A A E B M

ASSOCIATION OF
AGRICULTURAL ECONOMICS &
AGRI-BUSINESS MANAGEMENT

Dynamics of Prices and Arrivals of Major Vegetables: A Case of North Indian Markets

Niyati Thakur, Shilpa*, Ajit Sharma, Sandeep Kumari and Ravinder Sharma

Dr. Yashwant Singh Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh, India

*Corresponding author: dhatwaliashilpi@gmail.com

ABSTRACT

The present study aimed to analyse the market arrivals and wholesale prices of significant vegetables in North Indian markets. The monthly data on market arrivals and wholesale prices were collected from 2001-2020. Karl Pearson correlation coefficient and CAGR were used in the study. The analysis revealed that the variation for selected crops differed through the markets and the months. The price variation was highest for potato in Delhi market during December (338%), followed by cabbage (121.47%) in the same market and month and then onion (114.74%) in Chandigarh market during July. On the contrary, the variation for arrivals was maximum in the case of onion (302.7%) in Dehradun market during December month, followed by potato (152.58%) and cabbage (121.5%) in Shimla market in May, and then tomato (129.92%) in Dehradun market in August month. However, there exists a normal price-demand relationship in selected markets; yet, the study confirmed the cases positive and significant relationship between arrivals and prices across different years attributed to off-season supplies of the crop, cold storage facilities, import, and availability of poly house technology, etc. Additionally, the compound growth rates for arrivals and prices in different markets were significant and positive during the study period. Hence, there is a need for market information dissemination, storage structures, and regular monitoring of market arrival and pricing, which can all help reduce fluctuation in market arrival and prices and safeguard farmers and consumers.

Keywords: Arrival, prices, variability, fluctuations, markets, growth rate, correlation

Food, nutritional security, livelihood, and health care are the critical elements for socio-economic development, and attaining it can lead to the path of overall development. The horticultural crops provide nutrition to humans who contribute to the nation's development and prosperity. Besides, the horticultural crops form a vital part of the Indian agricultural production, adding 30 percent to agricultural GDP from 8.5 percent of cropped area (World Bank, 2020). During 2020-21, India exported fruits and vegetables worth ₹ 9,940.95 crores which comprised fruits worth ₹ 4,971.22 crores and vegetables worth ₹ 4,969.73 crores (APEDA, 2021). The demand for fruits and vegetables will increase to around 540 million tonnes by 2050 (IIHR, 2014).

This sector has various weaknesses, along with the changing consumption pattern and the increased demand. Due to the higher perishability, bulkiness, and seasonality, the marketing of horticultural crops is quite complex. Therefore, there is a need for protection regarding favorable policies and price support. The price acts as a catalyst in boosting the production, and further, the magnitude of price variation adversely affects the production.

The lack of market intelligence about the pattern of market arrivals and prices and the inability to obtain fluctuating price information are the major threats for the producers (Sharma, 2011). In addition to this, it is necessary to have effective and proper market intelligence and price forecast (Kalloo and Pandey, 2002; Rai and Pandey, 2004). The knowledge regarding price behavior over time can help in deriving the appropriate price regulation measures for better marketing (Meera, 2016). Moreover, the studies related to the behavior of price and arrivals can help policymakers in devising tools for controlling price instabilities and reproducing a preview of market conditions to the producers. Therefore, enabling them to make firm decisions related to the adjustments in the disposal of the produce at the best place and time. The diverse climate of India ensures the cultivation of various horticultural crops making it the world's second-largest vegetable producer next to China, with a total production of 1,85,883 thousand metric tons on an area of 10,100 thousand hectares (Department of Agriculture Cooperation & Farmers Welfare, 2018-2019). India has a rich supply of most of agricultural commodities due to the wide geographical area and various agroclimatic niches. Because of the high dependence of crop cultivation on climate and other factors, price fluctuation is a common phenomenon that eventually results in product variation. The variations in the output of the vegetable crops lead to wild fluctuations in their prices, exposing the vegetable growers to more risk than the growers of other crops. Moreover, arrival fluctuations are responsible for short-term price fluctuations, resulting in imbalances in demand and supply fundamentals of agricultural commodities (Bera *et al.*, 2017). To increase the producer's share in consumer's rupees, we need to establish coordination between agricultural output and demand and supply changes (Sharma and Burark, 2015). Price uncertainty is mainly due to perishability and seasonality in vegetable crops. This affects both the producer and consumer in the case of low prices received by the producers and higher prices paid by the consumers. Stable price plays an important role in determining the farmers' income. Therefore, the analysis of price behavior helps producers and intermediaries make decisions, viz. 'When to grow and sell?' on the producer part and 'When, where, and how to store and dispose of the produce?' on the part of a middleman.

