International Journal of Research Publication and Reviews

Journal homepage: www.ijrpr.com ISSN 2582-7421

The Review on Crop and Fertilizer Prediction using Deep Learning

S. Lakshmi Devi, U. Ramesh, P. Preethi, R. Swapnique, A. Bhavani

CSE, GMRIT, Rajam.

ABSTRACT:

Agriculture has several effects on our nation, including supplying food, shelter, employment opportunities, the raw materials needed to produce food, the creation of enterprises, and other essentials that contribute to economic development. Crop productivity is a major factor in India's economy. When it comes to agricultural productivity, one must choose a crop carefully. Here, crop choice is a crucial component of agriculture. Precipitation, humidity, temperature, and the amounts of potassium, nitrogen, and phosphorus in the soil all have an impact on crop predictions. The right kinds and dosages of fertilisers give the soil the vital nutrients it needs to keep producing crops. The crop that will be grown can be chosen by farmers in the initial stages. But today, it is challenging for farmers to estimate the yield because of constant changes in the environment. Additionally, this has caused a number of issues for farmers. Farmers are also experiencing a lot of difficulties as a result of their ignorance of fertilisers. Deep learning algorithms are therefore utilised to forecast the crop and recommend fertiliser. Over time, the neural network adds layers, and as the network gets deeper, performance gets better. Deep learning aims to do this. For predicting new output values, deep learning approaches like CNN and machine learning models like SVM, Naive Baye's, Random Forest, and XG Boost are useful. Two datasets that are useful for crop recommendation and fertiliser suggestion are the one for fertiliser prediction and the other for crop recommendation. According to deep learning, an ensemble technique provides a greater level of prediction accuracy.

Keywords: Deep Learning, Machine Learning, Agriculture, crop prediction, fertilizer

INTRODUCTION:

Agriculture is the cornerstone of India's economy. Natural farming methods, such as chemical-free or traditional farming practises, have been employed in India for a long time [1]. But as globalisation advanced, it altered to accept more contemporary methods, giving rise to modern farming that heavily utilises chemical fertilisers, pesticides, etc[2]. We created a web application to help farmers identify the type of crop they are producing by letting them enter values [3]. A crop and fertiliser recommendation system can be created using a variety of deep learning techniques. A crop, fertiliser, and disease prediction system is created using CNN and a few other deep learning algorithms, including LSTM [4]. To obtain the outcome, farmers enter the values into the modules. To build and launch the front end, HTML, CSS, and Bootstrap are utilised. Farmers will find this online application to be a terrific companion. The standard methodologies have limited capacity for learning from the data, and it is usually difficult to pinpoint the optimum traits [5]. Because of advancements in computing technology, new multilayer algorithms may now be developed and learned.

Literature Survey:

Nevavuori, P., Narra, N., & Lipping, T. et al., smart farming is employed to make it easier to extract data-relevant information for data-driven decisions. New multilayer algorithms may now be created and trained thanks to developments in computational technology. Deep learning is the name given to these techniques. The authors proposed Convolutional neural network (CNN) has emerged as one of the most effective deep learning frameworks for picture categorization and analysis. The convolutional layers of the CNN perform the feature extraction process, and the network learns the best features during training, therefore no features need to be calculated in before. In this study, the mean absolute error—the mean absolute difference between the genuine yield value and CNN output—is used to assess the performance of the CNN. Loss is what we call this. The results show that CNN models are able to generate yield predictions that are quite accurate and based on RGB images [1].

D. Devi, A. Anand, S. S.Sophia, M. Karpagam and S. Maheswari et al., author proposed IOT (Internet of Things) devices based deep learning algorithms to identify the quantity of pesticides and disease present in crops. A fruit was used in the experiment together with the ailments that are most common in fruits as a dataset. The amount of pesticides present in the selected fruit was calculated using sensors (IOT devices) such temperature sensors, pH sensors, and ESP8266. A total of 50,000 training image sets and 20,000 simultaneous test image tests are used to train and test the input image. The server already has these photos saved. Although SVM successfully predicted the diseases, it did not indicate how much (or what percentage) of the fruit was harmed. In terms of accuracy, CNN generated findings that were quite accurate, even though its training and testing procedures took 6.5 minutes longer than those of SVM [2].

