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UNVEILING SEASONAL TRENDS AND GROWTH PATTERNS IN KEY SEED SPICES OF JODHPUR, RAJASTHAN

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Article Info

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Abstract

India holds a prominent position as the global leader in spice production, export, and consumption. This reputation is underpinned by its diverse agro-climatic conditions, which provide an optimal environment for cultivating a rich variety of spices. Among these, seed spice crops emerge as pivotal contributors to the nation's extensive spice output. These annual herbaceous plants, distinguished by their remarkable flavor-enhancing attributes, are an integral component of Indian cuisine, with their young leaves and dry seeds imparting distinctive taste profiles to a multitude of dishes. Beyond their culinary significance, seed spices boast noteworthy medicinal properties, rendering them invaluable in addressing gastrointestinal ailments including digestive disorders, flatulence, and diarrhea, while also ameliorating colic. Moreover, these spices serve as reservoirs of essential vitamins such as A and C. The multifaceted utility of seed spice crops extends beyond their culinary and medicinal domains. They find application in the carminative industry, acting as agents that prevent and alleviate flatulence and associated discomfort. Furthermore, their role as preservatives is indispensable, enhancing the shelf life of various products. The diverse employment opportunities generated by these industries contribute to local economies and livelihoods. This paper aims to shed light on the manifold dimensions of seed spice crops in India. By analyzing their cultural, culinary, and medicinal significance, we intend to underscore their role in the nation's economy and society. Key emphasis will be placed on the pivotal species that make up this category, elucidating their distinct attributes and applications. Additionally, the paper delves into the challenges and opportunities associated with seed spice cultivation, considering aspects of sustainable production, agricultural practices, and market trends. Through an extensive review of available literature and statistical data, we endeavor to provide a comprehensive overview of

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the seed spice crops' impact on India's culinary heritage, healthcare sector, economic growth, and employment landscape.

Introduction

India is renowned as the world's largest producer, exporter, and consumer of spices. The country's vast and diverse agro-climatic conditions have made it an ideal place for growing a variety of spices. The seed spice crops, in particular, are the prime contributors to the country's total spice production. These annual herbs are known for their flavoring properties, and their young leaves or dry seeds are used as a food flavoring agent in Indian cuisine. In addition to their flavoring qualities, they also have medicinal value, such as treating digestive issues, flatulence, diarrhea, colic, and are sources of vitamins A and C. They are also used in carminative, preservative, and other industries, creating employment opportunities.Rajasthan, Gujarat, Maharashtra, Uttar Pradesh, Andhra Pradesh, Karnataka, and Tamil Nadu are the main states growing different varieties of seed spices in large-scale production in the country. During 2017-18, India produced around 14.59 lakh tonnes of seed spices, holding 14.75 lakh hectares of land under various seed spice crops [1]. Rajasthan is the foremost contributor to the total area and production of seed spices in the country. The state's diversified climatic and soil attributes are most suitable for growing many species of seed spices.

The Western part of Rajasthan is leading in coverage of area under coriander (Coriandrum sativum L.), cumin (Cuminum cyminum L.), fenugreek (Trigonella foenumgraecum L.), and fennel (Foeniculum vulgare Miller) crops. During 2017–18, the area and production of seed spices in Rajasthan were recorded as 7.82 lakh hectares and 6.24 lakh tonnes, respectively, with coriander, cumin, fenugreek, and fennel contributing 1.44, 3.55, 0.96, and 0.2 lakh tonnes from 0.98, 5.81, 0.68, and 0.21 lakh hectare cultivated area, respectively. In order to expand the area, production, and productivity of seed spices, the Rajasthan government has initiated many productions and productivity-based schemes and programs from time to time. The National Research Centre on Seed Spices, Ajmer, has recognized the enormous potential for large-scale cultivation of seed spices in the state [2].

However, the production of seed spices in the agriculture sector is uncertain in nature. This uncertainty in supply leads to fluctuations in prices by two ways: seasonal and cyclical variations. The fluctuating supply of seed spices in the market causes uncertainty for farmers and buyers, leading to price volatility. The trend analysis of seed spices provides us with the sequential backdrop of how seed spice farming influences the lives of farmers, either positively or negatively. Many researchers and scientists have conducted numerous studies on arrivals and prices of spices in different states of the country, such as cumin, pepper, chilies, turmeric, cardamom, and other agricultural commodities [3-7]. However, the study of arrivals and prices of coriander, cumin, fenugreek, and fennel in Rajasthan is scarce.

