



ISSN (E): 2277-7695  
ISSN (P): 2349-8242  
NAAS Rating: 5.23  
TPI 2023; SP-12(12): 2329-2334  
© 2023 TPI  
[www.thepharmajournal.com](http://www.thepharmajournal.com)  
Received: 07-09-2023  
Accepted: 13-10-2023

**A Bharath Chandra**  
PG Scholar, Agril. Economics  
and Statistics Section, College of  
Agriculture, Nagpur,  
Maharashtra, India

**NT Bagde**  
Assistant Professor and Head,  
Agricultural Economics, College  
of Agriculture, Nagpur,  
Maharashtra, India

**MS More**  
Assistant Professor, Agricultural  
Economics, College of  
Agriculture, Nagpur,  
Maharashtra, India

**AB Kayarwar**  
Assistant Professor, Statistics,  
College of Agriculture, Nagpur,  
Maharashtra, India

**RA Ansari**  
Assistant Professor, Statistics,  
College of Agriculture, Nagpur,  
Maharashtra, India

**Corresponding Author:**  
**A Bharath Chandra**  
PG Scholar, Agril. Economics  
and Statistics Section, College of  
Agriculture, Nagpur,  
Maharashtra, India

## Dynamics of arrivals and prices of potato in APMC Nagpur

**A Bharath Chandra, NT Bagde, MS More, AB Kayarwar and RA Ansari**

### Abstract

The present study was conducted to understand the behaviour of arrivals and prices of potato in APMC, Nagpur. Potato (*Solanum tuberosum* L.) is one of the major non-cereal food crops. The vegetable basket of Indians is almost incomplete without potato. Potato is highly nutritious than the regular rice and wheat but its nature of high perishability, seasonal production etc., made the crop highly sensitive to price fluctuations. In the present study, the secondary data on arrivals and prices of potato for a period of ten years i.e., from 2012-13 to 2021-22 were obtained from Agmark.net and processed to analyse the trends, growth rate and seasonal behaviour of potato crop in APMC, Nagpur. The trend analysis revealed that, both the prices and arrivals had followed the cubic trend. The growth rate was analysed using compound growth rate and identified that the growth rate of arrivals over the period of study was negative (5.83 percent) and non-significant. In the month of October (over the years), the growth rate was negative (12.26 percent) and significant. In all other months the growth rate was negative and non-significant. The growth rate of prices was positive (3.36 percent) but non-significant and highest in the month of January (6.44 percent) which was non-significant. There exists seasonal behaviour in the arrivals and prices of potato from January to April. The arrivals started increasing in the month of January and continued till April whereas the prices started to drop from December and continued till March.

**Keywords:** Trend analysis, growth rate, instability, seasonal indices

### Introduction

“Potato (*Solanum tuberosum* L.), - The King of Vegetables” is a member of the Solanaceae family. It is the 4th most significant food crop in the world after rice, wheat, and maize (Mangal *et al.*, 2022) <sup>[7]</sup> and it is ranked 1st among the non-cereal crops. By giving small and marginal farmers direct and immediate access to nutritious food, raising household income, and lowering their vulnerability to fluctuations in food prices, potato cropping systems serve to promote resilience. The early maturity of potatoes and their short growing cycle are further advantages of potatoes over many other crops.

The Potatoes contain dry matter, edible energy and edible protein which makes it nutritionally superior vegetable as compared to other vegetables. It is staple food all over the world and is a short duration crop. It provides high quantity of dry matter, edible energy and edible protein in short time than cereals like Rice and Wheat. Therefore, it may be considered as major component in nutritional balance. It is *Rabi* seasonal crop. The current trend of diversification from cereals to horticultural crops, led to a shift in cultivation traditional crop like Wheat, Barley etc., towards cultivation of crops like Potatoes, etc., that provide relatively higher levels of income.

The crop plays an important role in ensuring food security of present and future generation. Keeping in view the potential of potato in the food security of developing nations, FAO has rightly declared it as ‘Future Food Crop’. Considering its importance, United Nations (UN) had declared 2008 as the International Year of Potato. Indian vegetable basket is incomplete without potato. Potato is native of the High Andes in South America. It occupies the largest area under any single vegetable in the world.

