GreenGrow

Smart Fertilizer Recommendation System

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Introduction

Agriculture plays a vital role in food security and Economic Development

Fertilizers are essential for improving crop yield and soil fertility

Soil degradation

Improper fertilizer usage causes long-term damage to soil structure and health

Water pollution

Excessive fertilizers contaminate water sources and ecosystems

Reduced long-term productivity

Unsustainable practices diminish future agricultural output

Farmers often lack access to scientific, data-driven fertilizer guidanceNeed for a smart system to support sustainable agricultural practices

Problem Statement

A majority of small and marginal farmers in India rely on traditional knowledge, local shopkeepers, or guesswork for crop selection, pest control, and fertilizer use. They lack access to personalized, real-time advisory services that account for soil type, weather conditions, and crop history.This often leads to poor yield, excessive input costs, and environmental degradation due to overuse of chemicals.

Existing advisory systems:

Provide generalized recommendations

One-size-fits-all approaches that don't account for specific conditions

Ignore soil conditions, crop type, and weather variability

Critical factors are overlooked in traditional advisory methods

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Farmers face difficulty in selecting:

Right type of fertilizer

Choosing appropriate nutrients for specific crops

Correct quantity

Determining optimal application amounts

Proper application time

Timing fertilizer use for maximum effectiveness

Research Background

Literature Review

Name of Paper	Year	Methodology	Result	Limitation
Applying Machine Learning Techniques to Extract dosages of Fertilizers for Precision Agriculture	2020	**CART Regression** models applied to soil datasets using Minitab to predict N, P, and K dosages.	Models achieved **>90% accuracy** (99.5% for Nitrogen in training). Zone was found to be the most important parameter.	Initial blanket recommendations ignored **adversely varying soil nutrients** and target yields.
Crop Recommender System Using Machine Learning Approach	2021	Comparative analysis of **RF, SVM, ANN, MLR, and KNN**. Developed as a GPS-based mobile application.	**Random Forest (RF)** showed best results with **95% accuracy**.	Existing systems were often **hardware-based/costly** or not easily accessible to farmers.
Crop and Fertilizer Recommendation System Applying Machine Learning Classifiers	2023	**GaussianNB, Decision Tree, SVM, and LR**. Integrated data preprocessing with Power BI.	Models achieved **99.15% validation accuracy**. Recommended best crops based on environmental NPK.	High reliance on **hybrid varieties** can lead to soil acidification if not managed with data.
ML-Based Soil Analysis for Crop Suggestion and Fertilizer Recommendation	2025	**Random Forest** (Crop/Fertilizer) and **Linear Regression** (Rainfall). Used a 6-wheel autonomous agricultural vehicle.	**92.3% average accuracy**. Real-time data transmission latency was **<1 second**.	Current systems are often **static or semi-automatic**, requiring high human interference.

Gap Identified

No unified system combining:

- Soil health parameters
- Crop-specific nutrient requirements
- Weather data

Limited accessibility of smart tools for farmers

Existing solutions remain out of reach for many agricultural communities

Absence of decision-support systems for optimised fertilizer usage

Farmers lack comprehensive tools to make informed fertilizer decisions

Need for a user-friendly, data-driven fertilizer recommendation platform

Our Solution

Proposed Solution

Development of a Smart Fertilizer Recommendation System

System integrates:

- Soil nutrient data (NPK, pH, moisture)
- Crop type and growth stage
- Weather conditions

Provides:

Accurate fertilizer type recommendations

Optimal quantity suggestions

Benefits:

- Reduced fertilizer wastage
- Improved soil sustainability
- Increased crop productivity

System Architecture

Module Description

01

User Module

- Farmer registration and login
- Input soil and crop details
- View fertilizer recommendations

02

Soil Data Module

- Stores soil nutrient values
- Processes soil health indicators

03

Crop Module

- Crop-specific nutrient requirement database
- Growth-stage based recommendations

