Stochastic Simulation in Agricultural Economics

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***Abstract*:** This document presents a brief outline of the work carried out as a part of the Project in the eighth semester of the undergraduate study. The document first presents the aim of the project and the background information that is necessary for understanding the project. It then describes the method that has been employed to derive the expected output. At the end, the document presents the effectiveness of the project and its analysis along with its application in the current business scenario.

Data mining (the analysis step of the "Knowledge Discovery in Databases" process, or KDD), an interdisciplinary subfield of computer science, is the computational process of discovering patterns in large data sets involving methods at the intersection of artificial intelligence, machine learning, statistics, and database systems

***Keywords* –** *Stochastic Modelling, Agricultural economics, Random walk, futures market, data analysis, Data Mining.*

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I. INTRODUCTION

The behaviour of the prices of agricultural commodities in the futures market of India has been volatile. At times, the price shoot up to around 10% of their original value while at other times they plunge down to around 20% of their original value. Speculations in the futures market is an important cause of this volatile behaviour.

The project was aimed at understanding this volatile behaviour of the commodity prices by creating a model that could depict their behaviour in a realistic way. A Random walk model, considering the random behaviour of future prices, was chosen for the problem.

II. PROBLEM STATEMENT

To use appropriate random walk theory to model the behaviour of three different commodities (Chana, Soybean and Cardamom) prices over the past to derive insights into the trading of futures of the commodities at the NCDEX and MCX market and understand their volatile behaviour.

III. INTRODUCTION OF THE COMMODITIES:

A. CARDAMOM

Cardamom is known as the “Queen of Spices”. It is one of the most highly priced and exotic spices in the world. Kerala, Karnataka and Tamil Nadu are the cardamom growing states in India. In 2013-14, as per provisional trade estimates, India's production is around 17000 MT. Generally, harvesting of cardamom starts from July every year [1].

Despite the fall in exports due to increased competition, Indian cardamom sector is still thriving due to the increase in domestic consumption. The growth of the Pan industry, the single largest consumer of Cardamom, has been one of the major factor for increase in domestic consumption.

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Cardamom prices display huge volatility as it is affected by domestic and international supply-demand parameters. While, the demand has been displaying a steady to positive trend, the supply is highly volatile. The major importing countries are the Arabian nations and the demand peaks during the Ramadan fasting period. The crop is highly susceptible to pests, diseases and the vagaries of the monsoon. This also has a strong influence on the prices [2].

Cardamom is traded at the MCX (Multi-Commodity Exchange of India Pvt Ltd).

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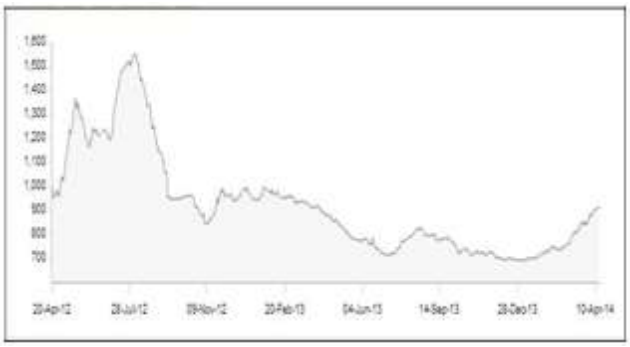
COMMODITY TREND

Cardamom prices have been highly volatile in the past especially at the end of 2012. The prices reached an all-time high of 1500Rs/Kg in the month of August and within a span of two months they plummeted to as low as 840Rs/Kg in November 2012[3].

Unexpected rain in the initial stages of South West monsoon raised worries over crop output and lifted prices to such a great extent. The crop failure in Guatemala (due to lack of pest control) during this period also resulted in a shortage of supply. Due to the crop failure, exports from India increased manifolds. Exports rose from approximately 1,200 tonnes in 2010-11 season to above 4,000 tonnes in 7 months of 2011-12 season [4].

But higher arrivals in major spot markets, carryover stock, sluggish domestic and overseas demand and conducive weather conditions in major growing areas led to the downfall of the prices afterwards [4]. The ban on the pan masala and gutka manufacturing sector also aggravated the situation by decreasing the demand.