S. Bhanumathi, M. Vineeth and N. Rohit et al., the main focus of this study is on crop yield analysis and fertiliser recommendations to help farmers grow crops in accordance with local climatic conditions. In order to estimate future data, this article uses a variety of past data. They classified the outcomes

using SMO classifiers in WEKA. They are artificial intelligence models. The average temperature, lowest temperature, maximum temperature, information about the crop from the previous year, and information about the yield are the main factors considered. This study made use of a sample dataset made up of several parameters. State, district, crop, area, season, and productivity are a few of them. We can create a machine learning model utilising this data, train it, and calculate production estimates. Additionally, it enables us to figure out how much fertiliser should be used to get the required yield. The two methods that are mostly employed in this paper to forecast the results are the Random Forest algorithm and Backpropagation. In terms of error rate, it was discovered that the random forest algorithm had a lower error rate than the backpropagation algorithm when the error rates of the two algorithms were compared to achieve the results [3].

Mythili, K., & Rangaraj, R et al., the author was recommend a system for precision agriculture that would increase crop productivity utilising ant colony optimization and deep learning. In this study, precision agriculture—using new technologies to boost crop yields and profitability while using less traditional inputs like land, water, herbicides, etc.—is the main topic of discussion. Here, the hybrid approach ACO-IDCNN-LSTM is utilised to predict crops. ACOs (Ant Colony Optimizations) are used to enhance the inputs of DCNN (Deep Convolution Neural Networks) and LSTM (Long ShortTerm Memory) networks. DCNNs frequently generate high levels of accuracy, but the complexity of the calculation rises with the number of processing layers. Our work changes these weights during training to reduce processing complexity because adding weights to DCNNs' nodes accounts for a sizable amount of complexity increases. In terms of effectiveness and precision, ACO-IDCNN-LSTM outperformed baseline models. It is found that choosing an acceptable crop is successful using the suggested ACO-IDCNN-LSTM recommender model [4].

Pudumalar, S., Ramanujam, E., Rajashree, R. H., Kavya, C., Kiruthika, T., & Nisha, J et al., the author focuses on crop recommendations that can assist farmers in minimising the selection of incorrect crops and boosting agricultural yield. The soil testing facility in Madurai, Tamil Nadu, India, collected and analysed a dataset of soil-specific properties for the Madurai area. Our model takes into account millet, groundnut, legumes, cotton, vegetables, banana, paddy, sorghum, sugarcane, and coriander among other crops. Depth, Texture, Ph, Soil Color, Permeability, Drainage, Water retention, and Erosion were the factors taken into account. This experiment uses the algorithms random tree, CHAID, K-Nearest Neighbor, and Naive Bayes to forecast the crop and yield. The ensemble model, which consists of CHAID, random forest KNN, and nave bayes, is supplied the training data after it has been retrieved using feature extraction. By applying rules induction, the recommendation system is then formed, and it will calculate the crop yield. This experiment yielded results with an accuracy of 88%. Our future effort will focus on a larger data set with more features and will also include yield prediction [5].

JuhiReshma, S. R., & Aravindhar, D. J et al., the author implemented an estimating the quantity of fertilisers needed for a specific crop of bananas. In the deep layers of the neural network, a new variation of the Rectified Linear Unit (ReLU) known as the Parameterized ReLU is utilised to forecast the amount of fertiliser. To train the training dataset, Relu classifiers 1 and 2 are employed. Classifiers 1 and 2 are compared based on their accuracy, sensitivity, specificity, and error rate performance. The suggested network's performance can be contrasted with that of current state-of-the-art classifiers like Decision Tree, Random Forest, and SVM. The network may overfit with an increase in training duration and hidden nodes, which could result in high accuracy during data training but poor interpolation during data testing. A model is created to suggest how much fertiliser to use on a crop.The study takes into account the key determinants of crop production, and data on crop, crop yield dataset, crop nutrients, location, and soil were collected from various sources such agricultural websites [6].

