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Review on: Machine Learning Approach for Efficient Agriculture Management

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ABSTRACT - Agriculture is an important component in emerging countries such as India and others. Self-sufficient villages have always been at the heart of India's rural economy, which is built on agriculture. Productivity, on the other hand, has been dropping for nearly a decade. In agriculture, yield prediction is a critical issue. Any farmer wants to know how much he may expect in terms of yield. Yield prediction used to be done by taking into account a farmer's previous experience with a certain field and crop. Machine learning classifiers are crucial in deciding decision-making on a variety of characteristics, including crop production, fertilizer prediction, and recommendation systems. We look at the role of machine learning in agriculture, as well as a few machine learning classifiers and their applications, in this research. The purpose of this work is to develop a crop yield forecast model that can be used in the future. It gives a quick overview of how machine learning techniques can be used to predict crop yields. This research examines a variety of machine learning classifiers, including J48, Naive Bayes, KNN, Random Forest, Support Vector Machine, and J-Rip, for predicting if soil is suitable for a specific crop in a given region. Also fertilizer prediction with machine learning (Harmful or not). If a fertilizer is harmful then we suggest good alternatives using a recommendation system.

KEYWORDS: Agriculture, Machine learning, Crop yield, Classification, Regression, Fertilizers,SVM,Random Forest, KNN,Naive Bayes

I. INTRODUCTION

Agriculture is a very important and sensitive research domain; in terms of consultation with farmers, all citizens are assisting farmers in terms of finding new solutions in existing systems, research and innovation in actual farming, and the government is also providing some funding for the same, which will directly benefit our farmers. The field of computer engineering is also working on this, with a lot of work being done in the tech field as part of the smart agriculture system. This research will focus on several machine learning techniques that have been proposed by various authors over the last decade, keeping in mind various parameters of soil nutrients such as Organic Carbon, Electric conductivity, Potassium, pH value, Nitrogen, Phosphorous, and so on.In addition, the suggested method aims to assist farmers in cultivating crops for increased output. The crops chosen for this research are significant crops from a specific location.When we compare India's per hectare yield to that of other countries, we find that it is the lowest in the world. Lack of irrigation infrastructure, improper pest management, soil erosion, natural calamities, insufficient storage facilities, lack of transportation, scarcity of capital, and so on are some of the reasons. Furthermore, the majority of Indian farmers are illiterate and underprivileged. They can't afford good seeds or modern fertilizer, and they can't make decisions that might help them enhance crop yields.

Motivation: India is an agricultural country, and farming is the most common occupation among Indians. Agriculture has made a significant contribution to India's economic development. However, productivity has been declining for almost a decade.There are several reasons for this, including improper fertilizer use, farmers' lack of decision making capacity in selecting good fertilizers, seeds, manure, and irrigational facilities, agriculture field assessments such as soil quality prediction, soil salinity, soil pH level, soil nitrogen level prediction, temperature update, humidity prediction, and crop yield prediction. This type of prediction necessitates a large amount of data as well as the proper data processing technique.Machine learning technologies were implemented in agricultural science to better automated guessed work for future prediction.As a result, machine learning approaches are the better option for this.

Aim and Objectives:

India is an agricultural country, but due to the lack of experts, insufficient information, low rainfall farmers can't get a good income from farming. This project aims to raise stronger and more fruitful crops, plants and to help them to choose appropriate crops based on various attributes as well as make an accurate prediction of soil nutrients, fertilizer prediction (harmful or not), then suggest the good alternatives of fertilizers using recommendation systems.

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The main objectives of this project are as follows:

- Farmers can perfectly schedule their farming activities.
- Farmers do not require expert advice for farming.
- Farmers save their time and money for advice.
- To provide information about the different variety of crops suitable for the type of soil,new methods and technologies can be adapted to.
- Surveillance for pests and diseases, as well as crop recommendations.
- Farmers will know which disease is affecting the crop, which sprays to apply and when to apply it
- If the crop needs watering and spraying, then with the help of this system it will know what the crop needs first.
- Schedule of future management activities.

II. LITERATURE REVIEW

This paper tried out three different algorithms. 1.Naive Bayes, 2. J48(C4.5), 3. J-rip algorithm, and 1988 soil cases were used in the J48: It is a very simple classifier that generates a decision tree with a 91.90 % accuracy. Soil samples from the Pune regions of Bhor, Velhe, and Khed from testing laboratory and 9 instances(attributes) such as (a). pH (b). EC (c). OC (d). % P (e). K (f). Fe (g). Zn 8) Mn 9) Cu. [1]

Classifier Used	Instance of Soil	No. attributes	Attribute Name	Accuracy
Naïve Bayes	1988	9	OC, pH, P , K, Fe, Zn, Mn, Cu, EC	38.40%
J-rip	1988	9		90.24%
J48	1988	9		91.90%