The following graph presents the price trends over a period of two years.



The above graph Fig 3.1 shows the future prices of cardamom for the financial year (2012-2013 and 2013-2014) [5].

B. CHANA

Chana or Chickpea is a major pulse crop in the Indian subcontinent and several other countries. Known for rich protein content, Chana is used as an edible seed as well as making flour. Chana is broadly divided into two categories – Kabuli and Desi-- according to the colour, seed size and taste.

India is the leading producer and consumer of Chana in the world. The Indian production is estimated to be between 4-7 million tons per year. Normally Chana accounts for around 40 percent of India's total pulses crop production of 12-15 million tons. Major producing states are Madhya Pradesh, Uttar Pradesh, Rajasthan and Maharashtra.

A fragmented market with a very long value chain is the main characteristics of the present Chana market scenario in the country. Commission agents, brokers, wholesalers, flourmills and retail outlets are the key players in the market.

The sentiments of traders play a significant role currently, as a consequence of the lack of free-flow of information. There is also high substitutability between pulses in India among the consumers. So the price of other major pulses like tur, yellow peas, green peas etc also influence the prices of Chana.

Besides output and demand, other key parameters shaping Chana prices include carryover stocks, imports and the extent of substitution with other pulses [6].

COMMODITY TREND

Chana prices have fallen 50% from record high of Rs5000 made in October 2012 to Rs2500 in August 2013. Record production in 2012-13 rabi season has put pressure on prices.

Output in this season estimated at 8.88 million tonnes as per Agricultural department data. It failed to follow price seasonality in 2013 and remained bearish throughout the year.

MSP for rabi 2014 season fixed at Rs3100 per quintal up by Rs100 from last year. Currently prices are hovering around Rs3000 across major mandis.

Market is urging imposition of import duty on pulses or allowing exports as prices have fallen sharply in this year [7].

The above graph Fig 3.2 shows the future prices of Chana for the current financial year (2013-2014) [8].

C. SOYBEAN

Soybean is one of the major oilseed crops in the world. It comes in three forms: - soya seed, soya oil and soya meal. It constitutes 24% share of the vegetable oils in the international market. United States, China, Argentina, and Brazil are among the major exporters

India is the 6th largest producer in the world. But its domestic oil consumption doesn't meet its production, hence it is the largest importer too.

The soya bean crop production in India is 30 years old.

In 1960's-1970's the domestic production met the

country's demand. In 1980's the production and consumption grew at rapid pace increasing the imports.

The soya bean prices are influenced by a number of factors including weather conditions of the field area, Supply-Demand scenario in consuming countries (large population and adequate production), International prices(the price movements in domestic and global agencies) etc. The prices in India are also affected by the government policies and import tariffs [9].

COMMODITY TREND

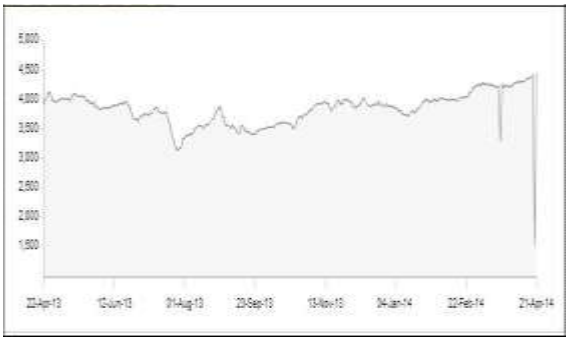
Prices in the first half are decided by new arrivals and quality while weather is the key factor in the second half.

Indian soybean prices rose significantly in 2013 due to the falling rupee and high demand from Iran and China [10].

The weather conditions remain key factor in determining soybean price trend both domestic and international markets in the month of July 2013.

Incessant rains in July 2013, in the major soy growing belt of MP and Maharashtra, led to damage of the soy crop. However, the area under the crop remains Significantly higher and marginal yield losses did not have a significant impact on the output.

Prices may fluctuate further in 2014, with the possibility of lower prices due to increase in global supply (major exporters like Argentina and Brazil).



The above graph Fig 3.3 shows the Soybean future prices of the current financial year (2013-2014) [9].