The present study aims to examine the growth rate in acreage, output, and yield of Rajasthan and instability and seasonal indices of major seed spices in Jodhpur district of Rajasthan. Monthly (2015 to 2018) and yearly (1998 to 2018) wholesale price and market arrivals time-series data were collected from Krishi Upaj Mandi Samiti, Jodhpur. The analysis of production and price behavior over time is imperative in formulating a sound price policy of seed spices in India. The results of this study could help policymakers and stakeholders in the agriculture sector to understand the trends and patterns of seed spice production and price fluctuations in Rajasthan, which is a significant contributor to the total production of seed spices in India. The findings could also provide insights into the potential of seed spice farming in the state and inform the design of policies and programs to support the sector's growth and development. Moreover, the study's contribution to the existing literature on the topic could inspire further research in the area of agricultural economics and trade.

MATERIALS AND METHODS

The present investigation is completely based on secondary information and confined to major seed spices viz., coriander, cumin, fennel and fenugreek seed spices in Rajasthan only. For drawing a meaningful clarification on growth in area, production, productivity and instability in annual wholesale prices, the study period was selected from 1998-99 to 2017-18. The information on the area, production, productivity and annual wholesale prices were collected from the Directorate of Economics and Statistics Rajasthan and Krishi Upaj Mandi Samiti, Jodhpur. However, to estimate the seasonal indices of selected seed spices in Mandor-Jodhpur, monthly time series data on arrivals and wholesale prices were collected for the study period from 2015-16 to 2017-18.

Statistical structure

The collected data were analyzed by using the following statistical techniques to achieve the stated objectives.

Trend analysis

The linear and compound growth models were used to estimate the trend in acreage, production, productivity and annual wholesale price of selected seed spice crops. These trend models are given as follows:

1. Linear trend equation

$P_t = \alpha_0 + \alpha_1 T_t + \mu_t$ …….. (1)

Where;

P_t is annual production, area, productivity and wholesale prices of seed spice(s) in time t (Where t- 1, 2, 3, 4, 5, ... 20)

α_0 and α_1 are regression coefficients μ_t is error terms with common assumptions

T_t is time in years where t values take 1, 2, 3, 4 ... 20

2. Exponential growth model $P_t = \alpha_0 \alpha_1 T \mu_t$ …….. (2)

Where;

P_t is annual production, area, productivity and wholesale prices of individual crops in time "t" (where t = 1, 2, 3, ...20)

α_0 and α_1 are regression coefficients μ_t is error terms with common assumptions

T_t is time in years where t values takes 1, 2, 3, 4 ... 20

Now takes both sides logarithms of the equation (2)

$Log\ P_t = Log\ \alpha_0 + T\ Log\ \alpha_1 + Log\ \mu_t$ …….. (3)

This equation was estimated by using Ordinary Least Square (OLS) procedure. Now the compound annual growth rate (r) is estimated as given below:

(r) = (Antilog α_1-1) × 100..... (4) The student "t" test was used to test the level of significance of compound growth rates.

Instability

In graphical approach of instability, we can only compare view, but not precise measures of the extent of instability. Therefore, three type's quantitative instability methods were used to measure the variation in annual wholesale prices of selected seed spices.

1) Instability Index by coefficient variation

$$I_1 = \frac{SD}{AM} \times 100$$

Where;

I = Instability Index (C.V.)

SD = Standard deviation

AM = Arithmetic mean

2) Cuddy Della Valle instability index Cuddy and Della Valle developed it in 1978 [8].

$I2 = CV \square \sqrt{(1-R2)}$

Where;

I is the instability index (%),

CV is the coefficient of variation and

R^2 is the coefficient of determination from a time trend regression adjusted by the number of degrees of freedom.

3) Index of dynamic instability

The proportion of total variation not explained by the trend line measures it.

$I_3 = (1 - R^2) \times 100$ Where;

I = Index of dynamic instability in the price

R^2 = Coefficient of multiple determination

Analysis of seasonal components

To determine the seasonal price behavior, time series data on monthly wholesale price were used. The following approaches were used in order to study the price behavior.

Ratio to moving average method

It was employed to compute the seasonal indices through the following steps.

Step I: The centered 12 months moving average will be computed from the original data. These centered 12 months moving average data contain the trend and cyclical component.

Step II: Divide the original data by the centered moving average.

