# A LITERATURE SURVEY OF CROP RECOMMENDATION IN AGRICULTURE

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**ABSTRACT**

With over 60% of the workforce employed in the sector and contributing over 17% of the country's GDP, agriculture is vital to the Indian economy. But the agricultural industry deals with a lot of challenges, including a number of difficult tasks like harvesting, threshing, winnowing, the bagging method, shipping, storage, processing, and trading, all of which contribute to significant crop losses at various stages before reaching the market. Indian agriculture encounters challenges such as uncertain water supply, inadequate income generation, and fragmented land holdings. Previous studies have primarily centered on using meteorological data and soil factors to forecast about which crops would grow best on a particular soil. To deal with this kind of problem, numerous researchers have created their own Crop Recommendation System models using a variety of Deep Learning and Machine Learning techniques. This article presents a comprehensive overview of different algorithms for deep learning and machine learning that is utilized in constructing Crop Recommendation Systems, providing valuable insights into the most effective algorithms for this purpose.

**Keywords:** Machine Learning, Deep Learning, Crop Recommendation, Agriculture.

## I. INTRODUCTION

Agriculture is the foundation of the nation, continuing to serve as a primary source providing income for a sizable segment of the Indian populace, sustaining livelihoods and fostering general economic expansion. Moreover, half the population is employed in agriculture, while over 60% of the land in the nation is used for agriculture, providing food for 1.3 billion people. In the past, farming was practised using traditional tools, but with the advent of the Green Revolution and globalization, advanced technologies have been embraced. The introduction of high-yielding varieties of crops and vegetables has propelled India's agricultural sector to expand. As a result, our nation has emerged as the biggest producer of fresh vegetables, food grains, and fruits in the world.

However, successful agriculture relies on several factors, including nutrient-rich soils, accurate weather forecasts, and sufficient water supply. Access to freshwater is crucial for crop cultivation, but only a small percentage of the Earth's surface contains freshwater resources. Consequently, various methods, such as rainwater conservation, are employed to address water scarcity. India has diverse water resources, including rivers, lakes, ponds, and groundwater sources like wells and borewells.

According to records from 2018 and 2019, India had approximately 145 million land holdings. However, there are challenges associated with agriculture, including suicides by farmers and the conversion of land use from agricultural to non-agricultural purposes. Additionally, 51% of village farmers desire for their next generation to pursue careers outside of agriculture, favoring urban settlements instead. Poor decision-making regarding crop selection, such as choosing crops unsuitable for the soil or planting during the wrong season, contributes to these challenges. Lack of knowledge about the land's previous status can result in significant losses, particularly for families heavily dependent on agriculture for their income.

In order to tackle these challenges, farmers have been suggested to use a crop recommendation system, leveraging Machine Learning models to provide predictive insights on crop sustainability and recommendation. Important climatic factors including temperature, rainfall, and geographic location are taken into account by this approach, along with soil properties like potassium (K), phosphorus (P), and

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nitrogen (N). Taking these factors into account, the system predicts the most suitable crop for a farmer's land. Several researchers have developed their own Crop Recommendation Systems using various Machine Learning and Deep Learning algorithms. These algorithms include Decision Tree, Neural Network, Random Forest, Logistic Regression, Linear regression, LSTM, Lasso and Ridge Regression, RNN, SVR, ANN, Naïve Bayes and DNN. Out of these algorithms, Random Forest has demonstrated superior accuracy and performance in Crop Recommendation Systems, providing precise crop recommendations to farmers.

## II. REVIEW OF LITERATURE SURVEY

The papers mentioned propose different approaches to assist farmers in making informed decisions about crop growth and selection. I'll provide a summary of each paper's key points:

This paper that focuses on analyzing crop growth in relation to various climatic conditions using the Random Forest algorithm. They collected a crop growth dataset from different sources and used it for training and testing the algorithm. The authors found that the Random Forest algorithm provided more accurate results compared to other algorithms [1].

Agro Consultant is an intelligent system that was introduced [2], which aims to support Indian farmers in decision-making regarding crop growth. The system considers factors such as sowing season, geographical location, soil characteristics, temperature, and rainfall. Agro Consultant consists of two subsystems: one for recommending crops to farmers and another for predicting rainfall in specific regions to aid in crop sustainability prediction.

A system that assists farmers in choosing the right crop by providing intuitive insights that cannot be easily tracked. The system incorporates real-time monthly weather data for efficient yield forecasting. The authors implemented a sequential model with three input layers and 15 output layers using the Linear Regression algorithm and Neural Network. The crop recommendation accuracy achieved by the Linear Regression Model and Neural Network were 88.26% and 89.88%, respectively. The authors concluded that the algorithms used in their system provided the best accuracy and results, thereby enhancing the efficiency of the system [3].

