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Determining the Yield of the Crop using Artificial Neural Network Method

Ritesh Kumar Ranjan, Priyasha Nandi, Yugit Chauhan, J.Jagadeesan

Abstract: ***The agricultural system is complex and comprehend since it deals with large data that comes from several factors. Lot of techniques and have been used to identify any interactions between factors affecting yields with crop performance. The major objective of this paper is to help us predict the yield of a particular crop before even cultivating it for its production. We are using artificial neural networks for forwarding and implementing a system that will help the farmers in finding their crop yields according to their given data as input in the system and the system will give output based on previous data. The method used in this crop yield system is an artificial neural network and the algorithm used is feed forward and back propagation. Provide the input of data sets and the desired outcome of the system. Compute the error between the actual and desired outcome of the system. Amendment of the weight associated with different inputs and different functions. Compare the errors and the tolerance ratio of the output. Various machine learning techniques have been used in the past for calculating the crop yield using remote data. However, these methods are less useful and effective for predicting the yield of maize and for some other crops, which is cultivated at different times in various fields.The major application of this crop yield system is that it will help us to predict the yield before even cultivating it by studying the previous data collected such as soil fertility, pH level.***

Keywords: Artificial Neural Network, Agriculture, Back Propagation , Crop Production, Feed Forward.

I. INTRODUCTION

Cultivation is the backbone for the Indian economy, about 60-70% of the Indian population depends on agriculture. It contributes 16-17% of GDP. The share for the population depending on cultivation for the living on the crops consists of landowners, farmers who cultivate on a piece of land, farmers who only plant for their needs and agricultural labourers who are employed on these farms and many farms like this. Despite the high levels of production, countryside yield in India is lower than in other large maize or other crop-producing countries. Cultivation yield is the quantity of the maize and crop produced on one unit of land. Precision agriculture had become an important point for agriculture and sustainable development of the country and for sustainable development of the society, which could make farmers mostly free the perspective of the farming land, it also increases the using efficiency of water and it can be done by using drip irrigation in the fields for the minimal use of the water and for helping the waters to reach the roots and decreases uses of fertilizers and pesticides, it also prevents our environment from being polluted like-soil pollution and water pollution and air pollution etc, and it will improve crops quality i.e. it will give better yield of the crop and it will also increase crop quantity i.e. better growth of the maize which will indirectly help in increasing or improving the current status of the farmer and also the economy of the country. ANN i.e. artificial neural networks are inspired by but one of the many computing models that can be used for the crop predictions. Other methods that can be used for crop prediction are machine learning, spiking neural networks, convolution networks, artificial intelligence, spatiotemporal, etc. In this, the algorithm used is fed forward and back propagation. Feed forward and back propagation wherein connections between the nodes do not form a cycle. The feed-forward back propagation was the first and the simplest type of artificial neural network. The following section provides a literature survey, details of the agriculture system in India, the methodology used for crop yield prediction.

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* Correspondence Author

Ritesh Kumar Rajan, student in Dept of Computer Science & Engineering at SRM Institute of Science & Technology, Ramapuram.

Priyasha Nandi, student in Dept of Computer Science & Engineering at SRM Institute of Science & Technology, Ramapuram.

Yugit Chauhan, student in Dept of Computer Science & Engineering at SRM Institute of Science & Technology, Ramapuram.

Dr. J Jagadeesan, professor in in Dept of Computer Science & Engineering at SRM Institute of Science & Technology, Ramapuram.

II. LITERATURE SURVEY

E. Manjula & S. Djodiltachoumy[1] states the requirement and importance of crop yield analysis and prediction using the data-mining process. Data mining is the process of training co-relations of patterns among dozens of fields. Different were used for prediction of crop yield. This research proposed and also implements a technique to predict the yield of crop from earlier data used. This kind of technique was used for some selected region only this is the major drawback was found. Nani Raut, Jens B. Aune, Bishal K. Sitaula, and Roshan M. Bajracharya[2] describe future and also better scope of intensified agriculture of the mid-hills which is located in the centre of Nepal. Intensified agriculture increases the crop production and was also helpful for farmers in discontinuation of pest problem for getting good prices for their crop they have grown. Without any financial cost farmer, intensified agriculture increases variety and number of crops and decreases pest affected crop production. Issue is only need of balance of food demands with respective soil and crop management which have very less potential. Andrew Crane-Droesch[3] specifies that crop yield prediction and also the impact of climate change on agriculture. Crop yields depends on weather, irrigation, soil fertility, PH of soil, etc. Machine learning and deep neural network is used to predict crop yield prediction. Methods used in predicting crop yield semi-parametric neural network and algorithm used is yield modelling algorithm.

