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# Agricultural Crop Yield Prediction Using Artificial Intelligence and Satellite Imagery

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***Abstract:*** The influence of climate change and its unpredictability, has caused majority of the agricultural crops to be affected in terms of their production and maintenance. Forecasting or predicting the crop yield well ahead of its harvest time would assist the strategists and farmers for taking suitable measures for selling and storage. Accurate prediction of crop development stages plays an important role in crop production management. Such predictions will also support the allied industries for strategizing the logistics of their business. Several means and approaches of predicting and demonstrating crop yields have been developed earlier with changing rate of success, as these don't take into considerations the weather and its characteristics and are mostly empirical. For this a combined constructional and methodological approach is proposed like variety inception, pesticide & fertilizer management, integrated cropping, rainwater harvesting, efficient irrigation techniques etc. would also be needed. The neural network algorithm is less prone to error than other machine learning and data mining techniques, making it an effective machine learning tool for predicting crop yields. The ANN back propagation algorithm is used to determine the appropriate weight value to calculate the error derivative. The accuracy of the crop yield estimation for the diverse crops involved in strategizing and planning is deliberated to be one of the utmost significant issues for agronomic production purposes. The yield prediction is still considered to be a major issue that remains to be explained based on available data for some agricultural areas. Crop monitoring and forecasting of crop yields for the proposed system will be carried out via satellite images with low resolution. The combination of extensive and extended topographical coverage and its high temporal frequency make these images an appropriate choice for the prediction of crop yields. To ease the training, the dimensionality of the data is reduced by supposing that the position of pixels doesn't influence the typical crop yield. The prototype distinguishes between crops, the infrared and temperature bands of images taken during apex growing season contribute the most to the crop prediction.

Using Satellite Imagery and CNN algorithm to forecast crops in all states produces better efficiency than only using ANN algorithm. The main aim is to compare the output of ANN and CNN to verify whether the results are accurate for crop yield forecasting.

***Keywords:*** Artificial Neural Network (ANN), Convolutional Neural Network (CNN), K nearest neighbor (KNN), Back Propagation (BP).

## INTRODUCTION

Agriculture is the main support and the major sector of the Indian economy. The production of agronomy is far too low. low. As the demand for food is growing exponentially, the researchers, analysts,

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farmers, scientists, specialists and government try to place further effort and strategies to increase agricultural production to accommodate the needs.

The objective of agricultural production is to achieve maximum crop yield. Initial discovery and management of complications like crop yield can help amplify return yield and ensuing profits. If regional weather patterns are influenced, large scale weather events can have a substantial effect on crop production. Crop managers can use predictions to minimize damage in critical conditions. Furthermore, these forecasts could be used to make full use of the crop forecast if the potential for favorable conditions of growth exists.

Crop Yield Prediction is the methodology to predict the yield of the crops using different parameters like rainfall, temperature, fertilizers, pesticides, ph level, and other atmospheric conditions and parameters. ANN (Artificial Neural Network) is a method to predict the yield. For the purposes of this paper, ANN will be considered using zero, one and two hidden layers in this research. The ideal numbers of the different hidden layers and the numbers of units in each of the hidden layers will be determined by calculating MSEs that provide the correct or precise output. The forecast for crop yield is based on numerous types of statistics compiled and extracted.

It is a fascinating method of estimating crop and the quantity of yield in an advance way before the harvest essentially takes place. Foreseeing the crop yield can be tremendously valuable for farmers. It tells them the indication of when and how to harvest crops certainly.

The contribution of agricultural professionals and re- searchers in the prediction of crop yield leads to issues like nescient farmers about natural occurrence's, the negation of personal awareness and exhaustion etc. such problems can be altered by using crop yield techniques using ANN algorithms.

The main objective is to compare the output of ANN and CNN to verify whether the results in crop prediction are accurate. This paper uses crop yield prediction techniques to forecast the appropriate crop by identifying different soil parameters and atmospheric condition parameters. This paper demonstrates the ability of the artificial neural network algorithm to monitor and predict crop yields in remote areas and cities.

