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An Analysis of Market Arrivals and Price Behavior of Coriander in Madhya Pradesh, India

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Authors' contributions

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

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ABSTRACT

The current research embarked on analysing wholesale prices of coriander in Madhya Pradesh spanning a decade from 2012-13 to 2021-22, sourced from specific A.P.M.Cs. The examination predominantly relied on secondary data regarding coriander arrivals and prices. Results uncovered a positive regression coefficient (β) correlated with time (T), indicating a consistent upward trend in

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wholesale coriander prices in Madhya Pradesh. Annual prices of coriander in Ashok Nagar, Guna, and Bhopal markets exhibited two cycles, one spanning 7 years and the other 2 years. Across all selected markets, a similar irregular fluctuation pattern observed in yearly coriander prices, lacking any distinct periodicity. Seasonal analysis revealed varying patterns in coriander prices across Bhopal, Ashok Nagar, and Guna markets, with no stable trend discernible. The Seasonal price variation of coriander in these markets was lowermost in January and remained relatively less throughout the sowing time. Coriander arrivals conspicuously dispersed more evenly in Bhopal market compared to the other two. In terms of IPR (Index of Price Relative), significant price variability was observed; with Guna market exhibiting the highest and Ashok Nagar market the lowest variability. Conversely, ASPV (Average Seasonal Price Variation) showed an inverse relationship with IPR, with Ashok Nagar market experiencing the maximum price variation among all selected markets.

Keywords: Periodic; variations, pattern; recurring; sporadic; price fluctuations; average periodic price variations etc.

1. INTRODUCTION

Agriculture stands as one of humanity's oldest professions, emerging as the primary occupation when settlement became commonplace on Earth. Before the advent of agriculture, sustenance relied on hunting animals for food. The discovery of fire prompted experimentation with cooking methods, gradually leading to the exploration of fruits and vegetables as dietary staples. India boasts the world's second-largest expanse of arable land, encompassing 20 distinct agro-climatic regions that cover all 15 major global climates. Additionally, the country boasts 46 out of 60 soil types found worldwide. The significance of agriculture to India's economy cannot be overstated. A substantial 54.6% of the nation's workforce is engaged in agricultural activities and related industries, as per the 2011 Census. The agricultural sector's contribution to the GDP saw a rise from 17.8% in 2019-20 to 19.9% in 2020-21. In the fiscal year 2020, the Gross Value Added (GVA) by agriculture, forestry, and fishing amounted to approximately 19.48 lakh crore (US$ 276.37 billion). Recent estimates indicate an enhancement in the agriculture and allied sector's share of total GVA, reaching 20.2% in 2020-21 and 18.8% in 2021-22. India holds the potential to become one of the world's top five exporters of agricultural commodities by prioritizing cultivation and offering effective support to farmers, as outlined by the World Trade Centre. In the fiscal year 2021, total exports of agricultural and allied products reached US$ 41.25 billion [1].

As per the fourth advance estimates for 2020-21, the nation is poised to achieve a record-breaking total food grain production of 308.65 million tonnes, a substantial increase of 11.15 million tonnes compared to the previous year's production of 297.50 million tonnes. Looking ahead to FY 2021-22, the government aims to boost production further by 3.9% [2,3]. Additionally, India reached a significant milestone in horticulture crop production, with output surging to 331.05 million metric tonnes (MMT) in 2020-21, based on the third advance estimate. This represents a noteworthy growth of 10.5 million metric tonnes compared to the preceding fiscal year. Forecasts suggest a promising rise in the production of fruits, flowers, spices, and honey [1]. Madhya Pradesh claimed the top spot in spice production for the 2021-22 period, particularly excelling in coriander production. Covering an expansive area of 0.28 million hectares, the state yielded an impressive 0.39 million tonnes of coriander. Alongside Madhya Pradesh, Rajasthan and Gujarat emerged as significant contributors to India's coriander output [4-6]. Notably, Kumbhraj, located in Guna district, stands out as a major global hub for coriander seed production. To further boost coriander cultivation in Guna district, the Madhya Pradesh government has instituted special incentives [7-9]. The establishment of a spices park in Mavan village of Guna district serves as a prime example of initiatives aimed at enhancing coriander production in the region [10,11,12].

