



# THE IMPACT OF DATA MINING IN MACHINE LEARNING ALGORITHM FOR CROP RECOMMENDATION TO YIELD – A REVIEW

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**Abstract :** Data mining is the practice of examining and deriving purposeful information from the data. Data mining finds its application in various fields like finance, retail, medicine, agriculture etc. Data mining in agriculture is used for analyzing the various biotic and abiotic factors. 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 precision agriculture. Precision agriculture is a modern farming technique that uses research data of soil characteristics, soil types, crop yield data collection and suggests the farmers the right crop based on their site specific parameters. This reduces the wrong choice on a crop and increase in productivity. In this paper, has been prepared as an effort to reassess the research studies on the relevance of machine learning techniques in the domain of agricultural crop production.

**IndexTerms:** Crop Prediction, Machine Learning, Crop Recommendation, Classification, Agriculture.

## I. INTRODUCTION

India is one among the most seasoned nations which is as yet rehearsing 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. Numerous new innovations have been advanced to recapture the wellbeing. 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. In spite of the fact that accuracy agribusiness has conveyed better upgrades it is as yet confronting specific issues [1]. 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.

Machine learning means to give the knowledge to the machine. There are various types of machine learning techniques such as supervised and unsupervised learning. Supervised learning means there is one supervisor to supervise the thing that is the program is trained by training examples and then that can be used to find the accurate conclusion for new data. Artificial neural network, Bayesian network, decision tree, support vector machines, ID3, k-nearest neighbor, hidden markov model etc. are some of the examples of supervised learning[2]. The unsupervised machine learning means a vast amount of data is given to the program and the program will find the patterns and the relations between them. So hidden patterns in the data can be discovered using unsupervised learning. Some examples of unsupervised

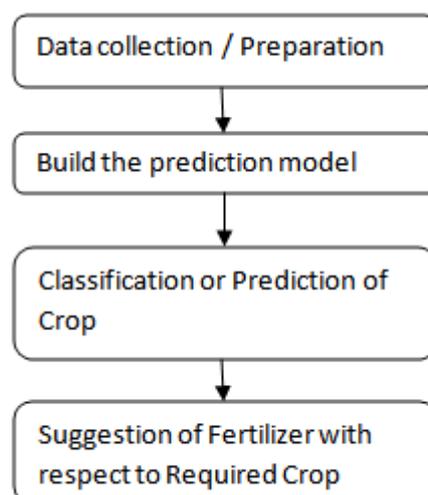
learning algorithms are k-nearest neighbor, self organizing map, and partial based clustering, hierarchical clustering, k-means clustering etc.

## II. SURVEY ON CROP RECOMMENDATION TO YIELD USING MACHINE LEARNING ALGORITHMS

S.Veenadhari [3] proposed a Machine learning approach for forecasting crop yield based on climatic parameters in which the impact of climate change in India, majority of the agricultural crops are being badly affected in terms of their performance over a period of last two decades. Predicting the crop yield well ahead of its harvest would help the policy makers and farmers for taking appropriate measures for marketing and storage. Such predictions will also help the associated industries for planning the logistics of their business. In the present study a software tool named 'Crop Advisor' has been developed as an user friendly web page for predicting the influence of climatic parameters on the crop yields. C4.5 algorithm is used to find out the most influencing climatic parameter on the crop yields of selected crops in selected districts of Madhya Pradesh. Rakesh Kumar [4] proposed a

Crop Selection Method to Maximize Crop Yield Rate using Machine Learning Technique for Crop Selection Method (CSM) to solve crop selection problem, and maximize net yield rate of crop over season and subsequently achieves maximum economic growth of the country. The proposed method may improve net yield rate of crops.

