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Analyzing Price Dynamics and Instability in the Soybean Market of Gautampura: A Decadal Analysis

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This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Soybean stands as a cornerstone of global agriculture, renowned for its versatility, economic value, and pivotal role in both food and feed industries. This study examined the decade-long trends in soybean price dynamics at the Gautampura market in Madhya Pradesh, India, from 2014 to 2023. The research aim to analyze the price trend and instability of soybean in the Gautampura using

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methods such as Compound Annual Growth Rate (CAGR) and the Cuddy-Della Valle Instability Index (CDVI), the research reveals a gradual 0.672 per cent CAGR in soybean prices over the study period, punctuated by seasonal variations. Quarterly analyses further highlight varying growth rates, with Q4 consistently demonstrating the highest growth, likely driven by harvest cycles and market demand fluctuations. Despite this growth trend, the market exhibits significant price instability, underscored by a CDVI of 21.65, influenced by climatic factors, market dynamics, and policy changes. The forecasted prices indicate a steady upward trajectory from 2024 to 2025, aligning with historical data and suggesting potential opportunities amidst challenges in managing price volatility. This research provides valuable insights for stakeholders aiming to navigate the evolving soybean market dynamics effectively.

Highlights:

- The CAGR for soybean prices was found to be 0.672 per cent over the study period. Quarterly analyses reveal varying growth rates across the year 2014 to 2023.
- Its mainly focuses the instability and forecast pattern of Soybean in Gautampura, Madhya Pradesh.

Keywords: Soybean gautampura market; price trends; compound annual growth rate; CDVI instability; forecast.

1. INTRODUCTION

Soybean stands as the most prominent and widely cultivated oilseed globally, largely due to its adaptability to diverse climates and soils, making it a highly cost-effective crop with substantial market value. This oilseed plays a pivotal role in global agriculture, contributing 25 per cent to worldwide vegetable oil production and providing approximately two-thirds of the protein concentrate used in animal feed, making it indispensable for livestock and poultry industries. Furthermore, soybean is integral to improving soil fertility, which enhances its importance in sustainable farming practices [1].

Annually, about 85 per cent of the world's soybean production is allocated for meal and oil production. The meal is primarily processed into animal feed, with a portion further utilized in the production of soy flour and protein products [2]. The United States leads global soybean production, followed by Brazil, Argentina, and China, collectively accounting for 80 per cent of global supply. In India, soybean cultivation is concentrated in Madhya Pradesh, Maharashtra, Rajasthan, Andhra Pradesh, and Karnataka, with Madhya Pradesh leading by producing 4.981 million tonnes, representing nearly 53 per cent of India's total soybean output [3].

India, being the world's second-largest producer of soybeans, plays a crucial role in the global oilseed market, despite facing challenges such as fluctuating productivity due to rain-fed cultivation conditions and varying market dynamics. While India’s soybean production is robust, domestic demand significantly limits export volumes, with the crop’s primary utilization being for domestic oil and meal consumption. India is the world's fourth-largest producer of soybean, with Madhya Pradesh accounting for the highest share of production, contributing over 50 per cent to the national total [4]. The Gautampura market in the Dewas district of Madhya Pradesh is a prominent trading hub for soybean, serving as a crucial link between producers and consumers. The strong domestic consumption, driven by a large and growing population, often curtails the amount available for export, aligning with global trends where only about 5 per cent of the world's soybean production is traded internationally.

Objective: The study was conducted for the period of 2014 to 2023 by collecting purely secondary data from the Gautampura market in Madhya Pradesh. Data was sourced from the official agricultural marketing website agmarknet.gov.in. The focus of the study was on soybean daily prices arrivals, with the data was transformed into monthly and then annual formats. The final data being divided into four quarters annually: January-March (Q1), April-June (Q2), July-September (Q3), and October-December (Q4).The market was selected purposively based on its significance in soybean trading within the region, characterized by high prices and substantial arrivals. Gautampura is recognized as one of the prominent markets in

the major soybean-growing state of Madhya Pradesh, India [4]. The analysed the following objective/ this research aims to:

1. **Examine price trends:** Analyze quarterly and annual soybean price trends to identify growth patterns and seasonal fluctuations.
2. **Assess market instability:** Evaluate the volatility in soybean prices using statistical measures to determine the extent and causes of price instability.
3. **Forecast future prices:** observed the future soybean prices from 2024 to 2027 based on historical data and linear trend forecasting, providing actionable insights for market participants.