The initiation of remote sensing data along with ANN to predict the crop is used to acquire data regularly taken from satellites orbiting around the Earth and powerful image- processing techniques like Convolutional Neural Networks is being used to predict the harvest which aptitudes increased prediction coverage and even precision.

By using both ANN and CNN algorithms for crop yield prediction, it is guaranteeing the accuracy and efficiency of crop yield prediction to maximize crop production.

## BACKGROUND

Some of the most valuable documents and papers after extensive background work are:

S.V Baria [1] built up a strategy to demonstrate how a high- resolution satellite imagery is essential to isolate rice cultivation. LAI's multi-regression model was taken as an input and NDVI or any other vegetation index calculated from red and near-infrared spectral reflection was taken as another influence under normal environmental conditions and common agronomic practices. The top methodology of estimating rice yield using satellite imagery could be during the period of maximum vegetative growth.

SnehalS.Darikar et al. [2]discussed in their paper the use of Artificial Neural Network to predict crop yield. The paper senses the parameters of the regional soil and the various atmospheric conditions. Then it furthers analyses by using feed forward back propagation ANN. By using Mat lab ANN approach was made more efficient. They structure a system that accurately links climate effects to crop yield, can be used to estimate long - term or short-term crop production and can also obtain an ANN with adequate and useful data.

AgaarwalSachin [3] discovered the air quality index by utilizing neural system-based air quality factors, which worked with a fractional number of informational indexes and are sufficiently strong to deal with information with noise and inaccuracies. Various accessible varieties of neural system models, for example, Repetitive Network Model (RNM), Consecutive System Development Demonstrate (SNCM),

Change Point Discovery Display with RNM (CPDM), and Self Sorting out Element Maps (SOFM) are executed in this paper for anticipating air quality. The created models were utilized to reproduce and figure the air quality index dependent on long haul (yearly) and in addition present moment (every day) informational collections. The models can accurately anticipate air quality patterns.

B.A. Smith et al. [4] discussed about all year or long-haul atmospheric temperature expectation models that were produced for estimating forecast horizons of 1 to 12 h utilizing Ward-style Artificial Neural System. These models were intended for general support in decision making. The variations of the ANN plan described here provide greater precision compared to previously developed winter models amid the winter time frame. The models that had included precipitation terms likewise as a part of the air prediction model in the input vector were progressively exact.

B. J I et al. [5] The aim of this study was to: (1) research whether Artificial neural system (ANN) models could effectively and efficiently forecast Fujian rice yield for characteristic mountainous climate and atmospheric conditions, (2) assess the performance of the ANN model in comparison to varieties of rising parameters and (3). Compare the effectiveness of multiple linear models of regression with models of ANN. The models were developed using historical harvest data from several locations in Fujian Field-explicit rainfall information and the climate conditions were utilized at every location for the rice yield prediction.

Lillian Kay Peterson [6] Here, Lillian created satellite investigation methodologies and programming devices to forecast crop yields two to four months ahead of time, before the harvest. This procedure estimated relative vegetation condition dependent on pixel-level customary irregularities of NDVI, EVI and NDWI indices. Since no crop mask, modification, or sub-national ground truth information are vital, this procedure can be valuable to any area, location, harvest, or climate, making it ideal for African nations with little fields and poor ground perception.

This model generally separated three primary groups of techniques which are widely used to monitor or observe and estimate crops on a rough scale. [7] D.M. Johnson summarized the groups on the basis of advancement from qualitative to increasingly quantitative and process-based practices and thus the history of agronomic remote sensing based on low resolution satellite imagery:

1. Qualitative crop monitoring 2. quantitative harvest yield forecasts by utilizing models of regression 3. Quantitative harvest forecasts utilizing dynamic crop developing models. This interaction was intended to help the reader to decide the primary broad methodologies that can be initiated in this field.

