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Welcome to Agronomics
The Smart Soil Sensor is designed to give farmers, agronomists, and researchers a dependable, real-time understanding of soil health. By combining advanced sensing technology with the Agronomics mobile app, the system delivers accurate soil insights that help you make better decisions, reduce input waste, and improve crop performance.

This manual guides you through installation, setup, testing, and maintenance so you can get the best results from your device.

What the Smart Soil Sensor Does:
The sensor measures **nine essential soil parameters** that directly influence crop growth:

- **Temperature**
- **Moisture**
- **Electrical Conductivity (EC)**
- **pH**
- **Available Nitrogen (N)**
- **Available Phosphorus (P)**
- **Available Potassium (K)**
- **Organic Matter (OM)**
- **Soil Texture**

These parameters form the foundation of soil fertility and crop management. With accurate readings, you can:

- Understand nutrient availability.
- Detect soil imbalances early.
- Optimize fertilizer and irrigation schedules.

- Improve yield potential.
- Reduce unnecessary input costs.

Why This Sensor Matters
Traditional soil testing is slow, expensive, and often done only once per season. The Smart Soil Sensor changes that by offering:

- **Instant results** directly on your mobile phone
- **Geo-tagged testing** for field-level traceability.
- **Multiple testing modes** for farms, pots, nurseries, and spot checks
- **AI-powered recommendations** for fertigation and irrigation
- **Automatic PDF reports** for record and sharing.

This makes it a powerful tool for modern, data-driven agriculture.

How the Sensor Fits Into the Agronomics Ecosystem
The Smart Soil Sensor is part of a larger digital agriculture platform. When combined with:

- **LBS (Location Based Suitability)**
- **AI-powered Soil Analysis**
- **Crop advisory modules.**
- **Fertigation and irrigation engines**

you get a complete decision-support system that helps you manage your land with confidence.

Who Is This Manual For
This manual is designed for:

- Farmers use the sensor for routine soil checks.
- Agronomists conduct field assessments.

- Researchers collecting soil data.
- Input companies and service providers.
- Anyone using the Agronomics app for soil-based decision-making.

The instructions are written in a clear, step-by-step format so that users of all experience levels can follow them easily.

This chapter provides a complete overview of the Smart Soil Sensor's physical, electrical, and measurement capabilities. Understanding these specifications helps users operate the device correctly and interpret results with confidence.

2.1 Physical Specifications

The Smart Soil Sensor is engineered for durability, field-readiness, and long-term performance in diverse soil conditions.

Component	Specification
Sensor Dimensions	45 × 15 × 135 mm
Electrode Length	50 mm
Electrode Material	Anti-corrosion special alloy
Sensor IP Rating	IP68 (submersible, long-term)
Dock Dimensions	90 × 64 × 20 mm
Dock IP Rating	IP65 (splash-proof)

Design Notes

- The IP68 sensor probe can be safely inserted into wet soil.
- The USB-C connector and dock should remain dry to avoid damage.
- The compact form factor allows easy insertion into fields, pots, and nursery beds.

2.2 Parametric Measurement Specifications

The sensor measures nine key soil parameters essential for crop management. Each parameter is calibrated for field accuracy and stability.

Parameter	Range	Precision
Temperature	–40°C to 80°C	± 0.5°C

Moisture	20% to 100%	± 3%
Electrical Conductivity (EC)	0 to 20,000 µS/cm	± 10%
Nitrogen (N)	%	± 2%
Phosphorus (P)	0 to 2,999 mg/kg	± 2% CF
Potassium (K)	0 to 2,999 mg/kg	± 2% CF
pH	3.0 to 10.0	± 0.3 pH
Organic Matter (OM)	Calculated from N	—
Soil Texture	Sandy, Sandy Loam, Loam, Silt Loam, Silty Clay, Clay Loam, Clay	—

Interpretation Notes

- Moisture readings are most accurate when soil moisture is between **20% and 75%**.
- EC readings may vary with soil temperature and moisture; the app automatically adjusts for this.
- NPK values are based on ion-selective sensing and optimized for field-level decision-making.
- Soil texture is determined through multi-parameter analysis and machine-learning classification.

2.3 Electrical Specifications

The Smart Soil Sensor is designed to operate safely with low power consumption and stable communication.

Electrical Parameter	Specification
Supply Voltage	DC 5–24V
Power Consumption	15 mA @ 12V DC
Communication Protocol	RS485 (Modbus)

Baud Rate	115200 bps
Fuse	Non-exchangeable internal fuse

Electrical Notes

- The sensor is powered directly through the mobile phone via USB-C.
- Low power consumption ensures minimal battery drain during testing.
- The Modbus protocol ensures stable, interference-resistant data transmission.

2.4 Measurement Principles

Each parameter is measured using a dedicated sensing technology optimized for field conditions.

Parameter	Measurement Principle
Temperature	Thermistor / RTD
Moisture	Capacitive sensing
Electrical Conductivity	AC conductometry
Nitrogen / Phosphorus / Potassium	Ion-Selective Electrodes (ISE)
pH	ISFET (Ion-Sensitive Field-Effect Transistor)

How These Technologies Work

- **Capacitive moisture sensing** avoids corrosion and provides stable reading.
- **ISE-based NPK sensing** detects nutrient ions directly in the soil solution.
- **ISFET pH sensing** offers faster response and better durability than glass electrodes.
- **AC-based EC measurement** reduces polarization errors common in DC systems.

2.5 Operating Conditions

To ensure accurate and reliable measures:

Condition	Recommended Range
Soil Moisture	20%–75%
Soil Temperature	–20°C to 60°C
Ambient Temperature	–10°C to 50°C
Soil Type	All mineral soils (avoid stones/rocks)

Environmental Notes

- Extremely dry or waterlogged soils may reduce accuracy.
- Avoid inserting the probe into rocky or compacted soil to prevent damage.
- The sensor is waterproof, but the **USB-C connector must remain dry**.

