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Crop Cost Forecasting using Artificial Neural Network with feed forward back propagation method for Mysore Region

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ABSTRACT: In recent days, agriculture crop price examination is emerging as a significant research field. In this scenario, Mysore district (Karnataka) is undertaken for research investigation. One of the major concern in Crop Cost Prediction (CCP) is to manage large database with maximum attributes. In order to avoid this difficulties, a methodology named Artificial Neural Networks (ANN) with Feed Forward Back Propagation (FFBP) scheme is employed for accurate CCP. In this paper, the cost prediction accuracy is enhanced by minimizing the Mean Squared Error (MSE) by means of forecast values. Therefore, this proposed methodology outcome shows a clear idea about crop price in Mysore region.

KEYWORDS: Artificial neural network, Crop cost prediction, Feed Forward Back Propagation, Mean squared error.

I. INTRODUCTION

Agriculture is the backbone of the nation, which is the major source of income for many people in India. The demand of food is extremely high in highly populated countries. So, the agricultural sectors are needed to be advanced [1]. Nowadays, modern people don't have awareness about the cultivation of crops in a right time at a right place [2]. India's agriculture composed of numerous crops, with the major crop of rice and wheat. Over 70 % of the rural households depend on agriculture that contributes about 17% to the total Gross Domestic Product (GDP) and provides employment to over 60% of the population [3], [4]. Whereas, crop production is completely depend on geographical factors such as, soil chemical composition, rainfall, terrain, soil type, temperature, etc. These factors plays an essential role in crop yield and weather prediction. [5].

Researchers are continuously developing the new methods in weather and crop yield forecasting. Some common machine learning schemes utilized for predicting weather and crop yield are Fuzzy-C-Means (FCM), Self-Organizing Maps (SOM), Machine Learning (ML) and so on [6], [7]. Generally, weather forecasting is employed for monitoring the rainfall rate that gives an idea about suitable crop yield prediction [8]. After suitable crop prediction, the economic forecasting or cost prediction is the most essential factor in the agriculture production. There are some methods available for estimating the agricultural profit such as, Decision Support System (DSS), Genetic Algorithm (GA), etc., [9]. In this scenario, ANN with FFBP scheme is employed for predicting the cost benefit of crop [10]. Experimental outcome confirms that the proposed methodology shows a superior improvement in cost prediction rate in light of accuracy and Mean Square Error (MSE).

This paper is composed as follows. In Section II, survey several CCP strategies. In section III, the standards of ANN strategies are portrayed to seek the better prediction accuracy. In Section IV, the execution of back propagation feed forward based ANN methodology for crop cost estimation is assessed. Conclusion is made in Section V.

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II. LITERATURE REVIEW

Traore, *et al* [11] determined an ANN method for forecasting near prediction of Evapotranspiration (ETo) using public weather forecast restricted messages. Here, three sets of inputs composed for forecasting ETo in Dallas such as, air temperature, extraterrestrial radiation and net solar radiation. Outcome of proposed technique helps the irrigation districts to accommodate in advance their crop water demand to near-future irrigation requirement.

Jiang, *et al* [12] evaluated a crop representation data assimilation with Particle Filter (PF) for estimating the winter wheat harvests. Significant improvement in the crop estimation suggested that PF-based crop representation assimilation was feasible. PF model successfully applied in data assimilation with a process-based agro ecological model due to its strong ability to address nonlinearity and non-Gaussian issues. Though, PF model concentrated only on single crop yield estimation.

Giannaros, *et al* [13] illustrated a weather research and predicting scheme for evaluating wind resource in Greece. Proposed model calculated the basic features of the wind field over Greece and reproduced the wind resource. Whereas, the wind measurements were resultant from a system of surface synoptic weather stations implemented for evaluating model performance.

Abdulrahman, *et al* [14] projected a unified rain attenuation prediction method named as Silva Mello and Pontes for the prediction of rain attenuation in slant paths. This proposed methodology utilized the simplified model of equivalent rain cell and the effective rain rate. Whereas, this research work mainly concentrated on rain rate parameters, but it showed limited attention on crop type, different season, and profit estimation.

To overcome the above mentioned drawbacks, an effective methodology is implemented in ANN, which enhances the procedure acclimated in our anticipated strategy.