This system developed by [8] Jiaxuan, Xiaocheng, Melvin, David, Stefano was expected to foresee the soybean yield creation utilizing the profound gaussian process in the convolutional neural system in remote detecting information. The multispectral pictures alongside the geological areas were taken as information. The profound Learning strategy is utilized to foresee the yield. The fundamental methodology in this paper was to foresee the yield from the crude information present. The measurement decrease was done through histograms and the Deep Gaussian process is utilized to effectively eliminate all the errors.

This paper aimed to predict the crop yield by using Back Propagation (BP), Kohonen Self Organizing Map (KSOM) which comes under supervised and unsupervised algorithms. [9] R.Ghadge et.al. centered around how to analyze the nutrients in the crop productivity which depend on geographical locations. This paper predicted the crop yield by comparing the accuracy of different algorithms and selecting the best and efficient method for prediction of crop. Along with the output it contains the recommendations of the best fertilizers.

The model developed by P. Vinciya and D.A.Valarmathi [10] uses data mining techniques. The main techniques used by this paper are Multi Linear Regression, Classification, and Clustering (Supervised Learning Techniques), Back Propagation. The prediction of the crop was done by taking the input from the organic, inorganic and real data sets. Data analysis was done and profit and loss of each mining technology was calculated and applied. These analyses were used in the real estate business of cultivated and non-cultivated land. The difference in efficiency is calculated in these types of farming and the best way is delivered.

## METHODOLOGIES

### Artificial Neural Network

Artificial neural network is a prediction technique that is used to predict non- linear relationships from an input provided. They are based on biological neural processes of an animal brain. Neural Network, to predict the output requires training, once it is trained it can predict the crop yield which contains patterns even if the previous input include any error. Neural Network is known for giving accurate results even if the input provided is complex, multivariate, nonlinear and then the output is extracted. Artificial Neural Networks (ANN) has a variety of applications like speech recognition, computer vision, character recognition, signature verification recognition, human face recognition.

ANN constitutes of three different blocks- Network Topology, Weights or Learning, Activation Functions. Network Topology contains two types of network — Feedforward and Feedback. Feedforward layer consists of different layers which are connected to each other through nodes, there is no loop and signal is passed only in one direction from input to output. It consists of two types of network, single layer feedforward network and multi-layer feed forward network. Feedback network encompass different layers which are connected through nodes but the network contains loops where the signal flows in both directions. It is also divided into three types Recurrent networks, Fully Current Network and Jordan Network. These nodes have different weights, In the Learning method, if the desired output is not derived then the weight of these nodes is modified. These nodes are called as Neurons. It consists of 3 different types of learning- Supervised Learning, Unsupervised Learning and Reinforcement Learning. Activation functions are used to get the precise output. The process of classification by ANN follows:

An experiment is run by giving the input values as attributes. The weights and activation function values are added and applied at each node of the hidden layer, till the desired output of the feed forward algorithm is achieved. The output at every level is compared with the expected output from the data set. If the output doesn't match, it is sent back to the initial layer and is given different values for weights and activation function and then back propagation algorithm is applied. The data and the input value are then tested. The method finally stops when it matches with the expected output.

## Clustering

It is an unsupervised learning method used to classify the different types of data into different clusters and groups. Clustering has been classified into different techniques and the most important technique is the hierarchical agglomerative, partition, robust and unsupervised technique. The data divided into different groups are such that it belongs to similar group having similar characteristics as compared to the data in different groups. It is a cluster of the objects characterized based on similarity and dissimilarity between them.

## K-Means Clustering

The K-Means clustering is a highly used algorithm in machine learning approach. This technique is used to put unlabelled data in a group and the number of groups are represented by the variable name K. The data is differentiated according to their similarity. Each group or each cluster has one k, which is a centroid and the unlabelled data is clustered according to the centroid. The unlabelled data values are compared to the centroid and then are clustered according to the nearest centroid. To get the best results these centroids are placed very far from each other. Cluster assignment is based on the Euclidean Distance between each input and centroid. A straight line is drawn between each input and then a line perpendicular to this straight line is used to divide this line into different cluster. This step is repeated until the values of centroid stop moving. At last the mean of all the values of the centroid of different clusters will be the new value of centroid. K means is used by the agronomic industries to predict crop which eventually help in increasing profit for all farmers and motivate them to work harder.

