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A comprehensive review on Artificial intelligence in Agricultural field

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Abstract *– The growing agricultural field demands, integration of modern techniques to improve product quality. The artificial intelligence offenly called as AI found its applications in every field nowadays. The effective use of such technique can lead to increase output. The agricultural field experiences several challenges like crop prediction, crop health monitoring, and weather forecasting, disease prediction for plants and payment gateway systems for effective farming. The implementation of AI in agricultural field offer better flexibility, better stability, better performance and cost effectiveness. This paper highlighted exhaustive review of use of the AI techniques in agricultural field by focusing on higher productivity and economical considerations.*

Keywords*- Crop prediction, Crop health monitoring, Plant disease prediction, Weather forecasting*

Introduction

The contemporary market demands substantial increment in production of commodities and food to fulfill successive needs of peoples. These needs completed by Agriculture field which also called as foundation for the growth of the country. The various factors like outbreaks of diseases, changes in climates and inadequacy of pesticides affects effectiveness of agricultural systems. More than 70% increment in output needed to satisfy current demands since the agricultural field stands highlighted. The integration of intelligent techniques in farming system enhances the efficiency, sustainability and also helps to decrease the environmental degradation. These methods initiate the integrated methodologies to develop ecological balance to overcome complex challenges for satisfying the global need of peoples with preserving natural resources.

The Artificial Intelligence technique was introduced in 1950's by McCarthy. It is the branch of computer science engineering deals firstly with game theory and solving of simple problems. [Hassani 2010]. "Artificial intelligence is the study of how to make computers do things that humans currently do correctly or better." [Nilsson 1998]. The artificial intelligence mainly classified into two main categories viz. Strong and weak artificial intelligence. The strong artificial intelligence system is more advantageous as it effectively deals with building a machine which is capable of pre-awareness, thinking, understanding inputs like human intelligence [Jahromi 2013]. Since, Artificial intelligence term utilized to systems which works on human intelligence nature for solving complex problems for gaining insightful knowledge. [Turban 2005].

1.1 Classification of Artificial Intelligence techniques

Variety of artificial intelligence branches were used in computer science and engineering some of the common referred branches are

1) Machine Learning
2) Machine Vision
3) Expert System
4) Fuzzy Logic
5) Robotics
6) Artificial Neural Networks (ANN)
7) Natural Language Process (NLP)
8) Genetic Algorithm [Irani 2016]

1.1.1 Machine Learning

It is an execution study based on pattern and interface task with statistical models rather than using clear instructions [Hastie 2009]. It is technique which learns computers related to specific purpose irrespective need of an explicit program. The machine learning algorithm formulates mathematical models with trained data inputs for predictions or decision making [Piryonesi 2020]. In our day to day life we deals with variety of machine learning based search engine platforms like Google because there ML model perfectly understands the user requirements and preferences. Also, Image based ML algorithms identifies the peoples photos effectively [Provost 2013].

1.1.2 Machine Vision

Among all five senses of humans like smell, hearing, taste, vision and touch, the vision is the most vital sense for getting information from the surrounding regions [Davis 2012]. The machine vision technique implies signals generated from images which are transmitted due to sensors. These signals were interpreted with signal analysing instrument or computers. It can be used as a digital tool to monitor, analyse and control the robotic equipment's like arms, end effectors. It is also used to identify defective devices for effective workability [Raisi 2022].

1.1.3 Expert System

The expert systems are the type of artificial intelligence systems that used to find quick solution for complex problems. It requires domain experts which deals with system like one car can be treated as a system for identifying the existence of machine [Huang 2002]. It is computer software of specific category for quickly helping the experts to find the solution for complex problems. These systems are quite simple and based on advanced technology [Durkin 1994].

1.1.4 Fuzzy Logic

Classical logic models are based on binary systems while fuzzy logic models are dealing between values of zero to one. The human beings are capable to identify millions of colours in presence of adequate lighting conditions. The colour identification for robots is base on Fuzzy logic algorithms. To achieve higher efficiency of automotive machines with effective antilock breaking systems, the fuzzy logic algorithms were highly used. Fuzzy logic found advantageous for designing of electronic devices like cameras and microprocessors, management and controlling of agricultural parameters [Dernoncour 2013].