Vegetable price swings have a significant impact on vegetable growers and place them at greater risk relative to growers of other crops (Kumar *et al.*, 2005). Hence, it is difficult for both producers, particularly small and marginal farmers with a low propensity to save and a lack of access to effective saving instruments, and consumers to cope with high market volatility (Huka *et al.*, 2014). Therefore, to achieve the goal of efficient marketing to formulate a sound agricultural price policy for price stabilization and supply regulation, there is a need to properly analyze the interrelationship between market arrivals and farm product prices (Bera *et al.*, 2017). In addition, the information regarding market arrival and price behavior is very important for the producer as it helps in finding out the best time for marketing to fetch higher profit (Thakare *et al.*, 2017). However, a lot of researchers have performed studies related to price and arrival dynamics in markets of India and abroad (Murphy *et al.*, 2017; Mishra *et al.*, 2012; Virenderkumar *et al.*, 2005; Chaudhary *et al.*, 2019; Saha *et al.*, 2020; Singh *et al.*, 2017; Sreepriya and Sindhu, 2020; Shukla and Rai, 2014 and Kumar *et al.*, 2006) for various time frames. Many studies related to such analyses were made earlier during different time frames, and it is necessary in order to forecast the prices of agricultural commodities to the best level possible. Under this backdrop, an attempt has been made to fix this issue to examine the pattern of market arrival and prices of selected vegetable crops in terms of a degree of variability, a degree of the relationship between market arrival and prices over time well as space.

MATERIALS AND METHODS

The data about 20 years, i.e., from 2001-2020, was collected on monthly market arrivals and wholesale prices of significant vegetable crops based on the arrival volume viz. Tomato, Potato, Cabbage, and Onion from the selected markets of Delhi, Chandigarh, Dehradun, and Shimla. These markets were selected for the study, being the largest vegetable markets in the region in terms of vegetable trade with voluminous market arrivals (Mishra R and Kumar DA, 2012). The variability pattern of prices and arrivals, growth rates, and the relationship between market arrivals and prices were analyzed. The coefficient of variation (CV) was worked out to study the variability in arrivals and prices of selected

crops in selected markets which have been used by many researchers (Asmatoddin *et al.,* 2009; Prakash *et al.,* 1995 Rathore *et al.,* 1995) using the following formula:

$$CV = \frac{\sigma}{\overline{X}} \times 100$$

Where,

CV = Coefficient of variation, Mean = $\Sigma \frac{X}{N}$

SD = Standard deviation

X = Monthly arrivals and prices of selected crops, N = Number of years

Relation between market arrivals and prices

Karl Pearson correlation coefficient was calculated using the monthly data to analyze the relation between market arrivals and prices of significant vegetables in the selected markets. A lot of researchers have used this method of finding correlation (Sreepriya and Sidhu, 2020; Kumar *et al.,* 2006; Singh *et al.,* 2017; Kumar *et al.,* 2005; Sharrif and Ramappa, 2018) the following formula:

$$r = \frac{COV(X,Y)}{\Sigma X \Sigma Y}$$

OR

$$r = \frac{\Sigma XY}{\sqrt{\Sigma X}\sqrt{\Sigma Y}}$$

Where $X = X - \overline{X}$ and $Y = Y - \overline{Y}$

X = Price and Y = Arrival

The trend in prices and arrival can be estimated using a compound annual growth rate (Bhosale *et al.,* 2017; Saha *et al.,* 2020 Kundu *et al.,* 2019). The compound growth rates were worked out for market arrival and prices with the help of the formula:

- $Y = ae^{bt}$
- $\log y = \log a + bt$
- Y = price/arrival
- a = intercept
- t = time

Compound growth rate was computed by using the formula.
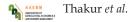
$CGR = b \times 100$

This enables to know the percent increase or decrease in arrivals and prices of selected commodities over a study period.

RESULTS AND DISCUSSION

The production and, consequently, the supply of vegetable crops in the market is subject to the natural vagaries because vegetable crops are seasonal and perishable. The wholesale prices are determined by the supply of each vegetable on the one hand and the demand for them on the other, at a particular time and market. The price is affected by the change in determinants of supply and demand over a period of time which leads to a seasonality effect in price series that is prominent in off-seasons (Kundu *et al.,* 2019). The behavior of market arrivals and prices has been studied by Dey *et al.,* 2014; Bera *et al.,* 2017; Keerthi and Naidu, 2013; Mhatre *et al.,* 2018; Naidu and Reddy, 2013 and Preethi *et al.,* 2019. The variability in the prices and arrivals is denoted by a coefficient of variation (Kumar, 2005; Asmatoddin *et al.,* 2009; Sharma, 2011; Reddy *et al.,* 2012; Singh, 2017).

Tomato

The arrivals and prices of vegetable crops always show high volatility. The prices volatilization has a catastrophic effect on all the groups of farmers involving consumption, production, and marketing of the commodities (Tamilselvi *et al.,* 2020). The analysis for various crops in four markets of North India showed that the maximum variability (77.43%) in the market arrival of tomatoes was during May, whereas the minimum was during February-March (48%). The average value of tomatoes received by the Delhi market was lowest in May (6353.27 tonnes) and highest in the off-season, during January (10696.68 tonnes). Similar findings were reported in many studies(Virender *et al.,* 2005 and Agarwal *et al.,* 2018). However, in the Chandigarh market, variability in market arrival was maximum (50-54%) during March – July, with a maximum average volume received in August (1272 tonnes). The variability extent in the Dehradun market ranges between 63.04 percent to 130 percent in June and August, respectively. The mean tomato arrival in the Dehradun market was maximum in July (1406 tonnes) and minimum in November (688 tonnes). Chandigarh and Dehradun

Table 1: Arrival variability of tomato in the selected markets (tonnes)

