Futuristic Trends in Computing Technologies and Data Sciences
e-ISBN: 978-93-6252-043-2
IIP Series, Volume 3, Book 8, Part 2,Chapter 4
ENHANCING AGRICULTURE COMMODITY PRICE
FORECASTING: INTEGRATION OF DEEP LEARNING AND SOFT
COMPUTING TECHNIQUES FOR ECONOMIC, FARMER, AND INDUSTRY PERSPECTIVES

ENHANCING AGRICULTURE COMMODITY PRICE FORECASTING: INTEGRATION OF DEEP LEARNING AND SOFT COMPUTING TECHNIQUES FOR ECONOMIC, FARMER, AND INDUSTRY PERSPECTIVES

Abstract

Forecasting the price of agriculture commodities such as vegetables, fruits, cereals etc. is important related to economic concerned, farmer perspective, Agriculturist and Industrialist. Price forecasting contributes to agricultural producers and all others agro audiences in making sound choices regarding the mandi price, or the retail cost, for their commodity in addition to what crop is most profitable for cultivation with the goal to earn the greatest returns. The result ultimately boosts the circumstance and income for agricultural producers meanwhile also assisting government officials in arriving at decisions associated with agriculture. In the realm of agriculture, neural network techniques have been employed for short-term as well as long-term price predictions. It's possible to find an extensive amount of information available regarding the prices of commodities, daily price movements, and arrival costs. Upcoming commodity price prediction might gain from the integration of deep learning and soft computing techniques.

Keywords: Agriculture commodity; Time series data; price forecasting; Artificial Neural Network; fuzzy

Authors

Rubi Kambo
Department of Computer Science and Engineering
Rungta College of Engineering and Technology
Bhilai Institute of Technology
Durg, Chhattisgarh, India

Jyothi Pillai
Department of Computer Science and Engineering
Bhilai Institute of Technology
Durg, Chhattisgarh, India

Sunita Soni
Department of Computer Science and Engineering
Bhilai Institute of Technology
Durg, Chhattisgarh, India

Futuristic Trends in Computing Technologies and Data Sciences
e-ISBN: 978-93-6252-043-2
IIP Series, Volume 3, Book 8, Part 2,Chapter 4
ENHANCING AGRICULTURE COMMODITY PRICE
FORECASTING: INTEGRATION OF DEEP LEARNING AND SOFT
COMPUTING TECHNIQUES FOR ECONOMIC, FARMER, AND INDUSTRY PERSPECTIVES

I. INTRODUCTION

In recent year, agriculture commodity price affects the economics of our country. Increasingly demand of crops or fruits in India or outside the country affect the price of commodity. Private Agriculture Industry or Farmer growth not only depends on the production or yielding of crop but also on the price of commodity. Factors such as time horizon, temperature, season, policies, productivity, and transportation cost etc., affect the price. Agriculture commodity price changes drastically and affecting the life of farmer and human being. Future price forecasting of agriculture commodity is not an easy task. Price fluctuation, price analysis, trend analysis in price can be done so that early information regarding crop price help farmer in decision related activity for a crop to sowed in field or to sell product in market.

Agriculture is one of the fields that contribute to Gross Domestic Product. New tools and techniques are developing that help famer providing early information related to crop, policies etc. So, for the risk related to crop price ,or pricing information analysis, price forecasting, price fluctuation of a crop are the different concerned area where one can applied the Soft computing technique, fuzzy approach, data mining technique to identify the truth or hidden pattern from agriculture product market price.

Data mining is a method that can be used for identifying undetected patterns, establishing the correlations among data, and anticipating trends in the future. The geographical region of farming may employ methods of data mining for estimating retail prices via modelling with predictive accuracy. Regression analysis, categorizing, time series data assessment, and predictions all constitute activities included in data mining and models for forecasting.

Employing historical price data from earlier days or periods of time, prediction can be done in order to forecast price trends in the future.

The data value has been mapped to the true value of the predictive factor with the support of a regression model. Functionality-based mapping requires for learning so that previous values is capable of being utilized to adapt the function and anticipate the value in the future.

