"An Artificial Neural Network Approach for Agricultural Crop Yield Prediction Based on Various Parameters"

Snehal S. Dahikar, PG Student (EXTC), Dept. Of EXTC, Sipna College of Engineering, Amravati, Maharashtra, India

Prof. Dr. Sandeep V. Rode, Dept. Of EXTC, Sipna College of Engineering, Amravati, Maharashtra, India

Prof. Pramod Deshmukh, HEAD, Dept. of Soil Science & Agri, Chemistry, Shri Shivaji College of Agriculture, Amravati, Maharashtra, India

***Abstract*— by considering various situations of climatologically phenomena affecting local weather conditions in various parts of the world. These weather conditions have a direct effect on crop yield. Various researches have been done exploring the connections between large-scale climatologically phenomena and crop yield. Artificial neural networks have been demonstrated to be powerful tools for modeling and prediction, to increase their effectiveness. Crop prediction methodology is used to predict the suitable crop by sensing various parameter of soil and also parameter related to atmosphere. Parameters like pH, nitrogen, phosphate, potassium, depth, temperature, rainfall,. For that purpose we are used artificial neural network (ANN).In this paper, we suggested fertilizer by using ANN.**

***Index Terms*— Artificial neural networks, pH, Nitrogen, Temperature, Rainfall. Crop yield prediction**

I. INTRODUCTION

Farming is the main occupation of India. About 70% of primary and secondary business is based on farming and it is also the backbone of our Indian economy. So for the betterment of farming Indian govt. is providing subsidies fertilizers for the farmers. But, due to illiteracy in the farmers they can't use the proper amount of fertilizers for their land and results the in fertile land. For this govt. is giving basic education to farmers that how to keep our land and crops healthy.

A prerequisite of intelligent system has brought artificial neural network (ANN) to become a new technology which provides assorted solution for the complex problems in agriculture researches. Since it can solve many problems that linear system is incapable to resolve, ANN becomes crucial especially in innovating and developing better products for society. Though there are many types of ANN, this project only presented the most commonly used type of ANN, which is the feed-forward back propagation network.

The basic principle of ANN architecture, application of ANN in predicting crop yield by using various types of crop performance factors as the input parameters, guidelines for selecting ANN method and future development and current trends in the application of ANN to predict yield will also be presented. Here using ANN, predicting the proper crop for particular soil and also suggesting proper fertilizer for that crop.

Most farmers were relied on their long-terms experiences in the field on particular crops to expect a higher yield in the next harvesting period. Shearer had listed two important steps to predict crop performance. First was by using traditional approach of mathematical models and the second was on the application of artificial intelligent for the prediction of crop response.

II. LITERATURE REVIEW

After a thorough background work, some of the most valuable recent documents and papers are,

B. J I ET AL [2] developed agricultural management need simple and accurate estimation techniques to predict rice yields in the planning process. The necessity of the present study were to: (1) identify whether artificial neural network (ANN) models could effectively predict rice yield for typical climatic conditions of the mountainous region, (2) evaluate ANN model performance relative to variations of developmental parameters and (3) compare the effectiveness of multiple linear regression models with ANN models. In this paper describes the development of artificial neural network models as an alternate and more accurate technique for yield prediction.

B.A. Smith et al [3] discuss year-round air temperature prediction models were developed for prediction horizons of 1 to 12 h using Ward-style ANNs. These models were intended for use in general decision support. The ANN design modifications described herein provided increased accuracy over previously developed, winter specific models during the winter period. It was shown that models that included rainfall terms in the input vector were more accurate than those that did not.

D.L. Ehret et al [5] introduce all crop attributes responded in much the same way to individual climatic factors. Radiation and temperature generally induced strong positive responses while RH produced a negative response. In the NN models, radiation and temperature were still prominent, but the importance of CO2 in predicting a crop response increased. One advantage of these automated systems is that they offer continuous information across a range of timescales. Furthermore, these systems can readily be used in commercial greenhouses so the derived NN models are relatively

ISSN: 2278 – 909X

easy to deploy to a commercial setting where they can subsequently be improved over time.