Globally India stands third in terms of area and second in terms of production (54.283 million tonnes) after China (94.36 million tonnes) (Global Potato Statistics-FAO, January 2023). The total potato acreage in India was 23.46 million hectares with a production of 59.73 million tonnes and productivity 25.46 t/ha (1<sup>st</sup> Advanced estimates of Production of Horticultural Crops, DoA, MoAFW).

In India, Uttar Pradesh, West Bengal and Bihar are the largest producers and account for nearly 75 percent of area and 82 percent of production. In Maharashtra state, potato is grown in Pune and Satara districts and account for 87 percent of area and 72 percent of production. Total area under potato in Maharashtra is 0.19 million hectares with a production of 3.89 million tonnes and productivity 20.75 t/ha. (1<sup>st</sup> Advance Estimates of Area and Production of Horticultural Crops 2023, Ministry of Agriculture and Farmers Welfare)

### The present study was carried out with the following objectives

1. To study the trends in arrivals and prices of potato
2. To estimate the growth rate of arrivals and prices of potato
3. To analyse the variability in arrivals and prices of potato
4. To analyse the seasonal indices in arrivals and prices of potato

### Importance of Study

Vegetables are highly susceptible to spoilage due to their perishability resulting in significant output variations and considerable price fluctuations, thereby exposing growers to elevated risks. The concern over price fluctuations extends to consumers, farmers and policymakers, emphasizing the crucial need for efficient and accurate trend analysis to facilitate effective monitoring and planning. Although the marketable surplus of the potato crop surpasses that of other food crops, the impact of perishability and seasonality results

in more pronounced price fluctuations, presenting a major challenge for farmers. Potato prices demonstrate fluctuations both within and across years. Seasonal variations stem from changes in cultivation area, unforeseen weather conditions, outbreaks of pests or diseases, pricing dynamics of other vegetables, demand for potatoes in major cities and food processing industries, seasonal factors, transportation costs, hoarding, and the regional concentration of cold storage facilities. The current state of timely and reliable market intelligence falls short of meeting the escalating demands of the potato economy. Intelligence focusing on potential markets, market arrival patterns, and pricing in key regional and national markets throughout the year gains substantial importance due to the widespread cultivation of potatoes across various states in India. During 2021-22 period, the total area under the vegetables in the state was 1.19 million hectares, with the production of 17,189.50 thousand tonnes and productivity of 14.42 MT/ha. The examination of trends, growth rates, and seasonality in potato arrivals and prices aids farmers in comprehending the dynamics of arrivals and pricing within the Nagpur Market APMC.

### Methodology

#### Selection of Agricultural commodity

The agricultural vegetable commodity in APMC, Nagpur (Nagpur district) with the highest price fluctuation over the period of 10 years i.e., from 2012-13 to 2021-22 was selected for the present study.

**Table 1:** CV of various vegetable crops over the period of 10 years (2012-13 to 2021-22)

Vegetable Crop	CV (%)	Vegetable Crop	CV (%)
Onion	40.44	Brinjal	20.99
Coriander leaves	34.42	Spinach	19.37
Potato	32.20	Beet root	19.35
Tomato	31.79	Drumstick	16.59
Sweet Potato	30.21	Cauliflower	15.88
Pointed gourd	26.22	Bitter gourd	14.58
Cabbage	22.44	Bhindi	10.93
Bottle gourd	22.02	Pumpkin	10.52

From the above table, Potato is one of the vegetable crops with the highest price fluctuation over the period of 10 years i.e., from 2012-13 to 2021-22 and hence the crop was selected for the present study.

### Period of study

The present study was based on daily arrivals and prices of Potato, in Agricultural Produce Market Committee, Nagpur for the period of 10 years i.e., from 2012-13 to 2021-22.

### Data Collection

Secondary data was collected from the website of agmark.net regarding the arrivals and prices of Potato. The daily arrivals and prices of Potato were converted to monthly arrivals and prices by performing simple addition and calculating the mean respectively.

### Analytical tools and techniques

#### Different analytical techniques that are used were

1. Trends in Arrivals and Prices
2. Growth rate of Arrivals and Prices
3. Variability in Arrivals and Prices
4. Seasonal indices in arrivals and prices

### 1. Trends in Arrivals and Prices

The trends in arrivals and prices of Potato were computed for the time series monthly data of arrivals obtained by the addition of day-to-day arrivals within a month and by calculating the mean of day-to-day prices within a month. To trace the path of process different parametric trend models were used. The best model was selected based on the goodness of fit (measured in terms of  $R^2$ ) value and significance of coefficients.