III. STUDY AREA

This literature mainly focus on an objective of CCP that helps the farmers to decide on the crop they would like to plant for the forthcoming year, which helps them to obtain maximum price for their products. In this scenario, Mysore region is undertaken for experimental analysis, because they are the largest cultivator of ragi, sugarcane and coarse cereals. Also, Mysore has an increasing focus on agriculture economy with 41.8% of the net area under farming. The sample flow chart diagram for CCP is mention in figure 1.

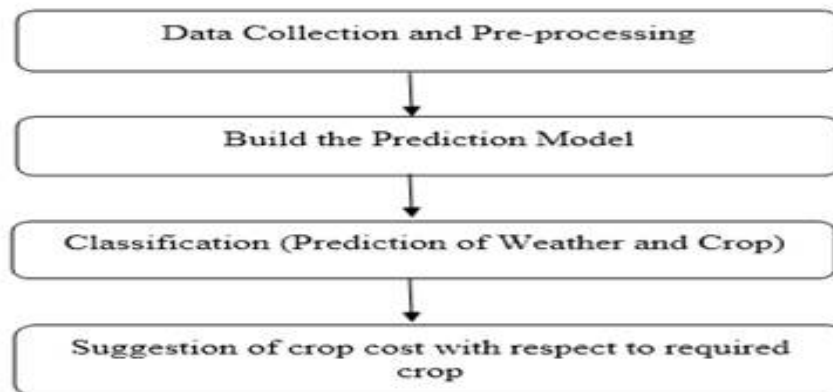


Figure 1. Sample flow chart for crop cost prediction

1. Data collection and Pre-processing

Input data are collected from Karnataka State Department of Agriculture (KSDA) for Mysore region. For CCP, totally six attributes are undertaken such as, temperature, humidity, pressure, soil type, rainfall and seed variety. These are the most important features suggested by the domain expert from KSDA. Here, pre-processing is employed for the examination of collected data that helps to recognize the absent values in the attributes, because there is a chance for data missing in old data set. Though, the missing attribute values are filled with the suitable new values by analyzing previous and past results. Sample data collection for crop price prediction is stated in table 1.

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Attributes	Temperature	Humidity	Pressure	Soil Type	Rainfall	Seed Type	Crop Cost (Profit or loss) (%)
Number of Collected Data	f_1^1	f_1^2	f_1^3	f_1^4	f_1^5	f_1^6	Profit or Loss
	f_2^1	f_2^2	f_2^3	f_2^4	f_2^5	f_2^6	Profit or Loss
	f_3^1	f_3^2	f_3^3	f_3^4	f_3^5	f_3^6	Profit or Loss

	f_{k-1}^1	f_{k-1}^2	f_{k-1}^3	f_{k-1}^4	f_{k-1}^5	f_{k-1}^6	Profit or Loss
	f_k^1	f_k^2	f_k^3	f_k^4	f_k^5	f_k^6	Profit or Loss

Table 1. Sample Pre-processed Data for crop price prediction

III. PROPOSED METHODOLOGY

This section assesses a method named as standard-FFBP, which is a neural network based methodology. Among several approaches, the ANN approach is employed as a classifier in order to enhance the accuracy of prediction rate. This investigation concentrates on automatic crop selection, suitable soil type for crop cultivation and CCP by implementing ANN.

A. Artificial Neural Network

In computer engineering and related fields, ANNs are computational models stimulated by animal central sensory systems (specifically the brain) that are capable for machine learning and pattern recognition. They are displayed as frameworks of interrelated "neurons" that can register values from inputs by feeding data through the system. Like other machine learning techniques, neural networks have been utilized to solve a wide range of tasks that are difficult to solve utilizing normal rule-based programming.

The word network denotes inter-connections between the neurons in the diverse layers of every framework. A framework has three layers, the primary layer has input neurons, which send information by means of neuro-transmitters to the second layer of neurons, and then more synapses to the third layer of output neurons. More complex frameworks will have more layers of neurons with some having increased layers of information neurons and output neurons. The neuro-transmitter parameters called "weights" that control the information in the computations. An ANN is normally characterized by three sorts of parameters, for example, interconnection design between various layers of neurons, learning process for updating the weights between inter-connections and activation function that transforms a neuron's weighted input to its output activation.

Back propagation calculation is utilized as a part of feed forward ANNs. First term, "feed forward" defines how this neural network works and recalls patterns and the term "back propagation" defines how this kind of neural networks are accomplished. The network obtains 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 additional intermediate hidden layers.

