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Abstract: —Agriculture is that the mainstay of a rising economy in India. Traditionally farmers followed ancestral farming patterns and norms. However, one farmer can't be expected to require under consideration all innumerable factors that contribute to crop growth. One misguided or imprudent decision by the farmer can have undesirable ramifications. With the advancements in various domains, an intelligent agricultural system is needed for the upliftment of the Indian economy. The collaboration of the recommender system with machine-learning will lead to an Intelligent Agriculture System that helps the farmer community in their decision making of farm management and agribusiness activities such as crop disease prediction, weather forecasting, etc. It also helps a farmer to perform the activities like crop management including applications on disease prediction, fertilizers recommendation, crop quality, and growth prediction, etc. The study includes identification of crop condition, disease detection, prediction about the specific crop, and recommendation using machine learning algorithms. It gives an idea about how the recommender system is used in agriculture for disease detection and prediction.

***Keywords**: Agriculture; machine learning; recommender system; disease detection; Classification Rule; K-Nearest Neighbor (kNN); Density based clustering; IOT; etc.*

I. INTRODUCTION

Recently, agriculture is the fundamental source of food industry. It is one of the oldest and most important economic activities which is being practiced in the world wide since thousands of years. Its development has taken over the period of many years with the emergence of new technology, equipment, techniques of farming and domestication. Huge advancement and growth can be seen in this sector with the time period. This sector, not only witnessed the enormous growth but also gave rise to many other sectors with significant progress. Majority of the people are being involved in this occupation as it is the basic need of human beings' survival. More than 50% of the land in the world has been devoted to agriculture. Agriculture sector accounts for 14% of Gross Domestic Product (GDP) of the Indian economy. About 70% of the population of India lives in rural areas and majority of them depend upon agriculture as their primary source of income. Agriculture not only helps people to survive but keeps economy on-going. It plays vital role in the economic development of India. Government of India has shown concern about the improvement of cultivator's knowledge of the soil,

improvement of the fertility of the soil, irrigation facilities, fertilizer utilization, cattle-manure utilization, precise pesticides usage and grazing in forest area. Thus, productivity has to be increased with the increase in population.

In agriculture planning to obtain maximum crop yield with restricted area of land is the largest task in an agro-based country like India. Yield rate of the crop can be increased with the help of indicators by investigating crop related problems. Crop selection will be more accurate and beneficial with minimum loss, whether unfavourable condition occurs. Maximum crop yield can be obtained in favourable growing condition. Improving production rate of crop can be an important topic for research for the agro-meteorologists, for the development of economic growth of the country. The two main factors responsible for the yield rate of the crop is, first one is quality of seeds which can be improved by genetic development using hybridization technology and second one is the selection of crop based on the favourable and unfavourable conditions. The two techniques: statistical and machine learning both these techniques models. Many researchers had been tried to get an efficient and accurate model for crop yielding prediction, soil classification, crop classification, weather predictions, crop disease pre-diction classification of crops.

Crop disease prediction is the art of predicting crop yields and production before the harvest actually takes place, typically a couple of months in advance. Crop forecasting relies on computer programs that describe the plant environment interactions in quantitative terms. Data Mining is a process of extracting hidden information from a database and transforms it into an understandable structure for further use. It is the computational process of discovering patterns in large data sets involving methods at the intersection of artificial intelligence, machine learning, statistics, and database systems. The ultimate goal of data mining is prediction - and predictive data mining is the most common type of data mining and one that has the most direct business applications. Throughout the years, many algorithms were created to extract knowledge from large sets of data. There are several different methodologies to approach this problem: classification, association rule, clustering, etc. Here we will focus on classification methodology. Classification techniques are designed for classifying unknown samples using information provided by a set of classified samples.

II. LITERATURE SURVEY

Kelkar, S. et al (2021, May) [1] Artificial Intelligence in agriculture has brought a major agricultural revolution. In this study, we have worked on disease detection and crop recommendation system. For disease detection, we have implemented the Deep Convolutional Neural Network (CNN) models i.e., Sequential and VGG-16. In the proposed model we detect whether the crops are infected or not, and if they are further particular disease is identified according to the crop.