04

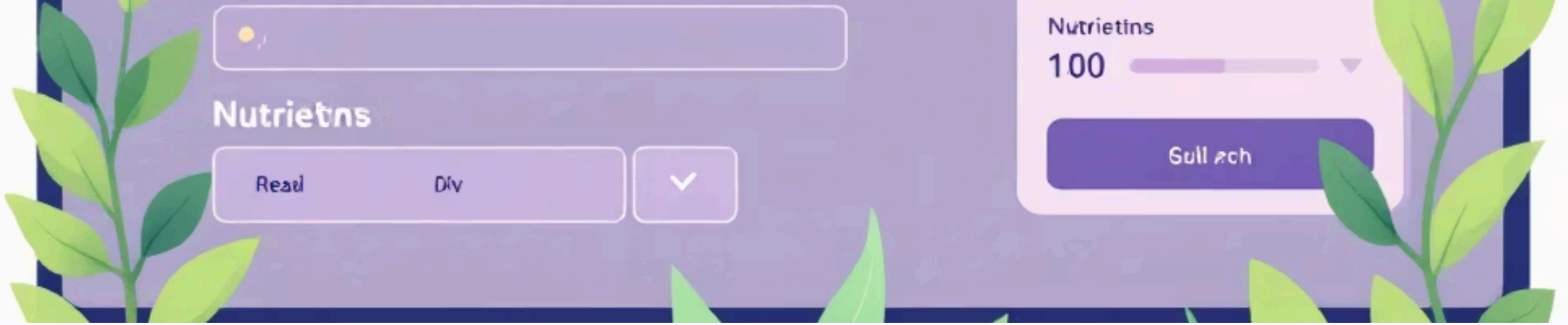
Weather Module

- Weather data integration
- Adjusts fertilizer advice based on climate conditions

05

Recommendation Engine

- Analyzes all inputs
- Generates optimised fertilizer suggestions



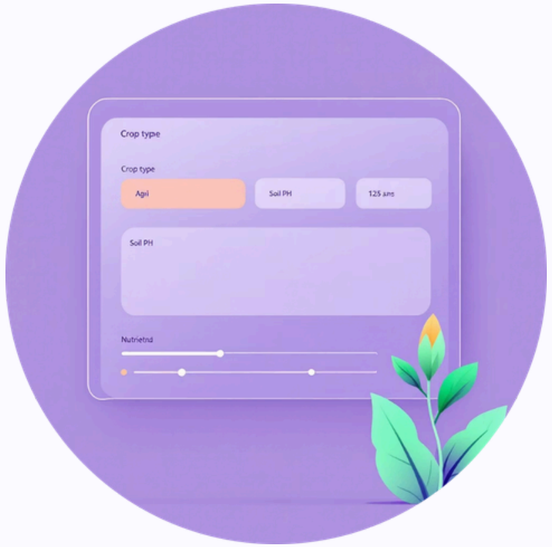
Technical Specifications

Software Requirement Specification (SRS)

- Defines system behaviour and constraints
- Acts as a blueprint for development
- Ensures clarity between stakeholders

Technical Specifications

User Interface Requirements



DATA INPUT

Essential Parameters

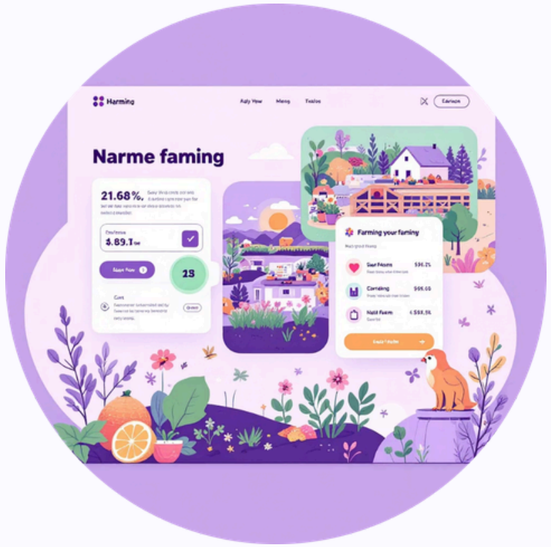
Users can easily input critical data via dedicated fields:

- Crop type (dropdown selection)
- Soil pH value
- Nitrogen (N), Phosphorus (P), Potassium (K) levels

DESIGN PRINCIPLES

Intuitive & Accessible

The application will be a web-based platform with a simple, user-friendly interface designed for farmers.



RECOMMENDATIONS

Clear Output

A submit button will process inputs, displaying:

- Predicted fertilizer type
- Recommended fertilizer quantity

Technical Specifications

Software and Hardware Requirements

Software Requirements

- Operating System: Windows / Linux
- Programming Language: Python
- Frontend Technologies: HTML, CSS
- Backend Framework: Flask
- Machine Learning Algorithm: Random Forest Classifier
- Libraries and Tools: Scikit-learn, Pandas, NumPy
- Optional API: OpenWeatherMap API (for weather-based adjustment)

Hardware Requirements

- **Minimum Requirements**
  - Processor: Intel i3 or above
  - RAM: 4 GB
  - Storage: 20 GB free disk space
- **Recommended Requirements**
  - Processor: Intel i5 or above
  - RAM: 8 GB
  - Internet connection (for optional weather API)

Technical Specifications

Functional Requirements

- Accept soil nutrient values (pH, N, P, K) from user
- User registration and authentication
- Input and storage of soil parameters
- Weather data processing
- Accept crop type as input
- Preprocess input data
- Apply Random Forest model to predict fertilizer type
- Display fertilizer recommendations to the user
- Use rule-based logic to calculate fertilizer quantity

Use Case Description

Farmer Interaction Workflow

01

Login to System

Farmers securely access their personalized dashboard using unique credentials.

