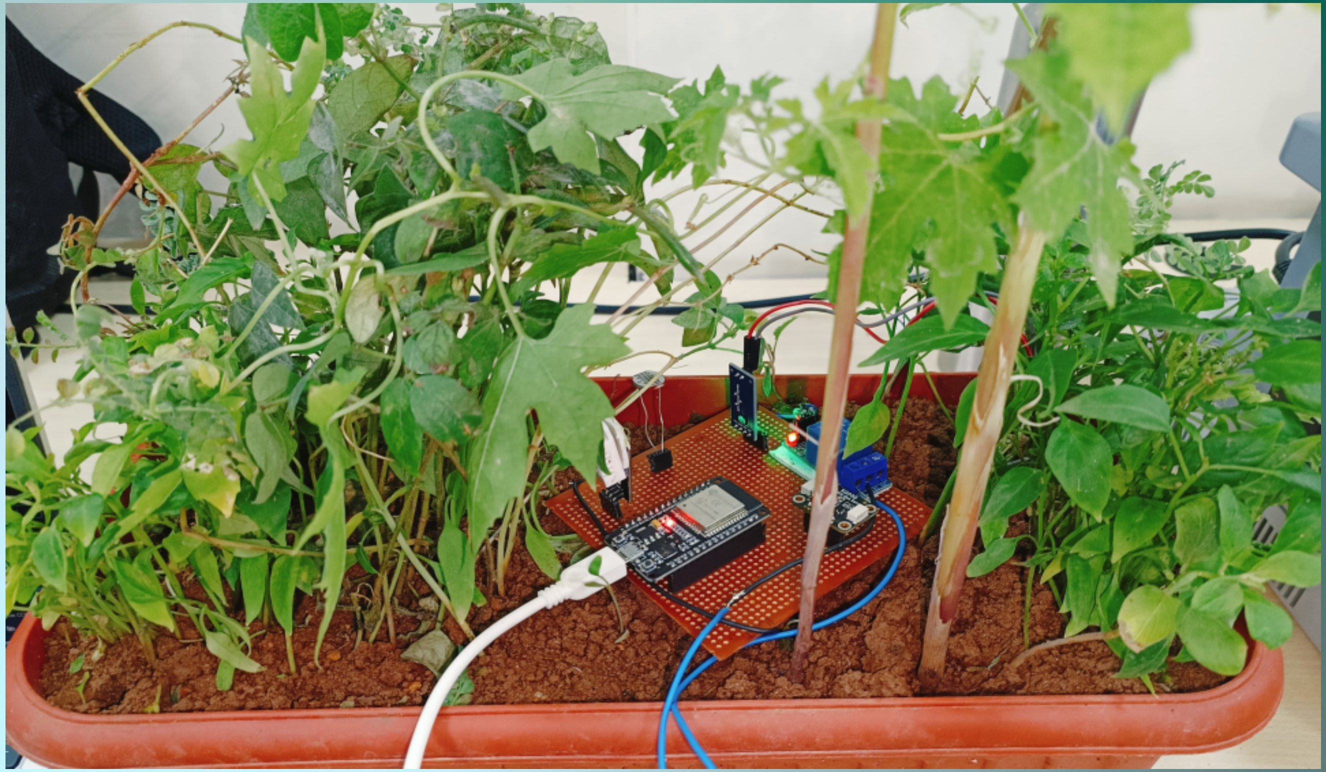
Key Indicators of High Pathogen Likelihood:

1. **Humidity (95%)**
2. **Temperature (36°C)**
3. **VOCs (600 ppb)**
4. **Soil Moisture (90%)**
5. **CO_2 Levels (1000 ppm)**

