

# Optimizing Fertilizer Usage for Sustainable Farming

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12th June 2024

# Problem Statement

- Challenging for farmers to determine the optimal amount of fertilizer to use for their crops.
  - Too much fertilizer = soil degradation and wasted resources
  - Too little fertilizer = poor crop growth and low yield
- Building a decision support system to provide optimal fertilizer amount to use based on:
  - Soil conditions
  - Weather conditions
  - Crop types
- Farmers can input these easily obtainable data into the system to receive optimal fertilizer amount to use to:
  - Increase crop yield
  - Reduce costs
  - Minimise environmental impact

# Data Schema for Dummy Data

Feature	Type	Description
soil_color	String	Qualitative measure of soil color (e.g., dark brown, reddish)
soil_ph	Float	Soil pH level
soil_n	Float	Nitrogen content in soil (ppm)
soil_p	Float	Phosphorus content in soil (ppm)
temp	Float	Current temperature (°C)
rainfall	Float	Recent rainfall (mm)
forecast_temp	Float	Forecasted temperature (°C)
forecast_rainfall	Float	Forecasted rainfall (mm)
crop_type	String	Type of crop being grown
plant_health	String	Qualitative measure of plant health (e.g., healthy, yellowing, wilting)
optimal_fertilizer_amount	Float	Target value: Optimal fertilizer amount (kg/ha)

## Assumptions:

- 10 Features, 1000 Rows of dummy data generated
- Features like soil content, weather, crop type, and plant health affect optimal fertilizer amount
- Farmers can collect these data easily to get recommendations
- Low percentage of outliers and missing data to mimic real-world imperfections
- Temperature and rainfall values are based on Indonesia's tropical climate
- Crop types are limited to common crops grown in Indonesia (wheat, corn, rice)
- Plant health conditions are randomly assigned as healthy, yellowing, or wilting.
- Fertilizer amount calculated with a simplified formula based on input features

# Model Development Process

Simplified model development process to predict optimal fertilizer usage

## Process:

1. **Data Splitting:** dummy data split into 67% train and 33% test sets
2. **Preprocessing Pipeline**
  - a. Fill missing values with median
  - b. Scale numeric features
  - c. Encoded categorical features
2. **Model training:** Trained an XGBRegressor model using preprocessed train data
3. **Evaluation:** RMSE of 4.28 when predicting on test set

# Recommendations for Farmers (2 ways to give practical recommendations)

1. Give **general recommendations** for optimal fertilizer amounts by using the model to predict based on pre-defined scenarios:
  - a. **Yellowing wheat with low rainfall and low soil nutrient levels**: Use 132.80 kg/ha of fertilizer
  - b. **Healthy rice with high rainfall and high soil nutrient levels**: Use 105.19 kg/ha of fertilizer
  - c. **Wilting wheat with very low nutrient levels and low rainfall**: Use 136.64 kg/ha of fertilizer

2. Give **tailored recommendations** to farmers by predicting based on the specific data that the farmer provided.

- Created a simple Streamlit web app to host the model to demonstrate how farmers can access the model via web/mobile apps:
  - Link to web app: <https://dayataniassignment.streamlit.app/>
  - Farmers enter soil, weather, crop data
  - Receive predicted optimal fertilizer amount

The screenshot shows a Streamlit web application titled "Agronomic Decision Support System to Predict Optimal Fertilizer Amount". The interface is divided into three main sections: Soil Condition, Weather Condition, and Crop Condition. Each section contains several input fields and sliders. The Soil Condition section includes Soil Color (light brown), Soil pH (6.58), Soil Nitrogen (30 ppm), and Soil Phosphorus (40 ppm). The Weather Condition section includes Temperature (25°C), Rainfall (100 mm), Forecasted Temperature (25°C), and Forecasted Rainfall (100 mm). The Crop Condition section includes Crop Type (wheat) and Plant Health (healthy). A "Predict" button is located at the bottom left. At the bottom, a green box displays the "Optimal Fertilizer Amount: 104.84 kg/ha".

Soil Condition	Weather Condition	Crop Condition
Soil Color: light brown	Temperature (°C): 25	Crop Type: wheat
Soil pH: 6.58	Rainfall (mm): 100	Plant Health: healthy
Soil Nitrogen (ppm): 30	Forecasted Temperature (°C): 25	
Soil Phosphorus (ppm): 40	Forecasted Rainfall (mm): 100	

Predict

Optimal Fertilizer Amount: 104.84 kg/ha

Thank You