# Crop Recommendation Application

## Abinas Behera

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**Abstract**

This project presents a Crop Recommendation Application that leverages machine learning algorithms to provide personalized crop suggestions to farmers. The system utilizes a dataset comprising crucial agricultural parameters and soil concentration. By analyzing these factors, the system identifies the optimal crops for a given set of conditions, aiming to maximize yield and ensure sustainable farming practices. The implementation involves data preprocessing, feature selection, model training, and validation to deliver accurate and reliable recommendations. The proposed system not only empowers farmers with data-driven insights but also contributes to improved resource management and agricultural sustainability. The ultimate objective is to support farmers in making informed decisions that enhance productivity, economic stability, and environmental management.

# 1 Problem Statement

Farmers often face challenges in selecting the most appropriate crops for cultivation due to the variability in soil conditions, climate, and other environmental factors. Traditional methods of crop selection, which heavily rely on experience and general guidelines, may not always lead to optimal decisions, resulting in suboptimal yields, inefficient use of resources, and economic losses. There is a need for a data-driven solution that can analyze specific agricultural parameters and provide personalized crop recommendations. The goal of this project is to develop a Crop Recommendation Application that leverages machine learning algorithms to analyze these factors and suggest the most suitable crops for a given set of conditions. This application aims to support farmers in making informed decisions, thereby improving crop yields, enhancing resource efficiency, and promoting sustainable agricultural practices.

# 2 Customer Needs Assessment

## 2.1 Market Analysis

The global agriculture technology market is rapidly growing, with an increasing adoption of digital tools and technologies by farmers. According to Grand View Research, the global agricultural technology (AgTech) market size in 2024 is valued to be $24.08 billion and it is expected to reach $43.38 billion by 2030 at a compound annual growth rate (CAGR) of 10.2%.

## 2.2 Customer Segmentation

Farmers with small landholdings, often relying on traditional farming methods and limited access to modern agricultural technology. They needs cost-effective solutions, easy-to-use interfaces, localized recommendations, and support in local languages.

Farmers with larger landholdings who may already use some modern farming technologies and practices needs advanced features such as real-time data integration, detailed soil and weather analytics, and resource optimization tools.

# 3 Target Specifications and Characterization

1. S. Jain and D. Ramesh, "Machine Learning convergence for weather based crop selection," 2020 IEEE International Students' Conference on Electrical,Electronics and Computer Science (SCEECS), 2020, pp. 1-6, doi: 10.1109/SCEECS48394.2020.75.

## 3.1 Core Functionalities:

Utilize machine learning algorithms to analyze input data given by the user and generate crop recommendations tailored to specific field conditions.

**User Interface:** Conduct user testing with farmers to ensure that the application is simple and straightforward to use, with clear instructions and minimal technical terminology.

**Multiple Language Support:** We also emphasize that many farmers only know regional languages, so we need to develop a model that supports multiple languages.

## 3.2 Performance:

**Accuracy:** Every short period, we need to update the model with new data and feedback from customers to enhance accuracy.

**Scalability:** We have to ensure the application can handle a large number of users and data points without performance degradation.

# 4 Bench marking alternate products

There are several applications that work on these types of problems.

1. **plantix:** It is a mobile crop advisory app that provides farmers with disease diagnostics, treatment advice, and agricultural information. Its primary features include image-based disease detection, crop-specific advice, and weather forecasting.

2. **Agrivi:** It offers farm management software that helps farmers manage their crop production efficiently. The main features of this application include comprehensive farm management tools, task and resource planning, as well as weather monitoring and pest alerts.

Plantix excels in disease diagnostics with image recognition but lacks comprehensive crop recommendations. Agrivi offers robust farm management tools suitable for larger farms, potentially overwhelming for smallholders. Whereas our crop recommendation application stands out by offering highly personalized, data-driven recommendations with a user-friendly interface that caters to diverse needs, especially those of smallholder farmers. It combines real-time data integration, offline access, and educational resources, making it a well-rounded solution for modern agricultural challenges.

# 5 Applicable Patents

## 5.1 Identify Key Technologies

We need to develop our machine learning algorithm for crop recommendation application, implement IoT devices for soil and weather data collection, and design a user interface for the mobile application.

## 5.2 Patent Databases

We use databases such as Google Patents, USPTO (United States Patent and Trademark Office), EPO (European Patent Office), and WIPO (World Intellectual Property Organization) to search for relevant patents.

By identifying and understanding relevant patents, we can ensure that our crop recommendation application is unique and compliant with current intellectual property regulations. This also allows for innovation based on existing patents and potentially applying for our own patents for new features or technologies we create.

