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"Cultivar's Choice": An imperative application of Agriculture Intelligence

[1]Dr. Tejaskumar R. Ghadiyali *
18, Shivdarshan row house, Near Meru-Laxmi Temple,
Tadwadi, Rander Road, Surat, Gujarat - 395009, India.
E-mail: tejas_ghadiyali@rediffmail.com

[2]Dr. Kalpesh B. Lad
Srimad Rajchandra Institute of Management and Computer Application
Uka Tarsadia University, Maliba Campus, Bardoli-Mahuva Road,
Tarsadi, Barodli, Gujarat-394350, India.
E-mail: kalpesh.lad@srimca.edu.in

Abstract

The farmer community is the backbone of the agriculture sector. Cultivar's Choice as knowledge based application helps them in their decision making of cultivation before Crop Cultivation. It is a part of an Agriculture Intelligent System and agricultural mathematical model provides intelligence to choose better cultivar to plant in farm with a view to achieve higher margin at the time of cropping of that crop. GUI of this application helps the farmer community to take decision with ease.

Keywords: Agriculture Intelligence, Cultivar's Choice, Agriculture Market Price Prediction

1.0 INTRODUCTION:

Agriculture has a noteworthy role to play in the economic development of India. Agriculture sector accounts for 14% of Gross Domestic Product (GDP) of the Indian economy. About 70% of the population lives in rural areas and majority of them depend on agriculture as their primary source of income [1]. Thus, Agriculture sector in India provides productive employment to a significantly large section of rural Indian society.

Agribusiness is a key segment for both agricultural growth and industrialization based on agricultural products. Indian agribusiness has many opportunities and scope to grow in the recent times. In agribusiness the price of the agriculture crop is determined by demand and supply mechanism. Here, the price of the product in the market is not the price that the farmer receives. Expenses like transportation expenses, processing charges, sales brokerage, storage charges etc. are deducted from the market price and the remaining amount, after having the profit of middlemen, wholesaler and retailers, is given to the farmer. In this scenario, in spite of many opportunities from Agriculture to Agribusiness the farmer community has to suffer a lot in terms of the profit margin.

The Government of India has declared, formed and implemented various 'Fiscal policies' and 'Minimum Support Price' policies in favour of the farmer so that with the proper policy plan, the agriculture sector will accelerate more in the future for the betterment of Agriculture Management in India. To push up and handle smooth agribusiness in India, there is a need of a knowledge based system in the agriculture domain.

Earlier agriculture information such as crop cultivation, market prices, fertilizer and pest control was delivered to the farmer community using traditional communication devices like Radio and Television. The technology that facilitates communication and the processing and transmission of information by electronic means is identified as Information and Communication Technology (ICT). ICT can be useful in many ways through mobile, internet, computers, GIS and sensor technology that make it possible to spread agricultural information widely and in different formats to the farmer community. By delivering such important information to rural people, ICT can make a significant contribution in their social and economic development. Through such information, the farmer community has an idea about the involved risk and uncertainties.

- Further, ICT applications [19-29] are available to provide information for the farmer regarding the crop production. Other government and private portals [30-35] also offer agriculture information to help the farmer community. Some of the major issues of these ICT applications are as given below.
- Provide agriculture data only
- Create information overflow without proper integration of correlated information
- Information exists in scattered manner at heterogeneous resources
- Not sufficient knowledge for agriculture stake holder

So there is an urgent need of proper linkage of agriculture technology and ICT in the form of knowledge based system.

2.0 MOTIVATION:

The Indian farmer community faces major problems at the pre-cultivation level. The majority of them do not have any idea about the expenditure needed for future

cultivation. They do not even have the estimation of the cost that they will have to bear during the production period in terms of use of fertilizers, pesticides, and other such requirements. Furthermore, they are unable to determine the future revenue generation including risk factor that they will face after production of the said cultivated crop. Such ignorance of the farmer community leads them towards attempt of suicide. As per the National Crime Records Bureau (NCRB) of India, 5650 farmers committed suicide in 2014 and farmer suicides account for 11.2% of all suicides in India [37]. There are many factors responsible for such condition, such as low returns, price crash, high operational cost, failure of crop etc. Considering the above mentioned issues of the agriculture community, agriculture information alone is not sufficient to solve such problems and there is an urgent need of proper linkage of agriculture technology and ICT in the form of knowledge based information system to disseminate knowledge to the farmer community.

