RESEARCH ARTICLE Bhartiya Krishi Anusandhan Patrika, Volume 40 Issue 3-4: 405-409 (September and December 2025)

Seasonality Analysis of Sorghum Prices and Arrivals in Maharashtra

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10.18805/BKAP851

ABSTRACT

Background: Sorghum (*Sorghum bicolor* L.*)* contributes to more than 60% of millets produced globally. In India, Maharashtra state is the largest producer of sorghum over the period of time. The present study was aimed to estimate the seasonal variation and trends of arrival and prices and price volatility by using advanced time series analysis.

Methods: The time series data on monthly arrivals and prices of sorghum were collected from the major six number of APMCs markets of Maharashtra. The seasonality of arrivals and prices were analyzed by estimating seasonal arrival and prices indexes and intra year variability. Data used were pertaining to the period of 20 years *i.e.*, 2004-2024.

Result: Seasonality analysis of data indicated that all of the selected markets seasonal arrival indices of sorghum were higher than the price indices. The clear pattern of maximum and minimum arrivals and prices were noticed in most of the market. The peak arrivals of sorghum were noticed from the month march to June and the peak prices were seen from November to December with few exceptions. The estimated historical price and arrival patterns, fluctuations and trends of sorghum revealed that there is need of appropriate policy measures to ensure fair prices to farmers in order to increase the potential area and production of sorghum in the Maharashtra.

Key words: Coefficient of variation, Intra year variability, Seasonal indices, Sorghum prices and Arrivals, Trend.

INTRODUCTION

Sorghum (*Sorghum bicolor L.)* is grown in nearly 100 countries and contributes to more than 60% of millets produced globally. It is the world's fifth major cereal food crop in terms of production and acreage after rice, wheat, maize and barley. In India, major sorghum growing regions are north-western, western and central India, Southern peninsula and some parts of north-eastern states. In India, Maharashtra state contributes maximum area and production of sorghum over the period of time. The area, production and productivity of sorghum were 1.65 million ha., 1.71 million tonnes and 1038 qtl. /ha respectively in the Maharashtra during the year 2021-2022. There has been a shift in area from millets around the 1980s, initially towards non-millet cereals (which, is largely paddy) and pulses and then in the 1990s, primarily to non-millet cereals and in the subsequent decades to pulses. (Jena and Mishra, 2022). Sorghum crop has inherent drought tolerant characteristics but less tolerant to low temperatures. The grains of sorghum have other industrial uses such as bioethanol production and potable alcohol production. It is also recognized as nutritive and healthy food among all the cereals and millets as it is rich in protein, fibre, thiamine, riboflavin, folic acid and carotene.

Agricultural prices are an important signal of marketing system and have enormous economic implications. These prices play an important role in bringing market equilibrium between demand and supply. The variations of market arrival largely responsible for price instability of agricultural commodities. Price fluctuations have significant effect on area, productivity and the production of agricultural commodities (Blay *et al.*, 2015). In order to devise the appropriate ways and means for reducing the price fluctuation of agricultural commodities, there is need to have a thorough understanding of the price behavior of agricultural commodities over time. The estimation of seasonal arrival and price indexes and intra year variability of sorghum would be insightful to all stakeholders including farmers to understand the market dynamics that influence the prices.

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How to cite this article: Jagtap, P.P., Hile, R.B., Sale, Y.C. and Nirgude, R.R. (2025). Seasonality Analysis of Sorghum Prices and Arrivals in Maharashtra. *Bhartiya Krishi Anusandhan Patrika*. **40(3-4):** 405-409. doi: 10.18805/BKAP851.

Submitted: 19-05-2025 **Accepted:** 12-07-2025 **Online:** 28-08-2025

MATERIALS AND METHODS

The time series data on monthly arrivals and prices of sorghum were collected from the major APMCs markets of Maharashtra for the period of 20 years *i.e.,* 2004-2023. Selection of markets were decided on the basis of maximum arrivals of in the market. For the data analysis four markets from western Maharashtra and one market each from Marathwada and Vidarbha region were selected.

Seasonal indices of arrivals and prices were estimated by ratio to moving average method. Similar measure was used to estimate seasonal indices by (Savitha and Kunnal, 2016) (Sharma and Singh, 2014).