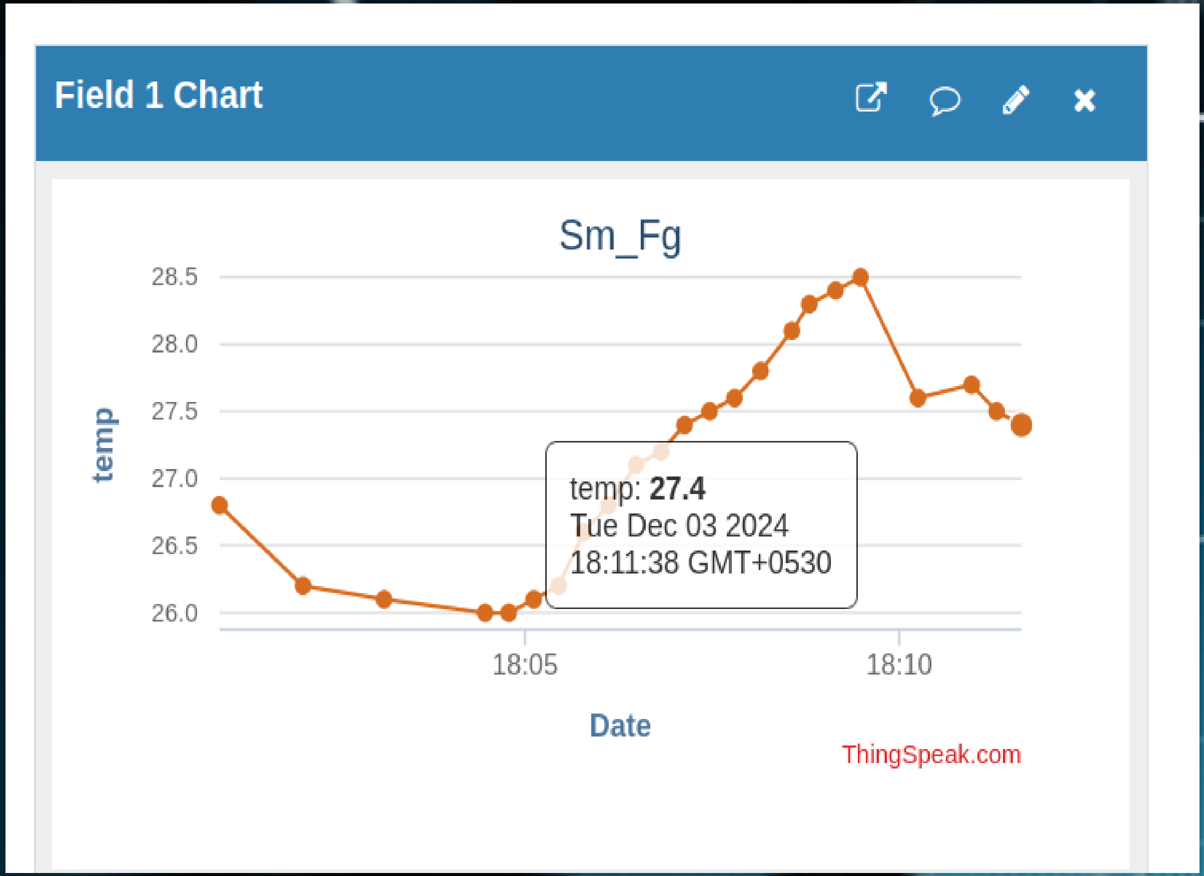
Likely Pathogens:
High VOCs, CO_2, and waterlogged, humid, warm conditions favour pathogens like **Botrytis cinerea**, **Pythium spp.**, and **Phytophthora spp.**(Stress signals (elevated VOCs), and High CO_2 levels. ($>$ 600 ppb and $>$ 1000 ppm).

