Report on

DEVELOPING A DIAGNOSTIC TOOL AND TIME SERIES ANALYSIS IN RESPECT OF WHEAT ARRIVALS AND PRICES

Submitted By:

Sohail Bakshi

(2K15/MBA/55)

Under the Guidance of:

Dr. Pradeep Kumar Suri

Professor

DELHI SCHOOL OF MANAGEMENT

Delhi Technological University

Bawana Road Delhi 110042

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CERTIFICATE

This is to certify that the dissertation report titled **"Developing a Diagnostic Tool and Time Series Analysis in Respect of Wheat Arrivals and Prices"** is a bonafide work carried out by **Mr. Sohail Bakshi** of **MBA 2015-17** and submitted to Delhi School of Management, Delhi Technological University, Bawana Road, Delhi-42 in partial fulfillment of the requirement for the award of the Degree of Masters of Business Administration.

Signature of Guide **Signature of Head (DSM)**

Seal of Head

Place:

Date:

DECLARATION

I, **Sohail Bakshi**, student of **MBA 2015-17** of Delhi School of Management, Delhi Technological University, Bawana Road, Delhi – 42, hereby declare that the dissertation report **"Developing a Diagnostic Tool and Time Series Analysis in Respect of Wheat Arrivals and Prices"** submitted in partial fulfillment of Degree of Masters of Business Administration is the original work conducted by me.

The information and data given in the report is authentic to the best of my knowledge.

This report is not being submitted to any other University, for award of any other Degree, Diploma or Fellowship.

Place: **Sohail Bakshi**

Date:

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ABSTRACT

Timely disseminating marketing related information of agricultural commodities throughout the country is essential in today's scenario. AGMARKNET portal is one such initiative to collect, compile and disseminate prices and arrival data of agricultural commodities. The information that this portal provides is critical to all the stakeholders associated with agriculture. AGMARKNET aims to deliver correct and complete information to the farmers in order to strengthen their economic position. Farmers can know before going to the markets the price at which the crop can be sold which brings them in a better bargaining position. Consumers can benefit too as this will bring transparency in arrivals, curbing hoarding.

This study aims to develop a diagnostic for major markets where wheat arrivals are high. This diagnostic tool will help the data entry operators to have various checks on the entire process of data entry. Thereby, improving the data quality by monitoring the data reporting process continuously. Statistical Process Control (SPC) can help the correct reporting of data. Microsoft Excel 2016 was used for diagnostic tool development.

The second objective of the study is to forecast the modal prices of wheat for a particular variety using time series modeling. Data filtering, sorting and cleaning are the essential tasks conducted as part of this process. The time series modeling has been attempted to forecast wheat prices in 2017. Microsoft Excel 2016 and Eviews 9 have been used for time series analysis.

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Chapter 1

Introduction

1.0 Introduction to the Project

This chapter will emphasize on the importance of agriculture and agricultural related information for the nation like India. The chapter will also put a focus on the agencies directly associated with the agricultural marketing network. The significance and the various objectives to be covered in the study are also to be highlighted in this chapter.

1.1 Background

Food has been the most important need to mankind and thus various countries are moving forward to commercialize agricultural productions. India particularly has one third of its population directly or indirectly dependent on agriculture and contributing 25 per cent to the GDP. Buying and selling of agricultural products is the basic definition of agriculture marketing. Marketing information has become a very important aspect in order to plan their crop produce and marketing of the produce. Various stakeholders involved in the agriculture markets also require market information to make and take well informed decisions. So, over the years it had become important that the marketing information conveyed is complete and correct, and is also shared with all the key stakeholders. IT and IT enabled services have enabled to manage and disseminate information even in the remote corners of the country. It was the need of the hour to setup a marketing information network for agricultural commodities grown throughout the country.

As a result, the Central Sector Scheme project of Agricultural Marketing Information Network (AGMARKNET) was launched in March of the year 2000 by the Ministry of Agriculture under Government of India. It aimed to connect together all the agricultural produce wholescale markets throughout the country and the State Agricultural Marketing Boards and Directorates. The project is technically supported by the National Informatics Centre (NIC).

The key objective is to gather, break down and disseminate market information to the stakeholders. More than 3200 markets are networked under the scheme and more than 2700 markets are detailing information to AGMARKNET portal. More than 350 commodities and 2000 varieties are secured under the plan. Every unit is furnished with important PC equipment, alongside web network. "AGMARK," an easy to understand portal has been produced to encourage assemblage and transmission of information at market level. The revealing framework is currently web empowered. It additionally gives week by week information to value incline for real markets and significant agribusiness products. Online Exchange Portals are connected to the AGMARKNET entryways to give spot and future costs.

1.1.1 Directorate of Marketing and Inspection

The Directorate of Marketing and Inspection (DMI), under Ministry of Agriculture & Farmers Welfare, was set up in the year 1935. The Agricultural Marketing Adviser to the Government of India (AMA) heads the Directorate.

Its prime aim is to implement agricultural policies and plans so that an integrated development of marketing information pertaining to agriculture can take place. By maintaining a close liaison with Central Government and State Government DMI also thrives to safeguard the interest of both farmers and consumers (**source**: http://dmi.gov.in/About.aspx).

1.1.2 National Informatics Centre (NIC)

Since its establishment in the year 1976, National Informatics Centre (NIC) has been the major builder applications pertaining to the domain of e-governance having a reach up to the grassroots levels. "NICNET", connects all the Ministries and Departments of the Central Government, links 36 of the State Governments or Union Territories, and spans about 688 district administrations across India. NIC aims to implement Information Communication Technology based applications to derive competitive advantage in social as well as public administration.

NIC also has under its belt various initiatives such as Government eProcurement System (GePNIC), Office Management Software (eOffice), Hospital Management System (eHospital), Government Financial Accounting Information System (eLekha).

For the Agricultural Marketing Network Scheme, NIC had provided computer hardware, developed the software, provided training to market personnel towards the operation of the hardware and software systems and provided internet connectivity. It has also developed the integration between the software packages developed by the various states with AGMARKNET to bring about seamless uniformity in the database.

1.1.3 State Agricultural Marketing Boards

As far back as the nation accomplished independence, the Planning Commission of India has been endeavoring hard to augment agrarian creation. In quest for this objective, the Zamindari system was abrogated and surplus land must be conveyed among agriculturists and workers. The projects like Intensive Agricultural Development Program (IADP) were propelled. Also, rustic improvement was the fate of prime significance. In this way, on one hand, on the national level, endeavors were being made to augment creation, while on the state level, the emphasis was laid at a bargain, stockpiling and preparing of rural deliver. There was likewise the issue of appropriation of the deliver so that the create was sold off at costs which were to be reasonable for both agriculturists, merchants and shoppers. It was with this goal in view that many states built up State Agricultural Marketing Boards keeping in mind the end goal to encourage showcasing exercises in regards to horticultural create.

For AGMARKNET, the State Government/Marketing Boards gave the list of markets to be secured under the AGMARKNET project. The chosen

markets were to give site to establishment including offices for computer installation, phone network and computer operating personnel.

Showcase Committees/Controlling specialists of AGMARKNET hub at market level were doled out to gather pertinent information and data, encourage it and transmit it to the State level and AGMARKNET entry. NIC had additionally prepared suitable people from every hub in working on a computer and dealing with programming bundle.

At each market hub, there is a man appointed to gather information and transmit it. A motivation plot has been acquainted with reward information section administrators for keeping up execution guidelines consistently.

1.2 Significance of Study

The Agricultural Marketing Information System Network (AGMARKNET) which is based on the “NICNET” aims at linking all the important Agricultural Produce Market Committees (APMC), State Marketing Boards and Directorate of Marketing and Inspection regionals offices. So, that there can be seamless exchange of information.

The purpose of the study is to help AGMARKNET to improve the data quality of the reporting prices. As data quality of an agricultural commodity is of prime importance to the stakeholders particularly when it comes to issue such as price rise, hence with the study it was aimed to improve upon the quality of price reported. More over forecasting the future prices of an agricultural commodity can help the stakeholders to be better prepared for price rise or fall. Through timely awareness, forecasted values can provide the much-needed leverage of time to adapt and perform accordingly. Data filtering, sorting and data gap filling can help us to draw meaningful inferences from the agricultural data and perform activities

such as forecasting and diagnostic tool development using that data for distinct markets.

1.3 Objectives of the Study

The data pertaining to both arrivals and prices is easily available on the AGMARKNET portal, although the reported data has some short comings when it comes to the quality. Further, daily price reporting data also suffered from some irregularities because of lack of daily updated data. Also, the daily reporting makes the data prone to errors which might be unintentional or deliberate in nature. The study aims to find out any gaps in the data reporting, and then to bridge those gaps in order to improve upon the data quality. The study will primarily revolve around the agricultural commodity Wheat and will focus on the study of modal prices. After the analysis of data, the study aims to fulfil two major objectives:

- To develop a diagnostic tool which can report irregularities in price for major wheat markets
- Forecast the future prices of Wheat for major markets

1.4 Concluding Remarks

In this chapter, it was seen that how AGMARKNET is emphasizing the need to collect information and is facilitating it. Various agencies involved with the AGMARKNET project were also highlighted. The importance of the project and the key objectives of the study were highlighted in this chapter. Now, in the next chapter the review of the available literature regarding the study of the project shall be discussed.

Chapter-2

Review of Literature

2.0 Introduction to Review of Literature

Extensive literature pertaining to agricultural marketing and marketing information system is available online. Through the review of literature in this chapters, it was aimed to highlight some of the key definitions and features of agriculture related market information. It becomes necessary to see how that information can be monitored and controlled. So, applicability statistical process controls particularly in non-manufacturing sectors needs to explored. Through proper data monitoring, data quality can be improved which can provide accurate information to the stakeholders associated with agriculture.

