Asian Journal *of* Distance Education
http://www.AsianJDE.org

ISSN 1347-9008 Asian J D E 2017 vol 12, no 1, pp 69 - 78

Development of an Artificial Intelligence based Agriculture Distance Education Model for Prediction of Crop Price and Yield Levels in India

R.MADHUMATHI
Department of Computer Science and Engineering, Sri Ramakrishna Engineering College, Coimbatore, India
madhumathi.r@srec.ac.in

ABSTRACT :

Agriculture is the source of food and is indisputably the prime reason for the survival of the beings in the earth planet. With the surging population of people, there is a need for guaranteeing precision-centric, informed and optimized agriculture. It is all about generating quality, fresh and edible food in large quantities in order to feed the growing number of human beings. The role of information technology (IT) is therefore bound to escalate in the days to come towards intelligent agriculture. Newer trends and technologies are emerging and evolving fast. These bring forth a variety of transitions. With Smartphone's, wearable's, and IoT devices, the learning can happen everywhere all the time. Agriculturists and horticulturists ought to be knowledge-driven in their pursuits and passions in order to be hugely successful. Ubiquitous learning is, therefore, defined as an all-day learning environment supported by a bevy of edge technologies and tools. It is enriched with the Internet, which is emerging as the world's largest information superhighway. In this paper, we formulate a method for enabling ubiquitous learning for farmers to get the best price for their crops, to predict the crop yields, and to get other relevant information to attain the phenomenal success in their occupations. We have built and hosted a cloud application through which our farmers can easily get to know all the right and relevant details in order to plan and execute the farming in a clear and confident fashion.

Keywords: Open and Distance Education, crop yield and price prediction, Intelligent Agriculture, Machine and Deep Learning Algorithms, Artificial Intelligence, Prescriptive Analytics, Cloud Computing.

1. INTRODUCTION:

Agriculture is experiencing a transition driven by the population pressure and the climate changes. The world is tending towards the era of "more with less". That is, with less resources and assets, the goal is to produce more. Resource utilization has to be increased in order to produce more. Technologies need to be used in smart ways in order to increment food production.

The various advancements in the IT field need to be channelized accordingly and adeptly in order to move towards intelligent farming. The sustainability goal has to be also achieved through the splurge of competent technologies. The emergence of digitization technologies such as cloud computing, real-time analytics of big data, the IoT paradigm, machine learning algorithms, and prescriptive analytics

is a good omen for the agriculture industry.

In 20th century, the rise and use of open and distance learning (ODL) is very much popular (Sharma, 2010). This cost effective tool is used to reach the ample in imparting the required skills and technical proficiency. The successful implementation of the ODL programmes in agriculture, bridge the gap between demand and supply with the help of modern technologies. A lot of agriculture, horticulture and sericulture data gets created, collected, cleansed, crunched in order to emit out usable information in time. There are several input and output devices, handhelds, smartphone's, wearable's, etc. in order to access and get a lot of useful information to take decisions and plunge into actions with all the clarity and confidence. The cloud storage can stock a massive amount of raw as well as processed data. The ubiquitous access and usage of stocked data in cheap cloud storage appliances and arrays empowers the agriculture vertical to march forward.

The Internet, being the worldwide, public, open and inexpensive communication infrastructure, comes as a blessing and boost for farmers in retrieving correct information to chalk out workable strategy towards informed and intelligent agriculture. A number of distinct optimizations, disruptions, innovations and transformation are being achieved in the agriculture domain through the smart leverage of a variety of pioneering and path-breaking technologies. With the application of highly acclaimed and accomplished sensing, transmission, vision, perception, knowledge discovery and dissemination, decision-enablement, and actuation technologies, the agriculture sector is bound to see numerous improvements in the days to unfold.