**Table 2:** Trends in Arrivals and Prices

Sr. No	Function	Equation
1	Linear	$Y = a + bx$
2	Logarithmic	$\text{Log } Y = \text{Log } A + \text{Log } bx$
3	Inverse	$Y = f(x); Y = f^{-1}(x)$
4	Quadratic	$Y = a+bx+cx^2$
5	Cubic	$Y = a+bx+cx^2+dx^3$
6	Compound	$Y = b_0 (x^b)$
7	Power	$Y = a (bx)$
8	Growth	$Y = a+bc$
9	Square root	$Y = a+b\sqrt{x}$

**2. Growth rate of arrivals and prices**

The compound growth rate of arrivals and prices of Potato was worked out for 10 year time series data i.e., from 2012-13 to 2021-22.

The compound growth rates of arrivals and prices of coriander were worked out by using the formula

$$Y = ab^t$$

Where,

Y = Arrivals or Prices (Yearly or Monthly)

a = Constant

b = Regression coefficient

t = time period

Annual compound growth rate in percentage was calculated as

$$CAGR = [\text{Antilog}(\log b) - 1] \times 100$$

**3. Variability in Arrivals and Prices**

The degree of instability in arrival and prices of Potato crop was measured by using coefficient of variation.

$$CV (\%) = \frac{\delta}{\bar{X}} \times 100$$

δ = Standard Deviation

$$\sqrt{\frac{\sum(X-\bar{X})^2}{n}}$$

$\bar{X}$  = mean

X = Variable

n = Number of observations

**4. Seasonal Indices in arrivals and prices**

The seasonal index was worked out by using a simple linear regression model. The seasonal indices of monthly arrivals and prices of Potato were computed by using the formula proposed by Fielder and Osagie

$$SI = \frac{Y_{ij}}{Y_{i-(6-j)b}} \times 100$$

Where,

SI<sub>ij</sub> = Monthly Index for arrival/prices in j<sup>th</sup> month in i<sup>th</sup> year  
 Y<sub>ij</sub> = Average monthly arrival (t) prices (Rs/q) in j<sup>th</sup> month and i<sup>th</sup> year.

j = Number assigned to month (j=1,2,3..... 12) where j=1 for April

and j=12 for March

b = Trend coefficient

**Results and Discussion**

**Trend analysis in arrivals and prices of potato**

**Table 3:** Trend Coefficients of various models in arrivals of potato

Equation	Parameter Estimates				
	R <sup>2</sup>	Constant	b1	b2	b3
Linear	0.22	10814.32	-447.92		
Logarithmic	0.06	9870.85	-1006.41		
Inverse	0.01	8199.87	515.19		
Quadratic	0.58	5857.50	2030.49	-225.31	
Cubic	0.74	623.99	6672.33	-1231.76	60.98
Compound	0.27	11004.43	0.94		
Power	0.01	9904.44	-0.15		
Growth	0.27	9.31	-0.06		
Square Root	0.01	8.94	0.14		

**Table 4:** Trend Coefficients of various models in prices of potato

Equation	Parameter Estimates				
	R <sup>2</sup>	Constant	b1	b2	b3
Linear	0.14	984.71	49.92		
Logarithmic	0.07	1043.42	142.91		
Inverse	0.02	1324.77	-223.61		
Quadratic	0.28	1407.79	-161.62	19.23	
Cubic	0.29	1659.93	-385.26	67.72	-2.94
Compound	0.10	1004.24	1.03		
Power	0.04	1063.87	0.08		
Growth	0.10	6.91	0.03		
Square Root	0.01	7.12	-0.01		

**Table 5:** Trend in arrivals and prices of potato

Sr. No	Particular	Function	R <sup>2</sup>	Coefficients		
1	Arrivals	Cubic	0.74	6672.34	-1231.76	61.00
2	Prices	Cubic	0.29	-385.26	67.72	-2.94

From the above tables, path of movement of the series was traced out through parametric trend models from which the overall performance of the arrivals and prices could be analyzed. Among various competitive models, best fitted

models were selected based on the R<sup>2</sup> along with significance of coefficients. Among the competitive parametric models, cubic model is found best fitted both for arrivals and prices of potato. For trend analysis of arrivals, the range of R<sup>2</sup> varies

from 0.002 to 0.737 where maximum value of  $R^2$  i.e., 0.737 was the trend which was best suited. In trend analysis of prices, range of  $R^2$  varies from 0.024 to 0.294 where

maximum value of  $R^2$  i.e., 0.294 was obtained at cubic model which was the best fit model. Here hypothesis was tested and not accepted in both the arrival and prices of potato.

