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"A Multi-Parameter Artificial Neural Network Model for Estimating Agricultural Crop Yields"

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***Abstract*— byconsideringvarioussituationsofclimatologicallyphenomenaaffectinglocalweatherconditionsinvariouspartsoftheworld.Theseweatherconditionshaveadirecteffectoncropyield.Variousresearcheshavebeendoneexploringtheconnectionsbetweenlarge-scaleclimatologicallyphenomenaandcropyield.Artificialneuralnetworkshavebeendemonstrated to be powerful tools for modeling and prediction,to increase their effectiveness. Crop prediction methodology isusedtopredictthesuitablecropbysensingvariousparameterofsoil and also parameter related to atmosphere. Parameters likepH,nitrogen,phosphate,potassium,depth,temperature,rainfall,.Forthatpurposeweareusedartificialneuralnetwork(ANN).Inthispaper,wesuggestedfertilizerbyusingANN.**

***IndexTerms*—Artificialneuralnetworks,pH,Nitrogen,Temperature,Rainfall. Cropyieldprediction**

INTRODUCTION

Farming is the mainoccupationof India. About 70% ofprimaryand secondary business is based on farming and it is alsothe backbone of our Indianeconomy. So for the betterment offarmingIndiangovt.isprovidingsubsidiesfertilizersforthefarmers.But,dueto illiteracyinthefarmerstheycan'tusetheproperamountoffertilizersfortheirland andresultstheinfertileland.Forthis govt. is giving basic education to farmers that how to keep ourland andcropshealthy.

A prerequisite of intelligent system has brought artificialneuralnetwork(ANN)tobecomeanewtechnologywhichprovidesassortedsolutionforthecomplexproblemsinagriculturesearches. Since it can solve many problems that linear system isincapabletoresolve,ANNbecomescrucialespeciallyininnovating and developing better products for society. Thoughthere are many types of ANN, this project only presented the mostcommonly used type of ANN, which is the feed-forward backpropagation network.

The basic principle of ANN architecture, application of ANNin predicting crop yield by using various types of crop performancefactorsastheinputparameters,guidelinesforselectingANNmethodandfuturedevelopmentandcurrenttrendsintheapplicationofANNtopredictyieldwillalsobepresented.HereusingANN,

predictingthepropercropforparticularsoilandalsosuggestingproperfertilizer forthat crop.

Mostfarmerswerereliedontheirlong-termsexperiencesinthefieldonparticularcropstoexpectahigheryieldinthenextharvesting period. Shearer had listed two important steps to predictcropperformance.Firstwasbyusingtraditionalapproachof mathematical models and the second was on the application ofartificialintelligent for theprediction ofcropresponse.

LITERATUREREVIEW

After a thorough background work, some of the most valuablerecentdocuments andpapersare,

B.JIETAL [2]developedagricultural management needsimple and accurate estimation techniques to predict rice yields intheplanningprocess.Thenecessityofthepresentstudywereto: (1)identifywhetherartificialneuralnetwork(ANN)modelscouldeffectively predict rice yield for typical climatic conditions of themountainous region, (2) evaluate ANN model performance relativetovariationsof developmental parameters and(3) compare theeffectivenessofmultiplelinearregressionmodelswithANN models. In this paper describes the development of artificial neuralnetwork models as an alternate and more accurate technique foryield prediction.

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B.A.Smithetal[3]discussyear-roundairtemperaturepredictionmodelsweredevelopedforpredictionhorizonsof1to12h using Ward-style ANNs. These models were intended for use ingeneral decision support. The ANN design modifications describedhereinprovidedincreasedaccuracyoverpreviouslydeveloped,winter specific models during the winter period. It was shown thatmodels that included rainfall terms in the input vector were moreaccurate thanthosethat didnot.

D.L. Ehret et al [5] introduce all crop attributes responded inmuch the same way to individual climatic factors. Radiation andtemperature generally induced strong positive responses while RHproduced a negative response. In the NN models, radiation andtemperature were still prominent, but the importance of CO2 inpredictingacropresponseincreased.Oneadvantageoftheseautomatedsystemsisthattheyoffercontinuousinformationacrossarangeoftimescales.Furthermore,thesesystemscanreadilybeusedincommercialgreenhousessothederivedNNmodelsarerelatively

easytodeployto acommercialsettingwheretheycan subsequentlybeimprovedover time.