Variations in prices of commodities seen throughout the years. For the reason of forecasting prices in the future using historical data, time periods such as weekly, daily, and yearly price values for commodities are compiled. Discovering hidden or useful patterns or details in data is the hallmark of KDD. Facts are the inputs to while outcomes are the output from the KDD process. The details or patterns found via the technique of KDD is subsequently obtained through a data mining method. On information regarding prices for agricultural commodities that change over a period of time, an individual may perform a longitudinal analysis. The laws of association may consider relationships and temporal aspects. Time series data may be utilized to anticipate values in the future. A neuronal network is a type of computational system that derives its signals from way biological neurons perform and process the data.

Futuristic Trends in Computing Technologies and Data Sciences
e-ISBN: 978-93-6252-043-2
IIP Series, Volume 3, Book 8, Part 2,Chapter 4
ENHANCING AGRICULTURE COMMODITY PRICE
FORECASTING: INTEGRATION OF DEEP LEARNING AND SOFT
COMPUTING TECHNIQUES FOR ECONOMIC, FARMER, AND INDUSTRY PERSPECTIVES

NN assists in extracting patterns or information from complicated or unreliable data. In estimating vegetable market prices on both the short or long term, multiple investigators adopt neural network technique as well as deep learning technique. Recurrent neural networks or back propagation can be employed for predicting the commodity price. An idea of applying either deep learning or soft computing approaches for estimating the prices of commodities used in agriculture is laid out in this survey report. In advance of delivering items to mandis, farmers and agriculturalists may utilizes deep learning technique for price forecasting to gain insight about the upcoming progress, trend, or price worthy of their agricultural products. Price forecasting additionally assists policy-makers to establish novel rules by carving out legislation according to price investigation. Evaluating the price value, demands or availability, and land used for cultivation tied to a crop assists farmers to arrive at actions, which ultimately assists in our country's economic growth.

II. LITERATURE SURVEY

Soft Computing Techniques in Agriculture: From a year ago, artificial neural network is used by researchers for analysis, where its computational activity is similar to biological neurons. Neural network helps in dealing with problem related to finance economic.

Researchers Kohzadi et al. [1], for price forecasting of commodity compare neural network model with time series model. They used price data of US live cattle and wheat of forty years taken from USDA. Multi Layer Feed forward neural approach a supervised leraning technique is compared with ARIMA. Slinding window and walk forward approach is used. They claimed that NN surpasses ARIMA and was having a mean square error that varied between 26 and 56% lower as a result. Both the absolute mean error and mean absolute percent error, which are two extra indicators provided by a neural network, were also lower. The potential of artificial neural networks to identify key turning points for both wheat and cattle.

Aliev et al. [2], claimed an effective approach that uses fuzzy inputs and fuzzy weights are injected into artificial neural networks for learning reasons, in addition to fuzzy outputs which also get generated by the networks themselves. For quality evaluation and comparision ,simulated form of Fuzzy regression is explained by author and method is shows the usefulness of algorithm. Alpha cut and fuzzy arithmetic are used for learning. In oligopolistic environment auhtor demostrate their learning method for predicting fuzzy value profit. Genteic algorithm easily locate the global minimum error performance of fuzzy is easily located by Genetic algorithm where as alpha cut method fails.

In boiler industry pricing decision also play a great role and also assist in agriculture decision or also to pollutary association and also price help government for proper management of resources. Shih et al. [3], came up with a price prediction model that utilises a weighted case-based reasoning technique. Three cases such as equal wighted,unequal weigth and linear weighted CBR are investigated and compare.Most suitable weight for features are selected by genetic algorithm. For prediction model data related to imported chicken,economic index and production data from Taiwan agriculture is used. The outcome findings of the proposed research indicate that the CBR technique works superior when compared to other methods for predicting which includes regression using linear models,

Futuristic Trends in Computing Technologies and Data Sciences
e-ISBN: 978-93-6252-043-2
IIP Series, Volume 3, Book 8, Part 2,Chapter 4
ENHANCING AGRICULTURE COMMODITY PRICE
FORECASTING: INTEGRATION OF DEEP LEARNING AND SOFT
COMPUTING TECHNIQUES FOR ECONOMIC, FARMER, AND INDUSTRY PERSPECTIVES

regression tree modelling, the CART system, and neural networks. The research results additionally indicate that variables like the bright and cheerful boiler and chicks having a direct effect on the price.