1.1.5 Robotics

The robots were in use from 1920' s. The robot can be of variety of types such as modern, automatic, programmable and navigable machines and useful in various industries [Fridenberg 2006]. The robotics and AI are distinct field's but integration of those can fulfil the variety of user needs because, AI deals with programming and robotics deals with manufacturing of robots. Practical examples were noted such as Jogger and search engines which respond quite faster than conventional systems [Omankwu 2017].

1.1.6 Artificial Neural Networks (ANN)

Modern computational systems were capable of producing accurate outputs for complex problems. These networks are inspired by biological nervous system to build data [Fausett 1994]. The electrical impulse signals were transmitted in communication system of human brain. The cellular structure and grooves made neurons is the main element. The information flows to neurons with the help of grooves. Connection point of one neuron over other is called as synapse which also referred as gate. Purpose of neural network is to design mechanism that understands write and wrong interpretations just like human brain [Fridenberg 2006].

1.1.7 Natural Language Process (NLP)

Interaction among human language and computer is the most important field. The automating process of interpreting and understanding concepts of natural language with human natural language is most important challenge. Processing of written and spoken language subsidies accurately defines NLP. This encourages to enable subsidies for understand, analyse or writing, producing speech structure of Natural language [Crystal 2010].

1.1.8 Genetic Algorithm

It is an algorithm based on science of mimicking natural genetics for variety of problem solving like optimization, determination of topology, training of artificial neural network, image processing [Pichler 2004]. It is a better option for regression like prediction methods. The problem solving model such as genetic evolution can be used for programing of genetic algorithms.

Inputs from problems can be transformed into genetic evolution to solutions during modelling process. The solutions were later transformed into genetic algorithms. Once the fitness function evaluated the conditions for problem were satisfies and the algorithm tends to terminate [Mitchell 1996].

The common agricultural problems that can be address by AI are listed below:

1) Crop recommendation systems
2) Crop disease detection using images
3) Smart irrigation systems
4) Yield prediction using climate and soil data
5) Pest detection using drones devices
6) Soil nutrient classification system
7) Weed detection using computer vision

2. RELATED WORK

2.1 Crop Prediction Systems

Manjit Baishya et al [2025] Focuses on a crop recommendation system for precision agriculture 5.0 using tinyml. He compared accuracy for two levels. First level contains 94% precision of Logistic regression and decision tree classifier. Precision of support vector machine is 96% and the precision for random forest classifier is 99% and hence he chosen second level of random forest classifier (RFC) to integrate in ATMega328P , resource-constraint microcontroller for expand because of cost effective, real time, stand-alone CRS. Then he trims size of model up to 98.78% with accuracy 98.4%. Silent feature of this model is to provide real time crop prediction without transfer to servers and cloud and internet connection. The model occupied 28% lesser space.

Mrs Asha Sattigeri et al [2025] formed an AI powered crop prediction system in Karnataka. She builds the domain for crop varieties, pest control, soil health, and market price prediction and irrigation management for farming by using AI which made cultivation easier. She used ML algorithms for crop prediction. This model found valuable because of its integrated agriculture practices of modernization beneficiary because of AI and DA.

Emilin Shyni et al [2025] studied that most of the algorithms like Random Forest algorithms, Decision Tree algorithms, K-NN, Neural Networks, Linear and Logistic Regression algorithms, SVR, Lasso and Ridge Regression algorithms, LSTM, RNN, Naïve Bayes algorithm, ANN, DNN . He found that, the random forest algorithms perform much better than other as its accuracy is high as compare to others. Machine learning models works on the basis of crop recommendation components like nitrogen, Potassium, Phosphorus, soil pH and climate variables. He adds the chatboats to give instructions for farming to the farmers. It is the integrated Django framework and chat boat libraries. The study shows that in any climatic conditions, the farmers increased their productivity, profit and food security. Some future implementation suggested and it is in the form of image and video of crop as well as addition of calling feature.