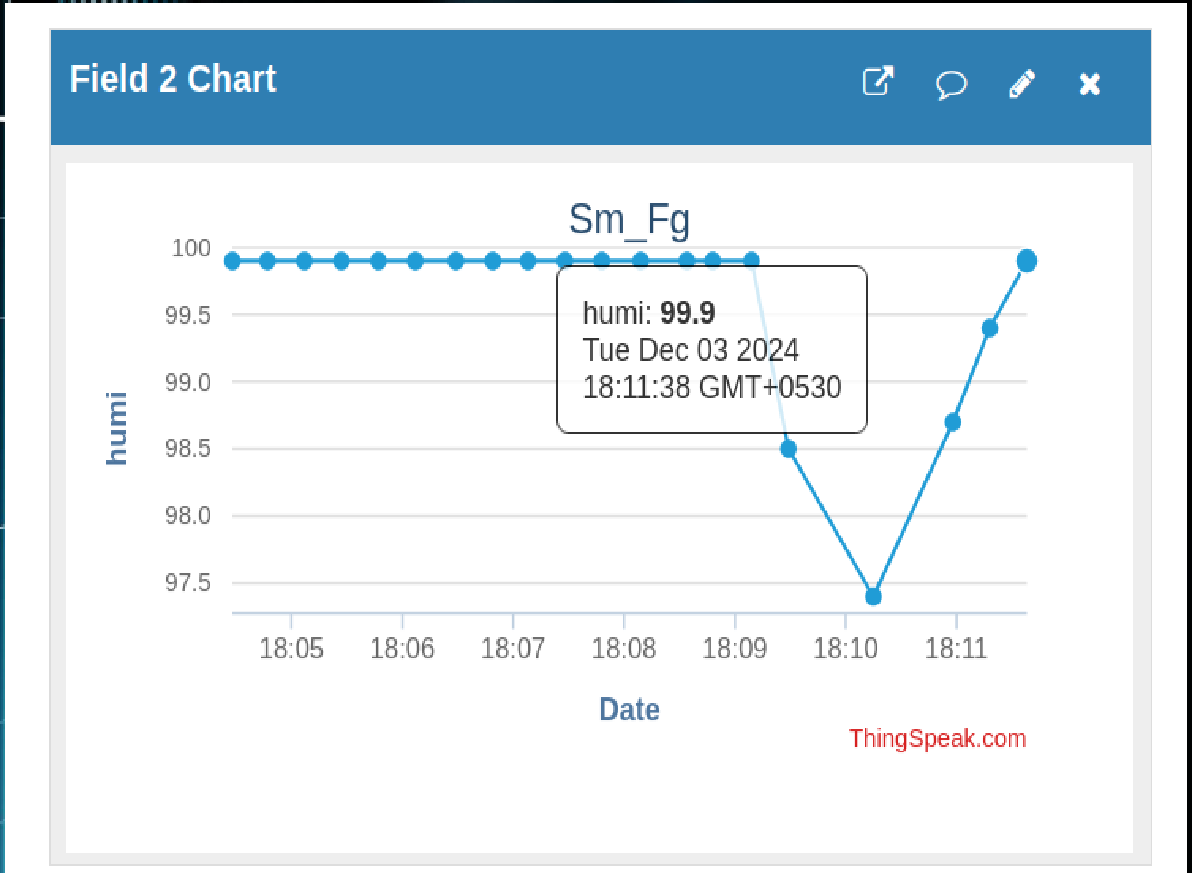
CIRCUIT DIAGRAM



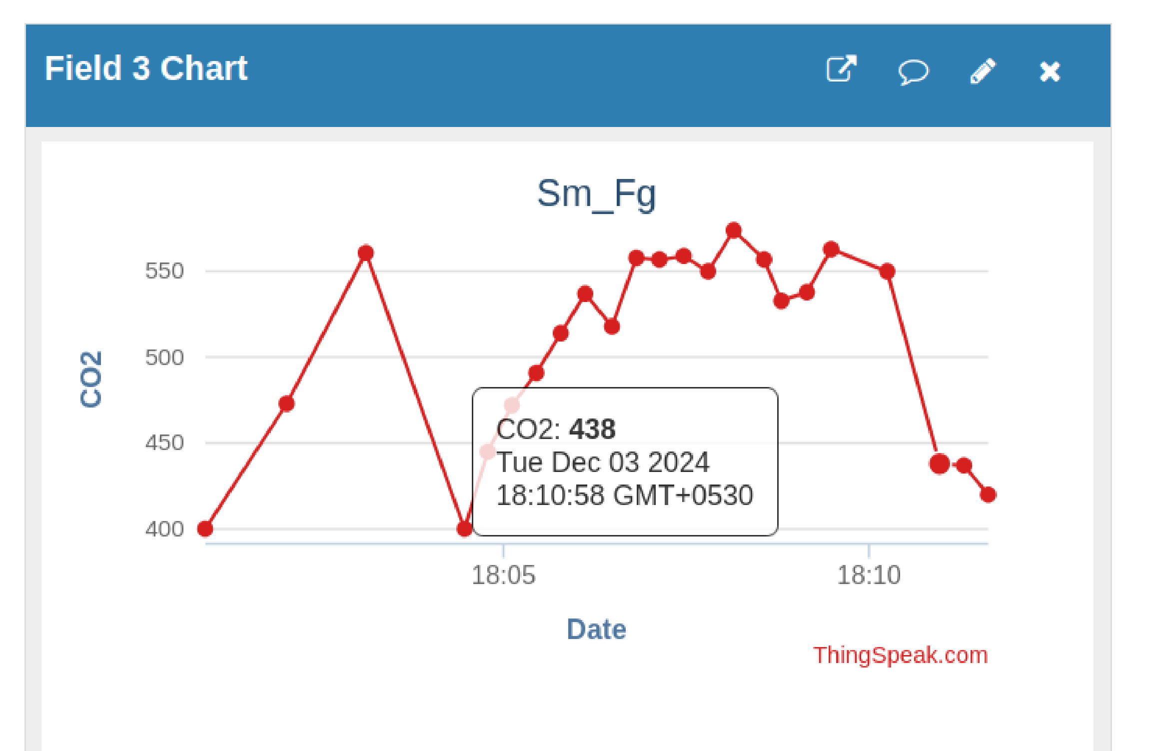


TEMPERATURE HUMIDITY

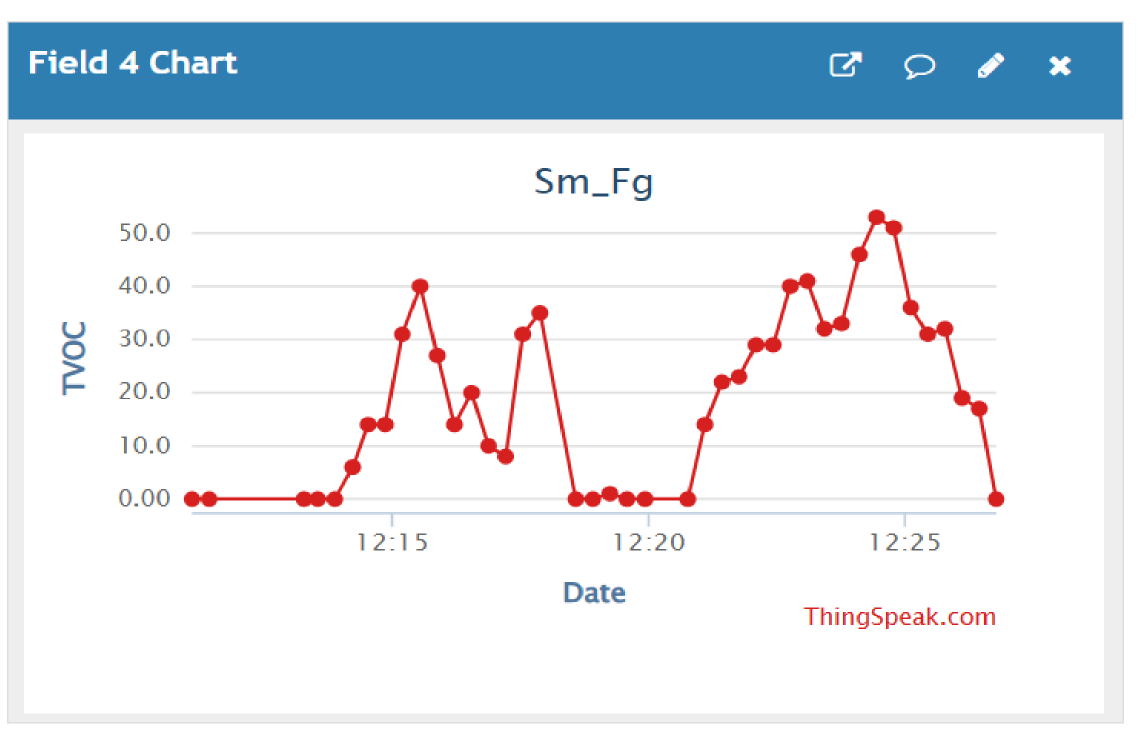




CO2
TVOC

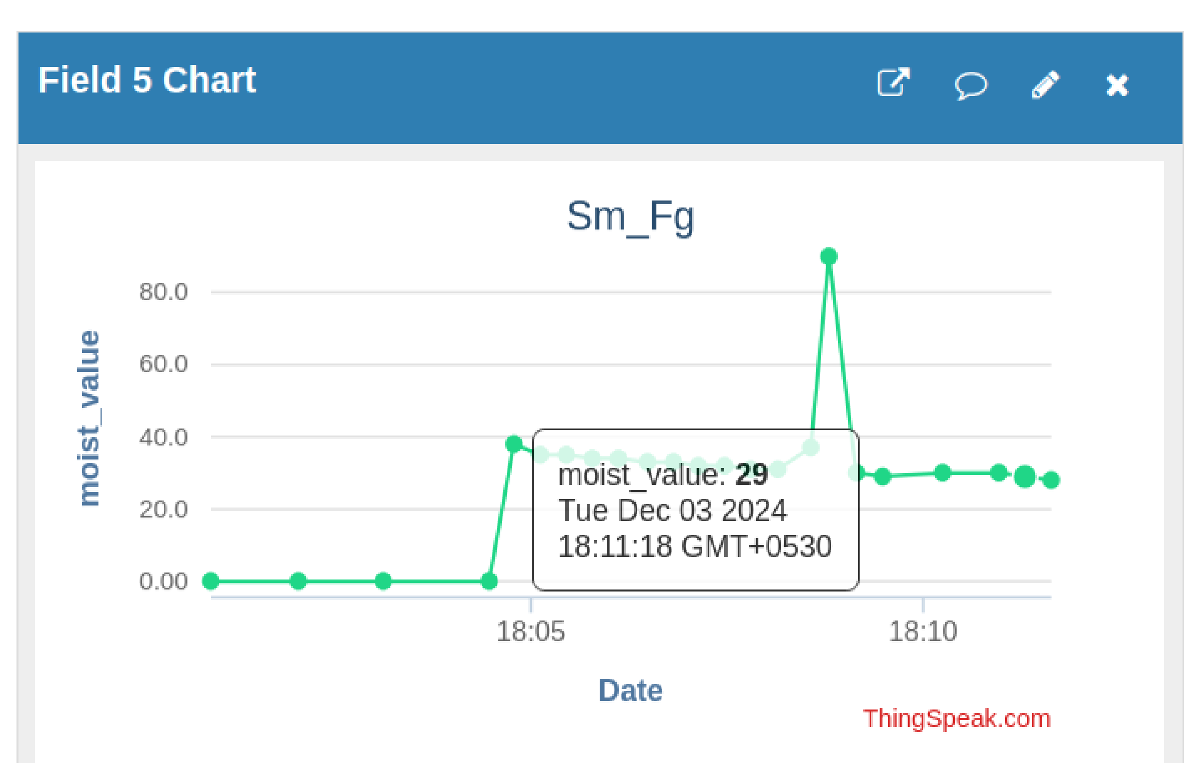


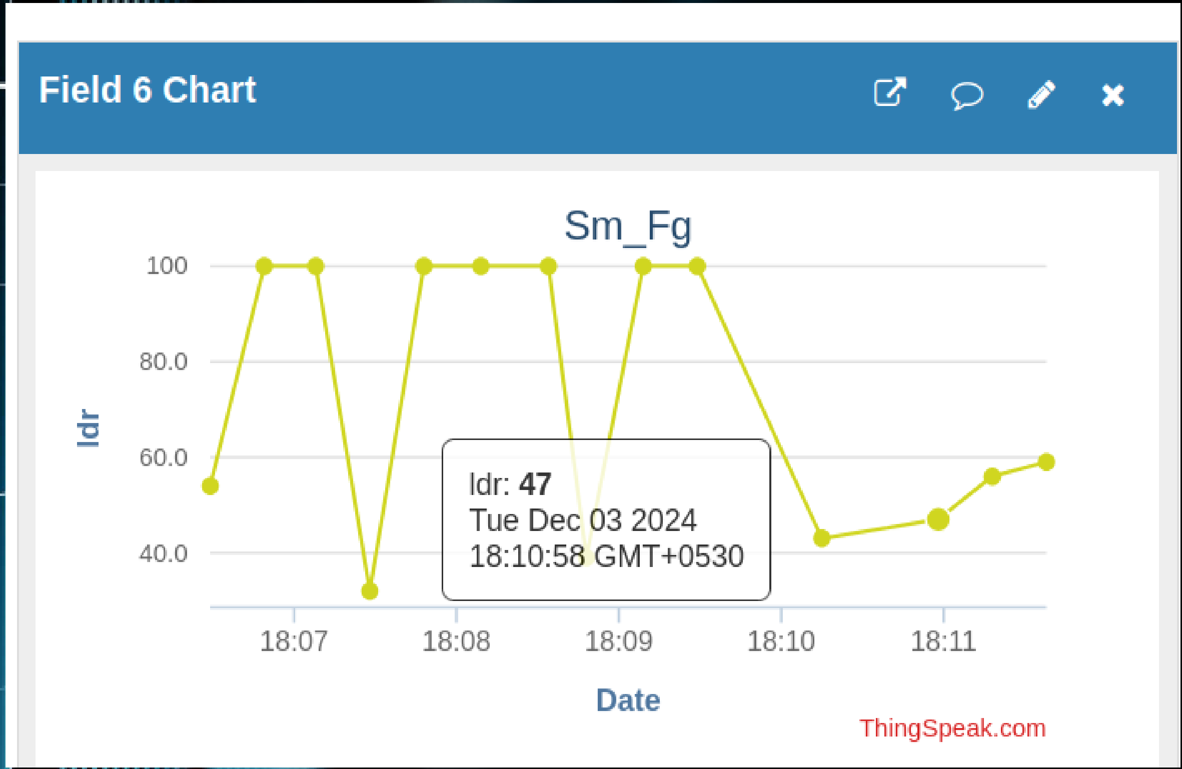
Field 3 Chart
Sm_Fg
CO2
550
500
450
400
CO2: 438
Tue Dec 03 2024
18:10:58 GMT+0530
18:05
18:10
Date
ThingSpeak.com



Field 4 Chart
Sm_Fg
TVOC
50.0
40.0
30.0
20.0
10.0
0.00
12:15
12:20
12:25
Date
ThingSpeak.com

MOISTURE
LDR





WEB PAGE FUNCTIONALITIES

1. Dashboard:

Displays real-time environmental data from sensors, including:

Temperature, Humidity, CO_2, VOC, Soil Moisture, and Light Intensity.

Uses color-coded alerts for critical values:

Red for high-risk levels (e.g., CO_2, VOC).

Green/Yellow for safe or cautionary thresholds.

Provides a quick overview for immediate decision-making.

2. Analysis Page:

Visualizes sensor data with **predicted trends** using **AI/ML models**.

Displays graphs showing future projections for parameters like temperature, humidity, and soil moisture.

Helps in identifying potential risks, such as plant stress or disease, based on trend analysis.

Each card shows current vs. predicted values, helping farmers anticipate changes in critical parameters.

Alerts (red icons) highlight values above safe ranges, requiring attention (e.g., CO_2 and VOC levels).