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B. Feed Forward Back Propagation Approach

Here, we inspect one of the most common neural network design, the ANN-FFBP. This neural network design is very standard, because it can be employed to numerous dissimilar tasks. At least three layers are essential in an ANN model such as, input, hidden and output layers, which is symbolized in figure 2.

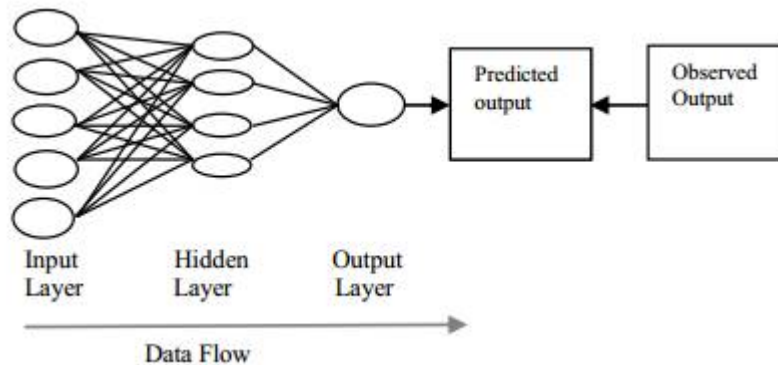


Figure 2. Feed forward back propagating ANN layer

Input and output layers comprise 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 , which is specified in the equation 1.

$$t_i = \sum_{j=1}^n W_{ij} X_j \quad (1)$$

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 . Transfer Function (TF) is then employed to the weighted value t , to analyze the node output O_i , the most frequently utilized TF is a sigmoidal function for the hidden and output layers and a linear TF is commonly applied for the input layer.

$$O_i = f(t_i) \quad (2)$$

The above formula only holds true for a neuron with a linear activation function (that is the output is solely the weighted sum of the input). In general, a non-linear, differentiable activation function is employed.

$$t_i = \phi(net) \quad (3)$$

$$\text{Where, } net = \sum_{j=1}^n W_{ij} X_j \quad (4)$$

This lays the basis for determining the partial subordinate of the error with respect to a weight utilizing the chain rule,

$$\frac{\partial E}{\partial W_{ij}} = \frac{dE}{dt_i} \frac{dt_i}{d_{net}} \frac{d_{net}}{\partial W_{ij}} \quad (5)$$

Where,

$\frac{\partial E}{\partial W_{ij}}$ = How the error changes when the weights are changed.

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$\frac{dE}{dt_i}$ = How the error changes when the output is changed.

$\frac{dt_i}{d_{net}}$ = How the output changes when the weighted sum change.

$\frac{d_{net}}{\partial W_{ij}}$ = How the weighted sum changes as the weights change.

In this scenario, crop forecasting approach is utilized to forecast the appropriate crop by sensing numerous parameters like soil, atmospheric pressure and so on. In order to sense those parameters ANN methodology is utilized, which is described in below section.

IV. RESULT AND DISCUSSION

The experimental analysis was implemented in PC with 1.8GHz Pentium IV processor using MATLAB (version 6.5). Here, the ANN-FFBP methodology was utilized to enhance the accuracy of CCP.

A. EVALUATION PARAMETERS

Proposed methodology for crop cost forecasting is exemplified with a few of the evaluation metrics. This evaluation metrics is applied to assess the efficiency of crop price prediction. Some of the undertaken metrics for evaluation purpose are accuracy and MSE. Accuracy is the suitable evaluation metric for identifying the effectiveness of CCP.

$$Accuracy = \frac{True\ Positive(TP) + True\ Negative(TN)}{TP + TN + False\ Positive(FP) + False\ Negative(FN)} \times 100 \quad (6)$$

MSE is a measure of the quality of an estimator, it is always non-negative, and values nearer to zero are superior. Whereas, \hat{y} is a vector of n predictions, and y is the vector of observed values corresponding to the inputs. The general equation for MSE estimation is mentioned in equation (7).

$$MSE = \frac{1}{n} \sum_{i=1}^n (\hat{y}_i - y_i)^2 \quad (7)$$

Where, $(\hat{y}_i - y_i)^2$ is illustrated as a square of errors, n is demonstrated as predicted value, \hat{y}_i is evaluated as predicted value, and y_i is determined as true value.

B. CLASSIFICATION EVALUATION

In classification evaluation, the proposed scheme (ANN-FFBP) was compared with existing approach (ANN-FF) in three dissimilar combination of testing and training percentage like 90% training and 10% testing, 80% training and 20% testing, 70% training and 30% testing of collected data, which is demonstrated in table 2.