2. MATERIALS AND METHODS

The compound annual growth model was used to examine the growth ofsoybean price arrival in the market Gautampura. CAGR predicted the size of the change in the variable under investigation per unit of time, as well as the variable's tendency to rise, decrease, or stay the same over time.

2.1 Study Area

Gautampura is located in the Indore district, which is one of India's primary soybean-producing areas. Its latitude and longitude are exactly 23.00525°N and 75.52936°E. Soybean farming is suitable due to the favourable climate and soil conditions. This area is semi-arid and receives enough rainfall during the monsoon to support soybean cultivation. The Gautampura market regulated in the year 1960 and currently focusing on major crops like soybean, wheat, chickpeas white.

2.2 Compound Annual Growth Rate

The compound growth rate was analyzed by using exponential growth function as given below

$$Y = ab^t \quad \ldots\ldots\ldots\ldots \quad \ldots. \quad (1)$$

Where,

Y = Price arrivals of soybean
t = Time variable
b = Regression coefficient
a = Intercept.

Equation (1) will be converted into the natural logarithmic form in order to facilitate the use of linear regression. Taking logarithms on both sides we obtain,

$$\text{Log } Y = \text{Log } a + t \text{ Log } b$$

The compound growth rates 'r' was computed by using the formula:

$$CGR\ (r) = [\text{Antilog } (\log b) - 1] * 100$$

Where, r = Compound growth rate

2.3 Instability Index

Instability in export is expected to hamper the process of economic development. The degree of instability in soybean price arrivals was measured by using the coefficient of variation. The standard deviation as a percentage of mean is called the coefficient of variation.

$$\text{Coefficient of variation (CV)} = \frac{\sigma}{\bar{x}} \times 100$$

Where,

σ = Standard deviation

$$\sigma = \sqrt{\frac{\Sigma(X - \underline{X})^2}{n}}$$

$\bar{x}$= Arithmetic mean

To examine the extent of variation and risk involved in prices, the instability index is calculated using the Cuddy-Della Valle approach [5].

$$CDVI = CV \times \sqrt{(1 - R^2)}$$

Where CDVI is the Cuddy-Della Valle instability index in percent, CV is the coefficient of variation in percent and is the coefficient of determination from a time-trend regression. The estimating index value is a close approximation of the average variation in annual prices which is adjusted for trend.

2.4 Casual Model Approach – Linear Trends – Forecasting

The most widely used method of fitting trend lines to time series data is the method of least squares. The problem of fitting a least squares line Y' = a + bx is essentially that of b for a given set of data and make $\sum(y - y')^2$ as small as

possible and the problem either by solving the two equation.

$$\Sigma y = na + b(\Sigma x)$$

$$\Sigma xy = a(\Sigma x) + b(\Sigma x)^2$$

Y'= Predicted value of the dependent variable Y
x= Independent variable (typically time)
a = Intercept (value of Y when X=0)
b = Slope of the trend line (rate of change in Y per unit change in X)

Alternatively, the values of a x and b can be determined by

$$a = \frac{(\Sigma y)(\Sigma x^2)-(\Sigma x)(\Sigma xy)}{n(\Sigma x^2)-(\Sigma x)^2}$$

$$b = \frac{n(\Sigma xy)-(\Sigma x)(\Sigma y)}{n(\Sigma x^2)-(\Sigma x)^2}$$

In a time series, however the x's practically always refers to successive periods (usuallyyears). In this case, the problem of fitting a trend line by the method of least squares can besimplified considerably by performing the following change of scale (coding).Letting x be the variable which measures time and taking the origin (the zero) of the newscale at the middle of series that is, at the middle of x's, we number of years (or other periods) sothat in new scale$\sum x = 0$. If the series has an odd number of years,, we assign x = 0 to the middleyear and number of years ……, -5, -4, -3, -2, -1, 0, 1, 2, 3, 4, 5, …… If the series hasan even number of years, there is no middle year, and we assign successive years the numbers …. -7, -6, -5, -4, -3, -2, -1, 1, 2, 3, 4, 5, 6, 7, ……., with -1 and 1 assigned to the two middle of years.This kind of coding makes $\sum x = 0$ and substituting this into the formula given earlier, the a and bcan be estimated as given below.