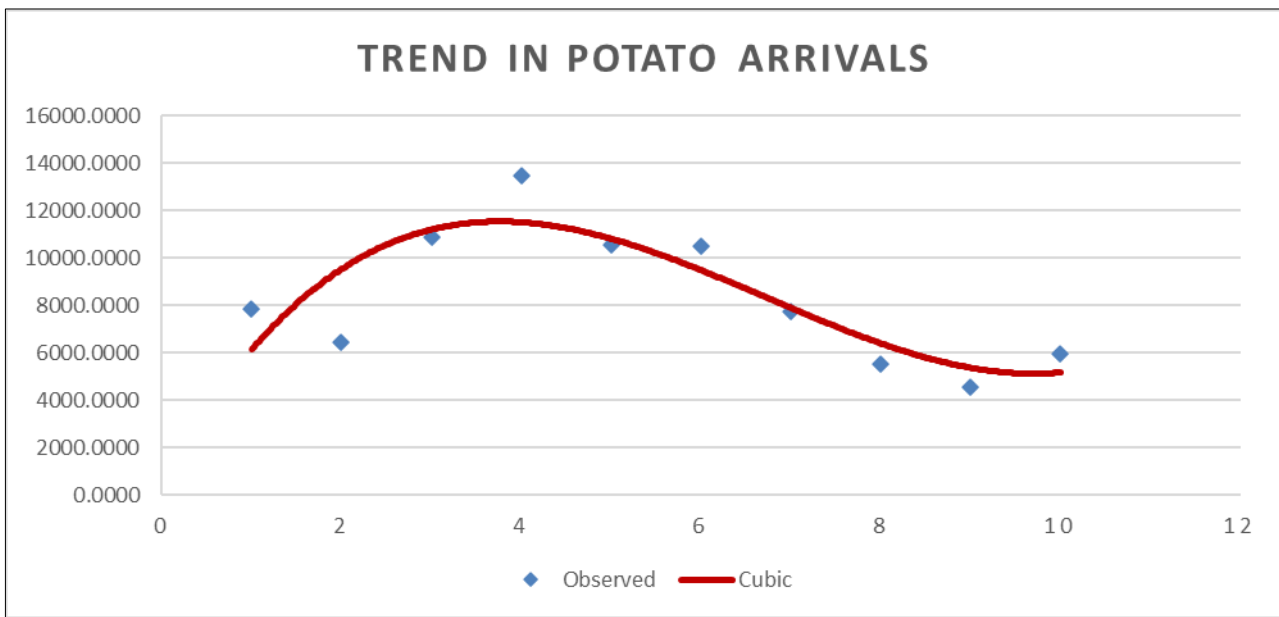


Fig 1: Trends in arrivals of Potato in APMC, Nagpur

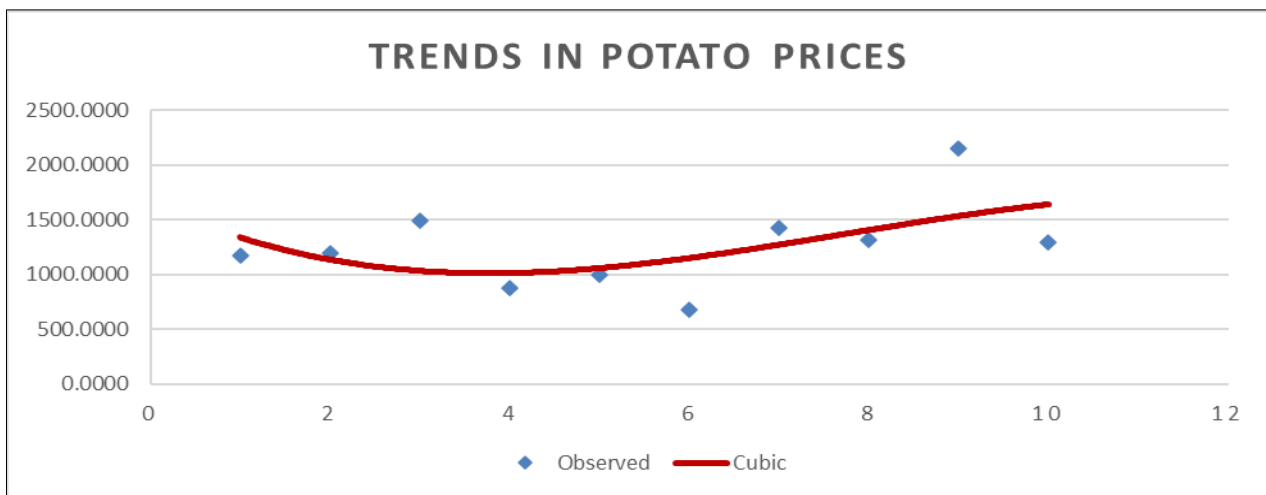


Fig 2: Trends in prices of Potato in APMC, Nagpur

**Growth rate of Arrivals and Prices of Potato Crop**

**Table 6:** Month wise growth rates of prices and arrivals of potato from 2012-13 to 2021-22

Month	CAGR of Arrivals	R <sup>2</sup>	CAGR of Prices	R <sup>2</sup>
April	-12.09	0.18	3.55	0.13
May	-12.52	0.19	3.82	0.08
June	-7.91	0.13	0.28	0.01
July	-5.89*	0.39	1.37	0.02
August	-0.11	0.01	1.93	0.03
September	-6.95**	0.32	1.88	0.02
October	-12.26*	0.38	4.06	0.08
November	-9.23*	0.39	4.47	0.09
Dec	-3.96	0.07	3.34	0.04
January	-10.30**	0.37	6.44	0.20
February	-3.01	0.07	3.33	0.10
March	3.32	0.02	4.44	0.15

\* Significant at 5% Level of Significance \*\* Significant at 10% Level of Significance

The study on monthly compound growth rate of arrivals of potato had revealed that the growth rate in arrivals of potato was following variable trend and was negative in all the months over the study period i.e., from 2012-13 to 2021-22 except in March. The decrease in growth rate was high and significant at 5 percent level during the month of October (12.26 percent) followed by January (10.30 percent) which was significant at 10 percent level. The highest declining growth rate in the months of May (12.52 percent) and April (12.09 percent) were found to be statistically non-significant. The negative growth rates in the month of November and July were found significant at 5 percent level and in September, the negative growth rate of 6.95 percent was registered and was significant at 10 percent level of significance. The growth