2.6 Accuracy Considerations

To achieve the best results:

- Insert the probe fully into the soil (minimum 7 cm depth) & Ensure good soil-probe contact (no air gaps or stones).
- Clean the probe between test points.
- Allow **5–6 minutes** for stable readings.
- Avoid movement during measurement.

Chapter 3 - Components

Proper installation and handling of the Smart Soil Sensor are essential for obtaining accurate and reliable soil readings. This chapter explains how to prepare the soil, insert the sensor correctly, and avoid common mistakes that may affect measurement quality.

3.1 Preparing the Soil

Before inserting the sensor, ensure the soil is ready for accurate measurement.

Steps for Soil Preparation

- Remove the top **2–3 inches** of loose or dry surface soil.
- Clear away stones, roots, or hard objects from the insertion area.
- Ensure the soil moisture is within the recommended range of **20%–75%**.
- If the soil is extremely dry, lightly moisten it and wait a few minutes for uniform absorption.
- Avoid testing immediately after heavy rainfall or irrigation, as waterlogged soil may distort readings.

3.2 Correct Probe Insertion

Accurate readings depend on proper insertion depth and soil contact.

Insertion Guidelines

- Insert the sensor **horizontally** or **vertically** depending on the testing mode.
- Ensure a minimum insertion depth of **7 cm** (probe fully submerged in soil).
- Push the probe gently but firmly to avoid bending or damaging the electrodes.

- Make sure the electrodes are fully covered by soil with **no air gaps**.
- Avoid inserting the probe nearby:
    - Rocks
    - Hard surfaces
    - Field boundaries
    - Irrigation pipes
    - Fertilizer bands

Important
Do **not** twist or force the sensor into compacted soil. If resistance is high, loosen the soil slightly before inserting.

3.3 Soil Conditions for Best Accuracy

The sensor is designed to perform reliably across a wide range of soil types, but optimal conditions improve accuracy.

Recommended Conditions

- Soil moisture: **20%–75%**
- Soil temperature: **–20°C to 60°C**
- Soil type: All mineral soils (avoid extremely rocky or gravelly areas)
- Avoid:
    - Frozen soil
    - Waterlogged soil
    - Recently fertilized spots
    - Recently disturbed soil

3.4 Cleaning the Sensor Before Use

Clean probes ensure stable and repeatable readings.

Cleaning Steps

- Remove the protective cap or rubber cover.
- Wipe the electrodes with a soft cloth or tissue.

- If soil is stuck from previous tests, rinse with clean tap water.
- Dry the probe before inserting it into the next test point.

Do Not

- Use chemicals or detergents.
- Scratch the electrodes with metal tools.
- Use abrasive materials.

3.5 Handling the Sensor During Testing

To maintain measurement stability:

- Keep the sensor **still** during the 5 minutes reading period.
- Avoid touching or moving the cable while the test is running.
- Do not press the back button on the mobile app.
- Avoid receiving phone calls during testing to prevent disconnecting.
- Ensure the USB-C connection remains secure and dry.

3.6 Removing the Sensor After Testing

Once the reading is complete:

- Pull the sensor out **straight and gently**.
- Avoid twisting or bending the probe.
- Rinse the electrodes with clean water.
- Dry with a soft cloth or tissue.
- Place the protective cover back on the probe.

3.7 Storage Guidelines

Proper storage extends the lifespan of the sensor.

Storage Recommendations

- Store in a **dry, cool place**.
- Keep the probe covered when not in use.
- Avoid prolonged exposure to direct sunlight.
- Do not store the sensor with wet soil on the electrodes.
- Keep the USB-C connector away from moisture.

3.8 Common Mistakes to Avoid

- Inserting the probe into rocky or compacted soil.
- Testing immediately after irrigation or rainfall.
- Using the sensor when the phone battery is below **30%**.
- Allowing water to enter the USB-C port.
- Moving the sensor during measurement.
- Not cleaning the probe between test points.

This chapter explains how to prepare your mobile phone, power the Smart Soil Sensor, and ensure a stable connection between the sensor, dock, and Agronomics mobile app. Completing these steps correctly is essential for accurate soil testing.

4.1 Mobile Phone Requirements

To ensure smooth operation, your mobile device must meet the following requirements:

Minimum Requirements

- Battery level **above 30%**
- USB-C port with OTG support
- Bluetooth enabled
- Location (GPS) enabled.
- Active internet connection (Wi-Fi or mobile data)

Recommended for Best Performance

- Battery above **50%**
- Strong GPS signal
- Stable 4G/5G or Wi-Fi connection
- No other Bluetooth devices connected.

4.2 Enabling Required Phone Settings

Before connecting the sensor, turn on the following:

Bluetooth

- Required for sensor-to-app communication.
- Ensure it is not paired with any other device.

Location (GPS)

- Required for geo-tagging test points.
- Ensures accurate Z-pattern tracking.

Internet

- Required for:
    - Sensor registration
    - Synchronizing test results
    - Weather-based recommendations

OTG (On-The-Go)

- Allows your phone to power the sensor through USB-C.
- Some phones require manual activation in settings.

4.3 Powering the Sensor

The Smart Soil Sensor is powered directly from your mobile phone through the dock.

Steps to Power the Sensor

1. Connect the **C-to-C cable** between your phone and the sensor dock.
2. The **red LED** on the dock will turn ON, indicating power.
3. The sensor will automatically initialize and attempt to connect to the app.

LED Indicators

- **Red LED ON** → Sensor is powered.
- **No LED** → Check cable, phone battery, or OTG settings

4.4 Connecting the Sensor to the App

Once powered, the sensor connects automatically.

Connection Steps

- Open the **Agronomics App**
- Ensure the **Bluetooth icon** turns ACTIVE (green)
- Ensure the **Transmission icon** turns ACTIVE (green)

- Do not press the back button during initialization.