A system that predicts crop yields in real-time based on various parameters such as production and season. The system utilizes Data Mining techniques and Big Data techniques to improve the precision of crop predictions. Personalized and relevant recommendations are provided to farmers, resulting in higher volume production [4].

A Supervised Machine Learning method has been used [5] to forecast crop yields in the agricultural industry. Past data is used to predict future yields, with a focus on weather and pesticide factors. The authors used a dataset from the Kaggle repository, consisting of parameters such as rainfall, perception, temperature, and production. The Random Forest algorithm is employed and compared with other algorithms, demonstrating higher accuracy in crop yield prediction. The proposed system covers a wide range of crop types, providing accurate predictions and potentially increasing farmers' profits.

Based on the title and conference details, it appears that the article focuses on estimating agricultural production in India with machine learning techniques. Crop yield estimation is an essential aspect of agriculture, and leveraging machine learning can provide valuable insights to farmers, policymakers, and researchers. The use of machine learning in crop yield estimation has gained significant attention due to its potential to improve accuracy and efficiency. By analyzing various factors such as weather patterns, soil conditions, historical data, and other relevant parameters, machine learning algorithms can predict crop yields with a certain level of accuracy [6].

An application designed to predict crop production in specific regions based on physical parameters such as rainfall and temperature. The prediction model utilizes data sets of various crops from different regions in India, as well as corresponding rainfall and temperature data sets. A modified ARIMA model is used to forecast rainfall and temperature values, which are then fed into a Linear Regression model for further prediction. The proposed system offers detailed recommendations for farmers to optimize their crop selection based on factors like location, farm size, temperature, rainfall, and crop data sets [7].

A new model that combines Machine Learning (SVM) Deep Learning (LSTM, RNN) and Machine Learning (SVM) techniques for accurate crop prediction. The model takes into account soil and temperature parameters to predict the most suitable crops with lower expenses. The proposed model achieves an accuracy of 97% and provides analysis to help farmers make profitable crop predictions [8].

That crop yield prediction is a significant challenge in agriculture, with implications for decision-making at various levels. To tackle this issue, two methods have been put forth: the Gradient Approach to Enhancing Agricultural Yield Prediction methodology and Crop Harvest Prediction Algorithm (CYPA), which makes use of IoT tools. These algorithms help farmers and politicians make decisions by predicting annual crop yields based on environment, the climate, yield from agriculture, and chemical data. Additionally, by lowering the quantity of labeled data required for training, the application of learning by implementing CYPA can improve its performance, improving efficiency and accuracy. Another approach involves developing a linear machine learning algorithm based on Generalized Linear Model (GLM) for early prediction of corn yield, which results in relative errors of less than 20%. Various machine learning methods, including ensemble XGBoost-RF, gradient boosting, random forest, and XGBoost, have been used to estimate crop yield, with ensemble XGBoost-RF showing maximum accuracy [9].

A soil analysis and crop prediction model. The main objective is to create a prediction engine that suggests the most suitable crop based on soil fertility and rainfall in a given region. The authors collect soil samples from different regions and analyze temperature, moisture, and humidity at regular intervals. Data is continuously monitored, displayed, and uploaded to the IoT cloud. Three algorithms, Naïve Bayes, Logistics, and C4.5, are used, with C4.7 achieving a maximum accuracy of 85% [10].

Focused on the use of Four algorithms for classification: J48, KStar, Random Tree, and Bayes Net implemented through the WEKA tool. The objective is to improve the efficiency and effectiveness of agricultural data analysis for better decision-making and crop yield improvement. The study is specifically conducted in the Nashik district of Maharashtra. Results show that the Random Tree algorithm performs well in terms of error rate and provides slightly better performance compared to the other three algorithms (KStar, BayesNet, and J48). The application of Machine Learning techniques aims to extract informative insights from the agricultural dataset to enhance crop yield prediction [11].

A machine learning algorithm-based crop yield forecast system has been proposed [12]. The main goal is to acquire higher agricultural crop production through accurate yield estimation. The process involves utilizing agriculture data, preprocessing the data, extracting features like soil information, field management, nutrients, humidity, etc. Machine Learning algorithms such as CNN, LSTM, ANN, KNN, and DNN are used for yield prediction. The developed model reduces relative error, and the paper provides a detailed analysis of accuracy using various Machine Learning techniques.