Coriander, an herb abundantly found in India, serves culinary and medicinal purposes. It enhances the flavour of vegetables and possesses medicinal properties, acting as an anxiolytic, carminative, and antithyroid agent. Coriander seeds are particularly rich in essential oils and volatile oils, renowned for their medicinal benefits. Alongside essential oils, coriander contains tannins, terpenoids, alkaloids, phenolic

compounds, flavonoids, fatty acids, sterols, and glycosides [13-16]. Moreover, it offers significant nutritional value, boasting minerals, vitamins, proteins, lipids, carbohydrates, and fibres. Referred to as Chinese parsley, coriander is cultivated for both its leaves and seeds, which usually used in cooking and medicine. Medicinally, coriander exhibits antioxidant, antifungal, antibiotic, and digestive properties, aiding in digestion. Studies reveal that the plant contains numerous polyphenols and antioxidant compounds, imparting substantial preventive effects against certain illnesses. Additionally, thyrotropin (TSH) plays a pivotal role as a hormonal regulator in testicular physiology during development [17,18]. Coriander (*C. sativum* L.), from the Umbelliferae family, is a native species for the Mediterranean region and it has been used as spice and medicine for ancient times [19]. The essential oil extracted from coriander is abundant in linalool, limonene, α-pinene, camphene, geranyl acetate, and linalyl acetate. Coriander exhibits diverse biological activities, serving as antioxidant, anti-inflammatory, analgesic, antiseptic, and antimicrobial agent [20].

Agricultural marketing plays a crucial role not just in stimulating production and consumption but also in fostering economic growth. It's important to manage the increased agricultural output in line with fluctuations in demand and supply for effective marketing. The aim is to ensure that farmers receive a substantial portion of consumer spending, regardless of the surplus they produce. Hence, marketing is rightly acknowledged as a key factor alongside improved seeds and fertilizers in modern agriculture. Prices reflect the state of a nation's economy. Agricultural products often face greater price volatility compared to non-agricultural items due to uncertainties like climate changes and pest infestations. Maintaining price stability is vital for farmers' income, as unpredictable supply results in price fluctuations. Many farmers consider price instability as a major challenge, second only to weather uncertainties. While prices are influenced by the interaction of demand and supply, it's crucial to understand that these factors act independently to shape prices [21].

1.1 Objectives

This research focused on examining the significant findings, followed by economic explanations and analytical deductions. The study concentrated on estimating and interpreting the price dynamics of specific agricultural commodities.

2. METHODOLOGY

Study focused specifically on the state of Madhya Pradesh and gathered secondary data on coriander arrivals and monthly prices for a ten-year period from 2012-13 to 2021-22. Data was sourced from the Directorate of Economics and Statistics, Government of Madhya Pradesh, as well as from mandi offices of selected markets and the AGMARKNET website. Coriander was chosen for detailed examination based on its production ranking in Madhya Pradesh compared to other crops across India. For the study, Ashok Nagar and Guna markets were selected as representative areas for coriander production, considering their production ranking within Madhya Pradesh. Bhopal district, housing major mandis, was also chosen for comparative analysis. Ashok Nagar and Kumbhraj (Guna) mandies were selected based on their maximum arrivals of coriander. Additionally, Bhopal grain market was selected for comparative analysis due to its status as the largest APMC in Madhya Pradesh.

3. RESULTS AND DISCUSSION

3.1 Price Behaviour of Selected Agricultural Commodities

The price behavior of specific agricultural commodities was analyzed by decomposing the monthly prices of coriander over a ten-year period. A time series typically consists of four components: Trend (T), Cyclical (C), Irregular (I), and Seasonal (S) variations. These components can appear individually or in combination within a time series. The relationship among these components is usually assumed to be multiplicative, with the multiplicative model being commonly employed in economic studies. In this study, the multiplicative model was utilized, and it can be represented as follows:

In monthly price data

$$P_t = T_t \times C_t \times S_t \times I_t$$

In annual price records

$$P_t = T_t \times C_t \times I_t$$

Where,

P_t = Time-series data pertaining to the prices of specific agricultural commodities (₹/qt).