2. AGRICULTUREDISTANCE EDUCATION

Highly impacting information content and knowledge are being elegantly shared across through different channels these days. Especially agriculture education happens in distant mode. Books are being sent to distant learners. With the Internet emerging as the public, open and affordable communication infrastructure, desktop, tablets, personal digital assistants, smartphone's and other nomadic I/O devices are being leveraged widely and wisely in order to get adequately and adroitly informed. The impact of agricultural education through distance mode will soon be paramount in the development of new breeds of entrepreneurs. This will lead to increased employment opportunities, higher earnings and better work environment. This will help to ensure poverty alleviation goals besides enhancing the livelihood security and sustainable productivity to change the quality of life, especially in rural areas. This paper has described the machine learning algorithms to extricate actionable insights in time and share them through electronic learning methods to farmers to assist them in their obligations.

3. LITERATURE REVIEW

A modern way of learning is E-learning and it makes use of information and communication technology (ICT). Mathur & Jha (2015) addressed e-learning is one of the popular tools in the field like medical, agriculture, and healthcare. It involves different types of media that provide video, audio, images and text. Particularly, e-agriculture involves the conceptualization, design, development, analysis and application of innovative ways in which ICT is used within the rural domain, with a primary specialize in agriculture. Agarwal & Kumar (2013) addressed e-agriculture is one of the new technology that is going to alter and evolves the understanding of the realm grows.

Subrahmanyam & Ravichandran (2013)and Sharma (2001) focused on the current state of distance education methodology and explained about the

effective usage of online distance education methodology rather than conventional methods. This work also explains the different approaches and tools used for online education leaning model. Hansra & Jain (2012) have presented the advantages of open and distance learning. IGNOU learning materials are supported by the several ICTs based tools like TV, radio, audio-video programmes, teleconferencing, interactive radio counselling, etc. (Sharma & Mishra, 2010). McLean, Gasperini, & Rudgard(2002) describe the challenges of food security and rural development around the world.

Kundu (2014) deals with the advantages, limitations and suggestions to overcome the problems faced by open and distance learning in India. With the help of ODL system, Central Open University of India, IGNOU is enrolling 7000 students per year from 36 countries around the world. Mundi & Tenebe (2013) examines the importance of expanding the activities of informal sector to reduce unemployment. Tothova & Hennyeyova (2002) explained the methodology for creating teaching materials for distance learning. Santhy, Jothi & Valluvaparidasan (2010) addressed the role Tamil Nadu Agricultural University (TNAU), Coimbatore, Tamil Nadu, India committed for the development of agricultural education. They also explained the benefits of various sectors of the farming community through its certificate courses which are skill oriented. Irani, Scherler, Harrington &Telg(2013) done an through study on how demographic, personality and course perception issues are related to distance learners' perceptions and performance outcomes and also determined the significant differences in performance and perceptions for on and off campus students.

Kalyani (2012) discussed about the knowledge discovery process and the basics of various data mining techniques such as association rules, classification, clustering, prediction and sequential patterns. Grajales, Mosquera, Mejia, Piedrahita & Basurto(2015) have proposed a web application that utilizes open dataset like historical production, land cover, local climate conditions and integrates them to provide easy access to the farmers. This proposed architecture mainly focuses on open source tools for the development of the application. The user can select location from map for which the details are available at one click.

Bendre & Thool(2015) collects data from GIS (Global Information System), GPS (Global Positioning System), VRT (Variable Rate Fertilizer) and RS (Remote sensing) and are manipulated using Map Reduce algorithm and linear regression algorithm to forecast the weather data that can be used in precision agriculture.The purpose of this study was to investigate the effective model to improve the accuracy of rainfall forecasting. Hemageetha (2016) mainly focused the soil parameters like pH, Nitrogen, moisture etc. for crop yield prediction. Naive Bayes algorithm is used to classify the soil and a77% accuracy is achieved.Rub (2009) presents a comparative study on the regression models that could be used for predicting yield. The algorithms discussed are Multilayer perception Model (MLP), Regtree (Regression tree), RBF (Radial Basis Function Network) and SVM (Support Vector Machine). They have concluded that SVM serves as a better model as far as yield prediction is concerned. Ankalaki, Chandra & Majumdar(2016) used Multiple Linear Regression (MLR) technique to the forecast crop yield.