Haque, F. F., Abdelgawad, A., Yanambaka, V. P., & Yelamarthi, K et al., in this, agricultural yield prediction will be calculated using deep neural networks. a deep neural network (DNN) strategy that benefited from cutting-edge modelling and resolution methods. With a root-mean-square-error (RMSE) of 12% of the average yield and 50% of the standard deviation for the validation dataset utilising anticipated meteorological data, the model was determined to have high prediction accuracy. According to our computational results, this model greatly outperformed other well-known techniques like Lasso, shallow neural networks (SNN), and regression trees (RT). The dataset utilised for this research is from the Syngenta Crop Challenge (Syngenta, 2018), which uses real-world data to forecast how several corn hybrids will perform in 2017. With the aid of two deep Networks Two deep neural networks were trained—one for yield and the other for check yield—and the yield difference was predicted using the difference between the two networks' outputs. These dimensions were discovered to offer the optimal balance between prediction accuracy and constrained overfitting after experimenting with deeper network architectures. The Xavier initialization method was used to initialise all weights. When compared to Lasso, shallow neural networks (SNN), and regression trees, the experiment's accuracy is 95% (RT) [7].

Der Yang, M., Tseng, H. H., Hsu, Y. C., & Tseng, W. C et al., the author discussed on the classification of crops using deep learning and edge computing. In this experiment, the two full convolution neural networks FCN-AlexNet and SegNet are employed and compared to one another. FCN-major AlexNet's goal is to convert AlexNet's original three-layer full-layer layer into a convolution layer before adding a sampling layer to produce semantic segmentation. In the first half of the network, SegNet utilised the VGG16 network architecture, followed by upsampling and another is (downsampled) index that enables the value to be placed in the appropriate location before down sampling in the up sampling process. In this experiment, the two full convolution neural networks FCN-AlexNet and SegNet are employed and compared to one another. FCN-Alexnet has an accuracy of 88.48%, while segNet has an accuracy of 89.44%, giving it a higher level of accuracy. The convolution process on the FCN-AlexNet network takes less time because it is a simpler network, but there are fewer convolutions and a larger convolution mask window. SegNet is utilised as the neural network model of the inference service because, after quantitative and qualitative study, it is determined that SegNet is reasonably complete in detail processing [8].

Jyothika, P., Ramana, K. V., & Narayana et al., this paper primarily focuses on a crop recommendation system that uses deep neural network techniques to boost crop productivity. The findings are evaluated using Deep Neural Network models, such as Deep Sequential Models that also comprise layers like ReLU layer, Dropout layer, and Classification layer. The suggested approach, a deep neural network model, outperforms earlier methods in determining which crop should be produced by more precisel keeping the original data distribution. Machine learning algorithms including the K-Nearest Neighbor (KNN) Algorithm, the Decision Tree Classification Algorithm, and the Random Forest classifier are employed. In terms of accuracy metric, a

sequential model with an accuracy of 96% has been achieved. Model accuracy is determined by the accuracy & sensitivity values produced by each method [9].

A. S. Terliksiz and D. T. Altýlar, et al., author suggested utilizing deep learning algorithms to estimate soybean yield. Recent crop prediction systems include LSTM and convolutional neural networks. The dataset used in this study is made up of satellite photos and soybean yield. Applications using deep convolutional networks for crop monitoring, crop type classification, and crop yield estimation are becoming more and more important. When using data frames, CNN has different cropland coverage% with an accuracy of 73.9, which can significantly alter the outcomes. The network is developed using keras, a high-level neural networks API written in Python, and is trained with several hyperparameters. The root mean squared error is utilised as the evaluation metric in order to compare the results with other works. The 64*64 frames used to create the 3D CNN [10].