# 6 Applicable Regulation

When deploying the Crop Recommendation Application, we must adhere to specific guidelines and regulations. Here is certain regulations:

## 6.1 Data Privacy and Security

- **Information Technology (IT) Act, 2000 and IT (Amendment) Act, 2008:**
  Mandates that companies which possess, deal, or handle any sensitive personal data or information (SPDI) must implement and maintain reasonable security practices and procedures.

- **Personal Data Protection Bill (PDPB), 2019:**
  The bill is not yet enacted but is anticipated to become the main framework for data protection in India. The proposed privisions on PDPB is it gives rights to the costumer to access, correct and delete data and certain categories of personal data be stored locally in India.

## 6.2 Agricultural Regulations

- **Essential Commodities Act, 1955:**
  This act aims to regulate the production, supply, and distribution of essential commodities to ensure their availability at fair prices. Also Government can control the production, supply, and distribution of essential commodities.

- **The Farmers Agreement on Price Assurance and Farm Services Act, 2020:**
  This act provides a legal framework for contract farming. It allows farmers to enter into agreements with buyers (processors, wholesalers, exporters, or large retailers) before sowing crops.

- **The Insecticides Act, 1968:**
  This act regulates the import, manufacture, sale, transport, distribution, and use of insecticides. It ensures quality and safety standards for insecticides to protect human health and the environment.

- **The Food Safety and Standards Act 2006:**
  This act consolidates various laws relating to food safety and establishes the Food Safety and Standards Authority of India (FSSAI). It sets standards for food products, including agricultural produce.

### 6.3 Environmental Regulations

- **Environment Protection Act 1986**
  This act provides a framework for environmental protection and is the umbrella legislation for various environmental regulations in India.

- **Air (Prevention and Control of Pollution) Act, 1981**
  This act aims to control and reduce air pollution. So we have to focus on promote farming techniques that reduce air pollution, such as recommending less polluting machinery and practices that minimize burning of crop residues.

### 6.4 Antitrust Regulation:

- **Consumer Protection Act 2019**
  It enforces regulation against unfair trade practices and false advertisement.

- **Advertising Standard Council of India(ASCI):**
  Provides guidelines for ethical advertisement.

## 7 Applicable Constraints

### 7.1 Technical Constraint

- Access to reliable and comprehensive agricultural data may be limited. So we have to partner with local agricultural institutions and government bodies for data sharing agreements and using IoT devices for real-time data collection.

- Rural areas may have poor internet connectivity, limiting the application's usability. So we have to develop an offline mode for the application that syncs data when connectivity is restored.

### 7.2 Financial Constraints

- High costs related to the development, maintenance, and updates of the application can be managed by securing funds from government grants, agricultural research organizations, and private investors.

# 8 Business Model

Creating a robust monetization strategy for the crop recommendation application is essential to ensure financial sustainability and growth. Here is certain monetization ideas:

- **Freemium Model:** Offer basic features of the application for free to attract a large user base. Advanced features and detailed analytics are available through a paid subscription. Some paid features are detailed crop health analysis and forecasting, personalized consultation with agricultural experts, access to premium educational content and training modules etc.
- **In-App Advertising:** Generate revenue through targeted advertisements from agricultural input suppliers (e.g., seeds, fertilizers, pesticides) and other relevant businesses.
- **Marketplace for Agricultural Products:** Create a marketplace within the app where farmers can buy and sell agricultural products and inputs. Here we can charges transaction fees or commissions on sales.

# 9 Final Product Prototype

The crop recommendation application is developed to address various challenges faced by farmers and agricultural stakeholders. The key reasons for developing this application is to help farmers choose best crop for their land depending on the soil health and weather data, advise on the optimal use of water, fertilizers,and pesticides based on the environmental condition etc.

Here is an overview of the product prototype,

- **Core Functionality** Using advance AI and machine learning algorithms, the system provide crop recommendation based on soil health analysis, weather data and historical crop performance data. It suggest optimal planting and harvesting schedules to maximize production and minimize risks.
- **Key Features** Our model provides a centralized view of weather updates, soil metrics and upcoming tasks. It integrates with IoT devices for real time data collection. The product also give facilities of sending timely alerts for weather changes, and recommended actions based on monitored data. It also tracks and analyzes historical data to improve future recommendations and decision making.
- **User Interface:** The user interface is designed to be intuitive and user-friendly, featuring a clean dashboard where farmers can easily access critical information and navigate through various functions. The interface includes simple forms for data input and clear visualizations for displaying recommendations and insights. Also Customizable settings for language, and notification preferences allowed.
- **Data Privacy and Security:** The system prioritizes data privacy and security, ensuring that user data is securely stored. It also provide clear policies on data usage and user consent for data collection.
- **Support and Engagement:** The system offers responsive support channels for technical assistance and user inquiries. It also provide educational materials, and webinars to help user and maximize application's benefits.