rate in prices in no month was found to be significant across the months over a period of 10 years. The growth rate in prices was highest in the month of January (6.44 percent), followed by November (4.47 percent) and March (4.44 percent) The lowest growth rate was observed in

the month of June (0.28 percent) followed by July (1.37 percent) and September (1.88 percent). There was no particular trend that had been observed in the growth rates of both arrivals and prices of potato.

**Table 7:** Compound growth rate of arrivals and prices of potato from 2012-13 to 2021-22

Years / Months	Arrivals			Prices		
	CAGR (%)	R <sup>2</sup>	t stat	CAGR (%)	R <sup>2</sup>	t stat
Yearly (2012-13 to 2021-22)	-5.83	0.27	-1.72	3.36	0.13	0.94
Monthly (April – March)	-0.03	0.0008	-0.03	-1.02	0.07	-0.86

The yearly compound growth rate of arrivals of potato was negative (5.83 percent), and non-significant during the period between 2012-13 and 2021-22. The monthly compound growth rate between the months i.e., from April to March was -0.03 percent which was statistically non-significant. The registered negative growth rates even during optimum production could be due to lack of storage facilities in the APMC Nagpur.

The yearly compound growth rate of prices was positive (3.36 percent), and non-significant from the period 2012-13 to 2021-22. The monthly compound growth rate between the months i.e., from April to March was negative (1.02 percent) and non-significant. The results obtained are in accordance with Warde and Chakravorty, 2018 who stated that the growth rate of arrivals and prices of potato during 2006-07 to 2016-17 was negative and slightly positive respectively.

