



USER MANUAL

User Manual

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1. System Overview

1.1 Introduction

The Smart Agriculture Monitoring System (SAMS) is an integrated IoT solution designed to revolutionize agricultural management in Sri Lanka's plantation sectors. The system addresses critical challenges in traditional farming methods by providing real-time monitoring, automated alerts, and data-driven decision-making capabilities.

1.2 Key Benefits

- **Real-time Monitoring:** Continuous environmental and soil condition tracking
- **Cost Reduction:** Eliminates frequent laboratory testing requirements
- **Improved Yields:** Data-driven irrigation and nutrient management
- **Remote Access:** Monitor fields from anywhere via mobile and web applications
- **AI Integration:** Automated tree health detection using advanced computer vision

1.3 System Architecture

SAMS consists of four main components:

1. **Fixed Monitoring Unit** - Permanent field installation for environmental sensing

2. **Portable Monitoring Unit** - Handheld device for soil analysis
3. **Mobile Application** - Field operations and real-time monitoring
4. **Web Dashboard** - Administrative control and analytics

All components communicate through Firebase Cloud for seamless data synchronization.

2. Getting Started

2.1 System Requirements

Minimum Requirements:

- **Mobile Device:** Android
- **Internet Connection:** Wi-Fi or 4G/5G mobile data
- **Web Browser:** Chrome 90+, Firefox 88+, Safari 14+
- **Hardware:** ESP32-compatible power supply (3.7V Li-ion battery recommended)

Recommended Specifications:

- **Mobile RAM:** 4GB or higher
- **Storage:** 2GB available space
- **Network:** Stable broadband connection for web dashboard
- **Field Coverage:** Wi-Fi range extenders for large plantations

2.2 Account Setup

Step 1: Request Access

Contact your system administrator to create your account with appropriate user permissions.

Step 2: Initial Login

1. Open the SAMS mobile app or web dashboard
2. Enter your registered email address
3. Enter your temporary password (provided by admin)
4. Complete the mandatory password change on first login

Step 3: Profile Configuration

1. Navigate to **Profile Settings**
 2. Update your personal information
 3. Set notification preferences
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3. Hardware Components

3.1 Fixed Monitoring Unit

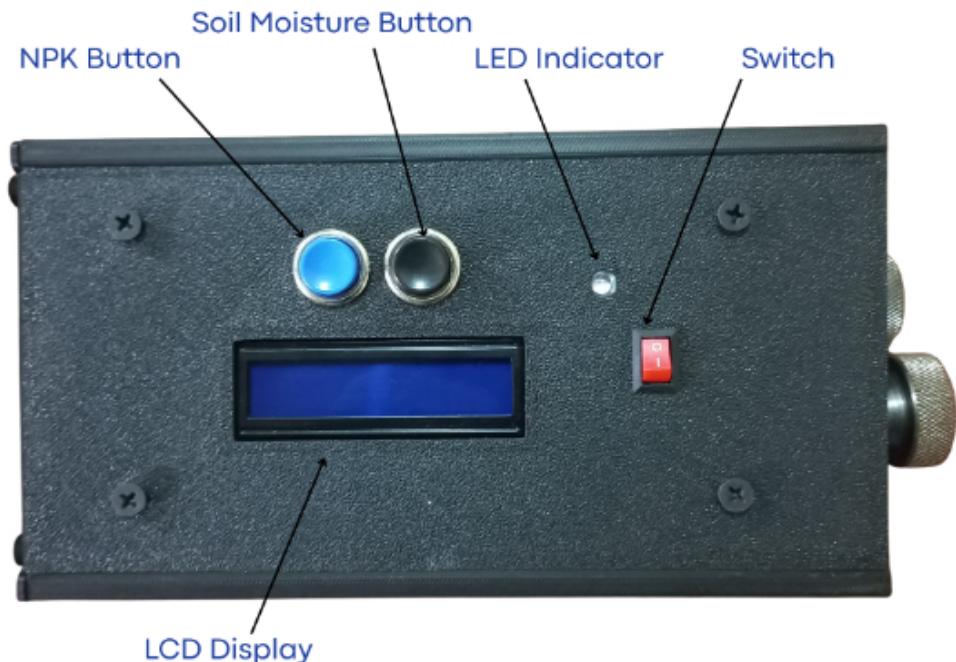


Purpose: Continuous environmental monitoring installed permanently in the field.

Components Overview:

Component	Function	Installation Notes
Tipping Bucket Rain Gauge	Measures rainfall accumulation	Mount 1m+ above ground, level surface
BH1750 Light Sensor	Monitors sunlight intensity (Lux)	Position in full sunlight, avoid shadows
DHT11 Sensor	Temperature and humidity monitoring	Ventilated, shaded enclosure required
ESP32 Controller	Data processing and transmission	Waterproof enclosure (IP65+ rating)

3.2 Portable Monitoring Unit



Purpose: Handheld soil analysis tool for field officers and farmers.