P = TSCI

$$\frac{P}{MA} = \frac{TSCI}{TC} \times 100 = (S \times I)\ 100$$

Step III: The irregular component was eliminated by averaging the data for each month over the years that get in step 2. After averaging the data and multiplied it by 100, the resultant will be a seasonal index for each month.

Step IV: The sum of the seasonal indices should be 1200. If it is greater or less than 1200 then it was adjusted by using a correction factor i.e., K = 1200 / S.

Where;

K = Correction factor and

S = Sum of seasonal indices. The extent of seasonal price variation was determined by using following three measures of intra-year price variations as given below:

(i) Extent of intra-year price rise (IPR)

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

Where;

IPR = Intra-year price rise

HSPL = Highest seasonal price index and

LSPI = Lowest seasonal price index

(ii) Coefficient of average seasonal price variation (ASPV)

HSPI

$$ASPV = \frac{HSPI - LSPI}{\left(\frac{HSPI + LSPI}{2}\right)} X100$$

Where;
ASPV = Average seasonal price index variation
HSPI = Highest seasonal price index
LSPI = Lowest seasonal price index

(iii) Coefficient of variation (CV)

$$CV = \frac{SD}{AM} \times 100$$

Where;
CV = Coefficient of variation,
SD = Standard deviation of seasonal price indices and
AM = Arithmetic mean of the seasonal price indices
Since the mean of seasonal indices is 100, therefore, coefficient of variation is the magnitude of standard deviation [9].

RESULTS AND DISCUSSION

Trend and growth rate analysis

Seed spices are an essential ingredient in Indian kitchen for daily diet and they have a great demand over the year. Based on a significant level, R^2 value and shape of function, the exponential trend model is a good fit over linear trend model. The coefficients of determination (R^2) from linear and exponential functions were presented in (Table 1). Most probably, the coefficient of determination (R^2) values of exponential model were higher than the linear trend model for area, production and productivity aspects of coriander, cumin, fennel and fenugreek. Therefore; exponential model was used for fitting trend pattern in acreage, output and yield of each selected seed spice crop in the Rajasthan. The compound annual growth rate in acreage, output and yield of major seed spices viz., coriander, cumin, fennel and fenugreek were also presented in (Table 1), where highest CAGR in the area (13.0), production (17.3) and productivity (4.10) were recorded for fennel crop followed by cumin, fenugreek and corianders in the state. This might be due to expanding the area under seed spices and shifting of farmers from livestock production to dry land farming in the western part of Rajasthan. [10] also found a positive and significant growth rate in area, production and productivity of the major spices in Rajasthan and India.

The results of trend analysis in all four major seed spices crops namely, coriander, cumin, fennel and fenugreek are presented in (Table 2). It was revealed from the exponential trend analysis in area, production and productivity that the value of a_1 and a_1 regression coefficient is positively linked with the time component. These were statistically significant at 1 per cent for all the selected seed spice crops in Rajasthan. This indicated that production of coriander, cumin, fennel and fenugreek were expanded with increasing area and productivity of respective crops. [11] also reported the increasing growth trend in area, production and productivity of the major spices in the Northern region. The highest value of regression coefficients in the area was found in fennel (1.13) followed by cumin (1.07), fenugreek (1.06) and coriander (1.01). Similar patterns of trend were also reported in production and productivity of coriander, cumin, fennel and fenugreek spices [12].

Table 2 Trend line fitted results for major seed spices of Rajasthan (Period: 1998-99 to 2017-18)

Table 1 R^{2-} Value of Linear and Exponential Function and Compound Annual Growth Rate for Major Seed Spices of Rajasthan (Period: 1998-99 to 2017-18)

Crop	R^2 Value (Linear Function)			R^2 Value (Exponential Function)			Compound annual growth rate (%)		
	Area	Production	Productivity	Area	Production	Productivity	Area	Production	Productivity
Coriander	0.037	0.037	0.02	0.027	0.04	0.01	0.80	1.00	0.20
Cumin	0.612	0.556	0.17	0.561	0.487	0.13	6.80	9.10	2.10
Fennel	0.414	0.327	0.578	0.66	0.708	0.625	13.00	17.20	4.10
Fenugreek	0.376	0.377	0.016	0.463	0.458	0.019	5.70	6.00	0.30
Total seed spices	0.62	0.521	0.007	0.593	0.53	0.005	4.90	5.00	0.20