Kentaro Kuwata and Ryosuke Shibasaki [5] proposed a estimating crop yields with deep learning and remotely sensed data in which Deep learning is a technique that has been attracting attention in recent years of machine learning, it is possible to implement using the Caffe. High accuracy estimation of crop yield is very important from the viewpoint of food security. However, since every country prepare data inhomogeneously, the implementation of the crop model in all regions is difficult. Deep learning is possible to extract important features for estimating the object from the input data, so it can be expected to reduce dependency of input data. Narayanan Balakrishnan [6] proposed a Crop Production-Ensemble Machine Learning Model for Prediction in which The method used for the analysis of statistical data over a period of time is the time series analysis. This strategy is logical and solid in determining occasions to follow over a period. Likelihood of creation could continuously be anticipated to the close flawlessly by time series examination. In this work, food creation is the pushed for expectation. The noticeable classification methods in this study are the Support Vector Machine (SVM) and Naive Bayes. Jig Han Jeong [7] proposed a Random Forests for Global and Regional Crop Yield Predictions in which Accurate predictions of crop yield are critical for developing effective agricultural and food policies at the regional and global scales. We evaluated a machine-learning method, Random Forests (RF), for its capacity to anticipate crop yield reactions to environment and biophysical factors at worldwide and provincial scales in wheat, maize, and potato in examination with multiple linear regressions (MLR) serving as a benchmark. The following figure 2.1 shows the data flow diagram for the crop recommendation to yield.



**Figure 2.1: Data Flow Diagram**

Niketa Gandhi [8] proposed a Rice Crop Yield Prediction in India using Support Vector Machines in which the sustainability and productivity of rice growing areas is dependent on suitable climatic conditions. Fluctuation in occasional environment conditions can make impeding difference, with occurrences of dry spell decreasing creation. Growing improved strategies to foresee crop efficiency in

various climatic circumstances can help rancher and different partners in better dynamic concerning agronomy and harvest decision. The boundaries considered for the review were precipitation, least temperature, normal temperature, greatest temperature and reference crop evapotranspiration, region, creation and yield for the Kharif season (June to November) for the years 1998 to 2002. Ozdarici Ok et al. [9] proposed a Evaluation of random forest method for agricultural crop classification in which This study aims to examine the performance of Random Forest (RF) and Maximum Likelihood Classification (MLC) method to crop classification through pixel-based and parcel based approaches. Analyses are performed on multispectral SPOT 5 image. First, the SPOT 5 image is classified using the classification methods in pixel-based manner. Next, the produced thematic maps are overlaid with the original agricultural parcels and the frequencies of the pixels within the parcels are computed. Then, the majority of the pixels are assigned as class label to the parcels. Results indicate that the overall accuracies of the parcel-based approach computed for the Random Forest method is 85.89%, which is about 8% better than the corresponding result of MLC.

Rohit Kumar Rajak [10] proposed a Crop Recommendation System to Maximize Crop Yield using Machine Learning Technique in which The data from soil testing lab given to recommendation system it will use the collect data and do ensemble model with majority voting technique using support vector machine (SVM) and ANN as learners to recommend a crop for site specific parameter with high accuracy and efficiency. Sk Al Zaminur Rahman [11] proposed a Soil Classification using Machine Learning Methods and Crop Suggestion Based on Soil Series model that can predict soil series with land type and according to prediction it can suggest suitable crops. Several machine learning algorithms such as weighted k-Nearest Neighbor (k-NN), Bagged Trees, and Gaussian kernel based Support Vector Machines (SVM) are used for soil classification. Experimental results show that the proposed SVM based method performs better than many existing methods. Zeel Doshi [12] proposed a AgroConsultant: Intelligent Crop Recommendation System Using Machine Learning Algorithms in which The mainstream Indian population depends either explicitly or implicitly on agriculture for their livelihood. It is, hence, undeniable that horticulture assumes a crucial part in the country. A larger part of the Indian ranchers have faith in relying upon their instinct to conclude which harvest to plant in a specific season. An intelligent system, called AgroConsultant, which intends to assist the Indian farmers in making an informed decision about which crop to grow depending on the sowing season, his farm's geographical location, soil characteristics as well as environmental factors such as temperature and rainfall. Rashmi Priya [13] proposed a Crop Prediction on the Region Belts of India: A Naïve Bayes MapReduce Precision Agricultural Model in which Big data provide facilities like data storage, data processing, and data analysis with accuracy, hence its use in the field of agriculture can benefit farmers and nation's economic growth. In this work, a precision agriculture model is presented to suggest farmers, which crop to cultivate according to field conditions. Focusing mainly on the agriculture in Telangana region, the model uses a Naïve Bayes classifier to recommend about the crop to the farmers. It also suggests which crop can be grown in a specific given environment.

