

Smart Crop Rotation Recommendation System Using ML

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Abstract - To maximize crop yield and to maintain the health of the soil, farmers need to make data-driven and intelligent decisions regarding their agriculture. Traditional farming methods rely on the experience of the farmer and do not allow for flexibility in the face of changing environmental conditions. This project provides an intelligent Smart Crop Rotation Recommendation System powered by Artificial Intelligence that will assist a farmer in deciding which crops to plant given a range of climatic and soil characteristic variables. The Smart Crop Rotation Recommendation System provides recommendations based on key variable parameters such as Nitrogen (N), Phosphorus (P), Potassium (K), temperature, humidity, pH, and rainfall in order to obtain the optimum crops to grow under a particular set of climatic and soil conditions. The system also analyzes and incorporates suitable Crop Rotation Strategies in order to ensure the sustainability of the physical and biological elements of the soil, while also preventing soil degradation. Prediction accuracy is enhanced through the use of Machine Learning models such as Random Forest and Support Vector Machines (SVM) that have been developed using the Python programming language and made available through a convenient Web Based Interface utilizing the Streamlit tool. Farmers who utilize the Smart Crop Rotation Recommendation System will experience improved productivity and reduced risk by making data-driven and informed decisions regarding their agriculture.

Keywords: Crop Recommendation, Machine Learning, Agriculture, Random Forest, SVM, Crop Rotation, Smart Farming

I. INTRODUCTION

The Importance of Agriculture in Economic Growth of Country. The success of farmers in selecting a suitable crop can depend on a variety of factors including soil conditions and environment. When an incorrect crop is planted, farmers can experience a loss in soil productivity, poor yields and financial strains. Farmers often have to rely on past experiences and historical knowledge when determining which crops to grow. This does not take into account real time data and changing climate conditions; therefore, reducing the chances of

achieving optimal results. Utilizing machine learning technology to analyse large datasets and recognize trends found in the input data of soil nutrients (N, P & K) and other environmental data (temperature, humidity, rainfall and ph.), provides a solution to this problem by being able to identify the best crop for a specific area with high accuracy. The Smart Crop Rotation Recommendation System (S.C.R.R.S.) is an application developed to help growers to not only know which crop is best to plant, but also provide various options for crop rotation.

Crop rotation is a good agronomic practice by improving soil health, preventing the proliferation of

pests, and promoting long-term sustainability. The S.C.R.R.S. is designed to integrate machine learning

II. Existing and Proposed System

2.1 Existing System

Currently existing methods of making crop recommendations and planning agricultural operations rely heavily on traditional farming methods, manual decision making and basic computing capabilities. Farmers typically make decisions regarding what to plant each year by leveraging their own experience, historical data, and understanding of their local environment. The large majority of farmers use these methods for making decisions about what crops to plant every year, but due to the reliance on "traditional" methods have some level of uncertainty; thus it is very difficult to predict what will be able to grow based on how weather patterns change from year to year, so most farmers have difficulty making accurate predictions about what they can grow.

Some technology has recently been introduced into some aspects of agriculture; specifically in the form of a limited number of machine learning and data analysis techniques. Some algorithms such as Decision Trees, Linear Regression, and Random Forest are employed for crop recommendations depending on the location of lands being planted and their soils' nutrients and weather conditions. All of these algorithms take into account soil nutrients.

However, most of those systems only provide one year recommendations for growing single crops, therefore they could be said to be inherently unsustainable because they do not account for how to integrate multiple principles of agricultural management and practices such as crop rotation, seasonal fluctuations in crop yield (i.e. Kharif vs. Rabi vs. Zaid), and managing soil nutrients over an extended time span. Thus they are not able to

technology with agricultural knowledge to allow for reliable and sustainable crop production.

recommendations for the long-term ramifications to soil fertility.

2.3 Proposed System

The proposed system introduces a Smart Crop Rotation Recommendation System that aims to overcome the limitations of existing agricultural systems by integrating machine learning techniques with agricultural domain knowledge. The system is designed to provide accurate, sustainable, and data driven crop recommendations while also ensuring proper crop rotation practices for long-term soil health.

Unlike traditional systems that focus only on single crop prediction, the proposed system adopts a comprehensive approach by considering multiple factors such as soil nutrients (Nitrogen, Phosphorus, Potassium), pH level, temperature, humidity, and rainfall. These parameters are analysed using advanced machine learning algorithms to predict the most suitable crops for a given set of conditions.

The system utilizes models such as Random Forest Classifier and Support Vector Machine (SVM), which are capable of handling complex relationships between input features. These models are trained using agricultural datasets to ensure high accuracy and reliability in predictions. Among these, the bestperforming model is selected based on evaluation metrics such as accuracy and precision.