IV. INTRODUCTION OF THE MODEL

A. EFFICIENT MARKET HYPOTHESIS (EMH)

The EMH was considered as the rule that governed the financial world but it has been defied to some extent

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by various academicians. According to the hypothesis, the stock prices of any commodity follow a random walk. The prices always fully reflect the information available and no profit can be made from information based trading. The more efficient is the market, lesser is the predictability of price changes.

B. RANDOM WALK THEORY

The random walk theory is the occurrence of an event determined by a series of random movements - in other words, events that cannot be predicted.

Applying the random walk theory to finance and stocks suggests that stock prices change randomly, making it impossible to predict stock prices. The Random walk theory is consistent with the EMH [12].

C. TECHNICAL ANALYSIS

Technical Analysis is a method of evaluating securities by analysing statistics generated by market activity, such
as past prices and volume. Technical analysts do not attempt to measure a security's intrinsic value, but instead use charts and other tools to identify patterns that can suggest future activity.

Technical analysts believe that the historical performance of stocks and markets are indications of future performance. They sharply contrast the Efficient Market Hypothesis and the random walk theory.

Academics cannot conclusively prove or agree on whether the stock market truly operates via a random walk or based on predictable trends because there are published studies that support both sides of the issue.

Here, we make an attempt to consolidate both the theories and create a model that can predict future stock prices with a realistic probability.

D. GEOMETRIC BROWNIAN PATH MODEL

A geometric Brownian motion (GBM) is a continuous-time stochastic process in which the logarithm of the randomly varying quantity follows a Brownian motion (also called a Wiener process) with drift [13].

Mathematically, in simple terms, the model can be expressed by the following equation:

$$X_t = \mu + X_{t-1} + \epsilon_t$$

Where

X_t is the log of the price of the asset at time t

μ is a drift constant

ϵ_t is a random disturbance term

Interpreting it in the stochastic differential form we get,

$$\mathrm{d}X_t = \mu X_t \,\mathrm{d}t + \sigma X_t \,\mathrm{d}B_t.$$

Where B denotes the Brownian motion, μ is the drift coefficient and σ is volatility. The stochastic process Xt is called stock value.

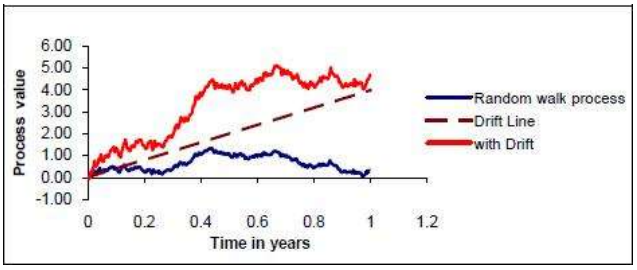

Fig. 4.1 Graphical representation [16]

This is the geometric Brownian motion model for the future stock prices.

E. PARAMETER ESTIMATION

Drift (μ) : It is a constant which tells us the amount of shift of the average value of a stochastic process. It can be positive or negative.

Volatility (σ) : It is the constant characteristic of the stock prices that tells us the measure of the fluctuations of the stock prices. Relatively high volatility means that the stock price varies continuously within relatively large interval [16]

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F. KEY ASSUMPTIONS

(A) The expected returns of GBM are independent of the value of the process (commodity/stock price), which agrees with what we would expect in reality [14].

(B) A GBM process only assumes positive values, just like real commodity prices.
(C) The price returns are normally distributed [15].

Assumptions (A) and (B) are straightforward and hold true in our case. To validate the assumption (C), we took the daily change in prices of the three chosen commodities and the following histogram resulted.