Concerned by such adverse situation, the researcher got motivation to help the farmer community in such a way that they can identify their future revenue of produce at the time of crop cultivation. Bearing in mind the current Indian agriculture scenario and studies carried out in this direction, this research study concentrates on meteorological parameters with supply of agriculture commodity and intelligently predicts agriculture commodity market price to help the farmer community to get rid of their indecisive, unintelligible and incomprehensible situation. This study also provides an intelligent environment that helps the farmer community in their risk management towards investment that leads towards betterment of rural management and thereby helps them in achieving their ultimate goal of good earning. For such intelligent environment in the domain of agriculture sector, the word "Agriculture Intelligence" was coined [2]. Agriculture Intelligence is neither a product nor a system. It is an architecture, which is a collection of integrated operational as well as decision-support components, technologies and databases that provide the agriculture community easy access to agricultural knowledge."

Such Intelligent environment helps the farmer community to avoid guess work and to improve performance in their decision making of farm related activities such as crop cultivation. Cultivar's Choice is one of the applications of the 'Agriculture Intelligent' which intelligently recommends crop cultivation priority that gives better returns to the farmer community to achieve their ultimate goal of profit making. This is possible by giving predicted agriculture commodity future price with higher accuracy. The higher the commodity prices the higher the recommendation priority.

To develop Cultivar's choice application, the researcher has performed literature review as indicated in the following sessions.

3.0 LITERATURE REVIEW:

To identify agricultural market price information provided to the farmer community and its related stake holders, the researcher found that there are many web-services [18-21] and government web-portals like E-Chaupal [30], agriwatch [32], itcportal

[33], kishan [34], indiagriline [35] and e-agriculture [36]. Moreover, many portals or web services also provide information about several rural services of Government of India such as E-post [25], E-seva [26]. Also there has been contribution from many private portals and universities such as E-sagu [27], StarAgri [22], MahaAgri [23] and Lokmitra [24].

There were several studies conducted [3-7] which determine future market price based on archive price data. The volatility of an agriculture commodity price is very high and therefore price forecasting for decision makers in this domain has become more sensitive and challengeable compared to non-agricultural domain. The approaches used by different researchers are time series analysis with various statistical techniques and soft computing techniques such as neural network.

Through literature study, the researcher came to know about the contribution of the meteorological parameters in the quality and quantity of the agriculture product. Naturally they have an important role in market price determination. There are many studies in the world [8-12] which have shown that meteorological data influence the production and quality of agriculture commodities.

To judge the impact of agriculture commodity market supply on its market price, the researcher studied about the demand and supply mechanism and its impact on agriculture market. Mordecai Ezekiel [13] theoretically explained the Cobweb Theorem of agricultural product price policy determination and said that, 'current year's price determines the next year's supply and next year's supply determines that year's price'. In support of the Cobweb Theorem, several econometrics literatures [14-16] show that particular agriculture product supply determines the entire price strategies of that product in the market for the next year.

By having literature review with regards to impact of agriculture commodity market price, this study experimentally [17] consider three meteorological parameters Temperature, Humidity, Rainfall and one fiscal parameter Old Supply to generate an agricultural mathematical model. Such model would help the farmer community in their decision making such as Cultivar's Choice.

4.0 EXPERIMENTS DESIGN AND RESULTS:

In this study, data was loaded into the mathematical model for training and predicted agriculture commodity market price was generated as mentioned below:

1. Load Pre-processed data to mathematical model.
2. Execute Multiple Linear Regression (MLR) (Eqn.4.1) and generate regression coefficient (Beta) (Eqn.4.2)value and intercept of the regression line (Const). (Eqn.4.3).
3. Compare predicted price with actual price and find out accuracy percentage.
4. Enhance Accuracy percentage of Step 3 result using Fitness Factor (α) (Eqn.4.4)