Zou et al. [4], for forecasting china food grain price, explore and compare the neural network and time series model. Researcher gives a new concept to create a model by combining two model such as time series model ARIMA and neural network approach such as back propagation using Equal weigth method i.e using arithmetic average of individual forecast as it is an easy method. Two kinds of evaluation criteria such as quantitative evaluation such as MSE,MAPE,and MAE and turning point is evaluated by advance version of Mertons test used by researcher. The result shows that forecasting performance of combine model is better then individual in terms of error evaluation measurement. The price data has been modelled using the network architecture represented by 241 and ARIMA(1,1,0) is realtively best as per researcher findings.Also suggested that ANN is best suited model for capturing profit and turning points and better then traditional ARIMA and also accuracy achieve by combine model is better than individual one.

Backpropagation is often employed in the world of financial markets to identify nonlinear patterns in financial data. Backpropagation, however, has downsides such slower convergence and a lack of durability. Haofei et al. [5] given the concept of multi-stage optimisation in backpropagation to address the problems associated with price forecasting using neural networks. In their research work, they argue that employing MSOA may assist to overcome the challenges of backpropagation, contributing to enhanced forecasting performance in terms of both error and directional evaluation indicators. The initial training time tends to be 4.25 seconds for MSOA and 7.83 seconds for backpropagation. Furthermore, MSOA showed enhanced convergence speed. For MSOA and backpropagation, the average Mean Squared Error (MSE) values are 2.11×10^{-4} and 6.22×10^{-4}, respectively. The fact that remarkable that the highest possible MSE of MSOA, 1.24×10^{-3}, is smaller than the highest possible MSE of backpropagation, 2.71×10^{-3}. The researchers figure that MSOA surpasses the other approaches while comparing ARIMA, backpropagation, and MSOA.

In order to develop a time series forecasting model that enhances prediction accuracy even when the data contains noise, Yu et al. [6] employ neural networks as a meta-learning strategy. Researchers do metamodelling by performing data partition and sampling for creation of different subset of training based on that base learning model is created and Fuzzy neural network is used in study for both as base learner and meta learner. They used PCA technique for model selection and pruning and then meta model is created from selected model.They concluded that prediction performance of nonlinear metamodelling technique is better when compare to single time series forecasting models such as ARIMA, FNN and SVM and other linear metamodelling technique such as simple averaging, simple MSE, Stack dregression ,variance weighting for financial time series data.netwrok perform well with pruning using PCA.

A forecasting model for the short-term price prediction of tomatoes was introduced by Gan-Qiong Li et al. [7]. The model employs the use of a three-layer feed-forward neural network, and if its outcome is juxtaposed with that of a time series ARIMA model, it can be observed that a neural network performs superior for price prediction of one day with an

Futuristic Trends in Computing Technologies and Data Sciences
e-ISBN: 978-93-6252-043-2
IIP Series, Volume 3, Book 8, Part 2,Chapter 4
ENHANCING AGRICULTURE COMMODITY PRICE
FORECASTING: INTEGRATION OF DEEP LEARNING AND SOFT
COMPUTING TECHNIQUES FOR ECONOMIC, FARMER, AND INDUSTRY PERSPECTIVES

accuracy of about ninety percent or price prediction of one week before the market opens with an accuracy of around 80%.

Riberio et al. [8], proposed a hybrid commodity price froecasting model for sugar price prediction using feed forward neural network such as multilayer perceptron model and Kalman filter. Data from brazilian and Indian market is taken for study. Kalman filter is used to consider price as stochastic process and also include future price in forecasting and also minimise the error measure. ANN is used for Exogenous variable analysis and also ANN applied to Kalman filter result to get improvement in result.