## Agglomerative Hierarchical Clustering

The basic idea of Agglomerative Hierarchical is that if there are two nearby subpoints they end up in the same cluster, if there are two same individuals they are in the same subpopulation, it's typically a bottom up cluster. It is the most important cluster from the tree plot. It starts with many singleton clusters. Each Singleton cluster contains one data point. By looking at the pair of clusters and find a point that is closest to one another. Once the closest point is found then the two clusters are merged into one single cluster. This step is repeated till only one single cluster is found.

## Regression

Regression analysis is a statistical technique that is used to predict the values from the expected output quantity when the output quantity is continuous.

## Algorithmic Classification

*1)LINEAR REGRESSION:* Linear regression is a linear method to build a relationship between two variables which are continuous – one variable which is independent and denoted by X and another variable which is dependent and denoted by Y. This is used for prediction which is based on statistical methods. The graph of linear regression classification is a straight line. The formula for calculating the linear regression is-

$y' = b + ax$

calculate the slope by calculating b.

## Non-Linear Regression

Nonlinear regression is a regression technique which does not depend on one variable but depends on multiple variables or predictor variables. The graph of this nonlinear regression is a curve where all the variables are dependent on each other. This model is used to calculate the sum of squares which is the dispersion of data points. This method is based on trial and error technique and needs many assumptions. The trial and error method is used to minimize the value of sum of squares to make the data point fit in the data set.

## Formulae

The formula of Multiple Regression

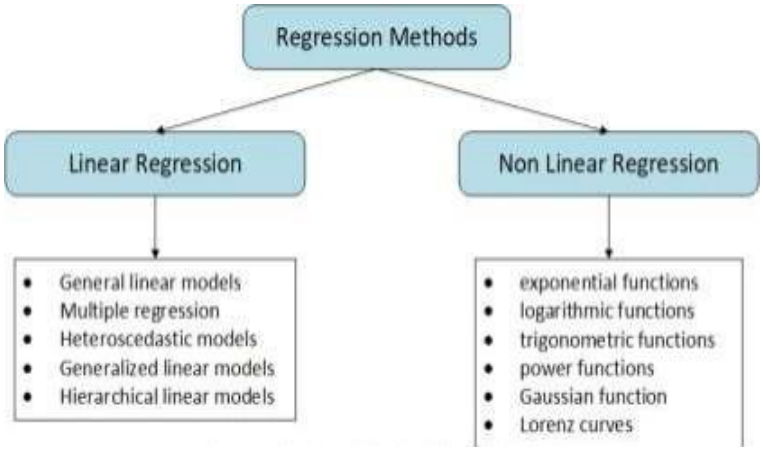
Model with predictor variable x1 and x2.

Y = B0 + B1x1 + B2x2+

Where B0, B1, B2 . . . are coefficients of Multiple LinearRegression

Xi 1, xi2 ... are independent variables.

This formula contains the linear parameters B0, B1, B2. Itcontains a three- dimensional space of Y, x1 and x2, where B0is the intercept of this plane. This model consists of the partialregression coefficient parameters, B1 and B2, where the change in the mean response is represented by the parameter B1 which corresponds to a unit change in x1, and this occurs when x2 is held constant and the parameter B2 represents the change in the mean response which corresponds to a unit change in x2 whenx1 is held constant.




## Classification

Classification and prediction are frequently occurring tasks of human decision-making by extracting models to predict future data trends. So, classification is used for predicting a value of the categorical variable called a target or class. One or more data sets with instances are present with different columns and different values, now these are the inputs from which a categorical variable therefore a class is predicted and this is done by building a model which is based on one more different numerical value or categorical which are called as predictors or attributes. Classification algorithm gives the output as 0 or 1, or YES or NO after examining the whole input data.