3. Charts Page:

Contains **historical data visualizations** from **ThingSpeak**.

Shows detailed, time-series graphs of all monitored parameters.

Useful for tracking long-term environmental changes and understanding past conditions for better crop management.

The **Charts Page** presents a detailed visualization of real-time sensor data trends over time, providing a historical perspective for each parameter.

4.Profile Page:

Displays personal details like name, email, and role.

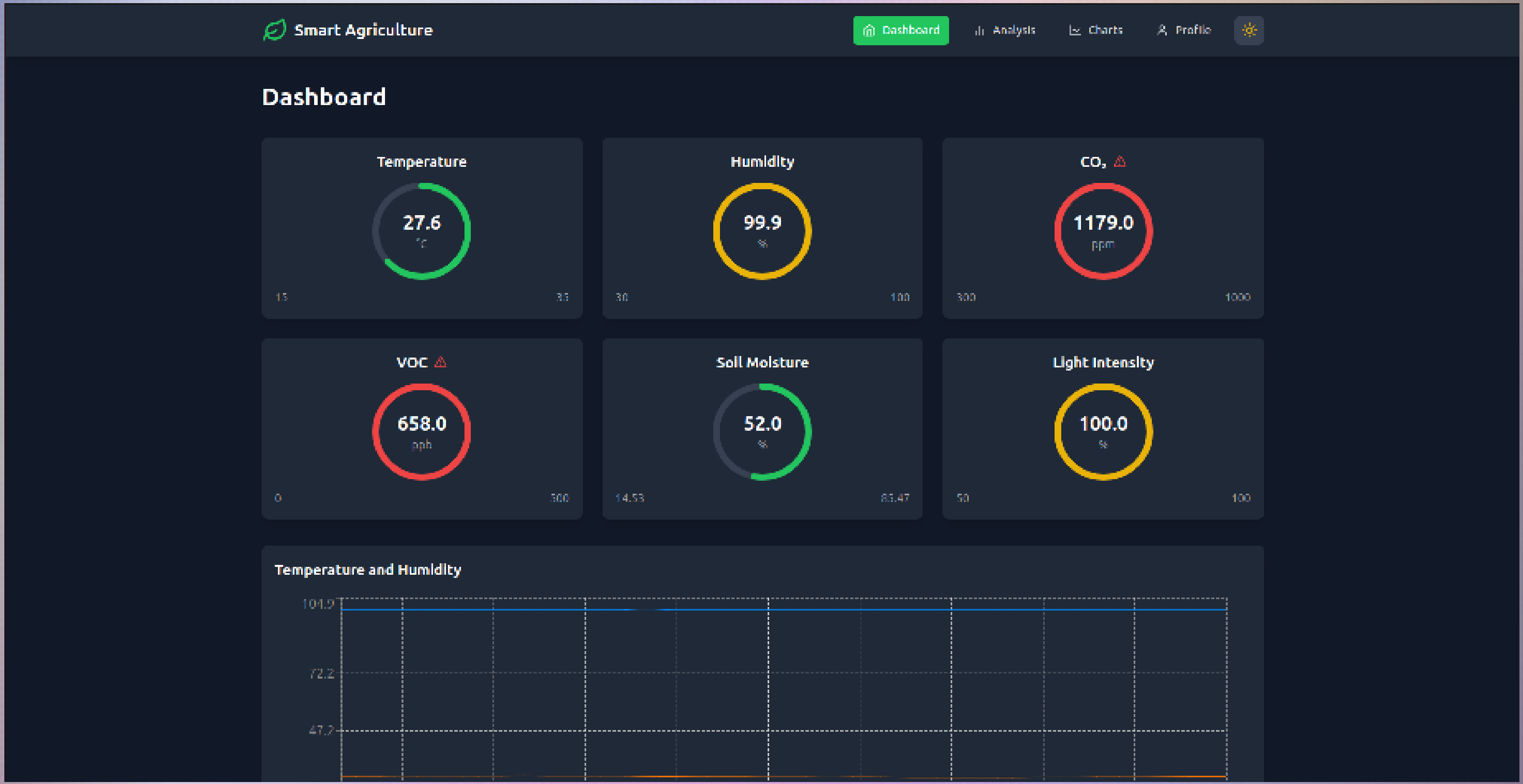
Contact Info:

Phone number for quick contact.