Kushwaha & Chrya(2015)predicts the suitability of a crop for a particular climatic condition and the possibilities of improving the crops quality by using weather and disease related data sets. They have proposed an analysis, classification and prediction algorithm that helps in building a decision support system for precision farming using cloud based learning. Fathima & Geetha (2014) used data mining technique called k-means clustering algorithm to cluster the farmers based on the crop type and irrigation

parameters on real time data using knowledge based learning system. This work generally focuses on the policies that government could frame by the cropping practices of farmers.

Sellam & Poovammal (2016) explained the various environmental parameters like the area under cultivation, annual rainfall and food price index that influences the yield of crop and the relationship among these parameters is established. Kaur, Gulati & Kundra (2014) analyzed a suitable model that helps in achieving high accuracy for price prediction. The market price of tomato data are collected and price is predicted using BP neural network and the results were demonstrated. Gayatri, Jayaskthi & Mala (2015) uses IoT and web services to handle large amount of data. Sensors are used to collect the data and this data is passed to the data centre using cloud.

4. PROBLEM IDENTIFICATION

The world's population will increase day by day. Much of this growth will happen in developing countries like India, which has the largest area in the world with arable land for agriculture. Global food production must increase their productivity by 70 percent in order to be able to feed the world. To keep up with rising populations and income growth, Traditional method of agriculture is practiced by performing a particular task, such as planting and harvesting, against a predetermined schedule. Predictive analytics can be used to make smarter decisions, by collecting real-time data on weather, soil and air quality, crop maturity and even equipment and labor costs and availability, predictive analytics can be used to make smarter decisions. A method for enabling ubiquitous learning is also necessary for farmers to get the best price for their crops, to predict the crop yields, and to get other relevant information for their occupations. . In this paper we discuss the development of an Artificial Intelligence based Agriculture Distance Education Model for prediction of crop and yield levels in India

5. PROPOSED SYSTEM

This proposed model is developed as a web application with PHP, HTML, and CSS serving in the front end and MySQL database is working as the backend. The data mining and machine learning algorithms are implemented and provided free by many integrated development platforms. RStudio is one such open source IDE for R programming language aiding to perform modern statistics with computing tools. Fig. 1 illustrates the architecture of the proposed system. This is a cloud application that can run in any private and public cloud environments. In the next version, this can be containerized using the open source Docker platform. Also, each of the participating and contributing components are to be made a micro service that can be automatically containerized and deposited in public as well as private Docker hub in order to easily found and used to compose process-aware and business-critical applications.

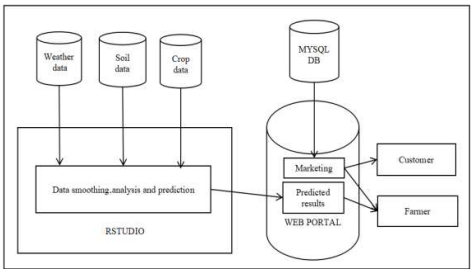

Fig. 1. Architecture of proposed system

The weather data, yield data and crop data are being loaded in RStudio database. In RStudio, the gathered data is pre-processed and prediction is done using the below-mentioned algorithms and formulae. The predicted outputs are loaded into the MySQL database in order to be accessed using the web portal. The marketing process is also done in the web portal. This web portal is made accessible for the farmers and customers freely in order to understand the latest status and accordingly they can take decisions and actions.

A. Algorithm 1: Arima (Auto Regression Integrated Moving Average)

This is one of the popular stochastic modeling approaches that can be used to calculate the probability of a future value and used for yield forecasting. The data flow diagram for ARIMA algorithm is shown in fig. 2.

1. Choose a dataset to be forecasted and plot the data against time.
2. Analyze the plot to see if it is stationary with time.
3. If necessary, difference the data until it appears stationary.
4. Plot Auto Correlation Factor (ACF) and Partial Auto Correlation Factor (PACF) of the differenced data and estimate possible model parameters.
5. Calculate AIC values for all model parameters to search for better model.
6. Plot the residual of the model parameters obtained to verify that no lag occurs for them.
7. If lag occurs in residual plot, try another estimated model parameters until we get a good residual plot.
8. Once a good residual is obtained, calculate forecast.