In this paper crop prediction methodology is used to predictthe suitable crop by sensing various parameter of soil and alsoparameterrelatedtoatmosphere.ParameterslikepH,nitrogen,phosphate, potassium, depth, temperature, rainfall. For that purposewe are used artificial neural network (ANN).This project shows theability of artificial neural network technology to be used for theapproximation andprediction of crop yields at rural district.

PROPOSEDWORK

ArtificialNeuralNetwork

Artificialneuralnetworks(ANN)aredesignedafterthelearning functions of the human brain so it can recognize patternsand predict. ANNs are formed from simulated neurons that areanalogous to functions of the human brain for numerous reasons. Inthe brain, a neuron sends out an electrical signal through a strandknown as an axon, which splits into many branches. At the end ofeach branch, there is an area called a synapse.). An ANN is similartothefunctioningofthebrainbecausethereareweightedconnections (correspond to synapses) between simulated neuronswheresignalsitreceives(numbers)aresummedandthen(with mostneuron models) a signal is sent (fired) if a certain threshold isreachedTherearedifferentneuralnetworkdesignswherebyinformationisprocessedindifferentmanners.ThemostusedtypeofANN today is nonlinear feed forward and by far the most popularfeed forwardtypeisbackpropagation.

A. *Feed Forward Back Propagation Method*

In this paper we shall examine one of the most commonneural network architectures, the feed forward back propagationneural network. This neural network architecture is very popular,becauseit can beapplied tomanydifferent tasks.

The first term, “feed forward” describes how this neural networkprocessesandrecallsPatterns.Theterm“backpropagation”describeshowthistypeofneuralnetworkistrained.Backpropagation is a form of supervised training. The figure is shownbelow.

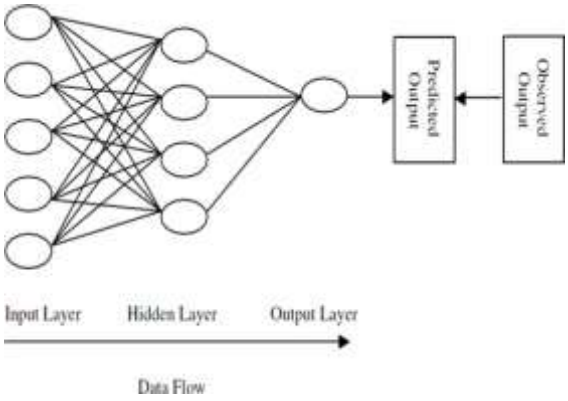

Fig:Layerandconnectionoffeedforwardbackpropagatingartificial Neural Network.

ANN models find relationships by observing a large numberof input and output examples to develop a formula that can be usedforpredictions(Pachepsky et al. 1996). Nonlinear relationshipsoverlooked by other methods can be determined with little a prioriknowledge of the functional relationship (Elizondo et al. 1994). Aminimum of three layers is required in an ANN model: the input,hiddenandoutputlayers(Fig.1).The input andoutput layerscontainnodesthatcorrespondtoinputandoutputvariables,respectively.Datamovebetweenlayersacrossweighted connections.Anodeacceptsdatafromthepreviouslayerandcalculatesa weightedsumofall itsinputs, t:

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

where n is the number of inputs, w is the weight of the connectionbetween node i and j, and x is the input from node j. A transferfunction is then applied to the weighted value, t, to calculate thenodeoutput,Oi:

$$o_i = f(t_i)$$

The most commonly used transfer function is a sigmoidal functionfor the hidden and output layers and a linear transfer function iscommonly used for the input layer. The number of hidden nodesdetermines the number of connections between inputs and outputsand mayvarydependingon thespecific problemunder study.

B. *DesignFlowChart*

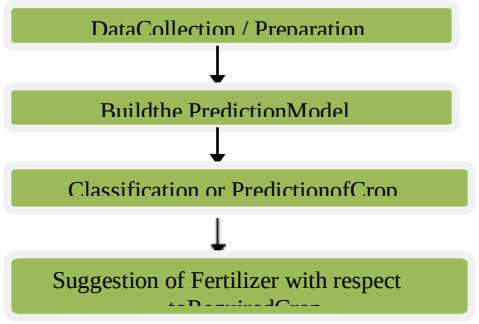

Fig:Designflowchart

DataCollection/Preparation

All related data related to plant nutrients and other parameter iscollected fromVidarbhregion.

Vidarbha'seconomyisprimarilyagriculturalandalsothereg ionis rich in forest and mineral wealth. The main cash crops of theregion are cotton, oranges and soya beans. Amravati is the largestOrange growing district. Traditional crops are sorghum (jowar),pearl millet (bajra) and rice. Yavatmal is the largest cotton growingdistrict. Gondia is the largest rice growing district. Gondia is a Ricecity.