M. Rashid, B. S. Bari, Y. Yusup, M. A. Kamaruddin and N. Khan, et al., the author implemented an algorithm for agricultural yield is predicted using deep learning algorithms, with a focus on palm oil. The back propagation algorithm uses backward and forward optimization to improve speed. The nonlinear operations in the activation layer can improve CNN's capacity to perform nonlinear fitting. For the purpose of target recognition tasks and the remote sensing area, CNN demonstrates its significant and great function in the field of computer vision. Deep neural networks can overcome the local minima and overfitting issues by vigorously optimising the deep network topology. The CNN algorithm is employed in this paper. Between the input and output layers are layered a number of fundamental units. Input and output gates-based sequence and time series data are successfully classified and predicted using LSTM networks. In this study, CNN outperformed LSTM in terms of accuracy, scoring 89.5 [11].

Van Klompenburg, T., Kassahun, A., & Catal, C et al., for quick decision-making, crop yield forecast is a crucial role for decision-makers at the national and regional levels. In order to predict agricultural yield, DNN algorithms are used in this work. While DNN algorithms share many of the same ideas as ANN algorithms, they also use alternative hidden layer types, such as convolutional and pooling layers, and have multiple hidden layers as opposed to only one. Farmers may determine what to grow and when with its assistance. The main algorithms employed in this paper are CNN and LSTM. The CNN model consists of three layers. The components of convolutional layers are feature maps and filters. Neurons in the layer known as filters provide a weighted output value from weighted inputs. In comparison to LSTM, CNN is shown to be 92.7% accurate. Future effort will concentrate on development [12].

Elavarasan, D., & Vincent, P. D, et al., the author focused on crop production prediction for sustainable agrarian applications utilising deep reinforcement learning models. In comparison to deep reinforcement, deep learning, artificial neural networks, random forests, and gradient boosting, the use of RNN-based feature processing and DQN algorithms is made. The output values of the recurrent neural network are translated into Q-values via a linear layer. The reinforcement learning agent combines a threshold and a set of parametric variables that help forecast crop yield. The agent then obtains an overall score for the actions taken, which is determined by minimising error and maximising forecast accuracy. The suggested study looks into the paddy crop yield forecast for the Vellore district in southern India. Here, the districts of Ponnai, Arcot, Sholinghur, Ammur, Thimiri, and Kalavai were taken into consideration for the study. The dataset is pre-trained using RNN, and the goal value function and RNN network are initialised with identical parameters and random weights. Additionally, use DQN to train the dataset, and initialise the prediction yield at random. With an accuracy of 93.7%, the suggested model accurately forecasts crop yield while outperforming other models and maintaining the original data distribution [13].

Banavlikar, T., Mahir, A., Budukh, M., & Dhodapkar, S, et al., the author discussed on the optimum type of crop to be harvested in the soil is suggested by a crop recommendation system in this paper employing neural network techniques. This model can identify the type of crop on its own after being trained using a specified dataset of previously gathered values (characteristics that have already been mentioned). The type of crop has an impact on the overall yield as well, making the recommendation method even more valuable. Artificial Neural Networks with their various kinds, including Perceptron, Multilevel Perceptron, Back Propagation, Sigmoid Function, SoftMax Function, RELU Function, and Input Bias Functions, are employed along with machine learning methods. The model for this recommendation system will consider variables including temperature, humidity, and soil moisture content. In this particular recommendation model, neural networks would be utilised to estimate the best type of crop. To anticipate the type of soil and crop used, Internet of Things (IOT) devices such the ESP8266, Raspberry Pi 3, Arduino IDE Tool, sensors, and MQTT Protocol are used. Along with optimization techniques like Stochastic Gradient Descent and Full Gradient Descent, software like TensorFlow and Keras is used [14].

