Decision Support System for Farmers using Business Intelligence

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ABSTRACT

Farmers in India work extremely hard in the farms but still their profit margins are comparatively low. The farmers have very little knowledge about the conditions that cause fluctuations in price of the crop. These fluctuations in the price are due to various factors like irregular rainfall, change in demand-supply, and import-export policies of the government. We, therefore, implemented Holt-winter's Forecasting Model and have incorporated the effects caused by factors such as Rainfall, Exports-Imports & Productivity into the model. This model examines some sample data and based on this data, forecasts the future trend and fluctuations in crop price. This model can help the farmers by providing prediction of price of the crops and thus, to extend the profit margins.

Keywords

Agricultural products wholesale prices; forecast; Holt-Winters' Forecasting Model;

1. INTRODUCTION

Last few years have been very hard on India on the economic and the agricultural front. The two fields are highly inter-related. Changes in any one of these fields affect the other one. We have witnessed many farmers ending their lives because of the inflations and not getting enough resources and the right amount of money for their hard work [2]. They are poorly paid and hence have to live with a standard of life that is worse than most of the people. This happens mainly due to lack of education and also being unaware of the changes happening in the environment and other related factors. Farmers are hence forced to sell their crops at a price demanded by the middle-man. This helps the middle-men to gobble up the major difference in the retail price and the spot prices. Thus, farmers are deprived of the deserving profit.

A solution for increasing the profits of the farmers is to eliminate the chain of middlemen, thus, connecting the farmers and the retailers to each other directly. In this way, the profits earned by the farmers will increase at the same time the retail customers will be buying the products at the same cost. However, India being an agrarian country, eliminating the middlemen may become a cause of a high unemployment which can prove deterrent to India's GDP.

Today we have a number of forecasting techniques that try to predict the sales, import and export, productivity, etc. but they are rarely used for welfare of the farmers. The farmer has no idea about what to expect in the near future using the past data. The aim of this work is to help the farmers by providing them with simple software that would predict the crop prices and its changes with respect to the factors affecting the crop prices.

Our Software aims at farmers as an individual. Farmers are ignorant about the current condition of the crops in India and the effects of various factors on the crop prices. The software takes into consideration the exports and the imports and the weather of that area affecting the crop prices and forecasts the price. The farmer can, with this software, decide when would be the right time to sell his crop so as to maximize his profit. If he knows that the demand of a particular crop will decrease in the next quarter then he can make the necessary changes in growing crops.

This includes a software implementation consisting of a user interface easily understandable by the farmer and forecasting the crop prices.

Our work takes into consideration the changes in the weather for a particular area over past years and forecasts the price of the crops if similar weather conditions are encountered. This helps the farmer as he would be aware of the situation that could arise in the future. Similarly, we also take the condition of the imports and exports of the country at that time and predict the price of the crops.

The above mentioned technique, though effective and sound, is difficult to implement. It involves taking into consideration the weather for a long period of time and also doing so for a large number of places all over the country as there will be different effect in different areas. We also have to take the recent changes which have been completely unpredicted (long cold season in Mumbai, etc.) and unusual. Also, we have to keep in mind the languages in which the application can be developed so as to overcome the linguistic barriers all over the country. The farmers generally do speak their local languages and thus we need to develop this software so as to suit their needs.

Thus, we have used simple desktop application for the interaction purpose and have made databases for retrieving data.

Selection and implementation of the right forecast methodology has always been an important issue in any field. Any significant over-or-under price- forecast error may cause the farmers to be overly burdened with excess inventory carrying costs.

Different forecasting models work best for different situations- the nature of the business, the nature of data, forecast granularity, forecast horizon, shelf life of the model and the expected accuracy of the forecasts. Forecast granularity is the unit of time of each forecast. Forecast horizon is the number of time units into the future for which forecasts are required. For example, weekly forecasts for the next 2 months have a granularity of a week and a horizon of 8 weeks. Shelf life is the time after which a model becomes useless and there is a need to switch to another model.