With very less error yield of crop prediction and impact in agriculture. An important portion of the work of modelling yield of crop for climate change impacts the judgement that depends on deterministic and bio-physical crop model.

Pritam Bose, Lorenzo Bruzzone, Reggio N. Hartono[4] specifies about spiking neural networks (SNNs), analysis of the image time series for the remote sensing spatiotemporal. This paper used the concept of the crop yield and the crop production estimation with the introduction of the first SNN computational model. The spatiotemporal analysis approach was done to estimate the yield of winter wheat, which is done in one of the best winter wheat-growing regions of China. It is possible to estimate crop yield by given data where average accuracy was more and error accuracy was very less. The major drawback is that winter crops were having average growth stage.

Jiri Stastny, Vladimir Konecny, Oldrich Trenz[5] specifies the crop yield prediction which uses an artificial intelligence approach which is a multilayer neural network model. Method used is multi-layer perceptron. The importance is given on judgement of accuracy of the individual methods and implementation. The task for the non-linear characters is that it increases the benefits of this method. The non-linear regressive model are the best models and also suitable for determining the sowing density of the chosen crop.

Rohit Kumar Rajak, Pooja Shinde, Mitalee Pendke, Avinash Devare, Ankit Pawar and Suresh Rathod[6] states about crop recommendation system to maximize yield of crop using machine learning method and technique. Algorithm used is random tree, SVM and ANN. The data from soil testing labs are given to the system which will use the collected data and do ensemble model by using an artificial neural network(ANN) and support vector machine(SVM). Common difficulty that is present among the Indian farmers is that they don't select or opt for the proper crop based on their soil fertilization and their climatic factors.

Hossein Aghighi, Hamid Salehi Shahrabi, Davoud Ashourloo, Mohsen Azadbakht, and Soheil Radiom[7] specifies about the machine learning which is used here for crop monitoring and also for calculation of yield of a crop. Main algorithm used are Gaussian process regression(GPR), NVDI, Support vector and Random forest regression. These methods are basically investigated for less production of crops, which can be cultivated, can be done seasonally and can also be done in different fields of the area. All the methods used or described in this journal paper that ML brings out results in averaged production of silage maize. The NVDI (Normalized difference vegetation index) can lead to yield prediction and also analyzing stability can be reduced.

Gang Liu, Xuehong Yang, Minzan[8] represents a model of an artificial neural network yield for crop prediction and responds to soil parameter. This model is established by tutoring the back-propagation neural network with 58 tests and tested the other 14 samples. This training results as that the co-relation co-efficient was 0.916 also average error value was (2.8)*(10-2). Precision(exactitude) agriculture(PA) had become the main feature of agriculture's sustainable development. It increases the using efficiency of fertilizer and water. Here though it increases and improves crop yield and quality of crops.

Ra Chandra Khanal[9] states about research findings focus on climate change which impacts on agriculture and vice verse. Both are dependent on each other. Method of Organic agriculture is more efficient than conventional agriculture. As researches revealed that the extent of climate change affects the ecosystem. Climate change is a natural process although anthropocentric reasons alarms climate change continuously. This is done with inadequate data to substantiate this fact.

Satis Devkota, Mukti Upadhyay[10] specifies the agriculture productivity as well as how reduction was reduced in Nepal. Methodology used is cobs-Douglas and trans-log production function Also paper identifies the determinant of productivity which helps in the reduction of poverty using Sen's property index. Result found to be stronger as there is a change in productivity determinant which gives better outcomes. As the paper describes that many rural farmers migrate to India. Also, high population density has led to land fragmentation due to lesser in cultivable land. Due to the host of factors always productivity remains constrained.