Madhuri, J., and M. Indiramma, et al., the author discussed on the basis of particular soil and climatic circumstances, crop recommendations are made in this study. ANN and decision trees are used to quantify accuracy. The framework is divided into four major stages. 1) Data gathering from various sources, 2) Data storage, 3) Machine learning module, and 4) Module for recommendations. It makes use of artificial neural networks (ANNs) to find the best crop, which will then be suggested based on a few key characteristics. Because the accuracy value of ANN is higher than that of Decision tree, it is taken into consideration [15].

Moreno, Rafael Hernández, and Olmer Garcia, et al., the authors recommended fertilisers using neural network models are implemented. Using an MLP neural network, pastures are cultivated to identify the fundamental soil components including nitrogen, phosphorous, and potassium. It claims that pasture cultivation is a crucial component of the dairy sector. For validation, this threshold value is used. In this model, fertilisers are used as datasets. In this, we will forecast the crop using neural networks [16].

Khaki, Saeed, and Lizhi Wang, et al., the authors are used neural networks to identify different agricultural yield-related parameters. There are 50 neurons and 21 hidden layers in these neural layers. The model's performance is largely dependent on how accurately weather predictions are made. Environmental factors have a greater impact than genetic ones. The yield forecast relies heavily on factors including genetics, environment, and their interactions. We use predictive models to compare the datasets [17].

F. F. Haque, A. Abdelgawad, V. P. Yanambaka and K. Yelamarthi, et al., the author discussed on a relationship between the independent qualities and yield scarcity. The technology will assist the farmer in selecting the necessary attribute to change and measuring the potential yield. The steps are

completed in a flowchart-style description of the process. The mean square error of the estimation was around 0.0045. The dataset included parameters for UV, water, pesticides, fertilizers, and the amount of land covered with its related agricultural output. In this study, a convolutional neural network is the algorithm. The main goal is to determine the yield per hectare of land with various parameter concentrations that are efficient under various weather conditions [18].

Escalante, H. J., Rodríguez-Sánchez, S., Jiménez-Lizárraga, M., Morales-Reyes, A., De La Calleja, J., & Vazquez, R, et al., the author introduces technology-based crop fertilizer prediction. It operates with high-tech adoption. Cyber systems, wireless GPS, and other factors define the Agri-smart industry. A significant amount of data is transformed into smart data in this. Low cost UAVs (Unmanned Aerial Vehicles) are being used to continually monitor crop photos, and low cost methods for crop variable estimate will be provided [19].

Table 1: literature review

Sl.no	**Technique (i.e. author names with reference number)**	**Year**	**Description**	**Limitations**	**Advantages**	**Performance metrics**	**Gaps**
1	Nevavuori, P., Narra, N., & Lipping, T.	2019	smart farming is used to facilitate the extraction of information relevant for data driven decisions.	It is difficult to get accurate output when features are more.	The output will be more accurate with CNN model.	Accuracy of 92.5%.	New approaches like RCNN can be used.
2	D. Devi, A. Anand, S. S.Sophia, M. Karpagam and S. Maheswari.	2020	IoT- Deep Learning based Prediction of amount of Pesticides and Diseases in Fruit.	edge based algorithms can result in noise.	CNN gave comparatively better results than SVM.	CNN had high accuracy which is the greatest advantage.	The training and testing time of CNN was 6.5 minutes more than SVM.
3	S. Bhanumathi, M. Vineeth and N. Rohit.	2019	Crop Yield Prediction and Efficient use of Fertilizers .	The backpropagation algorithm is used for large datasets which have no proper relationships between the attributes of the dataset .	By using Back propagation algorithm, efficient use of fertilizer is successfully predicted.	With respect to the error rate. We compared the error rate obtained while comparing the random forest algorithm.	No web application is developed yet, if implemented so, it would be very helpful to the farmers.
4	Mythili, K., & Rangaraj, R.	2021	Crop Recommendation for Better Crop Yield for Precision Agriculture Using Ant Colony Optimization.	It does not produce accurate results to farmers.	ACO-IDCNNLSTM recommender model it is found to be effective in recommendation.	Recall values 95.1833 %.	Auto encoder based deep learning mechanism should be implemented in order to obtain better results.
5	Pudumalar, S., Ramanujam, E., Rajashree, R. H., Kavya, C., Kiruthika, T., & Nisha, J.	2019	crop recommendation helps to the farmers to reduce the selection of choosing wrong crop.	the scenario in Kerala State where the average holding size is much lower than most of India.	Precision agriculture suggests the farmers the right crop based on their site specific parameters.	The prediction accuracy of the model accounts to 88%.	The evolution of DRL has raised the self-reliance and the intelligence of the Artificial Intelligence.