Yogesh Gandge et al [2017] he develop the crop recommendation system for only rice with accuracy 90-95% , soya bean and corn with 95% accuracy. He used ID3 algorithm for soya bean crop and multiple linear regression algorithms for rice crop and SVM algorithm is used for all the crops. Also uses KNN, C4.5, K-means, J48, LAD Tree, and Naïve Bayes algorithm but he didn't get full accuracy so he suggested more precise algorithm is needed for future use.

B. Arora et al [2020] trained the chatbot module and crop as well as weather prediction. CNN model is used for isolating the images in crop prediction. Final result will be produced only on telegram application. The accuracy of chatbot is 98% and crop prediction module is 94%. This study suggested language translation; location feature for weather predication is to be integrated.

Yash Gupta et al [2024] found increment in accuracy by using advanced ML algorithms, random forest algorithms and data analytics. He uses some historical data for weather prediction and crop prediction as well as to find out the quality of soil. He majorly focuses on deduct risk factors, increase product ability, profitability and food security. By using the factors like area of farming, climate condition, location his module suggest the best suitable crop for farming.

Shraban Kumar Apat et al [2022] he used AI and ML algorithms as well as SMOTE data balancing technique to get better quality of crop, accuracy and result . To define Temperature, Humidity, pH, and rainfall he used dataset which is readily available at kaggle online source. Also used optimization technique like (C-Boost) cat boosting and got accuracy value up to 99.519

Abrougui et al [2020] develop the model with the help of multiple linear regression techniques and ANN for recognize the organic yield of potato crop. For prediction of potato yield he used properties of soil, harvesting, and cultivation. Also he used ANN and MLR models for RMSE, correlation coefficient for better accuracy.

Aarthi S et al [2025] used different machine learning algorithms like random forest algorithm, SVM, naïve byes ,KNN ,logistic regression ,XG boost, decision trees and found 98.2% accuracy with Random forest algorithm. Nitrogen, phosphorus, potassium, humidity, pH, rainfall and temperature these soil variables are used for prediction of suitable crop. He also developed a web based application with the help of Flask which indicates the three types of responses like whether the crop suggestions is not recommended or highly recommended or slightly recommended so as to make farming easier for farmers. The said study is not included Geospatial integration, Real time and dynamic inputs, multilingual voice enabled support, Mobile application and User feedback system.

Mahmoud Y. Shams et al [2024] studied soil characteristics on crop historical data and climate change to give instructions. Study includes eXpianable AI principles. He compares both XAI-CROP and machine leaning model such as including Gradient Boosting (GB), Decision Tree (DT), Random Forest (RF), Gaussian Naive Bayes (GNB), and Multimodal Naive Bayes (MNB). For getting judgment he used three matrices as mean absolute error (MAE), mean squared error (MSE) and R^2 (R squared). He got MSE of 0.94 which indicates highly efficient crop prediction system and XAI-CROP error below 1. This study is dedicated to incorporating various geographical locations; crop yield predictions, enhancing allocation of resources, as well as improving the security of food. He suggested some future implementation to be incorporated in accuracy and adaptability of XAI-Crop and expanding the application for several regions.

Sun J et al [2020] developed the model for countries like Netherlands, France, Germany by using algorithms such as KNN, support vector regression, gradient boosting for prediction of crop like potato, sugar beet, soft wheat, spring barley and sunflower with extension of two features, first is temporal and second is spatial feature they used multilevel deep learning model for connecting convolutional neural network and recurrent neural network (RNN & CNN). He successfully predicted the corn yields for US for years 2013-2016.

Sourabh Shastri et al [2025] combined artificial intelligence and Machine Learning for crop yield prediction with multiple machine learning algorithms like gradient boosting. The LIME (Local Interpretable Model-agnostic Explanations) AI technique gives highest performance for crop prediction for 22 different crop categories by handling multiclass prediction algorithm.

