

# IoT-Based Soil Nutrients Monitoring and Management

## Innovation in Problem Solving

The depletion of soil nutrients and inefficient fertilizer usage significantly impact crop yield and sustainability. This project utilizes IoT-based soil monitoring to enable real-time nutrient analysis, smart irrigation, and site-specific fertilizer recommendations to improve soil health and productivity.

## Core Problems to Solve

1. Lack of real-time soil data for farmers.
2. Excessive or insufficient fertilizer application.
3. Soil degradation and reduced fertility.
4. Absence of decision-support tools for nutrient management.

## Innovative Solutions Proposed

### 1. Soil Sensor Deployment

- Deploy low-cost sensors to monitor NPK (Nitrogen, Phosphorus, Potassium), pH, temperature, and moisture levels.
- Sensors are solar-powered and communicate via NB-IoT or LoRaWAN.
- Technologies: Yara NPK sensor, DFRobot pH sensor, ESP32 microcontroller.

### 2. Cloud-Based Data Analytics

- Real-time data transmission using MQTT.
- Machine learning models predict nutrient deficiencies and suggest corrective actions.
- Dashboard for visualization and alerts.

### 3. Mobile App Interface

- Farmers receive data insights on nutrient levels and tailored fertilizer suggestions.
- Features: GPS-based soil profiling, weather integration, voice support.

### 4. Smart Irrigation Integration

- Automated irrigation based on soil moisture and crop type.
- Saves water and prevents nutrient leaching.

## **Implementation Strategy**

1. Sensor calibration and pilot installation on test farms.
2. Backend cloud setup and mobile dashboard development.
3. Testing and AI model training for nutrient prediction.
4. Partner with agriculture departments for deployment.

## **Challenges and Solutions**

- Sensor Calibration: Regular field calibration ensures accuracy.
- Connectivity Issues: Use of LoRa and offline data logging.
- Farmer Adoption: Training programs and multilingual app interface.

## **Expected Outcomes**

1. Improved fertilizer efficiency and cost savings.
2. Real-time nutrient insights across farm zones.
3. Increased crop yield and soil sustainability.
4. Data-driven farming practices.

## **Next Steps**

1. Expand sensor network across different soil types.
2. Integrate weather and crop type databases for enhanced insights.
3. Collaborate with agri-tech firms for scaling and research.