**Coefficient of Variation of Potato**

**Table 8:** Variability in yearly arrivals and prices of potato from 2012-13 to 2021-22

Year	Arrivals (tonnes)	CV (%)	Prices (Rs/q)	CV (%)
2012-13	94006.5	25.59	1172.02	15.80
2013-14	77352.4	52.59	1191.78	19.73
2014-15	130441	19.24	1495.56	26.36
2015-16	161726	14.33	873.62	10.91
2016-17	126821	28.79	1000.14	44.40
2017-18	126073	30.16	675.36	18.98
2018-19	93032	21.94	1425.15	12.99
2019-20	66081	22.18	1313.24	19.87
2020-21	54877	73.13	2151.75	39.03
2021-22	71682	43.34	1294.15	16.02

The potato arrivals in Nagpur market were decreased over a period of time from 2012-13 to 2021-22. The highest arrivals were observed during the year 2012-13, which was equal to 94006.5 tonnes and least quantity of arrivals was observed in the Nagpur market in the year 2020-21. The variability in the arrivals of Potato in the Nagpur Market was high during the year 2020-21 (73.13 percent) which was abnormally high. The variability in arrivals of potato was observed lowest in the year 2015-16 (14.33 percent). The prices of potato reached to its peak in the year 2020-21, which was Rs. 2151.75 and the least prices were observed in the year 2017-18 (Rs. 657.36). The variation in the prices of potato was high during the year 2016-17 (44.40 percent) and least variation was observed during the year 2015-16 (10.91 percent).

**Table 9:** Variability in monthly arrivals and prices of potato from 2012-13 to 2021-22

Year	Arrivals (tonnes)	CV (%)	Prices (Rs/q)	CV (%)
April	106067.8	47.52	1100.97	28.96
May	73212.9	61.04	1247.63	34.04
June	78970.6	39.81	1228.67	23.96
July	89628.1	28.70	1322.123	33.04
August	76385.8	46.98	1351.09	38.75
September	80901.5	36.32	1360.44	43.01
October	80504.6	44.07	1430.13	49.55
November	71079.1	40.26	1593.35	51.73
Dec	83326.5	44.01	1311.31	51.12
January	77359.6	49.49	1168.51	38.86
February	86835.6	32.09	999.717	27.41
March	97820.2	52.28	997.39	29.45

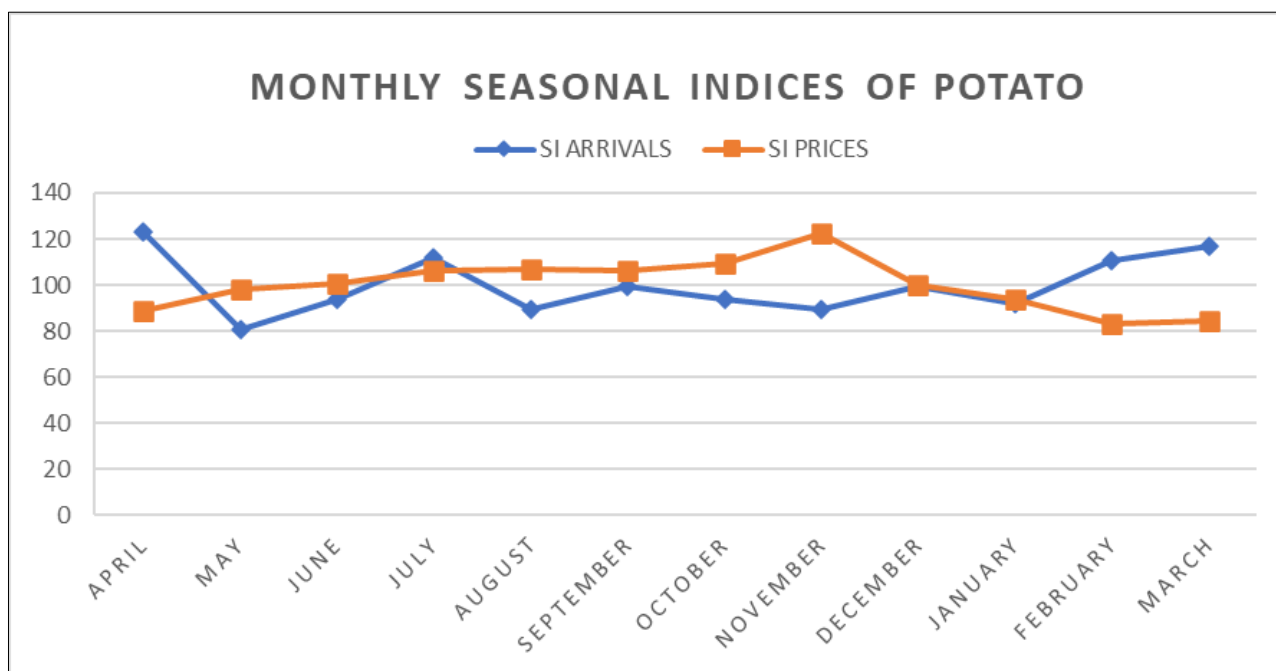
The potato arrivals vary significantly across different months. The highest monthly arrivals were noticed in the month of April, (106067.8 tonnes), while the lowest arrivals in the month of November, (71079.1 tonnes) over the period of 10 years. Similar to arrivals, potato prices show substantial variability across different months. The highest monthly prices were noticed in November, (Rs. 1593.34 per quintal) while the lowest were observed in March, (Rs. 997.38 per quintal). The variation in the arrivals was highest in May at 61.03 percent, indicating a substantial variation in arrivals relative to the monthly mean. The lowest was in the month of July (28.69 percent). The variation in prices was highest in November (51.73 percent) and lowest in June (23.95 percent). The results obtained were in accordance with the results of Bera *et al.* 2017, who stated that the highest arrivals of potato in Bishnupur market was observed in April. In Memari market, lowest arrivals were found in October.