2. DESIGN OF FORECASTING MODULE

2.1 Objective of the model

To increase the profit margins for the farmers by providing him with an intelligent forecasting software which will predict the crop prices so that farmers can make intelligent decision as to when to sell the goods so as to maximize his profits.

2.2 System Module Diagram

The system module as shown below takes rainfall prediction, crop conditions, inflation and yield per unit area as inputs. Using price is obtained. The temporary forecast price is Holt-Winters' Model, this is further processed with the help of the data of the previous years it can determine the condition of crops of current year comparatively to the previous years. It determines the change in price from the temporary forecast price from Holt-Winters' Model to obtain the actual price. The processing basically uses Holt-Winters Forecasting Model for forecasting the model. The price obtained from Holt-Winters' Model is further processed considering the factors affecting crop to come up with a forecast price.

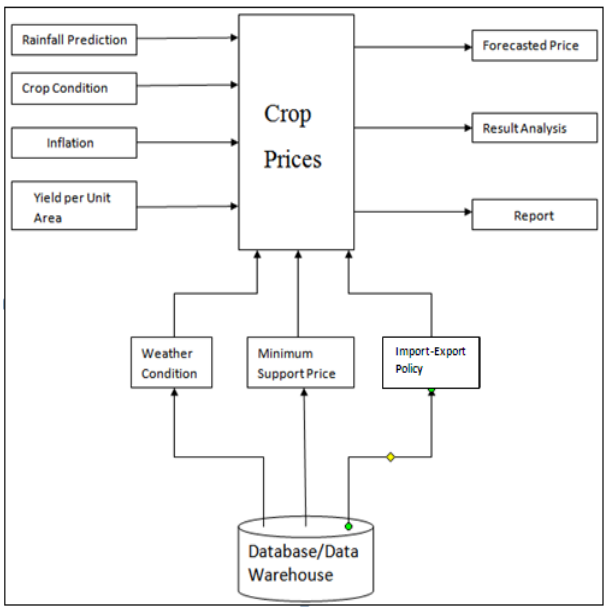

Figure 1 System Module Diagram

3. STRUCTURE OF FORECASTING MODEL

3.1 Selection of Forecasting Model

The Holt-Winters' Forecasting Model forms the basis of our model. Considering the factors that influence the spot prices in India, Holt-Winter's forecasting model is selected as the basis of our model.

Holt-Winters' Model considers three parameters:

- Trend
- Level
- Seasonality

3.2 Equations in Holt-Winters' Forecasting Model

$$L_t = \text{alpha}\,(L_{t-1} + T_{t-1}) + (1 - \text{alpha})\, y_t / S_{t-s} \quad (1)$$

$$T_t = \text{beta}\,(L_t - L_{t-1}) + (1 - \text{beta})\, T_{t-1} \quad (2)$$

$$S_t = \text{gamma}\, S_{t-s} + (1- \text{gamma})\, y_t / L_t \quad (3)$$

Where, the smoothing parameters alpha, beta and gamma all must be positive and less than one [1].

L_t : Level for month t
T_t : Trend for month t
S_t : Seasonality for month t
alpha : Weight to place on previously predicted price
(1-alpha) : Weight to place on the most recent actual value
Beta : Weight to place on historical trend
(1-beta) : Weight to place on most recent trend
Gamma : Weight to place on historical seasonality
(1-Gamma) : Weight to place on most recent seasonality

3.3 Processing of the Forecasted Price from Holt-Winters' Model

The forecast value obtained from Holt-Winters' model is strictly restricted to previous years' data. Holt-Winters' model requires minimum of 4 years of data for accurate predictions. So, it becomes redundant when there is a sudden change in one of the factors affecting the crop prices. So, to provide intelligence to the model, the forecast price obtained from the Holt-Winters' Model is further processed checking with the exports and imports of the current year as compared to previous years, the rainfall prediction for the next month, the change in the productivity of the crop in current year compared to previous years. With changes in all such factors, the software will add the change in price to Holt-Winters' forecasted price to come up with the actual forecasted price. The change in the price can be determined by analyzing the similar situation in previous years and using the same percentage change in the price in that particular year. The equations for forecasting the prices are as given below [1],