Address, likely of the organization or farm location

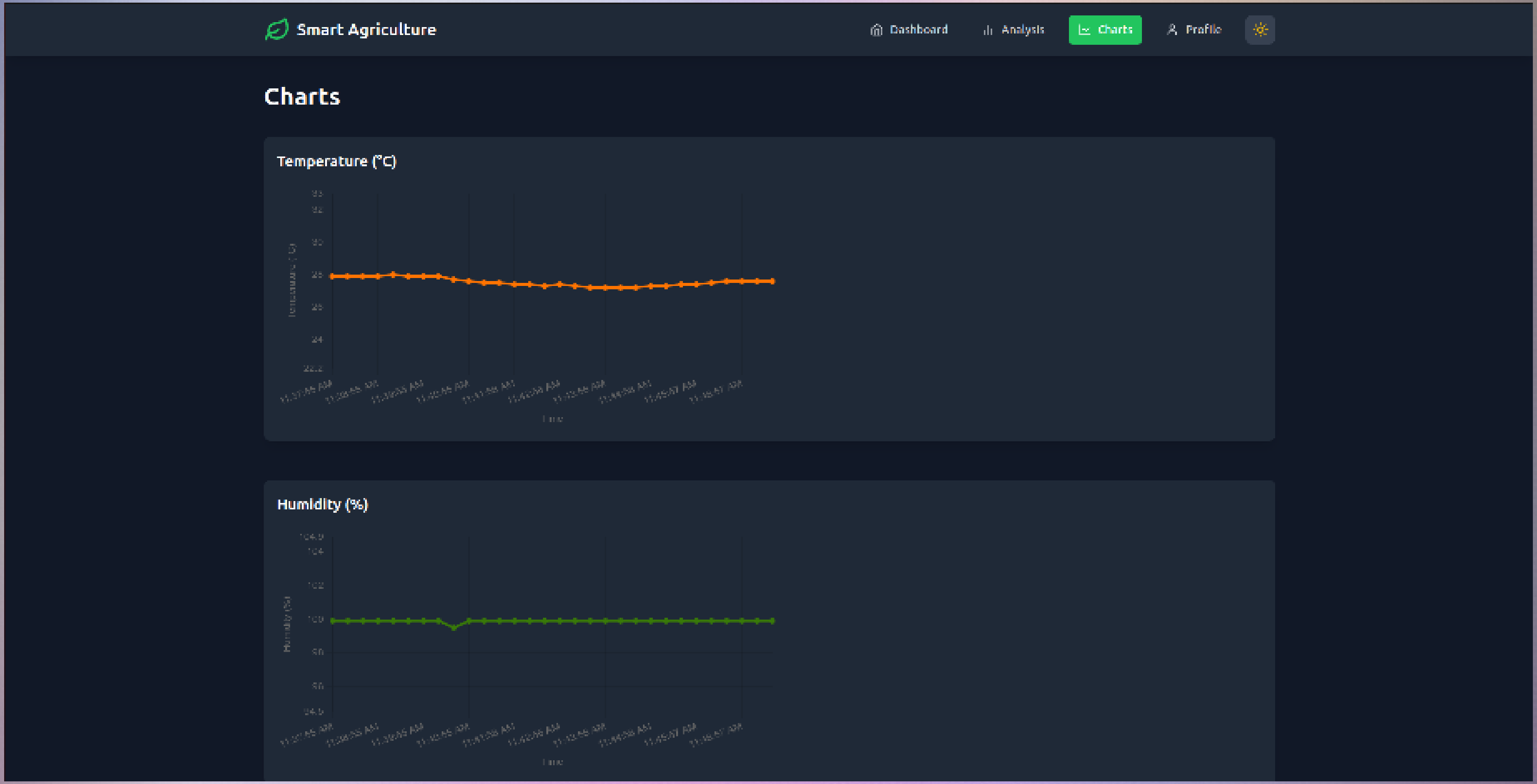
Email ID (e.g., rvhv@iiit.ac.in) for communication.