S_t = periodic variation at time t
T_t = trend component at time t.
C_t = cyclical variation at time t.
I_t = unpredictable fluctuation at time t.

3.2 Examining the Price Trend

Over an extended duration, a time series often demonstrates a propensity to either rise or fall over time. These changes in the time series primarily influenced by factors such as population growth, shifts in consumer preferences, technological advancements, and so forth. To analyse the trend in prices, a linear function was determined using the Ordinary Least Squares (OLS) technique.

$$P_t = \alpha + \beta T_t + U_t$$

Here,

P_t = Price index for chosen agricultural commodity in the in t^{th} year.
T_t = Identification number allocated to the t^{th} year.
U_t = Stochastic error term under typical OLS assumptions, where α and β represent regression coefficients to be determined.

3.3 Examination of the Cyclical Element

Fluctuations with cyclical patterns in price variations are distinct from recurring fluctuations, as they extend beyond a year and typically span several years, resembling business cycles. To isolate the cyclical component within the yearly price series under the multiplicative hypothesis, the following steps were employed:

1. Linear trend equations were estimated to calculate trend values.
2. The original price observations divided by the approximated trend values then multiplied by hundred. This process yielded indicator of the cyclical component, along with the random fluctuation, as per the multiplicative hypothesis.

Symbolically:

$$\frac{P_t}{\hat{P}_t} \times 100 = \frac{T_t \times C_t \times I_t}{T_t} \times 100 = (C_t \times I_t) \times 100$$

$$M.A.of\ (C \times I) \times 100 = C \times 100$$

Here,

P_t = Base price,

T_t = Projected trend estimate, where T_t, C_t, and I_t signify trend, cyclical, and irregular parts

To eliminate the irregular component, the weighted three-year moving average of the (C x I) 100 series derived in (b) assessed. This involves using a weight ratio of 1:2:1.

3.4 Assessment of the Unpredictable Variation

In this context, the influences could be entirely unforeseeable, fluctuating randomly. Individual observations impacted by occasional and incidental factors, also referred to as causal series, influenced by unknown factors that act unpredictably. The irregular component within an annual price series lacks a discernible pattern and deduced as the residual factor, using estimations of the trend and cyclical components. Following the multiplicative assumption, the C x I component separated by dividing the original price index figures by estimated linear trend values. Subsequently, the cyclical component (C) is extracted from the C x I component through a three-year weighted moving average of the C x I series. The index of the irregular component calculated as follows:

$$I_t = (C_t \times I_t / C_t) \times 100$$

3.5 Assessment of the Periodic Pattern

Method of comparing with moving averages commonly employed for seasonal analysis and widely regarded as the most effective approach. This method relies on the logical premise that a 12-month moving average effectively captures the combined cyclical and trend effect. By dividing the value extracted from the 12-month moving average centred on the given month, assumed that the effects of cycle and trend are effectively eliminated.

3.6 Annual Price Volatility

The following methods employed accurately assess the within-year price fluctuations.

3.7 Degree of intra-annual price hike

The intra-year price increase, which is the disparity between the lowest and highest prices observed within a year, was determined by calculating the following percentage coefficient.

$$IPR = \frac{HSPI - LSPI}{LSPI} \times 100$$

Where,

IPR = Annual price movement (in percentage)
$HSPI$ = Maximum seasonal price indicator
$LSPI$ = Least seasonal price measure

As this metric influenced by the lowest coefficient, an alternative measure known as the average seasonal price variation coefficient (ASPV) was calculated.

3.8 Mean Seasonal Price Fluctuation

The average seasonal price variation (ASPV) calculated as

$$ASPV = \frac{HSPI - LSPI}{HSPI + LSPI/2} \times 100$$

Where,

$HSPI$ = Uppermost seasonal price value
$LSPI$ = Minimum seasonal price indicator

3.9 Annual Price Trend, Cyclical Fluctuation, and Irregularity of Coriander

Table 1 presents the analysis of linear trend estimates in the yearly prices of coriander across selected markets in Madhya Pradesh indicates a consistent pattern. The regression coefficient (β) corresponding to the time factor (T) is notably positive and statistically significant at the 1 percent level across all three chosen markets. Specifically, the regression coefficient for time exhibits the highest value in Guna mandi (47.54), followed by Bhopal mandi (47.35), and finally, Ashok Nagar mandi (21.21).