In this paper crop prediction methodology is used to predict the suitable crop by sensing various parameter of soil and also parameter related to atmosphere. Parameters like pH, nitrogen, phosphate, potassium, depth, temperature, rainfall. For that purpose we are used artificial neural network (ANN).This project shows the ability of artificial neural network technology to be used for the approximation and prediction of crop yields at rural district.

III. PROPOSED WORK

A. *Artificial Neural Network*

Artificial neural networks (ANN) are designed after the learning functions of the human brain so it can recognize patterns and predict. ANNs are formed from simulated neurons that are analogous to functions of the human brain for numerous reasons. In the brain, a neuron sends out an electrical signal through a strand known as an axon, which splits into many branches. At the end of each branch, there is an area called a synapse.). An ANN is similar to the functioning of the brain because there are weighted connections (correspond to synapses) between simulated neurons where signals it receives (numbers) are summed and then (with most neuron models) a signal is sent (fired) if a certain threshold is reached There are different neural network designs whereby information is processed in different manners. The most used type of ANN today is nonlinear feed forward and by far the most popular feed forward type is back propagation.

B. *Feed Forward Back Propagation Method*

In this paper we shall examine one of the most common neural network architectures, the feed forward back propagation neural network. This neural network architecture is very popular, because it can be applied to many different tasks.
The first term, “feed forward” describes how this neural network processes and recalls Patterns. The term “back propagation” describes how this type of neural network is trained. Back propagation is a form of supervised training. The figure is shown below.

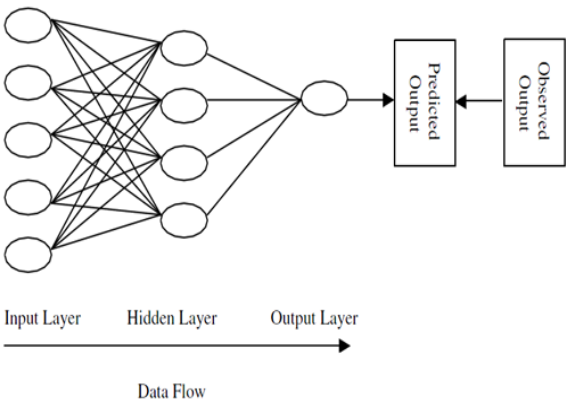

Fig: Layer and connection of feed forward back propagating artificial Neural Network.

ANN models find relationships by observing a large number of input and output examples to develop a formula that can be used for predictions (Pachepsky et al. 1996). Nonlinear relationships overlooked by other methods can be determined with little a priori knowledge of the functional relationship (Elizondo et al. 1994). A minimum of three layers is required in an ANN model: the input, hidden and output layers (Fig. 1). The input and output layers contain nodes that correspond to input and output variables, respectively. Data move between layers across weighted connections. A node accepts data from the previous layer and calculates a weighted sum of all its inputs, t :

$$t_i = \sum_{j=1}^{n} w_{ij} x_j$$

where n is the number of inputs, w is the weight of the connection between node i and j, and x is the input from node j. A transfer function is then applied to the weighted value, t, to calculate the node output, Oi:

$$o_i = f(t_i)$$

The most commonly used transfer function is a sigmoidal function for the hidden and output layers and a linear transfer function is commonly used for the input layer. The number of hidden nodes determines the number of connections between inputs and outputs and may vary depending on the specific problem under study.

C. *Design Flow Chart*

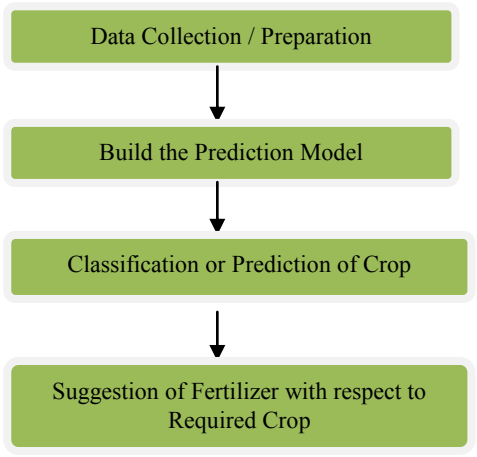

Fig: Design flow chart

Data Collection/Preparation

All related data related to plant nutrients and other parameter is collected from Vidarbh region.