Operating Instructions:

Step 1: Device Activation

1. Press and hold the **START** switch for 3 seconds
2. Wait for the LED indicator to light up (confirms successful initiation)
3. LCD display will show "SAMS Ready" message



Step 2: Taking Measurements

For Soil Moisture:

1. Press the **BLACK BUTTON**
2. Insert the moisture probe 10-15cm into soil near plant roots
3. Wait 10 seconds for stabilized reading
4. Record the percentage value displayed on LCD
5. Remove probe and clean with dry cloth

For NPK Analysis:



1. Press the **BLUE BUTTON**
2. Insert NPK sensor probe into prepared soil sample
3. Wait 30 seconds for complete analysis
4. LCD will display:
 - N: Nitrogen level (mg/kg)
 - P: Phosphorus level (mg/kg)
 - K: Potassium level (mg/kg)
5. GPS coordinates are automatically recorded

Battery Management:

- **Full Charge:** 8-10 hours continuous operation
- **Low Battery Warning:** Red LED flashes + "LOW BATT" on LCD
- **Charging:** Use provided USB-C cable, 2-3 hours for full charge

4. User Guide for Farmers

4.1 Mobile App Navigation

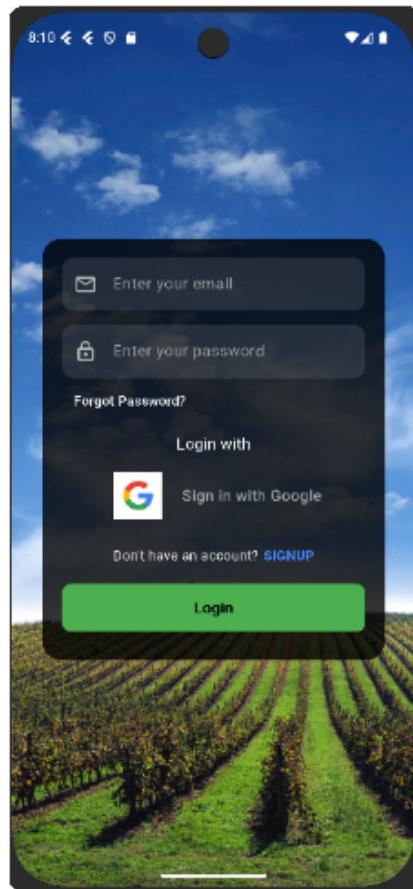
4.1.1 Daily Login Process

Step 1: App Launch

1. Tap the SAMS app icon on your device
2. Wait for the splash screen to load
3. If prompted, allow location access for GPS features

Step 2: Authentication

1. Enter your **email address** in the first field
2. Enter your **password** in the second field
3. Tap "**Login**" button
4. If login fails, check your credentials or use "**Forgot Password**"



4.1.2 Home Dashboard Overview

After successful login, you'll see the main dashboard with:

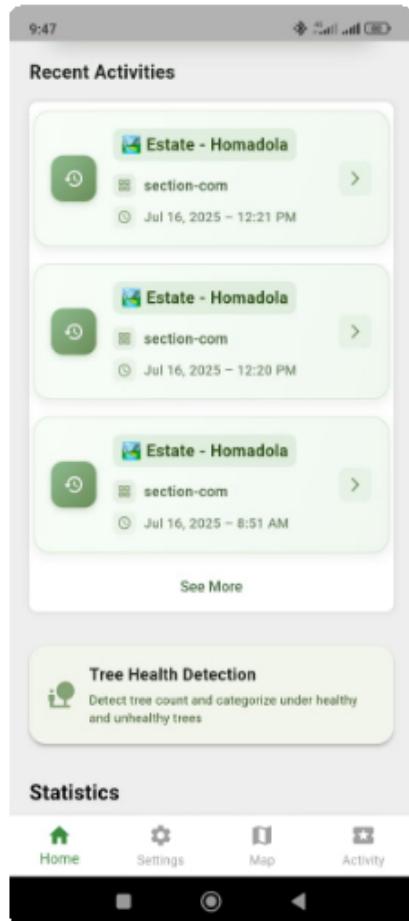
Weather Card (Top Section):

- Current temperature and humidity
- Today's rainfall total

- Sunlight intensity level
- Weather trend arrow (\uparrow improving, \downarrow declining)

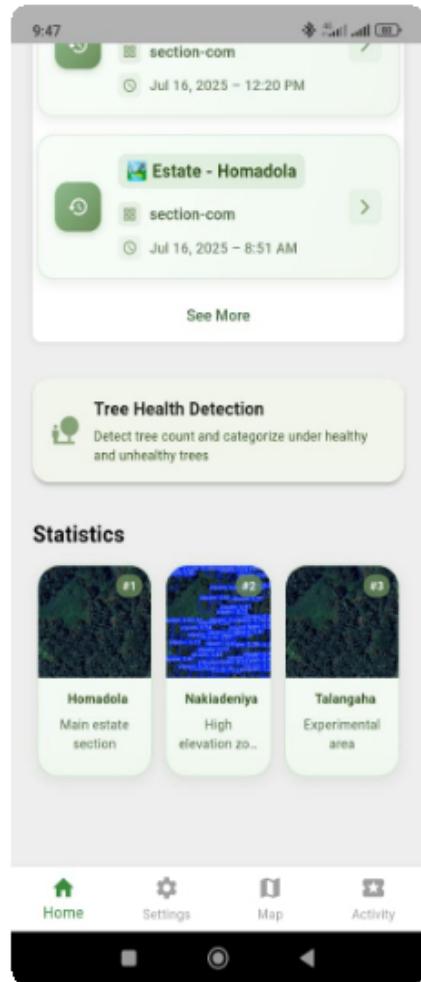


Recent Activities and Tree Health Detection (Middle Section):