2.1 What Is Agricultural Marketing?

As indicated by Thomsen (1951), the investigation of agricultural marketing contains every one of the operations, and the organizations leading them, required in the development of farm produced food, crude materials and their subordinates, for example, textiles, farms to the final consumers, and the impacts of such operations on famers, middlemen and buyers. Agricultural marketing is the study of the considerable number of activities, offices and arrangements required in the acquisition of farm contributions by the famers and the development of agricultural items from the farms to the consumers. The agricultural marketing framework is a connection between the farm supply and the non-cultivate segments. It incorporates the assessment of agricultural raw materials supply to handling businesses, the appraisal of interest for homestead data sources and crude materials, and the approach identifying with the marketing of farm items and information sources. As indicated by the National Commission on Agriculture (XII Report, 1976), agricultural marketing is a procedure which begins with a choice to create a saleable farm product, and it includes every one of the parts of market structure or framework, both practical and institutional, in

view of specialized and monetary contemplations, and incorporates pre-and post-gather operations, amassing, evaluating, capacity, transportation and circulation. Agricultural marketing framework incorporates the assessment of interest for farm inputs and their supply, post-gather treatment of farm items, execution of different exercises required in exchanging agricultural items from farms to preparing ventures as well as to extreme customers, evaluation of interest for farm items and open approaches and projects identifying with the valuing, taking care of, and buy and offer of farm information sources and agricultural items. Of late trade in the domestic and international markets also become the part of it (**Source:** FAO)**.**

2.2 Agricultural Marketing Information System

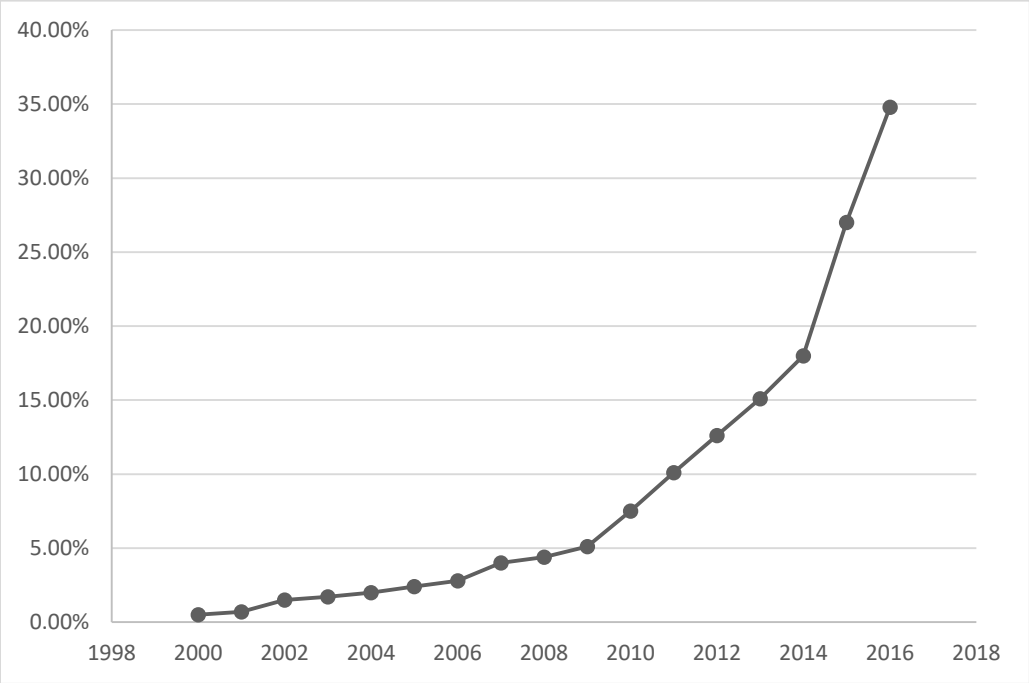
Jobber (2007) defines it as a "system in which marketing data is formally gathered, stored, analysed and distributed to managers in accordance with their informational needs on a regular basis." In nations like India, the different activities especially that of marketing data is prepared by government as a piece of agricultural marketing and agribusiness procedure advancement. Productive market data arrangement can be shown to have positive advantages for farmers, dealers and the government. Up-to-date, or current, market data strengthens the famer’s position to consult with dealers from a place of a better comparative advantage. It also encourages spatial dispersion of items from country territories to urban zones and between urban markets by sending the representation of data in its true form from urban shoppers to rural producers in regards to quantities and varieties required.

Current interchanges innovations open up the conceivable outcomes for market data administrations to enhance data conveyance through SMS on mobile phones and the fast development of FM radio stations in many creating nations offers the possibilities of more localized information services. Radio projects like Kisanvani on All India Radio and Kisan Suvidha on versatile give famers the genuinely necessary data in regards to farm and farm produce delivery.

Also, there has been an increase in penetration of internet over the last 16 years. This is evident from the fact in the year 2000, India had about 0.5% of its population using the internet whereas in July, 2016 34.8% of the total population of India uses internet, be it on desktop, laptop or mobile phones. As a result, there is rapid flow of information. AGMARKNET is one such portal giving agricultural related information of various varieties of crop to its stakeholders. The information needs to be complete and correct.

Figure 2.1: Showing Percentage of Population Using Internet

(**Source:** Internetlivestats)



2.3 Data Reporting on AGMARKNET portal

Data on the AGMARKNET portal is primarily reported as commodity Arrivals and Prices. The arrival data shows the amount of agricultural produce received in tonnes. Arrival data is reported on yearly, monthly, weekly and even daily basis which is used to compile reports. One can easily see which state, district or market receives maximum arrivals of a particular agricultural commodity.

On the other hand, the price data is reporting in the unit of Rs/Quintal. There are three types of prices reported on the portal they are:

- Maximum Price

  The maximum prices paid for an agricultural commodity during several transactions held in a day in a market is termed at maximum price.
- Minimum Price

  The minimum price paid for an agricultural commodity during several transactions held in a day in a market is termed at minimum price.
- Modal Price

  The modal price is the price at which most of the commodity was sold in a market during the day.

Along with these three prices one can also get the details of state name, district name, group to which agricultural commodity belongs, variety and grade.

Thus, the information being disseminated through the AGMARKNET portal is quite comprehensive and vital to all the stakeholders of agriculture.

2.4 Overview of Wheat Production

According to Agricultural Market Information System (AMIS) and FAO, wheat is a Rabi crop and it is sown in mid-October-mid-November and reaped in March. It develops well in cool, damp atmosphere and ages in a warm, dry atmosphere. The cool winters and the hot summers are helpful for a decent product. A cloudless sky having brilliant daylight amid maturing and gathering periods will improve quality wheat. Winter precipitation is perfect.

The climatic conditions suitable for growing wheat are given below:

- Temperature: The month to month normal temperature ought to go in the vicinity of 10°C and 15°C amid the time of sowing. The same ought to be

in the vicinity of 21°C and 26°C amid maturing period. Wheat grain does not develop completely if the temperature falls underneath 21°C.

- Rainfall: Wheat develops better in those ranges where precipitation happens in winter. Regions having 50 to 100 cm yearly normal rainfall develop wheat. Irrigation serves the best if rainfall falls underneath 50 cm.

2.4.1 Wheat Statistics

Directorate of Economics and Statistics reports that in the previous 10 years India's wheat generation has expanded at a CAGR of 2.46 percent. Likewise, over the most past 10 years there has been an expansion in the area under wheat production at CAGR of 0.77 percent. As indicated by United States Department of Agriculture Database from 2014-17, China was the leader as far as wheat production was concerned and was trailed by India and United States of America. In the year 2015-16, India's partake in worldwide wheat generation was recorded at 11.78 percent. In 2015-16, India's major export countries were Bangladesh, Nepal, UAE and Taiwan. As per AGMARKNET database (for Domestic Price) and FAO database (at International Costs) the local costs have been higher than that of International costs since April 2014 onwards. Commission at Agricultural Costs and Costs (CACP) announces the Minimum Support Price (MSP) for wheat and this figure has increased by 20.4 percent over the past 5 years.

2.4.2 Trade Policy

- Export Policy: Under the policy of the Government of India, the export of wheat is free.
- Import Policy: Import of wheat for human utilization is allowed through State Trading Enterprises but import of seeds is confined.

2.4.3 Major Wheat Producing States (2014-15)

The Major wheat producing states for the year 2014-15 according to Directorate of Economics and Statistics, Ministry of Agriculture are:

Table 2.2: Major Wheat Producing States

S.No.	State/ UT	Wheat (tonnes)
1	Uttar Pradesh	25220
2	Punjab	15783
3	Madhya Pradesh	14182
4	Haryana	11856
5	Rajasthan	9869
6	Bihar	4049
7	Gujarat	3220
8	Maharashtra	1236
9	West Bengal	950
10	Himachal Pradesh	721

Thus, it is seen that when it comes to agriculture then the quality of data reported becomes of prime importance. Data reporting of arrivals and prices on a daily basis becomes a cumbersome task often involving errors. Thus, the entire data reporting process keeps on running without any checks and controls.

2.5 Statistical Process Control

In 1920, Dr. Walter A. Shewhart developed the concept of control chart and state of statistical control while working at Bell Laboratories, thereby pioneering the Statistical Process Control (SPC) which was carried forward by W Edwards Deming. There are primarily seven key tools of statistical process control, they are:

- Check Sheets

  The check sheet may be a type (document) used to assemble data progressively at the range the place the data is processed. The majority of

the data it catches might make quantitative and alternately subjective. In that perspective, the point when some information is quantitative, then a check sheet is sometimes called a count sheet.

- Pareto Chart

  A Pareto chart, also called a Pareto distribution diagram, is a vertical bar graph where values are plotted in decreasing order of relative frequency from left to right.

- Histograms

  Introduced by Karl Pearson, a histogram graphically represents the distribution of data in which is in numerical form.

- Scatter Diagrams

  Values of two variables are plotted along two axes on a single graph, the pattern of the resulting points revealing any correlation present.

- Defect Concentration Diagrams

  The defect concentration diagram (also problem concentration diagram) is graphical apparatus that is helpful in breaking down the reasons for the item or part defects.

- Control Charts

  The control chart is a chart used to study how a procedure changes after some time. Information are plotted in time arrange. A control graph dependably has a central for the average, an upper line for the upper control limit and a lower line for the lower control limit. These lines are developed from past information.

2.5.1 SPC and Non-Manufacturing Sector

Since its being statistical process control was thought to be applicable to only manufacturing processes with the objective of reducing waste or scrap and it was thought impractical to apply statistical process control to non-manufacturing processes. But in the year 1988, Software Engineering Institute suggested that statistical process control could be applied to non-manufacturing processes, such as software engineering processes. The Level 4 and Level 5 practices of the Capability Maturity Model Integration (CMMI) use this concept. Also in his book titled “Statistical Process Control”, Leonard A. Doty has said that any of the control charts can be applied in the non-manufacturing sector (like education, health care, politics, family life and self-improvement) in the similar way as they are applied in the manufacturing process. Thus, there is enough evidence that statistical process control can be applied to non-manufacturing processes as well.

Due to the above evidence, it was clear that information relating to statistical process control tools particularly that of control charts needs to be gathered and comprehended. Control charts are basically graphs to show how a process changes over time. With three lines namely, Upper Control Limit (UCL), Lower Control Limit (LCL) and a Control Line (CL) determined by the previous data available. These charts can help in drawing conclusions about process variations.