J48: It is a very simple classifier that generates a decision tree with a 91.90 percent accuracy[1]. Chiranjeevi M N et al. used two algorithms, Naïve Bayes and J48, to construct a system for analyzing soil condition and nutrients. Potassium, pH, Nitrogen, EC, Phosphorus, OC, Sulfur, Iron, Zinc, Magnesium, Boron, and Copper were among the 12 attributes assessed for the experiment by the Belagavi Department of Agriculture in Belagavi. The accuracy of the J48 algorithm was 2.68 percent, whereas the accuracy of the Naive Bayes algorithm was 1.98 percent. The Naive Bayes algorithm outperformed the J48 algorithm. Which accurately identified the soil sample's determined number of instances[2]

Classifier Used	Instance of soil	No. Attribute	Attribute Name	Accuracy
Naïve Bayes	1003	12	Fe, Zn, Cu, Ph, pH, Mg, B	1.98
J48	692	12	EC, OC, N, K	2.68

J48 had given the accuracy 2.68% whereas Naive Bayes 1.98%, Naive Bayes has produced better results than J48 algorithm, which correctly classified the determined number of instances of the soil sample[2]. They compared and tested six algorithms, including J48, Random Tree, J-Rip, One-R, and Naïve Bayes[3].

Classifier Used	Instance of Soil	No. Attribute	Attribute Name	Accuracy
J48	203	6	Soil Type	93.46
Random Tree	203	6	Colour, pH	50.66
JRip	203	6	Lime Status	93.46
OneR	203	6	Soil Tecture	39.92
Naïve Bayes	203	6	Village Name	93.81

J48 has a high accuracy of 93.46 percent when compared to other algorithms, while Naive Bayes has a high accuracy of 93.81 percent when compared to other algorithms. There are slight differences between the two algorithms[3].Pawar M. et al. developed a method that informs farmers about the levels of harmfulness in their soil. If hazardous is present in their farm, the farmer or user may take appropriate action to empower their field farming and increase crop yields.[4]

Classifier Used	Instance of Soil	No. Attribute	Attribute Name	Accuracy
Decision Tree	-	11	Data set of crop: Soil nutrients(Na, Mg, N, P, Ca) Fertilizer: fertilizer name, crop name, date	J48 algorithm is more accurate
J48	-	11		

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When compared to decision trees, the J48 machine learning method is more accurate.[4]After building a system using classification algorithms like Bayes Net, Naive Bayes Updateable,J48, Random Forest had calculated the accuracy of soil instances.

Classifier Used	Instance of Soil	No. Attribute	Attribute Name	Accuracy
Bayes Net	1500			92.3%
Naïve Bayes	1500		Soil	100%
J48	1500		Classification	92.3%
Random Forest	1500			10%

In the categorization of soil nutrients, J48 computed 92.3 percent accuracy, whereas the Naive Bayes algorithm calculated 100 percent accuracy[5]. The author uses a variety of machine learning approaches to forecast fertilizer consumption in order to increase agricultural output. To forecast agricultural production based on fertilizer consumption, machine learning algorithms such as regression and multilayer perceptron are used.Weka is tool for evaluating algorithm performance.[6]

Comparing different Machine learning Algorithms

	Multiple Regression	Multi-layer Perceptron	SMOreg
Time taken to build(in seconds)	0.17	0.14	0,04
RMSE	12.1461	7.6281	12.8027
Correlation Coefficient	0.9796	0.9922	0.9776

The multilayer perceptron is more accurate in forecasting the results in this model. Soil characteristics, temperature, and rainfall are not taken into account in this model.[6]
Soil Classification: Soil nutrients data can be used to classify soils. Random Forest and Support Vector Machine Learning are two machine learning methods used for soil categorization. The two algorithms will categorize the data.Precision, Recall, and Display Confusion Matrix the f1-score and average values, and finally as an output, accuracy is expressed as a percentage.[7]

Crop Yield Prediction:
Crop yield statistics, nutrients, and location data can all be used to predict crop yields. These Random Forest and Support both receive inputs.Algorithms for vector machines these algorithm will be implemented to Crop prediction based on current inputs.[7]

Fertilizers Recommendation:
Fertilizer Recommendation can be done in a variety of ways based on data on fertilizer, crop, and location. In this section, appropriate crops and fertilizer requirements for each crop is suggested.[7]In this model, the user performs exceptionally well across all domains. Based on the findings, the author concludes that for soil classification random forest algorithm is superior to the support vector machine algorithm.For crop yield prediction, and that the support vector machine algorithm is superior to the random forest algorithm for crop yield prediction.[7]This work uses Naive Bayes, Decision Tree, and a hybrid approach of Naive Bayes and Decision Tree to investigate soil supplements such as nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, zinc, and so on. On the basis of accuracy and execution time, the classification algorithms' performance is compared[8].When compared to naïve bayes and decision trees, the hybrid algorithms in this study produce better results[8].
Agriculture has been transformed into an intellectual field with more complete data thanks to big data. Decisions are made using a variety of strategies in Big Data Analytics. With the use of big data analytics, the researcher's work assists farmers in producing the optimal seed depending on soil conditions, resulting in increased productivity and profit. As a result, better crop prediction, the ability to forward - and the use of weather forecasts to boost field productivity and income rates[9].