Study aims to analyse Patterned and stochastic fluctuations patterns per annum coriander pricing within the selected markets within the jurisdiction. The annual pricing of coriander in all three selected mandies displayed two cycles, with durations of 7 and 2 years. Additionally, a consistent irregular pattern observed in the yearly coriander prices across every selected marketplace.

Table 1. Analysis of linear trend projections for monthly coriander prices in selected markets of MP spanning from 2012-13 to 2021-22

Mandies	Ashok	Guna	Bhopal
Intercept (α)	4690.68	5721.74	5698.85
Slope Coefficient (β)	21.21**	47.54**	47.35**
Coefficient of determination (R^2)	0.01	0.01	0.01

*Note: ** represents significance at the 5 percent confidence interval*

Table 2. Component pertaining to time series within monthly rates of coriander in Ashok Nagar marketplace during 2012-13 to 2021-22

Annual cycle	Time Series Component		
	Trend	Cyclical	Irregular
2012-13	4711.887446	-	-
2013-14	4733.09455	0.492427731	2.035959504
2014-15	4754.301653	0.491455332	1.741942624
2015-16	4775.508756	0.506374354	2.298339132
2016-17	4796.71586	0.533892332	1.601609617
2017-18	4817.922963	0.538951894	2.194242374
2018-19	4839.130066	0.533017683	2.190418207
2019-20	4860.33717	0.501765958	1.81776021
2020-21	4881.544273	0.240599351	4.382295482
2021-22	4902.751376	-	-

Table 3. Component pertaining to time series within monthly rates of coriander in Guna marketplace during 2012-13 to 2021-22

Year	Time Series Component		
	Trend	Cyclical	Irregular
2012-13	5769.278	-	-
2013-14	5816.821	0.494	2.178
2014-15	5864.364	0.410	1.755
2015-16	5911.906	0.445	1.631
2016-17	5959.449	0.529	1.804
2017-18	6006.992	0.568	2.212
2018-19	6054.535	0.556	2.156
2019-20	6102.077	0.524	1.819
2020-21	6149.620	0.251	4.442
2021-22	6197.163	-	-

Table 4. Component pertaining to time series within monthly rates of coriander in Bhopal marketplace during 2012-13 to 2021-22

Year	Time Series Component		
	Trend	Cyclical	Irregular
2012-13	5746.201	-	-
2013-14	5793.554	0.494	2.178
2014-15	5840.906	0.410	1.755
2015-16	5888.259	0.445	1.631
2016-17	5935.611	0.529	1.804
2017-18	5982.964	0.568	2.212
2018-19	6030.316	0.556	2.156
2019-20	6077.669	0.524	1.819
2020-21	6125.022	0.251	4.442
2021-22	6172.374	-	-