Table 2.3: Various Types of Control Charts

(**Source:** isixsigma)

Attribute Data Chart	**Variable Data Chart**
p Chart (Fraction Defective)	$\bar{X}$ and R (Average and Range Chart)
np Chart (Number Defective)	X and R_m (Individuals and Moving Range Chart)
c Chart (Number of Defects)	
u Chart (Number of Defects per Unit)	

Attribute data chart is used when the data is counted as discrete events, whereas, in variable data chart data is measured on a continuous scale. The type of chart used is determined by the type of data collected as well as the subgroup size of the data. Since the aim is to collect price data over a period of year, variable data chart will be most suitable for the process. When it comes to control charts it is important to understand the subgroups i.e. a group of measured units under the same conditions. The subgroup restrictions for Individuals and Moving Range Chart are that the data must have a subgroup size equals 1 (i.e. data cannot be grouped and each measurement is unique), whereas subgroup size for Average and Range Chart is greater than 1 (i.e. data can be grouped and each measurement is not unique).

2.5.2 Individuals and Moving Range Chart

An I-MR chart is a plot of individual observations (I chart) and moving ranges (MR chart) over time for variables data. The moving range is defined as $MR_i=|X_i- X_{i-1}|$, which is also the absolute value of the first difference.

Table 2.4: Control Limits

Lower Control Limit	Control Limit	Upper Control Limit
$\bar{X} - \frac{3\overline{MR}}{d_2}$	$\bar{X}$	$\bar{X} + \frac{3\overline{MR}}{d_2}$

The value of d_2 is 1.128(Shewhart constants) for moving range value that equals 2 (since we are taking the absolute first level difference). So, substituting this value in the control limits equations, the equation becomes $\bar{X} \pm 2.66\overline{MR}$, where $\bar{X}$ is the average of the series and $\overline{MR}$ is the moving range.

According to Nancy R. Tague's 'The Quality Toolbox', the control chart basic procedure is to firstly choose the appropriate control chart for the data. Secondly, determine the appropriate time period for collecting and plotting data. And third, collect data, construct the chart and analyze the data. Once the chart is plotted one should look for "out-of-control signals" on the control chart. Continue to plot data as they are generated. As each new data point is plotted, check for new out-of-control signals.

2.6 Time Series Forecasting

A time series is a series of information focuses filed (or recorded or diagramed) in time arrange. Most normally, a time series is an arrangement taken at progressive similarly separated focuses in time. Forecasting is a technique that is utilized widely in time series examination to foresee a reaction variable, for example, month to month benefits, stock execution, or unemployment figures, for a predetermined timeframe. Conjectures depend on examples in existing

information. One can utilize an assortment of time series techniques, such as trend analysis, decomposition, or single exponential smoothing, to model examples in the information and extrapolate those examples to what's to come.

Ramasubramanian V. of Indian Agricultural Statistics Research Institute(IASR) with expertise in Agricultural Economics, Aquaculture, Artificial Neural Network has discussed various time series models for agricultural forecasting in “Forecasting Techniques in Agriculture” namely:

- Exponential Smoothing Models
- Auto Regressive Integrated Moving Average (ARIMA) Models

So, from the above references it is seen that there is evidence that forecasting of time series has been done in agriculture sector to predict the future crop yields.

2.6.1 Exponential Smoothing Models

Exponential smoothing weights past observations with exponentially decreasing weights to forecast future values. For any time period t, the smoothed value S_t is found by computing where S_i stands for smoothed observation and Y stands for the original value.

$$S_t=\alpha Y_t-1+(1-\alpha)*S_{t-1} \quad , \quad 0<\alpha\leq 1, \ t\geq 3.$$

Alpha (α) is known as the smoothing constant. The optimized value of alpha can be chosen using the value of Mean Absolute Percentage Error (MAPE) i.e. choose the value of alpha for which the value of MAPE is least.

Another form of Exponential Smoothing method is ETS (Error-Trend-Seasonality) exponential smoothing method. The ETS modelling framework was developed in 2002 IJF paper (with Hyndman, Koehler, Snyder and Grose), and in 2008 Springer book (with Koehler, Ord and Snyder). Exponential smoothing methods were originally classified by ‘Pegels’ (1969). This was later extended by Gardner (1985), modified by

Hyndman et al. (2002), and extended again by Taylor (2003), giving a total of fifteen methods seen in the following table.

Figure 2.5: The fifteen exponential smoothing methods

(**Source:** Automatic Time Series Forecasting: The forecast Package for R)

Trend Component		Seasonal Component N (None)	A (Additive)	M (Multiplicative)
N	(None)	N,N	N,A	N,M
A	(Additive)	A,N	A,A	A,M
A_d	(Additive damped)	A_d,N	A_d,A	A_d,M
M	(Multiplicative)	M,N	M,A	M,M
M_d	(Multiplicative damped)	M_d,N	M_d,A	M_d,M

According to Rob J. Hyndman and Yeasmin Khandakar, “the cells (N, N) describes the simple exponential smoothing (or SES) method, cell (A, N) describes Holt’s linear method, and cell (A_d, N) describes the damped trend method. The additive Holt-Winters’ method is given by cell (A, A) and the multiplicative Holt-Winters’ method is given by cell (A, M). Equations for method (A, A), the Holt-Winters’ additive method.”

Figure 2.6: Equations in ETS Models

(**Source:** Automatic Time Series Forecasting: The forecast Package for R)

$$
\begin{aligned}
\text{Level:} \quad & \ell_t = \alpha(y_t - s_{t-m}) + (1-\alpha)(\ell_{t-1} + b_{t-1}) \\
\text{Growth:} \quad & b_t = \beta^*(\ell_t - \ell_{t-1}) + (1-\beta^*)b_{t-1} \\
\text{Seasonal:} \quad & s_t = \gamma(y_t - \ell_{t-1} - b_{t-1}) + (1-\gamma)s_{t-m} \\
\text{Forecast:} \quad & \hat{y}_{t+h|t} = \ell_t + b_t h + s_{t-m+h_m^+}.
\end{aligned}
$$

Also, according to Rob J. Hyndman and Yeasmin Khandakar, in the above equation “where m is the length of seasonality, t represents the level of the series, b_t denotes the growth, s_t is the seasonal component, ˆyt+h|t is the

forecast for h periods ahead. Some interesting special cases can be obtained by setting the smoothing parameters to extreme values. For example, if α = 0, the level is constant over time; if β ∗ = 0, the slope is constant over time; and if γ = 0, the seasonal pattern is constant over time."

2.6.2 Making Time Series Stationary

To check a whether a time series is stationary or not a test known as Breakpoint Unit Root Test is used. This test has a null hypothesis that *H_o: Series has a unit root.*

If a series has unit root then it a non-stationary series. To check the hypothesis, p-value is seen i.e. if p-value is less than 0.05 then hypothesis is rejected and time series is stationary, where as if p-value is greater than 0.05 then hypothesis is accepted and the time series is non-stationary.

One approach to make a time series stationary is to find the differences between the data recorded. This is known as differencing. Changes, for example, logarithms can balance out the variations of a time series. Differencing can help balance out the mean of a time series.

- Random walk model

  The differenced series is formed by subtracting the next observation from the previous one, and can be written as

  $$y'_t = y_t - y_{t-1}$$

  The differenced series will have only t−1 values since it is not possible to calculate a difference for the first observation.

Once the series is stationary one can run time series analysis to perform forecasting.

2.7 Conclusion of the Literature

Through the review, it has been brought to light that extensive literature is available online regarding marketing information. Also, how AGMARK reports prices and arrivals to deliver timely information was also noted. There are evidences regarding the applicability of statistical process control in non-manufacturing sector and how time series forecasting has been done on the agricultural sector as well. Now, the methodology involved in the study shall be discussed.

Chapter-3

Methodology

3.0 Introduction to Methodology

Analytical research was embraced keeping in mind the end goal to study this venture. Analytical research is a particular sort of research that includes basic deduction abilities and the assessment of truths and data in respect to the research being directed. Inside analytical research articles, information and other essential truths that relate to a venture is gathered; after the data is gathered and assessed, the sources are utilized to demonstrate a speculation or bolster a thought. A person can bring out small details to form greater assumptions about the material by using critical thinking skills effectively.

The research in this project focusses on secondary data obtained from the AGMARKNET.GOV.IN portal. Through this analysis, the study aims to bring to forward the data gaps in order to develop an effective diagnostic tool and a forecasting model.

In this chapter, the various phases involved in the study shall be discussed.

3.1 Project Phases

3.1.1 Understanding Phase

Step 1: To comprehend the broader purpose(s) of the project.

The project aims to develop a diagnostic tool for a particular commodity in order to improve the quality of the data reported in future. Developing a diagnostic tool will help farmers and citizens of the country to have correct information regarding the crop commodity as it will help address the issues such as modal prices reported as zeros, modal prices reported as averages of maximum

and minimum price and modal prices with extreme values. Thereby reducing the error in reporting.

The second objective of the project is to forecast the prices of the chosen commodity. This activity will help farmers and government to understand the prices in the coming months of 2017.

Step 2: To understand the data reporting fields of AGMARKNET portal.

The AGMARKNET portal reports Arrivals (in tonnes) and Prices (in Rs/Quintal) along with crop commodities' state, district, variety, grade and date of reporting.

3.1.2 Defining Phase

Step 1: To choose a commodity for analysis.

The commodity chosen for the project was Wheat.

Step 2: To define a time frame of the data reporting period for that commodity.

The time frame for the data so that the diagnostic tool can be developed was 01 January, 2016 to 31 December, 2016. Whereas, the time period for data forecasting for the year 2017 was chosen to be 01 January,2012 to 31 December,2016.

Step 3: To identify the key data term(s) to be worked upon for analysis from amongst maximum price, modal price and minimum price.

The data reporting on the AGMARKNET portal consists of maximum price, minimum price and modal price. Out of them modal prices

were chosen for the analysis part as this is the price at which most of the commodity is transacted in a market.

3.1.3 Data Preparation and Analysis Phase

Step 1: Tools chosen for Analysis

The software chosen for development of diagnostic tool was Microsoft Excel 2016, where the softwares chosen for time series forecasting were Microsoft Excel 2016 and Eviews 9.

Step 2: To find the state, district and market with maximum arrivals within the reporting period.

The state with maximum arrivals for wheat was found out. Then within that state the district and market with maximum arrivals for wheat were found.

Step3: Check for the reporting frequency of the data fields (modal price and date).

The plot of prices reported per month was done for the whole reporting period to check the consistency in the data.

Step 4: Clean the data for better analysis.

The data gaps were identified and they were filled using the average method in order to have a consistently reported past data which can be worked upon easily to develop diagnostic tool and forecast model.

Step 4: Analyze the data to develop diagnostic tool and forecast model in the next phase.

The data was analyzed for data gaps, zeros and reporting of averages of maximum prices and minimum prices in place of modal prices.

3.1.4 Developing Phase

Step 1: To develop a diagnostic tool incorporating statistical process control charts.