Devdatta A. Bondre [14] proposed a prediction of crop yield and fertilizer recommendation using machine learning algorithms in which Machine learning is an emerging research field in crop yield analysis. Yield forecast is a vital issue in farming. Any rancher is keen on realizing how much yield he is going to anticipate. In the past, yield prediction was performed by considering farmer's experience on particular field and crop. The yield prediction is a major issue that remains to be solved based on available data. Machine learning techniques are the better choice for this purpose. Different Machine learning techniques are used and evaluated in agriculture for estimating the future year's crop production. This paper proposes and carries out a framework to foresee crop yield from past information. This is achieved by applying machine learning algorithms like Support Vector Machine and Random Forest on agriculture data and recommends fertilizer suitable for every particular crop. D. Anantha Reddy [15] proposed a Crop Recommendation System to Maximize Crop Yield in Ramtek region using Machine Learning in which Precision agriculture helps in reduction of non suitable crop which indeed increases productivity, apart from the following advantages like efficacy in input as well as output and better decision making for farming. This method gives solutions like proposing a recommendation system through an ensemble model with majority voting techniques using random tree, CHAID, K \_ Nearest Neighbour and Naive Bayes as learner to recommend suitable crop based on soil parameters with high specific accuracy and efficiency. The classified image generated by these techniques consists of ground truth statistical data and parameters of it are weather, crop yield, state and district wise crops to predict the yield of a particular crop under particular weather condition.

Kodimalar Palanivel [16] proposed an approach for prediction of crop yield using machine learning and big data techniques in which Machine learning is one such technique employed to predict crop yield in

agriculture. Various machine learning techniques such as prediction, classification, regression and clustering are utilized to forecast crop yield. Artificial neural networks, support vector machines, linear and logistic regression, decision trees, Naïve Bayes are some of the algorithms used to implement prediction. However, the selection of the appropriate algorithm from the pool of available algorithms imposes challenge to the researchers with respect to the chosen crop. In this paper, an investigation has been performed on how various machine learning algorithms are useful in prediction of crop yield. An approach has been proposed for prediction of crop yield using machine learning techniques in big data computing paradigm. Mayank Champaneri [17] proposed a Crop Yield Prediction Using Machine Learning in which by analysing all these issues and problems like weather, temperature, humidity, rainfall, moisture, there is no proper solution and technologies to overcome the situation faced by us. In India, there are many ways to increase the economic growth in the field of agriculture. Information digging is likewise helpful for anticipating crop yield creation. Generally, data mining is the process of analysing data from various view point and summarizing it into important information. Random forest is the most popular and powerful supervised machine learning algorithm capable of performing both classification and regression tasks, that operate by constructing a multitude of decision trees during training time and generating output of the class that is the mode of the classes (classification) or mean prediction (regression) of the individual trees.

M Chandrababha [18] proposed a Machine learning based Pedantic Analysis of Predictive Algorithms in Crop Yield Management in which an conjectural evaluation on diverse prediction algorithms like support vector machines (SVM), recurrent neural networks (RNN), K nearest neighbour regression (KNN-R), Naïve Bayes, BayesNet, support vector regression (SVR) etc., is done and its performance are described on the basis of error rates and accuracy level in crop yield. BayesNet shows the higher accuracy of about 97.53% and RNN has less percentage error rates that dominate other algorithms in harvest prediction. Nischitha K [19] proposed a Crop Prediction using Machine Learning Approaches in which Our system will suggest the best suitable crop for particular land based on content and weather parameters. And also, the system provides information about the required content and quantity of fertilizers, required seeds for cultivation. Hence by utilizing our system farmers can cultivate a new variety of crop, may increase in profit margin and can avoid soil pollution. Pradeepa Bandara [20] proposed a Crop Recommendation System in which consisting of a theoretical and conceptual platform of Recommendation system through integrated models of collecting environmental factors using Arduino microcontrollers, Machine learning techniques such as Naïve Bayes (Multinomial) and Support Vector Machine (SVM), Unsupervised machine learning algorithm such as K-Means Clustering and also Natural Language Processing (Sentiment Analysis) concerned with the Artificial Intelligence to recommend a crop for the selected land with site-specific parameters with high accuracy and efficiency. It has been a major problem to identify what to grow, any man has adequate space in the owner's land. Not only domestic lands but also for farming lands. Why it has become a problem is that environmental factors such as temperature, water levels, and soil conditions are uncertain as they change from time to time. Due to these problems, this solution of crop recommendation system predicts the user, what crop type would be the most suitable for the selected area by collecting the environmental factors for plant growth and processing them with the trained sub-models of the main of the system.