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Method	Training (%)	Testing (%)	Accuracy (%)	MSE (%)
ANN-FF	70%	30%	65.4	21.4
	80%	20%	67.3	21.02
	90%	10%	67.89	20.98
Proposed (ANN-FFBP)	70%	30%	70.98	18.79
	80%	20%	71.67	14.15
	90%	10%	72.34	10.93

Table 2. Evaluation measures for proposed method

Table 2, shows the performance evaluation of ANN-FF and ANN-FFBP. Evaluation metrics confirms that the advanced scheme performs significantly in crop price prediction than the existing approach by means of accuracy, which is stated in figure 3. The MSE graph comparison of proposed methodology is displayed in figure 4 and 5.

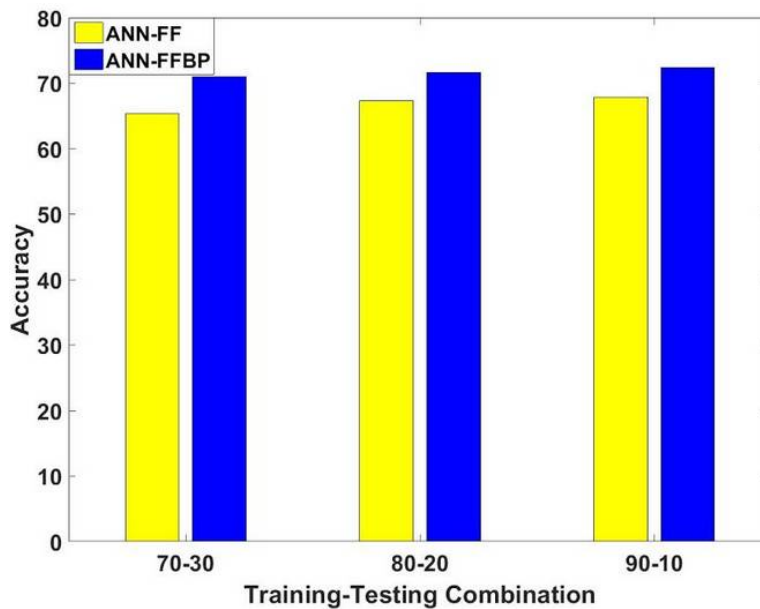


Figure 3. Accuracy graph comparison for advanced scheme

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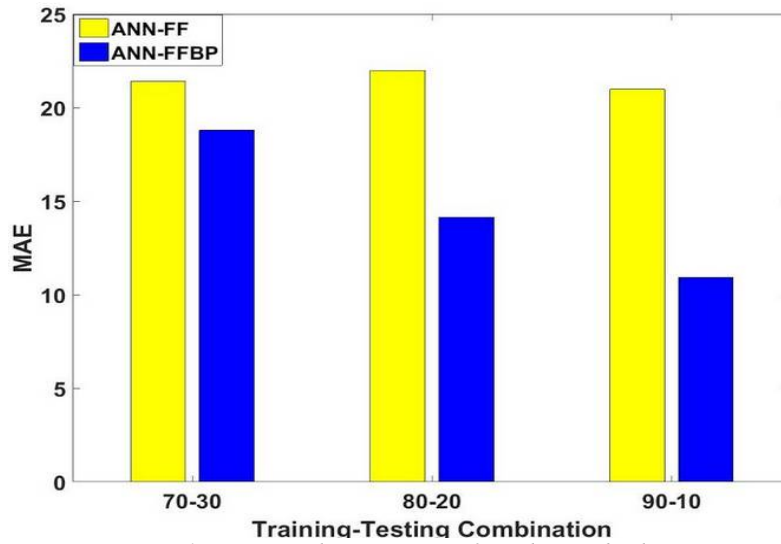


Figure 4. MSE graph comparison for advanced scheme

Figure.5 presented the validation performance and MSE of the network starting at a large value and reducing to a small value. The plot consists of three lines for three different steps of training, validation, and test. Training process on the training vectors continues until the model gets to the point that the training reduces the error of network on the validation vectors, which would lead to avoiding the over-fitting of the data sets. As it is shown in the Figure, the best validation performance is happened at epoch 3 with 0.43503.