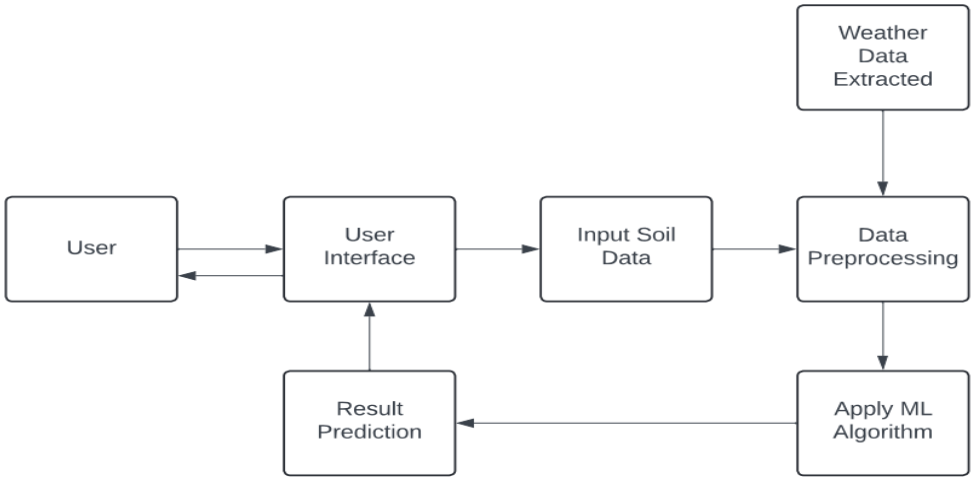


Figure 1: Schematic Diagram

# 10 Product Details

## 10.1 How does it work ?

- **Data Collection:** It collects basic information such as the land's location from the user, and if the user has a soil test report, they can provide it.
- **Data Processing:** Use machine learning or AI algorithm to analyze collected data to understand soil conditions and weather patterns. Then generates personalized crop recommendations based on analyzed data.
- **Recommendation Output:** Based on the analysis, the system recommend crops suitable for current conditions, optimal planting and harvesting schedules and suggestions for irrigation and fertilization.

## 10.2 Data Sources

- **Soil Data:** Obtained from on-site sensors, laboratory tests, and user input.
- **Weather Data:** Acquired from meteorological agencies or weather APIs.
- **Crop Performance Data:** Historical data collected from users and agricultural databases.

## 10.3 Algorithm

- Machine Learning model used for classification and prediction of crop suitable based on soil and weather data then also we use time series analysis for weather forecasting.

## 10.4 Team Required to Develop

- **Data Scientists:** To develop and modify the machine learning algorithm.

- **Software Engineer:** To build the mobile app and database management
- **Agricultural Experts:** To provide domain knowledge on crop management and agronomy.
- **Project Managers:** To oversee the development, timelines, and coordination among team members.

### 10.5 Cost:

Depending on the team size, complexity of algorithms, and integration of IoT devices, costs can vary significantly. Also some cost will go to server hosting, database management, marketing, and customer service.

## 11 Conclusion

The crop recommendation application represents a significant advancement in agricultural technology, designed to empower small and medium-scale farmers with data-driven insights and personalized recommendations. By leveraging modern machine learning algorithms and integrating real-time data from multiple sources such as soil sensors and weather APIs, the application delivers precise and actionable advice to optimize crop yield and sustainability.

The successful development and implementation of this application require a multidisciplinary team comprising data scientists, software developers, agricultural experts, and project managers. The collaborative efforts of this team will ensure the creation of a user-friendly, efficient, and reliable tool that meets the specific needs of farmers.

The application's monetization strategy, including a freemium model and various other revenue streams, ensures financial viability while providing essential services to a broad user base. Compliance with data privacy regulations and agricultural guidelines further enhances the application's credibility and user trust.

## 12 References


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- Hassan, Mohammad, Karan Malhotra, and Mohd Firdaus. "Application of artificial intelligence in IoT security for crop yield prediction." ResearchBerg Review of Science and Technology 2.1 (2022): 136-157.