6	JuhiReshma, S. R., & Aravindhar, D. J.	2021	The model deals with the prediction the required amount of fertilizers for a particular crop banana.	Experimenting data prediction through a wide range of ML predictive algorithms can be observed as a basis for decision making.	DRQN based process provides a complete solution that independently mines the non-linear mapping.	accuracy of 93.7%..	The evolution of DRL has raised the self-reliance and the intelligence of the Artificial Intelligence algorithms.
7	Haque, F. F., Abdelgawad, A., Yanambaka, V. P., & Yelamarthi, K.	2020	neural networks with different DL algorithms has been evaluated.	Evaluation metrics are valid.	Crop yield prediction can be done accurately.	Accuracy of 89%	on data mining future work is done.
8	Der Yang, M., Tseng, H. H., Hsu, Y. C., & Tseng, W. C.	2020	It deals with the Crop classification by using Deep learning and edge computing .	Although the FCNAlexNet network is simpler, the convolution operation takes less time, but the convolution mask window is large.	aims to use unmanned aerial vehicle (UAV) for agriculture applications with integrating edge computing.	By using precsion and overall accuracy is 89%.	FCN-AlexNet directly upsamples at 32 times interval in the deconvolution layer.
9	Jyothika, P., Ramana, K. V., & Narayana, L.	2021	Crop recommendation system to maximize crop yield using deep neural network.	It offer a Crop Recommendation system.	This system provides with a better level of accuracy, showing the effectiveness of the proposed approach.	Accuracy of 96%.	The crop recommendation system should be integrated with a yield predictor.
10	A. S. Terliksiz and D. T. Altýlar.	2019	World population is constantly increasing and it is necessary to have sufficient crop production.	Without choosing the data frames as input for CNN it is difficult to process.	The output will be more compared to machine learning algorithms.	Accuracy of 76%	In future new approachescan be utilized to know the yield of crop.
11	M. Rashid, B. S. Bari, Y. Yusup, M. A. Kamaruddin and N. Khan.	2021	Crop yield prediction are carried out to estimate higher crop yield through the use of deep learning algorithms to predict crop yield.	It is difficult to get accurate output when features are more.	The model will be more accurate which leads to feed a rising world population.	Accuracy of 80%	In future the relation between crop yield prediction and palm oil yield prediction can be known.
12	Van Klompenburg, T., Kassahun, A., & Catal, C.	2020	DNN algorithms are mostly used to predict the crop yield. Apart from evaluation parameters several validation approaches were used as well.	When more data is collected it is difficult to work accurately on that data.	When specific parameters for a specific place are measured and added the predictions will have higher precision.	Accuracy of 70%	The future work develop crop prediction advanced algorithm.