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This is an insufficient amount of time to reduce manufacturing and environmental hazards, and there is a need to increase possible economic benefits for the developing network in order to reduce the social effects of unpredictable weather extremes[9].The author of this work attempts to forecast mineral compositions in soil and choose the appropriate fertilizer for a soil sample. The LDR values of soil samples with known mineral compositions are read to build a dataset. After that, the dataset is used to train a machine learning model with the Logistic Regression Algorithm.[10]

Using the proposed NPK sensor, the author focuses on providing information about the soil to the farmer regarding the unavailability of macro-nutrients such as nitrogen, phosphorus, and potassium. As a result, the low-cost integration of IOT leads to improved cultivation[10].

This method is characterized by a soil database collected from the farm, crops provided by agriculture experts, achievement of parameters such as soil through soil testing lab dataset. The data from soil testing lab dataset given to the recommendation system will use the collect data and do ensemble model with majority voting technique using support vector machine and ANN as learners to recommend a crop for a site-specific parameter with high accuracy and efficiency. Here they recommend the crop according to the soil data so in addition to this we can recommend the fertilizer with help of this soil data and the crop yield.[11]

Two parameters namely yield response and agronomic efficiency are used by the recommendation system. Limin-Chuana and Ping Hea also consider the Nitrogen, Phosphorus and Potassium (NPK) contents for fertilizer recommendation of wheat. It helps to prevent the inappropriate application of fertilizers in wheat production systems in China. Yield response and agronomic efficiency were incorporated as part of the Nutrient Expert for Wheat fertilizer recommendation decision support system.[12]

Purchase recommendations are made based on previous fertilizer purchases. They took market trends data and applied a random forest algorithm to it to provide crop predictions. Kiran Shinde et al. [8] created a web-based recommendation system for crop and fertilizer recommendations based on previous market pricing data.[13]

It was created specifically for Chinese villages. Using ArcView in ArcGIS, maps of villages are created and location-specific recommendations are presented. Soil measurements, farm production level, and crop target yields are all taken into account when making recommendations. There are three sorts of databases here: system database, spatial database, and attribute database. Meteorological data, along with other factors, is taken into account while making decisions.[14]

The paper proposes the creation of an ontology-based crop suitability and fertilizer recommendation system. It brings farmers and technology closer together. Based on the region in Maharashtra, India, and the type of soil, the method forecasts a suitable crop for the field in question. It makes appropriate fertilizer recommendations to farmers. Along with fertilizer recommendations, the system also makes crop recommendations for a specific region. The random forest algorithm and the k-means clustering method are used in the recommendation system.[15]

They conducted experiments on Indian government dataset and it's been discovered that Random Forest machine learning algorithm gives the best yield prediction accuracy. Rainfall prediction is better with a sequential model that uses a Simple Recurrent Neural Network, whereas temperature prediction is better with LSTM. For yield prediction, the paper considers parameters such as rainfall, temperature, season, and location.
When all parameters are pooled, the results show that Random Forest is the best classifier [16].

specializes in random forest algorithm accuracy, strength, and correlation. The Random Forest method constructs decision trees on distinct data samples, predicts the data from each subset, and then gives the system a better answer by voting. The data was trained using the bagging approach using Random Forest.
To improve accuracy, randomization must be inserted in a way that minimizes correlation while preserving strength [17]. have implemented crop yield prediction by using only the random forest classifier. To anticipate agricultural yield, various factors such as rainfall, temperature, and season were considered.
The datasets were not subjected to any other machine learning methods. Comparison and quantification were missing due to the lack of alternative algorithms, making it impossible to provide the best algorithm [18].
their work fails to implement any algorithms and thus cannot provide a clear insight into the practicality of the proposed work [19].

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This research focuses on crop yield prediction using supervised learning approaches. To obtain the desired results, it is necessary to create an acceptable function from a set of variables that can map the input variable to the desired outcome.
The research claims that the predictions can be made using the Random Forest ML algorithm, which achieves the most accurate crop forecast with the fewest number of models [20].

III. CONCLUSION

Agriculture is the backbone of countries like India. Precision farming, on the other hand, necessitates the use of technology in agriculture. This research suggests an approach that will assist farmers in gaining a better understanding of crop production and fertilizer usage. This research project will be able to determine the weather for a certain crop and whether or not to utilize fertilizer for that crop. This proposed system will take into account variables such as soil characteristics, rainfall, and temperature. We'll see how well the learning algorithm works.

IV. FUTURE SCOPE

India is an agricultural country, but due to the lack of experts, insufficient information, low rainfall farmers can't get a good income from farming. This project aims to raise stronger and more fruitful crops, plants and to help them to choose appropriate crops based on various attributes as well as make an accurate prediction of soil nutrients, fertilizer prediction (harmful or not), then suggest the good alternatives of fertilizers using recommendation systems.

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