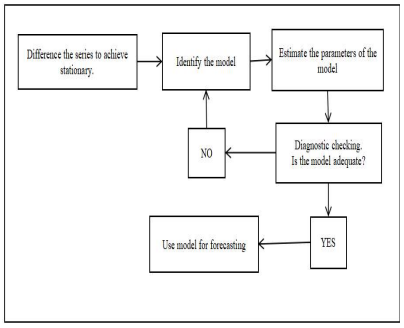

Fig. 2. Data Flow Diagram for ARIMA Algorithm

B. Algorithm 2: Seasonal ARIMA

This algorithm is used to forecast the price of the crops.

1. Choose a dataset to be forecasted and plot the data against time.
2. Analyze the plot to see if it is stationary with time.
3. If necessary, difference the data until it appears stationary.
4. Plot Auto Correlation Factor (ACF) and Partial Auto Correlation Factor
5. (PACF) of the differenced data and estimate possible model parameters.
6. Calculate AIC values for all model parameters to search for better model.
7. Plot the residual of the model parameters obtained to verify that no lag occurs for them.
8. If lag occurs in residual plot, try another estimated model parameters until we get a good residual plot.
9. Also include the seasonal and non-seasonal part.

Once a good residual is obtained, calculate forecast.

C. Algorithm 3: MLR (Multiple Linear Regression Algorithm)

This algorithm is used to predict the yield of each crop based on parameters such as temperature, Rainfall, etc. Multiple Regression simultaneously considers the influence of multiple explanatory variables on a single response variable. The intent is to look at the effect of each variable on the response variable.X1, X2,..,Xn are independent variables and Y is a dependent variable. The multiple linear regression fits the dataset to the model:

$$Y = a + b1x1 + b2x2 + \cdots + bnxn$$

Where,

a = y-intercept

b1, b2,…,bp = partial coefficients.

Here the response variable y is the yield and the explanatory variables are the factors that influence yield like temperature and rainfall.

6. EXPERIMENTAL RESULTS

We have fed the collected data into the above-mentioned algorithms and the results are vividly depicted through the charts, maps, and graphs. The price prediction results are given below. Fig. 3 depicts the consolidated outputs of price of certain crops from the year 2017 to 2020 using seasonal ARIMA algorithm.

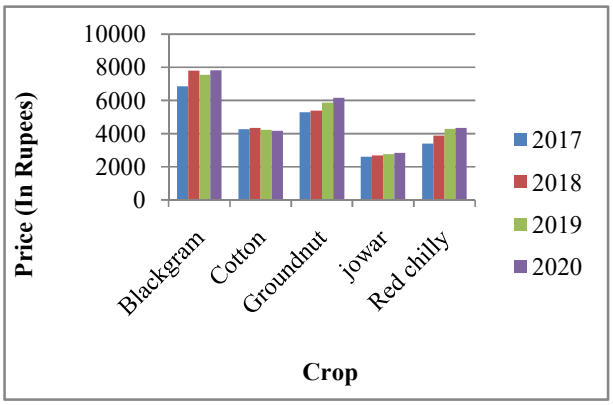

Fig 3. Price Forecast

The regression formula derived for individual crop using MLR is listed in the Table 1.

Crop	Regression formula
Paddy	Yield=3120.568+(12.70*T)+(1.188*R)
Cumbu	Yield=2427.5189+(-23.7308*T)+(0.8182*R)
Gingelly	Yield=618.3240+(-1.9783*T)+(0.2678*R)
Groundnut	Yield=2771.974+(-9.051*T)+(0.465*R)
Maize	Yield=1177.3990+(-1.5960*T)+(0.5245*R)
Ragi	Yield=2430.026+(2.571*T)+(1.134*R)