Sangeeta and Shruthi G (2020) [2], proposed suitable explanation behind the deficiency of adequate decision making by farmers on yield prediction. There isn't any framework in location to suggest farmer what plants to grow. The proposed machine learning approach aims at predicting the best yielded crop for a particular region by analyzing various atmospheric factors like rainfall, temperature, humidity etc., and land factors like soil pH, soil type including past records of crops grown. Finally, the system is expected to predict the best yield based on dataset collected.

J. Manjarrez-Sanchez (2020) [3], proposed several descriptors of a variety of images, the challenge is their suitability to solve these tasks efficiently. One proposal is the set of standard MPEG-7 visual descriptors. It addresses their suitability to efficiently describe plagues and diseases in images of maize plants. The importance of this crop is its worldwide relevance for human and animal consumption.

N Gobalakrishnan et al (2020, July) [4], proposed such techniques in the form of a survey that had been carried out comprehensively covering various image-based plant leaf diseases. There are huge accumulated losses due to such diseases that bring down the productivity and increase the economic losses in the agricultural industry. As part of technological innovation, researchers had been applying the image processing techniques for monitoring as well as diagnosing the plant diseases in its various stages. Appropriate machine learning algorithms are being designed and applied for precisely identifying the various infections on plants throughout its life cycle and the type of treatment that can be afforded for overcoming loss.

Farooq, M.S. et al (2020) [5], proposed the systematic study of the collection of all relevant research on IoT agricultural applications, sensors/devices, communication protocols, and network types. Furthermore, it also discusses the main issues and challenges that are being investigated in the field of agriculture. Moreover, an IoT agriculture framework has been presented that contextualizes the representation of a wide range of current solutions in the field of agriculture. Similarly, country policies for IoT-based agriculture have also been presented. Lastly, open issues and challenges have been presented to provide the researchers promising future directions in the domain of IoT agriculture.

Gray, R. S. (2020) [6], proposed the widespread consumer adoption of physical distancing measures has vastly increased the demand for retail food pickup and delivery services to the point where these services are being rationed by long wait times. From a policy perspective, there is an apparent need for (a) continued supply chain monitoring and industry engagement, (b) the proactive development of strategies to deal with absenteeism and other potential threats to the supply chain, and (c) an assessment of the economic and health merits of providing additional public resources to provide greater access to grocery pickup and delivery services.

A. Jenifa, Dr. R. Ramalakshmi and V. Ramachandran (2019, April) [7], proposed Multi-Support Vector Machine based classification for cotton leaf disease is proposed. Algorithm uses automatic snaps of the crops at every stage, process them at very early stages to determine their flaws, so that the farmer's loss both in terms of money and goods to be hence avoided. The Image processing is been implemented to get the capture of leaves at significant stages. This Multi-SVM when compared over the Convolutional Neural Networks has several advantages. While the Multi-SVM is global and unique, the Convolutional neural network suffers from multiple local minima. The complexity of computation of multi-SVM does not depend on the dimensions of the input space while the Convolutional Neural Networks does.

Kumar, A., Sarkar, S., and Pradhan, C. (2019, April) [8], proposed the best suitable crop to the farmer and detect the pest that may affect as well as suggest the pest control techniques and applied SVM classification algorithm, Decision Tree algorithm and Logistic Regression algorithm and found that SVM classification model gives the

better accuracy as compared to other algorithms.

S. M. Jaisakthi et al (2019, February) [9], proposed an automatic system for detecting the diseases in the grape vines using image processing and machine learning technique. The system segments the leaf (Region of Interest) from the background image using grab cut segmentation method. From the segmented leaf part, the diseased region is further segmented based on two different methods such as global thresholding and using semi- supervised technique. The features are extracted from the segmented diseased part and it has been classified as healthy, rot, esca, and leaf blight using different machine learning techniques such as Support Vector Machine (SVM), adaboost and Random Forest tree.

C. Khitthuk et al (2018, March) [10], proposed the plant leaf disease diagnosis system from color imagery using unsupervised neural network. Images are processed using both color and texture features. The system is mainly composed of two processes: disease feature extraction and disease classification. The process of disease feature extraction analyzes feature appearance using statistic-based gray-level co-occurrence matrix and texture feature equations. The disease classification process deploys the unsupervised simplified fuzzy ARTMAP neural network to categorize types of disease. Four types of grape leaf disease images are used to test the system's classification performance which is rust, scab, downy mildew and no disease.