MaximumtemperatureofVidarbhais410C,Minimumtemp erature 210C. Average annual rainfall is 700 to 900 mm75 %rains received in all districts of the zone. Soil color ranges fromblacktored.Type-
1)vertisols2)entisols&3)inceptisolsPH7-7.5

In this project all data related to crop production is collectedfromShriShivajiAgricultureCollege,Amravati.Infor mationrelated tocrop parameter isshown intablebelow.

BuildthePredictionModel

Using Artificial Neural Network (ANN) to build the predictionmodel, it separated into 3 steps. Step 1, In order to find out anoptimalconfigurationof neuralnetworkmodel,itwasnecessaryto

combinemanydifferentANNprototypes.Consequently,ninedifferen nttrainingalgorithmswereusedfornetworktraining.Step2,thenumb erofhiddenlayer(s)andthevalueofthetrainingparameters for every training algorithm were obtained by trial anderror method with considering of ANN performance. For selectingthenumberofhiddenlayersalongwiththerightnumber ofneuronsin the middle layers, comparison of networks which had differentnumber of neurons and also different number of hidden layers werecarriedout.ComparisonoftheperformancesofthedevelopedA NNmodels was conducted based on the scale of Root Mean SquareError (RMSE.) , Step 3, It was the initialization of the networkweightsand parametersbyadjustthemomentum.

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:EssentialParametersofCrop

Followingparametersweusedforcreatingfeed-forwardbackpropagation network.
No. of input layers =
7No. of output layers
=
1Noofhiddenlayers=5
0
Transferfunctionused={tansig,tansig}
TrainingAlgorithm=trainlm(BackPropogation
Algorithm)learning='learngdm';
Iterations = 1200

PredictionofCrop

On the basis of above training parameter for ANN, we train theANN. Now we are giving the seven parameter viz, pH, N, P, K,depth, rainfall, temperature to predict the crop by using ANN asshown infigbelow.

Fig:GUIofANN

Suggestion ofFertilizer

In some cases, user doesn't want to grow predicted crop in hisfield. He wants some other crop to take from his field. In that case,we are suggesting the fertilizer to fulfill his constrains. Fertilizer issuggested according to the values of N, P and K and its values arecomparingwithpredictedcrop.IfvaluesofN,PandKarehight henno fertilizers suggested and values are low then suggested fertilizerasfollows,

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

If"P"islessthenCalciumhydrogenphosphateorsuperphos phate [Ca (H2PO4)2], Ammonium hydrogen phosphateorammophos[(NH4)H2PO4],andAmmoniumphos phate[(NH4)3PO4].

If"K"islessthenPotassiumnitrate(KNO3),Potassiumchlo ride(KCl) andPotassiumsulphate(K2SO4).

I. RESULT

Inthisproject,MATLABwasusedtobuildtheANNpredictio n model.Theresult divided intothefollowingtopics;

A. PredictionofCrop

Cropispredictedby ANNby enteringvariousparameters.IfweenterpH=7.1,N=175,P=100,K=1 00,Temp=60,depth=30, rainfall=800.ThenpredictedcropbyANNissugarcaneandalsoshow itsstandardvalue. Itis showninfig