If the icons do not turn green

- Reconnect the USB-C cable.
- Restart Bluetooth
- Restart the app.
- Ensure no other device is using Bluetooth.

4.5 Understanding App Connectivity Icons

The app displays two important indicators:

Bluetooth Icon

- **Green** → Sensor is paired and communicating.
- **Grey** → Sensor not detected.

Transmission Icon

- **Green** → Data flows between sensor and app
- **Grey** → No data transmission

Both icons must be **green** before starting any soil test.

4.6 Avoiding Interruptions During Setup

To prevent disconnection:

- Do not receive phone calls during testing.
- Do not minimize or close the app.
- Do not disconnect the cable.
- Avoid shaking or moving the phone excessively.
- Keep the phone screen ON during the test.

4.7 Quick Troubleshooting Guide

Sensor not powering ON.

- Check phone battery.
- Ensure OTG is enabled.
- Try a different USB-C port (if available)

- Inspect cable for damage.

Bluetooth does not connect.

- Turn Bluetooth OFF → ON
- Restart the app.
- Ensure no other Bluetooth device is paired.

Transmission icons are not turning green.

- Reconnect the cable.
- Restart the app.
- Ensure the sensor is fully inserted into the soil.

Registering your Smart Soil Sensor ensures that each device is uniquely linked to your Agronomics account. This enables accurate tracking, history management, and seamless integration with your land records. Registration is required only once per sensor.

5.1 Before You Begin

To ensure a smooth registration process, confirm the following:

Phone Requirements

- Battery above **30%**
- Bluetooth turned ON
- Location (GPS) turned ON.
- Internet enabled (Wi-Fi or mobile data)
- No other Bluetooth device connected.

Sensor Requirements

- Sensor dock connected to your phone via USB-C.
- Red LED on the dock is ON.
- Sensor probes are clean and uncovered.

5.2 Why Registration Is Important

Registering your sensor allows you to:

- Link the device to your Agronomics account.
- Track usage history.
- Manage multiple sensors.
- Prevent unauthorized use.
- Ensure accurate mapping of test results.

Each sensor receives a unique digital identity stored securely in the Agronomics system.

5.3 Step-by-Step Registration Process

Follow these steps carefully to register your sensor:

Step 1 — Enable Required Settings

Turn ON:

- Internet (Wi-Fi or mobile data)
- Location (GPS)
- Bluetooth

Step 2 — Connect the Sensor

- Plug the **C-to-C cable** into your mobile phone.
- Wait for the **red LED** on the dock to turn ON.
- The app will detect the sensor automatically.

Step 3 — Open the Registration Screen

- Launch the **Agronomics App**
- Navigate to **Sensor Registration**
- Tap **Register Now**

Step 4 — Automatic Registration

- The app will automatically read the sensor's unique ID.
- Registration completes within a few seconds.
- A confirmation message will appear on the screen.

5.4 Verifying Your Registered Sensor

After registration:

- Go to **Sensor History** in the app.
- You will see:
    - Sensor ID
    - Registration date
    - Status (Active)

This confirms that your sensor is successfully linked to your account.

5.5 Adding Multiple Sensors

If you own more than one sensor:

- Repeat the same registration steps for each device.
- Each sensor will appear separately in **Sensor History**
- All sensors will be tagged with their correct registration dates.

This is especially useful for:

- Agronomy teams
- Service providers
- Multi-farm operations
- Research groups

5.6 Troubleshooting Registration Issues

Sensor Not Detected

- Reconnect the USB-C cable.
- Ensure OTG is enabled.
- Restart Bluetooth
- Restart the app.
- Try a different cable if available.

Bluetooth Icon Not Turning Green

- Turn Bluetooth OFF → ON
- Ensure no other device is paired.
- Restart the phone if needed.

Transmission Icon Not Active

- Ensure the sensor is powered.
- Reconnect the cable.
- Check that the sensor is not loose.

Registration Fails Repeatedly

- Check internet connection.
- Move to an accessible area for better GPS signal.
- Restart the app and try again.

5.7 Best Practices for Smooth Registration

- Keep your phone still during registration.
- Avoid incoming calls during the process.
- Ensure the USB-C connector stays dry.
- Do not press the back button until registration is completed.

The Smart Soil Sensor supports four testing modes designed for different field conditions and use cases. Each mode follows the same core principles but differs in movement, sampling pattern, and data recording. This chapter explains when to use each mode and provides step-by-step instructions to ensure accurate soil testing.

6.1 Overview of Testing Modes

The Agronomics App provides four testing modes:

Mode	Purpose
Test My Field	Full field assessment using a 5-point Z-pattern
Test Another's Field	Testing land owned by someone else, with owner verification
Spot Test	Single-point quick assessment
Pot Test	Soil testing in pots, beds, nurseries, and controlled environments

Each mode measures all nine soil parameters and generates a geo-tagged PDF report.

6.2 General Requirements for All Testing Modes

Before starting any test:

Phone Requirements

- Battery above **30%**
- Bluetooth ON
- Location (GPS) ON
- Internet ON (recommended for syncing)
- No other Bluetooth device connected.

Sensor Requirements

- Dock connected via USB-C.
- Red LED ON
- Probes clean and uncovered.
- Sensor inserted properly into the soil

App Requirements

- Bluetooth icon ACTIVE (green)
- Transmission icon ACTIVE (green)
- Do not press the back button.
- Avoid phone calls during testing.

6.3 Test My Field (Z-Pattern Testing)

This is the **recommended mode** for full-field soil assessment. It provides the most accurate representation of soil conditions across the entire land.

Purpose

- To capture soil variability across the field
- To generate a representative soil profile
- To support fertigation and irrigation recommendations

Sampling Pattern: The Z-Pattern

You will test **five points** arranged in a Z-shaped pattern:

1. Enter the field 30–40 meters from the boundary.
2. Move diagonally across the field.
3. Test at five evenly spaced points
4. Follow the Z-shape shown in the app.