5. Display mathematical model with fitness factor graphically to ease farmer community.

Mathematical model can be represented as follows:

$$y' = \sum_{k=1}^{p} \beta_k \times x_k + Const \tag{4.1}$$

$$\beta_k = \frac{\sum_{i=1}^{n}\left(x_{ki} \times y_{ki}\right) - \frac{\left(\sum_{i=1}^{n} x_{ki}\right) \times \left(\sum_{i=1}^{n} y_{ki}\right)}{n}}{\sum_{i=1}^{n}\left(x_{ki}^{\,2}\right) - \frac{\left(\sum_{i=1}^{n} x_{ki}\right)^2}{n}} \tag{4.2}$$

$$Const = \overline{y} - \left(\sum_{k=1}^{p} \beta_k \times x_k \right) \tag{4.3}$$

Where,

$\alpha =$ *Fitness Factor*
$y =$ *Price*
$y' =$ *Price with MLR*
$\hat{y} =$ *Predicted Price*
$x_1 =$ *Temperature*
$x_2 =$ *Humidity*
$x_3 =$ *Rainfall*
$x_4 =$ *Old Supply*
$n =$ *No. of Observations*
$e =$ *Influence Error*
$p =$ *4 (No. of Parameters)*

The mathematical Model development process is very critical and essential in the entire system development. It acts as a part of intelligent component in this system. In this model,

$$\hat{y} = y' + \left(\alpha - 1\right) \times y' + e \tag{4.4}$$

Predicted Market Price Y' is dependent variable and Daily Average Temperature ($\boldsymbol{X_1}$), Humidity($\boldsymbol{X_2}$)and Rainfall ($\boldsymbol{X_3}$) as well as Old Supply ($\boldsymbol{X_4}$) are independent parameters.

Here as shown in equation (4.1) n is the number of parameters. In this study the value of n is 4 i.e. four parameters such as Temperature, Humidity, Rainfall and Old Supply are used to construct the given mathematical model. As shown in equation (4.1), 'Const' is the intercept of the regression line. Its value can be calculated as per equation (4.3). Equation (4.4) gives the predicted value of the dependent variable $\hat{y}$

based on dependent variable of equation (4.4) y', influence error e and fitness factor α. The value of this fitness factor varies for different agriculture commodities and month. β_1 gives the beta value for respected parameters i.e. when value of 'i' is 1 the β_1 will give the beta value for first parameter $\boldsymbol{X_1}$ – Temperature and so on as per equation (4.2). In this way the output of equation (4.1) is substituted in equation (4.4) and finally dependent parameter value i.e. predicted agriculture produce market price is calculated.

Fig.1 below shows comparison of achieved accuracy percentage 'Without' and 'With' Fitness Factor for selected ten agriculture commodities. As shown in this Fig.1 each agriculture commodity accuracy is higher 'with' fitness factor compared to 'without' fitness factor (i.e. using only MLR). Although, agriculture commodity market price is highly volatile, the researcher got more than 80% accuracy in each selected agriculture commodity in this study.