$$a = \frac{\Sigma y}{n} \text{ and } b = \frac{\Sigma xy}{\Sigma x^2}$$

This makes the advantage of the coding evident.

3. RESULTS AND DISCUSSION

This research examines the price trends of soybeans in Madhya Pradesh, Gautampura market from 2014 to 2023, presenting data regarding growth rates, volatility, and forecast prices in the future. The results can help with strategic decision-making and enlighten stakeholders on the unique features of the market.

3.1 Price Trends and Growth of Soybean

Soybeanarrival prices in Gautampura have exhibited a moderate growth trajectory over the study period. The Table 1 reveals a Compound Annual Growth Rate observed (CAGR) of 0.672 per cent per annum from 2014 to 2023, indicating positive and gradual increase in prices with considerable fluctuations. During over all period, the quintal price average was ₹4017.50, with a standard deviation of ₹1188.96, indicating notable fluctuations in the market. An in-depth quarterly analysis demonstrates varied growth rates across different quarters:

The highest growth rate was observed in Q4 (Oct-Dec) 4.44 per cent per quarter respectively, suggested a seasonal influence likely driven by harvest cycles and market demand peaking towards the end of the year. September to November marks the peak season for soybeans in India, characterized by significant harvesting activity and the highest availability in the market. Seasonal output and sufficient quantity arrivals in the market are often reflected in soybean price movements [6]. During harvest seasons, when supply is abundant, prices generally stabilize or decrease due to the increased availability of soybeans. Conversely, during off-seasons, reduced supply can lead to price increases.So the government initiated the Krishi Upaj Mandi Samiti Schemes to reduce post-harvest losses and secure higher returns, these market committees provide farmers precise pricing information, procurement assistance, and storage facilities. Farmers are encouraged to invest in more advanced production techniques by market support, which guarantees an adequate price for their output.

Additionally, the Table 1, fourth quarter (Q4) typically sees the highest growth rates in soybean prices. This is driven by increased market demand following the harvest season. After the initial post-harvest period, traders and processors often increase their purchases to build inventories, which boost demand and consequently drive prices upward [7]. These seasonal and demand-driven patterns are key factors in the periodic fluctuations observed in the soybean market in regions like Gautampura.

In contrast, second quarter (Q2) exhibited the lowest growth rate (2.31%), the market is usually well-supplied with soybeans harvested in the previous season (typically in Q4 and Q1). The abundance of supply during this period leads to lower price increases, as there is no immediate

scarcity driving up prices.In India, Q2 typically aligns with the pre-monsoon season. Farmers focus on preparing for the upcoming monsoon rather than engaging in market activities, further reducing market demand and contributing to the lower growth rate in prices.

3.2 Instability Analysis of Soybean Price Arrivals

The study employed the Cuddy-Della Valle Instability Index (CDVI) to measure price volatility. The Table 2 observed the overall CDVI value ofsoybean prices arrivals was 21.65, indicating a significant and medium level of instability. Its shows the market is not highly volatile, there are notable fluctuations that can impact planning and decision-making for stakeholders such as farmers, traders, and policymakers. Gautampura's cropping pattern had a direct impact on soybean supply, which would impact demand in conjunction with market dynamics [8].