Months	DELHI		CHANDIGARH		DEHRADUN		SHIMLA	
	MEAN	CV (%)	MEAN	CV (%)	MEAN	CV (%)	MEAN	CV (%)
January	10696.68	56.52	858.72	40.95	895.44	78.58	443.73	113.86
February	10551.57	42.95	720.22	39.91	878.05	83.99	414.94	100.26
March	10395.57	43.7	757.57	52.18	846.05	83.99	394.26	90.41
April	8642.94	49.02	922.05	50.06	818.25	75.28	387.44	105.96
May	6353.27	77.43	899.64	50.62	869.43	72.12	469.16	81.66
June	6831.16	64.96	867.52	52.72	901.6	63.04	571.77	87.06
July	7444.77	66.13	812.35	53.8	1406	96.07	427.94	121.6
August	8549.72	59.77	1272	46.13	1046.05	129.92	443.5	118.58
September	8366.38	45.59	764.33	46.25	765.78	83.807	381.5	107.79
October	8809.88	54.76	938.31	45.85	752.2	86.26	316.89	105.08
November	8834.66	70.56	789.94	54.28	688.25	80.426	343.94	116.93
December	10394.7	56.88	808	48.58	790.33	73.94	299.1	87.08

Table 2: Price variability of tomatoes in the selected markets (₹/q)

Months	DELHI		CHANDIGARH		DEHRADUN		SHIMLA	
	MEAN	CV (%)	MEAN	CV (%)	MEAN	CV (%)	MEAN	CV (%)
January	918.63	56.52	1128.77	48.22	918.22	55.09	1184.63	46.52
February	821.78	42.95	1021.11	44.29	881.50	47.53	1191.89	31.31
March	899.68	43.70	1082.10	42.71	968.16	50.29	1290.26	36.75
April	835.78	49.02	1055.64	44.28	1002.62	42.45	1424.66	47.20
May	676.31	77.43	995.23	50.70	845.75	60.10	997.94	55.02
June	903	64.96	1081.58	46.86	987.06	64.54	1079.5	42.51
July	1741.11	66.13	1557.29	49.94	1532.29	48.71	1694.88	55
August	1699.50	59.77	1443.41	50.84	1659.16	57.55	1956.61	62.05
September	1403.05	45.59	1339.83	41.17	1408.36	46.12	1738.11	62.66
October	1531.77	54.76	1356.26	71.61	1373.80	50.19	1606.47	53.25
November	1411.68	70.56	1528.47	41.93	1511.50	66.71	1936.52	70.83
December	973.63	56.88	1158.57	46.18	1087.77	52.06	1548.31	57.55

markets showed almost similar arrival trends. In comparison, the Shimla market has the highest variability in January (113.86%), with maximum and minimum average arrival in June (571.77 tonnes) and December (299.1 tonnes).

Regarding the price variability in tomato crops as shown in Table 2, in the Delhi market, it was pretty high in May (77.43%), with the average mean price in the market ranging between ₹ 821.78 per quintal in February to ₹ 1741.11 per quintal in July. The same results were found by (Agarwal *et al.*, 2018; Keerthi and Naidu, 2013; Kumar *et al.*, 2005) in their study. Whereas, in the Chandigarh market, the highest price variability was during October (71.61%). In Dehradun, more pronounced variability was seen during November (66.71%) and lowest in April (42.25%). The Shimla market experienced the lowest

price variability during the months of February – March (31-36%) and the highest in November (70.83%).

Potato

The seasonal and perishable nature of potato shows wider fluctuations in terms of output which lead to fluctuations in the price. Various factors contribute to the price instability of potato, and fluctuations in market arrivals play a big role. Thus, there is a need to identify the behavior of prices and market arrivals over some time (Saha *et al.*, 2020). Table 3 and 4 shows the variability of arrival and price of potato in different markets. The market arrivals of potato in the Delhi market revealed that the market variability was lowest during January – February (40%) and highest during November (54.28%). The

Table 3: Arrival variability of potato in the selected markets (tonnes)

Months	DELHI		CHANDIGARH		DEHRADUN		SHIMLA	
	MEAN	CV (%)	MEAN	CV (%)	MEAN	CV (%)	MEAN	CV (%)
January	27032.89	40.95	2673.05	47.66	2636.05	55.29	707.1	53.76
February	24376.21	39.91	2343.33	54.87	2231.11	61.42	692.68	54.42
March	25873.1	52.18	1875.47	58.67	2149.55	54.03	696.42	64.08
April	22885.94	50.06	1327.76	50.61	1940.37	55.39	605.66	59.21
May	21916.66	50.62	1119.35	66.05	1945.25	51.76	897.61	152.58
June	18753.5	52.72	64.16	148.13	1618.93	76.95	869	111.97
July	23385.83	53.8	163	89.36	1782.42	61.08	772.16	138.37
August	22431.61	46.13	—	—	1473.5	85.13	625.5	54.77
September	24381.88	46.25	60	23.57	1517.26	80.86	597.66	58.33
October	24594.27	45.85	135	68.09	1906.16	67.3	693.52	100.6
November	29971.11	54.28	843.83	35.83	1613.16	68.72	563.73	74.61
December	28983.27	48.58	1967.1	47.43	2155.33	59.67	606.15	57.66

Table 4: Price variability of potato in the selected markets (₹/q)

