

Analyzing the seasonal variations and price trends in major onion markets of India

ABSTRACT

Aims:

1. To measure trend and estimate rates of change in onion price in major states of India
2. To measure the variability of onion prices in major states in India
3. To analyse the seasonal and irregular fluctuations in onion prices

Place and Duration of Study: Department of Agricultural Economics, Junagadh Agricultural University (between June 2019 and July 2021).

Methodology: The present study was undertaken to analyse the onion price trend, seasonality and correlation in major markets of larger onion producing states of India. The secondary data on monthly wholesale prices and arrivals were collected for this purpose for period from 2001 to 2020 from various public sources.

Results: The co-efficient of quadratic trend (T^2) found non-significant in all markets reveals no change in growth pattern of onion price in last two decades, which indicates that farmers were not benefited by rise in price; it is the effect of inflation factors only. On an average the onion prices in major markets of India was increased annually at the rate of 8.50 per cent during last two decades. The seasonality is prevailing throughout all markets of onion in India. The price indices were found more than 100 in the months of August to January and lower during February to July. The magnitude of price volatility was found the highest in Bhopal (88.25%) and the lowest in Mahuva (53.81%) market. Whereas, the magnitude of arrival volatility was found the highest in Mahuva (187.25%) and the lowest in Mumbai (31.97%) market. The monthly (>0.87) and yearly (>0.90) onion prices were found highly correlated among all the markets.

Conclusion: As onion price are highly volatile, requires creation of storage capacity to meet specific requirement of humidity and temperature, and the Government should take immediate action to enhance export, when price falls drastically and allow the import, when price increase beyond certain level.

Keywords: [Onion, price trend, seasonality, correlation, market, India]

1. INTRODUCTION

The demand of agricultural goods is inelastic and its prices fluctuate more than those of industrial goods. Hence, it has enormous human and political implications, especially in developing country like India, so price play a more important role in agricultural sector. Onion (*Allium cepa* L.) is one of the most important spice and commercial crop in India. Onion is consumed round the year by all sections of people throughout the world. In India, onion is cultivated in both seasons as kharif and rabi-summer crop. In last decades the area under onion in India increased to more than double and production to more than fourfold due to notable increased in productivity from 10.59 t/ha in 2000 to 18.70 t/ha in 2019 (DES, 2021). Maharashtra is the major onion growing state covering about 6.18 lakh ha area with production of 106.83 lakh tonnes, followed by Madhya Pradesh (42.70 lakh tonnes), Karnataka (22.75 lakh tonnes), Gujarat (14.22 lakh tonnes). Gujarat achieved the highest productivity of onion in the country ranging from 24 t/ha to 31 t/ha, since last three decades or more.

The production pattern of onion also changes considerably over years due to change in resource use pattern, production technology and price of input and output. The variation in the output of the onion leads to wild fluctuations in its prices, exposing the vegetable growers to more risk as compare to the growers of other crops. Considering the nature and causes of price rise and their impacts on consumers amidst the galloping price rise in onions is important (Saxena et. Al.,

2019) The prices of onion fluctuate widely and farmers' response to price change causes bumper production, which tends to decrease prices of onion drastically. Such a situation is not only creating domestic disturbances in the food economy, but also causing hardship to the farmers. Hence, this study has been taken up with the following specific objectives: (i) to measure trend and estimate rates of change in onion price in major states of India, and (ii) to analyse the seasonal and irregular fluctuations in onion prices.

2. MATERIAL AND METHODS

2.1 COMPOUND GROWTH RATE

The compound growth rates (CGRs) of sugar exports was calculated by using the exponential function of the following specification:

$$Y_t = ab^t u_t \quad (1)$$

Where,

Y_t = Dependent variable (export quantity/ export value, of sugar and Jaggery in the year 't', etc.)

t = Time variable in years taking the value of 1, 2, 3, ..., n

a = Intercept;

b = Regression coefficient (1+r)

r = Compound growth rate

u_t = Error term

For the purpose of estimation, the equation was expressed in logarithmic form.

$$\text{Log } Y_t = \text{Log } a + t \text{ log } b + \text{log } e \quad (2)$$

The value of log b in equation (2) was computed using the formula,

$$\text{Log } b = \frac{(\sum t \text{Log } Y - (\sum t \sum \text{Log } Y / N))}{\sum t^2 - (\frac{\sum t^2}{N})} \quad (3)$$

Where,

N = Number of years.