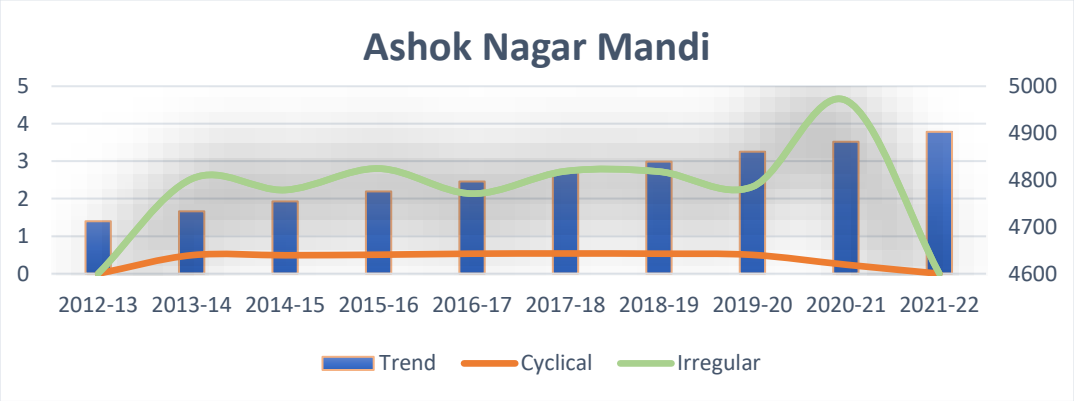

Fig. 1. Elements of time series in coriander prices at Ashok Nagar market

For the seasonal analysis of coriander prices, index numbers were calculated based on monthly price data from January 2012 to December 2021 for selected markets in Madhya Pradesh. The estimated results of seasonal indices for monthly prices and arrivals of coriander in these markets are presented in Tables 5 and 6, along with Figs. 4, 5, and 6. The presence of seasonality in coriander prices varied across Bhopal, Guna, and Ashok Nagar marketplaces, with no consistent pattern observed. In Bhopal trading centre, coriander price indices ranged from 87.88 in January to 108.21 in October, marking the highest seasonal price index. Conversely, in Ashok Nagar market, the indices increased steadily from 62.64 in January (the lowest seasonal price index) to 110.67 in October (the highest seasonal price

index). In Guna market, price fluctuations ranged from 87.88 in January to 108.21 in October. Regarding coriander arrivals, the lowest index was observed in Bhopal mandi for December (24.28), gradually rising to its peak in February (316.98). In Ashok Nagar trading centre, the lowest arrival index occurred in November (24.55), increasing steadily until March (332.06), the highest point. In Guna marketplace, arrivals ranged from 27.2 in December to 310.33 in April during the study period. Arrivals more evenly distributed across months in Bhopal market, while similar patterns observed in the other two markets. Rao et al. [22] conducted a study on rice in selected markets of Andhra Pradesh, revealing pronounced seasonality in arrivals with negligible variations in seasonal rice prices.