Seasonal index (prices) =

$$\frac{\text{Actual average prices for the month}}{\text{Moving average price for the month}} \times 100$$

Seasonal index (arrivals) =

$$\frac{\text{Actual average arrivals for the month}}{\text{Moving average arrivals for the month}} \times 100$$

Inter and intra year variability in arrivals and prices were studied by following formula. Similar measure was used to estimate extent of variability by (Chaudhary and Sharma, 2022).

$$C.V.\ (\%) = (SD/\ (\sum X / n) \times 100$$

Where,
C.V. = Coefficient of variation.
S.D. = Standard deviation.
X = Area, production, productivity.
N = Number of year.

RESULTS AND DISCUSSION

Seasonal indices of arrivals and prices of sorghum in Western Maharashtra

The seasonal indices of monthly arrivals and prices of sorghum in Barshi, Jamkhed, Sangli and Nandurbar markets were calculated and depicted in Table 1 showed that in the Barshi, Jamkhed, Sangli and Nandurbar markets, the arrivals indexes of sorghum in were maximum in the months of March (151.52%), March (221.81%), April (132.00%) and October (350.01%) respectively and minimum during the month of January (64.51%), October (54.48%), September (72.84%) and July (10.69%) respectively. The indices of per quintal prices were highest in the month November for the three markets namely Barshi (110%), Jamkhed (107.35%) and Sangali (106.59%) and for the Nandurbar market it was highest in the month of October (350.01%)

The arrivals indexes in Barshi market were maximum from March to June and per quintal price index were exceeded 100 from the month of September to December. In case of Jamkhed and Sangli market maximum arrival indexes were from the month February to May and January to May respectively. The per quintal price index of sorghum for the Jamkhed market were above the 100 in the month of April, November and December and for the Sangli market in the month of September, November and December. In case of Nandurbar market Sorghum arrival indexes were maximum from the month of October to December and indexes of per quintal prices were more than 100 from the month of March to June and in the month of September and November.

Seasonal Indices of arrivals and prices of sorghum in *Marathwada* and Vidarbha region

The seasonal indices of monthly arrivals and prices of sorghum for the period of last 20 years (2004 to 2023) in Jalna markets of *Marathwada* region and Khamgaon market of vidarbha region were calculated and the results are presented in Table 2.

It could be noticed from the Table 2 that, the maximum indices of arrivals of sorghum in the Jalna market of Marathwada region and Khamgaon market of vidarbha region were 163 per cent (April) and 254.90 (November) per cent respectively. The highest price indices of sorghum in the same markets market were in the month December as 109.30 per cent and 106.74 per cent in the Jalna and Khamgaon markets respectively. On the contrary, the lowest arrivals indices were recorded in the months of January, *i.e.* 42.44 per cent and 54 per cent in the month of September in the Jalna and Khamgaon markets respectively. In case

Table 1: Seasonal indices of arrivals and prices of sorghum in Western Maharashtra (2004 to 2023).

Month	Barshi		Jamkhed		Sangali		Nandurbar	
	Arrivals indices	Prices indices	Arrivals indices	Prices indices	Arrivals indices	Prices indices	Arrivals indices	Prices indices
Jan	64.51	96.09	56.02	96.43	111.00	96.46	61.97	90.23
Feb	93.59	94.91	199.56	97.13	104.30	95.27	65.50	94.99
Mar	151.52	99.65	221.81	98.84	108.96	96.28	133.48	107.73
Apr	147.88	98.62	162.00	101.25	132.00	99.03	63.81	110.63
May	113.16	98.73	105.04	99.47	118.95	98.99	44.35	103.09
Jun	130.22	95.18	86.91	98.90	99.96	98.02	24.64	100.70
Jul	89.05	98.16	73.71	100.29	83.58	100.04	10.69	99.88
Aug	77.95	99.26	59.71	99.12	82.50	101.62	11.35	99.64
Sep	81.00	100.00	58.34	96.83	72.84	101.86	28.59	100.37
Oct	85.56	104.62	54.48	97.97	84.88	99.41	350.01	94.05
Nov	77.78	110.00	61.44	107.35	101.21	106.59	268.04	100.26
Dec	87.79	104.77	60.99	106.43	99.82	106.43	137.57	98.43
Total	1200	1200	1200	1200	1200	1200	1200	1200

of lowest indices per unit prices of sorghum were 95.44 per cent (June) and 93.55 per cent (February) in the Jalna and Khamgaon markets respectively.