Bannerjee, G et al (2018) [11], proposed field of artificial intelligence with its rigorous learning capabilities have become a key technique for solving different agriculture related problems. Systems are being developed to assist the agricultural experts for better solutions throughout the world. The paper addresses the application of artificial intelligent techniques in the major subdomain of agriculture so that the readers are able to capture the multidimensional development of agro-intelligent systems during last 34 years, from 1983 to 2017.

N. Krithika and A. G. Selvarani (2017, March) [12], proposed the classification of grape leaf diseases along with the leaf identification. The leaf skeletons are identified based on grape images. Since, the leaf skeletons are used for estimating the positions and directions of the leaves. The Tangential Direction (TD) based segmentation algorithm is proposed for retrieval of skeletons. If the grape leaf images are classified, then the histograms of H and a color channel are generated and the pixels values are observed to distinguish the healthy and diseased tissues. Then, extract the features and classify by using the KNN classification algorithm in order to find the leaf diseases.

Gillespie, S., and van den Bold, M. (2017) [13], proposed the theory and recent qualitative evidence (particularly from 2010 to 2016) in the public health and nutrition literature, on the role that agriculture plays in improving nutrition, how food systems are changing rapidly due to globalization, trade liberalization, and urbanization, and the implications this has for nutrition globally. The paper ends by summarizing recommendations that emerge from this research related to (i) knowledge, evidence, and communications, (ii) politics, governance, and policy, and (iii) capacity, leadership, and financing.

Warne, P. P and Ganorkar, S. R. (2015) [14], proposed an approach for careful detection of diseases, diagnosis and timely handling to prevent the crops from heavy losses. Initially preprocessing the input image using histogram equalization is applied to increase the contrast in low contrast image, K-means clustering algorithm is used for segmentation which classifies objects based on a set of features into K number of classes and finally classification is performed using Neural-network. Thus, image processing technique is used for detecting diseases on cotton leaves early and accurately. It is used to analyze the cotton diseases which will be useful to farmers.

Vishnu S and A. Ranjith Ram (2015) [15], proposed the various methodologies for plant disease detection. So, they presented fast, automatic, cheap and accurate image processing-based solution. Solution is composed of four main phases; in the first phase they created a color transformation structure for the RGB leaf image and then, they applied color space transformation for the color transformation structure. Next, in the second phase, the images are segmented using the K-means clustering technique. In the third phase, they calculated the texture features for the segmented infected objects. Finally, in the fourth phase the extracted features are passed through a pre-trained neural network.

Manikrao, N. D and Vyavahare, A. J. (2015) [16], proposed that due to diseases on cotton there may be chances of decrease in production and drastic change is occurred on crop. The fungal diseases like Verticilium Wilt, Bacterial blight, red spot, *Alternaria*, Downy Mildew are responsible for production loss. So, the paper presents various types of diseases and control on it using image processing technique. The comparative study of artificial neural network, Support vector machine is discussed.

Paul, M, Vishwakarma, S. K and Verma, A. (2015, December) [17], proposed that yield prediction is very popular among farmers these days, which particularly contributes to the proper selection of crops for sowing. The work presents a system, which uses data mining techniques in order to predict the category of the analyzed soil datasets. The category, thus predicted will indicate the yielding of crops. The problem of predicting the crop yield is formalized as a classification rule, where Naive Bayes and K-Nearest Neighbor methods are used.

Rothe, P. R and Kshirsagar, R. V. (2015, January) [18], proposed a work that presents a pattern recognition system for identification and classification of three cotton leaf diseases i.e., Bacterial Blight, Myrothecium and Alternaria. The images required for this work are captured from the fields at Central Institute of Cotton Research Nagpur, and the cotton fields in Buldana and Wardha district. Active contour model is used for image segmentation and Hu's moments are extracted as features for the training of adaptive neuro-fuzzy inference system. Theclassification accuracy is found to be 85 percent.