Field Statistics Panel (Bottom Section):

- List of all assigned field sections

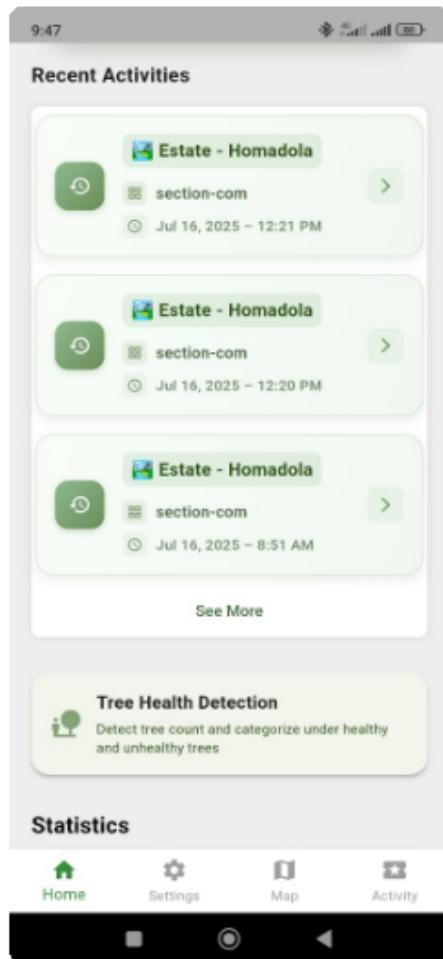


4.2 Field Monitoring

4.2.1 Accessing Field Data

Step 1: Select Field Section

1. From the home screen, tap on any field card
2. Or use the "**All Fields**" tab in bottom navigation
3. Choose between **List View or Map View**

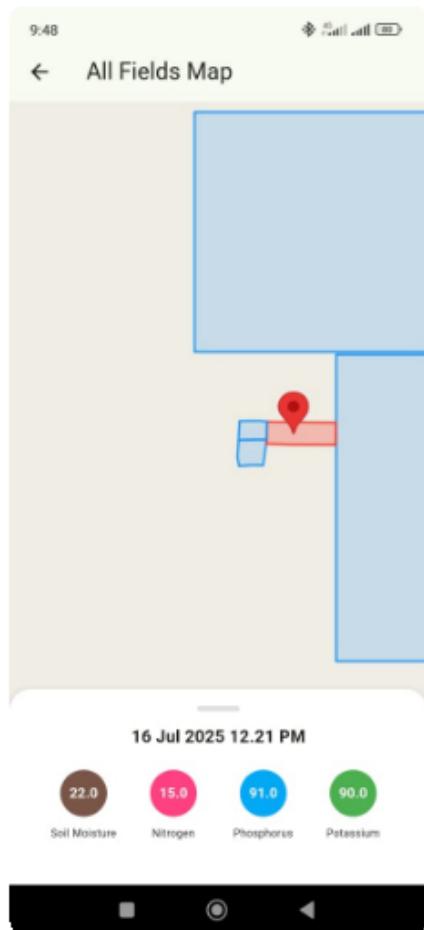


Step 2: Real-time Data Review The field detail screen displays:

Environmental Data:

- **Soil Moisture:** Percentage (%) with status indicator
- **Temperature:** Current air temperature (°C)
- **Humidity:** Relative humidity percentage
- **Rainfall:** Last 24-hour accumulation (mm)
- **Sunlight:** Light intensity in Lux





Soil Nutrition:

- **Nitrogen (N):** mg/kg with optimal range indicator
- **Phosphorus (P):** mg/kg with status
- **Potassium (K):** mg/kg with recommendations

4.3 Using the Portable Device

4.3.1 Pre-Measurement Setup

Step 1: Location Preparation

1. Choose a representative area of the field section
2. Clear surface debris (leaves, stones, weeds)
3. Ensure the area is typical of the section's overall condition

Step 2: Device Preparation

1. Power on the portable unit (START button)
2. Wait for GPS lock (GPS icon stops blinking)

3. Verify battery level is above 20%

4.3.2 Taking Soil Measurements

Moisture Reading Process:

1. Press **BLACK BUTTON** once
2. Insert probe vertically 10-15cm into soil
3. Avoid hitting rocks or roots
4. Wait for "STABLE" message on LCD (usually 10-15 seconds)
5. Record the displayed percentage
6. Clean probe with dry cloth before next measurement

NPK Analysis Process:

1. Press **BLUE BUTTON** once
2. Insert NPK probe into soil
3. LCD shows "ANALYZING..." for 30 seconds
4. Results display as N-P-K values
5. Take photo of LCD screen for records if needed
6. Clean probe thoroughly after use