Subsequently, the compound growth rate (%) was computed using the formulation,

$$\text{Compound growth rate (r)} = [(\text{Antilog of log } b) - 1] * 100 \quad (4)$$

2.2 TREND IN YEARLY PRICES

Initially, a trend diagram of yearly index numbers of major market wise wholesale prices of onion were drawn for the period from 2001 to 2020. The trend in annual prices has been analyzed with the help of following models.

Linear and quadratic models

Following two models were employed.

$$P_t = \beta_0 + \beta_1 T + U$$

$$P_t = \beta_0 + \beta_1 T + \beta_2 T^2 + U \quad \dots(5)$$

Where,

P_t = Yearly index numbers of wholesale prices,

T = Time (1,2,3, ..., t),

U = Disturbance term with usual assumptions, and, $\beta_0, \beta_1, \beta_2$ are parameters estimated

2.3 COMPUTATION OF SEASONAL VARIATION

The seasonal variations are short term fluctuations that occur within a year, which could be isolated from the original composite series and to study them separately, the decomposition of the time series data was done by assuming a multiplicative model of the following form.

$$P = T \times C \times S \times I \dots (6)$$

Where,

P = Monthly Price,

T = Trend values,

C = Cyclical variations,

S = Seasonal variation,

I = Irregular variations.

This multiplicative model assumes the interaction among the different components.

Taking the whole period together seasonal indices were worked out. To remove the effect of trend and cyclical variations, twelve months moving averages were calculated and centered. A further ratio of original price indices to centered moving average was calculated to obtain the combined effect of S x I. In order to remove the effect of I, these ratios were averaged and adjusted seasonal indices has been obtained.

Coefficient of average seasonal variations

Highest and lowest values were compared by plotting the seasonal indices on a graph. Then the coefficients of the average seasonal price index variation were worked out using following formula.

$$\text{Coefficient of av. seasonal price index variation} = \frac{\text{Highest index} - \text{Lowest index}}{(\text{Highest Index} + \text{Lowest index})/2} \times 100$$

...(7)

Irregular fluctuations in Prices

The irregular component in an annual series of process does not have a definite pattern. It was estimated by following formula.

$$\text{Index of irregular variation} = \frac{\text{Ratio to moving average in a month}}{\text{Adjusted seasonal index in that month}} * 100 \quad \dots (8)$$

2.4 INTER-RELATIONSHIP BETWEEN PRICES OF DIFFERENT MARKETS

Correlations co-efficient between yearly prices of crop under study would be worked out to determine inter-relationship between them.

$$r = \frac{n(\sum xy) - (\sum x)(\sum y)}{\sqrt{[n\sum x^2 - (\sum x)^2][n\sum y^2 - (\sum y)^2]}}$$

Where,

R	=	Co-efficient of correlation,
x and y	=	Two variables under study,
N	=	Total number of observations.

4. RESULTS AND DISCUSSION

3.1 TRENDS IN YEARLY PRICES

3.1.1 ESTIMATION OF LINEAR TREND

Linear model was fitted to estimate the linear trend during twenty years data, *i.e.* 2001 to 2020 using yearly index numbers of wholesale prices of onion in selected markets. It could be seen from Table 1 that all regression coefficients were highly significant for the price series of selected markets. This clearly indicated that a considerable amount of variation in the price could be explained by the linear trend. Among the selected markets, the annual rate of increase was the highest *i.e.* 24.95 per cent in Lasalgaon market and the lowest was 14.18 per cent in Bhopal market. Co-efficient of multiple determination (R^2) was more than 52 per cent for all markets, indicating that more than 50 per cent of variation in price of onion could be explain through linear trend.