Dr.G.Suresh [21] proposed a Efficient Crop Yield Recommendation System Using Machine Learning For Digital Farming in which to assist ranchers with deciding the dirt quality by doing examination on its different boundaries and to recommend crops dependent on the outcomes acquired utilizing information mining approach. The structure uses the Arrangement estimation of Help Vector Machine to work on the adequacy of Harvest Suggestion Framework. The system maps the soil and yield data to predict the overview of sensible harvests for the soil and it also gives the information about supplements which are deficient in soil for the particular collect. Thusly it leaves upon the client to choose the respect be planted. Thusly, the structure helps with giving data to the novice farmers. Sayed Mazhar Ali [22] proposed a Machine Learning based Crop Recommendation System for Local Farmers of Pakistan in which idea of ideal harvest prior to planting it, it would be of extraordinary assistance to the farmers and others required to settle on fitting choices on upgrading the creation of yields for neighborhood utilization needs and may prompt the capacity and expanded fare choice for business. The structure used Machine Learning techniques with the ultimate objective that it proposes the proper corps reliant upon the temperature. This system thusly decreases the money related adversities looked by the ranchers achieved by laying out the unpropitious harvests and moreover it gives the data on an intermittent portrayal of yields what reap is sensible for which season. It is inferred that proposed calculation has a typical exactness of 90% on the given dataset. The accomplished exactness is more in contrast with existing work.

Anguraj.K [23] proposed a Crop Recommendation on Analyzing Soil Using Machine Learning in which Crop production has greatly affected due to changes in weather pattern. Emerging technologies can be used to improve productivity of the crops by converting traditional farming to precision farming. The new technologies that are used include data analysis and Internet of things (IOT). The major issue yet to be resolved is cultivating precise crop at precise time. This can be done with the help machine learning algorithms which is found to be an effective method for predicting the suitable crop. The soil parameters such as soil moisture, temperature, humidity and pH are collected from the sensors using IOT and given to Graphical User Interface (GUI). GUI gets the inputs and suggests the suitable crops. The system developed using IOT and ML greatly helps the farmers to take a valuable decision. Aman Sinha [24] proposed a Crop Recommendation Assistant Using Machine Learning in which soil database acquired from the farm characterizes exact agriculture. The data accumulated by these sensors is put away in the microcontroller and broke down by utilizing AI procedures, for example, irregular timberland to create crop development proposals. This process emphasizes engaging a convolutional neural network as a primary method for deciding whether a plant is at risk of disease.

Atharva Jadhav [25] proposed a Crop Recommendation System Using Machine Learning Algorithms in which effective technology can be used to increase the yield and to reduce the maximum possible challenges in this field. Most of the times it is observed that farmers tend to sow the crop according to its market value and possible financial profits rather than taking factors like soil conditions, sustainability etc. in to the account. This may lead to undesirable results for farmers and for the nature of soil too. In today's time, technologies like machine learning and deep learning can become game changers in such fields if they are used in a proper manner. This paper will represent an effective use of such technologies in order to provide maximum assistance to farmers in the area of crop recommendation. Below table 2.1 illustrates a review of crop recommendation to yield techniques which were above discussed.

**Table 2.1: Review of Crop Recommendation to Yield Techniques**

S.No	Author Name	Ref. No	Algorithm Used	Highlights
1	S. Veenadhari	[3]	- C4.5 algorithm	- demonstrated the potential use of data mining techniques in predicting the crop yield based on the climatic input parameters. - The user friendly web page developed for predicting crop yield can be used by any user their choice of crop by providing climatic data of that place.
2	Rakesh Kumar	[4]	- CSM (Crop Selection Method) - GBDT (Gradient Boosted Decision Tree)	- This paper develops a new method called Crop Selection Method (CSM) to maximize net yield rate of crops over season.
3	Kentaro Kuwata and Ryosuke Shibasaki	[5]	- Support Vector Machine Regression	- The highest accuracy is achieved by deep learning with two InnerProductLayer. - Correlation coefficient is 0.810 and RMSE is 6.298. - For single InnerProductLayer, correlation coefficient is 0.727 and RMSE is 7.427.
4	Narayanan Balakrishnan	[6]	- Support Vector Machine (SVM) - Naive Bayes	- The two parameters used separately for prediction of output are the accuracy and the classification error. - The finding yields that AdaSVM and AdaNaive are agreeable than SVM and Naive Bayes for the data set analyzed.