4.4 Alert Management

4.4.1 Understanding Alerts

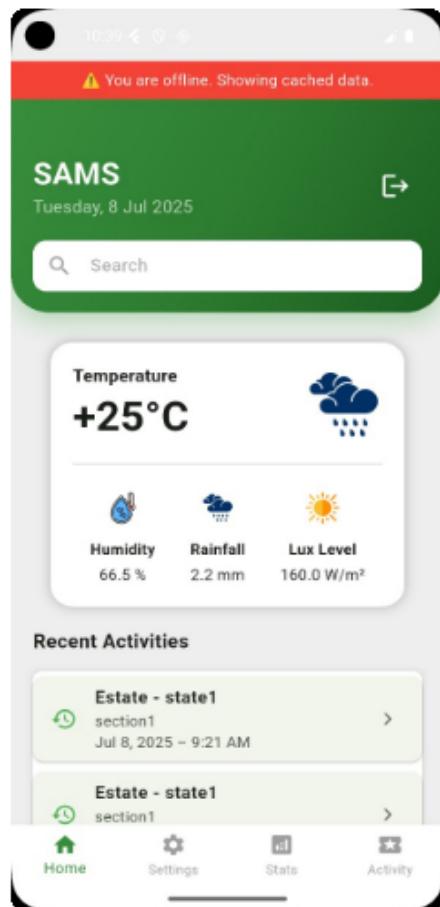
SAMS automatically sends alerts for:

- **Low Soil Moisture:** Below optimal range for crop type
- **Nutrient Deficiency:** NPK levels requiring attention
- **Weather Warnings:** Extreme temperature, heavy rain, or drought conditions
- **Device Issues:** connectivity loss

4.4.2 Responding to Alerts

Step 1: Alert Notification

1. Push notification appears on your device
2. Tap notification to open relevant field section
3. Review the specific parameter causing the alert



Step 2: Assessment

1. Check the current reading against historical data
2. Consider recent weather conditions
3. Verify with physical field inspection if needed

Step 3: Action Planning

1. For moisture alerts: Schedule irrigation or drainage
2. For nutrient alerts: Plan fertilizer application
3. For weather alerts: Implement protective measures
4. Document actions taken in the app notes section

4.5 Tree Health Detection

4.5.1 Capturing Images

Step 1: Access Feature

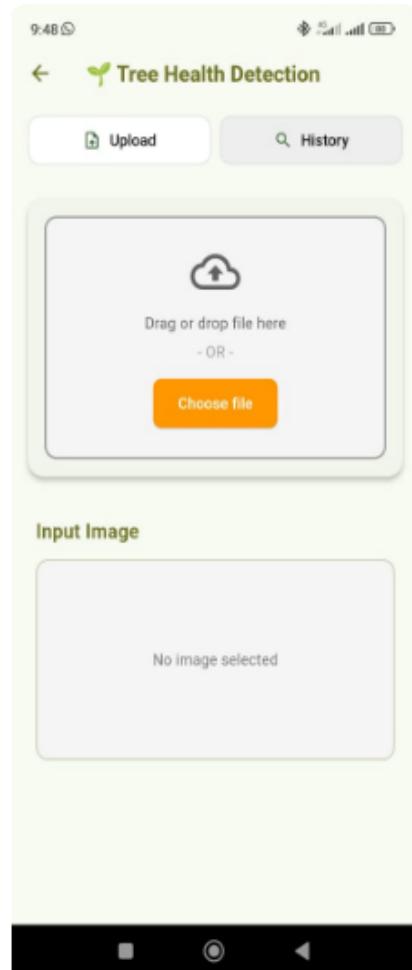
1. Navigate to "**Tree Health**" from home screen
2. Tap "**New Detection**" button
3. Allow camera permissions if prompted

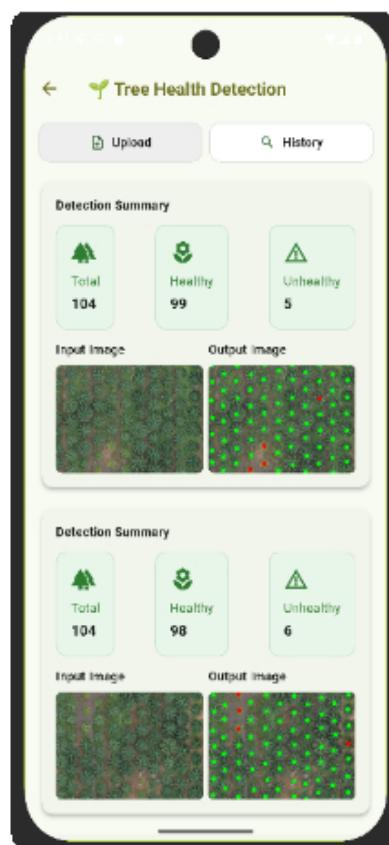
Step 2: Photo Guidelines

- **Distance:** Stand 3-5 meters from trees
- **Lighting:** Natural daylight preferred, avoid harsh shadows
- **Angle:** Capture multiple trees in frame when possible
- **Focus:** Ensure leaves and trunk are clearly visible
- **Quality:** Use highest resolution setting available