The app displays a **green GPS marker** that moves with you to guide your pattern.

Step-by-Step Instructions

Step 1 — Prepare the Sensor

- Remove probe cover & Clean the electrodes.
- Ensure the dock LED is ON

Step 2 — Prepare the Soil

At each test point:

- Remove top 2–3 inches of loose soil.
- Dig 5–6 inches deep &
- Insert the probe fully.
- Ensure no stones or hard objects nearby.

Step 3 — Start the Test

- Wait **5–6 minutes** for stable readings.
- Keep the phone and sensor still.
- Do not disconnect the cable.

Step 4 — Move to the Next Point

- Clean the probe.
- Follow the Z-pattern.
- Ensure the GPS marker matches your real position.

Step 5 — Complete All 5 Points

- The app automatically saves each reading.
- A final combined report is generated.

6.4 Test Another's Field

This mode is used when testing land that **does not belong to you**.

Purpose

- To test soil on another farmer's land
- To ensure correct ownership and field mapping

Additional Requirements

If the land belongs to someone else:

- The **landowner must add their land** in the LBS module.
- You must enter:
    - The **Field ID**
    - The **Owner's registered mobile number** (if required)

Testing Steps

The testing process is identical to **Test My Field**, including:

- Z-pattern with 5 test points with GPS tracking
- Probe cleaning between points.

The only difference is **ownership verification** before starting the test.

6.5 Spot Test (Single-Point Testing)

This mode is ideal for quick assessments.

Purpose

- To check soil at a specific location
- To diagnose problem areas
- To test small plots or sample points

Procedure

1. Select a representative spot.
2. Move 30–40 meters inside the field boundary.
3. Remove top 2–3 inches of soil.
4. Dig 5–6 inches deep & Insert the probe vertically.
5. Wait 5–6 minutes.
6. Clean the probe after testing.

A single-point PDF report is generated automatically.

6.6 Pot Test (Nursery / Greenhouse / Controlled Environments)

This mode is designed for small containers and controlled setups.

Purpose

- To test soil in pots, beds, trays, and nursery bags
- To monitor soil health in greenhouses
- To support precision fertigation in controlled environments

Procedure

1. Select the pot or container.
2. Remove loose topsoil if needed.
3. Ensure no stones or roots block insertion.
4. Insert the probe vertically.
5. Ensure the probe does not touch the pot wall.
6. Wait 5–6 minutes.
7. Clean and dry the probe after testing.

A single-point PDF report is generated.

6.7 After Every Test

Regardless of the mode:

- Remove the sensor gently.
- Rinse the probe with clean water.
- Dry with soft cloth
- Replace the protective cover.
- Store the sensor safely.

All test results are automatically saved in the **History** section of the app.

The Agronomics platform uses a Location-Based Suitability (LBS) system to link soil test results with land boundaries, crop requirements, and environmental conditions. This chapter explains how LBS works, why it matters, and how soil parameters directly influence crop suitability.

7.1 What Is Location-Based Suitability (LBS)?

LBS is a geo-spatial system that allows you to:

- Digitally map your land
- Assign a unique **Field ID** to each plot.
- Store soil test results against exact GPS coordinates.
- Analyze crop suitability based on soil, climate, and management needs.

Every soil test performed with the Smart Soil Sensor is automatically geo-tagged and linked to the correct field through its Field ID.
This ensures that recommendations are **field-specific**, **accurate**, and **repeatable**.

7.2 Why LBS Matters

LBS transforms raw soil data into actionable insights by:

- Identifying which crops are suitable for your land.
- Highlighting soil limitations (e.g., low N, high EC, poor texture)
- Supporting long-term soil health planning
- Enabling precision fertigation and irrigation
- Tracking soil changes over time

Instead of generic advice, LBS ensures that every recommendation is tailored to **your exact field**, not just your general region.

7.3 How Soil Properties Influence Crop Suitability

Different crops require different soil conditions. The Smart Soil Sensor measures nine parameters that directly determine whether a crop can thrive in a specific field.
Below is a clear explanation of how each parameter affects crop suitability.

7.3.1 Soil Texture

Texture determines:

- Water-holding capacity.
- Root penetration
- Nutrient retention
- Aeration

Examples

- **Sandy soils** → Good for groundnut, watermelon, carrot
- **Clay loam soils** → Suitable for wheat, rice, sugarcane
- **Silty soils** → Ideal for vegetables and orchards

Texture is one of the most principal factors in crop selection.

7.3.2 Soil Moisture

Moisture affects:

- Germination
- Root development
- Nutrient uptake
- Irrigation scheduling

Examples

- Low moisture → Not suitable for rice
- High moisture → Not suitable for chickpea or lentil

Moisture also helps determine **irrigation recommendations**.

7.3.3 Soil Temperature

Temperature influences:

- Seed germination
- Microbial activity
- Nutrient mineralization

Examples

- Potatoes prefer cooler soil.
- Cotton and maize require warm soil.

Temperature suitability varies by season and crop.

7.3.4 Electrical Conductivity (EC)

EC indicates **salinity**, which affects:

- Water uptake
- Nutrient absorption
- Crop stress tolerance.

Examples

- High EC → Not suitable for onion, citrus, potato
- Moderate EC → Tolerated by barley, cotton, sugar beet.

EC is one of the strongest predictors of crop failure in saline regions.

7.3.5 Soil pH

pH controls:

- Nutrient availability
- Microbial activity
- Fertilizer efficiency

Examples

- pH < 6 → Not suitable for most cereals
- pH > 8 → Reduces P availability, affects vegetables.
- Neutral pH (6.5–7.5) → Ideal for most crops

pH is a key factor in determining fertilizer recommendations.

