

ABSTRACT

NutriRoot:

Smart Fertilizer Recommendation & IoT Soil Monitoring System

Modern agriculture requires precise nutrient management to enhance crop productivity while preserving soil health. **NutriRoot** is an integrated IoT-enabled smart agriculture system designed to provide real-time soil insights and accurate fertilizer recommendations through a web-based decision-support platform. The system captures key soil and environmental parameters—including **Nitrogen (N)**, **Phosphorus (P)**, **Potassium (K)**, **soil pH**, **moisture level**, **temperature**, and the **selected crop type**—using IoT-based soil sensing devices. These measurements enable intelligent and data-driven fertilizer optimization.

The IoT hardware deployed in the field continuously collects soil metrics and transmits the data to the cloud through an embedded microcontroller system. The **NutriRoot** web application—developed using **HTML5, CSS3, and JavaScript** on the frontend and **Python** on the backend—features a **Real-Time Dashboard**, **Fertilizer Recommendation Page**, **Crop Suggestion Page**, **Historical Data Graphs**, and an **Alert System** that notifies users of abnormal soil conditions. User authentication and profile management ensure secure, personalized access.

All collected data is efficiently stored and managed in a **MySQL database**, while IoT communication utilizes **HTTP-based APIs** for seamless data transfer. Users can also generate and download customized **PDF reports** summarizing soil status and fertilizer requirements.

By integrating IoT sensing technology, intelligent backend processing, and modern web frameworks, **NutriRoot** advances precision agriculture, enhances decision-making, reduces fertilizer wastage, and empowers farmers with real-time, actionable insights for sustainable crop management.