Months	DELHI		CHANDIGARH		DEHRADUN		SHIMLA	
	MEAN	CV (%)	MEAN	CV (%)	MEAN	CV (%)	MEAN	CV (%)
January	543.52	66.08	418.3	55.62	462.22	65.99	605.52	45.34
February	490.68	49.58	379.22	47.5	446.72	58.29	598.26	50.97
March	569.42	47.58	482.57	48.4	527.52	56.28	687.36	50.23
April	653.33	43.83	538.17	41.55	577.06	51.14	781.77	45.79
May	732.889	46.68	650.64	45.19	660.06	40.03	851.61	50.78
June	946.33	45.48	796.8	43.36	880.35	42.08	944.66	45.7
July	1166.88	43.29	475	—	423.78	114.69	1179.55	43.64
August	1220.38	46.7	450	—	1080	57.25	1179.27	42.57
September	1347.55	44.15	8133	—	1142.52	48.69	1277.33	47.02
October	1348.42	43.79	1019	11.24	1196.55	60.47	1304.1	47.9
November	3221.26	288.88	810.61	41.04	1162.88	60.1	1229.15	41.52
December	2792.47	338.33	858.31	94.55	613.16	56.79	837.68	43.62

mean market arrivals ranged between 18753.5 tonnes in June to 29971.11 tonnes in November. Whereas, in the Chandigarh market, minimum and maximum variability was observed to be 23.57 percent in September and 148.13 percent in June, with average monthly arrival in terms of volume ranging between 60 tonnes in September to 2673.05 tonnes in January. In the Dehradun market, variability was maximum in August (85.13%), with the highest arrivals in January (2636.05 tonnes). However, minimum variability was observed in February (61.03%) and the lowest arrival of 1473.5 percent in August. The magnitude of variability in the Shimla market ranged between 53.76 percent to 138.37 percent, with maximum volume received in May (897.61 tonnes) and minimum in September (597.66 %).

In the case of potatoes, the variability in both market arrival and prices are on the higher side, but variability in price is more than that of arrival. This is because potato price is subjected to high volatility. Same was reported in a earlier study (Saha *et al.*, 2020). Regarding price variability in the Delhi market, it was very high in December (338.33%) and the lowest in July (43.21%). The variability was also higher from November to December (288.88 – 338.33%). In the Chandigarh market, price variability was recorded to be highest in December with a coefficient of variation value of 94.55 percent and lowest in October (11.24%). In the Dehradun market, minimum price variability was observed in May-June with a coefficient of 40-42 percent and a maximum in July (114.69%). Whereas, in the Shimla market,

the most pronounced price variability was observed in February (50.97%) and the lowest in November (41.52%). In the Shimla market, there was not much fluctuation in the price variability. As far as potato variability in arrival, it was maximum in the Delhi market. "This is because the Delhi market receives off-season supplies of potato from various regions, particularly from Himachal Pradesh, which is called "*Pahari Aloo*". Potato variability in arrival was maximum in the Delhi market during 2009 due to more crop production during this year, especially in Bihar and West Bengal. Several findings have shown that potato prices fall every alternate year due to the market glut situation (Singh *et al.*, 2017). Their price volatility is due to changes in output and eventual changes in market arrivals (Latwal *et al.,* 2017) and supply disruptions.

Cabbage

Cabbage is a winter season crop for mid-hills and a summer and rainy season crop for high-hills. The cabbage prices must be more than average, roughly from June to December, which means lower than average during December to June the primary production season. The prices should start increasing from June despite its arrival from high-hill as the harvesting season is in July (Mishra and Kumar, 2012). Similar result about the arrival of cabbage was found in this study. The market arrivals variability of cabbage was found to be maximum (54-58%) during the months of July to September and quite low (32-36 %) from December to February. On the contrary, it was concluded in a study (Kundu *et al.,*

2019) that the maximum arrival was observed from October to February, which resulted in gluts in the markets. The average volume of cabbage received in the Delhi market was lowest (2007.84 tonnes) in March and maximum during June (4630.83 tonnes) and December (3924.84 tonnes). A similar pattern was observed by Chaudhary *et al.,* 2019.

In comparison, the Chandigarh market had more pronounced variability in the arrivals of cabbage in terms of coefficient of variation ranging from 20.29 percent in January to 61.80 percent in October. The average market arrivals ranged from 44.60 tonnes in May to 1051.83 tonnes in January. The extent of variability in the arrivals of cabbage in the Dehradun market was greater, as evident from a relatively large range of coefficients of variation (45.37 % in June to 89.81 % in January). In so far as the Shimla market was concerned, the variability in arrivals was comparatively highest in May (121.5%) and lowest in November (45.32%). The mean monthly arrivals ranged from 347.94 tonnes in November to 803.16 tonnes in May.