Vidarbha's economy is primarily agricultural and also the region is rich in forest and mineral wealth. The main cash crops of the region are cotton, oranges and soya beans. Amravati is the largest Orange growing district. Traditional crops are sorghum (jowar), pearl millet (bajra) and rice. Yavatmal is the largest cotton growing district. Gondia is the largest rice growing district. Gondia is a Rice city.

Maximum temperature of Vidarbha is 410C, Minimum temperature 210C. Average annual rainfall is 700 to 900 mm 75 % rains received in all districts of the zone. Soil color ranges from black to red. Type- 1) vertisols 2) entisols & 3) inceptisols PH 7-7.5

In this project all data related to crop production is collected from Shri Shivaji Agriculture College, Amravati. Information related to crop parameter is shown in table below.

Build the Prediction Model

Using Artificial Neural Network (ANN) to build the prediction model, it separated into 3 steps. Step 1, In order to find out an optimal configuration of neural network model, it was necessary to

ISSN: 2278 – 909X

combine many different ANN prototypes. Consequently, nine different training algorithms were used for network training. Step 2, the number of hidden layer(s) and the value of the training parameters for every training algorithm were obtained by trial and error method with considering of ANN performance. For selecting the number of hidden layers along with the right number of neurons in the middle layers, comparison of networks which had different number of neurons and also different number of hidden layers were carried out. Comparison of the performances of the developed ANN models was conducted based on the scale of Root Mean Square Error (RMSE.) , Step 3, It was the initialization of the network weights and parameters by adjust the momentum.

Crop	pH	N	P	K	Depth	Temp	Rainfall
Cotton	7-8.5	100	50	50	30	27-33	700-1200
Sugarcane	6.5-7.5	175	100	100	60	20-50	750-1200
Jowar	6.0-8.5	80	40	40	50-20	25-30	800-1000
Bajra	7-8.5	40	20	25	15	28-32	400-750
Soybeans	6.5-7.5	30	75	15	15-20	25-33	700-1000
Corn	7.5-8.5	100	25	0	20-50	13-30	500-600
Rice	6-8.5	100	50	50	15-20	16-22	25-180
Wheat	5.5-8.5	100	50	50	50-20	22-25	1000-1500
Groundnut	6-7.5	25	50	30	20	24-27	500-1250

Table: Essential Parameters of Crop

Following parameters we used for creating feed-forward back propagation network.

No. of input layers = 7
No. of output layers = 1
No of hidden layers = 50
Transfer function used = {tansig,tansig}
Training Algorithm = trainlm (Back Propogation Algorithm)
learning = 'learngdm';
Iterations = 1200

Prediction of Crop

On the basis of above training parameter for ANN, we train the ANN. Now we are giving the seven parameter viz, pH, N, P, K, depth, rainfall, temperature to predict the crop by using ANN as shown in fig below.

