Forecast of Demand and Supply of Pulpwood using Artificial Neural Network

V. Anandhi[1], Dr. R. Manicka Chezian[2] and Dr. K.T. Parthiban[3]

[1]Department of Forest Resource Management, Forest College and Research Institute, Mettupalayam-641 301, Tamil Nadu, India
[2]Department of Computer Science, NGM College, Pollachi-642 001, Tamil Nadu, India
[3]Department of Tree Breeding, Forest College and Research Institute, Mettupalayam-641 301, Tamil Nadu, India

Abstract– **Artificial Neural Networks (ANN) are widely used for superior performance reduced forecasting errors and consequently enhanced decisions and planning. Wood Pulp is the most common raw material in paper making. This paper is an attempt to forecast demand and supply of pulp wood using Artificial Neural Network (ANN). A Levenberg-Marquardt Back Propagation (LMBP) algorithm has been used to develop the ANN models. In developing the ANN models, different networks with different numbers of neuron hidden layers were evaluated. The forecast is done using the feed forward Back Propagation Network (BPN). Consumption of paper per person increases every year. On account of steady increase in paper demand, the forecast on demand and supply of pulp wood is considered to improve the socio economic development of India.**

Index Terms– **Artificial Neural Networks (ANN), Back Propagation Neural Network (BPN), Levenberg-Marquardt Algorithm, Forecast and Pulp Wood**

I. INTRODUCTION

FOREST and Forest products play a significant role in socio economic development of the country. These forests provide various services which include direct and indirect benefits. Since independence the country's forest area has been under pressure due to industrialization, urbanization and the associated science and technology development which resulted in the forest area of 23.58 % [8] against the mandatory requirement of 33%. The pace of development in the country has also accelerated the demand of the forest products, which ushered in a major gap in the demand and supply pattern [7].

Hence wood based industries in the country have been directed [6] to generate their own raw material without depending on forest department supply. Accordingly a large number of wood based industries in the country have developed. Plantations are both through captive farming and also through contract farming. However the achievement in this front is very modest for want of suitable linkage among various stake holders. Forest College and Research Institute developed industrial linkages with pulp and paper industries in the state of Tamil Nadu, India through a National Agricultural Innovation Project on a consortium mode. The demand and supply pattern has been assessed for pulpwood and the same has been forecasted using artificial neural network. The demand and supply data collected from Tamilnadu Newsprint and Papers Limited is used for forecasting pulpwood and this paper discusses the problems and the lessons learnt.

II. LITERATURE REVIEW

A neural network is a massively parallel distributor processor made up of simple processing units. It has a natural property for storing experiential knowledge and making it available for use. A supervised training is accomplished by presenting a sequence of training vectors, or patterns, each with an associated target output vector. The back propagation algorithm is used in layered feed-forward ANNs. This means that the artificial neurons are organized in layers [4], and send their signals "forward", and then the errors are propagated backwards. The network receives inputs by neurons in the input layer, and the output of the network is given by the neurons on an output layer. There may be one or more intermediate hidden layers. The back propagation algorithm uses supervised learning, which means that by providing the algorithm with examples of the inputs and outputs the network to compute, and then the error (difference between actual and expected results) is calculated. The idea of the back propagation algorithm [2] is to reduce this error, until the ANN learns the training data.

The training begins with random weights, and the goal is to adjust them, so that the error will be minimal. A network is created, data is trained and a feed forward propagation network is used for forecasting. The Neural Networks package supports different types of training or learning algorithms [3]. One such algorithm is Back Propagation Neural Network (BPN) technique. The training of a back propagation network involves three stages. They are:

- The feed forward of the input training pattern
- The calculation and back propagation of the associated error
- The Weight adjustments

After the network has been trained, its application involves only the feed forward phase. MATLAB is a high-level language and provides an interactive environment that enables

us to perform computationally intensive tasks faster than with traditional programming languages. Neural Network Toolbox provides tools for designing, implementing, visualizing, forecasting and simulating neural networks. The artificial neural networks are widely used and have become increasingly popular in a broad range of fields [2]. The toolbox supports feed forward networks, radial basis networks, dynamic networks, self-organizing maps, and other proven network paradigms. The main objective of this paper is, to train ANN to forecast the demand and supply of pulpwood.