2.2 Crop health monitoring

Muhammad Waqas et al [2025] focuses on years 2018-2024 by using deep learning and machine learning for components such as weed control, selection of crops, post-harvest and harvest practices, insects , pest, water, soil and nutrient management, or land management systems . Integration of ML/DL model with IOT required for allowing real time analytics for increasing resourcing allocation and decision making.

Sarowar Morshed Shawon et al [2025] did research in between 2017-2024 for crop yield prediction using machine learning and deep learning algorithms. This research contains the consequences of state of the art and hybrid models for better execution. The algorithms used for developing the models by various researchers are Linear Regression, Random Forest, Gradient Boosting Trees, and Support Vector Machines (SVM) Convolutional Neural Networks (CNN), Long Short-Term Memory (LSTM) networks, Recurrent Neural Networks (RNN), and Deep Neural Networks (DNN). He studied different hybrid ML models and found R-MSE, R-square, and MAE to be mostly preferred by the researchers. This study encourages extensive comparison of application on various ML and DL models which ultimately highlights its strengths and weakness.

Pradyum Raj D et al [2021] developed the integrated model of machine learning and IOT. Also he creates new technology which includes IOT and AI for the prediction of crop price for profit. After that he develops the web based application of predicting the price of crop and implementation of sensors for sensing the quality of soil. The main aim of this project is to supply the scheme related information to farmers for the use and involving less efforts.

2.3 Plant disease prediction

G. N. Balaji et al [2024] uses deep learning and CNN module for categorizing the plant diseases based on effective categorization of image. Also he take the advantage of RasNeXt, InceptionNet, MobileNet for prediction of accuracy and compared old methods with previous models. He used RasNeXt and got accuracy up to 98.2% for various 47 plant diseases. He suggested further work to be carried out for detection of plant disease with multiple plant leaves instead of single. He also suggested including environmental factors like dust, rain, wind factors and clarity of image to detect the plant disease with higher accuracy.

Imane Bouacida et al [2025] demonstrate concept of deep learning used for crop prediction based on leaves diseases for different leaves. He calculates the overall disease rate of overall leaf by using Plant Village dataset and got accuracy of 94.04%. He used PDDB dataset and got accuracy of 97.13%. This method is not only suitable for plant disease prediction but also used for addressing the most difficult challenge of crops and disease. The evaluation of the proposed system he developed various classification performance metrics which includes accuracy, confusion matrix and loss. For better results he employed various evaluation metrics such as precision, recall, and the F_1 score.

Aliyu M. Abdu et al [2020] compared study based on two different models of machine leaning for detection of plant disease by using data of leaf image. Deep learning (image recognition and pattern analysis) and support vector machine type of technique were used for this work. Also he used three factors for large plant leaf disease such as amount of training data, architecture, and computational power. On the basis of overall observation he found the deep learning has high accuracy for large samples and SVM with RBF kernel is best for new feature for observation, tuning, also less architecture and complexity. He suggested future work to be incorporated with integration of machine learning for food security also it reduces the burden of manual extraction from SVM.

Volipi Uday Kumar [2022] includes two techniques of crop disease prediction which contains machine learning and computer vision techniques. In this study he detects only 5 different types of diseases of apple plant and got accuracy of 95% by using 3 models and custom model based on vagg19. He builded the model for detection of disease of plant with image using dataset, but he divided the dataset into test, val, and train dataset to achieve better accuracy and fscore.

Plant leaf disease detection using machine learning algorithms

T.lalithya rama [2023] study consists to detect the plant disease with the help of machine learning by using the videos and images of infected plants. To gain the proper result like precision, accuracy, F1 score, recall and efficiency he used Rasnet50 deep learning algorithm for video analysis. For classification he used random forest classifier technique. Also used KNN and support vector machine in supervised learning , logistic regression, naïve bayes algorithms for detection of the plant diseases.

Haseeb Nazki et al [2020] studied 2789 tomato plant disease images. Deep CNN and generative Adversarial Network used to train the model. The images quality found best so it's quite easy to detect the disease. Since about 86.1% accuracy recorded for develop model. But this model required more guidelines to generate the result. The training process is unstable due to lack of variance so the future work analysis is to be required.