## Bayesian Network

Probabilistic relationships among variables of interest through graphical models. These graphical models are called as directed acyclic graph and the nodes of this directed acyclic graph are called as variables. By using this algorithm, the probabilities of all the possible outcomes from the graphical model can be predicted. First the model is being represented into different states in the graphical model. All these possible states are the outcomes a model can lead to under certain conditions. Then the relationship between them is detected and can form different loops in the graph. The cyclic graph cannot afford to form the cycles. It checks every probability and comes up with the best solution. When checking a probability every variable is dependent on each other. It has several advantages when used through graphical model than statistical technique. Casual relationship between all the factors can be learned through Bayesian relationship and can be used to predict the consequences of intervention. Bayesian network is a powerful tool and is used in agriculture department for dealing with wide variety of uncertainties. The advantage of using the Bayesian network is that they are feasible and efficient.

1) *K-NEAREST NEIGHBOUR:* The k-Nearest neighborhood which is also called as KNN is a major classification problem which is used in machine learning. It comes under the category of Supervised Learning Method. Data Mining and Pattern Recognition use the KNN algorithm.

When the N training data set points are provided for each data set the nearest class is taken. For example, if K = 3 then the data set point in the graph will look for the 3 nearest classes from that point. When k = 1 each training data set defines its region in the space which is called as Voronoi Partition. K should always have the odd values for example if it has the value 2, it can have a tie between two classes and might have a problem of which class should be considered. K should not have multiple number of classes. KNN faces a complexity of finding the nearest neighbor in large complex data set because the large data sets contain thousands of points which are near to each other making it difficult to find the nearest point which is at the minimum distance to it. KNN gives the best result for a large complex dataset.

**Convolutional Neural Network**

The Convolutional neural network is important in the field of artificial neural networks and in data mining too. Convolutional neural network is used mainly for image classification and pattern recognition and in many different areas where detecting any object is a necessity. Here CNN is used to detect the images. In this process an unknown image is given as input and the CNN is used to identify or classify this unknown image under different categories. This image is then divided in different pixels. When the input is divided into different parts or pixels then each pixel is called as receptive field. The receptive field is basically used to process the portions of input image. This results in an output that are combined so that their input regions overlap, which results in better representation of the naïve image; this process is done for each layer.

**Typical Convolutional Layer: Layers Involved in Convolutional Network Layer Are**

It is an important building block and is the first layer of Convolutional Network, the convolutional operation is implemented to the input to pass the result to next layer. The input data is broken into small squares. It takes two inputs as an image matrix and as a filter. The filter is small and expands according to input data. The two-dimension activation map of the filter is produced when the filter is mapped on the dimensions of the input layer. The dot product of the filter and the input is calculated when the filter is mapped onto the input. This dot product results into an output matrix.

POOLING LAYER:

Pooling layers are used to reduce the dimensions of the image and each dimension are applied to different functions and are used to increase the robustness.

Pooling layer. Pooling layer is of 3 types:

MaxPooling

Average Pooling SumPooling

Each layer has its defined function and provides the suitable output.

Hyper parameters that are used in max or average pooling layer are ‘f’ and ‘s’.

‘f’ for filter size.

‘s’ for stride.

**Max Pooling Layer**

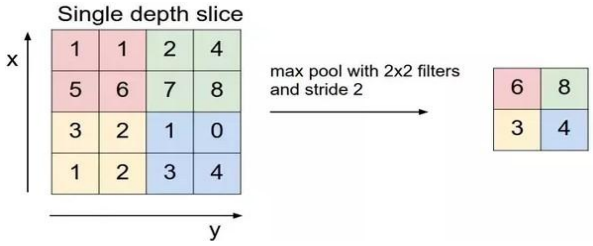
The Max Pooling can be explained using an example. A 4*4 matrix is taken and the output for this matrix will be a 2*2 matrix. This 4*4 matrix has a total of 16 blocks and is divided into a 2*2 matrix. From each 2*2 matrix the maximum value is selected, so a total of 4 maximum values are selected from each matrix and these four values will be the maximum values from all the input values. These 4 values are the output which is fit into the 2*2 matrix. Max pooling layer is used more than average pooling layer and sum pooling layer.

