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Smart Farming: AI-Powered Crop Selection for Optimal Yield and Sustainability

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ABSTRACT: Indian formers face uncertainty in agriculture which decreases its production. With more population and area, more productivity should be achieved but it cannot be reached. Agricultural factors and parameters make the data to get insights about the Agri-facts. Growth of IT world drives some highlights in Agriculture Sciences to help farmers with good agricultural information. Intelligence of applying modern technological methods in the field of agriculture is desirable in this current scenario.

Machine Learning Techniques develops a well-defined model with the data and helps us to attain predictions. Agricultural issues like crop prediction, rotation, water requirement, fertilizer requirement and protection can be solved. Due to the variable climatic factors of the environment, there is a necessity to have an efficient technique to facilitate the crop cultivation and to lend a hand to the farmers in their production and management. This may help upcoming agriculturalists to have a better agriculture.

To implement such an approach, crops are recommended based on its climatic factors and quantity. Crop Dataset has been analyzed and recommendation of crops is done based on productivity and season.

KEYWORDS: Machine Learning, Crop prediction and fertilizers

I. INTRODUCTION

India is one among the oldest countries which is still practicing agriculture. But in recent times the trends in agriculture has drastically evolved due to globalization. Various factors have affected the health of agriculture in India. Many new technologies have been evolved to regain the health. One such technique is precision agriculture. Precision agriculture is budding in India. Precision agriculture is the technology of "site-specific" farming. It has provided us with the advantage of efficient input, output and better decisions regarding farming. Although precision agriculture has delivered better improvements it is still facing certain issues. There exist many systems which propose the inputs for a particular farming land. Systems propose crops, fertilizers and even farming techniques. Recommendation of crops is one major domain in precision agriculture. Recommendation of crops is dependent on various parameters.

Agriculture makes a dramatic impact in the economy of a country. Agriculture directly depends on the environmental factors such as sunlight, humidity, soil type, rainfall, Maximum and Minimum Temperature, climate, fertilizers, pesticides etc. Knowledge of proper harvesting of crops is in need to bloom in Agriculture. India has seasons of

1. Winter which occurs from December to March
2. Summer season from April to June
3. Monsoon or rainy season lasting from July to September and
4. Post-monsoon or autumn season occurring from October to November.

1.1 Recommendation Techniques

Many crop prediction yield models have been developed. Clustering approaches such as k-means, kmeans++are used to perform grouping o f data as clusters to predict crop yield is used [1]. Tripathy et al., [2] provided a system to have management of pesticides for crop cultivation using data mining process.Essential parameter for agriculture analysis is nature o f soil. Diverse varieties o f soil are available in this India. Crops are cultivated depending on the type of soil in the land. The role of soil in improving crop cultivation is discussed [3]. Data mining techniques are applied to analyze the soil parameter. JRip, J48 and Naive Bayes techniques are applied[4] which

produces more reliable results in analyzing red and Black soil. Impact of parameters o f agriculture in crop management is studied to improve productivity [5]. Pritam Bose [6] developed a SNN model to have a spatiotemporal analysis with crop estimation. An automatic system to gather the information about soil nature, weather conditions was developed [7] with clustering techniques to extract the knowledge and use it by farmers in crop cultivation.

1.2 Existing System

The traditional kind of soil testing involves taking samples around and sending to labs for testing and based on lab's result, they apply a uniform mixture of nutrients or fertilizer to the entire field. Generally, these lab makes fertilizer and lime recommendation. Hence later on applying fertilizers to fields, resulting in damage to crop yield and also possibly to the environment.

1.3 Problem Statement

Agriculture in India plays a predominant role in economy and employment. The common problem existing among the Indian farmers are they don't choose the right crop based on their soil requirements. Due to this they face a serious setback in productivity. This problem of the farmers has been addressed through machine learning based crop recommendation system.

1.4 Proposed System

Crop production depends on many agricultural parameters. Proposed work is based on the recommendations given by considering the season of crop production to the farmers. This kind of suggestions will make farmer to know that whether that particular is yielding a good production in recent years. Production of crops may become less due to any crop disease, water problem and many other factors.

Based on this farmer can take decision of trend on crops in recent years. Farmers will be given recommendation by considering the season of crop production.Recommender systems have lent its hands to users to choose items they like. Recommendation system is the approach to provide the suggestions to the users of their interest. This can be practiced for agricultural use too. Based upon the factors of agriculture, farmers are given with ideas for their cultivation process. New techniques to increase crop cultivation can also be recommended.