Focused on new methods that use deep neural networks (DNNs) to forecast crop production and measure differences in efficiency between them. Here is a short overview of this information. The use of deep neural networks in agriculture to predict crop yield and measure yield disparities is a novel approach. Many advances have been made with deep

learning techniques in other areas, thus making it possible to apply these technologies in farming [13].

A system of recommendations has been proposed which utilizes Machine Learning techniques to suggest suitable crops based on soil qualities. The system aims to resolve agricultural issues, improve crop yields, and decrease losses. Classifier models combining Logistic Regression, Naive Bayes, and Random Forest are used, with Random Forest achieving the highest accuracy. The research aims to leverage machine learning algorithms to forecast agricultural production and provide advice to farmers based on factors such as rainfall, temperature, and region [14].

This research work which is a user-friendly GUI system, which is a commendable approach. By developing a system that is easy for farmers to use, it increases the likelihood of adoption and implementation in real-world farming scenarios. The use of machine learning algorithms, specifically SVM for rainfall prediction and Decision Tree

## III TABLES AND FIGURES

**TABLE 1: ANALYSIS**

| Title | Summary | Advantages | Technology used | Accuracy |
|---|---|---|---|---|
| "An Effective Crop Prediction Using Random Forest Algorithm" [1] | In this research article author has Focuses on predicting crop yields using the Random Forest is a popular machine learning algorithm known for its ability to handle complex datasets and perform well in prediction tasks. The article likely explores the application of Random Forest in predicting crop yields or other related aspects in agriculture. | To develop a predictive model that can determine the crop yield based on various input factors such as climate conditions, soil properties, and agricultural practices. By analyzing these factors, the researchers aim to assist farmers in making informed decisions and optimizing their crop production. | Random Forest Algorithm | 95% |
| AgroConsultant's Intelligent Crop Recommendation System using Machine Learning Algorithms[2] | In this article author has developed Intelligent System for Crop Recommendation | AgroConsultant consists of two subsystems: one for recommending crops to farmers | Neural Network, Random Forest, Leaflet.js Decision Tree, KNN | NN:91.00% RF:90.43% DT:90.20% KNN:89.78% |

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| | System that employs machine learning algorithms. The system aims to provide intelligent and data-driven recommendations for crop management. | and another for predicting rainfall in specific regions to aid in crop sustainability prediction. | | |
| Intelligent Crop Recommendation System using Machine Learning[3] | In this paper, the author likely delves into the potential benefits and applications of this intelligent crop recommendation system in improving overall agricultural productivity. | Implemented a sequential model with three input layers and 15 output layers using the Linear Regression algorithm and Neural Network. | Linear Regression Model and Neural Network | 88.26% and 89.88%, |
| Agricultural Crop Recommendations based on Productivity and Season[4] | In this paper author has proposed a system that predicts crop yields in real-time based on various parameters such as production and season. | The system utilizes Data Mining techniques and Big Data techniques to improve the precision of crop predictions | Data Mining techniques and Big Data techniques | - |
| Supervised | In this paper author | The Random | Random Forest | - |

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| Machine learning Approach for Crop Yield Prediction in Agriculture Sector[5] | has implemented a Supervised Machine Learning approach for predicting crop yields in the agriculture sector. Past data is used to predict future yields, with a focus on weather and pesticide factors. | Forest algorithm is employed and compared with other algorithms, demonstrating higher accuracy in crop yield prediction. | algorithm, Decision Tree | |
| Crop Yield Estimation in India Using Machine Learning[6] | In this paper author has presents a system that predicts crop yields for India using data from 1950 to 2018. Five crops ( Maize, Bajra, Jowar, Tobacco and Wheat) are considered in the prediction process. | The dataset includes parameters such as rainfall, area, area under irrigation, crop names, seasons, production, and yield. | Ridge Regression, Decision Tree, Lasso Regression and Linear Regression. | DT:97.73% LR: 89.36%. LassoR:85.75% RidgeR:88.64% |
| Design and Implementation of Mobile Application for Crop Yield Prediction using Machine | In this paper author have proposed a predicting crop production in specific regions by utilizing physical parameters such as | The proposed system offers detailed recommendations for farmers to select innovative approach, | Linear Regression, SVR Model | - |