Jha et al. [9], focuses on direction of change i.e prediction of turning point as important factor for any commodity price froecasting. They develop a ANN based decision support system included linear and nonlinear method such as ARIMA and ANN. The study incorporates the usage of a time delay with multi-layer feed-forward neural network. They use data of two crops of oilseed such as soyabean and rapeseed-mustard for prediction. Augmented Dickey –fuller test for different time series is used and also McLeod and Li for nonlinearity test is used. Out of twenty four model 2:3s:1L perform better than other computing model for soyabean series.

Wang et al. [10] devised a system architecture specifically tailored for short-term price prediction of agricultural products, including cucumber, tomato, cabbage, and potato, in the context of Beijing. To implement their system, they employed various open-source projects such as JAVA, Spring, Struts, and others. The market price transmission, price forecasting, early warning, and trend analysis all have been addressed by the model. The proposed structure comprises a database, system support, application services, and a system user layer as each of its four elementary parts. Effective volatile factor are estimated by multi linear or multi variate regression model with assist of Eview software. For product price risk evaluation method of value at risk is used by embedding easyfit software.For price prdeition both exponential smoothing and autoregressive moving average method is used.

The future price intervals of agricultural commodities, particularly cotton and maize in the Chinese market, are estimated using a novel approach put forward by Xiong et al. [11] that integrates linear and nonlinear techniques. Both the vector error correction model and multi-output support vector regression are utilised in conjunction for this. VECM-MSVR surpasses individual VECM, MSVR, and ARIMA-MSVR models when it comes to of forecast accuracy. This is because interval-valued time series' upper as well as lower limits can potentially be anticipated simultaneously by employing VECM. Additionally, the MSVR model outperforms VECM in terms of predicting accuracy for bigger prediction horizons (such as h=3,5).

Subhasree et al. [12], predict the next day price of vegetable using time series data. Machine learning algorithm such as Radial basis fucntion, back propagation neural network and genetic based neural network is used for study and comparative result concluded that predictive accuracy achieved by genetic based neural network is about 89% and error rate is 0.11 which is better than both back propagation whose accuracy is about 79 % and error rate is 0.21 and radial basis function accuracy is 52 % and error rate of 0.48.

Futuristic Trends in Computing Technologies and Data Sciences
e-ISBN: 978-93-6252-043-2
IIP Series, Volume 3, Book 8, Part 2,Chapter 4
ENHANCING AGRICULTURE COMMODITY PRICE
FORECASTING: INTEGRATION OF DEEP LEARNING AND SOFT
COMPUTING TECHNIQUES FOR ECONOMIC, FARMER, AND INDUSTRY PERSPECTIVES

The necessity of taking into consideration cross-dependency throughout several pricing models has been emphasised by Ahumada et al. [13] with the objective to boost forecasting accuracy. Food price of Soyabean,corn and wheat are strongly correlated. The study examined a total of four financial models for each food price: EqCM, DEqCM, DVAR, and random walk models. Various intervals and tactics, such as recursive and fixed strategies, were utilised for evaluating these models. The researchers ultimately arrived at a conclusion that, particularly over a time horizon of h=4, EqCM (used individually for wheat as well as together for maize and soybean) achieved the highest result.

For forecasting price of agricultural product in brazil, researchers Pinheiro and senna [14] perform multivariate analysis of price of products and also uses neural network application for forecasting price i.e, combine the ANN model with multivariate analysis. The primary goal of this investigation is to look into prices time series for a particular item. The product is selected based on the growth of its export volume. In the study, daily time series data is turned into weekly data. The final week of a 12-week dataset is employed as a sample for comparing the estimating capabilities of the ANN-MSSA (Artificial Neural Network-Multiple Singular Spectrum Analysis) model with the ANN model. The technique utilised for obtaining noise from the underpinning time series is the feature that puts the ANN-MSSA and ANN models separate from one another. Depending on data from experiments, the MSSA-ANN approach performs more effectively than an individual ANN model. The study proposes an acceptable alternative for accurately forecasting commodity prices through the use of MSSA to decompose the time series with the ANN model. The investigation is beneficial in formulating and carrying out policies that target the agricultural industry. The square error measure is employed in assessing the prediction model's performance, thereby assisting overall financial planning.