**Average Pooling Layer**

The Average pooling layer is used in deep neural networks. . This takes the input of any dimension and then divides itintosmallerdimensionlike4*4isdividedinto2*2 and then it takes the average of each 2*2 matrix and the output is the mean of each of this division.

**Sum Pooling Layer**

Like Max and Average pooling layer, sum pooling layer is used to calculate the sum all the values from each of the group of input data and the output is the sum of all the values from each group of the input.




## PROPOSED SYSTEM

The proposed system constitutes the prediction of crop yield by using Artificial Neural Network algorithm for areas where datasets are easily accessible and by using Convolution Neural Network algorithm through satellite imagery which allows us to predict crop yield in remote areas whose datasets are not easily distinguished.

The fundamental objective is to compare the output of ANN and CNN to verify whether the results in crop prediction is accurate. This paper utilizes crop yield prediction strategies to forecast the appropriate crop by identifying diverse soil and atmospheric condition parameters. This paper demonstrates the ability of the artificial neural network to monitor and predict crop yields in remote areas and cities. This CNN algorithm can also be used for the prediction of drought and other unfavorable climatic that could affect the crop yield prediction.

The most practical and difficult issue in agriculture is making sure the crop yield production is maintained on an increasing scale by using ANN and CNN to predict the crop yield and take necessary action if needed to ensure the crop yield is going to give greater profit. This gives a rise in the development in agriculture. It also defines area and problem specific machine learning approach and further consolidates these into a robust machine learning approach.

## CONCLUSION

Crop yield prediction still pertains to be a difficult issue to face by the farmers. The aim of this project is to suggest and implement a rule-based system to forecast the crop yield production from the pool of collected past data. This has been achieved by applying both ANN and CNN using satellite imagery on agriculture to foresee the different crop production.

By utilizing both ANN and CNN algorithms for harvest yield it helps to ensure the precision and effectiveness of crop yield for maximizing crop production.

## REFERENCES

[1] Noureldin, N. A., Aboelghar, M. A., Saudy, H. S., & Ali, A. M. (2013). Rice yield forecasting models using satellite imagery in Egypt. *The Egyptian Journal of Remote Sensing and Space Science*, *16*(1), 125-131.

[2] Dahikar, S. S., & Rode, S. V. (2014). Agricultural crop yield prediction using artificial neural network approach. *International journal of innovative research in electrical, electronics, instrumentation and control engineering*, *2*(1), 683-686.

[3] Sachin, A. (2001). Application of Neural Network to Forecast Air Quality Index. *Thesis submitted in partial fulfillment of requirements for a degree in Bachelor of Technology*.

[4] Ji, B., Sun, Y., Yang, S., & Wan, J. (2007). Artificial neural networks for rice yield prediction in mountainous regions. *The Journal of Agricultural Science*, *145*(3), 249-261.

[5] Smith, B. A., Hoogenboom, G., & McClendon, R. W. (2009). Artificial neural networks for automated year-round temperature prediction. *Computers and Electronics in Agriculture*, *68*(1), 52-61.

[6] Petersen, L. (2018). Real-Time Prediction of Crop Yields From MODIS Relative Vegetation Health: A Continent-Wide Analysis of Africa. *Remote Sensing*, *10*(11).

[7] Johnson, D.M. *Remote Sensing of Environment*.

[8] You, J., Li, X., Low, M., Lobell, D., & Ermon, S. (2017). Deep Gaussian process for crop yield prediction based on remote sensing data. In *Thirty-First AAAI Conference on Artificial Intelligence*.

[9] Ghadge, R., Kulkarni, J., More, P., & Nene, S. Prediction of Crop Yield using Machine Learning.

[10] Vinciya, P., & Valarmathi, D.A. A*griculture Analysis for Next Generation High Tech Farming in Data Mining*.