The price variability for different markets of cabbage has been brought out in Table 6. The price variability, measured in terms of coefficient of variation, in the Delhi market was maximum in December (121.47%) and minimum in August (47.01%). The pattern was not the same in the Chandigarh market, as price variability was highest for May (94.86%). The price for cabbage was relatively unstable in the Dehradun market, with a coefficient of variation ranging from 43.19 percent in September to 77.26

Table 5: Arrival variability of cabbage in the selected markets (tonnes)

Months	DELHI		CHANDIGARH		DEHRADUN		SHIMLA	
	MEAN	CV (%)	MEAN	CV (%)	MEAN	CV (%)	MEAN	CV (%)
January	2973.73	36.02	1051.83	20.29	497.38	89.81	487.84	57.42
February	2055.1	30.88	934.44	30.42	376.33	61.06	484.52	52.9
March	2007.84	42.86	742.68	33.86	370.55	59.28	545.78	59.54
April	2434.55	45.76	427.93	51.01	301.62	51.94	494.5	59.28
May	3292.55	40.27	44.66	45.72	342.13	62.69	803.16	121.5
June	4630.83	46.55	—	—	271.07	45.37	743.61	95.34
July	3899.27	54.83	76	—	227.68	66.06	432.61	50.73
August	3483.5	55.35	30	—	218.88	85.11	391.83	57.29
September	3854.66	58.7	176	61.06	282.26	84.38	432.11	59.14
October	3204.52	53.91	566.94	61.8	287.9	60.81	355.1	59.52
November	4091.68	44.48	624.31	36.3	273	67.35	347.94	45.32
December	3924.84	32.82	896.89	31.78	371.58	64.62	429.105	66.53

Table 6: Price variability of cabbage in the selected markets (₹/q)

Months	DELHI		CHANDIGARH		DEHRADUN		SHIMLA	
	MEAN	CV (%)	MEAN	CV (%)	MEAN	CV (%)	MEAN	CV (%)
January	497.94	53.19	627.83	44.66	576.55	63.46	962.73	69.28
February	437.63	50.74	579.66	45.2	492.72	55.6	767.73	59.69
March	397.52	53.76	641.52	42.91	480.38	57.28	798.15	53.14
April	356.61	60.99	764.62	42.486	531.12	57.86	847.88	51.72
May	440.77	71.84	1813.33	94.86	678.66	48.41	851.88	48.68
June	572.77	75.33	—	—	850	45.29	877.16	49.27
July	954.38	65.93	1400	—	1025.37	45.44	1136.38	51.85
August	1134.94	47.01	2800	—	1284.7	51.11	1264.66	52.33
September	1161.38	48.85	1620.7	47.78	1156.47	43.19	1206.88	49.67
October	1162.05	52.44	1236.83	51.54	1030.6	48.62	1335.89	49.48
November	910.78	60.09	1078.73	50.73	931.4	57.74	1137.21	59.35
December	728	121.47	868.84	52.32	619.95	77.26	969	52.3

Table 7: Arrival variablility of onion in the selected markets (tonnes)

Months	DELHI		CHANDIGARH		DEHRADUN		SHIMLA	
	MEAN	CV (%)	MEAN	CV (%)	MEAN	CV (%)	MEAN	CV (%)
January	19660.73	31.083	1993.77	55.35	1824	191.92	459.42	74.88
February	19307.26	34.59	1998.39	75.4	2129.29	207.68	485.78	81.69
March	20640.31	45.26	1689.15	71.67	2582.778	240.87	464.05	73.22
April	19572.38	40.49	1653.29	75.13	2278	225.4	552.94	81.07
May	21794.94	41.88	2000.23	78.66	2678.31	218.99	719.66	124.58
June	23726.44	45.09	2055.35	82.37	2977.2	243.72	759.05	91.55
July	22953.83	51.82	1856.52	55.57	2555.45	252.52	461.11	77.42
August	19326.27	43.5	1642.11	72.61	2092.056	252.64	500.11	81.13
September	19118.55	42.16	1461.88	64.95	2133.947	255.38	433.33	67.71
October	18318.73	43.82	1804.63	93.67	2619.45	210.55	394.1	70.85
November	23601.31	43.57	1496.1	54.06	2410.9	271.61	330.5	68.64
December	23396	39.35	1478.31	62.48	2910.88	302.7	383.57	83.85

percent in December. An almost similar pattern of price behavior was observed in the Shimla market, with the highest variability in January (69.28%). The increase in market arrival can be attributed to the higher production resulting from improvisation and the use of new varieties whereas the rise in price trend can be due to a change in demand for the cabbage (Kundu *et al.,* 2019).

Onion

Onion is considered an indispensable part of the Indian diet. Its price and arrival fluctuations occur all over Indian markets and are causing damage to both producers and consumers (Areef *et al.*, 2020). High variability in the market arrival of onion in the Delhi market was seen during July (51.82%). The

market arrivals were significantly less fluctuating, with the highest value in June (23726.44 tonnes) and the lowest in October (18318.73 tonnes). In the Chandigarh market, the variability in arrivals of onions fluctuated widely from 54 percent to 94 percent, and the highest mean market arrival was at 2055.35 tonnes in June. The low arrivals were seen from September to December. However, the Dehradun market witnessed the highest variability in arrivals throughout the year (192 – 302.7%). Here, the average market arrivals were between a low of 1824 tonnes in January to a high of 2910.88 tonnes in December. For the market of Shimla, the variability in the arrival was highest in May (124.58%), and the mean market arrivals ranged between 330.5 tonnes in November to 759.05 tonnes in June.