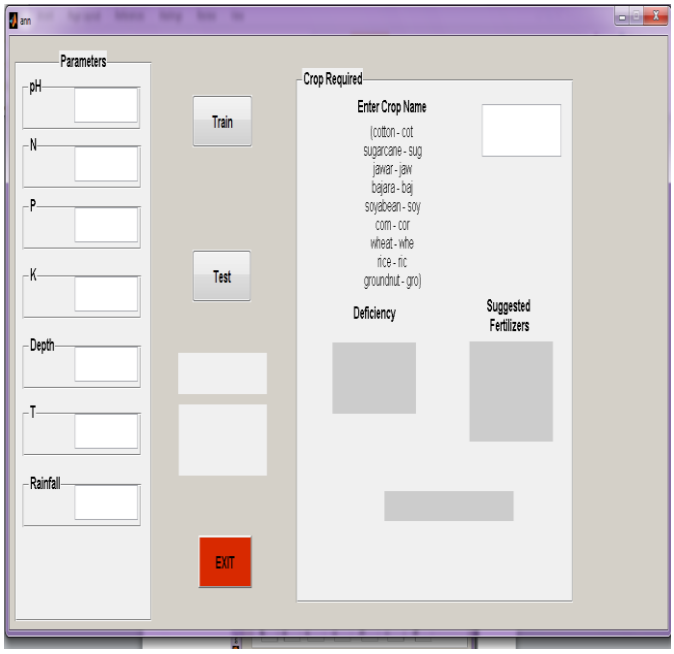

Fig: GUI of ANN

Suggestion of Fertilizer

In some cases, user doesn't want to grow predicted crop in his field. He wants some other crop to take from his field. In that case, we are suggesting the fertilizer to fulfill his constrains. Fertilizer is suggested according to the values of N, P and K and its values are comparing with predicted crop. If values of N, P and K are high then no fertilizers suggested and values are low then suggested fertilizer as follows,

If "N" is less then Urea [CO(NH2)], Ammonium sulphate [(NH4)2SO4], Ammonium nitrate (NH4NO3), and Sodium nitrate (NaNO3).

If "P" is less then Calcium hydrogen phosphate or superphosphate [Ca (H2PO4)2], Ammonium hydrogen phosphate or ammophos [(NH4)H2PO4], and Ammonium phosphate [(NH4)3PO4].

If "K" is less then Potassium nitrate (KNO3), Potassium chloride (KCl) and Potassium sulphate (K2SO4).

IV. RESULT

In this project, MATLAB was used to build the ANN prediction model. The result divided into the following topics;

A. Prediction of Crop

Crop is predicted by ANN by entering various parameters. If we enter pH=7.1, N=175, P=100, K=100, Temp=60, depth=30, rainfall=800. Then predicted crop by ANN is sugarcane and also show its standard value. It is shown in fig

ISSN: 2278 – 909X

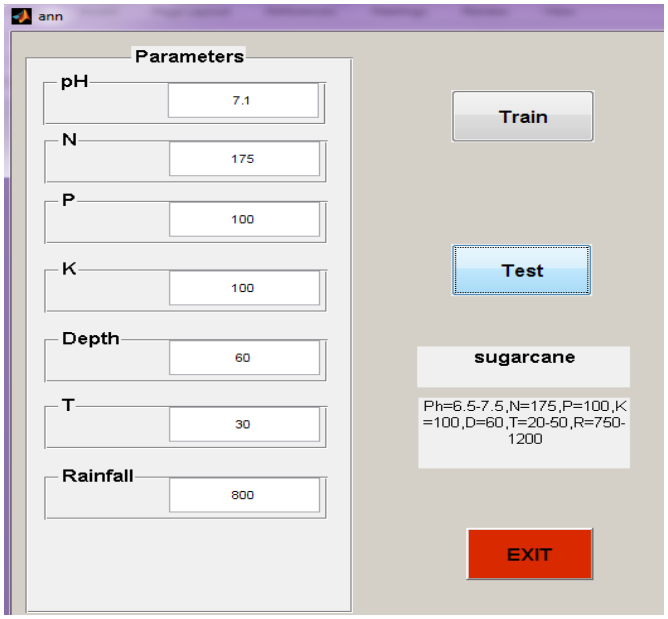

Fig: Result of Predicted Crop is Sugarcane

B. Suggestion of Fertilizer

In some cases, user doesn't want to grow predicted crop in his field. He wants some other crop to take from his field. In that case, we are suggesting the fertilizer to fulfill his constrains. Fertilizer is suggested according to the values of N, P and K and its values are comparing with predicted crop. If values are low then suggested fertilizers as shown in fig.