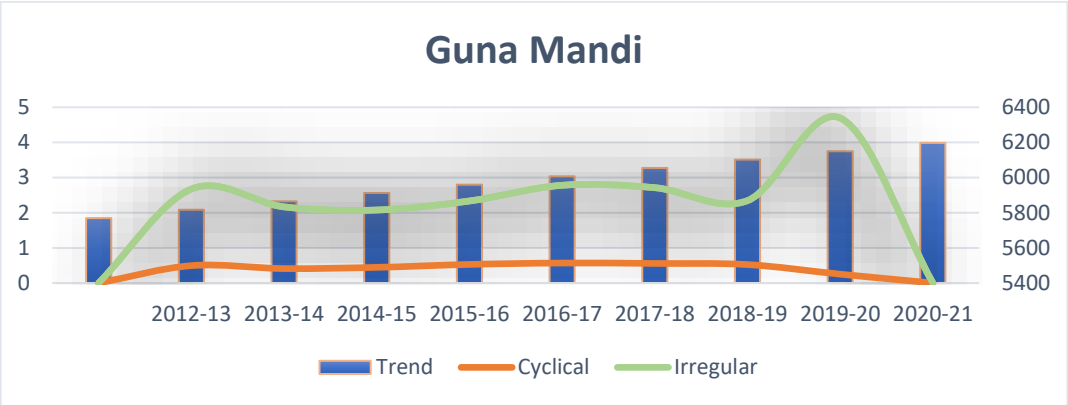

Fig. 2. Constituents of time series in coriander rates at Guna marketplace

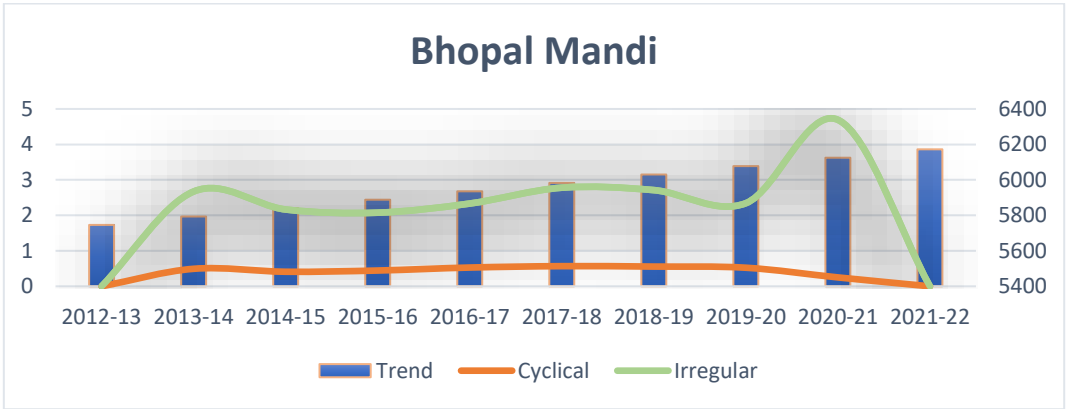

Fig. 3. Factors of time series in coriander rates at Bhopal market

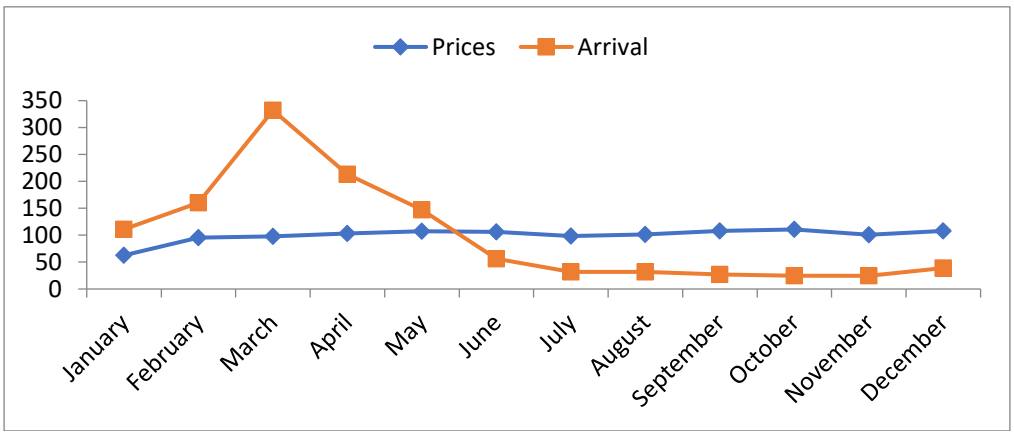

Fig. 4. Seasonal variations observed in monthly coriander prices and arrivals at Ashok Nagar market in Madhya Pradesh during 2012-13 to 2021-22

Table 5. Seasonal fluctuations in monthly coriander prices in the specified marketplaces of MP from 2012-13 to 2021-22

Months	Ashok Nagar	Guna	Bhopal
January	62.64	78.23	87.88
February	95.71	83.65	88.04
March	97.88	89.23	99.79
April	103.16	88.36	99.13
May	107.43	96.85	100.14
June	105.98	117.77	101.52
July	98.15	98.36	100.71
August	101.63	102.12	100.66
September	107.95	101.94	106.34
October	110.67	114.99	108.21
November	100.9	115.75	106.53
December	107.9	113.16	101.05

Table 6. Seasonal variations in monthly coriander arrivals at the designated marketplaces of Madhya Pradesh from 2012-13 to 2021-22

Months	Ashok	Guna	Bhopal
January	110.84	101.36	172.11
February	160.21	192.77	316.98
March	332.06	225.87	278.87
April	213.43	310.33	94.6
May	147.36	93.36	90.5
June	56.48	31.26	27.91
July	31.97	49.18	42.97
August	32.05	40.01	43.92
September	26.92	42.04	37.53
October	24.95	48.12	35.72
November	24.55	38.76	34.61
December	39.19	27.2	24.28

Fig. 5. Seasonal indices depicting monthly coriander price and arrival trends in Guna market, MP, over the period 2012-13 to 2021-22

3.10 Level of seasonal price Fluctuations in Specific Coriander Mandies within Madhya Pradesh

The findings from the analysis of yearly price escalation (presented in Table 7) revealed a range of variability. In particular, the extent of intra-year price rise (IPR) exhibited considerable diversity, with values ranging from as low as 7.95 % in Ashok Nagar market to as high as 25.52 percent in Guna market. Similarly, the extent of average seasonal price fluctuation also displayed