02

Enter Soil & Crop Details

Users input current soil test results, specifying parameters like NPK, pH, and moisture. They also select the crop type and growth stage for each plot.

03

System Processes Inputs

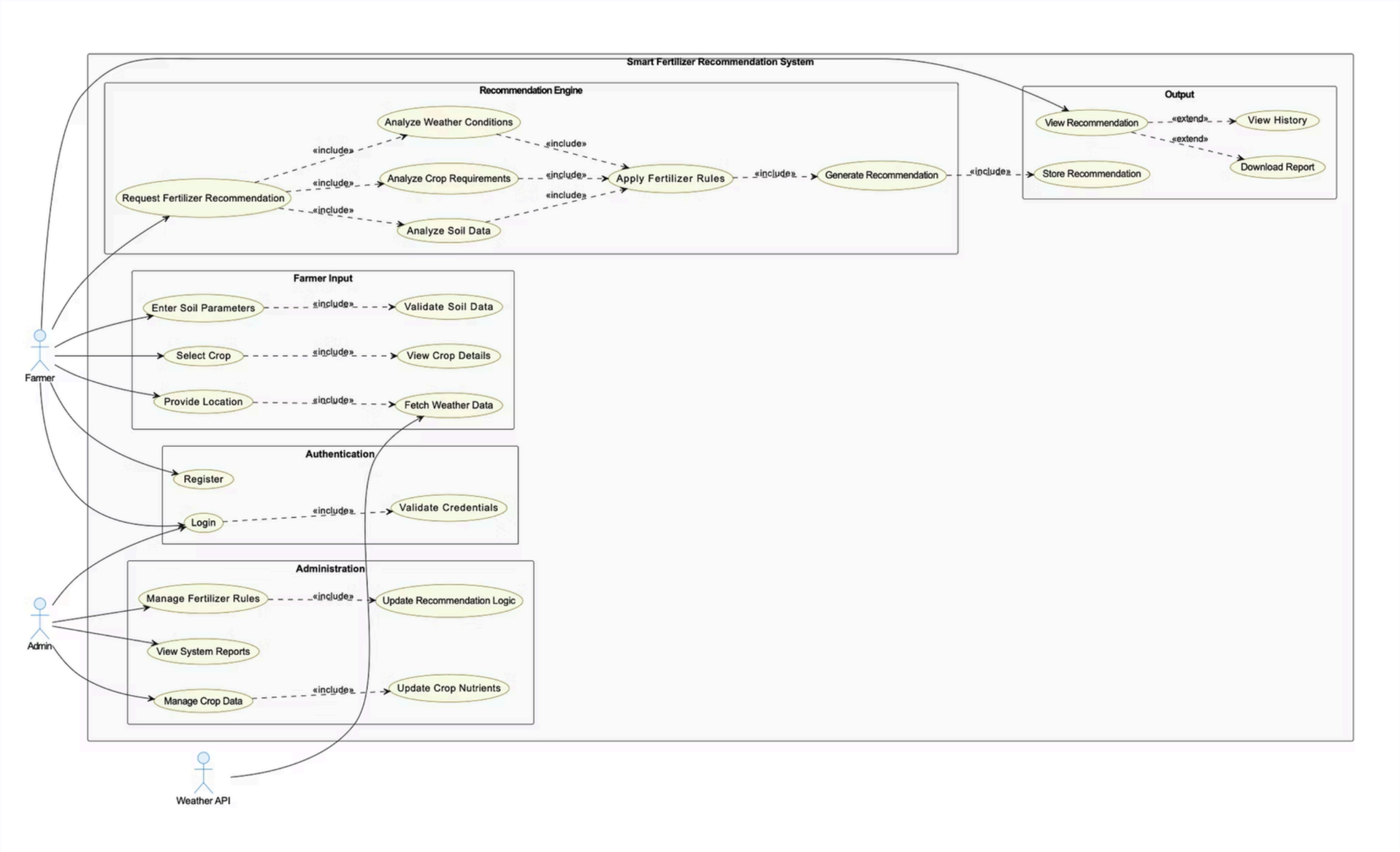
The recommendation engine integrates and analyses the provided soil data, crop requirements, and real-time weather conditions.