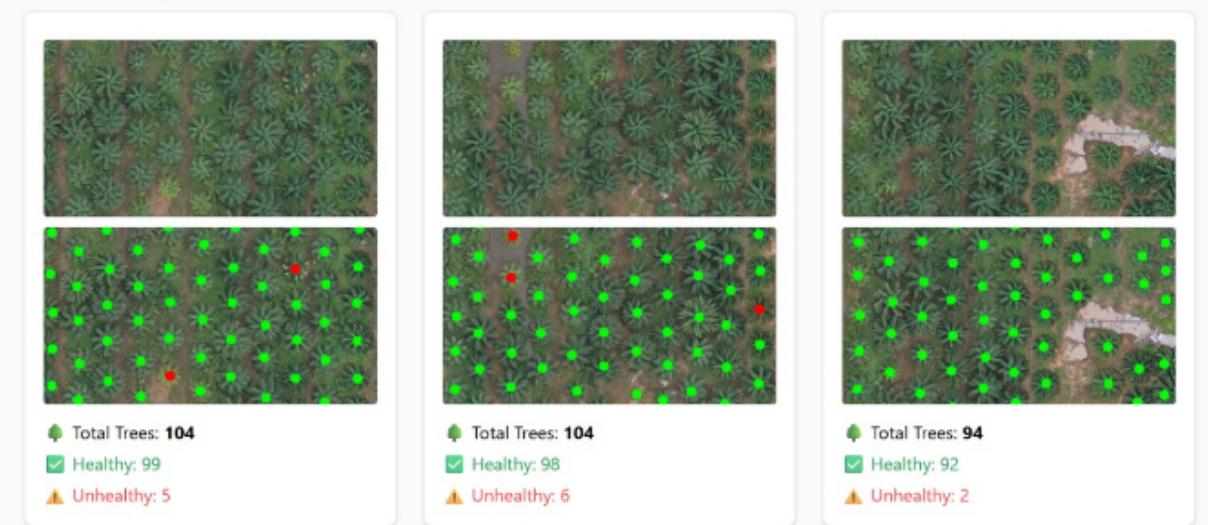
Step 3: Upload Process

1. Take photo using camera button or select from gallery
2. Tap "**Analyze Image**"
3. Wait for processing (usually 30-60 seconds)
4. Review results with highlighted healthy/unhealthy trees





Previous Analyses



4.5.2 Interpreting Results

Detection Output:

- Green boxes:** Healthy trees identified
- Red boxes:** Trees showing stress or disease symptoms
- Summary statistics:** Total count, health percentage

Follow-up Actions:

- Visit trees marked as unhealthy for physical inspection

2. Document specific symptoms observed
 3. Consult with agricultural extension officer if needed
 4. Schedule appropriate treatment or intervention
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5. Admin/Manager Guide

5.1 Web Dashboard Access

5.1.1 Administrative Login

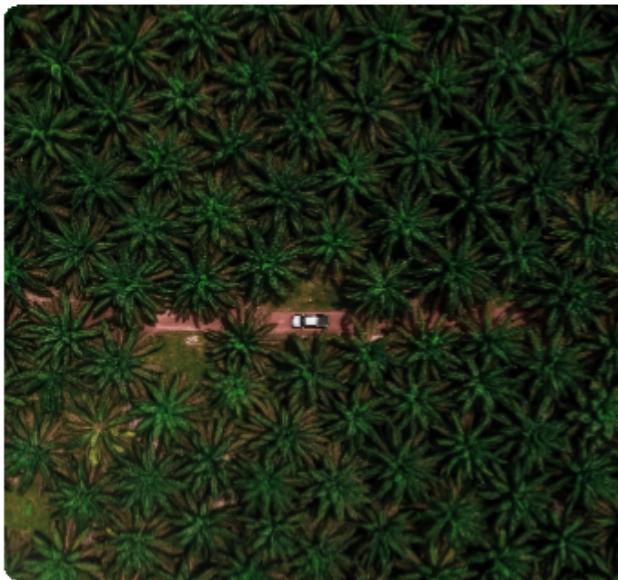
Step 1: Access Portal

1. Open web browser and navigate to SAMS admin portal
2. URL :
3. Ensure you're using a supported browser (Chrome/Firefox/Safari)



Step 2: Admin Authentication

1. Enter your administrative email address
2. Use your admin-level password
3. Complete two-factor authentication if enabled
4. Accept terms of service and privacy policy



Sign Up

Create your account below

Your email

Password

SIGN UP

Sign up with Google

Already registered? [Sign in](#)

Sign In

Enter your email and password to Sign In.

Your email

Password

SIGN IN

Sign in with Google

[Forgot Password](#)

Not registered? [Create account](#)



5.1.2 Dashboard Overview

Navigation Menu (Left Sidebar):

- **Dashboard:** System overview and key metrics
- **Notifications**
- **Tree Analyzer**

SAMS

Dashboard

Notifications

Tree Analyzer

AUTH PAGES

Sign Out

Tree Health Analyzer

Upload Image

Choose File No file chosen

Upload & Analyze

Previous Analyses

Input	Output	Input	Output	Input	Output

Main Dashboard Widgets:

- Weather Data
- Recent Readings

SAMS

Dashboard

Notifications

Tree Analyzer

AUTH PAGES

Sign Out

Dashboard

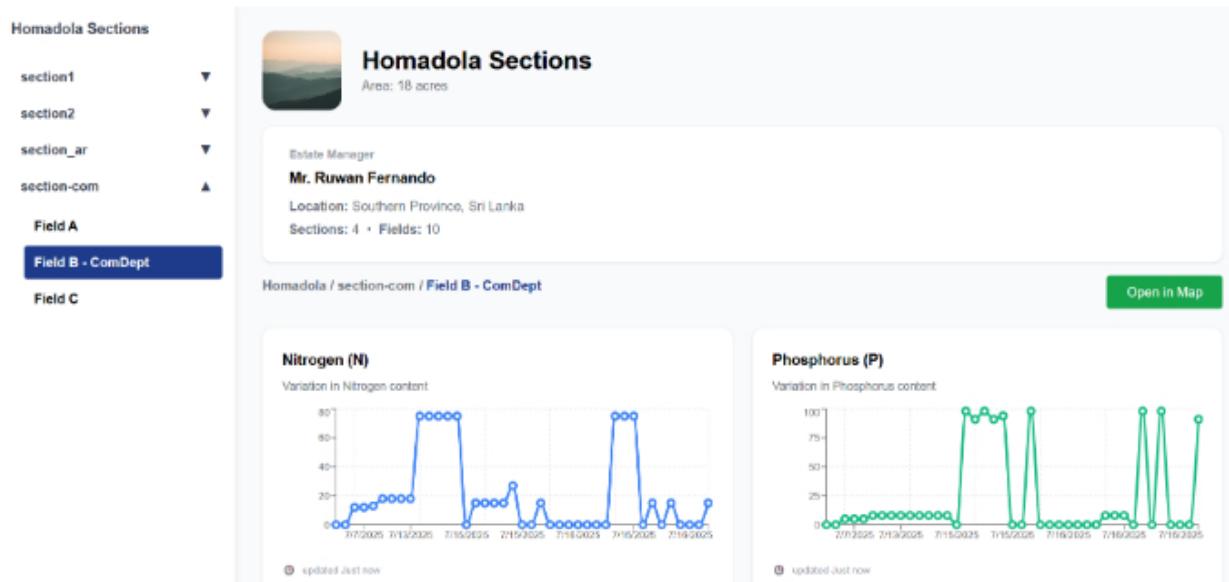
Rainfall	Lux Level	Temperature	Humidity
1.4 mm	855 lux	27.5°C	75 %

Recent Readings

Latest data from all estates

Estate	Section	Date & Time
H Homadola	section-com	7/16/2025, 12:21:07 PM
H Homadola	section-com	7/16/2025, 12:20:32 PM
H Homadola	section-com	7/16/2025, 8:51:22 AM

Show All



5.2 User Management

5.2.1 Adding New Users

Step 1: User Creation

1. Navigate to "User Management" > "Add New User"
2. Fill out required information:
 - Full name and contact details
 - Email address (will be username)
 - Assign user role (Farmer, Field Officer, Manager)
 - Select accessible field sections
3. Generate temporary password
4. Set user permissions and restrictions

Step 2: Account Activation

1. System sends welcome email with login credentials
2. Monitor first login and password change completion
3. Provide training materials and app download links
4. Schedule orientation session if needed

5.2.2 Managing User Permissions

Role Definitions:

Role	Mobile App Access	Web Dashboard	Device Control	User Management
Farmer	Field data view only	No access	Read sensors only	No access
Field Officer	Full mobile features	Limited dashboard	Take measurements	No access
Manager	Full access	Analytics access	Full control	View only
Admin	Full access	Complete access	Full control	Full management

5.3 Device and Field Management

5.3.1 Initiating Hardware

Network Configuration

1. Set Wi-Fi credentials for the device
2. Test connectivity and data transmission
3. Verify GPS coordinates for portable devices
4. Run calibration sequence for all sensors

5.3.2 Field Section Management

Creating New Field Sections:

1. Go to "**Field Management**" > "**Add Section**"
2. Define section boundaries using GPS coordinates
3. Upload aerial photos or satellite imagery if available
4. Set crop type and planting date
5. Assign responsible users and devices
6. Configure optimal ranges for each parameter

Section Monitoring:

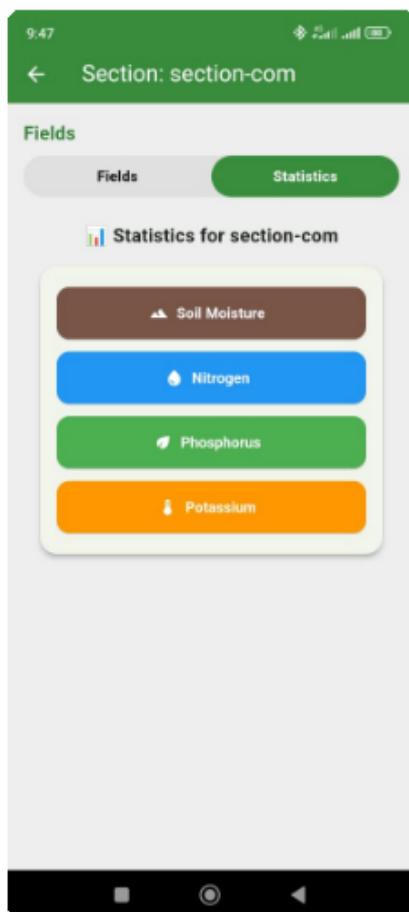
- **Real-time Status:** Live view of all sensors in the section
- **Historical Trends:** Data visualization over time periods
- **Alert Configuration:** Custom thresholds for different crop stages