III. ARCHITECTURE DIAGRAM

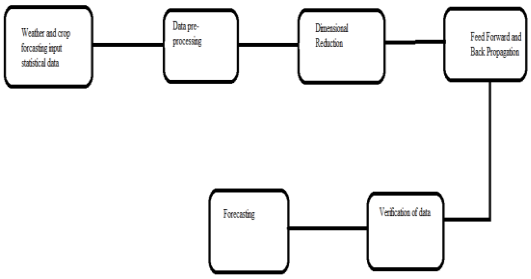

Figure 1: Architecture Diagram of the system

The architecture diagram denotes the workflow of the proposed system which will be covered in the forthcoming section. The basic idea is to get data as the input and processing the data for the given or the assumed data we have taken as output and the output is given as the text data.

IV. PROPOSED SYSTEM

Weather and crop forecasting:

Predicting a particular crop and maize production and its yield before the harvest. It takes place a couple of months in advance is known by the art of crop forecasting. Crop forecasting and weather forecasting depends on computer programs that describe the plant and environment interactions in quantitative and qualitative terms. These kinds of programs are called models, and they attempt to simulate plant-weather-soil interactions. They, therefore, need information and data from the most important factors that can affect crop yields and crop productions. After passing through the model test, the given various types of inputs are converted into outputs, such as maps of crop conditions and yields.

Data per-processing:

It analyses the data that has not been carefully screened for such problems can produce misleading results.It removes the useless data from the useful data.

Tasks of data per-processing:
1. Data cleansing
2. Data transformation
3. Data reduction

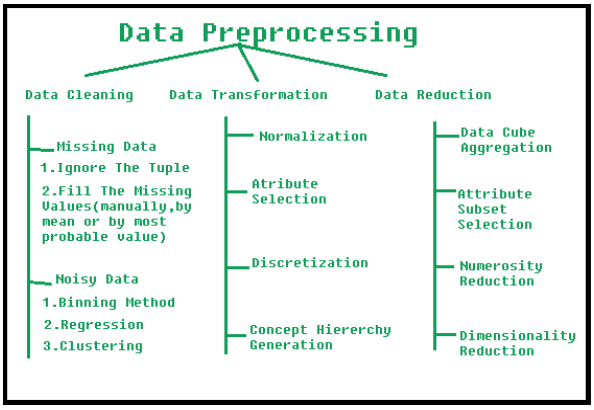

Figure 1: Data Pre-processing

Dimensions Reduction:

The process of reducing the number of random variables under consideration is obtained by a different set of principal variables is known as dimension reduction. It can be further divided into two types, feature selection and feature extraction.

Feature selection: In feature selection, we try to find out the subset of the original set of variables or the original set of data's, to get a smaller subset that can be used to model the problem. It usually involves three ways:

Filters
Wrappers
Embedded

Feature extraction: This reduces the data which is in a higher dimensional space to a lower dimension of space, i.e. it is changed to lower dimension of spaces.

Sustainable Algorithm:

The algorithm used herein the paper is the feed forward and back propagation algorithm.

The method used here is the artificial neural networks. ANN is one of the major topics studied in the field of machine learning.

Forecasting:

Forecasting is the process of predicting the future based on the past of the collected data and present of the data collected. It helps in managing its attempts to cope with the uncertainty and the error that may occur in the future, depending mainly on data collected from the past and present and the present and analysis of risk and error and approximation and uncertainty are the some of the major factors on which forecasting is dependent.

Verification of data:

This shows us the data collected as output and check that any modifications are required or not. The output is given based on the data provided as input. Here, in this paper, we provide the data collected of various crops in India and the factors of yield such as temperature, rainfall, humidity, etc as input.

V. YIELD OF CROP

Crop selection

To increase the crop yield, selection for a particular crop for a particular weather condition, for a particular soil composition i.e. soil's ph-value, soil's nutrients e.t.c., climatic changes i.e sunny,rainy,cloudy,e.t.c., geography of the region for the crop yield, market prices that may increase or decrease according to requirement of the market, insects that affect the crop i.e. maize, etc. Here we are considering maize crop. Maize is one of the most versatile cr□ps which have wider adaptability under various agro-climatic conditions. Maize, at the global scale, is also called as queen of cereals because it has a high genetic yield among other the cereals. Maize is contributing almost 9% of the Indian food for the people's living in India. It is the third of the most important food crop among India after rice and wheat as the topmost products to be consumed in India. The best time of cultivating or farming the crop is around in Kharif season that is from June to July. Maize can be sowed in all three season and differ the amount of production from season to season.

