

# PROJECT OVERVIEW

## Smart Farming Assistant using Soil-Crop-Stage Based Recommendation System

### Objective:

To empower farmers with personalized irrigation and fertilizer guidance by analyzing soil type, crop type, growth stage, and moisture/fertility levels. The system uses data visualization and contextual recommendations to improve agricultural productivity and reduce resource waste.

### System Overview:

This system is a React-based frontend interface that visualizes farming guidance, such as:

- When and how much to irrigate.
- What fertilizers (NPK) are needed.
- Real-time alignment with soil type, crop, and growth stage.

It also offers:

- Visual graphs for better interpretability.

- Natural language advice to make data actionable.
- Contextual metadata for user awareness (e.g., upcoming rain, soil type).

## Core Features:

### 1. Soil-Crop Matching

- Matches actual field data with ideal soil, crop, and growth stage combinations.
- Displays matched metadata including:
  - Soil Type
  - Crop
  - Growth Stage

### 2. Irrigation Recommendation Engine

- Compares current soil moisture to ideal moisture.
- Calculates how much water is needed (in mm).
- Determines if upcoming rain will cover the irrigation need.
- Provides natural language advice, e.g.:
  - *“Irrigate 25mm today unless it rains tonight.”*
- Uses a Pie Chart to visualize:
  - Water needed
  - Water expected from rainfall

### 3. Fertilizer Recommendation Engine

- Evaluates soil nutrition levels:
  - Nitrogen (N)
  - Phosphorus (P)
  - Potassium (K)
- Compares current vs ideal NPK values.
- Gives element-wise advice:
  - E.g., *“Apply urea for Nitrogen deficiency.”*
- Includes a general fertilizer recommendation section.
- Uses a Bar Chart to visualize:

- Current vs Ideal levels for N, P, K

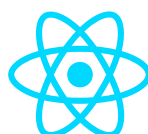
#### 4. Visualization & UI

- Uses Recharts for dynamic graphing.
- Uses Material-UI for card layouts, typography, chips (for status), and responsive design.
- Responsive container graphs adapt to screen size.
- Displays current date and context to help with real-time planning.

#### Workflow

1. Input: Data comes from sensors, APIs, or mock backend with:
  - Soil type
  - Crop & stage
  - Current soil moisture
  - Weather forecast
  - Current NPK values
2. Processing:
  - Determines gaps between current and ideal conditions.
  - Generates advice text and data visualizations.
  - Prepares metadata for user understanding.
3. Output: Renders all insights in a clean, user-friendly UI.

#### Technologies Used



#### Data Structure Used

```
{
  "metadata": {
    "actual_match": {
      "soil_type": "Loamy",
      "crop": "Wheat",
      "stage": "Germination"
    },
    "notes": "Rain expected tomorrow"
  },
  "recommendations": {
    "irrigation": {
      "current": 12,
      "ideal": 20,
      "status": "Low",
      "advice": "Irrigate 25 mm today",
      "amount": 25,
      "upcoming_rain": true
    },
    "fertilizer": {
      "N": {
        "current": 10,
        "ideal": 20,
        "recommendation": "Add urea"
      },
      "P": {
        "current": 5,
        "ideal": 15,
        "recommendation": "Apply phosphate"
      },
      "K": {
        "current": 15,
        "ideal": 15,
        "recommendation": "No action needed"
      },
      "general_advice": "Maintain balanced NPK ratio"
    }
  }
}
```



## Example Output Snapshot

## 🌾 Smart Farming Guidance

Soil: Loamy | Crop: Wheat | Stage: Germination

📄 Note: Rain expected tomorrow

### 💧 Irrigation Advice

- Current: 12%
- Ideal: 20%
- Status: Low
- Advice: Irrigate 25mm today unless rain occurs

[PieChart: Needed vs Rainfall]

### 🌱 Fertilizer Advice

- N: Add urea
- P: Apply phosphate
- K: No action needed
- General: Maintain balanced NPK ratio

[BarChart: Current vs Ideal NPK]

## 🎯 Strengths

- 📊 **Data-Driven Visualization:** Helps users interpret complex values quickly.
- 🧑 **User-Friendly Recommendations:** Simplifies decisions for farmers.
- 🖼️ **Clear UI:** Material-UI offers a responsive and modern layout.
- 🔗 **Extensible Architecture:** Easy to integrate with real sensors or APIs.