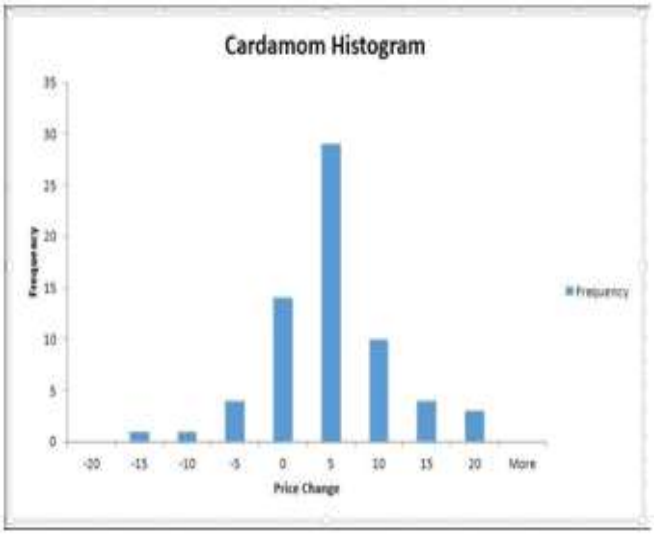

Fig. 4.2: Histogram for Cardamom

Fig. 4.3: Histogram for Chana

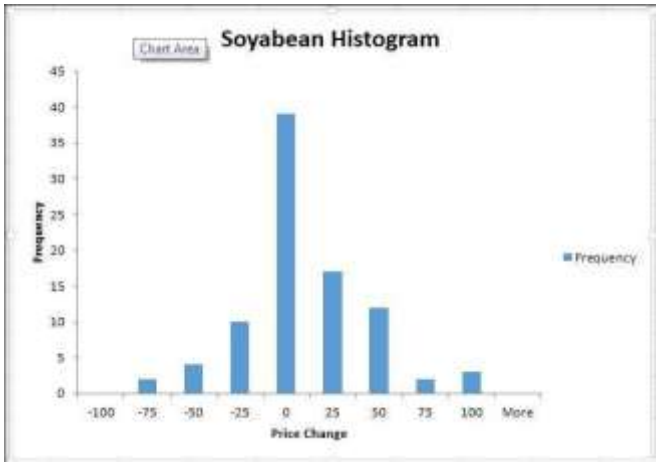

Fig. 4.4: Histogram for Soybean

V. WORKFLOW OF THE MODEL

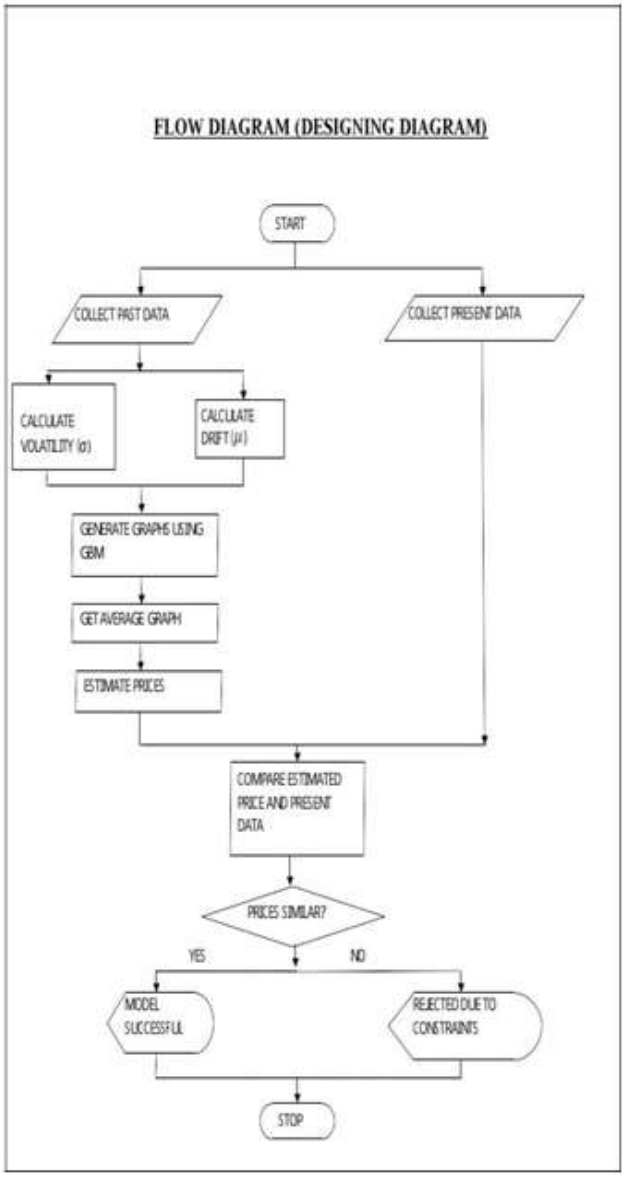

Fig 5.1 Flowchart of the process

VI. CONCLUSION

Our model will prove to be an important factor in the prediction of the future prices for the various groups of the society. On successful completion our model will be a cutting edge tool for the price prediction.