7.3.6 Nitrogen (N)

Nitrogen effects:

- Vegetative growth
- Leaf development
- Chlorophyll formation

Examples

- Low N → Poor growth in maize, rice, wheat
- High N → Excessive vegetative growth in vegetables

N-suitability varies by crop stage.

7.3.7 Phosphorus (P)

Phosphorus influences:

- Root development
- Flowering
- Fruit formation

Examples

- Low P → Poor root growth in legumes
- High pH soils often show P deficiency.

P suitability is critical for early crop establishment.

7.3.8 Potassium (K)

Potassium supports:

- Disease resistance
- Water regulation
- Fruit quality

Examples

- Low K → Affects sugarcane, banana, tomato.
- High K → Improves drought tolerance.

K suitability is essential for fruiting crops.

7.3.9 Organic Matter (OM)

OM improves:

- Soil structure
- Water retention
- Nutrient availability
- Microbial activity

Examples

- Low OM → Poor soil health, low fertility
- High OM → Better yields and nutrient efficiency

OM is a long-term indicator of soil productivity.

7.4 How LBS Uses Soil Data for Crop Suitability Analysis

The Agronomics system combines:

- Soil test results
- Field boundaries
- Crop requirement databases.
- Weather and climate data
- Historical test records

…to generate a **Crop Suitability Score** for each crop.

The system evaluates:

- Whether soil texture matches crop needs
- Whether EC and pH fall within acceptable ranges
- Whether NPK levels meet crop requirements
- Whether moisture and temperature are suitable

- Whether the field has any limiting factors

Each crop is classified as:

- **Highly Suitable**
- **Moderately Suitable**
- **Marginally Suitable**
- **Not Suitable**

This helps farmers choose the right crop for the right field at the right time.

7.5 Benefits of Soil-Driven Crop Suitability

- Reduces crop failure risk.
- Improves yield potential.
- Optimize fertilizer and irrigation use.
- Supports sustainable soil management.
- Help farmers plan crop rotations.
- Enables precision agriculture at field level.

7.6 Using LBS in the Agronomics App

Step 1 — Add Your Land

- Open the LBS module & Draw your field boundary.
- Save to generate a **Field ID**

Step 2 — Perform Soil Testing

- Use any testing mode & Ensure GPS is active.
- Test results automatically link to the Field ID

Step 3 — View Suitability Analysis

- Open the field in LBS.
- View crop suitability scores
- Review soil limitations.
- Access fertilizer and irrigation recommendations

After completing any soil test using the Smart Soil Sensor, the Agronomics App instantly processes the data and displays a complete analysis of the soil's physical and chemical properties. This chapter explains how results are presented, how to interpret them, and how to manage and share your reports.

8.1 What Happens After a Test Completes

Once the sensor finishes reading the soil (after 5–6 minutes):

- The app automatically receives the data.
- All nine parameters are analyzed.
- A geo-tagged soil test record is created.
- A PDF report is generated and saved.
- Recommendations become available (if applicable)

You do not need to manually save anything — the system handles it automatically.

8.2 Parameters Displayed in the Test Result Screen

Each soil test displays the following nine parameters:

Parameter	What It Indicates
Nitrogen (N)	Soil fertility and vegetative growth potential
Phosphorus (P)	Root development and flowering strength
Potassium (K)	Fruit quality, disease resistance, water regulation
pH	Soil acidity/alkalinity and nutrient availability
Electrical Conductivity (EC)	Soil salinity and salt stress risk

Moisture	Water availability and irrigation needs
Temperature	Soil warmth for germination and microbial activity
Organic Matter (OM)	Soil health, structure, and nutrient retention
Soil Texture	Water-holding capacity, aeration, and crop suitability

Each parameter is shown with:

- The measured value
- A color-coded indicator (Good / Moderate / Poor)
- A short interpretation

This helps users quickly understand the soil condition without needing technical knowledge.

8.3 Understanding the Color Indicators

To make results easy to interpret, the app uses a simple color system:

- **Green** → Optimal or acceptable
- **Yellow** → Needs attention or moderate adjustment
- **Red** → Critical issue requiring immediate action.

These indicators are based on agronomic thresholds aligned with crop requirements and soil science standards.

8.4 Geo-Tagging and Field Mapping

Every test result includes:

- GPS coordinates
- Field ID (if linked through LBS)
- Test mode (Z-pattern, Spot, Pot, etc.)
- Timestamp

This ensures:

- Traceability

- Field-specific recommendations
- Accurate historical comparisons
- Compliance for enterprise and research use

8.5 PDF Report Generation

After each test, the app automatically creates a **Smart Soil Sensor Analysis Report** in PDF format.

The PDF includes:

- Farmer name (if registered)
- Field ID (if applicable)
- GPS location
- Date and time.
- All nine soil parameters.
- Soil texture classification
- Summary of soil condition
- Agronomic insights (if enabled)

This report is designed for:

- Farmers
- Agronomists
- Input suppliers
- Researchers
- Government and enterprise programs

8.6 Sharing the Report

You can share the PDF instantly using:

- WhatsApp
- Email
- Messenger
- Any sharing app on your phone

How to Share

1. Open the test result.
2. Tap the **Share** icon.
3. Select your preferred app.
4. Send the PDF

This makes it easy to share results with:

- Agronomists, Landowners
- Buyers, Input dealers
- Project managers

8.7 Viewing Past Test Results

All soil tests are automatically stored in the **History** section of the app.

History Includes:

- List of all tests
- Dates and times
- Field IDs
- Test modes
- GPS locations
- Access to all past PDFs

This allows farmers and agronomists to:

- Track soil changes over time.
- Compare seasonal variations.
- Monitor the impact of fertilizers.
- Maintain digital records for compliance.

8.8 How Test Results Feed Into Recommendations

The Agronomics system uses soil test results to generate:

8.8.1 Fertigation Recommendations

Based on:

- NPK levels

- Soil texture
- Crop type
- Growth stage

8.8.2 Irrigation Recommendations

Based on:

- Soil moisture
- Soil texture
- Temperature
- Weather forecast

8.8.3 Crop Suitability Analysis

Based on:

- pH
- EC
- Texture
- OM
- NPK balance

These recommendations help farmers make data-driven decisions that improve yield and reduce input waste.