Table 8: Price variability of onion in the selected markets (₹/q)

Months	DELHI		CHANDIGARH		DEHRADUN		SHIMLA	
	MEAN	CV (%)	MEAN	CV (%)	MEAN	CV (%)	MEAN	CV (%)
January	1300.36	79.35	1413.44	82.23	1279	77.9	1563.526	88.89
February	974	58.91	1202.41	56.02	1104.27	57.22	1211.68	53.77
March	825.78	49.35	1035	52.14	1033.36	68.02	1038.842	44.18
April	701	43.62	923.06	46.99	969.82	86.83	909.05	38.21
May	656.55	47.47	860	47.36	950.94	88.55	843.61	36.293
June	804.33	48.45	977.8	46.54	992.58	102.17	847.55	41.54
July	1005.55	55.88	571.46	114.74	1178	90.53	1100.556	48.3
August	1320.27	73.44	1645.05	75.92	1357.58	79.27	1389.263	76.23
September	1488.72	79.35	1812.15	76.69	1566.33	73.67	1616.263	72.6
October	1529.26	52.31	1914.65	66.25	1571.84	72.3	1706.44	68.6
November	1669.21	50.9	1839.75	67.54	1547.21	71.07	1684	68.21
December	1530.89	60.32	1612.22	97.63	1543.47	102.87	1748.84	101.02

The general pattern of the price movement in the case of onion is lower prices during the post-harvest months and higher prices during the off-season and pre-harvest months in a year. In general, the significant factors that influence the price movement are arrivals of the crop, area and production estimates, perishability of the commodity, the cost of storage, availability of storage facilities, trader's stock limits, and minimum export price (Chengappa, 2012; Rajlaxmi and Gummagolmath, 2018). Moreover, the variations in the prices of onions in the Delhi market were highest in January and September (79.35%). In Dehradun, Chandigarh, and Shimla, the highest variability in price was seen in July (114.74%), June (102.17%), and December (101.02%), respectively. In all the four markets, maximum price variability was seen in September to December.

Relationship between the Market Arrivals and Prices of selected vegetable crops

The arrival of the vegetables in the market and prices are generally inversely linked to each other (Agarwal *et al.,* 2018). But various factors such as off-season crop supplies, cold storage facilities, enhanced opportunities for export and import, value-addition through agro-processing, and poly house technology availability affect this relationship and can even make it positive (Kumar *et al.,* 2005). The relationship between market arrival and prices is examined by computing the Karl Pearson coefficient for different years from 2001 to 2020. Table 9 shows the findings of the correlation analysis showed that for all crops and

all years, the negative relationship between market arrivals and prices was not necessarily true. Similar results of the relationship between market arrivals and prices were reported (Reddy *et al.,* 2012). In the case of tomatoes, the correlation coefficients in all markets for most of the year were negative (similar results reported by Agarwal *et al.,* 2018), although not statistically significant. In the case of tomatoes, Shimla market has seen a consistency in the negative correlation between price and arrivals for fifteen years out of twenty. In the case of potatoes, for most of the years, correlation coefficients were positive and negative but not statistically significant. Multiple instances of positive and significant correlation coefficients were found in the case of potatoes in the Dehradun and Chandigarh markets. In the case of potatoes, most of the years in all the four markets were seen with positive significant correlation. However, the few years with significant correlation were in Delhi (3 years) and Shimla (2 years). In the case of cabbage, only 6 years out of twenty showed a negative relationship between arrival and prices, whereas it was a maximum number of years in the Dehradun market. A positive correlation coefficient was found in all the twenty years for cabbage in the Chandigarh market, which was significant for almost all the years. However, in the Shimla market, correlation coefficients were significant only in 2001 (0.95) and 2020 (0.89). In the case of onions, several cases of negative and non-significant correlation coefficients have been identified in all four markets over most of the years. In the Delhi market, there were only two cases of significant results that were

Table 9: Correlation Coefficients between Market Arrivals and Wholesale Prices of selected vegetable crops (per cent)

Year	Delhi market				Dehradun market			
	Tomato	Potato	Cabbage	Onion	Tomato	Potato	Cabbage	Onion
2001	0.46	0.99**	0.86**	0.98*	0.82**	0.96**	0.88**	0.91**
2002	-0.34	0.20	-0.07	0.24	0.47	0.76**	0.66*	0.94**
2003	-0.13	-0.48	-0.63	-0.22	-0.45	0.16	0.38	-0.64
2004	-0.20	-0.42	-0.41	0.38	-0.09	-0.35	0.16	-0.22
2005	-0.46	-0.28	0.72*	0.09	-0.39	-0.16	0.69*	-0.22
2006	-0.52	-0.36	-0.54	-0.53	0.08	0.32	-0.03	-0.18
2007	0.01	0.10	0.27	0.01	0.74**	0.45	0.37	0.89**
2008	-0.49	0.14	0.31	-0.59	-0.74	0.71**	-0.72	-0.32
2009	-0.34	0.69*	0.14	0.13	-0.80	-0.65	-0.84	0.76**
2010	-0.22	-0.66	0.34	-0.55	-0.15	-0.28	-0.73	-0.21
2011	0.20	-0.03	0.46	-0.57	-0.76	0.02	-0.24	0.69*
2012	0.10	0.25	0.06	0.07	-0.31	-0.73	-0.41	-0.22
2013	-0.70	0.29	0.45	-0.68	-0.32	-0.71	-0.85	0.04
2014	-0.37	-0.33	0.73**	-0.03	0.35	0.09	-0.34	0.29
2015	0.35	0.03	0.13	-0.13	-0.40	-0.59	-0.67	-0.35
2016	-	-0.48	0.40	-0.22	0.31	0.08	-0.42	-0.27
2017	-0.61	0.19	-0.01	-0.58	-0.30	-0.78	-0.62	-0.96
2018	-0.19	0.02	0.75**	-0.01	0.63*	-0.12	0.31	-0.23
2019	0.23	0.20	-0.11	-0.64	0.25	-0.72	-0.40	-0.82
2020	0.98**	0.96**	0.97**	0.97**	0.63*	0.65*	0.68*	0.93**

*,**Denotes significance at 5% and 1% levels of probability.