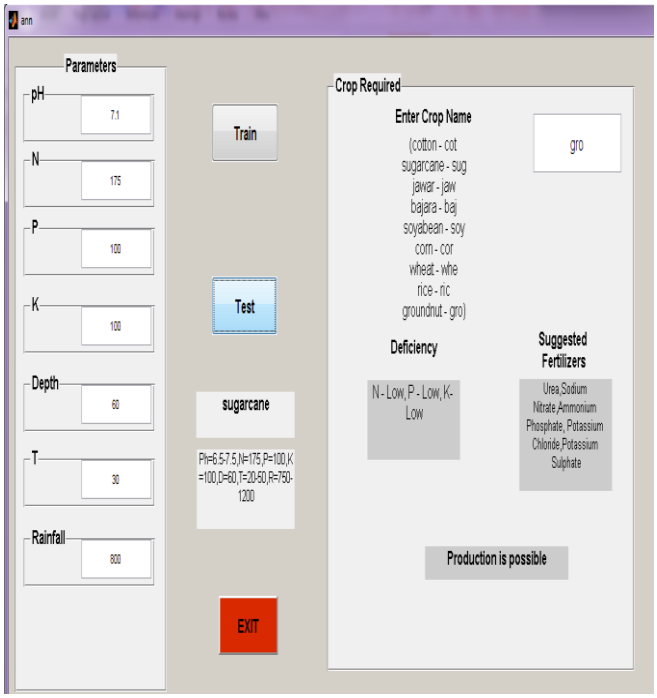

Fig: Suggestion of Fertilizer for N, P, K low

If values of N, P and K are high then no fertilizers suggested as shown in fig below.

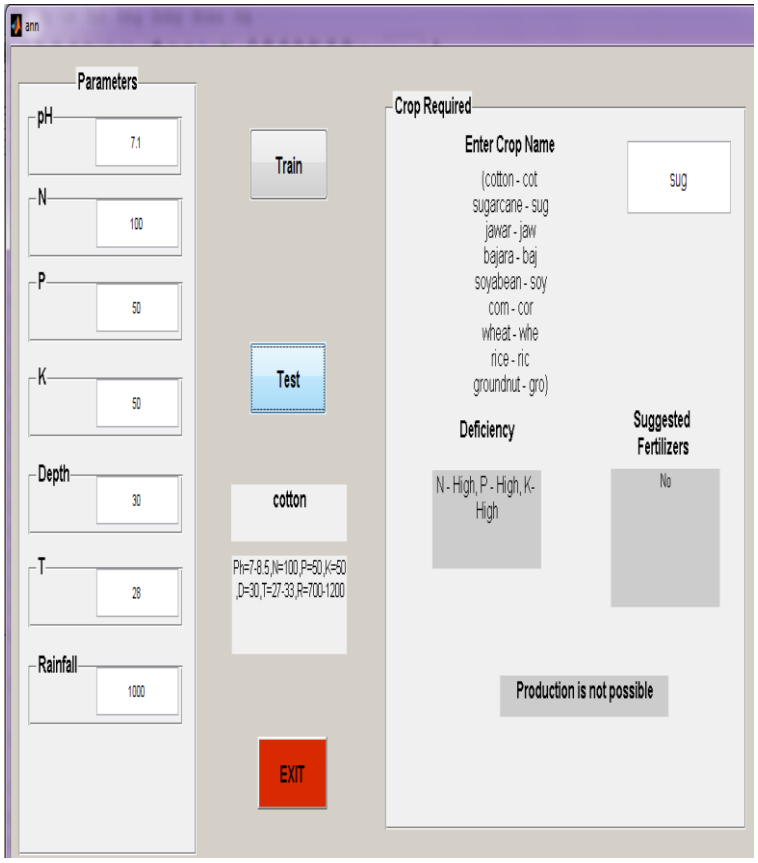

Fig: No Suggestion of Fertilizer for N, P, K High

.

These are the standard fertilizer for each nutrient which is required for these crops.