8.9 Accuracy and Interpretation Notes

To ensure reliable results:

- Always clean the probe between test points
- Avoid testing immediately after irrigation.
- Ensure proper insertion depth.
- Keep the phone stable during testing.
- Use the Z-pattern for full-field accuracy.

The app automatically adjusts for temperature and moisture variations to improve measurement stability.

Proper maintenance of the Smart Soil Sensor ensures long-term accuracy, reliable performance, and extended device life. This chapter outlines the essential steps for cleaning, handling, storing, and protecting the sensor and its components.

9.1 Why Maintenance Matters

The Smart Soil Sensor operates in harsh field conditions — moisture, salts, organic matter, and soil particles can accumulate on the probe and affect readings. Regular maintenance:

- Preserves measurement accuracy.
- Prevents corrosion and buildup.
- Extends the lifespan of electrodes.
- Reduces the risk of physical damage.
- Ensures consistent performance across tests.

A well-maintained sensor delivers more reliable data and better agronomic decisions.

9.2 Cleaning the Sensor After Each Test

Cleaning the probe after every test point is essential for accurate reading.

Steps for Cleaning

- Rinse the electrodes with **clean tap water.**
- Wipe gently using a **soft cloth or tissue.**
- Remove all soil particles from the probe surface.
- Dry the probe before storing or moving to the next test point.

Important Notes

- Do **not** use detergents, chemicals, or alcohol.

- Do **not** scratch the electrodes with metal or abrasive materials.
- Do **not** soak the USB-C connector in water.

9.3 Cleaning Between Z-Pattern Points

During Z-pattern testing (5 points):

- Clean the probe **after each point.**
- Ensure no soil from the previous point remains.
- This prevents cross-contamination and ensures accurate field-level variability detection.

9.4 Handling the Sensor Safely

To avoid damage:

- Insert the probe gently into the soil.
- Do not twist or force the sensor into hard or rocky soil.
- Avoid bending the electrodes.
- Keep the cable straight and untangled.
- Do not pull the sensor out with the cable.

If the soil is too hard

- Loosen the soil slightly before inserting.
- Never hammer or push the sensor with excessive force.

9.5 Protecting the USB-C Connector

The USB-C connector is sensitive and must remain dry.

Do

- Keep the connector away from water.
- Dry your hands before connecting.
- Inspect the cable regularly for damage.

Do Not

- Allow water to enter the connector.
- Use the sensor during rain without protection.
- Bend the connector or apply pressure.

9.6 Storing the Sensor Properly

Proper storage extends the lifespan of the sensor.

Storage Guidelines

- Store in a **dry, cool place.**
- Keep the probe covered with its protective cap.
- Avoid direct sunlight or high heat.
- Do not store with wet soil on the electrodes.
- Keep away from children and pets.

Ideal Storage Conditions

- Temperature: **10°C to 40°C**
- Humidity: **< 70%**

9.7 Caring for the Sensor Dock

The dock is splash-proof (IP65) but not waterproof.

Do

- Wipe with dry cloth.
- Keep away from direct water exposure.
- Store in a dust-free environment.

Do Not

- Submerge the dock in water.
- Leave it outdoors in rain.
- Expose it to mud or chemicals.

9.8 Cable Maintenance

The USB-C cable is essential for powering and communicating with the sensor.

Best Practices

- Avoid twisting or bending the cable.
- Do not pull the cable from the middle.
- Disconnect by holding the connector.
- Replace the cable if frayed or damaged.

9.9 Extending Sensor Lifespan

To maximize the life of the electrodes and electronics:

- Avoid testing in extremely dry or extremely wet soil.
- Do not expose the sensor to temperatures beyond **–20°C to 60°C.**
- Clean the probe immediately after use.
- Store the sensor in its protective case.
- Disconnect the sensor when not in use.

9.10 Common Mistakes to Avoid

- Leaving soil on the probe after testing
- Using abrasive materials to clean the electrodes
- Testing in rocky soil without preparation
- Allowing water to enter the USB-C port
- Storing the sensor in hot vehicles or direct sunlight
- Using the sensor with a phone battery below 30%

The Smart Soil Sensor is designed for safe and reliable field use. However, like any electronic device, it must be handled carefully to avoid damage, inaccurate readings, or injury. This chapter outlines essential safety precautions for farmers, agronomists, and field technicians.

10.1 General Safety Precautions

To ensure safe operation:

- Handle the sensor gently and avoid applying excessive force.
- Keep the device away from children.
- Do not use the sensor in unsafe or unstable environments.
- Avoid testing during thunderstorms or heavy rain.
- Keep your phone secure while connected to the sensor.

These precautions protect both the user and the device.

10.2 Electrical Safety

The Smart Soil Sensor is powered through your mobile phone, making electrical safety extremely important.

Do

- Use only a **5V power source** (your phone's USB-C port)
- Ensure the USB-C connector is **completely dry** before connecting.
- Disconnect the sensor when not in use.
- Inspect the cable regularly for damage.

Do Not

- Expose the USB-C connector to water.

- Use damaged cables or connectors.
- Connect the sensor to high-voltage power sources.
- Pull the cable forcefully or twist it excessively.

Electrical misuse may damage your phone or the sensor.

10.3 Soil Insertion Safety

Improper insertion can damage the sensor or cause injury.

Safe Insertion Practices

- Insert the probe gently into the soil.
- Avoid rocky, compacted, or extremely hard soil.
- Loosen the soil slightly if resistance is high.
- Never hammer or force the sensor into the ground.
- Keep your hands away from sharp stones or debris.

Safe Removal Practices

- Pull the sensor straight out.
- Do not twist or bend the probe.
- Clean the probe immediately after removal.