In India there are about 600 paper mills and out of which 30 to 40% of the industries use wood as a raw material predominantly. The current raw material recruitment is more than 5 million metric cube against the domestic supply of 2.6 million metric cube created a short fall of more than 45%. The short fall is met mostly from imports. Similarly in Tamil Nadu, there are about 39 paper mills and of which only 2 paper mills are wood based and the demand is around 8 lakhs tones of wood against the domestic supply of less than 4 lakhs tones of wood. The demand is increasing at an alarming rate without increase in the actual supply. Three main pulp wood based industries in Tamil Nadu are

- Tamilnadu Newsprint and Papers Limited (TNPL), karur District
- Seshasayee paper and Boards (SPB), Erode District
- South India Viscose industries Limited, Mettupalayam, Coimbatore District

Paper and paper board industries are classified into two groups namely, cultural paper used for writing purpose and Industrial paper for wrapping, packaging purposes. Newsprint is a low-cost, commonly used to print newspapers, and other publications and advertising material. The demand for pulp wood is mainly from the pulp, paper and the newsprint industry. The major supplies of pulp wood firms in Tamil Nadu are:

- State Forest Department
- Tamil Nadu State Forest Plantation Corporation (TAFCORN)
- Private Plantations

III. METHODOLOGY

The study is based on the data collected at the Tamil nadu Newsprint and Papers Limited (TNPL) in Karur District, Tamil Nadu. Over ten years of data are collected for the demand and the supply patterns of pulp wood. The data collected is normalized and a network is created using the newff function. It is trained using the activation function, the training function and the learning function. Back propagation is used as a tool for forecasting [5]. The success in the application of ANN for forecasting lies in the fact that when these networks are properly trained and configured they are capable of accurately approximating any measurable function. The neurons learn the patterns hidden in data and make generalizations of these patterns even in the presence of noise or missing information [1]. Predictions are performed by the ANN based on the observed data. The network has one input

layer, one hidden layer and one output layer (Fig. 1). The forecast is carried out with several numbers of neurons in the hidden layer. Generally the addition of a hidden layer could allow the network to learn more complex patterns, but at the same time decreases its performance [6].
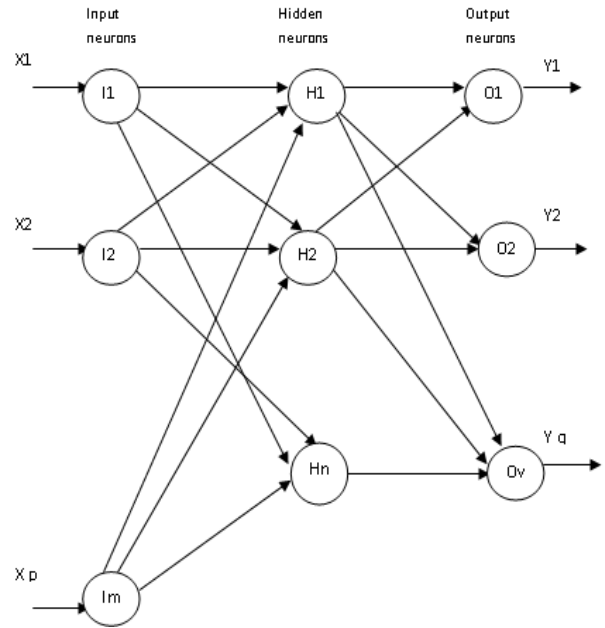

Fig. 1: Architecture of ANN

Table 1: Sample Data of the Supply and Demand of Pulp Wood in MT (Metric Tonnes)

Year	Supply (in MT)	Demand (in MT)
2003	125954	133719
2004	123026	147505
2005	162935	164804
2006	210152	166471
2007	222478	180577
2008	347139	383315

Source: TNPL Management Plan

The data for the demand and supply collected from TNPL is used for developing a network model. The training and forecasting is done using this model.