All compound annual growth rates are significant at 1% level

Fitted function	Crop	Regression coefficient	Coriander	Cumin	Fennel	Fenugreek	Total seeds spices
Linear Function	Area	α0	166880	97785	-1371.88	28291.21	304679.10
		α1	1636	20494.58	1598.07	3528.78	27346.27
	Production	α0	179310	2522.31	-5124.34	29915.07	211745.70
		α1	1999.54	11928.21	2004.23	4553.28	20752.53
	Productivity	α0	1049.78	288.06	502.27	1148.65	707.717
		α1	4.88	8.76	32.26	2.97	1.61

of different analytical methods that coriander, cumin and fennel crops were highly unstable in methods of I_1 (57.02 percent) and I_2 (38.38 percent) and I_3 (69.0 percent), respectively. During the same period, fennel and coriander crops were found highly stable in the context of I_1 (40.08 percent), I_2 (33.30 percent) and I_3 (44.0 percent) respectively in prices of KUMS (Krishi Upaj Mandi Samiti), Jodhpur [13-16].

Table 3 Instability in prices of major seed spices in Jodhpur district of Rajasthan (1998-99 to 2017-18)

Exponential Function	Area	α0 α1	162688	137882.9	3130.62	32569.14	338578.6
			1.01	1.07	1.13	1.06	1.05
	Production	α0 α1	171708.8	39875.02	1645.63	37121.18	237624.9
			1.01	1.09	1.17	1.06	1.05
	Productivity	α0 α1	1055.44	289.19	525.66	1139.765	701.83
			1.01	1.02	1.04	1.01	1.01

The instability measured through three methods viz., instability index of prices in seed spices of Jodhpur district CV, Cuddy Della Valle instability index and dynamic has been shown in (Table 3). It is revealed from the results

Crop	I_1	I_2	I_3
Cumin	50.84	38.38	57.00
Coriander	57.02	37.82	44.00
Fenugreek	49.49	33.56	46.00
Fennel	40.08	33.30	69.00

During the study period, the result of seasonal indices of wholesale price and market arrivals of cumin and Coriander in the Jodhpur market of Rajasthan was presented in (Table 4, Fig 1). It was shown that the seasonal indices of arrival of the cumin in Jodhpur market where more than 100 during March to June and the peak period of arrivals was found during March (297.96) and April (392.98) and the lower arrivals indices were found during January (14.01) and February (5.92) months. The highest and lowest value of price indices for cumin was found in the month of October (111.29) and March (94.54), respectively. While less than 100 price indices for cumin were observed during February to July month in the same market. Thus, cumin Crop is suitable for arid climate and irrigation conditions. In case of coriander, the highest and lowest seasonal indices of arrivals in Jodhpur mandi were reported in the month of March (358.35) and October (22.16), respectively. Arrival indices were more than 100 in the month of December (125.15), February (172.28) and March (358.53) with a peak arrival in March. During September to October, the arrivals indices were less than 30 showing less market arrivals.

Table 4 Seasonal indices of monthly arrivals and wholesale price of selected major seed spices in Jodhpur market of Rajasthan (2015-2018)

Crop / Month	Cumin		Coriander		Fenugreek		Fennel	
	Arrivals	Price	Arrivals	Price	Arrivals	Price	Arrivals	Price

January	14.01	104.50	53.51	92.39	62.35	90.93	45.81	81.46
February	5.92	99.31	172.28	85.02	33.12	97.60	2.02	92.73
March	297.96	94.54	358.53	93.86	32.46	100.75	7.89	95.91
April	392.98	95.96	99.45	103.85	193.34	99.50	590.71	117.10
May	191.03	103.67	86.74	99.41	240.18	102.20	310.25	107.86
June	121.88	89.86	70.12	104.50	229.28	93.00	114.57	107.23
July	76.09	77.53	33.94	93.05	121.81	106.52	60.13	95.89
August	19.37	109.86	89.83	91.59	77.22	99.75	34.30	122.03
September	26.46	103.43	27.48	100.64	70.26	106.00	3.60	99.07
October	16.04	111.29	22.16	111.95	62.65	90.39	26.72	88.31
November	19.17	102.43	60.79	114.53	34.81	102.42	3.79	87.05
December	19.10	107.62	125.17	109.23	42.50	110.95	0.22	105.36
Total	1200.00	1200.00	1200.00	1200.00	1200.00	1200.00	1200.00	1200.00