Table 1: Estimation of linear trend in yearly prices of onion in major markets of India

Markets	Intercept β_0	Co-efficient for Time β_1	R^2	Adjusted R^2
Ahmedabad	35.35	21.07* (5.44)	0.62	0.60
Bengaluru	65.45	18.14*** (5.77)	0.65	0.63
Bhopal	45.63	14.18*** (4.43)	0.52	0.49
Hyderabad	41.2	15.38* (7.12)	0.74	0.72
Jaipur	55.86	23.56* (3.81)	0.68	0.64
Mumbai	46.85	19.18* (3.47)	0.63	0.60
Patna	47.42	16.01* (5.71)	0.64	0.62
Lasalgaon	38.71	24.95* (5.60)	0.64	0.62
Mahuva	39.23	16.77*** (3.24)	0.57	0.55

Note: Figures in the parentheses are standard errors.

***, * Significant at 1 and 10 per cent probability level

3.1.2 ESTIMATION OF QUADRATIC TREND

It is also important to check the assumption of constant rate of increase in the prices over twenty years. Hence, a quadratic model was also tried, which indicates the change in growth pattern of prices over time. Table 2 reveals that the regression co-efficient associated with time variable (*i.e.* T) was maximum in Bengaluru market and minimum in Mahuva market. These co-efficient were non-significant in case of Mumbai and Ahmedabad markets. Whereas, the coefficients of quadratic term (*i.e.* T^2) found to be non-significant in all markets. The R^2 showed > 52 per cent variations in all the markets could be explained by quadratic trend. Adjusted co-efficient of multiple determination was also worked out to know the better fit, besides it indicated that linear model is a better fit than quadratic model.

The co-efficient of multiple determinations (R^2) was similar (as linear) in Bengaluru, Bhopal, Mumbai and Lasalgaon market suggesting absence of quadratic trend. Thus, quadratic trend results revealed that onion price in all the markets under study have not shown increasing growth pattern, but indicated almost constant growth pattern during 2001 to 2020. Hence, the rise in onion price was only due to inflation and farmers were not benefited at all.

Table 2: Estimation of quadratic trend in yearly prices of onion in major markets of India

Markets	Intercept β_0	Co-efficient for time β_1	Co-efficient for T^2 β_2	R^2	Adjusted R^2
Ahmedabad	69.32	11.81	0.44	0.63	0.59
Bengaluru	47.56	23.02*	-0.23	0.65	0.61
Bhopal	57.22	11.02*	0.15	0.52	0.47
Hyderabad	64.63	8.99*	0.3	0.75	0.72
Jaipur	55.85	18.77*	0.23	0.68	0.64
Mumbai	65.97	13.96	0.25	0.63	0.58
Patna	64.22	11.43*	0.22	0.65	0.6
Lasalgaon	56.32	20.14*	0.23	0.64	0.59
Mahuva	73.32	6.70*	0.44	0.58	0.54

Note: * Significant at 10 per cent probability level.

3.1.3 ESTIMATION OF COMPOUND RATE OF INCREASE IN ANNUAL PRICES

The estimates of the compound annual growth rates of prices of onion were determined for each market covered under study using exponential function as specified in methodology section. The decade-wise and overall period results obtained from this estimation are given in Table 3. The prices of onion for all markets were increased significantly during the period 2001 to 2010. Bengaluru market registered the highest increasing rate of 14.24 per cent per annum; whereas, it was the lowest in Patna market about 9.43 per cent per annum.

During the period 2011 to 2020, the price of onion in Ahmedabad market registered the highest increasing rate of 8.97 per cent per annum, while it was the lowest in Bengaluru market about 4.35 per cent per annum. This further indicates that onion prices were increased at a larger rate during 2000s as compared to 2010s.

From the year 2001 to 2020 the price of onion in Lasalgaon market registered significantly the highest increasing rate of 9.61 per cent per annum, followed by Jaipur (9.56%) and Ahmedabad (9.19%), whereas, Bhopal market shown the lowest rate of increase about 7.84 per cent per annum. Thus, on an average the onion prices in major markets of India was significantly increased annually at the rate of 8.50 per cent per annum during last two decades. Similar results were reported by Mulla *et al.* (2020) noted that onion price in Kurnool market of Karnataka was increased at the rate of 6.22 per cent per annum during 2003 to 2017.