Forecasted price=forecasted price$_{\text{Holt-Winters' Model}}$+change (1)

Change=change $_{\text{rainfall}}$ + change $_{\text{exports}}$ + change $_{\text{productivity}}$ (2)

Change $_{\text{rainfall}}$ = %change in actual price from forecasted price due to change in rainfall condition (3)

Change $_{\text{exports}}$ = %change in actual price from forecasted price due to change in exports (4)

Change $_{\text{productivity}}$=%change in actual price from forecasted price due to change in productivity (5)

here, %change in price is the % change in actual price and forecasted price for that particular year when the rainfall condition were similar to the current year.

By adding the change to the forecasted price obtained from Holt-Winters' Model, the model eliminates the error of Holt-Winters; Model in forecasting prices. The error is cost due to the change in the other conditions such as rainfall, exports, productivity.
The Model thus becomes dynamic to inculcate the current situations and determine the price of the crop. The price thus obtained would be more accurate for the farmers.

4. TEST OF FORECASTING MODEL

The software implemented has extended Holt Winter Forecasting Model thereby inculcating factors such as Soymeal Exports in India, rainfall in the previous year. Thus, the model forecasts prices according to the current situation in India along with the trends and seasonality of the spot prices in the previous years. Therefore the model gives more accurate results than the existing Holt Winter Model[3].

The graph in Figure 2 shows the comparison of actual spot price and forecasted spot price using Holt-Winters' Forecasting Model. The blue legend in the graph represents the actual data extracted from www.ncdex.com/MarketData/SpotPrice.aspx and the pink legend shows the forecasted price using Holt-Winters' Forecasting Model.

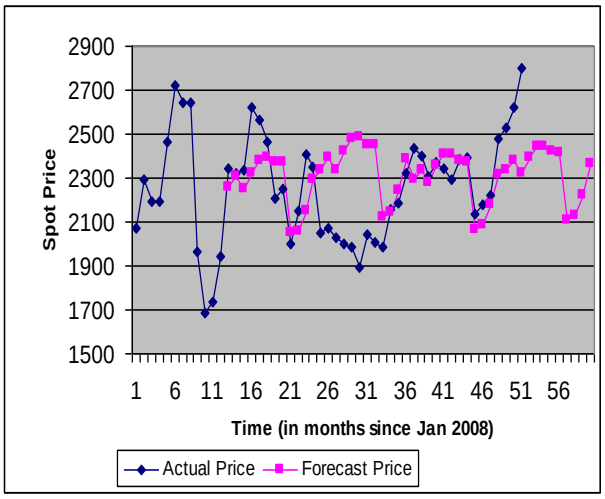

Figure 2 Holt-Winter Model

The extended Holt Winters method proves to be more accurate as the fluctuation of prices due to exports has been taken into consideration.
The graph in Figure 3 shows the comparison of actual spot price and forecasted spot price using Extended Holt-Winters' Forecasting Model. The blue legend in the graph represents the actual data extracted from www.ncdex.com/MarketData/SpotPrice.aspx and the pink legend shows the forecasted price using Extended Holt-Winters' Forecasting Model.