10.4 Environmental Safety

The sensor is designed for outdoor use, but certain conditions can cause damage.

Temperature Limits

- Operating range: **–20°C to 60°C**
- Storage range: **10°C to 40°C**

Water Exposure

- Probe: Waterproof (IP68)
- Dock: Splash-proof (IP65)
- USB-C connector: **Not waterproof**

Avoid

- Submerging the dock in water

- Leaving the sensor in direct sunlight for prolonged periods
- Using the sensor during heavy rainfall without protection

10.5 Mobile Phone Safety

Since the sensor draws power from your phone:

Do

- Keep your phone battery above **30%.**
- Avoid phone calls during testing.
- Keep the phone stable and avoid dropping it.
- Ensure the phone stays dry.

Do Not

- Use the sensor if your phone is overheating.
- Allow the cable to pull or strain the phone port.
- Use the sensor with a cracked or damaged phone port.

10.6 Chemical and Material Safety

The sensor is designed for soil only.

Do Not Insert the Sensor Into

- Fertilizer solutions
- Acids or chemicals
- Manure pits
- Industrial waste
- Saltwater or brackish water

Chemical exposure may permanently damage the electrodes.

10.7 Safe Handling of the Sensor Dock

The dock contains sensitive electronics.

Do

- Keep it dry.
- Clean it with soft, dry cloth.
- Store it in a dust-free environment.

Do Not

- Submerge it in water.
- Drop or strike it.
- Expose it to mud, chemicals, or extreme heat.

10.8 Safe Storage Practices

To protect the device when not in use:

- Clean and dry the probe.
- Cover the electrodes with the protective cap.
- Store in a cool, dry place.
- Keep away from direct sunlight.
- Avoid placing heavy objects on the sensor or cable.

Proper storage significantly extends the lifespan of the device.

10.9 Warning Signs to Watch For

Stop using the sensor immediately if you notice:

- Damaged or exposed wires
- Cracked electrodes.
- Loose USB-C connector
- Burnt smell or overheating.
- Water inside the dock

Contact Agronomics support if any of these issues occur.

10.10 Summary of Key Safety Rules

- Keep the USB-C connector dry.
- Never force the sensor into hard soil
- Avoid extreme temperatures.

- Clean the probe after every test.
- Disconnect the sensor when not in use.
- Store the device properly.
- Keep out of reach of children.

These simple rules ensure safe operation and long-term reliability.

The Smart Soil Sensor is built for durability and long-term field performance. However, like any precision instrument, it requires proper handling and care. This chapter explains the warranty terms, what is covered, what is not covered, and how to access technical support when needed.

11.1 Warranty Overview

The Smart Soil Sensor comes with a **6-month limited warranty** that covers manufacturing defects in the **main docking unit** only. This warranty ensures that users receive a functional device free from factory-related faults.

Warranty Duration

- **6 months** from the date of purchase
- Valid only with proof of purchase (invoice, receipt, or digital record)

11.2 What the Warranty Covers

The warranty applies **only** to manufacturing defects in the **main dock**. These include:

- Internal electronic faults
- Factory-related component failures
- Non-functional communication circuits
- Power-related issues originating from manufacturing defects.

If the dock fails due to a verified manufacturing issue, it may be eligible for replacement.

11.3 What the Warranty Does NOT Cover

To maintain transparency, the following items and situations are **not covered** under warranty:

1. Sensor Electrodes

- Electrodes are considered **consumable components.**
- Wear and tears from regular use is expected.
- Damage due to soil conditions, corrosion, or misuse is not covered.

2. Physical Damage

- Broken probes
- Bent electrodes.
- Cracked casing.
- Damaged USB-C ports
- Cable damage due to pulling or twisting.

3. Water or Liquid Damage

- Water entering the USB-C connector.
- Submerging the dock in water
- Exposure to chemicals or corrosive liquids

4. Heat or Fire Damage

- Overheating due to improper power sources
- Exposure to flames or extreme temperatures

5. Misuse or Unauthorized Handling

- Opening or tampering with the device
- Unauthorized repairs
- Using incompatible cables or power sources

6. Environmental Misuse

- Using the sensor outside its operating range
- Testing in inappropriate materials (chemicals, manure pits, industrial waste)

11.4 Warranty Eligibility Requirements

To qualify for warranty service:

- Provide **proof of purchase.**

- Provide the **sensor serial number** (if applicable)
- Describe the issue clearly.
- Ensure the device has not been tampered with
- Ensure the damage is not caused by misuse.

The Agronomics support team will evaluate the device before approving any replacement.

11.5 How to Request Warranty Service

If you believe your device has a manufacturing defect:

Step 1 — Prepare Required Information

- Your name and contact number.
- Proof of purchase & Description of the issue
- Photos or videos (if requested)

Step 2 — Contact Agronomics Support

Reach out to the Agronomics service team through:

- Official support number
- Email
- In-app support (if available)

Step 3 — Device Evaluation

The support team will:

- Review of your case
- Diagnosing the issue
- Confirm whether it qualifies for warranty.

Step 4 — Replacement (If Approved)

If the issue is verified as a manufacturing defect:

- The main dock may be replaced.
- Replacement terms follow company policy.

11.6 Post-Warranty Support

Even after the warranty period ends, Agronomics continues to support users with:

- Troubleshooting assistance
- Usage guidance
- Sensor care recommendations
- Replacement parts (if available)

This ensures long-term value and reliable performance.

11.7 Best Practices to Maintain Warranty Validity

To avoid voiding your warranty:

- Do not open or disassemble the device.
- Keep the USB-C connector dry.
- Use only approved cables.
- Avoid physical shocks or drops.
- Store the sensor properly.
- Follow all safety and maintenance guidelines.