Table 3: Estimation of compound rate of increase in onion prices in major markets

Markets	2001 to 2020		2011 to 2020		2001 to 2020	
	CGR%	R^2	CGR%	R^2	CGR%	R^2
Ahmedabad	12.24	0.70	8.97	0.29	9.19	0.71
Bengaluru	14.24	0.78	4.35	0.14	8.33	0.72
Bhopal	9.84	0.56	5.92	0.12	7.84	0.60

Hyderabad	11.06	0.58	8.08	0.42	8.57	0.76
Jaipur	12.52	0.11	6.59	0.24	9.56	0.78
Mumbai	12.12	0.71	7.25	0.23	8.66	0.71
Patna	9.43	0.67	6.59	0.23	8.17	0.74
Lasalgaon	13.32	0.76	6.78	0.20	9.61	0.74
Mahuva	11.60	0.69	7.90	0.24	8.33	0.69

Note: All the CGR values are significant at 1 per cent probability level.

3.2 SEASONAL VARIATIONS IN ONION PRICES

3.2.1 SEASONAL INDICES

The seasonality in supply of agricultural commodities mainly arises from the seasonality in production as the crops can grow only under particular weather conditions. It is important to study the magnitude of the change and seasonal variation in price during the period under study. The adjusted monthly seasonal indices trend of onion price in selected markets were prepared and depicted in Figures 1 and 2. The results revealed the existence of seasonality in the selected lead regulated markets. The maximum level of seasonal index was reached in October in Jaipur market (143.08 points), followed by Lasalgaon and Bhopal. While, Ahmedabad, Bengaluru, Mumbai, Patana and Mahuva markets, the seasonal index reached its maximum level in November ranging from 123.07 to 138.64 points. Besides, Hyderabad market reached its maximum level in December. The pattern of market prices showed slight differences among the selected markets. Price indices were more than 100 in the months of August to January.

Among the selected markets, lower indices were observed during April-May ranging from 54.30 (Bhopal) to 74.10 (Mahuva) points. The majority of the produce was sold soon after the harvest probably for want of cash or lack of storage facilities. This finding is in line with findings of Basavaraj (2019), for onion price in Karnataka, Shiyani and Kakalia (1999) during 1980s and 1990s for onion price in Gujarat, Sharma and Sharma (2001) for selected vegetables in India. Mulla *et al.* (2020) for onion price in Kurnool market of Andhra Pradesh.

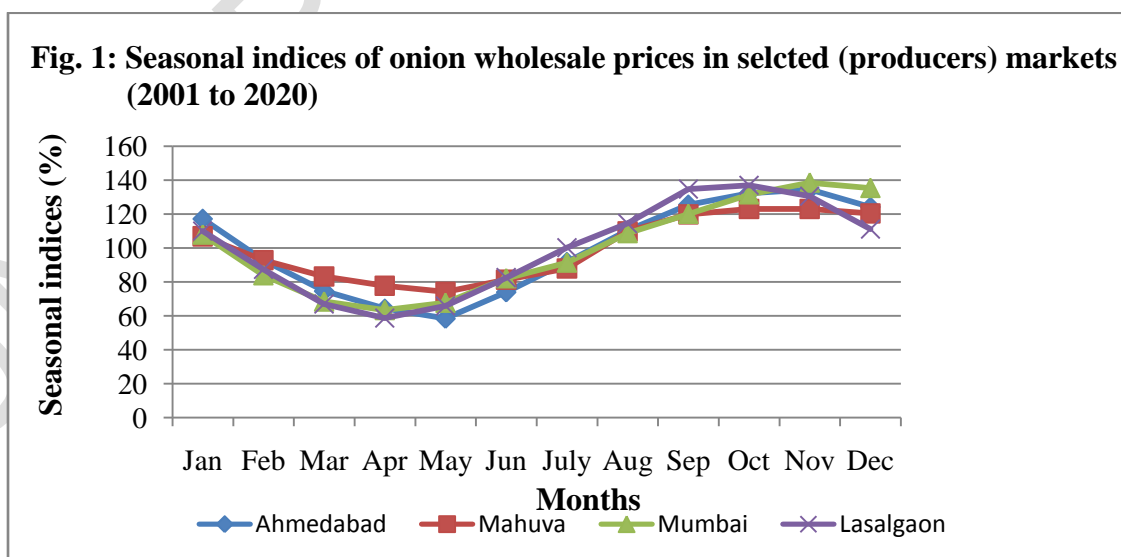
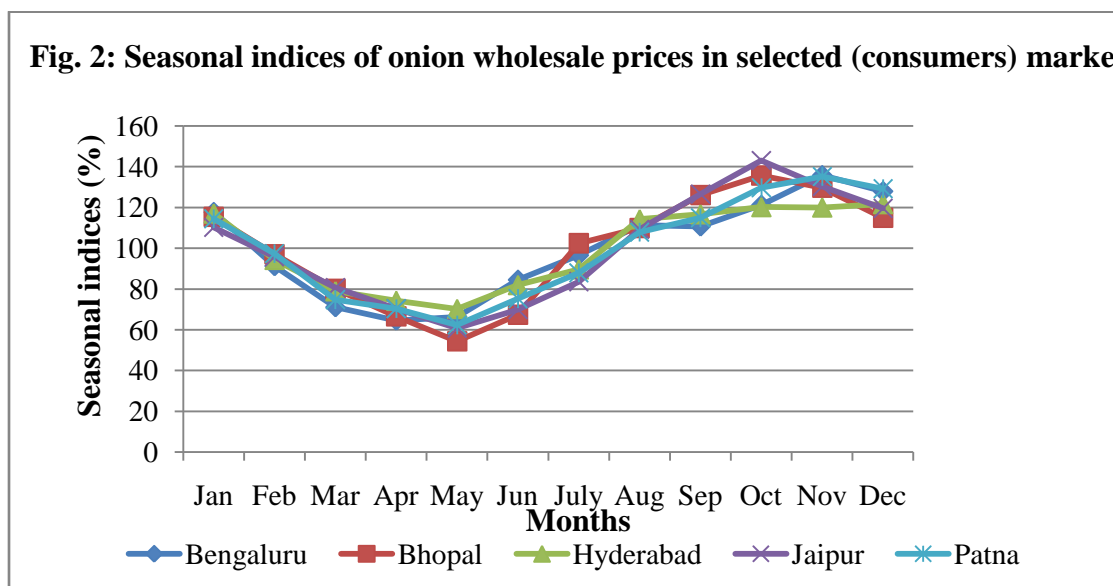