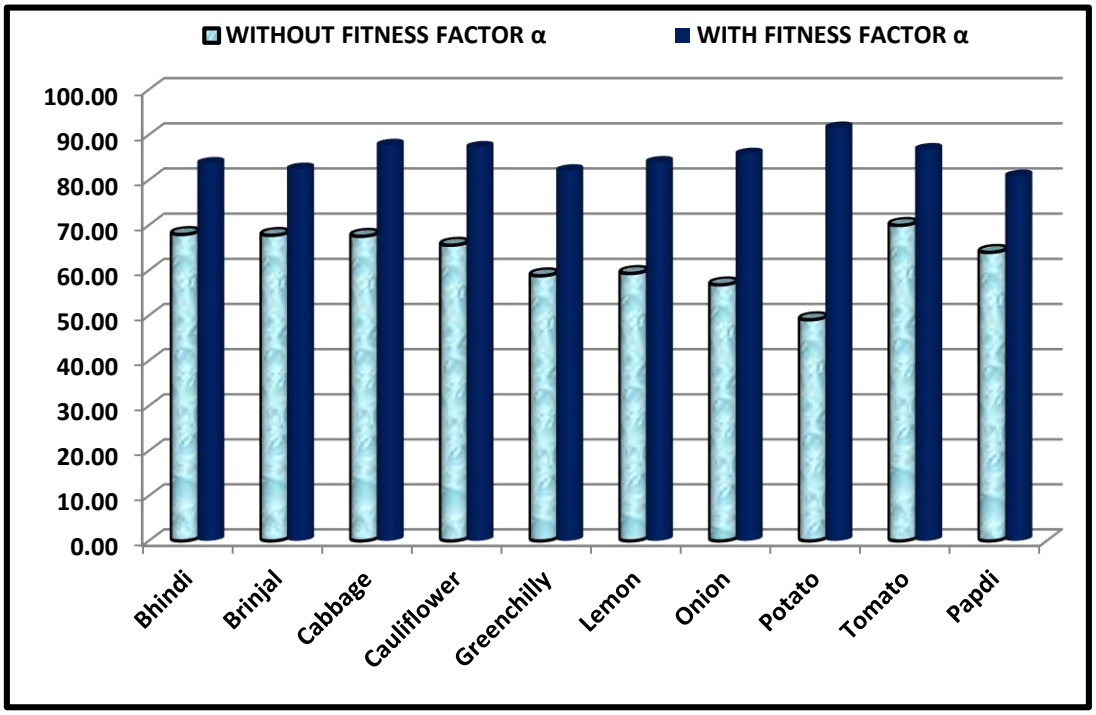

Fig.1: Accuracy % Comparison Chart with/without Fitness Factor – α

5.0 CULTIVAR'S CHOICE GUI:

As shown in Fig. 2, the farmer chooses the 'Season' in which he would like to cultivate the crop. Based on the input season, the system will offer recommendation of the top most two commodities for cultivation as shown in Fig. 2, with a view of getting higher price obtainable at the time of cropping period. Those who need

recommendation for more than two commodities can go through a detailed cultivar's choice analysis as shown in Fig. 3 and Fig. 4 with two different scenarios.

As shown in Fig. 3, the system will suggest detailed analysis for cultivation period of selected agriculture commodity based on the season input by knowledge consumer. At the same time based on the cultivation period and production period of given agriculture commodity, the system will generate 'Predicted Crop Period'. Here as shown in Fig. 3, above the crop period is classified into two different months based on the cultivated period of that agriculture commodity. Price Prediction for first month (February 2017) is given as First Scenario as shown in Fig. 3. By selecting specified month the system will predict average price for that month as well as display graphical representation as shown in the same Fig. 3 on the right side at the bottom. The system will also generate detailed date wise price prediction for the selected month that helps the farmer community in decision making of 'Selection of cultivar before crop cultivation'.