5.4 Analytics and Reporting

5.4.1 Data Analysis Tools

Trend Analysis:

1. Select "**Statistics**" from section
2. Choose time period (monthly)
3. Select parameters to analyze (moisture, NPK, weather)
4. Compare multiple field sections simultaneously
5. Export data in CSV or PDF format



5.4.2 Report Generation

Automated Reports:

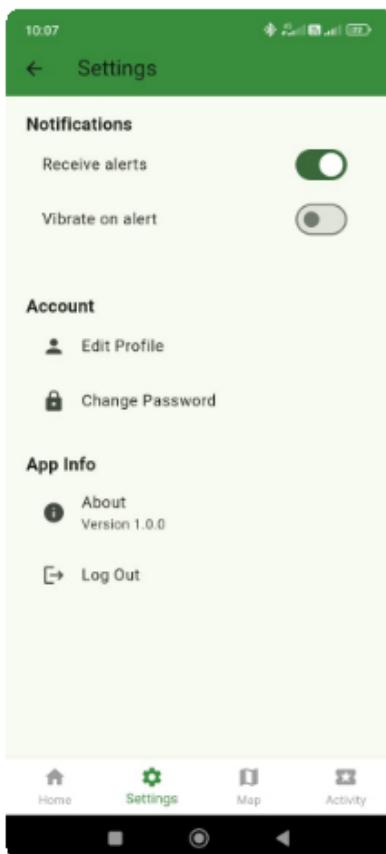
1. Set up scheduled reports (daily, weekly, monthly)
2. Configure recipient email lists
3. Customize report content and format
4. Include graphs, charts, and summary statistics

5.5 System Configuration

5.5.1 Alert Management

Global Alert Settings:

1. Navigate to "**Settings**" > "**Notifications**"
2. Set system-wide threshold values for each parameter done by admin
3. Configure notification frequency and escalation rules
4. Manage recipient groups for different alert types



5.5.2 Data Management

Backup and Archive:

1. Schedule automatic data backups
2. Set data retention policies
3. Archive historical data for long-term analysis
4. Export data for external analysis tools

Data Quality Control:

- **Sensor Calibration:** Schedule regular calibration checks
- **Data Validation:** Identify and flag anomalous readings
- **Gap Analysis:** Monitor data completeness and sensor uptime
- **Audit Trail:** Track all system changes and user actions

6. Installation & Setup

6.1 Hardware Installation

6.1.1 Fixed Monitoring Unit Installation

Site Selection:

- Choose representative location within field section
- Ensure 360-degree clear sky view for rain gauge
- Avoid shading from trees or structures
- Accessible for maintenance but secure from damage

Installation Steps:

Step 1: Mounting Post Installation

1. Dig post hole 60cm deep in firm soil
2. Install 2-meter galvanized steel post
3. Ensure post is perfectly vertical using spirit level
4. Secure with concrete base if in high-wind area

Step 2: Rain Gauge Setup

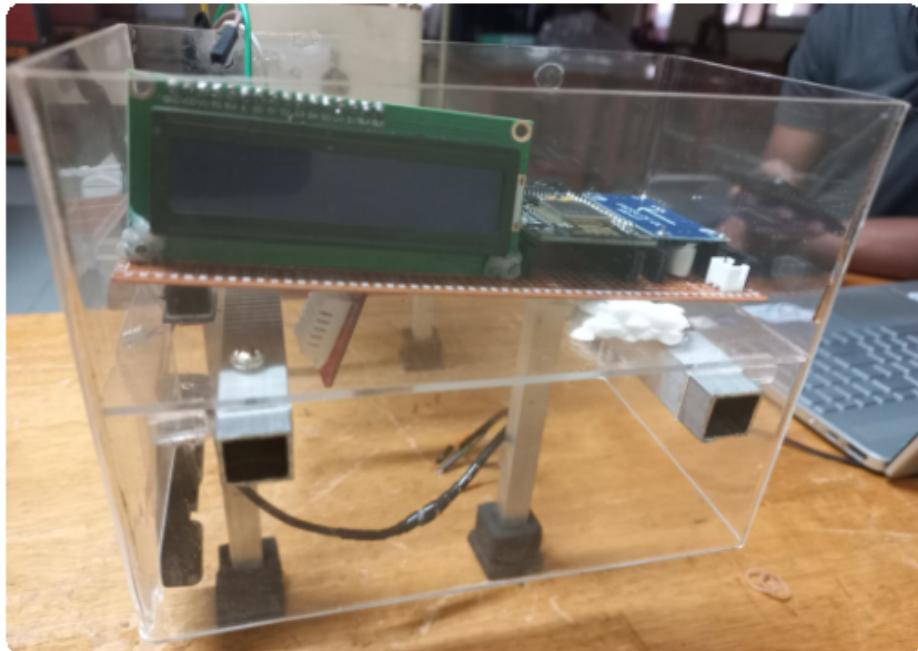
1. Mount tipping bucket at 1.5m height on post
2. Ensure gauge is perfectly level using built-in level bubble
3. Clear 2-meter radius around gauge of any obstructions
4. Connect signal cable to ESP32 controller box