A. ADVANTAGES OF THE MODEL

The project provides 95% accuracy for the future prices of the commodities.

The possibility of one random variation implies that many could occur. For this reason, stochastic models are not run just once, but hundreds or even thousands of times.

This larger collection of data not only expresses which outcomes are most likely, but what ranges can be expected as well.

B. LIMITATIONS TO THE MODEL

Fails to estimate the prices of commodities that are produced in small quantities.

More the fluctuation in prices the lesser accurate it is. One of the limitations of the model is the constant nature of drift and volatility with respect to time. The drift and volatility are calculated based on the yearly prices of the commodities. They are not dependent on the timely fluctuations in the futures market. For example, during the period of Ramadan, cardamom loses much of its volatile behaviour because of continuous high demand from the Arabian nations. Our model does not depict this change in the market.

C. FUTURE ENHANCEMENTS

A time-varying drift and volatility, which would explain patterns of the market, are prospects for future research for this model.

REFERENCES

[1] "Products-Spices-Cardamom - MCX." Products. Web. 20Jan.2014. <http://www.mcxindia.com/sitepages/contractspecification.aspx?Pro ductcode=CARDAMOM>.

[2] "Cardamom,MCX Cardamom Futures, Cardamom Prices."

[3] Web. 2 Feb. 2014. <http://www.commodityonline.com/commodities/spices/cardamom.p hp>.

[4] Krishnan, C.P. "Cardamom Prices under Pressure." The Hindu Business Line. Web. 1 Feb. 2014.

[5] "Cardamom Prices Rise." Web. 2 Feb. 2014. <http://www.business-standard.com/article/markets/cardamom-prices-may-rise-over-rs-2-000-per-kg-112050600061_1.html>.

[6] "Today's Cardamom Price." Cardamom Spot Price & Historical Charts on MCX-SPOT Exchange | Motilal Oswal. Web. 2 Feb. 2014. <http://www.motilaloswal.com/Broking/Markets/Commodity/MCX-Spot/CARDAMOM.htm>.

[7] "Chana Market Outlook -2013-14" Web. <http://www.inditrade.com/UploadResearch/635195113606848750_ Chana%20Market%20Outlook%20-2013-14.pdf

[8] "Today's Chana Price." Chana Futures Price & Historical Charts on NCDEX Exchange | Motilal Oswal. Web. 20 May. 2014. <http://www.motilaloswal.com/Broking/Markets/Commodity/NCDE X/CHARJDDEL.htm>.

[9] "2014 Corn, Soybean Price Prospects." Corn and Soybean Digest. Web. 7 Feb. 2014. <http://cornandsoybeandigest.com/marketing/2014-corn-soybean-price-prospects>.

[10] Rathod, Tushar. "Reaping High Returns." Agri Commodities. Web. 6 Feb. 2014.

[11] Gupta, Vivek. "Farming Profit." Farm Commodities. CapitalVia Global Research. Web. 6 Feb. 2014.

[12] Burton G. Malkiel - The Efficient Market Hypothesis and Its Critics, Princeton University -CEPS Working Paper No. 91 April 2003

[13] Diego Maldonado, Random walks, discrete Brownian motion, and numerical stochastic integration -Kansas State University, Manhattan.

[14] Hull, John (2009). "12.3". Options, Futures, and other Derivatives (7 ed.).

[15] Harper, David. "Monte Carlo Simulation With GBM" Web. 26 Feb, 2009. <http://www.investopedia.com/articles/07/montecarlo.asp>

[16] Abdelmoula Dmouj, Stock price modelling: Theory and Practice, MSc Thesis, Vrije Universiteit, Faculty of sciences Amsterdam, The Netherlands