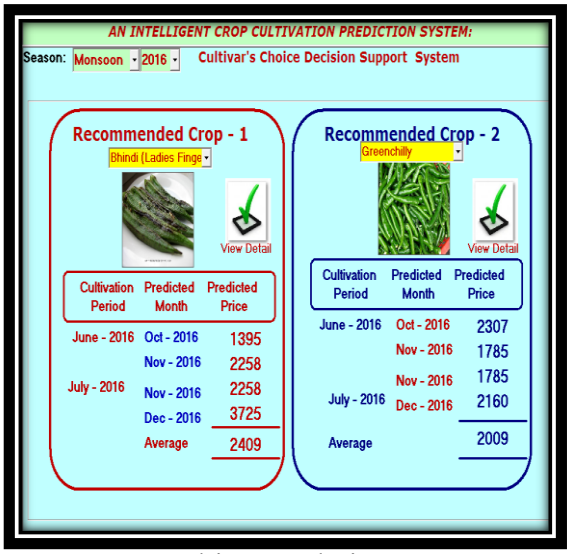

Fig.2 Cultivar's Choice – Crop Recommendation

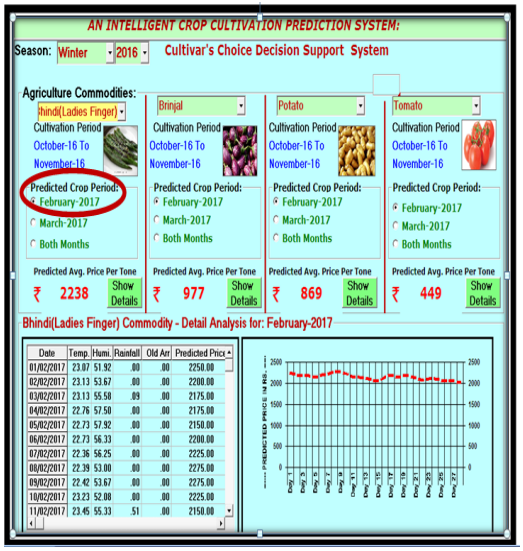

Fig.3 Crop Cultivars Choice – First Scenario

By comparing the given agriculture commodity, the farmer can have an idea about the probable income that can be gained through different agriculture commodities and accordingly they can plan for future farm management activities investment. The farmer can also select the next month and the system will generate relevant *Second Scenario* for that month as shown in Fig.4 below. As shown in Fig.3 and Fig. 4, farmers can *inference knowledge* about the situation that, earlier cultivation (i.e. in October-2016) of Brinjal and Tomato will give him higher market price at the time of its cropping. Similarly, later cultivation (i.e. November 2016) of 'Bhindi (Lady Fingers)' and 'Potato' will give him higher market price at the time of its cropping.

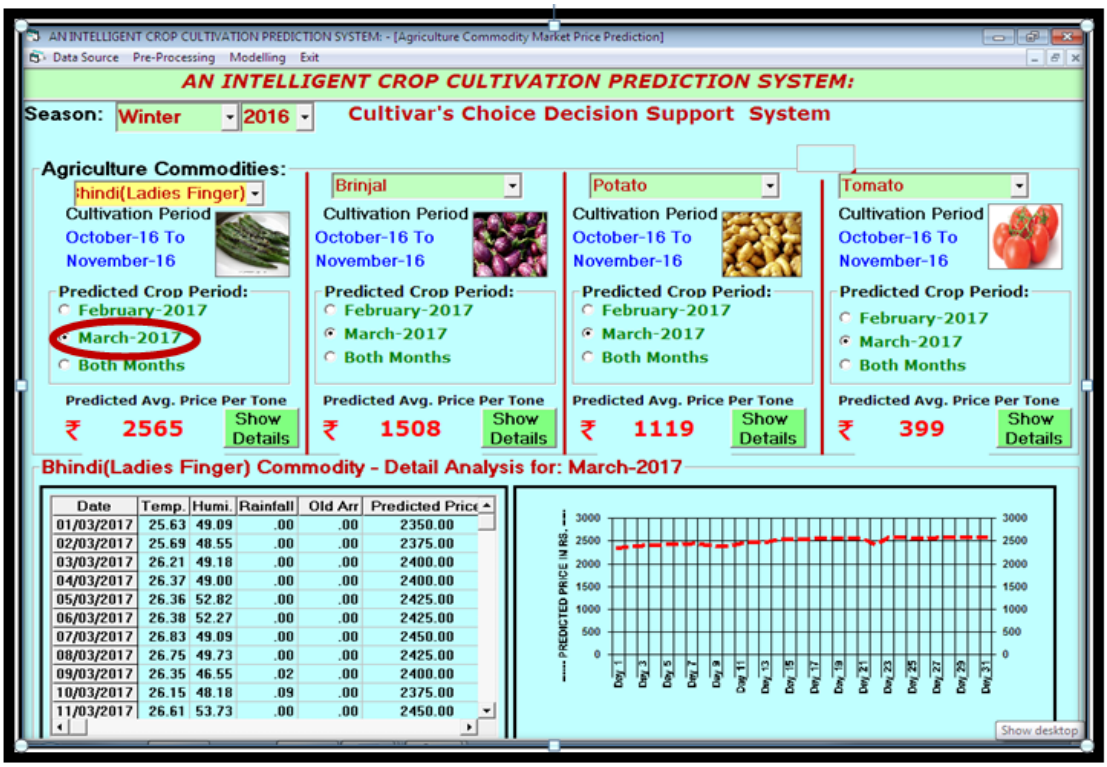

Fig.4 Crop Cultivars Choice – Second Scenario

6.0 CONCLUSION:

This study intelligently predicts the agriculture commodity market price of Surat, (Gujarat, India) APMC with more than 80% success rate in each selected agriculture commodity. Based on experiments of an integrated prediction model, the researcher constructed 'Monthly' model with fitness factor '**α**' to predict future market price in the form of generated knowledge. This 'generated knowledge' can help the farmer community in their decision making of crop cultivation (what crop to cultivate and when to cultivate) before crop cultivation. So this study determines best choice of cultivars to sow out of given choice of cultivars suitable to basic land structure of their farm; to achieve the ultimate goal of profit making of the farmer community.

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