IV. RESULTS AND DISCUSSIONS

The network is trained with the data (Table 1) and it uses the default Levenberg-Marquardt algorithm. During training, a training window opens as in Fig. 2. This window displays the training progress. The training stopped when the validation error increased for six iterations, which occurred at iteration 1567 for demand and 409 as in Fig. 4 for supply. The results are forecasted with the one hidden layer. Several iterations are carried out for each neuron in the hidden layer.
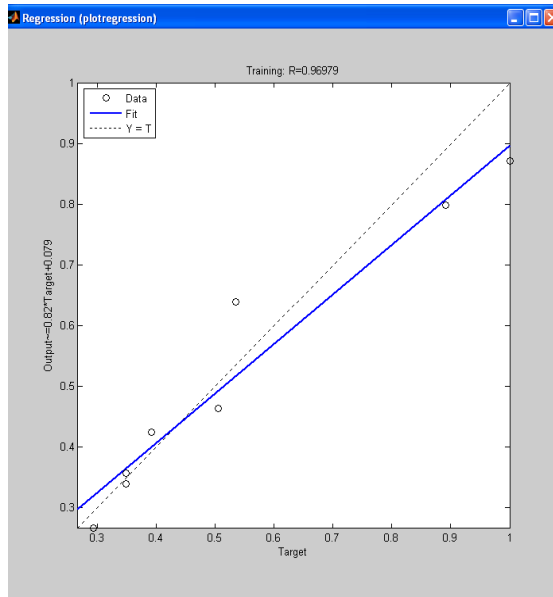
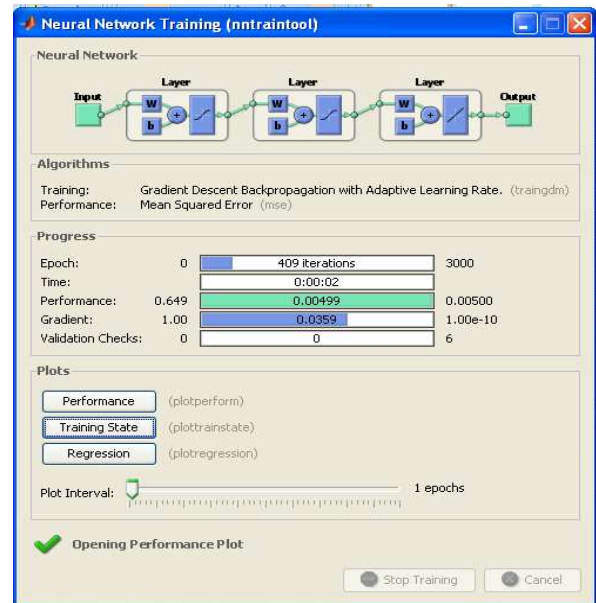Fig. 2: Neural Network Training for Demand

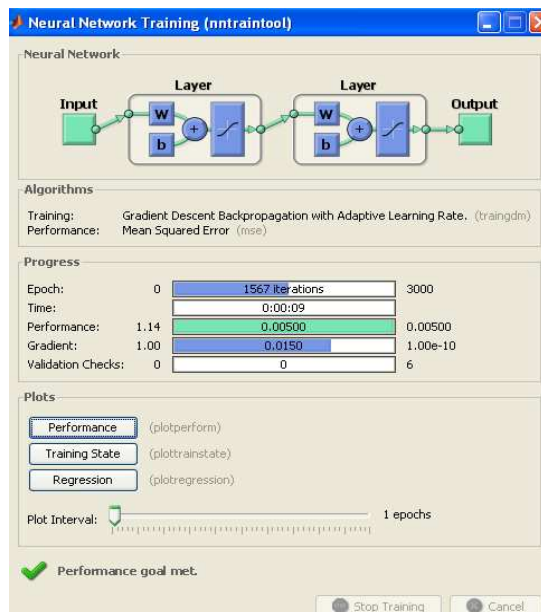Fig. 4: Neural Network Training for supply forecast