Step 3: Sensor Installation

1. Mount weatherproof enclosure on post at 1.2m height
2. Install DHT11 sensor in ventilated housing
3. Position BH1750 light sensor facing upward with clear sky view
4. Connect all sensor cables to ESP32 inside main enclosure

Step 4: Power System Setup

1. Install solar panel facing south at 30-degree angle
2. Connect to charge controller and 12V battery
3. Wire DC-DC converter for 3.3V ESP32 supply
4. Test all connections and verify voltage levels



6.1.2 Portable Unit Setup

Initial Configuration:

1. Charge device fully before first use (4 hours)
2. Power on and wait for GPS lock (up to 5 minutes outdoors)
3. Calibrate sensors using provided calibration solutions
4. Test data transmission to Firebase database

Calibration Process:

1. **Moisture Sensor:** Test in distilled water (should read 100%) and air (should read 0%)
2. **NPK Sensor:** Use provided calibration standards for each nutrient
3. **GPS Module:** Verify coordinates match known location
4. Record calibration values and date for maintenance records

6.2 Software Setup

6.2.1 Mobile App Installation

For Android Devices:

1. Download SAMS app from Google Play Store or provided APK file
2. Install and grant required permissions:
 - **Location:** For GPS features and field mapping
 - **Camera:** For tree health detection
 - **Storage:** For offline data caching
 - **Network:** For real-time data synchronization

Initial Setup:

1. Launch app and select language preference
2. Enter server configuration (usually pre-configured)
3. Test network connectivity to Firebase
4. Login with provided credentials

6.2.2 Web Dashboard Setup

System Requirements:

- **Server:** Node.js environment with Firebase Admin SDK
- **Database:** Firebase Firestore with proper security rules
- **Storage:** Firebase Cloud Storage for images
- **Authentication:** Firebase Auth with role-based access

Configuration Steps:

1. Set up Firebase project with required services
2. Configure security rules for data access control
3. Deploy web application to hosting service
4. Set up SSL certificate for secure HTTPS access
5. Configure domain name and DNS settings

6.3 Network Configuration

6.3.1 Wi-Fi Setup

For Fixed Units:

1. Connect ESP32 to setup computer via USB
2. Upload Wi-Fi credentials using serial monitor
3. Test connection and verify signal strength at installation site
4. Configure fallback hotspot mode if primary network fails

Network Requirements:

- **Bandwidth:** Minimum 1 Mbps upload speed
- **Latency:** Less than 500ms to Firebase servers
- **Reliability:** 95%+ uptime for real-time monitoring
- **Security:** WPA2 or WPA3 encryption required

6.3.2 Firewall and Security

Required Ports:

- **HTTPS (443):** For web dashboard access
- **Firebase (443):** For real-time database sync
- **NTP (123):** For time synchronization
- **DNS (53):** For domain name resolution

Security Measures:

1. Change default passwords on all devices
 2. Enable WPA3 encryption on Wi-Fi networks
 3. Regular firmware updates for ESP32 devices
 4. Monitor access logs for unauthorized attempts
 5. Implement VPN access for remote management
-

7. Troubleshooting

Hardware Issues

Problem	Possible Cause	Solution
Device not turning on	Battery drained or wiring issue	Check and recharge/replace battery. Ensure all cables are securely connected.
No sensor readings	Loose sensor wiring or faulty module	Reconnect sensor cables. Restart the ESP32. Test sensor individually.
Tipping Bucket not detecting rainfall	Funnel clogged or sensor misaligned	Clean debris from funnel. Adjust sensor position and test manually.
Light sensor shows 0 Lux	BH1750 miswired or shaded	Check wiring and ensure the sensor is exposed to light. Replace if faulty.
NPK sensor gives null values	RS485 communication error or dirty probe	Check A/B wiring. Clean probe gently. Recheck baud rate and Modbus address.
GPS not recording location	No satellite lock or permissions blocked	Move to open space. Ensure GPS is enabled and permissions are granted.
Device unresponsive	Firmware crash or SD card issue	Press reset on ESP32. Remove and reinsert SD card if used. Re-upload code.

Software Issues

Problem	Possible Cause	Solution
App not displaying data	No internet or Firebase error	Check Wi-Fi connection. Make sure Firebase rules allow access.
Sensor data not updating in app	Realtime sync failure	Restart the app and ensure the ESP32 is online. Monitor Firebase console.
Image upload not processed	Backend model delay or invalid format	Retry with correct image type (JPG/PNG). Wait for response.
Repeated alert notifications	Thresholds too sensitive	Reconfigure thresholds in control settings via Firebase.
App stuck in offline mode	No Firebase connection at startup	Reconnect to Wi-Fi and restart the app. Check Firebase status.
GPS location not showing on map	Location services disabled	Enable location access in app permissions. Ensure GPS is active on device.
Slow loading screens	Large data payload or weak signal	Reduce the amount of data displayed. Ensure strong network.