04

View Fertilizer Recommendations

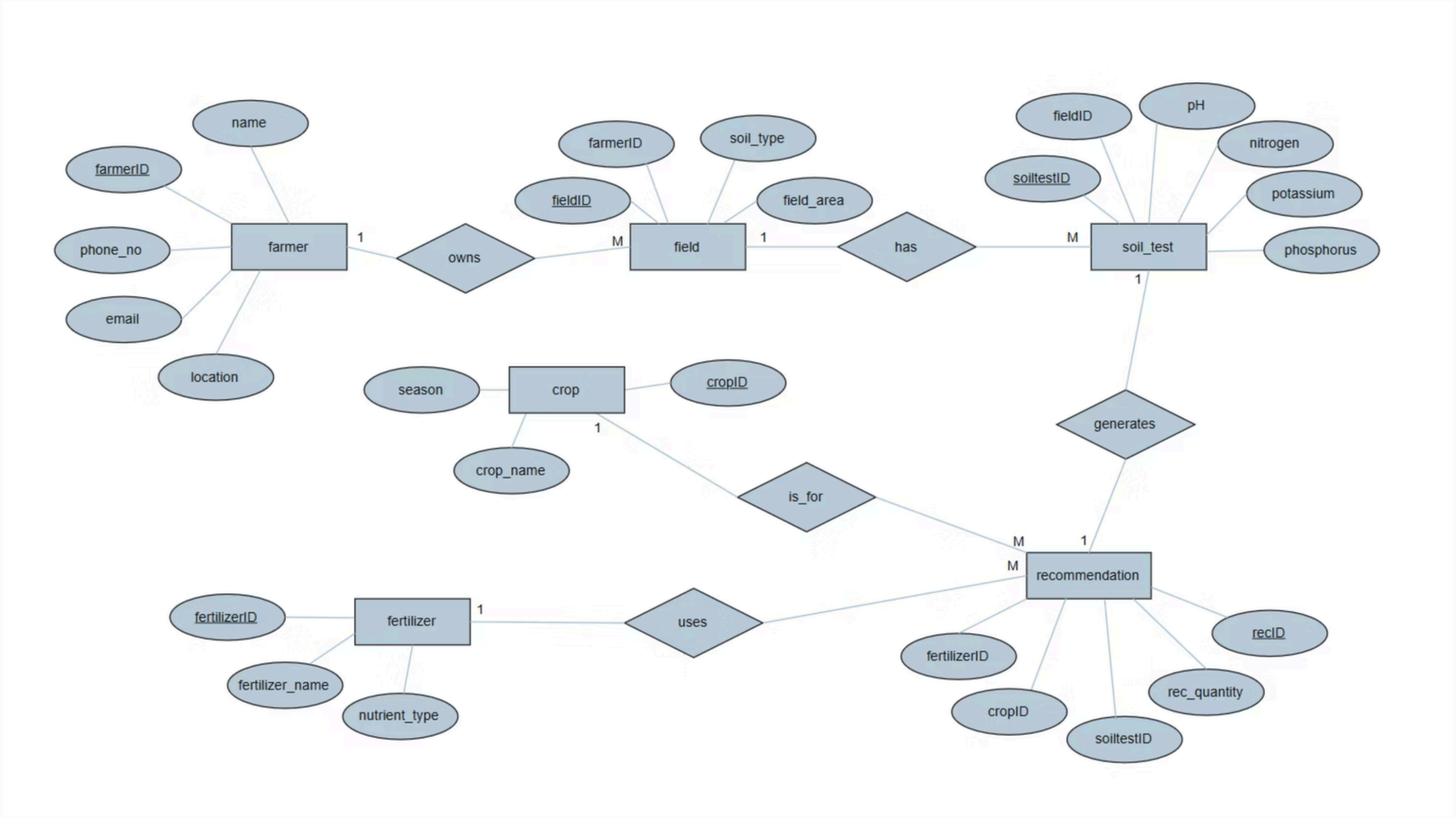
Optimized suggestions for fertilizer type, precise quantity, and ideal application timing are clearly displayed to the farmer.

Use Case Diagram



Database Requirement

A breakdown of the core tables and their key attributes, ensuring robust data management for the system.



Technical Specifications

Non-Functional Requirements

These requirements define the quality attributes of the system, ensuring an optimal user experience and robust operation.

Performance

Ensures quick response times for user queries and data processing.

Reliability

Delivers accurate and consistent fertilizer recommendations every time.

Usability

Provides an intuitive and easy-to-use interface for all farmers.

Security

Guarantees secure user authentication and protection of sensitive data.

