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Crop Recommendation Based on Geographical Factors Using Machine Learning Approach

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Abstract: Precision agriculture aims to optimize crop yield and sustainability by leveraging advanced technologies. This study investigates the application of machine learning for recommending suitable crops based on geographical factors, including soil properties, climate conditions, and topographical features. By integrating these diverse datasets, the proposed machine learning model aims to enhance the accuracy of crop recommendations. Experimental results demonstrate the model's effectiveness in capturing complex interactions between the factors, leading to improved agricultural decision-making compared to traditional methods.

Keywords: *Precision Agriculture, Machine Learning, Crop Recommendation, Geographical Factors, Soil Properties, Climate Conditions, Topographical Features, Data Integration, Agricultural Decision-Making.*

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I. INTRODUCTION

Agriculture is a vital component of the global economy and food security. The selection of appropriate crops for specific geographical regions is crucial for maximizing yield and ensuring environmental sustainability. Traditionally, farmers have relied on historical data, personal experience, and local expertise to make these decisions. However, these methods often fail to account for the dynamic and multifaceted nature of environmental factors. Agriculture has an extensive history in India. Recently, India is ranked second in the farm output worldwide [6]. Agriculture-related industries such as forestry and fisheries contributed for 16.6% of 2009 GDP and around 50% of the total workforce. Agriculture's monetary contribution to India's GDP is decreasing [7]. The crop yield is the significant factor contributing in agricultural monetary. The crop yield depends on multiple factors such as climatic, geographic, organic, and financial elements. It is difficult for farmers to decide when and which crops to plant because of fluctuating market prices [7]. Citing to Wikipedia figures India's suicide rate.

CNNs have revolutionized various fields by their ability to automatically extract hierarchical features from raw data. In agriculture, CNNs can be utilized to process and analyze multidimensional geographical data, providing insights that are not easily discernible through conventional methods. This paper presents a CNN-based approach to crop recommendation, leveraging a comprehensive dataset that includes soil properties, climatic conditions, and topographical information.

II. METHODOLOGY

The project starts with soil and climatic data supplied by the user, which is then preprocessed and features are extracted using methods like PCA and machine learning algo- rithms. Utilizing algorithms like XGBoost and Random Forest, these enhanced features are added to predictive models that use them to evaluate patterns and recommend fertilizer and crop types.

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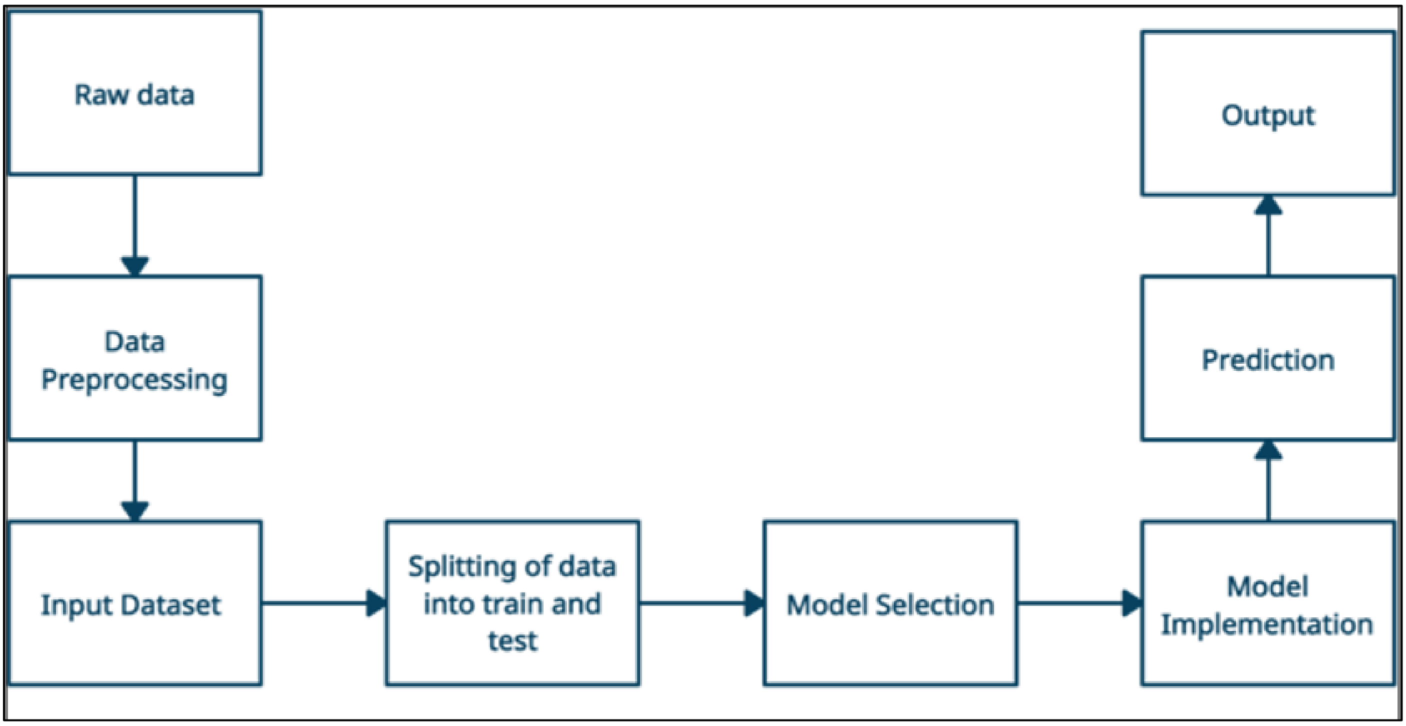