The Table 3 revealed that Q2 showed the highest instability among other quarters, highlighting the impact of transitional market conditions and external pressures during this period. Adverse weather conditions affecting crop yields, leading to inconsistent supply. Whereas changes in international demand, particularly from major importers like China, or fluctuations in global soybean production can impact local prices [9]. Farmers are more likely to prioritize on soybean production when the minimum support price is steady, which minimizes the country's dependence on imports and protects the domestic market from global price shocks [10]. The Madhya Pradesh government started Bhavantar Bhugtan Yojana (Price Deficit Financing Scheme) to protect farmers from price fluctuations. The government compensation is provided in the event that the market price of soybeans drops below the Minimum Support Price (MSP). This ensures farmers get a fair price even during market depression.

Conversely, Q1 and Q4 exhibited the lowest instability, indicating relatively stable price behavior compared to other quarters. During both Q1 and Q4, the behavior of the market is more predictable due to the regularity of harvest cycles. This predictability allows market participants, including farmers, traders, and processors, to make informed decisions about pricing, storage, and sales, thereby reducing price fluctuations. The strategic stocking by traders and processors during these quarters also helps in maintaining price stability, as they tend to purchase in bulk during the harvest and gradually release stocks into the market, preventing sharp price changes [11]. Indian government encouraged by a number of government programs and subsidies, including the Pradhan Mantri Fasal Bima Yojana (PMFBY) and the National Food Security Mission (NFSM) to protect the crop failure and improve domestic production and consumption.

Table 1. Growth rate of soybean price arrivals

Year	Quarter I (Q1)	Quarter II (Q2)	Quarter III (Q3)	Quarter IV (Q4)
	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec
2014	3507.619	3979.167	3395.000	2971.261
2015	3175.431	3597.222	3147.958	3632.828
2016	3427.972	3658.611	3122.879	2874.786
2017	2855.670	2751.885	2749.686	2646.160
2018	3486.663	3431.939	3257.949	3111.826
2019	3518.780	3458.989	3551.884	3709.313
2020	3675.500	3487.083	3173.642	3861.442
2021	4536.636	6798.929	6866.643	5624.801
2022	6778.339	6613.583	5523.940	5121.748
2023	5263.486	5002.038	4764.597	4585.996
CAGR (%)	4.14**	2.31**	3.45**	4.44***
R^2	0.5716	0.4006	0.4602	0.6155
Growth rate of soybean price arrivals over all period. (2014 to 2023)				
CAGR(%)	0.672***	R^2	0.4647	

*Note: ***indicates significant at 1 per centand **indicates 5 per cent level, respectively.(Source: www.agmarknet.gov.in), (Arrivals price value in Rs.)*

Table 2. Instability of soybean price arrivals overall period

Particulars / Crops	Mean	SD	CV (%)	CDVI (%)	Range
Soybean	4017.49	1188.96	29.59	21.65	Medium

Table 3. Instability of soybean price arrivals quarter wise

Year	Quarter I(Q1)	Quarter II (Q2)	Quarter III (Q3)	Quarter IV (Q4)
	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec
2014	3507.619	3979.167	3395.000	2971.261
2015	3175.431	3597.222	3147.958	3632.828
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2021	4536.636	6798.929	6866.643	5624.801
2022	6778.339	6613.583	5523.940	5121.748
2023	5263.486	5002.038	4764.597	4585.996
Mean	4022.60	4277.94	3955.41	3814.01
SD	1129.50	1327.09	1263.47	952.91
CV (%)	28.07	31.02	31.94	24.98
CDVI (%)	18.37	24.01	23.46	15.49
Range	Medium	Medium	Medium	Medium

Note: SD- Standard Deviation, CV- Coefficient of Variation and CDVI- Cuddy-Della Valle instability index