11.8 Summary of Warranty Terms

Covered	Not Covered
Manufacturing defects in main dock	Sensor electrodes
Internal electronic faults	Physical damage
Factory-related failures	Water damage to USB-C port
Power/communication faults	Heat/fire damage
—	Misuse, tampering, unauthorized repairs

This summary helps users quickly understand the scope of the warranty.

This chapter provides additional resources to help users understand technical terms, resolve common issues, and operate the Smart Soil Sensor with confidence. It is designed as a quick-reference section for farmers, agronomists, and field technicians.

12.1 Appendix

A. Soil Parameter Threshold Ranges (General Agronomic Guidelines)

(Note: Actual recommendations vary by crop and region.)

Parameter	Low	Optimal	High
Nitrogen (N)	< 50 mg/kg	50–150 mg/kg	> 150 mg/kg
Phosphorus (P)	< 10 mg/kg	10–25 mg/kg	> 25 mg/kg
Potassium (K)	< 80 mg/kg	80–200 mg/kg	> 200 mg/kg
pH	< 6.0	6.0–7.5	> 7.5
EC	< 1.0 dS/m	1.0–2.5 dS/m	> 2.5 dS/m
Moisture	< 20%	20–75%	> 75%
Temperature	< 10°C	10–35°C	> 35°C
Organic Matter	< 1%	1–3%	> 3%

These ranges help users interpret soil conditions briefly.

B. Recommended Soil Preparation Depths

Test Type	Depth
Field Z-Pattern	5–6 inches
Spot Test	5–6 inches

Test Type	Depth
Pot Test	Full probe depth (avoid pot walls)

C. Sensor Operating Limits

- Operating temperature: **–20°C to 60°C**
- Storage temperature: **10°C to 40°C**
- Soil moisture: **20–75%** recommended.
- Waterproof rating (probe): **IP68**
- Dock rating: **IP65 (splash-proof)**

12.2 Glossary of Terms

- **Agronomics App:** The mobile application used to operate the Smart Soil Sensor and view results.
- **EC (Electrical Conductivity):** A measure of soil salinity, indicating salt concentration.
- **Field ID:** A unique identifier assigned to each land parcel in the LBS system.
- **GPS Geo-Tagging:** Automatic recording of the test location using satellite positioning.
- **Ion-Selective Electrode (ISE):** Technology is used to measure N, P, and K ions in soil.
- **ISFET:** A solid-state sensor used for measuring soil pH.
- **LBS (Location-Based Suitability):** A system that links soil test results to mapped land boundaries.
- **Organic Matter (OM):** Decomposed plant and animal residues that improve soil health.
- **Z-Pattern Sampling:** A 5-point soil sampling method used for field-level accuracy.

12.3 Frequently Asked Questions (FAQs)

Q1: How long does a soil test take?

Each test takes **5–6 minutes** for stable readings.

Q2: Can I test soil immediately after irrigation?
No. Wait at least **24 hours** for moisture to stabilize.

Q3: Why is my EC reading high?
Reasons:

- High soil salinity
- Recent fertilizer application
- Poor drainage
- Waterlogging

Q4: Why does the sensor not connect?
Check:

- Bluetooth ON
- Location ON
- Cable properly connected
- Phone battery above 30%.

Q5: Can I use the sensor in pots and nurseries?
Yes — use **Pot Test Mode**.

Q6: How often should I clean the probe?
After **every test point**, especially in Z-pattern testing.

Q7: Can I test sandy or clay soils?
Yes — the sensor supports all mineral soil textures.

Q8: Does the sensor work without internet?
Yes, for testing, but **internet is required** for:

- Registration
- Synchronizing results
- Weather-based recommendations

Q9: Why is my pH reading unstable?
Potential causes:

- Very dry soil
- Poor soil-probe contact
- Stones or air gaps
- Dirty electrodes

Q10: How do I share my test report?
Tap the **Share** icon on the result screen and choose WhatsApp, Email, etc.

12.4 Troubleshooting Guide

This section helps users quickly diagnose and fix common issues.

12.4.A. Sensor Not Powering On

Possible Causes

- Phone battery too low.
- OTG not enabled
- Damaged cable
- Loose USB-C connection

Solutions

- Charge phone above 30%
- Enable OTG in phone settings.
- Reconnect cable.
- Try a different cable if available.

12.4.B. Bluetooth Not Connecting

Possible Causes

- Bluetooth paired with another device
- App does not detect sensors.

- Phone Bluetooth glitch.

Solutions

- Turn Bluetooth OFF → ON
- Restart the Agronomics App
- Restart the phone.

12.4.C. Transmission Icon Not Turning Green

Possible Causes

- Sensor not fully inserted into soil.
- Cable loose
- Soil too dry or too hard

Solutions

- Reinsert the probe properly.
- Ensure cable is secure.
- Moisten soil slightly if extremely dry.

12.4.D. Inaccurate or Unstable Readings

Possible Causes

- Dirty electrodes
- Air gaps around probe
- Testing immediately after irrigation
- Soil too dry or waterlogged.

Solutions

- Clean the probe.
- Insert deeper and ensure firm soil contact.
- Wait 24 hours after irrigation.
- Avoid extreme soil conditions.

12.4.E. Freezing or Crashing

Possible Causes

- Low RAM
- Background apps interfering
- Outdated app version

Solutions

- Close other apps
- Restart the phone.
- Update the Agronomics App

12.4.F. GPS Not Updating During Z-Pattern.

Possible Causes

- Weak GPS signal
- Location turned off
- Phone inside pocket during movement.

Solutions

- Move to open sky.
- Turn Location ON
- Hold phone in hand while walking.

12.5 When to Contact Support

Contact Agronomics Support if:

- The dock does not power on despite troubleshooting.
- The sensor shows repeated errors.
- The USB-C port is damaged.
- The electrodes are physically bent or cracked.
- You need warranty assistance.

Provide:

- Proof of purchase
- Photos/videos of the issue
- Sensor serial number (if applicable)