Table 1. Multiple Linear Regression equation for crop wise yields

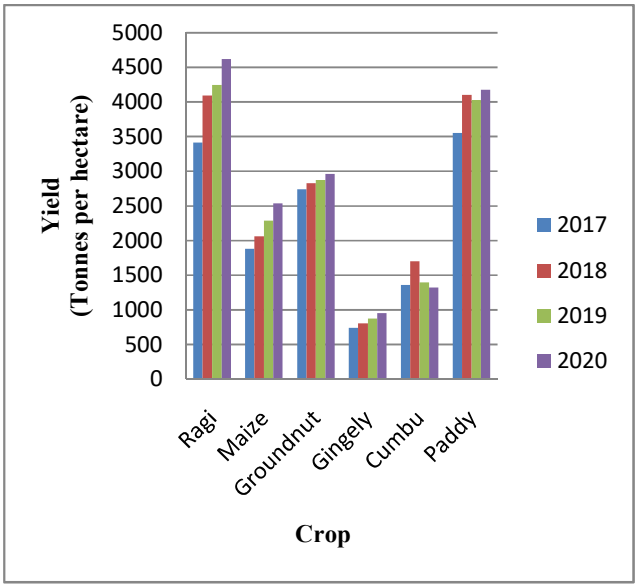

Fig 4. Yield Forecast Results

Fig. 4 depicts the consolidated outputs of yield of certain crops from the year 2017 to 2020 using the ARIMA algorithm.

7. ARTIFICIAL INTELLIGENCE BASED AGRICULTURE DISTANCE EDUCATION MODEL

The information and communication technology provides solutions to make farming more efficient rather than tradition methods. With the advancement of Artificial Intelligence and Cloud technology we can see farming today at any place from anywhere, farmers can make more with less resources and time to market is also possible. Bagchi (2000) discussed the change in the agriculture landscape with AI, the application of drone-based image processing techniques, precision farming landscape, the future of agriculture and the challenges ahead. Verma, Pabbi & Jat (2016) introduced the latest technology like expert system for leaf disease detection and diagnosis, to integrate diagnostic expert system with image processing and providing agricultural expert system with databases and multimedia to solve the problems faced by the farmers. These methods can be learnt and accessed by almost anyone and requires only internet and computers. Hence, by using Cloud services, the users can learn about these methods and it can in turn be incorporatedto help improve productivity, thereby increasing yields.

8. CONCLUSION

Having leveraged the proven Artificial Intelligence (AI) algorithms and approaches, we could accurately do crop quantity prediction and the best price for crops. These insights uncovered through the leverage of powerful machine learning (ML) algorithms and are being supplied to farmers to contemplate futuristic actions. Also, corrective measures can be considered and implemented by farmers in order to enhance the crop yields in the subsequent cultivation season.Thus, an AI and IoT-based data collection and crunching promises to bring forth a variety of innovations, disruptions and transformations for various industry verticals. Especially the agriculture sector is to get benefited immensely. We visualize to coming out with a new ubiquitous learning framework in order to empower our farmers to do precision-centric farming. All the insights getting extricated can be messaged across so that the farmers can study, learn and understand in order to do better in their occupations and obligations. The framework involves an intuitive and informative mobile application to capture and convey what is needed to identified groups and authorized farmers.

On concluding, the next-generation learning gets emboldened through the leverage of pioneering technologies and tools. In this paper, we have inscribed how the various digital and edge technologies cooperate with one another in extracting useful and usable information and how they are being shared across in time in order to enable our farmers with all the right and relevant knowledge in order to do a good job in their works. The proposed learning framework will open up other researchers to come out with advanced capabilities to make the life of farmers easy and elegant.

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R. MADHUMATHI is an Assistant Professor (Selection Grade), Department of Computer Science & Engineering Sri Ramakrishna Engineering College, Coimbatore, Tamil Nadu, India. She obtained her PhD degree awarded by Anna University, Chennai in the year 2016, Master of Engineering in Software Engineering at Sri Ramakrishna Engineering College, Coimbatore in the year 2009 and Bachelor of Engineering in Computer Science & Engineering at Jayam College of Engineering & Technology, Dharmapuri in the year 2002. She has 10 years of academic experience and 6 years of research experience. She has published papers in International Journals, International and national Conferences. Her area of specialization is Cloud Computing, Data Analytics and Artificial Intelligence. She is a member of IEEE Women in Engineering, life member in ISTE and CSI. Her Email address is E mail : madhumathi.r@srec.ac.in