Table 4. Forecast analysis-casual model appraoch

Year		Price arrivals(Y)	X	XY	X2
	Q1	3507.619	-20	-70152.38	400
	Q2	3979.167	-19	-75604.17	361
2014	Q3	3395	-18	-61110	324
	Q4	2971.261	-17	-50511.43	289
	Q1	3175.431	-16	-50806.89	256
	Q2	3597.222	-15	-53958.33	225
2015	Q3	3147.958	-14	-44071.41	196
	Q4	3632.828	-13	-47226.76	169
	Q1	3427.972	-12	-41135.66	144
	Q2	3658.611	-11	-40244.72	121
2016	Q3	3122.879	-10	-31228.79	100
	Q4	2874.786	-9	-25873.07	81
	Q1	2855.67	-8	-22845.36	64
2017	Q2	2751.885	-7	-19263.19	49
	Q3	2749.686	-6	-16498.11	36
	Q4	2646.16	-5	-13230.8	25
	Q1	3486.663	-4	-13946.65	16
	Q2	3431.939	-3	-10295.81	9
2018	Q3	3257.949	-2	-6515.89	4
	Q4	3111.826	-1	-3111.82	1
	Q1	3518.78	1	3518.78	1
	Q2	3458.989	2	6917.97	4
2019	Q3	3551.884	3	10655.65	9
	Q4	3709.313	4	14837.25	16
	Q1	3675.5	5	18377.5	25
	Q2	3487.083	6	20922.49	36
2020	Q3	3173.642	7	22215.49	49
	Q4	3861.442	8	30891.53	64
	Q1	4536.636	9	40829.72	81
	Q2	6798.929	10	67989.29	100
2021	Q3	6866.643	11	75533.07	121
	Q4	5624.801	12	67497.61	144
	Q1	6778.339	13	88118.40	169
	Q2	6613.583	14	92590.16	196
2022	Q3	5523.94	15	82859.1	225
	Q4	5121.748	16	81947.96	256
	Q1	5263.486	17	89479.26	289
	Q2	5002.038	18	90036.68	324
2023	Q3	4764.597	19	90527.34	361
	Q4	4585.996	20	91719.92	400
	Total	$\Sigma y = 160699.88$	$\Sigma x = 0$	Σ(xy)= 389833.93	$\Sigma x^2 = 5740$
	a = 4017.49		b= 67.91	Y'=4017.49+67.91X	

Table 5. Forecast of soybean price arrivals at Gautampura market (2024 to 2025)

Year	Jan-Mar	Apr-Jun	Jul-Sep	Oct-Dec
2024	5444.17	5512.08	5580.00	5647.91
2025	5715.83	5783.75	5851.66	5919.58

3.3 Forecast of Soybean Price Arrivals (2024-2025)

Based on past data, the Gautampura market's forecast price for soybeans from 2024 to 2025 was calculated using the Casual Model Approach, as shown in Table 4. According to Table 5, the forecasted price value starting at ₹5444.17 per quintal in January-March 2024, prices are projected to increase gradually to ₹5919.58 per quintal by October-December 2025.This anticipated gain is consistent with past evidence showing a steady, if gradual, rise in prices. Prices are influenced by the demand for soybean meal and oil on both national and international level. Prices typically increase due to higher demand within these geographic regions [12]. The forecast indicates a steady increase in soy prices, driven by variables including market demand and agricultural regulations [13]. These forecasts can be used by traders, farmers, and stakeholders to make sound decisions for a market that is projected to see moderate but consistent price rises throughout the duration of the forecast period.

4. CONCLUSION

In conclusion, while the soybean market in Gautampura has shown periods of relative stability, it remains subject to various factors that can cause significant price instability. The market exhibit clear seasonal patterns, with prices typically stabilizing during the post-harvest period (Q4 and Q1) and experiencing more volatility in the pre-harvest and off-seasons (Q2 and Q3). Understanding these dynamics is essential for making informed decisions in the agricultural sector. This study underscores the need for improved market intelligence and adaptive strategies to manage the volatility and leverage the growth potential in soybean prices. Policymakers and market participants should focus on enhancing the resilience of the supply chain, promoting sustainable agricultural practices, and developing value-added products to capitalize on the growing demand for soybeans. Gautampura farmers gain from advancements in seed varieties, insect management methods, and soybean growing practices developed by organisations such as the Indian Institute of Soybean Research (IISR) in Indore to obtain a sustainable production. The positive trend in future prices provides a conducive environment for investment and development in the soybean sector in Gautampura.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT,etc) and text-to-image generators have been used during writing or editing of this manuscript.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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