5	Jig Han Jeong	[7]	<ul style="list-style-type: none"> <li>- Random Forests</li> <li>- Multiple linear regression</li> </ul>	<ul style="list-style-type: none"> <li>- The RF algorithm has many advantages to regress complex crop systems</li> <li>-The results support that RF regression can be an effective tool for predicting crop yield at the global and regional scale with cautious selection of a training dataset that includes a wide range of predictor variability</li> </ul>
6	Niketa Gandhi	[8]	<ul style="list-style-type: none"> <li>- support vector machine (SVM)</li> <li>- Naïve Bayes</li> <li>- BayesNet</li> <li>- Multilayer Perceptron</li> </ul>	<ul style="list-style-type: none"> <li>- performed better by achieving the highest accuracy, sensitivity and specificity.</li> <li>- BayesNet and Multilayer Perceptron showed the highest accuracy and best quality and SMO showed the lowest accuracy and worst quality</li> </ul>
7	Ozdarici Ok et al.	[9]	<ul style="list-style-type: none"> <li>- Random Forest</li> <li>- Maximum Likelihood Classification</li> </ul>	<ul style="list-style-type: none"> <li>- the performance of the RF and MLC methods by pixel-based and parcel-based approaches. Pixel-based classification results indicate that the RF method improves the overall accuracy of the MLC method around 4% and it is computed as 76.15%.</li> <li>- The parcel based classification results also reveal that the highest overall accuracy of 85.89% is obtained for the RF method, which is higher 8% than the corresponding parcel-based MLC result.</li> <li>- In conclusion, it can be stated that the RF method along with the parcel-based approach can be a reliable way to produce crop maps in high accuracies for agricultural lands.</li> </ul>
8	Rohit Kumar Rajak	[10]	<ul style="list-style-type: none"> <li>- Support Vector machine</li> <li>- NAÏVE Bayes</li> <li>- Multi-layer Perceptron</li> <li>- Random Forest</li> </ul>	<ul style="list-style-type: none"> <li>- increase productivity in agriculture, prevent soil degradation in cultivated land, and reduce chemical use in crop production and efficient use of water resources.</li> </ul>
9	Sk Al Zaminur Rahman	[11]	<ul style="list-style-type: none"> <li>- KNN</li> <li>- SVM</li> </ul>	<ul style="list-style-type: none"> <li>- Bagged tree and K-NN shows good accuracy but among all the classifiers, SVM has given the highest accuracy in soil classification.</li> </ul>
10	Zeel Doshi	[12]	<ul style="list-style-type: none"> <li>- Decision Tree</li> <li>- KNN</li> <li>- Random Forest</li> <li>- Neural Network</li> </ul>	<ul style="list-style-type: none"> <li>- This system would assist the farmers in making an informed decision about which crop to grow depending on a variety of environmental and geographical factors.</li> <li>- Also implemented a secondary system, called Rainfall Predictor, which predicts the rainfall of the next 12 months.</li> <li>- The high accuracies provided by both these models make them very efficient for all practical and real-time purposes.</li> </ul>
11	Rashmi Priya	[13]	<ul style="list-style-type: none"> <li>- Naïve Bayes classifier</li> </ul>	<ul style="list-style-type: none"> <li>- The proposed work introduces an efficient crop recommendation system.</li> </ul>