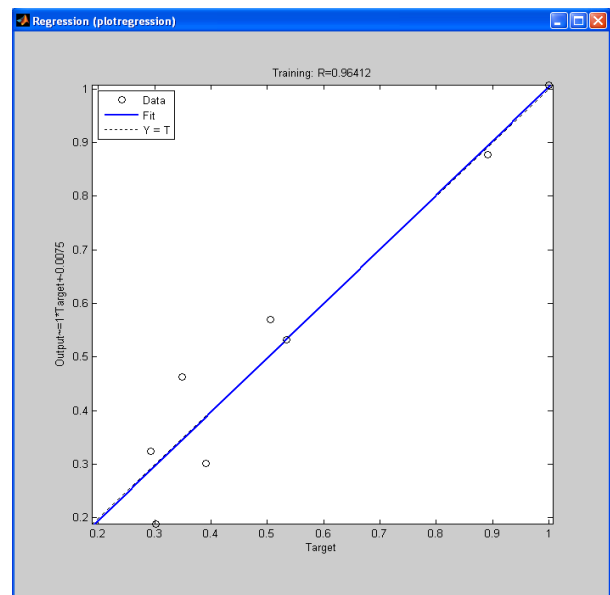Fig. 3: Plot Regression for the demand forecast

Fig. 5: Plot Regression for the supply forecast

The forecast of the demand of pulp wood is carried out and it is 4,90,000 MT for the forthcoming year for Tamilnadu Newsprint and Papers Limited (TNPL).

Regression plot in Fig. 3 in the training window, gives a linear regression between the network outputs and the corresponding targets. The output tracks the targets very well for training, testing, and validation, and the R-value is 0.96979 for the demand and 0.96412 for supply.

The training first creates a feed forward network. The function newff creates a feed forward network. Before training the weights and biasis are initialized. The newff command automatically initializes the weights. The weights can be reinitialized, if required with the init command.

The function takes the network object as input and returns a network object with all weights and biasis initialized. The function sim simulates the network. The Levenberg-Marquardt back propogation algorithm is then implemented. trainlm is a network training function that updates weight and bias values according to Levenberg-Marquardt optimization. trainlm is often the fastest backpropagation algorithm in the toolbox, and is highly recommended as a first-choice supervised algorithm, although it does require more memory than other algorithms. trainlm can train any network as long as its weight, net input, and transfer functions have derivative functions.

The forecast for the supply of pulp wood is found to be 4,52,000 MT respectively for TNPL. Performance in the training window, displays a plot of the training errors, validation errors, and test errors appears, as shown in the Fig. 5.

V. CONCLUSION

The study is conducted with the overall objective of the analysis and forecast of demand and the supply of pulpwood, so forest based industries can raise their raw materials to meet their needs through agro-forestry programs. A simple Artificial Neural Network based prediction model appropriately tuned can outperform other more complex models. To obtain the best performance in prediction, we can follow an experimental approach analyzing the entire ANN design space and applying different training strategies. The study can further be extended for forecasting the demand and the supply of various species of wood and also their price. The awareness of the demand and supply patterns is a supportive mechanism which demanded a systematic forecasting system similar to agricultural products.

ACKNOWLEDGEMENTS

REFERENCES

[1] Daniel Ortiz-Arroyo, Morten K. Skov and Quang Huynh, "Accurate Electricity Load Forecasting With Artificial Neural Networks" , Proceedings of the 2005 International Conference on Computational Intelligence for Modelling, Control and Automation, and International Conference on Intelligent Agents, Web Technologies and Internet Commerce (CIMCA-IAWTIC'05) , 2005

[2] Faridah Othman* and Mahdi Naseri, "Reservoir inflow forecasting using artificial neural Network" , International Journal of the Physical Sciences, 2011

[3] Dr. S. Santhosh Baboo and I.Kadar Shereef "An Efficient Weather Forecasting System using Artificial Neural Network", International Journal of Environmental Science and Development, 2010

[4] Huang, S. H., and Zhang, H. C., Neural-expert hybrid approach for intelligent manufacturing: A survey, 1995

[5] Gerson Lachtermacher, J. David Fuller, "Back propagation in time-series forecasting" , 2006

[6] Parthiban K T and Govinda Rao M , "Pulp wood based Industrial Agroforestry in Tamil Nadu – Case Study. Indian Forester" , 2008

[7] Government Of India Ministry Of Environment And Forests, New Delhi, "National Forest Policy" , 1988

[8] Ministry of Environment & Forests, Govt. of India, "Forest Survey of India" , 2009