Fig. 2: Seasonal indices of onion wholesale prices in selected (consumers) markets



3.2.2 COEFFICIENT OF AVERAGE SEASONAL VARIATIONS

In order to find out the differences in the magnitude of seasonal variation for peak and through period, the coefficient of average seasonal prices index were calculated for onion for their respective markets for the period under study *i.e.* 2001 to 2020. The maximum value of the coefficient in seasonal variation (Table 4) was found in Bhopal market (88.25%) and minimum in Mahuva market (53.81%). Thus, it can be revealed that onion price had showed high coefficient of average seasonal variation, in selected markets, except Mahuva market. Whereas, the maximum value of the coefficient of arrivals variation was found in Mahuva market (187.25%) and minimum in Mumbai market (31.97%). This is because, though Mahuva is the largest onion producing market in Gujarat, but its arrivals fluctuate widely in off-season due to lack of storage facilities. Reddy *et al.* (2012) in their study revealed the similar results and stated that there was high variability in the arrival of onion in the month of March and April in selected markets in India. Among the markets, the coefficient of variation in both, arrivals and prices were found to be higher in Ahmadabad and Kolkata. This might be due to the fact that onion is the vegetable crop and cannot be stored for longer period, but its demand is constant throughout the year. Hence, after harvesting season its price are mostly tends to go down, which results in wide seasonal variability. Besides, in many years unseasonal rain cause large damage to stored quantity and hoarding by big traders takes benefit of price increase in lean season.

It could be also seen from the Table 4 that the values of correlation coefficients of onion markets under study were ranged from -0.35 to 0.22. Bhopal, Lasalgaon and Mahuva markets shown negative correlation between the prices and arrivals. Whereas, Ahmedabad, Bengaluru, Hyderabad, Jaipur, Mumbai and Patna shown positive, but poor correlation between the prices and arrivals. The main reason behind this is that the price fluctuation in pre and post-harvest periods of the crops.

This result is in line with the Amand and Gummagolmath (2019) noticed that exogenous factors (such as cartels holding the stock in speculation of higher prices on crop failure estimates and traders reluctance to reduce the prices despite increased arrivals in the market) were interfering in the market functioning and kept the prices on higher side in onion despite increased arrivals.