				Use of naïve bayes makes the model very efficient in terms of computation. The system is scalable as it can be used to test on different crops. From the yield graphs the best time of sowing, plant growth and harvesting of plant can be found out.
12	Devdatta A. Bondre	[14]	<ul style="list-style-type: none"> <li>- Support Vector Machine</li> <li>- Random Forest</li> </ul>	<ul style="list-style-type: none"> <li>- The prediction of crop yield based on location and proper implementation of algorithms have proved that the higher crop yield can be achieved.</li> <li>- For crop yield prediction Support Vector Machine is good with accuracy 99.47% compare to Random Forest algorithm.</li> </ul>
13	D. Anantha Reddy	[15]	<ul style="list-style-type: none"> <li>- RANDOM TREE</li> <li>- K-NEAREST NEIGHBOR</li> <li>- RANDOM FOREST</li> <li>- DECISION TREE</li> </ul>	- would help farmers in sowing the right seed based on soil requirements to increase productivity of the nation.
14	Kodimalar Palanivel	[16]	<ul style="list-style-type: none"> <li>- Linear Regression</li> <li>- Artificial neural Networks</li> <li>- Support vector Machine</li> </ul>	<ul style="list-style-type: none"> <li>- crop prediction is made.</li> <li>- performance metrics of the machine learning algorithms such as root mean square error.</li> </ul>
15	Mayank Champaneri	[17]	- Random Forest Classifier	- Based on the climatic input parameters the present study provided the demonstration of the potential use of data mining techniques in predicting the crop yield based.
16	M Chandrapraba	[18]	<ul style="list-style-type: none"> <li>- Bayes Net</li> <li>- Naive Bayes</li> <li>- SVM</li> <li>- RNN</li> </ul>	- Various algorithms are calculated and their performances are evaluated. The entire algorithm operates well with different factors but when considering error rates as performance measure, recurrent neural network (RNN) works well when compared to other algorithms.
17	Nischitha K	[19]	<ul style="list-style-type: none"> <li>- SVM</li> <li>- Decision Tree</li> </ul>	- To reduce those type of loses we have developed a farmer friendly system with GUI, that will predict which would be the best suitable crop for particular land and this system will also provide information about required nutrients to add up, required seeds for cultivation, expected yield and market price.
18	Pradeepa Bandara	[20]	<ul style="list-style-type: none"> <li>- Naïve Bayes</li> <li>- Support Vector Machine (SVM)</li> <li>- K-Means Clustering</li> <li>- Natural Language</li> </ul>	- Before selecting any plant to grow it is important to have the knowledge and an understanding of the factors that affect the cultivation and how to maintain or control them. From this system, these above mentioned factors are automatically processed and select the

			Processing	crop type to be cultivated.
19	Dr.G.Suresh	[21]	- SVM	- The framework utilizes Supervised Machine Learning Algorithm to suggest appropriate harvests with higher precision and productivity. - The framework records the appropriate harvests dependent on the dirt and leaves it upon the ranchers to settle on the yield to be planted.
20	Sayed Mazhar Ali	[22]	- Regression Analysis	- It is necessary to cultivate the favourable crop according to the environmental and soil parameters to get maximum profit
21	Anguraj.K	[23]	- Random Forest - Naïve Bayes - Gradient Descent	- The inputs are fed to the generated model. The model then predicts and suggests the crops to be sown with an accuracy of about 96.89%.
22	Aman Sinha	[24]	- Decision Tree - Naïve Bayes - Support Vector Machine - Logistic Regression - Random Forest - XGBoost	- can boost the country's production and profit by utilizing this research. In this way, farmers can plant the appropriate crop, enhancing their production and the country's total profitability.
23	Atharva Jadhav	[25]	- Random Forest - Decision Tree - Logistic Regression - XGBoost	- Using machine learning algorithms, we predicted an accuracy of 98% of predicting the right crop to grow and if the farmer adopts to this technology which would not only make his life easier but also help him in making decisions that do not exploit the environment.

### III. CONCLUSION

In recent years, great efforts have been undertaken on the challenging task of predicting crop yield. Developing accurate models for crop yield estimation using Machine learning Technologies may help farmers and other stakeholders improve decision making in relation to national food import/exports and food security. Now-a-days a growing number of applications of machine learning techniques in agriculture are required for which a large amount of data currently available from many resources can be analyzed to find the hidden knowledge. This is an advanced researched field and is expected to grow in the future. The integration of computer science with agriculture helps in forecasting agricultural crops. It is required to build on objective methodology for pre-harvest crop forecasting. Building up a suitable model will have certain merits over the traditional forecasting method. The future work will comes under classification algorithm in data mining technologies.

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