Accuracy

High prediction accuracy using Random Forest

Scalability

Supports an increasing number of users and data without system degradation.

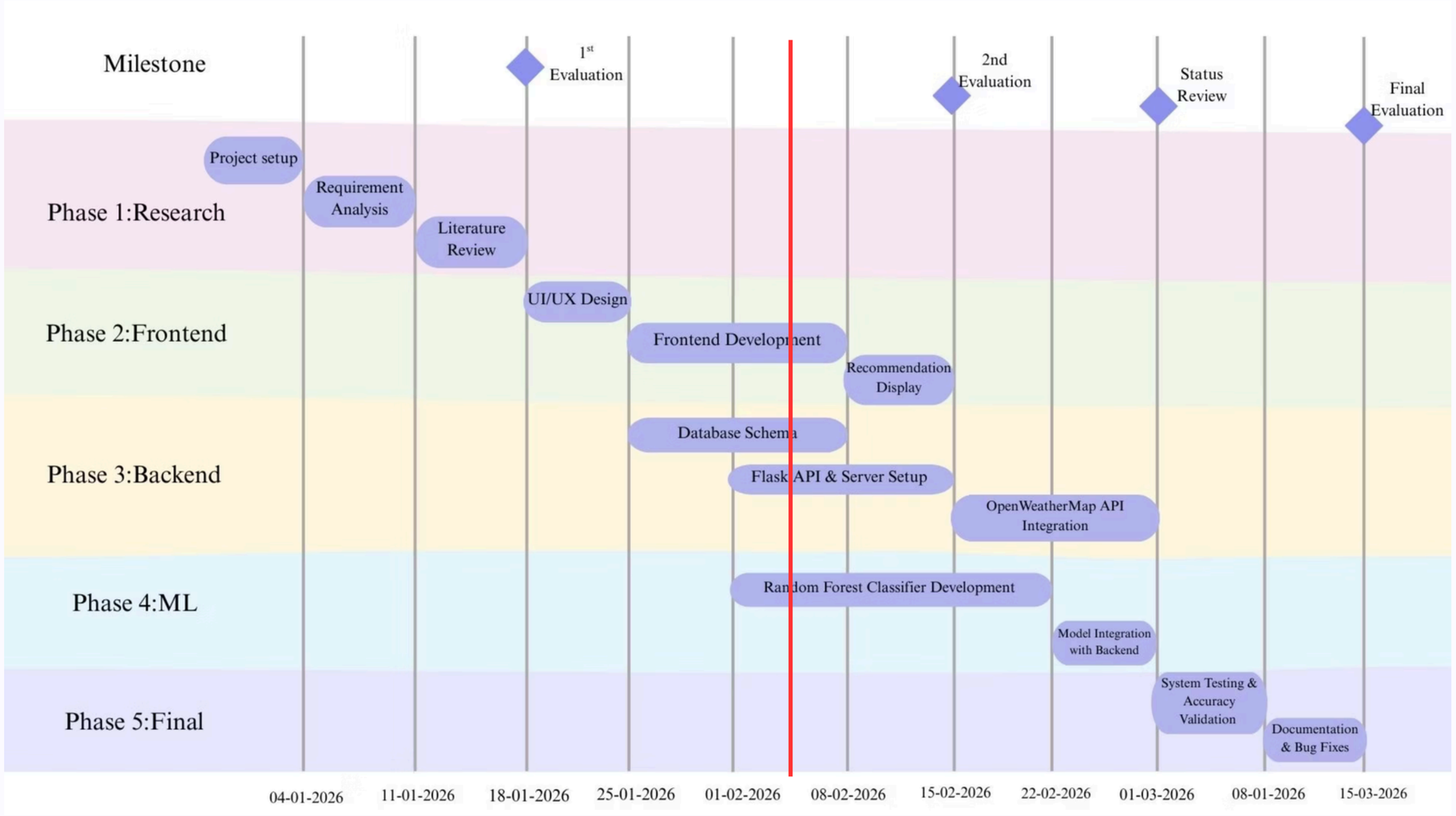
Maintainability

Modular code structure for easy enhancement

Project Management

Project Timeline

Below is an overview of the key phases and estimated durations for the development of the Smart Fertilizer Recommendation System.



GreenGrow Initiative

Conclusion

Our smart fertilizer recommendation system is more than just a tool; it's a commitment to a sustainable future for agriculture:

- Promotes sustainable farming practices
- Empowers farmers with data-driven decision-making
- Minimises environmental impact through optimised fertilizer usage
- Boosts crop yield and maintains long-term soil health
- Fosters agricultural productivity for future generations

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Thank you...