To develop a diagnostic tool, it was necessary to keep the process statistically controlled. For this control chart was used. Various literature pertaining to control charts was studied and the correct chart was chosen according to the best data fit. The chart helped us to get the upper and lower control limits.

Step 2: Develop a time series forecast model for the modal price of the chosen commodity.

To forecast the time series data into 2017, exponential smoothing method was used.

3.1.5 Testing Phase

Step 1: Test the diagnostic tool on other markets reporting the same commodity.

The diagnostic tool thus developed for one market was applied on other markets as well by using their respective control limits to check the applicability of the tool across markets for the same commodity.

Step 2: Check the accuracy of the forecast model.

To check the accuracy of the forecast various parameters like Mean Absolute Error (MAE) and Mean Absolute Percentage Error (MAPE) were used.

3.1.6 Findings and Recommendations Phase

After extensive analysis, one will be able to bring out some findings and recommendations through which the AGMARKNET portal can benefit. The

limitations of the diagnostic tool and forecasting model are also be highlighted.

3.2 Concluding Remarks

The approach towards the study of the project and the project methodology was discussed in this chapter. Now in the next chapter the data analysis, findings, limitations and recommendations regarding the study shall be discussed.

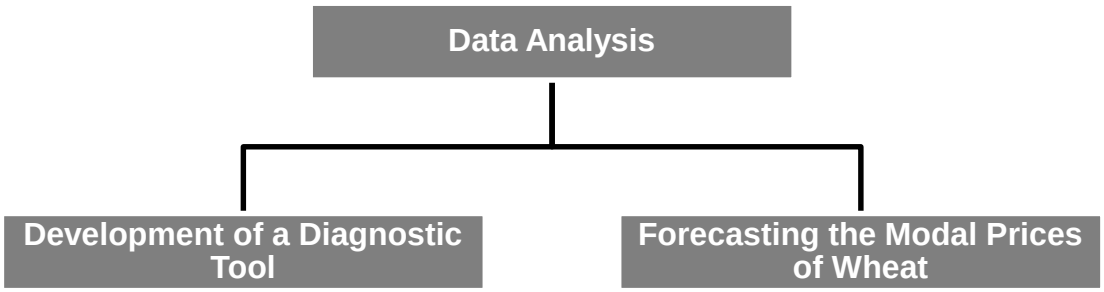
Chapter-4

Data Analysis

4.0 Introduction to Data Analysis

The commodity chosen for analysis in the understanding phase was Wheat. The commodity data for wheat obtained from the AGMARKNET portal was usually in .xls format and various operations such as data filtering, data sorting and data cleaning was done in order to draw and make sense out of the compiled data. Since, the project had two major objectives the entire analytics process was classified into two major headings as shown in Figure 4.1

Figure 4.1: Components of Data Analysis



4.1 Development of a Diagnostic Tool

The development of diagnostic tool was a multi phased process. The phases were as follows:

4.1.1 Choosing a Tool to Analyze Data

Since, the data obtained from AGMARKNET was in excel format, so, Microsoft Excel 2016 was chosen to analyze the data and develop a diagnostic tool also.

4.1.2 Selection of Market for Analysis

The arrival data for wheat for the past one year i.e. from 01 January,2016 to 31 December,2016 was obtained for all the states from the AGMARKNET portal. The arrivals were for each state and the percentage share of total arrivals for each state was found. It was clear to see that Punjab was the leader in wheat arrivals with 26.92% share of the total wheat arrivals. Hence, the data of the state Punjab was analyzed to find the district and market showcasing maximum arrivals in tonnes. The district that gave maximum arrivals was Sangrur with a share of 9.67% and in that district Bhawanigarh market showed the highest percentage of arrivals of about 51.96%. So, it was decided to develop the diagnostic tool for Bhawanigarh market of Sangrur district in Punjab. However, it was found that the Bhawnigarh market showed all its arrival in the month of April 2016 and the data reporting of prices during the same period was also not upto the mark. So, it was decided to do analysis for the next major state in terms of wheat arrivals viz. Madhya Pradesh. Hence the state of analysis was shifted from Punjab to Madhya Pradesh, which had 25.51% of the total wheat arrivals during the year 2016. The Indore district (11.93% of wheat arrivals for MP) ranked one in terms of wheat arrival and within Indore district, Gautampura market was seen to have 73.33% of the total district arrivals. The arrivals were seen throughout the year making the market appropriate for further analysis.

Table 4.2: Arrival Data for Wheat (State, District and Market Wise)

(**Source:** Own Analysis on AGMARKNET Data)

State	Arrival(tonne)	% of Total Arrivals
Andhra Pradesh	1329.5	0.00%
Assam	5225.4	0.02%
Bihar	561	0.00%
Chattisgarh	64961.78	0.23%
Gujarat	1027548.18	3.65%
Haryana	5755119.48	20.45%
Jharkhand	3397.31	0.01%
Karnataka	112421	0.40%
Kerala	1029.1	0.00%
Madhya Pradesh	7178623.57	25.51%
Maharashtra	255469	0.91%
NCT of Delhi	52844.8	0.19%
Orissa	356.64	0.00%
Punjab	7577292.2	26.92%
Rajasthan	1844872.43	6.56%
Telangana	8	0.00%
Uttar Pradesh	3935750.68	13.98%
Uttrakhand	186872.4	0.66%
West Bengal	139080.41	0.49%
Total	28142762.88	

District	Arrivals	% of Total Arrivals
Amritsar	366124	4.83%
Barnala	205184	2.71%
Bhatinda	283408	3.74%
Faridkot	321879	4.25%
Fatehgarh	392460	5.18%
Fazilka	572351	7.55%
Ferozpur	196370	2.59%
Gurdaspur	519687	6.86%
Hoshiarpur	55266	0.73%
Jalandhar	660828	8.72%
kapurthala	104649	1.38%
Ludhiana	698163	9.21%
Mansa	361144	4.77%
Moga	400638	5.29%
Mohali	37176.8	0.49%
Muktsar	712839	9.41%
Nawanshah	144856	1.91%
Pathankot	18325	0.24%
Patiala	448263	5.92%
Ropar (Rupnagar)	42623.5	0.56%
Sangrur	732364	9.67%
Tarntaran	302695	3.99%
	7577292	

Market	Arrivals	% of Total Arrivals
Amargarh	54100	7.39%
Bhawanigarh	380500	51.96%
Cheema	62310	8.51%
Dirba	54349	7.42%
Khanauri	7900	1.08%
Moonak	22260	3.04%
Sandaur	38550	5.26%
Sangrur	37810	5.16%
Sherpur	65085	8.89%
Sulargharat	9500	1.30%
	732364	

Month	Arrivals
Jan	-
Feb	-
Mar	-
Apr	380,500.00
May	-
Jun	-
Jul	-
Aug	-
Sep	-
Oct	-
Nov	-
Dec	-

Table 4.3: Arrival Data for Wheat for Madhya Pradesh

(**Source:** Own Analysis on AGMARKNET Data)

District Indore(11.93% of total state arrivals)		
Market	Arrivals	% of total Arrivals
Gautampura	628150.5	73.33%
Indore	154719.2	18.06%
Mhow	22902.2	2.67%
Sanwer	50867.1	5.94%
	856639	

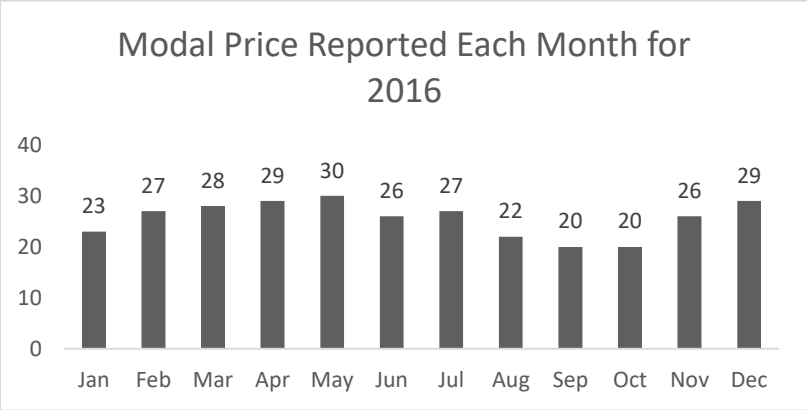
Month	Arrivals
Jan	6303
feb	38930
Mar	341766
Apr	186650
May	28178
Jun	20778.5
Jul	2097.5
Aug	942.8
Sep	757.2
Oct	399.1
Nov	542.26
Dec	806.1

4.1.3 Checking for Modal Price Reporting Frequency

Along with arrivals it became necessary to see the frequency with which prices were reported for Gautampura market in Madhya Pradesh. We found the price reporting to be good throughout the year as it reported for 307 days out of 366 days.

Figure 4.4: Modal Price Reported

(**Source:** Own Analysis on AGMARKNET Data)



4.1.4 Data Cleaning of Modal Prices

The price reporting sheet for Gautampura market was analyzed on the following points

- Modal Price is Average

  In the 307 entries, it was checked that how many entries had modal price equal to average of maximum and minimum price by using the “IF” statement in MS Excel. It was found that there were 50 entries in all where modal price was actually average.

- Modal Price is Zero

  The reported entries were checked for where the modal price is reported to be zero. No entry was found to be reporting modal price zero.

The entries having modal price as average of maximum and minimum prices were deleted. 257 entries were now reported after deletion and by using VLOOKUP command PIVOT TABLE the daily data gaps were filled by the average modal price of that month. Thereby, having a continuous series.

4.1.5 Developing a Control Limits and Control Charts

Once the data was properly cleaned it was necessary to develop control limits. For this statistical process control charts were referred. Since, the modal prices were of variable nature, measured on a continuous scale of daily dates and the data set had a subgroup size of one (as each day's price data cannot be combined with the next day's data), so, the Individual Moving Range Chart was chosen to get the upper control limit and lower control limit. The equation for control limits for I-MR chart is:

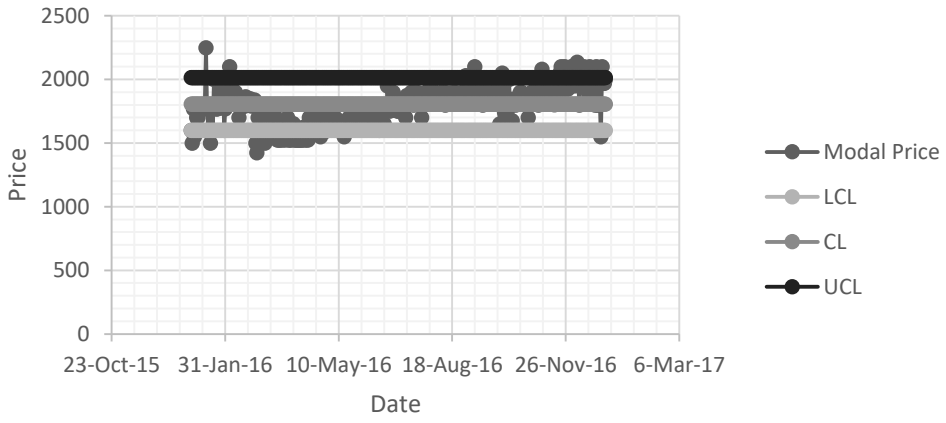
$$\bar{X} \pm \frac{3\overline{MR}}{d_2},$$ Where $E_2 = \frac{3}{d_2}$ and d_2=1.128.