13	Elavarasan, D., & Vincent, P. D.	2020	Deep learning based models are broadly used to extract significant crop features prediction system.	Evaluation metrics between different models are varied.	Crop yield prediction can be done accurately.	Accuracy of 81%	Further improvement in the computing efficiency of the training process.
14	Banavlikar, T., Mahir, A., Budukh, M., & Dhodapkar, S.	2018	Crop Recommendation System Using Neural Networks.	Only up to small datasets the recommendation system works effectively.	One of the major advantages of ESP8266 is that it is extremely cost effective.	Raspberry Pi does most of the working, based on the training dataset.	Traditional methods of farming unable to produce proper yield which did not help the farmers.
15	Madhuri, J., and M. Indiramma.	2019	crop recommendation is done depending on specific soil and climatic conditions It uses ANN for getting suitable crop,.	It is only for specified crops .	Using ANN gives high accuracy.	Accuracy : 91.5%	Will be applicable for all the crops.
16	Moreno, Rafael Hernández, and Olmer Garcia.	2019	neural network models are used for fertilizer recommendation, it says that cultivation of pastures is essential factor.	Pasture cultivation is mainly used.	Environmental factors have been used.	Accuracy : 97.21%	Method will be applicable for all the crops.
17	Khaki, Saeed, and Lizhi Wang.	2019	multiple factors of crop yield are determined using neural networks. It is helpful.	Not applicable for all the crops.	Predictive models are been used.	Accuracy : 96%	Efficiency of major factors will be improved.
18	F. F. Haque, A. Abdelgawad, V. P. Yanambaka and K. Yelamarthi	2020	neural networks with different DL algorithms has been evaluated. Deep learning algorithms are used to reduce the scarcity.	Evaluation metrics are varied.	Crop yield prediction can be done accurately.	Accuracy of 80%	On data mining agriculture future work can be done.
19	Escalante, H. J., Rodríguez-Sánchez, S., Jiménez-Lizárraga, M., Morales-Reyes, A., De La Calleja, J., & Vazquez, R.	2021	Technology based crop fertilizer prediction is introduced.it uses high-tech adoption in its Agri-smart working .	Used only for large amount of data.	Low cost solutions for estimation of Crop Variables will be given.	Accuracy : 94%	UAV's will be on demand for these methods.

From the above literature survey, machine learning and deep learning algorithms and recommendation systems are also recommended. But there is no combination of different models like crop yield prediction and disease prediction as a single model. So, this kind of combinational model which include crop recommendation system, fertilizer recommendation system, and crop yield prediction can be implemented.

Conclusion:

Agriculture plays a significant role in India. When farmers prosper, the entire country prospers. As a result, our study assists farmers in making predictions about crop production, crop disease, fertilizer recommendation, and crop recommendation. The crop and the crop disease are predicted using a variety of machine learning approaches, including SVM, random forest, decision trees, and naive bayes. Compared to previous techniques, the random forest used here is more accurate. Several deep learning algorithms, like CNN and LSTM, are used to recommend the crop and the fertilizers. CNN is more accurate in this case compared to other algorithms. The creation of front-end and back-end frameworks using React JS and Django. Farmers are thus able to cultivate the crops that will boost both their own yields and the nation's overall output. We intend to combine yield prediction with cutting-edge characteristics in the future and expand the data set with new qualities.

References:

[1]. Nevavuori, P., Narra, N., & Lipping, T. (2019). Crop yield prediction with deep convolutional neural networks. *Computers and electronics in agriculture*, *163*, 104859.

[2]. D. Devi, A. Anand, S. S.Sophia, M. Karpagam and S. Maheswari, "IoT- Deep Learning based Prediction of Amount of Pesticides and Diseases in Fruits," 2020 International Conference on Smart Electronics and Communication (ICOSEC), 2020, pp. 848-853, doi: 10.1109/ICOSEC49089.2020.9215373.

[3]. S. Bhanumathi, M. Vineeth and N. Rohit, "Crop Yield Prediction and Efficient use of Fertilizers," 2019 International Conference on Communication and Signal Processing (ICCSP), 2019, pp. 0769-0773, doi: 10.1109/ICCSP.2019.8698087.

[4]. Mythili, K., & Rangaraj, R. (2021). Crop Recommendation for Better Crop Yield for Precision Agriculture Using Ant Colony Optimization with Deep Learning Method. *Annals of the Romanian Society for Cell Biology*, 4783-4794.