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| Learning[7] | temperature and rainfall. The application is designed to leverage these parameters as inputs to forecast crop yields accurately. By incorporating these essential environmental factors, the authors aim to provide valuable insights and predictions regarding crop production in targeted regions. | potential for improved accuracy, versatility in dataset analysis, real-world applicability, and contribution to the field of crop yield prediction. | | |
| A Hybrid Approach for Crop Yield Prediction Using Machine Learning and Deep Learning Algorithms[8] | In this paper author has introduces a new model that combines (SVM) Machine Learning and (LSTM, RNN) Deep Learning techniques for accurate crop prediction. | The model takes into account soil and temperature parameters to predict the most suitable crops with lower expenses | SVM, LSTM, RNN | 97% |
| "Crop Yield Prediction Using | In this paper author explores the | A web application is | Linear Support Vector Machine | 96.5% |

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| Linear Support Vector Machine" [9] | utilization of the (LSVM) Linear Support Vector Machine technique as a promising tool for accurate and efficient crop yield forecasting. | implemented, allowing users to interact with the trained ML model and make predictions based on their inputs | | |
| Soil Analysis and Crop Prediction[10] | In this paper author have proposed a soil analysis and crop prediction model. | Data is continuously monitored, displayed, and uploaded to the IoT cloud. | Naïve Bayes, Logistics, and C4.5, are used, with C4.7 | 85%. |
| Experimental Analysis of Machine Learning Algorithms Based on Agricultural Dataset for Improving Crop Yield Prediction[11] | In this paper author improve the efficiency and effectiveness of agricultural data analysis for better decision-making and crop yield improvement | The application of Machine Learning techniques aims to extract informative insights from the agricultural dataset to enhance crop yield prediction. | WEKA Tool, Random Tree, KStar, BayesNet, and J48 | RT:97.89% KStar:95.7% BayesNet:70.5% J48:78% |
| Crop Yield Prediction using Machine Learning Algorithm[12] | In this paper author proposed a crop yield prediction system using | extracting features like soil information, field management, | CNN, LSTM, ANN, KNN, and DNN | - |

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| | Machine Learning algorithms. The main goal is to acquire higher agricultural crop production through accurate yield estimation. | nutrients, humidity, etc. | | |
| Crop Yield Prediction Using Deep Neural Networks[13] | In this paper author have trained two Deep Neural Networks (DNNs) to predict yield and check yield difference. | Including DNN(G), DNN(S), and DNN(W)are used to account for genotype and environment effects on yield | DNN(G), DNN(S), and DNN(W) | DNN:91.25% LassoR:28.31% SNN:71.18%, RT:82% |
| Crop Prediction and Mapping Using Soil Features with Different Machine Learning Techniques[14] | In this paper author has designed a recommendation model which is provide advice to farmers based on factors such as rainfall, temperature, and region. | Classifier models combining Logistic Regression, Naive Bayes, and Random Forest are used, with Random Forest achieving the highest accuracy. | Logistic Regression, Naive Bayes, and Random Forest | NB:91.12% LR:96.24% RF:98.68% |
| Crop Prediction using Machine Learning Approaches[15] | In this paper, the author has involves utilizing machine learning algorithms to analyze various factors such as environmental conditions, soil quality, and historical data to predict crop outcomes. | It provides farmers with information about required nutrients, seeds, expected yield, and market prices. | SVM, Decision Tree algorithm for crop prediction | - |

for crop prediction, reflects the adoption of state-of-the-art techniques in the field of agricultural data analysis. These algorithms have been widely used for similar tasks and are known for their effectiveness in handling complex datasets. The system's ability to predict the best suitable crop for a particular land based on soil content, weather parameters, and other relevant factors is a valuable feature. Additionally, providing farmers with information about required nutrients, seeds, expected yield, and market prices can empower them to make informed decisions and optimize their farming practices [15].

## IV CONCLUSION

One of the main drivers of the Indian economy is agriculture, with farmers relying heavily on it as their primary source of income. However, the sector faces significant challenges such as the direct impact of environmental changes due to global warming and a lack of knowledge and guidance regarding suitable crops for cultivation. These challenges often lead to substantial losses for farmers. To mitigate these issues, crop recommendation systems have been introduced to provide valuable guidance to farmers. Numerous Deep Learning and Machine Learning algorithms have been employed to build up efficient crop recommendation systems. Notably, the Random Forest algorithm stands out for its ability to produce highly accurate results. When combined with other algorithms, the Random Forest algorithm further enhances the overall performance of the model. After a thorough analysis of various research papers, it is evident that the Random Forest algorithm consistently achieves superior accuracy and results compared to other algorithms. This highlights its effectiveness in addressing the complex challenges faced by farmers and underscores its potential as a key tool in improving crop recommendations for sustainable and profitable farming practices.

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