Therefore, the equation becomes,

$$\bar{X} \pm 2.66\overline{MR}$$

Figure 4.5: Control Chart for Gautampura Market

(**Source:** Own Analysis on AGMARKNET Data)



To reduce the effect of seasonality, factors were developed for each month of the entire year 2016. To include some marginally rejected prices and to widen the limits the LCL was multiplied with 0.88 (lowest value) and UCL was multiplied with 1.09(highest value).

Table 4.6: Correction Factors for Gautampura Market

(**Source:** Own Analysis on AGMARKNET Data)

Indore-Gautampura		
Jan	1768.75	0.98
Feb	1825.52	1.01
Mar	1652.885	0.91
Apr	1595.37	0.88
May	1664.444	0.92
Jun	1758.333	0.97
Jul	1842.364	1.02
Aug	1890.611	1.05
Sep	1922.929	1.06
Oct	1844.214	1.02
Nov	1956	1.08
Dec	1969.4	1.09
	1807.568	

4.1.6 Developing the Interface of the diagnostic tool

The diagnostic tool was a standalone excel sheet where users can enter the data for modal price to check whether the price values where within the range or not. The excel sheet also consisted of dynamic Control Charts, reflecting new data value entered dynamically. The tool prompted for a warning message if the date did not belong to 2017 or if the modal price was out of the UCL and LCL or if the maximum and minimum prices were negative.

Figure 4.7: Warning Message for Date

(**Source:** Own Analysis on AGMARKNET Data)

Figure 4.8: Warning Message for Modal Price

(**Source:** Own Analysis on AGMARKNET Data)

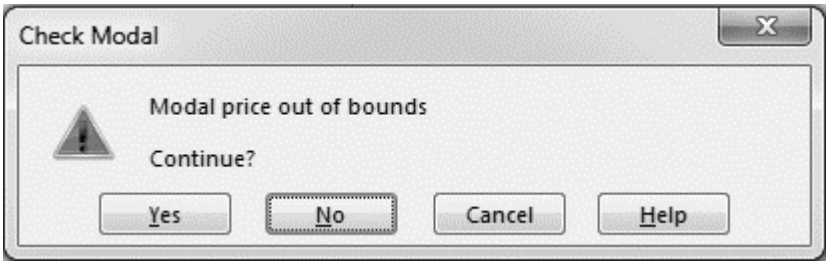
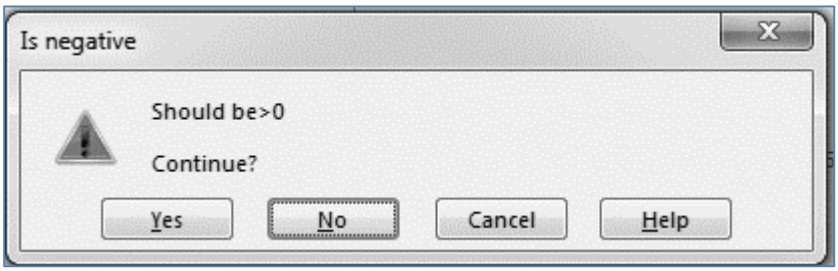


Figure 4.9: Warning Message for Maximum-Minimum Prices

(**Source:** Own Analysis on AGMARKNET Data)



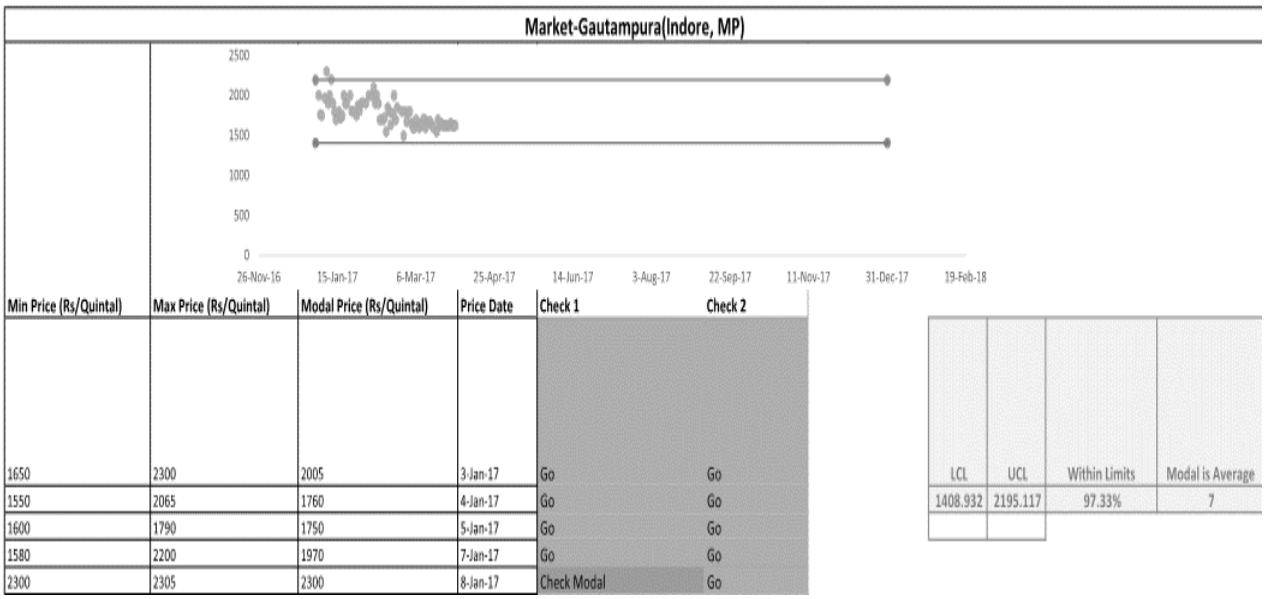
Apart from these errors if the data entry operator still wished to proceed with the reporting those prices, then, two checks were developed. These checks would keep the error messages on record if the data entry operator still proceeded with the price reporting. Check 1 took care of the error if the modal price thus reported was out of bounds and gave a red flag “Check Modal” or if the price is within limits then a green flag “Go”. Similarly, Check 2 took care if the modal price was the average of maximum and minimum

prices by giving a red flag “Modal is Average” or giving a green flag “Go” if modal is not average, dynamically.

The tool also showed the percentage of modal price data reported being within limits and the number of entries where modal price is the average of maximum and minimum prices.

Figure 4.10: Look of the diagnostic tool

(**Source:** Own Analysis on AGMARKNET Data)



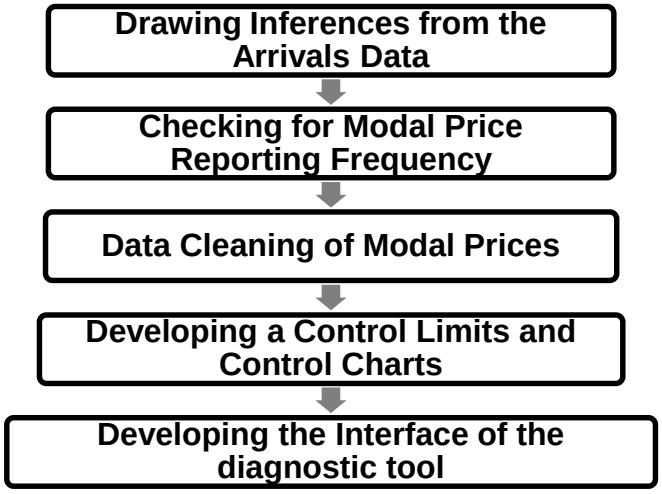
Min Price (Rs/Quintal)	Max Price (Rs/Quintal)	Modal Price (Rs/Quintal)	Price Date	Check 1	Check 2
1650	2300	2005	3-Jan-17	Go	Go
1550	2065	1760	4-Jan-17	Go	Go
1600	1790	1750	5-Jan-17	Go	Go
1580	2200	1970	7-Jan-17	Go	Go
2300	2305	2300	8-Jan-17	Check Modal	Go

LCL	UCL	Within Limits	Modal is Average
1408.932	2195.117	97.33%	7

To check the applicability of this tool developed for Gautampura market on other markets, similar activities were performed for four other top Wheat markets of Madhya Pradesh.

The activities performed for each of the 4 other markets are by Figure 4.11.

Figure 4.11: Diagnostic Tool Development



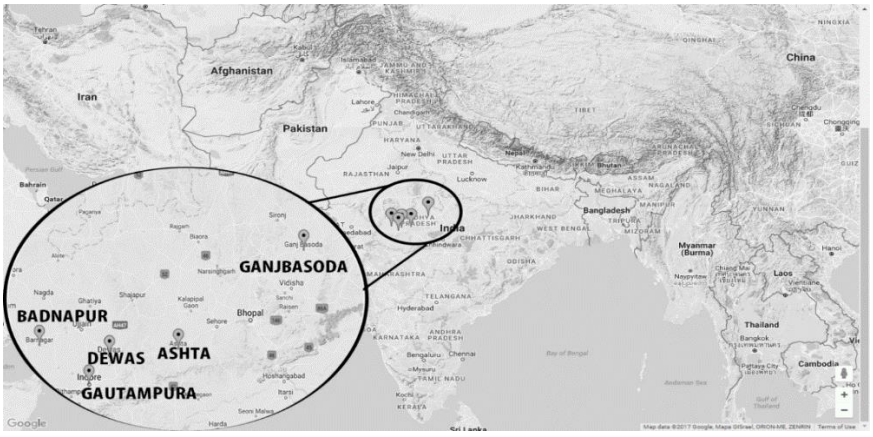
The Districts and their respective four other leading wheat arrivals markets are shown through Figure 4.12.

Table 4.12: District-Markets for diagnostic tool

S No.	District	Market
1	Vidisha	Ganjbasoda
2	Ujjain	Badnapur
3	Sehore	Ashta
4	Dewas	Dewas

Figure 4.13: Geolocation of various markets

(**Source:** Google)



4.2 Forecasting the Modal Prices of Wheat

In order to forecast the wheat modal prices for the year 2017 based on the modal prices of the previous years following steps were followed:

4.2.1 Choosing the Tools of Analyses

To develop a better forecast model two tools were used

- Microsoft Excel 2016: For sorting, filtering and cleaning data
- Eviews 9: To help choose a forecast model

4.2.2 Drawing Inferences from the Arrivals Data

It was aimed to develop forecast model for one of the top Wheat producing markets of Madhya Pradesh, and for that it became necessary to look into the arrivals data of Madhya Pradesh's markets.