Table1:,The above table shows the optimum time for sowing in different seasons.

Season	Best time for sowing
kharif	Last week of June to first week of July.
rabi	Last week of October to mid-November.
spring	First week of February.

Forecasting

Indian cultivation mainly depends on seasonal rain for irrigation of the maize crop. Therefore an error-free forecast of weather is required to reduce or minimize the problems that are faced by small Indian farmers like choosing crops according to rain or according to many more weather factors. Due to this purpose, Artificial Neural Networks have been adopted as it is a powerful tool. The Meteorological Department of India has bought the objective well to reduce the destruction caused because of the adverse weather on crops and also to make the use of the favourable weather to increase and to boost the agricultural production of maize in India. Management of climate as well as weather risk in agricultural or crop production has become an important issue due to climate change. The use of climate and weather information helps to make better-informed policy as well as reduces above-given risk and enhances opportunities inefficient use of resources and finally which increases crop production. Generally for maize the amount of water required for production 500-800(mm/total growing period). There are various climatic factors for maize production.

The below diagram shows the growth stage of the maize. Here V and R represent various vegetative and reproductive stages.VE denote that vegetation emerges, V1 denotes the first leaf collar, V2 denotes the second leaf collar, V3 denotes the third leaf collar, V9 denotes the ninth leaf collar, VT denotes the vegetative tasseling.R1 denotes reproductive stage silk.R6 denotes the maturity. And during the maturity, the crop is fully grown or the crop is fully ripe. Therefore the maize crop is ready to harvest.

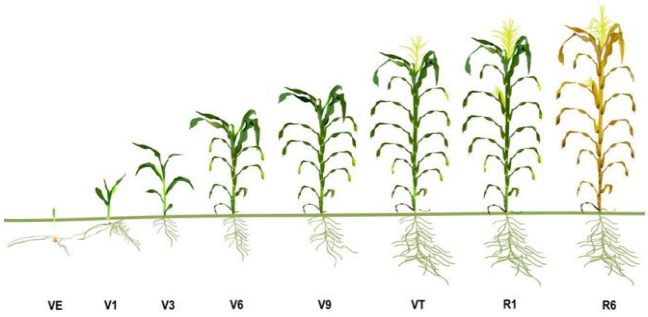

Figure 2: Growth stage of maize.

Table 2: The above table represents various climatic factors effecting maize yield.

CLIMATIC FACTORS	CROP WATER NEED(HIGH)	CROP WATER NEED(LOW)
SUNNY	Sunny (no clouds)	Cloudy(no sun)
TEMPERATURE	Hot	Cool
HUMIDITY	Low(dry)	High(humid)

Irrigation system

Maize crop is very responsive crop according to the moisture requirement of the crop that is required for the crop to be grown perfectly. As maize gets less amount of moisture i.e. water then the crop will get affected the same is applicable for the more amount of moisture in the soil. The most critical time for maize is from 40-65 days after sowing at this moment we are required to take care for the moisture in an appropriate way, otherwise, the yield will be decreased to a substantial extent.

Table3: Irrigation according to growth phase of the maize crop.

DIFFERENT PHASE	DAYS AFTER SOWING
Germination & establishment phase	1-14 days
Vegetative phase	15-39 days
Flowering phase	40-65 days
Maturity phase	66-90 days

Maize is a very important food crop which requires less water and is very sensitive to moisture. Hence, drip irrigation can be very effective for cultivating maize. Drip irrigation is required once in 2 days.

Irrigation based on climatical approach:

Irrigation volume = Pr x Ko x Kv x Ar x We – Rain

Pr – Pan evaporation (mm/day)
Ko – Pan coefficient (0.75 to 0.80)
Kv – Crops co-efficient (0.4 – Vegetative stage; 0.75 – Flowering stage; 1.05 – Grain formation stage)
Ar – Areas (75 x 30 cm)
We – Wet percentage (80% for maize)
Rain – Effective rainfall (mm)

$$\text{Irrigation duration} = \frac{\text{Water requirement for a plant once in 2 days}}{\text{Number of dripper / plant x Discharge rates}}$$

Plant protections

(a) Diseases

Leaf Blight: It is a foliar disease of corn. Characteristic of these diseases is that it forms a cigar like shape on the leaves of the crop. It basically affects the yield of a crop i.e. it significantly decreases the production. Control for these diseases is that the crop can be sprayed with blue copper at 60-65 grams in 18 liters of water; 2-3 sprays in approximately in 15 days.