Year	Chandigarh market				Shimla market			
	Tomato	Potato	Cabbage	Onion	Tomato	Potato	Cabbage	Onion
2001	0.87**	0.97*	0.77**	0.96**	0.59*	0.95**	0.95**	0.88**
2002	0.62*	0.28	0.62*	0.72**	-0.08	0.17	-0.15	-0.15
2003	0.06	0.81**	0.69*	-0.43	-0.28	-0.44	-0.19	0.05
2004	-0.22	0.33	0.49	0.11	0.48	0.34	0.06	-0.18
2005	-0.38	0.40	0.41	-0.14	-0.84	0.49	-0.19	0.44
2006	0.00	0.70*	0.83**	0.26	-0.47	0.05	0.06	-0.58
2007	0.65*	0.51	0.77**	0.57	0.67*	0.01	0.55	-0.25
2008	0.76**	0.40	0.63*	-0.61	-0.82	-0.54	-0.48	-0.28
2009	-0.31	0.53	0.70*	0.08	-0.79	-0.88	-0.48	-0.66
2010	-0.35	0.48	0.56	-0.59	-0.83	-0.66	-0.59	-0.31
2011	-0.57	0.31	0.61*	-0.66	-0.76	0.10	-0.53	-0.66
2012	-0.32	0.43	0.70*	-0.45	-0.86	-0.69	-0.50	-0.45
2013	0.17	0.53	0.47	-0.09	-0.79	0.32	-0.77	-0.85
2014	-0.24	0.58*	0.23	-0.33	-0.67	-0.81	-0.31	-0.33
2015	0.01	0.69*	0.721*	0.33	-0.30	-0.48	-0.28	0.33
2016	0.06	0.70*	0.17	-0.57	0.14	-0.32	-0.57	-0.57
2017	-0.74**	0.39	0.69*	-0.85	-0.88	-0.64	-0.84	-0.85**
2018	-0.46	0.54	0.79**	-0.62	-0.45	-0.81	-0.63	-0.62
2019	0.05	0.12	0.57	-0.89	-0.72	-0.93	-0.94	-0.89
2020	0.96	0.92**	0.97**	0.73**	0.96**	0.96**	0.89**	0.73**

*,** Denotes significance at 5%, 1% levels of probability.

Table 10: Compound growth rates in arrivals and prices of the crops in selected markets

Sl. No.	Crops	Arrivals/Prices	Growth Rate			
			Delhi Market	Chandigarh Market	Dehradun Market	Shimla Market
1	Tomato	Prices	5.7***	6.8***	9.6***	6.4***
		Arrival	5**	5.2***	10.8***	11.9***
2	Potato	Prices	4.7*	5.3*	6.5***	4.3*
		Arrival	1.7	8.3***	10.8***	10.8***
3	Cabbage	Prices	4***	7.3***	7***	7.5***
		Arrival	2.9*	2.7*	2.7*	9.6***
4	Onion	Prices	7.8***	8.9***	8.2***	7.2***
		Arrival	3.4*	9.3***	16.2***	13.6***

*, ** and *** indicates significance at 10, 5, and 1 percent level of significance.

too positive, in 2001 (0.98) and 2020 (0.97). In the Dehradun market, many years showed a negative relationship between arrivals and prices of onions but only positive coefficients were significant for six years. The significant positive response of onion to its price appeared to be contributed to factors like integration between hill and plain markets; arrival being received in hill markets from hill as well as plains, having different market seasons; and relatively less perishability of the commodity (Mishra and Kumar, 2012).

Similarly, a positive correlation between arrivals and prices of onions can be witnessed, indicating the existence of exogenous factors such as more traders operating during the harvesting season for hoarding the stock for onward sale in other markets (Rajlaxmi and Gummagolmath, 2018). A similar trend was seen in the Chandigarh market, but positive and significant correlation coefficients were there only for three years. Similar findings were reported by (Mishra and Kumar, 2012). In the case of the Shimla market, the relationship between arrivals and prices of onions was negative in most of the years; however, it was negative and significant only in 2017 (-0.85). Overall, several cases of a positive and significant correlation coefficient were identified in all markets for all the four vegetable crops, especially in 2001 and 2020. This can be attributed to off-season supplies of crops and COVID -19 in 2020.

Compound Annual Growth rate

CAGR is a handy measure of growth over multiple period. CAGR value gives the idea about the percentage change of price and arrival over the years. The positive CAGR value of market arrival indicates constructive growth of arrival and prices, whereas the negative one implies that there has been adversely affected growth over the years (Saha *et al.*, 2020).