Table 4.14: District Leading in Wheat Arrivals
(**Source:** Own Analysis on AGMARKNET Data)

District	% of Total Arrivals
Indore	11.93319
Ujjain	10.74455
Sehore	5.450352
Vidisha	5.238514
Dewas	5.137249

But after analyzing the data of Gautampura and Indore Market (leading markets in terms of arrivals) belonging to the leading district Indore in terms of wheat arrivals it was found that there were large number of data gaps prominently because of price reporting gaps. As a consequence, the analysis had to move to 2nd highest wheat arrival district of Madhya Pradesh i.e. Ujjain. In Ujjain, it was found that Badnagar was leading in terms of wheat arrivals (61.01% of total arrivals of Ujjain). So, Badnagar

was chosen as the market to develop a forecast model. During the period of 01 January 2012 to 31 December 2016, Badnagar reported three varieties of wheat, which were as follows:

- Lokwan
- Sharbati
- 147 Average

Lokwan was reported the maximum times, quite ahead of the other variteies (Sharbati and 147 Average). Also, Lokwan variety of wheat reported in Badnagar had fewer data gaps to be replaced.

Table 4.15: Arrivals-Ujjain(Wheat)

(**Source:** Own Analysis on AGMARKNET Data)

Market Name	% of Total Wheat Arrivals
Badnagar	61.01%
Khachrod	2.09%
Mahidpur	9.38%
Nagda	2.07%
Tarana	6.21%
Ujjain	17.64%
Unhel	1.60%

4.2.3 Data Cleaning of Modal Prices

To forecast the data, it was necessary to fill the data gaps and improve the quality of data. For this it was seen that how many number of times (count) the wheat variety-Lokwan was reported is month i.e. in days. To bridge the data gaps, the months which had more than 15 days of reporting of modal prices had their remaining non-reported days filled with the averages of that month. Whereas, the months having data reported days' count greater than 10 but less than or equal to 15 were replaced by the average of the modal price values present of that month and the average of annual modal price. Lastly, if the count of the modal price reported days was less than 10, then, the missing values were replaced by annual average.

4.2.4 Choosing a Forecast Model and Technique

Since, the series is a time series a popular technique of forecasting was used viz. Exponential Smoothing Method has been used for forecasting. To choose the right fit model the software EViews version 9 has been used.

First of all, it was checked that was the series stationary or not. Using the Breakpoint Unit Root Test which is based on the Dickey-Fuller test, the p-value came out to be 0.2112 which means that the null hypothesis "Series has a unit root" was not rejected, this acceptance means that the time series is non-stationary in nature.

Figure 4.16: Test for Stationarity

(**Source:** Own Analysis on AGMARKNET Data Using EViews)

Unit Root with Break Test on PRICE

Null Hypothesis: PRICE has a unit root
Trend Specification: Intercept only
Break Specification: Intercept only
Break Type: Innovational outlier

Break Date: 2015M09
Break Selection: Minimize Dickey-Fuller t-statistic
Lag Length: 1 (Automatic - based on Schwarz information criterion, maxlag=10)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-3.857186	0.2112

So, in order to make the time series stationary first level difference was taken i.e. $Difference_{n+1}=Price_{n+1}-Price_n$. We again ran the unit root test on it based on Dickey-Fuller test to get the p-value. The p-value this time was found to be less than 0.01, hence the null hypothesis was rejected, meaning that it does not have a unit root and thus is stationary in nature.

Figure 4.17: Test for Stationarity After Difference

(**Source:** Own Analysis on AGMARKNET Data Using EViews)

Unit Root with Break Test on D(PRICE)

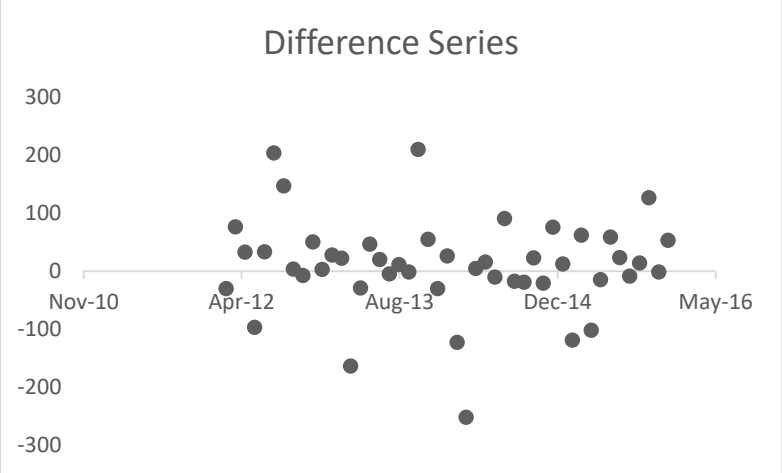
Null Hypothesis: D(PRICE) has a unit root
Trend Specification: Intercept only
Break Specification: Intercept only
Break Type: Innovational outlier

Break Date: 2017M01
Break Selection: Minimize Dickey-Fuller t-statistic
Lag Length: 0 (Automatic - based on Schwarz information criterion, maxlag=10)

	t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic	-6.631988	< 0.01

Figure 4.18 Stationary Series Plot

(**Source:** Own Analysis on AGMARKNET Data)

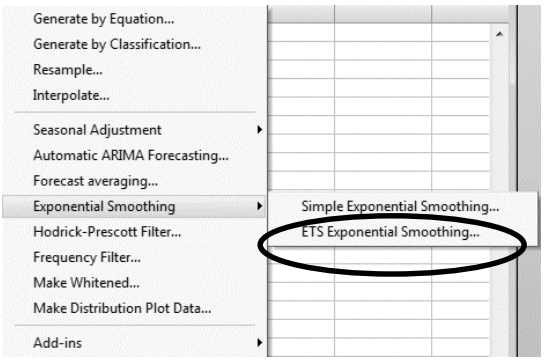


Thus, a stationary series at first level of difference was found.

Now, EViews has a special command titled “Exponential Smoothing” which helps users to find the best fit model out of the given models. The ETS(Error-Trend-Seasonality) Exponential Smoothing of EViews gives the best fit model according to the select criteria and justifies the chosen model statistically.

Figure 4.19: ETS Exponential Smoothing-EViews

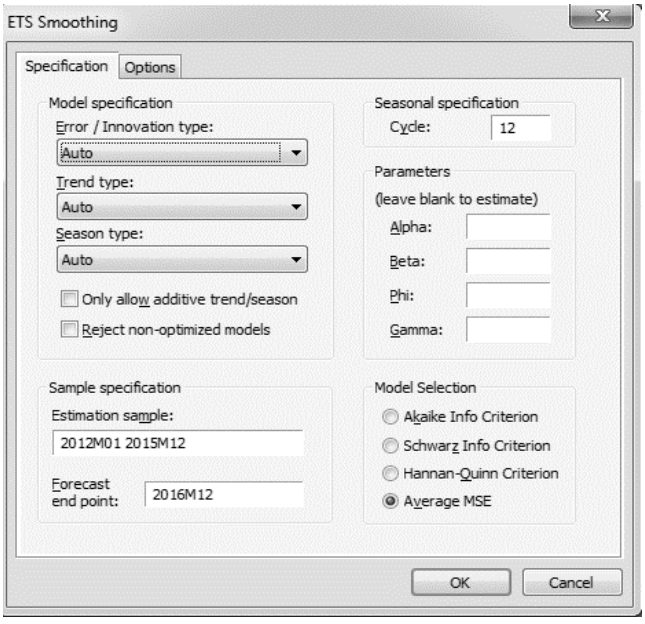
(**Source:** EViews)



The ETS exponential smoothing method was first employed on the period 01 January 2012 to 31 December 2015 to forecast the modal prices for the month January to December 2016. Since the data for 2016 was already present it was easy to check the model's accuracy by finding out various errors.

Figure 4.20: ETS Model Options

(**Source:** EViews)



In order to find the appropriate model, the value of Error, Trend and Seasonality was set to "AUTO". The Estimation sample was 2012M01

(Jan-2012) 2015M12 (Dec-2015) with a forecast endpoint 2016M12 (Dec-2016). The model selection criteria were set to Average MSE option. To further optimize the model the objective was set to Average MSE the cyclicity for the forecast was set as 12, since it focusses on 12 months a year. After running the operation, it was found that Eviews by using ETS Exponential Smoothing Technique gave the model A, A, A. It gave the value of alpha as 0.026873, beta as 0.026873. The MSE comparison made it evident (as visible in the screenshots below) that the A, A, A model has the least MSE as compared to other ETS exponential smoothing models. Thus, the model was applied on the modal price data from 01 January, 2012-31 December 2015, to get the forecast for 2016.

Figure 4.21: ETS Model Parameters and Comparisons

(**Source:** EViews)

Parameters	
Alpha:	0.026873
Beta:	0.026873
Gamma:	0.000000

4.2.5 Forecast Errors for the Months of the 2016

Once the model was applied and the forecast of the model prices were obtained month wise, then, the mean absolute percentage error and mean absolute error were calculated.

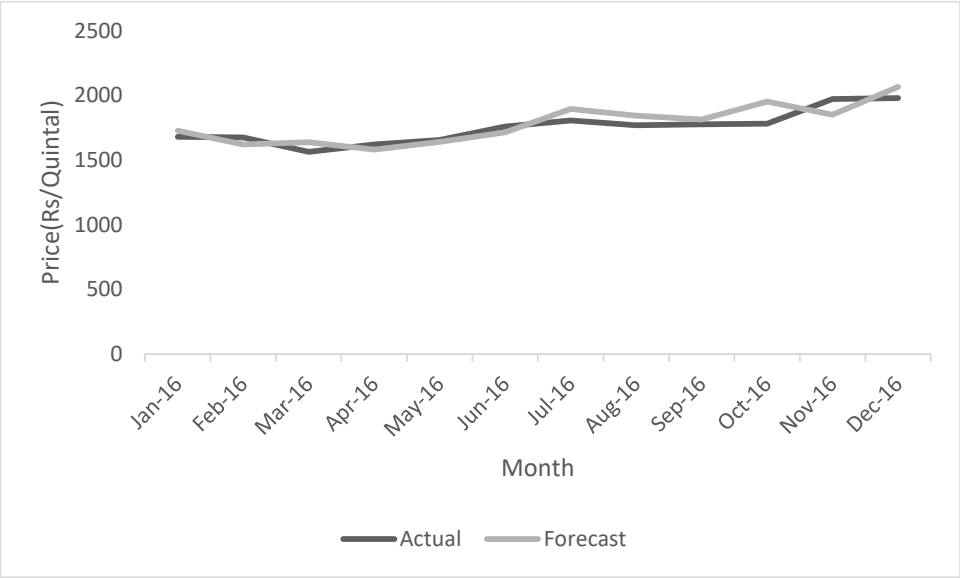
Table 4.22: Forecast Errors

(**Source:** Own Analysis on AGMARKNET Data)

Errors	**Value**
Mean Absolute Percentage Error(MAPE)	3.99%
Mean Absolute Error(MAE)	71

So, it was seen that the forecast accuracy for the months of 2016 was 96.01%.