1.5 Objectives

The aim of this work is to develop a crop recommendation system based on productivity and season. Therefore, following are the objectives of our proposed system:

- To collect the agriculture data from last decades of year from different regions and crops respectively.
- To pre-process the data and extract the attributes which affects the crop cultivation and production.
- To train the Machine learning model with these features and recommend the crop based on season and productivity.
- To evaluate performance analysis of the proposed recommendation system.

1.6 Methodology

Crop production depends on many agricultural parameters. Proposed work is based on the production of crops in previous years, crops can be recommended to the farmers. This kind of suggestions will make farmer to know that whether that particular is yielding a good production in recent years. Production of crops may become less due to any crop disease, water problem and many other factors. While considering about the production, farmers may get knowledge about which crop is in high volume in the market in that year. Based on this farmer can take decision of trend on crops in recent years.

Although farmer's knowledge sustains, agricultural factors has been changed to astonishing level. There comes a need to indulge engineering effect in crop prediction. Data mining plays a novel role in agriculture research. This field uses historical data to predict; such techniques are neural networks, K-nearest Neighbour. K-means algorithm does not use historical data but predicts based on-computing centres of the samples and forming clusters. Computational cost of algorithm acts as a major issue. Use of Decision tree machine learning classifier is a boon to agriculture field which computes accurately even with more input. The block diagram for proposed system is shown in figure1.

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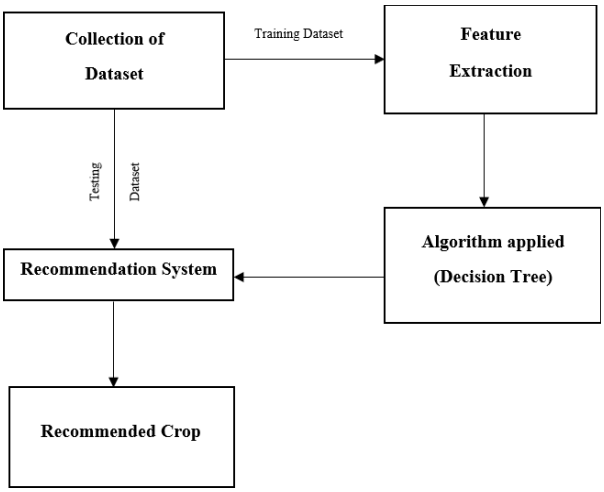


Block Diagram of proposed system

II. SYSTEM DESIGN

System design explains the architecture that would be used for developing a software product. The architecture diagram provides an overview of an entire system, identifying the main components that would be developed for the product and their interfaces.

2.1 Design Consideration

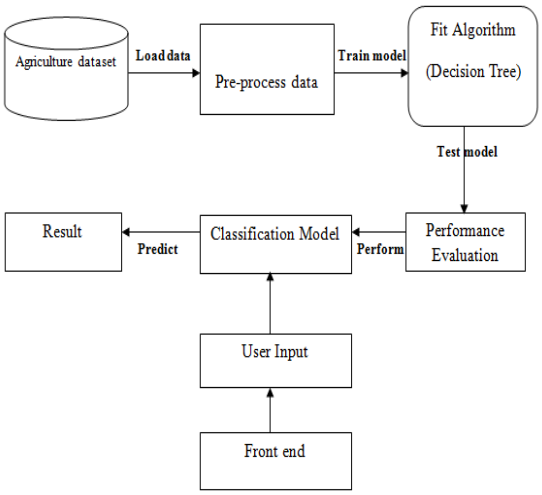
The design consideration briefs about how the system behaves for the boundary environments and what action should be taken if the abnormal case happens. Some of the design considerations Modules are

- Data Collection
- Dataset
- Data Preparation
- Model Selection
- Analyze and Prediction
- Accuracy on test set

Data Collection

This is the first real step towards the real development of a machine learning model, collecting data. This is a critical step that will cascade in how good the model will be, the more and better data that we get, the better our model will perform.

There are several techniques to collect the data, like web scraping, manual interventions and etc. The dataset used in this crop recommendation in India taken from some other source. Figure 2 shows system architecture of architecture crop recommendation system.