**Seasonal Indices of Arrivals and Prices of Potato**

**Table 10:** Seasonal Indices of monthly arrival and prices of Potato

Month	Arrivals	Prices
April	123.28	88.59
May	80.73	98.29
June	93.82	100.66
July	111.83	106.05
August	89.22	106.84
September	99.18	106.06
October	93.88	109.47
November	89.28	122.40
Dec	99.55	100.07
January	91.90	93.81
February	110.31	83.09
March	117.02	84.66

The result of seasonal indices of arrivals indicated that, arrivals were highest during the months of April (123.27) followed by March (117.02) and July (111.83). The lowest indices of arrivals were noticed in the months of May (80.72) followed by August (89.22) and November (89.28). In case of prices seasonal index was noticed highest in the months of November (122.39) followed by October (109.47) and August (106.84). The lowest indices of prices were noticed in the months of February (83.09) followed by March (84.66) and April (88.59). The results obtained are in close agreement with the findings of Patel *et al.* who stated that the pattern of arrivals in Deesa market was maximum during January to march and decreased afterwards.



**Fig 3:** Monthly seasonal indices of arrivals and prices of Potato in APMC, Nagpur

### Conclusions

1. The cubic trend was followed by both the arrivals and prices of potato in APMC, Nagpur
2. The growth rate in arrivals of Potato was negative and non-significant whereas there was non-significant positive growth rate in the prices in APMC, Nagpur
3. The highest arrivals were found in the month of April and highest prices were found in the month of November.
4. The variability in arrivals was high in the month of May and variability in prices is high in the month of November.
5. There exists seasonality in the arrivals and prices of Potato in APMC, Nagpur.
6. The arrivals (prices) started increasing (decreasing) from January and continue to increase till April and then decreases.

response to the monkeypox outbreak—Laboratory Response Network, United States, May 17–June 30, 2022. *Morbidity and Mortality Weekly Report*. 2022 Jul 7;71(28):904.

### References

1. Bera B, Dutta J, Nandi A. A study on the variability in market arrivals and prices of potato in some selected markets of West Bengal. *Int. J of Agric. Sci.* 2017;9(40):4621-4625.
2. Dhakre DS, Bhattacharya D. Price Behaviour of Potato in Agra Market - A Statistical Analysis. *Indian R. J Ext. Edu.* 2014;14(2):12-14.
3. Kachroo MM, Nazir N. Trend and Seasonality Analysis in Prices and Arrivals of selected Agricultural Commodities in India. *Madras Agric. J;* c2021. p. 10-12.
4. Patel B, Delvadiya J, Padaliya M, Patel PM. Seasonal indices and correlation between market arrivals and price of potato in Banaskantha District of Gujarat. *Int. J Statistics and Applied Mathematics.* 2023;8(5):249-252.
5. Sreepriya P, Sidhu JS. An analysis of Market Arrival and Price Behaviour of Potato in India. *Economic Affairs.* 2020;65(1):09-15.
6. Warde S, Chakravorty C. Market movement of major vegetables in Kalamna market. *Int. J Agric. Sci.* 2018;10(24):7652-7654.
7. Aden TA, Blevins P, York SW, Rager S, Balachandran D, Mangal CN *et al.* Rapid diagnostic testing for