Some organic fertilizers are as follows,

Manure (cow dung)

Worm compost

Some composite fertilizer

Mono ammonium phosphate

Di ammonium phosphate

Ammonium phosphate sulphate

Urea ammonium phosphate

Ammonium nitrate phosphate

V. CONCLUSION

From the above result we can conclude that the system gives the verified result as given by ANN test and the result is satisfactory. from the above description and based on the Matlab we conclude that by using Artificial Neural Network we can predict the crop based on various parameter. By calculating deficiency of N, P and K suggest the fertilizer. This system is useful for farmers who are economically weak and can't afford the lab soil test.

ISSN: 2278 – 909X

Future Scope

We can extend this project for more than 9 crops and also make a system for single crop and take the care for its nutrient from sowing to harvesting.

Crop disease detection and prevention.

Total care for single crop.

Giving information about micronutrients also.

VI. REFERENCES

[1] Aggarwal Sachin (2001). Application of Neural Network to Forecast Air Quality Index. Thesis submitted in partial fulfillment of requirements for a degree in Bachelor of Technology, April 2001.
[2] B. J I ET AL Artificial neural networks for rice yield prediction in mountainous regions. Journal of Agricultural Science (2007), 145, 249–261.
[3] B.A. Smith et al, Artificial Neural Networks for Automated Year round Temperature Prediction. Computers and Electronics in Agriculture 68 (2009) 52–6.
[4] Cheng, B. and Titterington, D. M. (1994). Neural networks: A review from a statistical perspective Statistical Science, 9: 2-54.
[5] D.L. Ehret et al, Neural network modeling of greenhouse tomato yield, growth and water use from automated crop monitoring data. Computers and Electronics in Agriculture 79 (2011) 82–89.
[6] Enfield, D. B., 1996. Relationships of inter-American rainfall to tropical Atlantic and Pacific SST variability. Geophysical Research Letters 23(23): 3305-3308.
[7] Everingham, Y. L., R. C. Muchow, R. C. Stone, and D. H. Coomans, 2003. Using southern oscillation index phases to forecast sugarcane yields: a case study for Northeastern Australia. International Journal of Climatology 23(10): 1211-1218.
[8] Handler, P, 1990. USA corn yields, the El Niño and agricultural drought: 1867-1988. International Journal of Climatology 10(8): 819-828.
[9] Hansen, J. W., J. W. Jones, C. F. Kiker, A. W. Hodges, 1999. El Niño-Southern Oscillation impacts on winter vegetable production in Florida. Journal of Climate 92-102.
[10] Hansen, J. W., A. W. Hodges, and J. W. Jones, 1998. ENSO Influences on agriculture in the southeastern United States. Journal of Climate 11(3): 404-411.
[11] Haykin, S, 1999. Neural Networks: A Comprehensive Foundation (Second Edition). Upper Saddle River, NJ: Prentice Hall.
[12] Izaurralde, R. C., N. J. Rosenberg, R. A. Brown, D. M. Legler, M.T. Lopez, R. Srinivasan, 1999. Modeled effects of moderate and strong Los Niños" on crop productivity in North America. Agricultural and Forest Meteorology 94(3): 259-268.
[13] Jain, A., R. W. McClendon, G. Hoogenboom, and R. Ramyaa, 2003. Prediction of frost for fruit protection using artificial neural networks. American Society of Agricultural Engineers, St. Joseph, MI, ASAE Paper 03-3075.
[14] Jain, A., R. W. McClendon, and G. Hoogenboom, 2006. Freeze prediction for specific locations using artificial neural networks. Transactions of the ASABE 49(6): 1955-1962.
[15] Jones, J. W., G. Hoogenboom, C. H. Porter, K. J. Boote, W. D. Batchelor, L. A Hunt, P. W. Wilkens, U. Singh, A. J. Gijsman, and J. T. Ritchie, 2003. The DSSAT cropping system model. European Journal of Agronomy 18(3): 235-265.

ISSN: 2278 – 909X