Fig 1 Block Diagram of Crop Recommendation Model

➢ *Methodology:*

The Methods used in the suggested Machine Learning based proposed system are listed below:

- *Gathering Data:*

Machine learning is being used to create a system that recommends crops and fertilizers based on a variety of agricultural data, including soil quality, weather, crop varieties, and past yields. The system then recommends suitable crops and the best fertilizer types and amounts for a given set of agricultural conditions after processing and analyzing this data using machine learning algorithms to find patterns and connections.

- Soil Data: pH level, organic matter, texture, and nutrient content.
- Climate Data: Temperature, rainfall, humidity, and solar radiation.
- Topographical Data: Elevation, slope, and aspect.

➢ *Preprocessing Data:*

Raw agricultural data is cleaned in the preprocessing stage of a crop and fertilizer project to get rid of mistakes, missing numbers, and outliers. Then, to maintain uniform scales, characteristics such as soil pH, temperature, and crop type are standardized or normal- ized. Numerical values are used to represent categorical variables such as crop vaety. delivering precise and trustworthy crop and fertilizer recommendations.

- Normalization: Continuous variables were normalized to ensure uniformity.
- Encoding: Categorical variables were one-hot encoded.
- Imputation: Missing values were handled through interpolation.

➢ *Model Creation:*

Based on the complexity of the data, choose an appropriate algorithm, such as decision trees, random forests, or neural networks, to develop a machine learning model for the crop and fertilizer project. Analyze the model using metrics like recall,accuracy, and precision, and make any necessary adjustments. Once satisfied, use the trained model to generate suggestions for crop and fertilizer inputs in real time.

➢ *Model Training:*

Divide the preprocessed data into training and validation sets for the crop and fertilizer recommendation model. Select a suitable algorithm, such as Gradient Boosting or Ran- dom Forest, and train the model with the training set. Iterate this procedure until the model reaches the desired accuracy. To fine-tune the model, tweak its hyperparameters. Then, test the model's performance using the validation set. The model can be used to recommend crops and fertilizers based on input data once it has been trained and vali- dated.

➢ *Integration of Real-time Analysis and Correction:*

Gather real-time agricultural data on soil moisture, temperature, and crop health by integrating sensors and IoT devices. Apply machine learning techniques to this data analysis to produce immediate insights. Implement a feedback loop so that the system can adjust fertilizer advice in real-time in response to shifting environmental factors, assuring optimum crop development and resource efficiency.

- Assessment: By assessing the model's precision, recall, and accuracy on test data, perform a thorough evaluation of the crop and fertilizer project. Based on actual agricultural conditions, eval- uate how well it recommends acceptable crops and fertilizers.[10]

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III. TRAINING AND EVALUATION

The enhanced features are incorpo- rated into a prediction model that uses algorithms like XGBoost and Random Forest to evaluate data trends and suggest suitable crops and improved fertilizer mixes. The user is subsequently shown[10] The data was split into training, validation, and test sets to ensure a robust evaluation. Performance metrics included accuracy, precision, recall, and F1-score. Cross-validation was employed to mitigate overfitting.

IV. CONCLUSION

The use of Convolutional Neural Networks in crop recommendation systems based on geographical factors presents a significant advancement in precision agriculture. The CNN model's ability to analyze complex patterns in multidimensional data results in more accurate and reliable crop recommendations, supporting farmers in optimizing productivity and sustainability. Future research will focus on integrating real-time data and expanding the model's applicability to a broader range of crops and regions. It is impossible to overestimate how important technology has been in influencing sustainable and productive farming methods in today’s dynamic agricultural landscape. Our re- search’s conclusion highlights the revolutionary potential of a knowledgeable crop and fertilizer recommendation system that is adapted to local conditions. A system like this acts as a beacon, pointing farmers in the direction of higher harvests, financial success, and environmental preser- vation.

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