The maximum arrival indexes in Jalna market were from the month March to June and November to December in the Jalna market of Marathwada region and Khamgaon market of vidarbha region respectively. In Jalna and Khamgaon market, the per quintal price indexes were above the 100 in the month of January, November and December.

Overall, it was found that in all of the selected markets seasonal arrival indices of sorghum were higher than the price indices. The clear pattern of maximum and minimum arrivals and prices were also noticed in most of the market. The peak arrivals of sorghum were noticed from the month march to June and the peak prices were seen from November to December with few exceptions. The general pattern of seasonal variation in prices *i.e.* lower prices during the postharvest month and higher prices during the pre-harvest or off season month is a national feature for food grains and it was reported year after year (Jambhale *et al.*, 2012). With the increase in the market flow, price goes down. It means commodity flow is as per the market demand of the crop (Borah *et al.*, 2025).

Intra-year variations in arrivals and prices of sorghum in Maharashtra

The coefficient of variation measure is used to estimate the intra-year variability of selected major millets from the year 2004 to 2023. The region wise results of sorghum are presented in Table 3.

Western Maharashtra region

The intra-year variability in the arrivals and prices of sorghum in Barshi, Jamkhed, Nandurbar and Sangli markets over 20 years are presented in Table 3.

The overall variation in sorghum arrivals and prices was 80.38 percent and 50.87 percent in Barshi market, 60.39 per cent and 47.13 per cent in Jamkhed market, 68.83 per cent and 49.69 per cent in Sangli market and 66.26 per cent and 44.51 per cent in Nandurbar market

Table 2: Seasonal indices of arrivals and prices of Sorghum in *Marathwada* and *vidarbha* region (2004 to 2023).

Month	Jalna		Khamgaon	
	Arrivals indices	Prices indices	Arrivals indices	Prices indices
Jan	42.44	102.17	107.27	94.58
Feb	73.40	98.45	78.79	93.55
Mar	152.10	97.66	69.70	93.97
Apr	163.00	99.12	88.50	99.62
May	145.15	95.53	72.67	94.80
Jun	125.04	95.44	63.11	96.95
Jul	87.58	99.08	65.24	106.26
Aug	92.58	99.45	68.87	106.04
Sep	109.36	96.35	54.00	104.69
Oct	87.51	98.35	72.03	99.09
Nov	67.68	109.12	254.90	103.73
Dec	54.15	109.30	204.91	106.74
Total	1200	1200	1200	1200

Table 3: Intra-year coefficient of variations in arrivals and prices of Sorghum in Western Maharashtra (WM) (2004-2023).

Month	Barshi		Jamkhed		Sangali		Nandurbar	
	Arrivals	Prices	Arrivals	Prices	Arrivals	Prices	Arrivals	Prices
Jan	99.93	52.32	73.73	47.29	67.16	48.72	79.74	45.63
Feb	72.20	51.73	54.45	47.60	56.32	48.67	56.79	42.18
Mar	70.48	50.44	66.05	45.71	52.15	49.57	39.06	47.13
Apr	82.30	50.55	59.23	43.94	67.12	48.82	55.15	43.11
May	78.46	49.12	55.15	44.93	67.39	48.85	70.20	40.71
Jun	81.73	47.38	46.50	44.87	91.69	48.63	82.56	43.66
Jul	67.82	49.68	55.67	45.35	81.60	49.92	66.26	42.56
Aug	73.40	48.03	48.86	47.12	75.50	49.72	72.42	42.03
Sep	73.32	50.99	62.42	50.03	56.71	49.35	86.33	42.38
Oct	90.51	51.44	59.91	48.79	71.92	50.29	61.57	46.71
Nov	83.87	55.69	74.12	50.65	74.36	52.28	59.44	50.31
Dec	90.48	53.05	68.59	49.25	64.02	51.52	65.55	47.77
Mean	80.38	50.87	60.39	47.13	68.83	49.69	66.26	44.51

Table 4: Intra-year coefficient of variations in arrivals and prices of Sorghum in Marathwada and Vidarbha region (2004-2023).