Shanwen Zhang et al [2019] used global pooling dilated convolutional neural network and acquisition for infected 6 regular cucumber leaves from 600 cucumber diseased leaves. He got accuracy of 94.65%. He suggested refined study to be carried out because of the speed of model and over fitting conditions.

Muhammad Shoaib et al [2025] study deals with reviews of various deep learning technique for plant and pest disease prediction based on artificial intelligence driven approach. He recorded highest accuracy of 95%

Dr. T. Praveen Blessington et al [2023] Used image processing and convolutional neural network in deep learning to develop a model for detection of the illness of plant leaf and its prevention against illness. Classification of plant was done through RasNet architecture and leaf diseases identified using deep learning and image processing.

Lili Li et al [2021] reviewed several deep learning and advanced imaging techniques based crop leaf disease prediction.

Munaf Mudheher Khalid at al [2023] study represents plant disease detection using deep learning models on the basis of MobileNet architecture and convolutional neural network (CNN). In this model the result were fetched by using images of plant. He used eXplainable artificial intelligence (XAI) for decision making. The table 1 shows summary of his work.

Table 1: Prediction matrix based on CNN and MobileNet [Khalid 2023]

Model	Accuracy	Precision	recall	F1 score
CNN	89%	96%	96%	96%
MobileNet	96%	90%	89%	89%

He got superior accuracy for MobileNet architecture about 96%. But in future implementation , there will be requirement of web application for easy of use to farmers for real time plant disease detection and use of smart farming tools like sensors and (IOT) devices for automation purpose.

Abdulridha et al [2020] trained model by using hyper spectral imaging technology blended with MLP classification method and got accuracy of 99%. He studies a symptomatic, early stage, late-stage for tomato bacterial spot disease and bacterial target spot disease.

Khattak et al. [2021] Paper represents the detection of diseases of citrus fruit and leaves by using CNN (Convolutuional Neural Network). CNN model is used for predicting dominant citrus disease which includes scab, canker, melanose, greening, and black spot by combining various layers to derive attributes and reported accuracy to 94.55%.

2.4 Weather forecasting

Weather forecasting plays essential role in many fields which includes transportation, agriculture and in case of natural disasters. Several years ago, the forecasting of weather is dependent on numerical weather prediction (mathematical) model but possesses some disadvantages like lack of accuracy and computational power. Forecasting of weather is dependent on various factors so it would be difficult to use traditional methods. To avoid this problems machine learning technique such as Long Short-Term Memory (LSTM) and random forest algorithm was implemented for better precision and results. Also with the use of data mining technique, the company can capable to receive input. The weather data of previous years based on Machine learning algorithms helps to give better forecasting of weather in future. Use of mobile learning technique also helps to show better precision and accuracy in comparison to other techniques because of its effectiveness as it contains large amount of datasets. [Arslan Ansari 2025]

Climate analysis (meteorology) is most important concept in day to day life. But when anyone can analyse the climatic situations it would be difficult to find the result with traditional numerical weather prediction method. So to overcome these problems the new technique was introduced for precise and effective results. By using Machine learning technique it helps to overcome this problem as it includes supervised and unsupervised learning. Wind, radiation, precipitation, pressure, temperature are parameters to be consider for analysis to find effective results. [Bogdan Bochenek 2022]

Accurate and authentic weather prediction is important aspect in our day to day life. All the activities in our daily life are important on weather so its role is very crucial. Old weather prediction method which contain numerical weather prediction model, gives output but it takes too much time for execution and still fails to give valid predictions. So to avoid this, the concept of artificial intelligence and machine learning is to be used for proper execution and to speed up the work as it not takes a longer

