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Review on Crop Yield Prediction using Data Mining Focusing on Groundnut Crop and Naive Bayes Technique

Haresh L. Siju*[1], Pinal J. Patel[2]
*[1] PG Student, Department of Computer Engineering, Government Engineering College Gandhinagar, Gandhinagar, Gujarat, India
[2]Assistant Professor, Department of Computer Engineering, Government Engineering College Gandhinagar, Gandhinagar, Gujarat, India

ABSTRACT

In Indian economy, Agriculture is the most important branch and 70 percentage of rural population livelihood depends on agricultural work. Farming is the one of the important part of Agriculture. Crop yield depends on environment's factors like precipitation, temperature, evapotranspiration, etc. Generally farmers cultivate crop, based on previous experience. But nowadays, the uncertainty increased in environment. So, accurate analysis of historic data of environment parameters should be done for successful farming. To get more harvest, we should also do the analysis of previous cultivation data. The Prediction of crop yield can be done based on historic crop cultivation data and weather data using data mining methods. This paper describes the role of data mining in Agriculture and crop yield prediction. This paper also describes Groundnut crop yield prediction analysis and Naive Bayes Method.

Keywords: Data Mining, Crop Yield Prediction, Naive Bayes Method

I. INTRODUCTION

Data Mining is the discovering of knowledge from large dataset. Data mining operations like classification, prediction, clustering is used in Agriculture for making complex decisions. These techniques are used in crop selection system, crop cultivation planning, seed category recommendation, fertilizer recommendation, soil data analysis, crop yield prediction, pest and disease prediction, Spatial data analysis, time series data analysis, remote sensed data analysis. The main purpose of usage of data mining in agriculture is to increase the yield to get maximum benefit and to decrease the cost of crop cultivation.

17% in GDP of in Indian economy is only dependent on agriculture. Over 58% of household rural population depends on Agriculture work to survive their lives. In Agriculture following sub sectors are livestock, agro-forestry, and fishing, and aquaculture[1].

Crop yield prediction is the forecasting of harvest in Kg per Hectare. Prediction of yield can be done based on historic crop cultivation data and environment data and environment data crop yield can be predicted. To analyse these data various statistical and data mining technique can be used. The accuracy of prediction is important in decision support system. Also correctness and completeness of historic dataset is important for accurate prediction. Crop yield prediction can be used by Government, policy makers, agro-based industries, traders and agriculturists. The Government use crop yield prediction in procurement, distribution, buffer-

stocking, import export, price fixation and marketing of agricultural commodities.

Groundnut is an annual legume primarily grown for high quality edible oil (36 – 54% on dry matter basis) and easily digestible protein (12 – 36%) in its seeds. In India, it is spread over an area of 6.7 million hectare with production of 7.3 million tonnes and productivity of 1155kg per hectare (FAO, 2009)[2].

Naive Bayes method is based on the probabilistic model. It uses Bayes theorem to predict target value class. This theorem derives probability of prediction from observed data. Naive Bayes method is easy to build and useful for large data set.

The organization of this document is as follows. In Section 2 (**Literature Survey)**, the literature review done on Data Mining roles in Agriculture, Crop Yield Prediction, Naive Bayes Method, and Groundnut Crop. In Section 3 (**Conclusion and Future Scope**) conclusion derived based on literature survey.

II. LITERATURE SURVEY

A. Data Mining roles in Agriculture

Following are applications of data mining in agriculture: crop selection system, crop cultivation planning, seed category recommendation, fertilizer recommendation, soil data analysis, crop yield prediction, pest and disease prediction, Spatial data analysis, time series data analysis, remote sensed data analysis. Following description shows literature survey on data mining applications in agriculture.

A study by [3] review the various data mining research related to agriculture for decision making process. This review has been done referencing 115 different research works. Authors described the literature review on four techniques: Artificial Neural Network, Bayesian Network, Association Rule Mining, and Support Vector Machine.

A Soil behaviour analysed using Naïve Bayes and K-Nearest Neighbour and based on analysis crop yield can be predicted. RapidMiner 5.3 used for experiment. Nutrients and Micro Nutrients categorised into different classes like low, medium, high[4].

A study [5] described the application of data mining in agricultural industry. This research work also described following things: data mining methods and techniques, difficulties of applying data mining in agriculture, obstacles faced by data mining in agriculture.

The research work carried out by [6] states applications like acquiring new farmers using K-mean clustering algorithm, retaining the current farmers using association rule mining, crop selection system using classification algorithm like K- Nearest Neighbour, and Correlation between different crops schemes.

Real time application, smart farming using Arduino and Data Mining developed by authors [7]. The model controlled by android application. The system used for automatic plant watering and data mining techniques used for soil analysis and weather analysis. Comparative study was done by [8] of data mining tools. The tools described are Weka, KEEL, R, KNIME, RapidMiner, ORANGE.