Figure 3: Leaf Blight

(b) Insect Pests

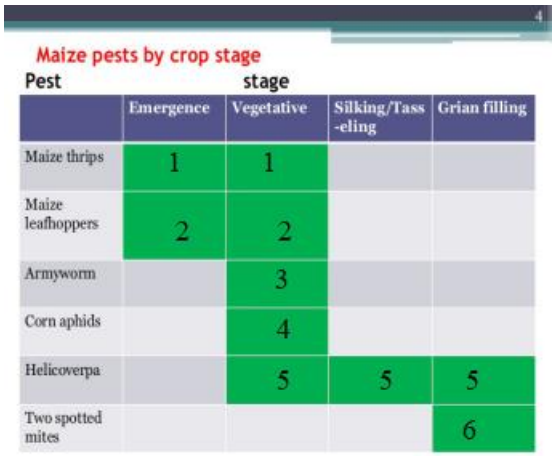

Figure 4: Pests attack on maize at different stages of crop.

The above figure defines that:

1. Maize thrips can affect the crop during emergence and vegetative stage.
2. Maize leafhoppers can affect the maize during the period of emergence and vegetative stage.
3. During the vegetative stage, the maize may get affected by Armyworm.
4. Corn aphids can hurt crop during the vegetative state.
5. Helicoverpa can prove to be very harmful to the crop during the period of vegetative, silking/tasseling and the grain filling stage

6. Two-spotted mites can affect the crop only during the grain filling stage.

VI. METHODOLOGY

This algorithm is used in feed-forward ANN. In this algorithm, artificial neurons are made in layers and forward its signals are sent. Then the error is proceeds backwards. In the input layer, the networks receive input from the neurons or perceptrons and in the output layer output is given with the neurons at the output of the network. Then there are chances of one or more hidden layers. In the paper, we will examine one of the popular and occurring types of network architecture, the feed forward and back propagation of the neural network. It can be applied to various objects. The term feed forward explains how this kind of neural networks recalls the patterns and processes of the system. The neurons are only connected forward in a feed forward way in a neural network system. Each layer of the neural network is connected to the next layer i.e input, hidden, output via connector in forward way but it is not connected backwards (for example. from the input layer to the hidden layer and the output layer).

Back Propagation methodology:

1. Two inputs.
2. Two hidden neurons.
3. Two output neurons.
4. Two biases.

Steps involve in Back Propagation algorithms are the following:

1. Provides different input for data sets and the desired outputs.
2. Calculate the error - error between actual output and model output.
3. Update the parameters as error is used then, update the parameters it again check the error and repeats until the error becomes minimum.
4. Compare the tolerance ratio with the error.

The back propagation and the feed forward algorithm are often utilize together. However, this is not a required for the process to be continued.

In feed forward and back propagation we have taken different data sets of input:

1.Max Temperature And Min Temperature

Table 4: Maximum and Minimum Temperature

Month	9 Days	Tmax(C)	Tmin(C)	Rainfall(mm)
July	1	35.1	20.8	32.0
July	2	36.5	21.5	113.4
August	3	34.5	21.6	29.1
August	4	34.1	20.3	46.0
t August	5	33.3	20.6	147.0
September	6	32.8	20.1	121.0
September	7	34.2	19.5	139.0
October	8	32.6	19.3	25.1
October	9	31.2	18.5	32.7

2.NUTRIENTS

(A) POTASSIUM

0,9 M rows : not more than 40 kg P/ha
1,5 M rows : not more than 30 kg P/ha
2,1 M rows : not more than 20 kg P/ha

(B) NITROGEN

0,9 M rows : not more than 40 kg N/ha
1,5 M rows : not more than 30 kg N/ha
2,1 M rows : not more than 20 kg N/ha