time span. By using supervised learning in machine learning the labelled data is used to train the data for predicting input and outputs relationships. Once it done the algorithm can predict the future conditions of weather on the basis of new entered inputs.
Unsupervised learning the unlabelled data is used to find the structures and patterns within the data without external guidance. Visualization and Discovery of pattern on weather data can be done through the use of technique like clustering and dimensionality reduction.
Reinforcement learning interacts with outside environment. The agent takes decisions in this type of learning type of algorithm. Granting to improve the power of decision making over time, agent receives the comment card in the form of consequences and incentives. Generally to upgrade the weather related decisions in specific situations the Reinforcement learning is to be utilized.
Numerical weather prediction to improve the accuracy the machine learning models merge with (NWP). Also the integration of data assimilation techniques like use of neural network and observational data with NWP output gives much better results.
Weather Pattern Recognition helps meteorologists to efficiently track and identify weather system. Pattern reorganization can help to predict conditions of weather effectively.
Short-term Forecasting used to integrate predictions and multiple models to reduce uncertainty and improve reliability of forest.
Extreme weather event prediction useful at the time of natural disasters like heat waves, hurricanes and tornadoes. The model records early time warnings with machine learning to reduce their consecutive effects. [Er. Vaishali Jamwal 2023]
Weather forecasting defines as practice of predicting the atmospheric conditions. Places like any of the cities, countries or in overall world locations to predict the correct and real time weather the meteorologists uses the components like sophisticated computer models, radars and satellite to take correct decision and planning. In traditional system the numerical weather prediction model is used for prediction and it is dependent on the feature of thermodynamics and fluid dynamics to generate the forecasting result. By using regression analysis for continuous variable prediction and model classification to achieve categorical outcome provides better and real time result about weather forecasting conditions. Short term, long term forecasts also helps to predict localized weather conditions. Dynamic and Nonlinear nature of weather indicates more accessible and reliable results. To identify correlations and patterns the combination of deep learning model and neural networking concept is to be use. Convolutional neural network and recurrent neural network should be develop for complex pattern and large datasets handling .The performance of forecasting model is observed through metrics, which includes root mean square error (REME),mean absolute error (MAE) and for classification of task the accuracy concept is used. [M.Naga Keerthi 2024].Arslan Ansari et al [2025] Studies two machine learning algorithms such as LSTM (Long Short-Term Memory) network and random forest algorithm to forecast weather variables like rainfall and temperature. He studied both models and found LSTM as more suitable for rainfall recording an R square of 0.89 because it is time dependent variable of forecasting. Random forest is best for temperature forecasting because its mean absolute error (MAE) is 1.3 °C. He used LSTM for upgrade the accuracy. Finally the result received on the basis of supervised leaning which includes naïve bayes algorithm in machine learning. The execution of this model is based on factors like precision, accuracy , F1 score and recall. The table 2 and table 3 shows summary of his work.

Table 2: Temperature Prediction matrix [Ansari 2025]

Metric	High temperature	Low Temperature
Accuracy	0.87	0.75
Precision	0.88	0.79
Recall	0.83	0.74
F1 score	0.85	0.76

Table 3: Rainfall Prediction matrix [Ansari 2025]

Metric	High temperature	Low Temperature
Accuracy	0.82	0.75
Precision	0.83	0.71
Recall	0.78	0.72
F1 score	0.80	0.72

Singh and Sharma et al [2019] uses support vector machine for forecasting rainfall and recorded accuracy of 87%. This study suggested tree based random forest algorithms in machine learning model has best option for old statistical methods in both aspects of accuracy and effectiveness.
S. Zahir Hussain et al [2025] studies combination of machine learning techniques for weather forecasting for recent trends. He used deep learning models like ConvLSTM and LSTM. He noted best accuracy of deep learning model. Future implementation suggested for hybrid approaches that combines ML with physics-based models and deployment of edge computing systems for real-time forecasting.
Er. Vaishali Jamwal et al [2023] represents the study based on machine learning techniques such as supervised and unsupervised learning, regression algorithm, time series analysis and classification for weather predictions. To improve the accuracy of weather forecasting, deep learning techniques such as CNN and RNN are used. To detect temporary nature of weather data, time series forecasting methods like prophet, ARIMA, LSTM network were used. To improve forecasting outcomes and observational data, integrated model of weather prediction model and machine learning found useful. Future work is to be implemented for big data utilization and explainable AI for reaching higher efficiency's.