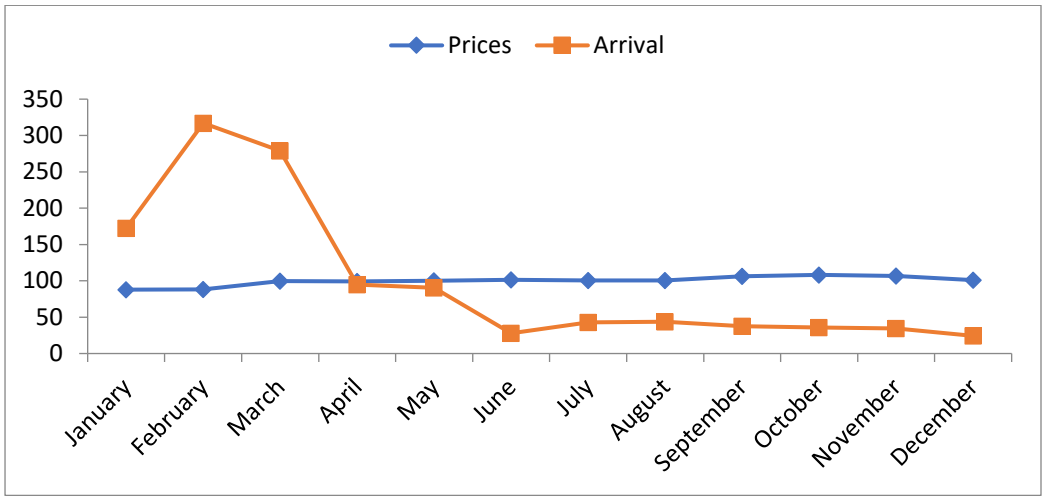

Fig. 6. Seasonal variations observed in monthly coriander prices and arrivals at Bhopal mandi in Madhya Pradesh during 2012-13 to 2021-22

Table 7. Yearly price variations in coriander across designated markets of MP spanning 2012-13 to 2021-22

Marketplaces	Minimum Seasonal Price Index		Maximum Seasonal Price Index		Extent of Variability (%)		
	Monthly intervals	Seasonal indicator	Monthly intervals	Seasonal indicator	IPR	ASPV	C.V.
Ashok Nagar	January	62.64	October	110.67	7.95	5.03	12.60
Guna	January	78.23	June	117.77	25.52	7.62	24.05
Bhopal	January	87.88	October	108.21	8.21	8.01	24.05

IPR = Intra Year Price Rise, ASPV = Average Seasonal Price Variation, C. V. = Coefficient of Variation

notable differences, ranging from 5.03 percent in Ashok Nagar market to 8.01 percent in Bhopal trading place. The coefficient of variation, representing the variability across all chosen markets including the state, spanned from 12.60 percent to 24.05 percent. Notably, the maximum variation in prices among all selected marketplaces observed in Guna market.

4. SUMMARY AND CONCLUSIONS

The examination of the linear trend in wholesale coriander prices in Madhya Pradesh unveiled a positive regression coefficient (β) linked with the time element (T), signifying an upward trend throughout the study duration. Furthermore, the annual coriander prices in all three designated markets exhibited dual cycles, lasting 7 and 2 years. Irregular price fluctuations did not demonstrate any consistent periodic pattern across most crops. Additionally, the seasonal price indices for all chosen coriander marketplaces consistently reflected elevated prices from September to December. During this period, arrivals were lower due to the lean season, contributing to price increases. The peak periods of coriander arrivals typically occur from February to June, leading to price declines. Coriander arrivals typically commence in February and persist for the following 3-4 months. Considering the Intra-Year Price Rise (IPR) and Average Seasonal Price Variation (ASPV), significant variability in prices observed, with the highest variation noted in Guna trading centre. The maximum price variation among all selected markets observed in Guna market.

POLICY IMPLICATIONS

Considering the aforementioned findings, the following policy measures recommended:

While warehouse receipt financing presents an opportunity for farmers to sell their crops at opportune moments, observed that small and marginal farmers tend to sell their produce immediately after harvesting, thereby missing potential price fluctuations and benefits. Farmers Producer Organisations can help them in

aggregating, storing and selling the produce at right place and at right time.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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