Table 4: Coefficients of average seasonal prices and arrivals index variation (2001 to 2020)

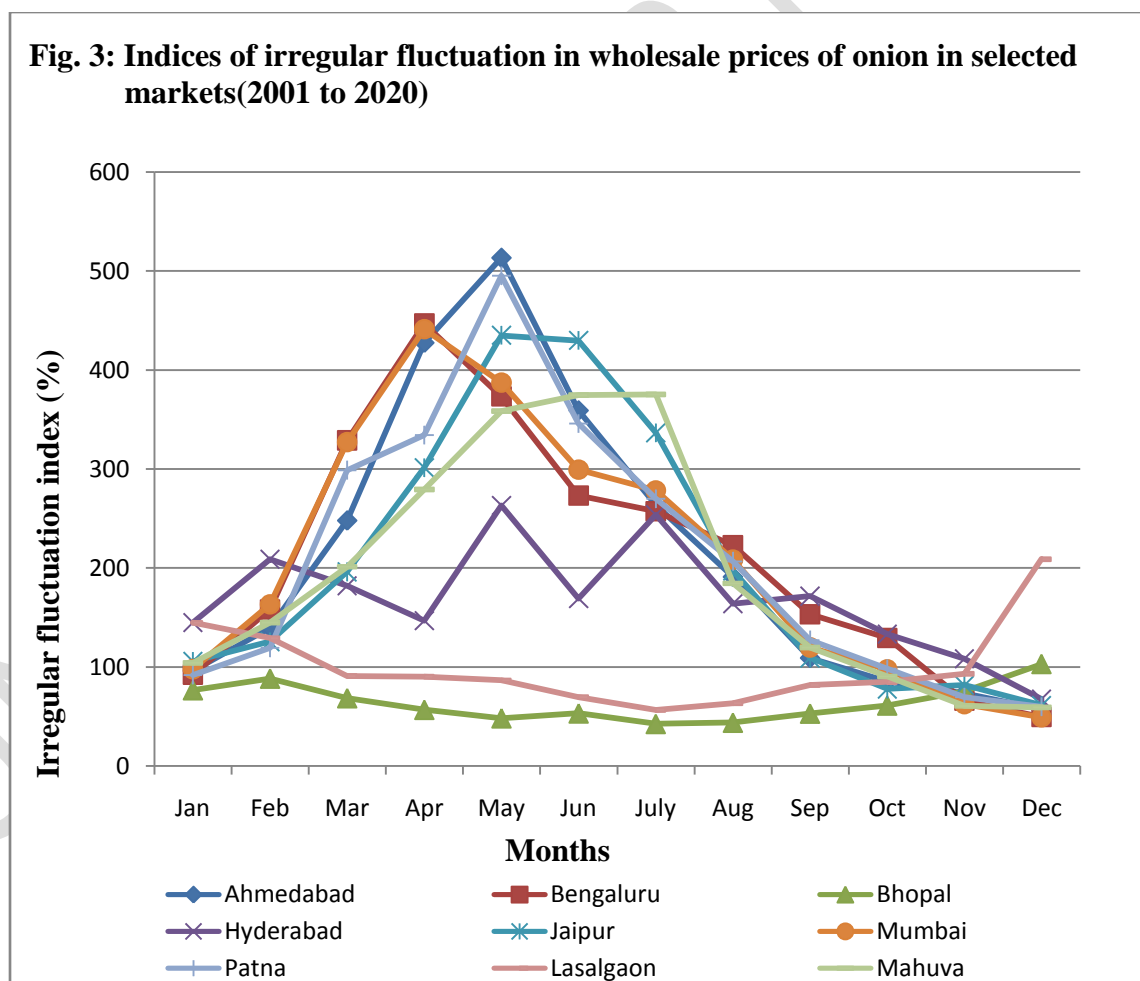
Markets	Price variation (%)	Arrivals variation (%)	correlation coefficient of monthly arrivals and prices
Ahmedabad	82.45	45.65	0.15
Bengaluru	74.46	95.89	0.19

Bhopal	88.25	102.78	-0.07
Hyderabad	57.06	34.31	0.19
Jaipur	83.87	45.78	0.03
Mumbai	79.63	31.97	0.16
Patna	76.57	70.89	0.22
Lasalgaon	82.75	92.87	-0.35
Mahuva	53.81	187.25	-0.10

3.3 IRREGULAR FLUCTUATIONS IN ONION PRICES

The movement of price shows irregular behaviour, which is not systematic, is termed as irregular price variation. These irregular price variations are random in nature. The index of irregular fluctuation was calculated for the middle year 2010 of the entire period under study using the formula given in methodology section.