M.Naga Keerthi et al [2024] show dynamic and nonlinear nature of weather system. He uses machine learning algorithm such as Long Short Term Memory (LSTM) and convolutional neural network (CNN) for surveying the large datasets. To examine historical weather data, real time sensor input and satellite imagery incorporated. The model developed for predicting weather parameters like cloud, humidity, temperature and precipitation. To predict the performance of this model R squared values, Root Mean Square error (RMSE) and Mean Absolute Error (MAE) were used. Future implementation is to be carried out for improving the accuracy of model by combining Artificial intelligence, big data and machine learning together. Similarly by using satellite technology and improved sensor network will leads higher resolution operations for various climatic conditions.

Sunny Kumar et al [2025] study concluded weather forecasting using machine learning and artificial intelligence. It consist hybrid models, regression models, deep learning approaches and classification models for extending the weather forecasting accuracy. By using distinct datasets like real time sensor data and satellite imaginary efficiency boosted. Further prediction supports localized, high resolution forecasts. To detect next level challenges features like multimodal data integration, edge computing, explainable AI and real time systems are integrated for future implementations.

Asmita Mukherjee et al [2023] concluded an exhaustive review study of integrating machine learning (ML) and deep learning (DL) models on meteorological and climatological weather forecasting. She also used climate modeling for effective advanced short term weather predicting better ability.

Anish Porwal et al [2024] represent the impact of artificial intelligence on climate and weather forecast. To enhance accuracy, he analyzes the large amount of climate data for more reliable short term weather forecast.

Md Saydur Rahman et al [2024] study focuses on variety of machine learning algorithms for studying temperature patterns based on last 20 year dataset of city Dhaka. He considered different factors for weather prediction model viz wind speed, absolute and relative humidity, surface pressure, precipitation, specific altitudes and directions. He studied artificial neural network, Adaboosting, Stacking random forest, gradient boosting, stacking KNN, Stacking neural network with comparison of confusion matrix and performance matrix. He recorded highest accuracy of 92% for Adaboost model with integration to artificial neural network model with least accuracy of 90%.

Dr Siddaraju et al [2025] represents weather forecast and prediction system using machine learning by taking user input mainly city name and parameters like wind speed, humidity, atmospheric pressure, and temperature. He uses three algorithms such as random forest for handling regression and classification task, linear regression for showing the relationship value of parameters and KNN (K – Nearest Neighbors for classifying the future or current weather state based on historical weather patterns.

Varshney et al [2024] reviewed different artificial intelligence techniques based on weather prediction ability. He considered different attributes like regions, range, duration and suggested to use the hybrid models for better weather prediction ability.

B.K. Gund et al. [2023] Concluded that, the factors like Rainfall, wind, temperature, speed of wind, humidity based data size were needed to be consider as they directly affects the crop health. He used Tensor flow model for result predictions. The model based on k-means clustering and hidden markov model. He combined most of machine learning algorithms for event prediction in future.

Tanzila Saba et al. [2017] represents (MLP and RBF) hybrid neural model to improve the accuracy results of weather predictions. He studied weather of country Saudi Arabia. He developed individual and hybrid neural network which consist min/max temperature, mean temperature, average moistness, dew point, wind speed (high/low), dew point and cloudiness. For sharp calculation, criteria of coefficient correlation, Scatter index and RMSE techniques were used. He compared MLP and RBF models and found that MLP is more promising. The study suggested that hybrid neural model's experimental outcome indicates that hybrid neural model found to be best rather than the individual feed forward network. He also indicates that hybrid model has best learning ability with possessing good generalization capabilities.

Nikhil Sethi et al [2014] used most relevant methods for prediction of rainfall by using clustering, ANN, and regression analysis. He illustrates multiple linear regression methods for early prediction of the rainfall. To calculate the quality of multiple linear regression equation the predicted rainfall amount is to be compared with real rainfall. He found multiple regressions were to be best. He received model data from Rajasthan, Udaipur from last 30 years for calculation. He doesn't found adequate accuracy because of variations in the climate factors as they got directly affected by rain.