Month	Jalna		Khamgaon	
	Arrivals	Prices	Arrivals	Prices
Jan	55.83	52.57	94.00	40.10
Feb	96.71	50.26	77.77	39.45
Mar	64.33	46.43	72.87	40.60
Apr	53.17	42.99	88.71	46.66
May	42.77	41.60	76.94	42.70
Jun	42.64	45.20	85.97	42.61
Jul	43.66	44.86	105.72	44.60
Aug	42.79	46.59	98.42	46.12
Sep	41.72	48.19	98.58	47.36
Oct	48.39	49.57	101.52	49.09
Nov	56.00	51.77	125.32	50.47
Dec	58.71	50.62	123.29	49.13
Mean	53.89	47.55	95.76	44.91

respectively. It was observed that in all the four of the selected markets, the variation in arrivals was greater than the variation in prices. The greatest overall variation in arrivals and prices was observed in barshi market.

In Barshi market, estimates of the monthly variability over the period of 20 years (2004-2023) revealed that, variation in arrivals and prices of sorghum were ranged between 67.82 percent (July) to 99.93 per cent (January) and 47.38 per cent (June) to 55.69 per cent (November) respectively. In case of Jamkhed market, variation in arrivals and prices of sorghum were ranged between 46.50 per cent (June) to 74.12 per cent (November) and 43.94 per cent (April) to 55.65 per cent (November) respectively. Similarly, in Sangli market variation in arrivals were ranged between 52.15 per cent (March) to 91.69 per cent (June) and variation in prices were ranged between 48.63 per cent (June) to 52.28 per cent (November) respectively. Moreover, in Nandurbar market, variation in arrivals were ranged between 39.06 per cent (March) to 86.33 per cent (September) while variation in prices were ranged between 40.71 per cent (May) to 50.31 per cent (November) respectively.

Marathwada and Vidarbha region

The intra-year variation in the arrivals and prices of sorghum in Jalna market of Marathwada region and Khamgaon market of vidarba region over a period of 20 years (2004-2023) are given in Table 4.

From the Table 4 it is observed that, the overall variation in arrivals of sorghum in Jalna market of Marathwada region and Khamgaon market of vidarbha region are 53.89 per cent and 95.76 per cent respectively, while variation in prices were 47.55 per cent and 44.91 per cent respectively. The month wise analysis shows that, the estimates of arrivals were varied between 41.72 per cent (September) to 96.71 per cent (February) in Jalna market of Marathwada region, while variation in prices were ranged between 41.60 percent (May) to 52.57 per cent (January). In case of Khamgaon market of vidarbha region, the variation in arrivals ranged between 72.87 per cent (March) to 125.32 per cent (November) and variation in prices were ranged between 39.45 per cent (February) to 50.47 per cent (November). Prices of agricultural commodities are the lower during the post-harvest period and higher during the pre-harvest months (Mahammadhusen *et al.*, 2016).

CONCLUSION AND RECOMMENDATIONS

Maharashtra state has potential to increase the production of sorghum because of suitable climatic conditions. Government is also taking various initiatives on the awareness of millets consumption for their nutritional and health benefits. However, there is need to increase the area, production and productivity of sorghum. The fair and stable prices to the farmers and other stakeholders such as processors and exporters helpful to increase the area and production of sorghum. Seasonality analysis of arrival and prices of sorghum revealed that, high volume of arrivals immediate to harvesting season brings instability in prices. The policy measures such as maintaining the buffer stock by the government, creation of warehousing facilities in order to maintain optimum balance between price support to the millet farmers and price stabilization measures for the consumers.

Disclaimers

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Informed consent

All animal procedures for experiments were approved by the Committee of Experimental Animal Care and Handling Techniques were approved by the University of Animal Care Committee.

Conflict of interest

The authors declare that there are no conflicts of interest regarding the publication of this article. No funding or sponsorship influenced the design of the study, data collection, analysis, decision to publish, or preparation of the manuscript.

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