Innovative applications can be developed using data mining techniques in Weka. Different classifiers ZeroR, OneR, Naive Bayes, Decision Table, IBk, j48, SMO, LWR, and DecisionStump studied. The boosting and bagging classifier also mentioned in the research work. Clustering and Association rule described in context of Weka. Mushroom grading case study has been done[9].

Soil type classified based on soil data using JRip, Naive Bayes, and J48. JRip performs better than other two classifiers, so it is recommended to predict soil type[10].

The top ten algorithms of data mining described by[11] which can be used for different agricultural applications.

Weather plays import role in agricultural work. Time series data processed collected from six weather stations located at various locations in the southern part of Vancour, Island. Dickey Fuller Test of Stationary statistical technique, ARMA model and ARIMA models used. K – fold cross validation used for time series data[12].

K- Mean clustering algorithm can be used to analyse spatial data for agricultural applications. Temperature and rainfall data is analysed. Association rule mining also implemented to test relation between objects[13]. Different weather factors used to forecast rainfall, these weather factors contains temperature, dew point temperature, humidity, pressure of sea and speed of wind. This study implements the classifiers like Classification and Regression Tree algorithm, Naïve Bayes approach, K- nearest Neighbour and 5-10-1 Pattern Recognition Neural Network for forecasting of rainfall and concludes that pattern recognition gives maximum accuracy[14]. Two applications of agriculture is reviewed in study [15]. Greenhouse gas emission from agricultural production of EU countries assessed and prognosticated using DEA window analysis and artificial neural network[16].

A study by [17] analyses the land use change in a periurban area in Northern Italy. This research implements models artificial neural network as weighted approach and spatial correlation as clustering method. Artificial Neural Network and Multiple Linear Regression Model used for prediction of CO_2 emission from farm inputs in Wheat production[18]. Data mining also used in Decision Support System for Agro technology transfer(DSSAT) model, DSSAT model described in detail by [19].

A recent study by [20] has implemented an experimental analysis for prediction of Indian natural rubber price with better accuracy and minimum error. This study also described different approaches like ARIMA(Auto-Regressive Integrated Moving Average) Model, GARCH(Generalized Autoregressive Conditional Heteroskedasticity) Model, Naive Bayes Approach, Wavelet Approach, Support Vector Regression Model, Back Propagation Neural Network(BPNN) Approach, Support Vector Machine Approach, ANFIS(Adaptive Neural Fuzzy Inference System) approach, K- Nearest Neighbour approach, Random Forest approach.

B. Crop Yield Prediction

This section describes the literature survey on crop yield prediction only. The Decision support system proposed by [21] for rice crop yield prediction. Study area was Maharashtra State, India. Association Rule Mining applied for prediction and DSS Model GUI created in NetBeans using Java as programming language and Microsoft Access as Database or Backend.

The different data mining algorithms described in context of crop yield predictions. Following algorithms were studied in research work: Decision Tree, J48, Naïve Bayes, Simple Cart, and SVM. Among these algorithms three algorithms (J48, Naïve Bayes, Simple Cart) used in experiment into the Weka tool. Authors also used 10-fold cross validation procedure. Based on comparison of three algorithms J48 algorithm gives better prediction[22].

J48, LADTree, IBk, and LWL classifiers implemented for rice crop yield prediction of tropical wet and dry climate zone of India. Experiment was done in Weka tool. J48 and LADTree give highest accuracy, specificity, and sensitivity[23].

A study by [24] described short literature review on crop yield prediction and agricultural crop yield prediction done using Multiple Linear Regression and Density based clustering technique. Based on

comparison MLR gives less error than Density based clustering method.

The research work [25] implemented the Artificial Neural network for prediction of rice crop yield in Maharashtra State, India. For training and testing the ANN, 10-fold cross validation method was used to subset the data. The algorithm achieved the accuracy of 97.54%, sensitivity of 96.33% and specificity of 98.12%.

A study [26] described literature review in tabular form. Some research study only summarized the data mining techniques for crop yield prediction, the research study [27] does same. The techniques include Naïve Bayes, J48, Random Forest, Artificial Neural network and decision tree and support vector machine.

Rice crop yield predicted using support vector machine. Different performance measures have been evaluated[28]. Different data mining techniques applied to predict rice crop yield in Humid subtropical climate zone of India. A recent study [29] implemented the Multiple Linear Regression, Adaptive Boosting(Adaboost), Support vector machine , and Modified Nonlinear regression for rice yield prediction.

Sugarcane yield predicted using Random Forest Algorithm in study [30]. The research carried out on data of different districts of Bangladesh to predict yield of crops like Boro, Amon, Aus, Potato, and Wheat. K- Mean Clustering, K – Nearest Neighbour, Linear Regression and Neural Network techniques used for yield prediction. ANN provides better prediction for some of the crops, which have more missing values than others, for example wheat, potato and Aus. Linear regression provide better performance of predicting boro and amon[31].