Table 5: Values for N, P, K, S and Mg

	Yield(t/ha)	N	P	K	S	Mg
Grain	5.0	80	17	22	8	10
stover	5-6	56	9	90	10	19
Total DM*	11.0	136	26	112	18	29
Silage	32(wet)					
Grain	10.0	160	32	41	15	17
Stover	10-11	112	14	166	17	35
Total DM*	20.8	272	46	207	32	52
Silage	60(wet)					
Grain	12.5	200	39	51	18	20
Stover	12-13	140	16	194	20	38
Total DM*	24	340	55	245	38	58
Silage	75(wet)					

ALGORITHM

The squared error of function is:

F=1/2[T(o)-A(o)]
F=square error
T(o)=Target Outputs
A(o)=Actual Outputs
A(o)=∑^n 1WiXi

n=Number of input units to the neuron.
Wi= Weight of ith term
Xi= ith input value for neuron.
For activation function:
A(o)=ϕ(net)
net= ∑^n 1WiXi
This shows the ground work for calculating the partial derivative of error w respect to Wi using chain rule:
∂F/∂Wi = dF/dA(o) * dA(o)/d(net) * d(net)/∂Wi
∂F/∂Wi = Error change when weight is changed.
dF/dA(o) = The error change when the output is change.
dA(o)/d(net) = The output change when weighted sum changed.
d(net)/∂Wi = The weighted sum changed as the weight change.
In this paper crop prediction methodology is used to predict crop by using various parameters of atmosphere and also parameters of soil. ANN is used for this purpose. Prediction and approximation of crop yield in India are done by the ability of ANN technology.

VII. RESULTS

The proposed methodology used in determining the yield of a crop is an artificial neural network with feed forward and back propagation algorithm. At first, the data set is loaded in the application. The data consists of various factors that determine the yield of a crop such as pH level, nitrogen, rainfall, humidity etc. Various crops depending upon the various factors show the yield, how these factors play an important role for a yield of a particular crop. crop has various positive factors for higher yield. Advantage of the new result is that when we give input in the system it gives an approximate value of the crop prediction according to the requirement of the crop i.e. maize. When we give input of the nutrients and the rainfall and the temperature required for the crop and the fertility of the soil according to the crop maize then it will analyse the history of the crop for the maize and it will give output like what other fertilizer and pesticides and chemicals and how much of water we have to give to crop for the better yield of the crop. In this project, we have changed the irrigation system for the crop because maize is a very sensitive crop that's why excessive amount of water as well as the less amount of water can ruin the crop. Fewer amount or more amount of water can ruin the maize crop of the whole field. To avoid this situation we are using drip irrigation as the source of irrigation in the maize field.

VIII. CONCLUSIONS

The main point of our study is to prove the effectiveness of artificial neural networks for determining the yield of crop maize. In this paper, we have used various algorithms to classify such as feed forward and back propagation. While determining the yield of a crop, we got results using the feed forward algorithm first, then the back propagation algorithm has corrected those error that was occurring during the use of the algorithm. Thus in the future, we will perform and use most accurate models and idea for easy conductance of artificial neural networks. The output we got are more efficient than the previous output according to our data set that we are using as the output for a crop called maize.
For the betterment of the crop yield or crop production, we are using drip irrigation. Drip irrigation is a better option because first of all, it helps in increasing crop production. Secondly, it also helps us in saving water. Third, maize is a very sensitive crop and hence improper irrigation (over-irrigation or less irrigation) may affect the crop adversely.

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AUTHORS PROFILE

Ritesh Kumar Rajan is a pre-final year student in Dept of Computer Science & Engineering at SRM Institute of Science & Technology, Ramapuram. He has experience in Networking and Cloud computing.

Priyasha Nandi is a pre-final year student in Dept of Computer Science & Engineering at SRM Institute of Science & Technology, Ramapuram. She has experience in Networking and Cloud computing.

Yugit Chauhan is a pre-final year student in Dept of Computer Science & Engineering at SRM Institute of Science & Technology, Ramapuram. He has experience in Machine Learning.

Dr. J Jagadeesan is a professor in in Dept of Computer Science & Engineering at SRM Institute of Science & Technology, Ramapuram. Awaiting for the acceptance from Malaysian Journal of Computer Science paper titled "Efficient Data Management approach for Distributed DBMS with Integrated Extensive Archival Resolution".