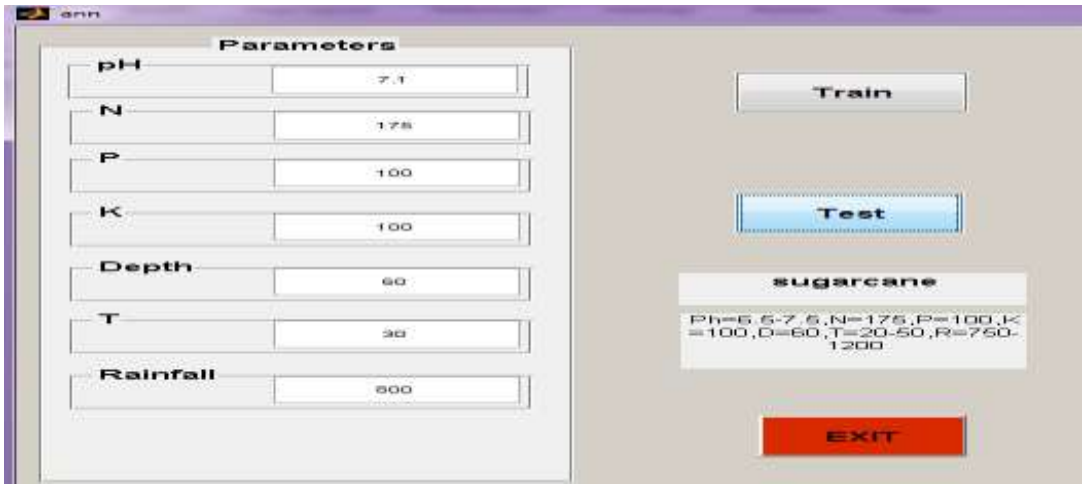

Fig:ResultofPredictedCropisSugarcane

B. Suggestion ofFertilizer

Insomecases,userdoesn'twanttogrowpredictedcropinhisf ield. He wants some other crop to take from his field. In that case,we are suggesting the fertilizer to fulfill his constrains. Fertilizer issuggested according to the values of N, P and K and its values arecomparing with predicted crop. If values are low then suggestedfertilizersasshowninfig.

Fig:SuggestionofFertilizerforN,P,K low

If values of N, P and K are high then no fertilizers suggested asshown infigbelow.

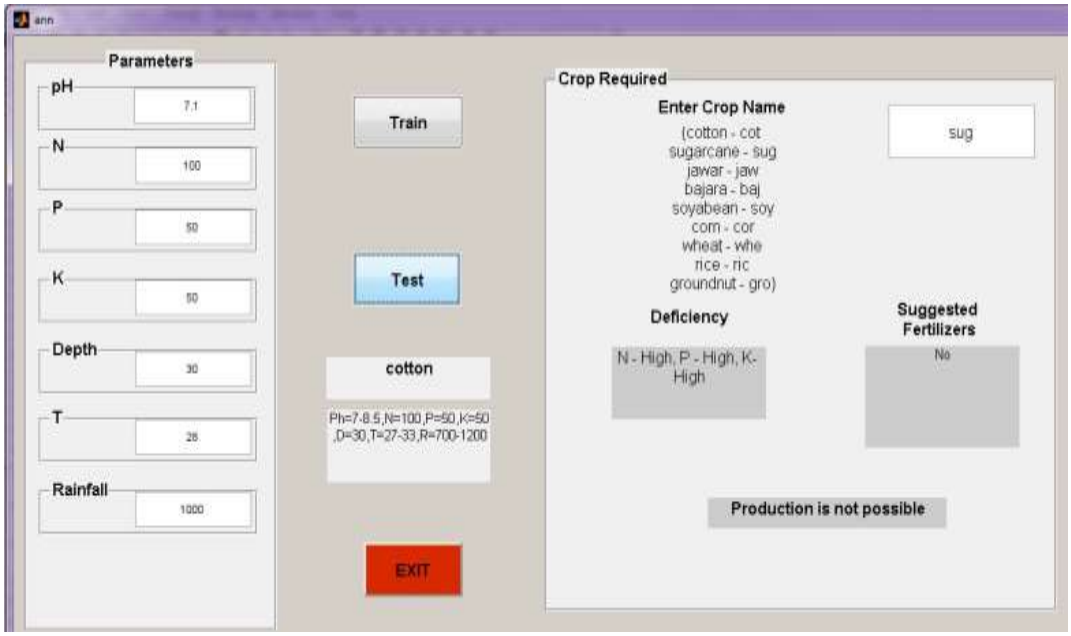

Fig:No SuggestionofFertilizerfor N,P,K High

.

Thesearethestandardfertilizerforeachnutrientwhichisrequired forthese crops.

Someorganicfertilizersareasfollow

s,Manure(cowdung)

Worm

compostSomecompo

sitefertilizer

Monoammoniumphosphat

eDi ammonium

phosphateAmmonium

phosphate sulphateUrea

ammonium

phosphateAmmoniumnitra

tephosphate

We can extend this project for more than 9 crops and also make asystemforsinglecropandtakethecareforitsnutrientfromsowingto

II. CONCLUSION

From the above result we can conclude that the system givestheverifiedresultasgivenbyANNtestandtheresultissatisfactory.from the above description and based on the Matlab we concludethat by using Artificial Neural Network we can predict the cropbasedonvariousparameter.BycalculatingdeficiencyofN,PandKsuggest the fertilizer. This system is useful for farmers who areeconomicallyweakandcan'taffordthelabsoiltest.

FutureScope

harvesting.

Crop

diseasedetectionandprevention.Totalca

refor singlecrop.

Givinginformationaboutmicronutrientsalso.

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