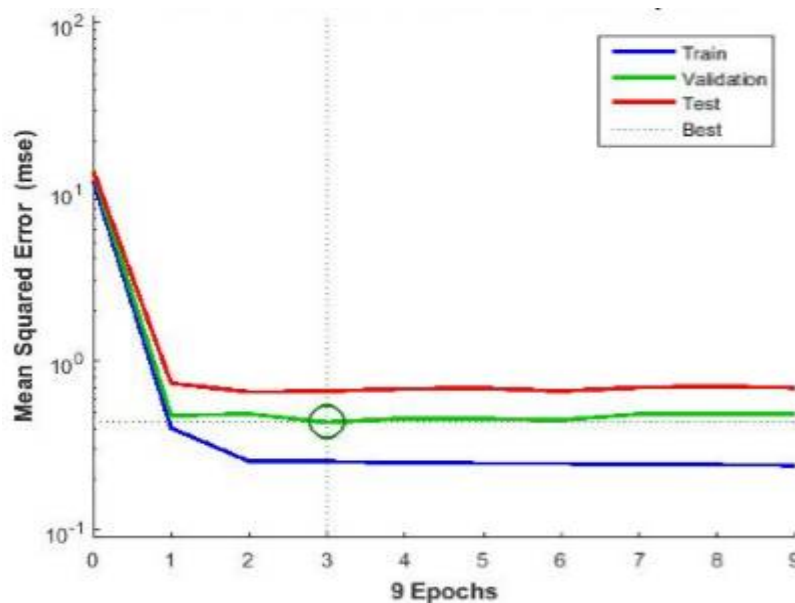


Figure 5. MSE graph for different epochs

Validation performance of proposed methodology was estimated in terms of gradient, mu, and validation checks, which is displayed in figure 6.

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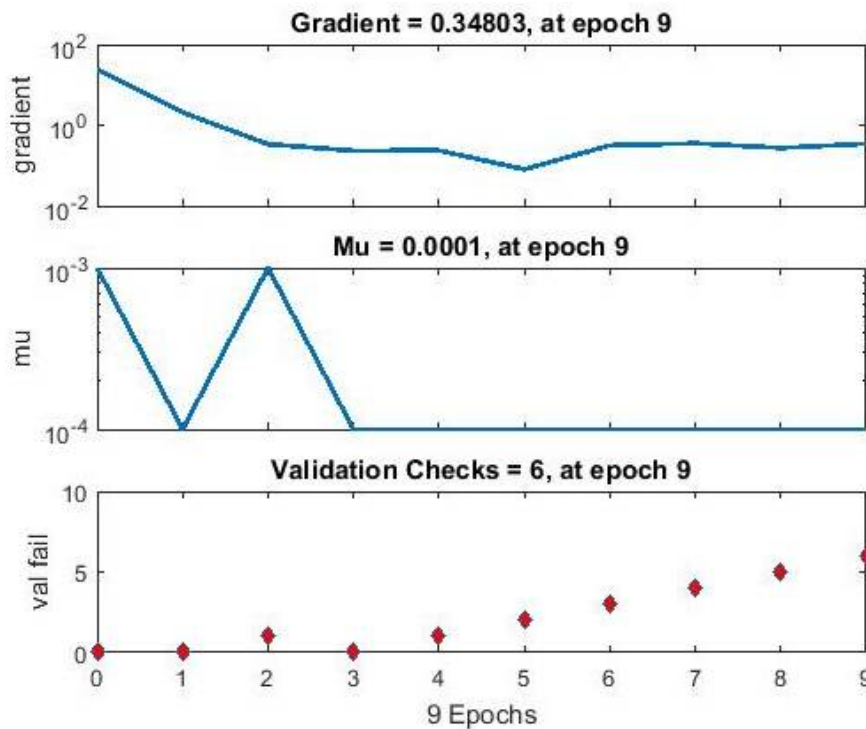


Figure 6. Validation Evaluation

Feedforward neural network is the simplest type of ANN devised. In this network, the information transfers in only one direction, forward, from the input nodes, through the hidden nodes (if any) and to the output nodes. By utilizing FFBP in ANN shows a significant improvement in crop price prediction in light of accuracy and MSE.

V. CONCLUSION

This literature assessed a statistical examination of CCP that was conducted in the Mysore region. The scope of this investigation to deliver an information about crop, which helps farmers to obtain maximum price for their products. In this scenario, ANN with FFBP scheme was implemented in order to improve the cost prediction accuracy of crop. Compared to the other available methodologies for crop cost prediction, the proposed scheme delivered a superior performance in light of accuracy and MSE. Proposed method achieved around 0.2-0.5% improvement than the previous approaches.

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