In addition to prediction, the system incorporates crop rotation logic, which is a key feature that differentiates it from existing systems. It considers the previously cultivated crop and recommends a sequence of crops that helps maintain soil fertility, reduce pest cycles, and improve agricultural productivity. The system applies agricultural rules

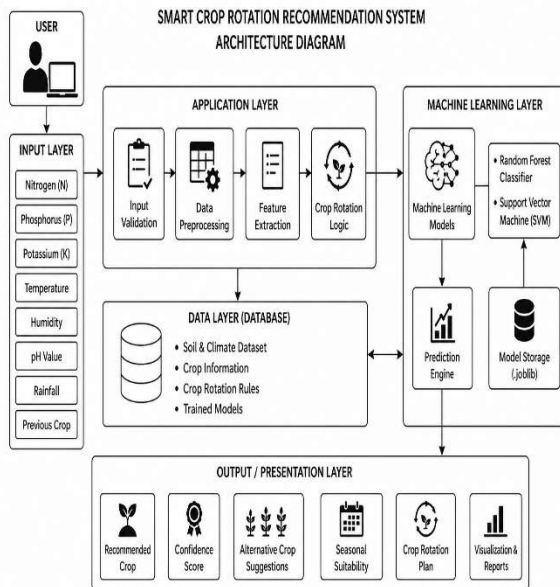
based on crop families and nutrient requirements to ensure that the recommended crops are compatible with soil conditions.

The proposed system is implemented as an interactive web application using Streamlets, which allows users to easily input parameters and receive instant recommendations. The interface is designed to be simple and user-friendly, making it accessible even to non-technical users such as farmers. The system also includes visualization features such as graphs and charts to help users understand the results more clearly. These visual insights improve decision-making and enhance user trust in the system. Another important feature of the proposed system is its ability to provide soil health insights. By analysing how

different crops affect soil nutrients, the system helps users maintain a balanced nutrient level in the soil, promoting sustainable farming practices. The design of the system is modular and scalable, allowing it to be extended with additional features such as real-time weather data integration, IoT-based soil sensors, and cloud deployment.

This makes the system adaptable to future technological advancements in agriculture. Overall, the proposed system provides a complete and intelligent solution for crop recommendation and rotation planning, addressing the shortcomings of existing systems and supporting modern agriculture.

III. DATAFLOW DIAGRAM:



VI. RESULT:

The Smart Crop Rotation Recommendation System has been developed and tested successfully with agricultural data (soil nutrients and environmental parameters). The system offers accurate crop predictions and increased user convenience based on the user-identified values (nitrogen, phosphorus, potassium, temperature, humidity, pH, and rainfall).

Numerous machine-learning models were tested, including the Random Forest and Support Vector Machine models. Among those tested, the SVM model produced the highest rate of accuracy for producing valid recommendations for crop rotation.

The system produces suggested crops based on user input, confidence scores, and alternate crop suggestions; assists in crop rotation planning to increase soil fertility; and reduces the likelihood of risks associated with the continuous growing of the same crop. The system also utilized visualization techniques (graphs and charts) to analyse model accuracy (the performance of the models) and examine patterns in the data (tools to help better understand the results).

The overall conclusion is that the Smart Crop Rotation Recommendation System produces better crop recommendations than the previous systems and offers improved accuracy, better decision-making, and effective use of technology in agriculture.

V. CONCLUSION :

The Smart Crop Rotation Recommendation System presents an effective and intelligent solution to the challenges faced in modern agriculture. The system successfully integrates machine learning techniques with agricultural domain knowledge to provide accurate, reliable, and data-driven crop recommendations. By analysing key parameters such as soil nutrients (Nitrogen, Phosphorus, Potassium), temperature, humidity, pH value, and rainfall, the system is capable of identifying the most suitable crops for cultivation under specific environmental conditions.

One of the major achievements of this system is the implementation of multiple machine learning algorithms, including Random Forest and Support Vector Machine (SVM), to improve prediction accuracy. Among these, the Support Vector Machine demonstrated superior performance, producing highly reliable results. The ability of these models to capture both linear and non-linear relationships in agricultural data ensures better prediction outcomes compared to traditional methods.

In addition to crop prediction, the system introduces an important feature of crop rotation planning, which plays a vital role in maintaining soil fertility and promoting sustainable farming practices. By recommending appropriate crop sequences, the system helps in preventing nutrient depletion, reducing pest and disease cycles, and improving long-term agricultural productivity. This makes the system not only a predictive tool but also a decision support system for farmers. The development of a user-friendly interface using stream lit enhances the accessibility of the system

visualizations such as graphs and charts further improves the understanding of recommendations and model performance

this system is its ability to support sustainable agriculture. By optimizing crop selection and rotation, the system helps in efficient utilization of resources such as water, fertilizers, and soil nutrients. This leads to reduced agricultural costs and increased profitability for farmers while minimizing environmental impact.

Despite its effectiveness, certain limitations exist, such as dependency on the quality of the dataset and lack of real-time data integration. However, the system provides a strong foundation for future enhancements, including integration with real-time weather data, IoT-based soil sensors, and advanced deep learning models.

In conclusion, the Smart Crop Rotation Recommendation System demonstrates how modern technologies like machine learning can significantly improve agricultural practices. It offers a scalable, efficient, and sustainable solution that can assist farmers in making informed decisions, increasing crop yield, and maintaining soil health. This project highlights the potential of smart agriculture systems in addressing global food security challenges and supporting the advancement of precision farming.

the project offers a cost-effective and accurate solution to modern agricultural challenge. It combines the conventional knowledge of agriculture with technological advancements, which help in increasing productivity as well as proper utilization of land. Incorporation of features like real-time data availability and accessibility through mobile devices can make the application even more effective in the future.

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