Figure 4.23: Forecast-Actual Comparison for 2016
(**Source:** Own Analysis on AGMARKNET Data)



The forecasted values were close to the actual values of model price, and hence the data from 01 January 2012 to 31 December 2016 was used to forecast the values of various months of 2017 using the same model constraints obtained earlier.

4.3 Findings

- Once the diagnostic tool was prepared it was seen that what percentage of values of the months January, February and March for the year 2017 actually fell within limits. It was also seen whether the seasonal correction improved the tool or not. It was evident that the control limits were increased marginally to include nominally larger or smaller modal prices. Thus, the diagnostic tool was improved.

Table 4.24: Control Limits and Percentage Values within Limit (before adjustment)

(**Source:** Own Analysis on AGMARKNET Data)

District	Market	LCL	UCL	% Data within Limits
Indore	Gautampura	1601	2014	85.33%
Vidisha	Ganjbasoda	1965	2262	75.38%
Ujjain	Badnapur	1672	1838	23.73%
Sehore	Ashta	1670	1874	20.37%
Dewas	Dewas	1600	1733	22.03%

Table 4.25: Control Limits and Percentage Values within Limit (after adjustment)

(**Source:** Own Analysis on AGMARKNET Data)

District	Market	Adjustment Factors LCL-UCL		Adjusted-LCL	Adjusted-UCL	% Data within Limits
Indore	Gautampura	0.88	1.09	1409	2195	97.33%
Vidisha	Ganjbasoda	0.91	1.04	1788	2353	93.85%
Ujjain	Badnapur	0.89	1.13	1488	2076	98.31%
Sehore	Ashta	0.91	1.16	1520	2174	90.74%
Dewas	Dewas	0.91	1.13	1456	1958	100.00%

- The forecast model (A, A, A) obtained after ETS exponential smoothing was applied to the previous data to get forecasts for the months of January, February and March 2017. The MAPE for first three months of 2017 was 7.92% whereas the MAE was Rs 136/Quintal. The Market was Badnagar and wheat variety Lokwan.

Figure 4.26: Actual and Forecast Values

(**Source:** Own Analysis on AGMARKNET Data)

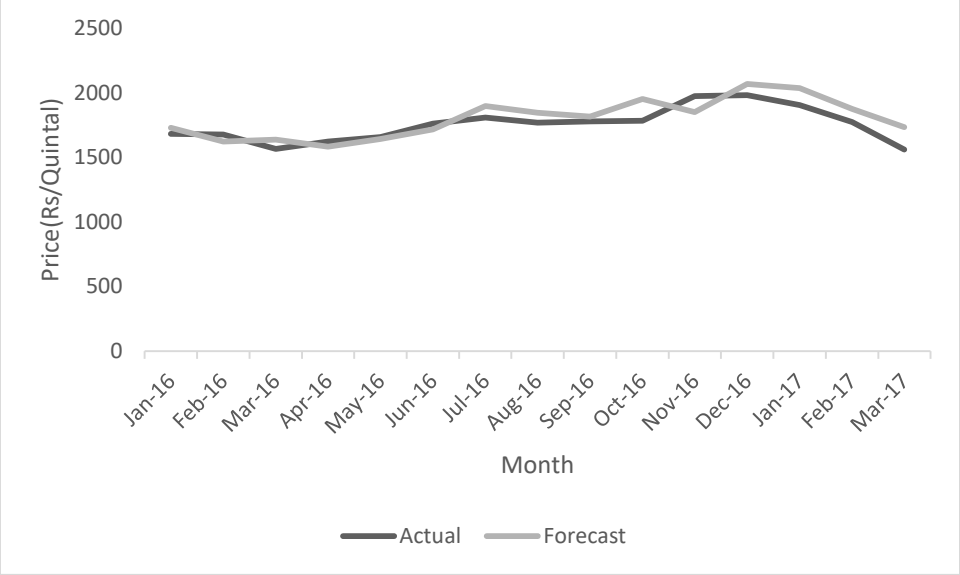


Figure 4.27: Actual and Forecast Values

(**Source:** Own Analysis on AGMARKNET Data)

Month	Actual	Forecast	MAPE	MAE
Jan-17	1903	2035	6.96%	132
Feb-17	1773	1875	5.74%	102
Mar-17	1561	1734	11.06%	173
			7.92%	136

- It was seen that the data reported on the AGMARKNET portal was sometimes wrong for example the data for arrivals taken on **3 February 2017** showed West Bengal as the leading wheat producing state with

large tonnes of wheat arrival from a single market. But this error was subsequently corrected by the market.

Figure 4.28: Arrival Data on 3-February 2017

(**Source:** AGMARKNET Portal)

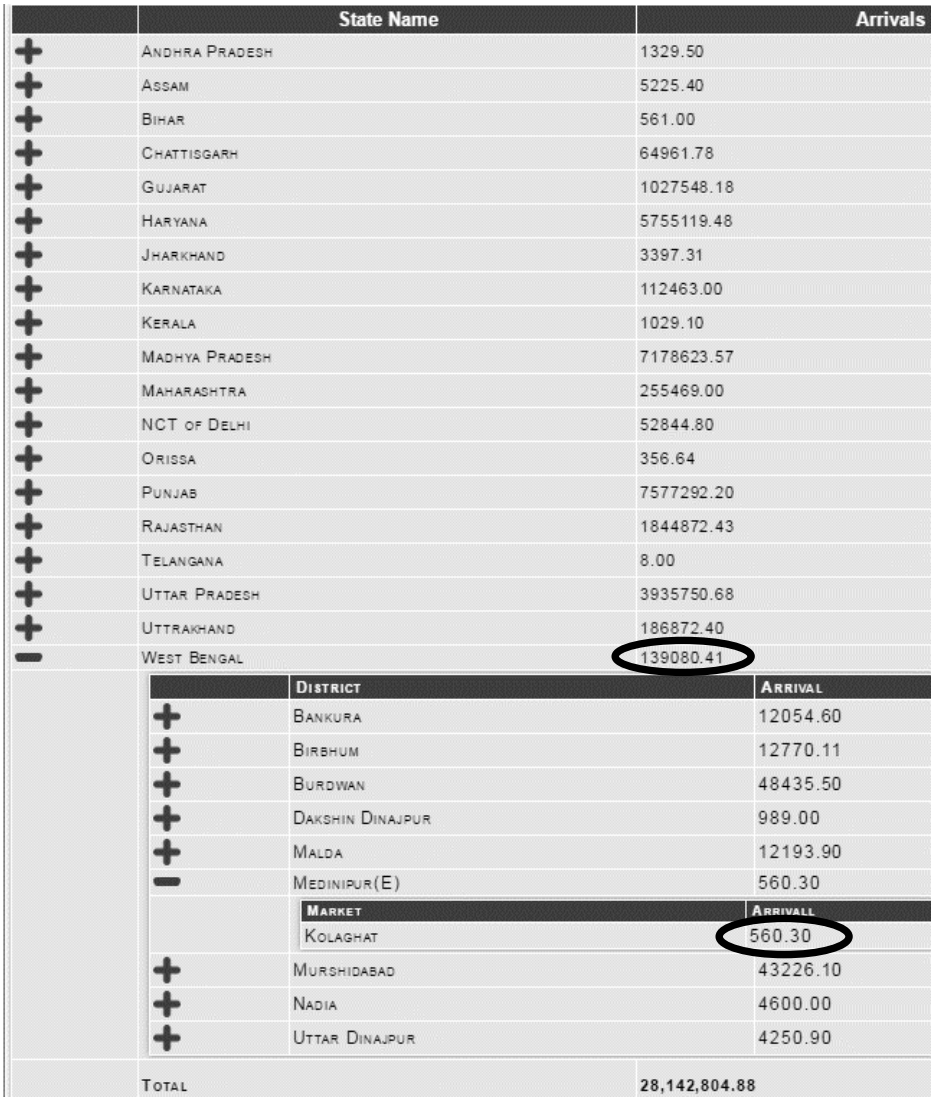
State Name	Arrivals (T
Andhra Pradesh	1329.50
Assam	5225.40
Bihar	561.00
Chattisgarh	64961.78
Gujarat	1027548.18
Haryana	5755119.48
Jharkhand	3397.31
Karnataka	112421.00
Kerala	1029.10
Madhya Pradesh	7178623.57
Maharashtra	255469.00
NCT of Delhi	52844.80
Orissa	356.64
Punjab	7577292.20
Rajasthan	1844872.43
Telangana	8.00
Uttar Pradesh	3935750.68
Uttrakhand	186872.40
West Bengal	170017340820.41

	District	Arrival
+	Bankura	12054.60
+	Birbhum	12770.11
+	Burdwan	48435.50
+	Dakshin Dinajpur	989.00
+	Malda	12193.90
−	Medinipur(E)	170017202300.30
	Market	Arrival
	Kolaghat	170017202300.30
+	Murshidabad	43226.10
+	Nadia	4600.00
+	Uttar Dinajpur	4250.90

Total	170,045,344,502.88

Figure 4.29: Arrival Data on 6 April 2017

(**Source:** AGMARKNET Portal)



State Name	Arrivals
Andhra Pradesh	1329.50
Assam	5225.40
Bihar	561.00
Chattisgarh	64961.78
Gujarat	1027548.18
Haryana	5755119.48
Jharkhand	3397.31
Karnataka	112463.00
Kerala	1029.10
Madhya Pradesh	7178623.57
Maharashtra	255469.00
NCT of Delhi	52844.80
Orissa	356.64
Punjab	7577292.20
Rajasthan	1844872.43
Telangana	8.00
Uttar Pradesh	3935750.68
Uttrakhand	186872.40
West Bengal	139080.41

District	Arrival
Bankura	12054.60
Birbhum	12770.11
Burdwan	48435.50
Dakshin Dinajpur	989.00
Malda	12193.90
Medinipur(E)	560.30

Market	Arrivall
Kolaghat	560.30

Murshidabad	43226.10
Nadia	4600.00
Uttar Dinajpur	4250.90

Total	28,142,804.88

- After preliminary analysis, it was seen that the arrival data was changed because the state of Karnataka was reporting lower arrivals on 7 February 2017, whereas the wheat arrivals were changed when the data was rechecked on the AGMARKNET portal on 21 April 2017. Thereby, it was seen that the analysis can go bad if the data is being changed continuously. The data range for arrivals was from 01 January 2016 to 31 December 2016.