SystemArchitecture

Dataset

The dataset consists of 821 individual data. There are 14 columns in the dataset, which are described below.

i. States: total number of states in India
ii. Rainfall: rainfall in mm
iii. Ground Water: Total ground water level
iv. Temperature: temperature in degree Celsius
v. Soil type: Number of soil types
vi. Season: Which season is suitable for crops
vii. Crops: Types of crops
viii. Fertilizers Required: Types of fertilizers required
ix. Cost of cultivation: Total cost for cultivation
x. Expected revenues: Total expected revenues
xi. Quantity of seeds per hectare: seeds for quantity per hectare
xii. Duration of cultivation: number of day for duration of cultivation.
xiii. Demand of crop: demand of crop (High, low)
xiv. Crops for mixed cropping: which crop can mixed for cropping.

Data Preparation:

Wrangle data and prepare it for training. Clean that which may require it remove duplicates, correct errors, deal with missing values, normalization, data type conversions.

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Model Selection:

A decision tree is a flowchart-like tree structure where an internal node represents feature (or attribute), the branch represents a decision rule, and each leaf node represents the outcome. The top most nodes in a decision tree is known as the root node. It learns to partition on the basis of the attribute value. It partitions the tree in recursively manner call recursive partitioning.

Analyze and Prediction:

In the actual dataset, we chose only 7 features:

1. States: total number of states in India.
2. Rainfall: rainfall in mm.
3. Ground Water: Total ground water level
4. Temperature: temperature in degree Celsius
5. Soil type: Number of soil types
6. Season: Which season is suitable for crops
7. Crops: Types of crops

Accuracy on test set:

System got an accuracy of 90.7% on test set.

III. ALGORITHM

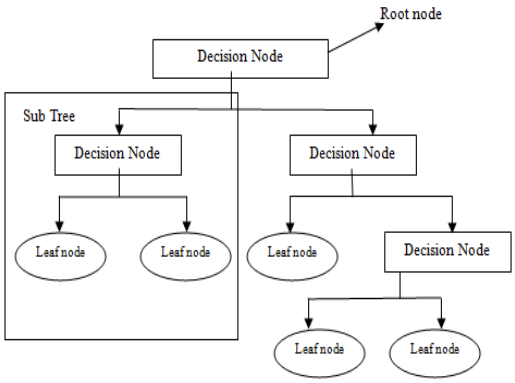
One of the most popular machine learning algorithms is the Decision Tree algorithm. To solve a specific problem, it employs a tree-like structure and all of its possible combinations. It belongs to the supervised learning algorithm class and can be used for both classification and regression.

A decision tree is a hierarchical structure composed of a root node, branches, and leaf nodes. Each internal node represents a test on an attribute, each branch represents the result of the test, and each leaf node represents a class label. The root node is the tree's highest node. Classification and Regression Trees are Decision Tree algorithms that can be used to model classification and regression problems.

3.1 Working of Decision Tree algorithm:

To predict the class of a given dataset in a decision tree, the algorithm begins at the root node of the tree. This algorithm compares the values of the root attribute and the record attribute and, based on the comparison, follows the branch and jumps to the next node.

The algorithm compares the attribute value with the other sub- nodes for the next node and moves on. It continues the process until it reaches the tree's leaf node. Figure 4 shows the working of decision tree algorithm.



Decision tree algorithm

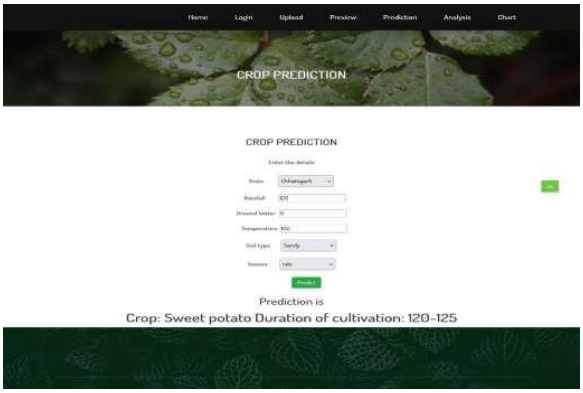
IV. EXPERIMENTAL RESULTS

When predict the input data states, Rainfall, Ground water, Temperature, Soil type and Season, it predicted the crop recommendation with cultivation duration. Figure 3 shows the result of user input data.

Crop Prediction with Cultivation Duration

V. CONCLUSION

Significance of management of crops was studied vastly. Farmers need assistance with recent technology to grow their crops. Many Machine Learning techniques have been used to analyze the agriculture parameters. Considering the parameter like production and season, more personalized and relevant recommendations can be given to farmers which makes them to yield good volume of production. System is achieved the accuracy of 91%.



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