Rice crop yield predicted using regression analysis, experiment implemented in MATLAB tool. Yield predicted from Annual Rainfall, Area under Cultivation, and Food Price Index. Relationship established between AR, AUC and FPI[32]. A study by [33] implemented C 4.5 Algorithm to predict yield of crops like paddy, maize, wheat, soybean. Interactive web pages developed for crop yield prediction. Accuracy is highest in case of Soybean.

K- Mean, K-Nearest Neighbour, Artificial Neural Network applications described for crop yield prediction in the study[34], and architecture for crop yield prediction proposed in research work. Season wise analysis, Trend Line, and Clustering based on Productivity used for quantifying yield gap of rice production in various regions of Karnataka[35].

One of the study carried out to compare two machine learning algorithms Boosted Regression Tree (BRT) and Support Vector Machine (SVM) to predict winter wheat yield. The models constructed of Normalized Different Vegetation Indices (NDVI) derived from low resolution SPOT VEGETATION imagery. Remote sensed data used for analysis[36].
Support Vector Machine, Random Forest, Neural Network, REPTree, Bagging, Bayes algorithm described in the study [37]. These classifiers used for Soybean Crop Yield Prediction and results are compared. Bagging algorithm gives maximum accuracy for soybean crop yield prediction among REPTree, Random Forest, Neural Network, SMO classifiers.

A study [38] used spatial data of Oakes Irrigation Test Area research site of North Dakota, USA to predict corn crop yield using neural network techniques. The model constructed using Multiple Linear Regression method to predict tea crop yield against climate change in Assam, India[39]. A Decision Support System Framework proposed for prediction of Wheat crop yield of western Australian[40]. In this study Association rule mining applied on the rainfall, yield and soil type.

C. Naive Bayes Technique

Rice crop yield predicted using BayesNet and NaiveBayes Classifiers in the research work[41].In this research work model constructed in Weka. BayesNet gives more accuracy, specificity, and sensitivity than NaiveBayes.

Naive Bayes, K Nearest Neighbour, and Decision Tree algorithms performance has been compared to construct Energy Simulation Tool. Naive Bayes technique gives better performance than other techniques in this study[42].

Bayesian modelling used for wheat crop yield prediction using small dataset[43]. A study also identified drought related agronomic factors that significantly affect the variation in the rain fed wheat yield and relative importance of these factors. One of the studies compared the performance of naive Bayesian Classifier and C4.5 Decision Tree Classifier in classifying engineering material dataset, the study shows that naive Bayesian classifier gives better accuracy than C4.5 DTC[44].

New performance measure AUC proposed in the study and then comparison of Naive Bayes, Decision tree, and SVM done[45]. This study analysed 18 datasets collected from UCI repository. Comparison result shows that Naive Bayes gives slight higher accuracy in terms of AUC than C4.4, C4.5 classifiers of Decision Tree and SVM.

Agricultural land soil has been classified using Naive Bayes technique. Research study performed in Andhra Pradesh, India[46]. A study [47] proposed new modified naive Bayes method by using L1 penalty for reducing redundant predictors for tomato crop yield prediction weekly. And proposed method gives more accuracy than old one. Classification techniques can be improved by combining K-Nearest Neighbour and Random forest with Naive Bayes classifier. The NB+RF has given best result. The detailed study given in the research work [48]. A recent study by [49] made survey of Bayesian network applications in agriculture.

D. Groundnut Crop Yield prediction

Groundnut is called as the king of oilseeds. It is one of the most important food and cash crop in India. A study by [50] research made survey of area, production, and productivity of Groundnut crop at India level, state level(Andhra Pradesh), and district level(Anantapuram) from 1996-2000 to 2001-2008.

Crop yield-weather model has been developed for Groundnut crop yield forecasting using correlation analysis and multiple linear regressions. Weather factors observed during stage of 50 percent flowering of crop[51]. Correlation analysis and regression analysis used to develop crop management system[52].In this study Principal component analysis also described.

Groundnut crop growth and yield can be predicted using dynamic simulation model 'PNUTGRO' under Punjab condition[53].

Batchelor & Wilkins, DBSCAN, AGNES, Multiple Linear Regressions used to forecast of yield of major crops cultivated in different districts of Karnataka[54]. Cotton, Groundnut, Jowar, Rice and Wheat considered as major crops in Karnataka.
Partition Around Medoid(PAM), Cluster Large Applications(CLARA), and DBSCAN described in the study[55].Multiple Linear Regression used to forecast the groundnut crop yield and also in this study new modified approach of DBSCAN proposed.

III. CONCLUSION AND FUTURE SCOPE

In this paper a review of different data mining applications in agriculture has been discussed. First, different data mining roles in Agriculture has been described, then literature related to Crop yield prediction has been reviewed. Literature reviewed on Naive Bayes technique implemented for different applications. Then review of research works for

Groundnut crop yield prediction has also been discussed. This survey presents different data mining techniques which has been implemented on groundnut crop. This survey concludes that the more accurate groundnut crop yield prediction model can be constructed by using different data mining techniques.

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