The irregular indices of onion price in selected markets under study can be clearly seen in Figures 3. The index of irregular fluctuation of onion prices were maximum in the month of May (513.48 points) in Ahmedabad market, followed by Patna (495.31points) and in April in Bengaluru (446.48points). Whereas, it noticed minimum in December (49.24 points) in Mumbai, followed by Bengaluru (49.61points) Ahmedabad (57.42points).



3.4 INTER-RELATIONSHIP OF ONION MONTHLY AND YEARLY PRICES IN

DIFFERENT MARKETS

It is important to determine the inter-relation between prices of onion in their respective markets. To estimate this relationship, simple correlation coefficient were worked out for monthly and yearly prices for the period under study are present in Table 5 and 6, respectively. It can be seen from the table that the values of correlation coefficients of onion monthly price movement in selected market under study were more than 0.87 and are also highly significant indicating high correlations among all the consumption and production markets. Besides, the correlation coefficients of yearly prices of onion in selected market under study were more than 0.90, and are also found to be highly significant. Similar results were noted by Dave and Tarpara (2016) in their study on price behavior of major pulses in Gujarat state during 2003 to 2013. They revealed that the values of correlation coefficient of monthly and yearly prices of pulses under study were more than 0.90 and were highly significant.

Table 5: Simple correlation coefficients of monthly prices of onion

Markets	Ahmedabad	Bengaluru	Bhopal	Hyderabad	Jaipur	Mumbai	Patna	Lasalgaon	Mahuva
Ahmedabad	1	0.934	0.960	0.931	0.937	0.982	0.977	0.951	0.940
Bengaluru		1	0.899	0.916	0.875	0.954	0.932	0.897	0.908
Bhopal			1	0.893	0.916	0.955	0.958	0.911	0.898
Hyderabad				1	0.897	0.926	0.933	0.876	0.889
Jaipur					1	0.929	0.937	0.904	0.908
Mumbai						1	0.979	0.949	0.933
Patna							1	0.941	0.913
Lasalgaon								1	0.909
Mahuva									1

Note: *** Significant at 1 per cent probability level

Table 6: Simple correlation coefficients of yearly prices of onion

Markets	Ahmedabad	Bengaluru	Bhopal	Hyderabad	Jaipur	Mumbai	Patna	Lasalgaon	Mahuva
Ahmedabad	1	0.975	0.980	0.973	0.980	0.993	0.991	0.991	0.972
Bengaluru		1	0.966	0.961	0.967	0.981	0.972	0.978	0.967
Bhopal			1	0.943	0.974	0.984	0.981	0.981	0.962
Hyderabad				1	0.980	0.980	0.980	0.979	0.935
Jaipur					1	0.990	0.993	0.993	0.952
Mumbai						1	0.995	0.997	0.968
Patna							1	0.997	0.956
Lasalgaon								1	0.959
Mahuva									1

Note: *** Significant at 1 per cent probability level

4. CONCLUSION

In the last two decades, onion price has increased considerably in major markets of India annually at the rate of 8.50 per cent. The co-efficient of quadratic trend (T^2) found non-significant in all markets noticed that there was no change in growth pattern of onion price in last two decades, which indicates that farmers were not benefited by rise in price, it is the effect of inflation factors only. The seasonal indices indicated the minimum onion price in the months of April-May and the maximum in the months of October-November in most of the markets, besides revealed high seasonal and irregular fluctuations. In some markets, positive correlation between arrivals and prices of onion witnessed may be due to the existence of exogenous factors. The monthly (>0.87) and yearly (>0.90) onion prices were found highly correlated among all the markets. To check the high volatility in onion prices, increase in storage and irrigation facilities, and curb on traders cartel in APMCs are requisite actions needs to be taken by the Government

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