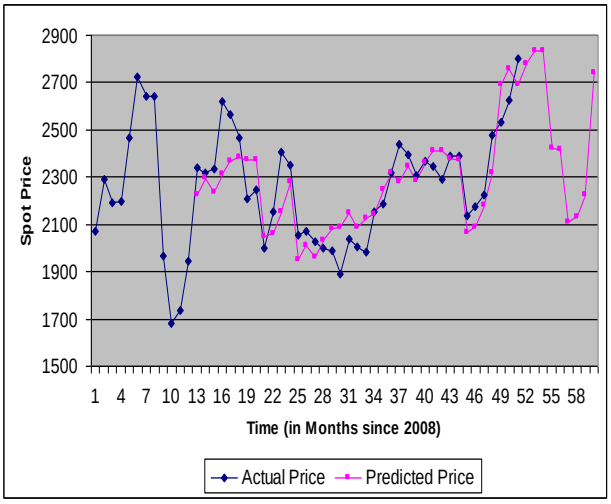

Figure 3 Extended Holt Winter Model

The average error ratio given by Extended Holt- Winters' method is 4.14% in contrast to that given by Holt-Winters' model's 6.96%.More importantly the spot prices in 2012 have also risen owing to increase in Exports thereby creating a shortage of soybean in India. The Extended Model implemented has accurately predicted the prices of 2012 in contrast to Holt Winter Method.

5. LIMITATIONS

5.1 Regional languages

Maharashtra and overall India contain people from a various religions. They speak various different languages. Some of them may not be aware of English (the current language of our software). Also, in process of development, if we develop this software in other languages like Hindi, Marathi still there will be groups of farmers unknown of these languages.
Region-dependant condition of crops:

5.2 Region-dependant condition of crops

Government fixes minimum support prices to ensure remunerative prices to farmers to encourage higher investment and production of agricultural commodities. Each year MSPs for major agricultural products are announced which are fixed after taking into account the recommendations of the Commission for Agricultural Costs and Prices (CACP). The CACP takes into account factors such as change in prices of inputs, demand and supply, cost of production, market price trends and cost of living.

So the MSPs can vary from one state of Maharashtra to another. We have considered and implemented this software for MSPs given by Maharashtra government.

5.3 Drastic change in climatic conditions

Among the economic havoc brought by this winter's extreme weather, none has been more severe than the impact on the global food supply chain.
Over the past few years, rising global demand for crops and production shortfalls have whittled grain surpluses to historically low levels. As extreme weather continues to cut production, those surpluses have shrunk further and forced prices higher.
Now meteorologists and weather risk analysts are warning that more frequent floods and droughts may continue to crimp production and keep foods supplies tight for years to come. Until surpluses of key grains can be restored to more normal levels, weather-related crop failures will produce more price spikes. In such cases, the forecasts may vary from the actual price to a large extent.

6. CONCLUSION AND FUTURE SCOPE

We have described the implementation of the extended Holt Winters model for forecasting crop prices in this report. This will result in farmers being confident about their production rates and also being less dependent on others for their survival. In this project, this model is used as a stand-alone system in its most basic sense. We can also consider implementing this on the smart phones and tablets in the future as an application.
The future applications can be developed to involve much functionality such as dependence with respect to other factors like inflation, yield per unit are and overcoming linguistic barriers so as to be useful all over the country. We can also use it in similar areas such as forecasting the sales of the companies and forecasting prices of all other types of commodities where the logic for forecasting is the same.

7. REFERENCES

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[2] Tejas Ghadiyali, Kalpesh Lad and Bankim Patel, "Agriculture Intelligence: An Emerging Technology for Farmer Community", in 2011 Second International Conference on Emerging Applications of Information Technology.

[3] Li Junfeng and Niu Jiangao , "Analysis on Demands for Agricultural Science and Technology Based on Bayesian Network", in 2011 Fourth International Conference on Business Intelligence and Financial Engineering.

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7.2 Links visited

[1] For rainfall data in Pune, referred monsoon reports of years 2008 to 2011 from http://www.imdpune.gov.in/

[2] For actual Spot Prices: http://www.ncdex.com/MarketData/SpotPrice.aspx

[3] For Exports data: http://www.sopa.org/st16.htm

[4] For selection of Holt Winter's Method: http://home.ubalt.edu/ntsbarsh/Businessstat/otherapplets/PolynoReg.htm

[5] For comparison of forecasting methodologies and Selection of Holt Winters Method http://www.decisioncraft.com/dmdirect/forecastingtechnique.htm