Bendre, M. R, Thool, R. C and Thool, V. R. (2015, September) [19], proposed a scenario for the use of Information and Communication Technology (ICT) services in agricultural big data environment to collect huge data. Big data analytics in agriculture applications provide a new insight to give advance weather decisions, improve yield productivity and avoid unnecessary cost related to harvesting, use of pesticide and fertilizers. Paper list out the different sources of big data in precision agriculture using ICT components and types of structured and

unstructured data. Also discussed big data in precision agriculture, an ICT scenario for agricultural big data, platform, its future applications and challenges in precision agriculture.

P.R. Rothe and R. V. Kshirsagar (2015, January) [20], proposed a distinct feature extraction algorithm that makes the classification process more effectual and efficient. The allocation and recognition of cotton leaf diseases are of the major importance as they have a cogent and momentous impact on quality and production of cotton. In this work they presented a snake-based approach for the segmentation of images of diseased cotton leaves. We extract Hu's moments which can be used as shape descriptors for classification. A theory of two-dimensional moment invariants for planar geometric figures is also presented.

Badnakhe, M. R and Deshmukh, P. R. (2012) [21], proposed that *leaf diseases are identified with help of the feature extracted by the machine learning approach. Image feature extraction is an important part of the paper They proposed the technique for feature extraction and comparison of two techniques. Digital Analysis of crop color is the important. Now it's becoming popular day by day. It is also of the cost-effective method. Changes in the color are a valuable indicator of crop health. Then it can be measured with visual scales and inexpensive crop color*

Al-Hiary et al (2011) [22], proposed the developed processing scheme that consists of four main phases. The following two steps are added successively after the segmentation phase. In the first step they identified the mostly green colored pixels. Next, these pixels are masked based on specific threshold values that are computed using Otsu's method, then those mostly green pixels are masked. The other additional step is that the pixels with zeros red, green and blue values and the pixels on the boundaries of the infected cluster (object) were completely removed. The experimental results demonstrate that the proposed technique is a robust technique for the detection of plant leaves diseases.

Meunkaewjinda, A et al (2008, May) [23], proposed the system that consists of three main parts: (i) grape leaf color segmentation, (ii) grape leaf disease segmentation, and (iii) analysis & classification of diseases. The grape leaf color segmentation is pre-processing module which segments out any irrelevant background information. A self-organizing feature map together with a back-propagation neural network is deployed to recognize colors of grape leaf. This information is used to segment grape leaf pixels within the image. Then the grape leaf disease segmentation is performed using modified self-organizing feature map with genetic algorithms for optimization and support vector machines for classification. Finally, the resulting segmented image is filtered by Gabor wavelet which allows the system to analyze leaf disease color features more efficient. The support vector machines are then again applied to classify types of grape leaf diseases. The system can be able to categorize the image of grape leaf into three classes: scab disease, rust disease and no disease. The proposed system shows desirable results which can be further developed for any agricultural product analysis/inspection system.

Adams, R. M et al (1995) [24], proposed the use of recent GCM forecasts, improved plant science and water supply data and refined economic modeling capabilities to reassess the economic consequences of long-term

climate change on U.S. agriculture. Economic consequences of the three GCM scenarios are mixed; GISS and GFDL-QFlux result in aggregate economic gains, UKMO implies losses. The yield enhancing effects of atmospheric CO_2 are an important determinant of potential economic consequences. Inclusion of changes in world food production and associated export changes generally have a positive effect on U.S. agriculture.

Adams, R. M. et al (1990) [25], proposed that Agricultural productivity is expected to be sensitive to global climate change. Models from atmospheric science, plant science and agricultural economics are linked to explore this sensitivity. Although the results depend on the severity of climate change and the compensating effects of carbon dioxide on crop yields, the simulation suggests that irrigated acreage will expand and regional patterns of US agriculture will shift. The impact on the US economy strongly depends on which climate model is used.

III. CONCLUSION

In this proposed system the crop disease prediction as per weather condition and Machine learning plays vital role. Many ML techniques are developed for prediction. The comparative studies are done by multiple researchers for defining most accurate technique. As very limited number of crops is evaluated, still exact decision is not achieved. Production of crop depends upon some factors such as weather condition, soil type, geographical region, and also harvesting method. Traditionally, monitoring techniques does not gather the crop conditions properly and prediction results were not yet optimized. Therefore, to overcome this problem, a system has been designed that identified type of crop disease and recommend its fertilizers in different conditions using machine learning techniques. The main aim was to detect disease and predict maximum production of crop using limited land resource.

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