Wolfert et al. [15], discussed in their review paper about smart farming, use of ICT in farm management and also about the application of big data in smart farming. They discussed that big data helps in analytics of farm data and provide insight information about yield forecasting, product future price, business processes in farming. They also discussed about pull factor such as business driver, public drivers and push factor such as IOT, precision agriculture in smart farming. They concluded that big data analytics and its application will change the future of farming.

Shastry et al. [16], discussed that agriculture data set mainly contain continuous feature and for classifying dataset with multiple classes they used Multi-Class SVM. As SVM is popular as classification method, it uses concept of hyper plane for defining boundary for decision in high dimension feature space. Kernels are often utilised in training data for converting the input space to a higher-dimensional space, particularly while confronted with non-linear challenges. The hybrid kernel utilised by the author highlights the substantial impact of kernel selection plays for classification accuracy. They argue that implementing a single kernel hinders the ability to gather data from numerous sources while paying focus on the likelihood of bias, a drawback of single kernels. In order to determine the most appropriate values for parameters such as c and γ, that are having significant impacts on the performance of Support Vector Machines (SVM), the author utilises both the genetic algorithm and the gradient descent approach. By mixing a variety of models, notably linear, quadratic, polynomial, RBF, and MLP on the training data, the researchers have been capable

Futuristic Trends in Computing Technologies and Data Sciences
e-ISBN: 978-93-6252-043-2
IIP Series, Volume 3, Book 8, Part 2,Chapter 4
ENHANCING AGRICULTURE COMMODITY PRICE
FORECASTING: INTEGRATION OF DEEP LEARNING AND SOFT
COMPUTING TECHNIQUES FOR ECONOMIC, FARMER, AND INDUSTRY PERSPECTIVES

to generate ten kernels. They use GA for parameter selection not by Gradient descendent. For evaluation of method they use different performance metric. The H-SVM model and other classifiers which includes NB, K-NN, and SVM have been evaluated by the author. Based to the research findings, the H-SVM model is a versatile classifier that can be utilised used for a variety of agricultural data, including but not limited to soil or crop data. They found that hybrid kernel that is quadratic and RBF kernel both show high performance for real world data and used as standard for agricultural multi class dataset. RBF kernel is local kernel that extracts the local feature of sample but unable to extract global features, so for global feature extraction author uses quadratic kernel. Thus both kernel were combine and give the prominent result.

III. CONCLUSION

In the aforementioned investigation, several forecasting methods are investigated in relation to the context of the agricultural market. Accurate forecasting of future prices for commodities is crucial for farmers and other market participants in order to achieve maximum revenues in the marketing of agricultural products. Several factors, which include seasonality, trends, cycles, holidays, economic indicators, and more, has an influence on a commodity's price. Due to so many factors, price forecasting is a difficult endeavour.

In summary, there is a variety of methods involved with forecasting, such as data smoothing and filtering to cope with missing and noisy data, in addition to the retrieval and storage historical data. For analysis of historic data as well as to forecast future trends or values, models needs to be constructed. In order to evaluate the accuracy of modelling techniques for forecasting, indicators of performance like MSE (Mean Squared Error) and MAPE (Mean Absolute Percentage Error) have been utilised.

Researchers integrate linear and nonlinear forecasting methods, including backpropagation, feed-forward neural networks, radial basis functions, hybrid ARIMA-GARCH, and genetic algorithms for optimisation. The aforementioned methods are employed to enhance the forecasting process' precision as well as dependability.

Future forecasting accuracy could potentially be improved further through the integration of fuzzy logic with additional soft computing techniques, evolutionary methods in deep learning. Big data and deep learning techniques can additionally be employed to forecast prices for agricultural commodities in a more comprehensive and precise way.

REFERENCES

[1] Nowrouz Kohzadi, Milton S. Boyd, Bahman Kermanshahi, and Iebling Kaastra, "A comparison of artificial neural network and timeseries model for forecasting commodity prices," NeuroComputing, pp. 169-181, 1996.