DASHBOARD

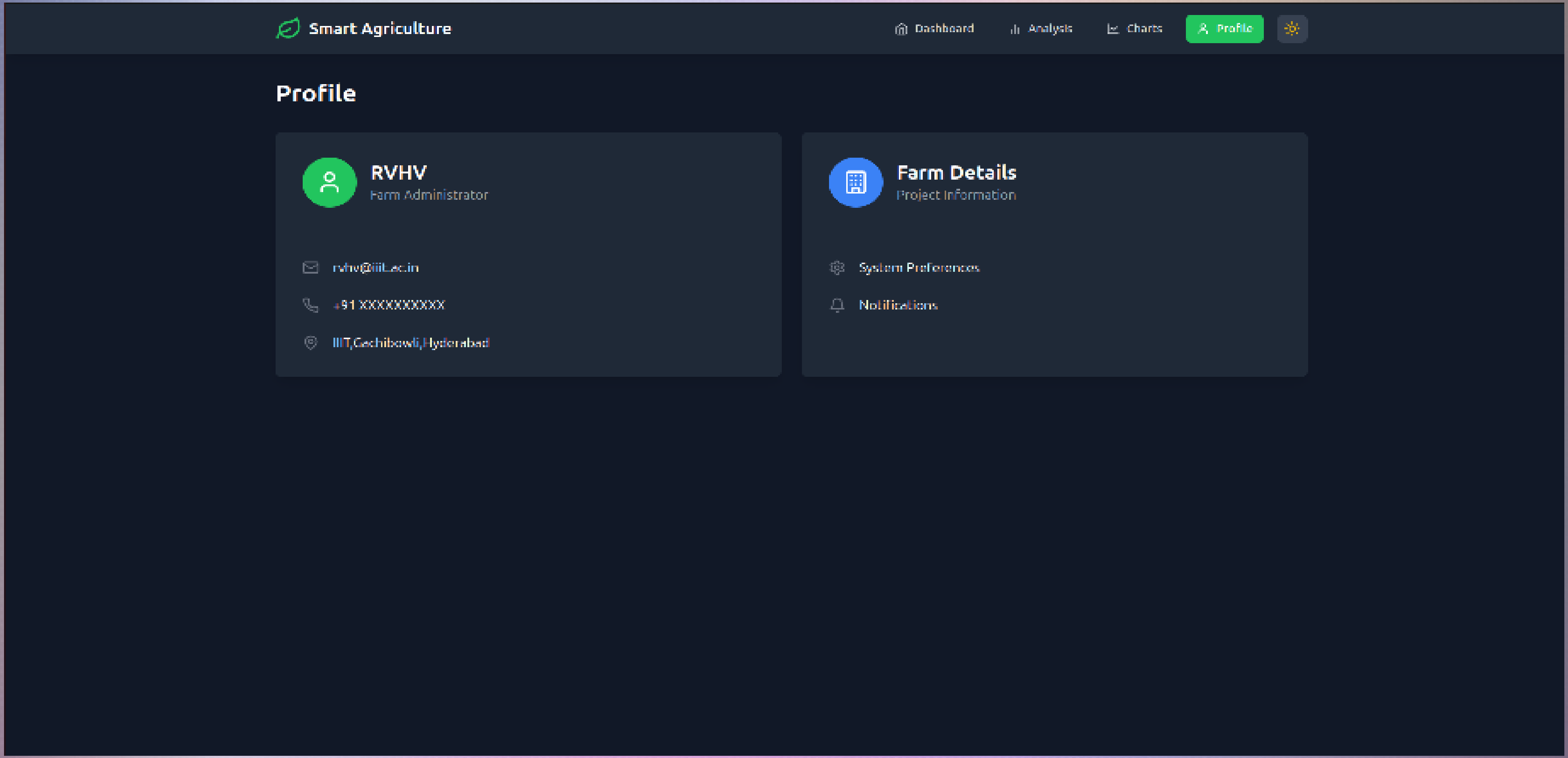

Smart Agriculture
Dashboard
Analysis
Charts
Profile
Dashboard
Temperature
27.6
15
35
Humidity
99.9
%
30
100
CO₂
1179.0
ppm
300
1000
VOC
658.0
ppb
0
500
Soil Moisture
52.0
%
14.53
83.47
Light Intensity
100.0
%
50
100
Temperature and Humidity
101.9
72.2
47.2

ANALYSIS PAGE

CHARTS PAGE


Smart Agriculture
Dashboard
Analysis
Charts
Profile
Charts
Temperature (°C)
Humidity (%)

PROFILE PAGE



CONTRIBUTIONS

M. VAISHNAVI, K. RITHVIKA, S. HARSHIKA
Role: **Hardware Design & Sensor Integration**
Integrated IoT sensors for temperature, humidity, soil moisture, VOCs, and CO2 monitoring.
Ensured proper sensor placement and microcontroller connectivity for seamless data transmission.

K. RITHVIKA, M. VAISHNAVI
Role: **Cloud Integration & Backend Development**
Configured ThingSpeak for data collection and analysis using MQTT for secure, real-time transmission.
Developed Python scripts for data retrieval via API and processed it for frontend visualization.

P. VISWAS REDDY
Role: **Data Analysis & Predictive Modeling**
Applied ML techniques to analyze sensor data and developed models to forecast environmental and plant health trends.

S. HARSHIKA, P. VISWAS REDDY
Role: **Frontend Development & Data Visualization**
Designed a user-friendly webpage to display real-time sensor data with interactive graphs and charts.

SUMMARY / CONCLUSION

The SMART FARMING project aims to enhance agricultural practices by leveraging IoT technology to monitor critical environmental and plant parameters. By integrating sensors for VOCs, temperature, humidity, light, soil pH, and soil moisture, and utilizing the ESP32 microcontroller for data processing and transmission, the system will provide actionable insights for early pathogen detection and precise pesticide application. This approach promises to improve plant health, reduce environmental impact, and support sustainable farming practices.


THANK YOU