[5]. Pudumalar, S., Ramanujam, E., Rajashree, R. H., Kavya, C., Kiruthika, T., & Nisha, J. (2017, January). Crop recommendation system for precision agriculture. In 2016 Eighth International Conference on Advanced Computing (ICoAC) (pp. 32-36). IEEE.

[6]. JuhiReshma, S. R., & Aravindhar, D. J. (2021). Fertilizer Estimation using Deep Learning Approach. NVEO-NATURAL VOLATILES & ESSENTIAL OILS Journal| NVEO, 5745-5752.

[7]. Haque, F. F., Abdelgawad, A., Yanambaka, V. P., & Yelamarthi, K. (2020, June). Crop Yield Prediction Using Deep Neural Network. In 2020 IEEE 6th World Forum on Internet of Things (WF-IoT) (pp. 1-4). IEEE.

[8]. Der Yang, M., Tseng, H. H., Hsu, Y. C., & Tseng, W. C. (2020, January). Real-time crop classification using edge computing and deep learning. In 2020 IEEE 17th Annual Consumer Communications & Networking Conference (CCNC) (pp. 1-4). IEEE.

[9]. Jyothika, P., Ramana, K. V., & Narayana, L. Crop recommendation system to maximize crop yield using deep neural network.

[10]. A. S. Terliksiz and D. T. Altýlar, "Use Of Deep Neural Networks For Crop Yield Prediction: A Case Study Of Soybean Yield in Lauderdale County, Alabama, USA," *2019 8th International Conference on Agro-Geoinformatics (Agro-Geoinformatics)*, 2019, pp. 1-4, doi: 10.1109/Agro-Geoinformatics.2019.8820257.

[11]. M. Rashid, B. S. Bari, Y. Yusup, M. A. Kamaruddin and N. Khan, "A Comprehensive Review of Crop Yield Prediction Using Machine Learning Approaches With Special Emphasis on Palm Oil Yield Prediction," in *IEEE Access*, vol. 9, pp. 63406-63439, 2021, doi: 10.1109/ACCESS.2021.3075159.

[12]. Van Klompenburg, T., Kassahun, A., & Catal, C. (2020). Crop yield prediction using machine learning: A systematic literature review. *Computers and Electronics in Agriculture*, *177*, 105709.

[13]. Elavarasan, D., & Vincent, P. D. (2020). Crop yield prediction using deep reinforcement learning model for sustainable agrarian applications. IEEE access, 8, 86886-86901.

[14]. Banavlikar, T., Mahir, A., Budukh, M., & Dhodapkar, S. (2018). Crop recommendation system using Neural Networks. *International Research Journal of Engineering and Technology (IRJET)*, *5*(5), 1475-1480.

[15]. Madhuri, J., and M. Indiramma. "Artificial Neural Networks Based Integrated Crop Recommendation System Using Soil and Climatic Parameters." Indian J. Sci. Technol. 14.19 (2021): 1587-1597.

[16]. Moreno, Rafael Hernández, and Olmer Garcia. "Model of neural networks for fertilizer recommendation and amendments in pasture crops." 2018 ICAI Workshops (ICAIW). IEEE, 2018.

[17]. Khaki, Saeed, and Lizhi Wang. "Crop yield prediction using deep neural networks." Frontiers in plant science 10 (2019): 621.

[18]. F. F. Haque, A. Abdelgawad, V. P. Yanambaka and K. Yelamarthi, "Crop Yield Prediction Using Deep Neural Network," *2020 IEEE 6th World Forum on Internet of Things (WF-IoT)*, 2020, pp. 1-4, doi: 10.1109/W IoT 48130 .2020

[19]. Escalante, H. J., Rodríguez-Sánchez, S., Jiménez-Lizárraga, M., Morales-Reyes, A., De La Calleja, J., & Vazquez, R. (2019). Barley yield and fertilization analysis from UAV imagery: a deep learning approach. International Journal of Remote Sensing, 40(7), 2493-2516.