Table 4.30: Reporting Higher Arrivals for Karnataka by 42 tonnes

(**Source:** AGMARKNET Portal)

State	Arrivals (Data taken on 7 Feb 2017)	Arrivals (Data taken on 21 April 2017)
Andhra Pradesh	1329.5	1329.5
Assam	5225.4	5225.4
Bihar	561	561
Chattisgarh	64961.78	64961.78
Gujarat	1027548.18	1027548.18
Haryana	5755119.48	5755119.48
Jharkhand	3397.31	3397.31
Karnataka	112463	112421
Kerala	1029.1	1029.1
Madhya Pradesh	7178623.57	7178623.57
Maharashtra	255469	255469
NCT of Delhi	52844.8	52844.8
Orissa	356.64	356.64
Punjab	7577292.2	7577292.2
Rajasthan	1844872.43	1844872.43
Telangana	8	8
Uttar Pradesh	3935750.68	3935750.68
Uttrakhand	186872.4	186872.4
West Bengal	139080.41	139080.41
Total	28142804.88	28142762.88

- The total of arrivals of wheat on AGMARKNET portal for the state of Madhya Pradesh was reported to be 944262.23 tonnes, whereas, upon

downloading the file the total was 7178623.57 tonnes which was the actual value obtained after using the sum rows formula in excel. Thus, higher arrivals were being shown on the AGMARKNET portal before downloading.

Figure 4.30: Higher Arrivals-Wheat for Madhya Pradesh
(screenshot taken on 9-April 2017)
(**Source:** AGMARKNET Portal)

State Name	District Name	Market Name	Arrivals
Madhya Pradesh	Alirajpur	Alirajpur	5724.70
Madhya Pradesh	Alirajpur	Jobat	9242.10
Madhya Pradesh	Anupur	Anuppur	1113.50
Madhya Pradesh	Anupur	Jaithari	3049.50
Madhya Pradesh	Anupur	Kotma	290.63
Madhya Pradesh	Ashoknagar	Ashoknagar	92566.20
Madhya Pradesh	Ashoknagar	Isagarh	3221.50
Madhya Pradesh	Ashoknagar	Mungawali	6890.50
Madhya Pradesh	Ashoknagar	Piprai	1954.40
Madhya Pradesh	Ashoknagar	Shadora	1575.80
Madhya Pradesh	Badwani	Anjad	10954.08
Madhya Pradesh	Badwani	Badwani	4336.12
Madhya Pradesh	Badwani	Balwadi	241.50
Madhya Pradesh	Badwani	Khetia	1692.50
Madhya Pradesh	Badwani	Sendhwa	3552.70
Madhya Pradesh	Balaghat	Balaghat	14.27
Madhya Pradesh	Balaghat	Lalbarra	263.21
Madhya Pradesh	Balaghat	Mohgaon	1384.20
Madhya Pradesh	Balaghat	Praswada	275.22
Madhya Pradesh	Betul	Betul	50643.30
Madhya Pradesh	Betul	Bhensdehi	837.50
Madhya Pradesh	Betul	Multai	6211.73
Madhya Pradesh	Bhind	Alampur	15484.20
Madhya Pradesh	Bhind	Bhind	154.00
Madhya Pradesh	Bhind	Gohad	8745.79
Madhya Pradesh	Bhind	Lahar	8310.30
Madhya Pradesh	Bhind	Mehgaon	5662.50
Madhya Pradesh	Bhind	Mow	2058.40
Madhya Pradesh	Bhopal	Berasia	45750.40
Madhya Pradesh	Bhopal	Bhopal	70645.90
Madhya Pradesh	Burhanpur	Burhanpur	2006.00
Madhya Pradesh	Chhatarpur	Badamalhera	14570.58
Madhya Pradesh	Chhatarpur	Chhatarpur	10732.40
Madhya Pradesh	Chhatarpur	Harpalpur	13982.40
Madhya Pradesh	Chhatarpur	Lavkush Nagar(Laundi)	1183.60
Madhya Pradesh	Chhatarpur	Rajnagar	10095.70
Madhya Pradesh	Chhindwara	Chaurai	18415.40
Madhya Pradesh	Chhindwara	Chhindwara	58444.80
Madhya Pradesh	Chhindwara	Pandhurna	2639.30
Madhya Pradesh	Chhindwara	Saunsar	3386.43
Madhya Pradesh	Damoh	Damoh	21305.00
Madhya Pradesh	Damoh	Hata	4740.53
Madhya Pradesh	Damoh	Javera	18045.70
Madhya Pradesh	Damoh	Patharia	10687.00
Madhya Pradesh	Datia	Bhander	31387.90
Madhya Pradesh	Datia	Datia	64676.00
Madhya Pradesh	Datia	Sevda	21747.00
Madhya Pradesh	Dewas	Bagli	4188.37
Madhya Pradesh	Dewas	Dewas	223470.40
Madhya Pradesh	Dewas	Haatpipliya	13511.07
Total			944,262.23

4.4 Limitations

- The analysis was done only on modal price and not on maximum and minimum prices.

- The data used for the development of the diagnostic tool was only of one year i.e. of 2016. To develop a better tool the data horizon can be widened to include previous year data.

- The diagnostic tool was checked for accuracy on five markets viz. Gautampura, Badnagar, Dewas, Ashta and Ganjbasoda.

- The diagnostic tool needs to be developed for each market separately which can make the task cumbersome.

- The data used for forecasting the modal prices of 2017 was taken from 01 January 2012 to 31 December 2016, giving a forecast horizon of only five years which can be made large.

- The forecast was done only for one market and one specific variety of wheat. Thus, it can only be applied to that market and that variety of wheat (market-Badnagar, wheat variety-Lokwan).

4.5 Concluding Remarks and Recommendations

After the data analysis, the diagnostic tool was developed for five major wheat markets (in terms of arrivals) of Madhya Pradesh. Also, the time series forecasting for Lokwan variety of wheat for a chosen market (Badnagar-Madhya Pradesh) was done. To conclude the data analysis of the project, here are some recommendations.

- The diagnostic tool developed as part of the project work can be accommodated alongside the data entry reporting portal of wheat prices i.e. http://agmarknet.nic.in/market_online/. Integration with the portal will give the checks and raise alerts then and there itself, making the data entry process effective and thereby improving the data quality of reporting.

- The price data reporting frequency should be monitored daily as it can help provide the actual data. This actual data can in turn help in developing robust diagnostic tools and accurate forecast models. For example, Punjab-the leading wheat producer for 2016 had a poor reporting frequency for the market Bhawingarh and the state of analysis was shifted.

- The time series forecast in the case of this study was done for a specific variety of wheat and for a specific market but instead the forecast model needs to be developed for all varieties of wheat across various markets.

- The variety terms of wheat on AGMARKNET portal like “Others” need to classified as well to maintain effective tracking on the wheat arrivals.

- In the findings of the study it was seen that the data reported historically pertaining to an agricultural commodity can be edited and changed. The

editing of already reported data can disturb and hamper the entire data analysis of the project and thus, the changing of the data should be done in a restrictive manner to ensure integrity of reported data.

Chapter 5

Conclusion of the Study

The project began by understanding the agencies associated with AGMARKNET. Also, the importance of the study and objectives of the study were highlighted which gave a direction to develop a well-planned methodological approach to the project study.

Further on in the project, the review of literature had highlighted the importance of the information particularly when it comes to the aspect of agricultural marketing information. The review of literature had also brought to light the need manage and improve the quality of data being reported. Various definitions of marketing information were obtained. The working of AGMARKNET, an agricultural commodity data reporting portal which can help in bringing insightful information to the farmers, government and consumers was understood. It was also seen how the data is being reported on this portal. The agricultural commodity's data worked on in this project was that of wheat. Whereas, time series forecasting was done for the Lokwan variety of wheat. It was also necessary to understand some facts related to wheat like major wheat producing states, temperature and rainfall conditions and trade policies, and the same was done in this study.

The study had also highlighted how statistical process control can be used in non-manufacturing sector to continuously monitor the data being reported. In this project, it was also emphasized that which statistical process control charts can be used to have mechanism of check on the prices being reported on the AGMARKNET portal for a particular commodity such as wheat. The equations of upper control limit, lower control limit and control limit were highlighted for variable process control chart i.e. individual moving range chart. It was also discussed that how the control limits can be improved by developing seasonal factors for each month so that marginally neglected prices can be accommodated. The diagnostic tool developed on the platform of Microsoft Excel was on the basis of statistical process control charts for one major wheat arrival market of Madhya Pradesh. To

check whether the approach adopted for developing the diagnostic tool was scalable to other markets or not, the same approach was applied to other four markets of Madhya Pradesh. It was seen that more than 90% of the modal prices reported for all the five markets was within the limits developed by using statistical process control chart. The diagnostic tool also took care of the modal prices that were being reported as average of maximum and minimum prices and reported a warning whenever modal prices was average.

Also, the study of this project emphasized the importance of time series forecasting particularly when it comes to the prices of agricultural commodities. Through the review of the available literature it was seen that what were the different models and techniques to analyze the time series. With a well-defined mechanism for data gap filling and after applying data filtering and data sorting in Microsoft Excel 2016, EViews 9 was used to develop a suitable model to forecast the modal prices for wheat for the year 2017. Using the ETS exponential smoothing, EViews gave a particular model, this model was applied to a subset of the dataset and was checked for errors. The error percentage came out to be less than 4%. Then the ETS exponential model was applied on the entire data set to get the forecasted values for the year 2017. Till March 2017, the mean absolute error percentage was 7.92%. The forecasting of time series was done for one particular market of Madhya Pradesh and for one specific variety of wheat (Lokwan).

During the study, it was also seen that AGMARKNET had some data reporting inconsistencies i.e. the data reported was changed after a time period. Screenshot comparison of the data taken on a previous date with that of the reported data values in the future showed enough evidence of data inconsistencies. Along with the findings, the study also highlighted the findings and recommendations of the study.

Thus, we see that by developing a diagnostic tool for various markets can help in improving the quality of data being reported as it will create a mechanism of checks and balances. The need for developing these kinds of diagnostic tools

across all markets and for all varieties of agricultural commodities was emphasized in the study. Whereas, the forecasted modal prices will assure the farmers, government agencies and consumers to get a prior information regarding the agricultural commodities. It was also highlighted that with a wider range of data set the forecasted model thus developed can be more accurate.

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