Rosnay et al [2012] explored the study of soil in other various countries by considering different conditions such as biome and climate conditions. He accessed two ECMWF soil moisture variations. First is for operations and second is for ERA-Interim. He used 133 datasets from this datasets 117 datasets used for accessing ECMWF analysis of first layer and rest of datasets will be used to calculate the moisture of second layer.

Ms. Ashwini Mandale et al [2015] uses the data mining technique for classification of weather variables like rainfall, evaporation, minimum temperature, maximum temperature, and wind speed for weather prediction. It will be executed by using decision tree algorithm, meteorological data as well as artificial neural network. He then compares all algorithms by using standard performance practice to find out mean weather variables.

2.5 Online payment system

Online payment system involves risk checks, pricing and methods. These comparable things are called as terminals. Each and every gateway has various terminals. Main probability of increasing the rate of successful transaction is to rout a transaction of payment by selection of best terminal for payment transaction. By using AI and ML integrated techniques helps to predict best terminal based on previous performance and various attributes related to payment accurately. By using the integration of various

machine learning methods like block chain, razor pay with a higher dimensional triage model made exceptionally strong. To recognize and avoid fake payments the real time fraud detection system is to be developed to secure digital transactions. For tamperproof results every initiated transaction should indicate flagged or approved in private blockchain loop. The modern architecture must include various components like blockchain logger, frontend form, razor pay interface, ML fraud identifier, Flask backend API to make scalable, intelligent and secured transactions. Such end to end encryption help to build consumers trust, prevents frauds, and also make system compatible with real world requirements. The various results were noted as Accuracy to be 99.81%, Precision to be 93.47%, Recall being 91.20%, F1 Score to be 92.32% and AUC-ROC to be 0.988 [Loganathan D 2025].

3. CONCLUSIONS

The following conclusions were noted by exhaustive literature review on AI in agricultural systems.

1) The various researchers used tinyML, random forest classifier, SMOTE, C-Boost, CNN, XAI type of machine learning algorithms to predict crop prediction systems. They receive highest accuracy about 99 % for XAI and least about 95% CNN. Also it is observed that using C-boost or SMOTE type of technique can increases output accuracy up to 99%.

2) The Random forest, Gradient boosting trees , SVM, LSTM, RNN, CNN, DNN , IOT and linear regression type of techniques preferred by various researchers for crop health monitoring requirements effectively. The integrated systems like CNN and IOT found more reliable.

3) The RasNeXt, InceptionNet, MobileNet , PDDB dataset, computer vision techniques, supervised learning , logistic regression, naïve bayes algorithms , IOT type of techniques studied by various researchers for plant disease prediction and recorded highest 98.2% accuracy for RasNeXt and lowest accuracy around 94% for CNN.

4) The LSTM, NWP, naïve bayes, ARIMA, CNN , RNN , ANN, Adaboost type of techniques found application in weather predictions. The highest accuracy shown by Adaboost around 92% and lowest for ANN around 90%. Also by considering wind, radiation, precipitation, pressure, temperature like factors improves the efficiency.

5) The online gateways created significant impact on farmers. The blockchain logger, frontend form, razor pay interface, ML fraud identifier, Flask backend API type of components should be considered to reach accuracy about 99% for fraud free transactions.

4. FUTURE SCOPE

As we know very well that, the worlds population increasing day by day. It could reach approximately up to nine millions around year 2050. To cope up these needs our current agricultural production should increase more than 70 %. We may could not complete this as we have only 10 % unused land and these needs should get fulfilled by current agricultural production units. Since integration of modern technology for ease of farming becomes vital. The use of sensors for soil management, weed management, soil nutrient classification systems, yield prediction using climactic conditions based machine vision and AI techniques significantly increases the production and cost effectiveness and ultimately help us to reach our target.

5. REFERENCES

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