[2] Rafik A. Aliev, Bijan Fazlollahi, and Rustam M. Vahidov, "Genetic algorithm-based learning of fuzzy neural networks.Part 1:feed-forward fuzzy neural network," Fuzzy Sets and Systems, pp. 351-358, 1998-2001.

[3] M. L. Shih, B. w. Huang, Nan-Hsing Chiu, C. Chiu, and W. Y. Hu, "Farm price prediction using case based reasoning approach-A case of broiler industry in Taiwan," Computer and Electronics in Agriculture, pp. 70-75, 2009.

Futuristic Trends in Computing Technologies and Data Sciences
e-ISBN: 978-93-6252-043-2
IIP Series, Volume 3, Book 8, Part 2,Chapter 4
ENHANCING AGRICULTURE COMMODITY PRICE
FORECASTING: INTEGRATION OF DEEP LEARNING AND SOFT
COMPUTING TECHNIQUES FOR ECONOMIC, FARMER, AND INDUSTRY PERSPECTIVES

[4]   H. F. Zou, G. P. Xia, H. Y. Wang, and F. T. Yang, "An investigation and comparision of artificial neural network and time series model for chinese food grain price forecasting.," NEURO COMPUTING:Elsevier, pp. 2913-2923, january 2007.

[5]   Zou Haofei, Xia Guoping, Yang Fangting, and Yang Han, "A neural network model based on the multi stage optimization approach for short term price forecasting in china," Expert system with Application, pp. 347-356, 2007.

[6]   Lean Yu, Shouyang Wang, and Kin Lai Keung, "A neural network based nonlinear metamodeling approach to financial time series forecasting.," Applied Soft Computing, vol. 9, pp. 563-574, August 2009.

[7]   Gan-qiong Li, Shi-wei Xu, and Zhe-min Li, "Short-Term price forecasting for Agro-products using Artificial Neural Networks," in Elsevier, 2010, pp. 278-287.

[8]   Celma Q. Ribeiro and Sydnei M. Oliveria, "A hybrid commodity price forecasting model applie dto the sugar-alcohol sector," Autralian Journal of Agricultural and Resource Economics, vol. 55, no. 2, pp. 180-198, April 2011.

[9]   Girish K. Jha and Kanchan Sinha, "Agricultural Price Forecasting Using Neural Network Model: an Innovative Information Delivery System," Agricultural Economics Research Review, vol. 26, no. 2, pp. 229-239, July-December 2013.

[10]   Chuan Wang, Anping Zhao, and Yousen Zhao, "Design and Implementation of Agricultural Product Prices Short Term Forecasting System," in Springer, 2013, pp. 15-27.

[11]   Tao Xiong, Chongguang Li, Zhongyi Hu, and Lu Zhang, "A combination method for interval forecasting of agricultural commodity furture prices," Knowledge-Based System, pp. 92-102, january 2015.

[12]   M. Subhasree and Mrs. C. Arun Priya, "Forecasting Vegetable price using Time Series Data," International Journal of Advanced Research, vol. 3, pp. 535-541, february 2016.

[13]   H. Ahumada and M. Cornejo, "Forecasting Food Prices : The case of Corn, Soyabean and Wheat," International Journal of Forecasting, pp. 838-848, 2016.

[14]   Carlos Alberto Orge Pinheiro and Valter de Senna, "Multivariate analysis and neural network applications to price forcasting in the brazilian agricultural market," Ciencia Rural,Santa Maria, vol. 47, pp. 1-7, 2017.

[15]   Sjaak Wolfert, Lan Ge, Cor Verdouw, and Marc- Jeroen Bogaardt, "BigData in Smart Farming : A review," Agricultural System, pp. 69-80, feburary 2017.

[16]   K. Aditya Shastry, H. A. Sanjay, and G. Deexith, "Quadratic-radial-basis-function-kernel for classifying multi-class agricultural datsets with continuous attributes," Applied Soft Computing, pp. 65-74, april 2017.