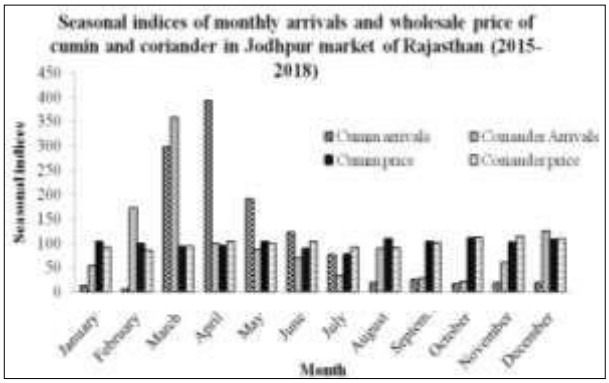

Fig 1 Seasonal indices of monthly arrivals and wholesale price of cumin and coriander in Jodhpur market of Rajasthan (2015-2018)

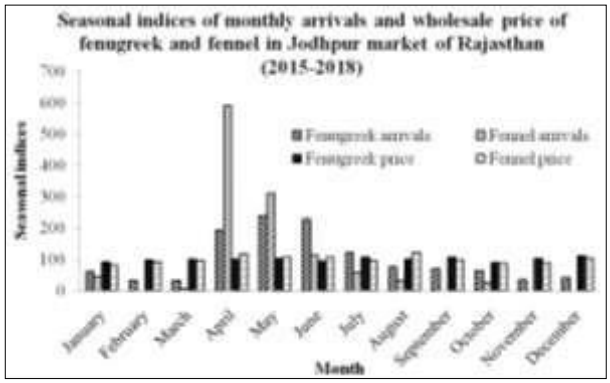

Fig 2 Seasonal indices of monthly arrivals and wholesale price of fenugreek and fennel in Jodhpur market of Rajasthan (2015-2018)

During the study period, the seasonal indices of arrivals quantity and prices for fenugreek and fennel were presented in (Table 4, Fig 1-2). The results of seasonal indices showed that highest seasonal indices of arrivals for fenugreek were found in the month of May (240.18) followed by June (229.28) and April (193.34) and lowest in March (32.46). The highest and lowest price indices for fenugreek were found in December (110.95) and October
(90.39), respectively. The price indices in Jodhpur market were more than 100 in the month of December (110.95), followed by July (106.52), September (106) and November (102.42).

The results of intra-year price variations of average seasonal indices were presented in table 5, which were measured with three methods viz., IPR, ASPV and CV. For this purpose, the magnitudes of fluctuation in seasonal indices of seed spices were analyzed with the help of average seasonal price indices range. The coefficient of intra-year price variation for coriander, cumin, fenugreek and fennel were 34.71 percent, 43.54 percent, 22.75 percent and 49.80 percent, respectively in Jodhpur market. The coefficient of average seasonal price variation

varied from 20.42 percent to 39.87 percent for selected seed spices. The coefficient of variation for all selected seed spices of
Jodhpur market ranged from 6.32 percent to 12.27 percent.

The magnitude of CV reciprocally related to the degree of stability in prices. The variability in arrivals after immediate harvest time, stock of seed spices in the market and demand affects the price to a great extent. The farmers can obtain better prices by keeping such variation in mind and equating supply with the market demand during the period of the seasonal price index.

Table 5 Coefficient of average seasonal price variation of major seed spices in Jodhpur market of Rajasthan (2015-2018)

Crop	Lowest seasonal price index		Highest seasonal price index		Magnitude of variation (%)		
	Month	Seasonal Index	Month	Seasonal Index	IPR	ASPV	CV
Coriander	February	85.02	November	114.53	34.71	29.58	9.12
Cumin	July	77.53	October	111.29	43.54	35.76	9.48
Fenugreek	October	90.39	December	110.95	22.75	20.42	6.32
Fennel	January	81.46	August	122.03	49.80	39.87	12.27

CONCLUSION

From the results, it could be concluded that the results of growth in production, acreage and productivity revealed that there is an attractive trend in seed spices in Rajasthan. These have extreme potential to expand commercial attributes since long back (last two decades), and it is an obvious fact about increase in area as well as production from the year 1998-99. During the study period, the highest fluctuation in wholesale price was obtained in fennel crop, followed by cumin, fenugreek and coriander in the Mandor market of Jodhpur district. Further, the maximum intra-year price variation was recorded in fennel (49.8%) followed by cumin (43.54), coriander (34.71), fenugreek (22.75) in the same market during 2015-18.

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