The compound growth rates of arrival and prices were computed for selected vegetable crops -Tomato, Potato, Onion, and Cabbage in all the selected four markets of North India. It was found growth rates were positive and significant in all the markets. Similar findings were reported in a study on Market Arrival and Price Behaviour Analysis of Potato in Four Major Markets in India (Saha *et al.*, 2020). Table 9 shows that in the case of tomatoes, the annual prices of tomatoes are increasing at a rate of 9.6 percent in the Dehradun market which means. Additionally, the growth rate for arrivals were maximum in the Shimla market (11.9). For potato, the growth rate for prices was highest in the Dehradun market (6.5) but market arrivals witnessed the same positive and significant growth rate of 10.8 in both the Dehradun and Shimla markets. In case of cabbage, the growth rate for prices (7.5), as well as arrivals (9.6), was the maximum in the Shimla market. The Chandigarh market projected maximum growth rate for prices (8.9) and Dehradun market for arrivals (16.2) for onion. Similar results were reported by Kundu *et al.*, 2019.

CONCLUSION

The study showed that the prices of tomatoes in the Shimla market were slightly more volatile than other

markets and arrival variability was higher in the case of the Delhi market. In the case of potatoes, the market price variability was higher in the Shimla market. Still, in the Delhi market, the arrival variability was higher, and similar trends were observed in the Chandigarh and Delhi markets. The mean monthly price and arrival variability of different crops was also calculated, and the results showed that the degree of price and arrival variability was highest in Shimla and Delhi, respectively, and similar trends were found in the rest of the markets. Maximum variability in prices and arrivals in the Delhi market was observed over the months in the case of potatoes. However, the price variability of cabbage was highest in Chandigarh and lowest in the Shimla market, but its arrival variability was highest in the Delhi market. Price fluctuations in the case of onions were highest in Dehradun, and similar trends were observed in other markets. However, in the Chandigarh market, variability in arrival was maximum, and similar trends were noted in the rest of the market. The study demonstrated a significant positive relationship in all four markets between market arrivals and prices. There were, however, many instances of a negative relationship between arrivals and prices in all four markets across different years. The results showed that during the 2001-2020 years, exponential growth rates in arrivals and prices were significant and positive in different markets. From the study, it is suggested that proper dissemination of market information, the establishment of storage structures, and constant watch on market arrival and prices can help in reducing variability in market arrival and prices and protect farmers and consumers.

REFERENCES

Agarwal, P., Singh, R. and Singh, O.P. 2018. Dynamics of Prices and Arrivals of Major Vegetables: A case of Haldwani and Dehradun Markets, Uttarakhand. *J. Agric. Dev. Pol.,* **28**: 1-11.

Anonymous. 2019. Area and production of Horticulture crops of India and Himachal Pradesh. https://agricoop.nic.in. (4.25 PM, 20th December 2020).

APEDA. 2021. https://apeda.gov.in/apedawebsite/six_head_product/FFV.html

Areef, M., Rajeshwari, S., Vani, N. and Naidu, G.M. 2020. Price Behaviour and Forecasting of Onion Prices in Kurnool Market, Andhra Pradesh State. *Econ. Affairs,* **65**: 43-50.

Arisoy, H. and Bayramoglu, Z. 2017. Determination of the effect of price fluctuations on producer income – the case of Potatoes. *Turk J. Agric. Food Sci. Technol.,* **5**: 1342-49.

Asmatoddin, M., Satpute, T.G. and Maske, V.S. 2009. Arrival and price behaviour of important pulse crops in Parbhani district. *Int. J. Agric. Sci.,* **5**: 428-30.

Bera, B., Dutta, J. and Nandi, A. 2017. A study on the variability in market arrivals and prices of potato in some selected markets of West Bengal. *Int. J. Agric. Sci.,* **9**: 4621-25

Bera, B., Dutta, J. and Nandi, A. 2017. A Study on the Variability in Market Arrivals and Prices of Potato in some selected Markets of West Bengal. *Int. J. Agric. Sci.,* **9**: 4621-25.

Bhosale, S.S., Shinde, V.A. and Satpute, S.V. 2017. Trends in Arrivals and Prices of Mango in APMC, Gultekadi, Pune. *Contemp. Res. India,* **7**: 36-43.

Borah, K.C. and Datta, S.K. 1991. Price variation of Rapeseed and Mustard: A study of five major markets in Assam. *Indian J. Agric. Market,* **5**: 77-84.

Chaudhary, J., Lal, H. and Singh. 2019. Behaviour of Market Arrivals and Prices of the Selected Vegetables: A Study of Baijnath Regulated Market of District Kangra, Himachal Pradesh, India. *Int. J. Curr. Microbiol. Appl. Sci.,* **8**: 1454-62.

Chengappa, P.G. 2012. Competitive Assessment of Onion Markets in India. *Competition Commission of India.*

Dey, Chhabi, and Nirmal. 2014. Variation in Market Dynamics of Fresh Tomato Crop in Some Selected Capital Market of the Indo-Gangetic Plain Region. *Agric. Sustain. Dev.,* **2**: 175-179.

http://web.worldbank.org/archive/website01291/WEB/0__CO-60.HTML

Huka, H., Ruoja, C. and Mchopa, A. 2014. Price fluctuation of agricultural products and its impact on small-scale farmers' development: Case analysis from Kilimanjaro Tanzania. *Eur. J. Bus. Manag.,* **36**:155-60

Kalloo, G. and Pandey, A.K. 2002. Vegetable production-Commendable progress in research. *The Hindu Survey of Indian Agriculture,* pp. 159-163.

Kanungo, S. 2015. Influence of market arrival on price formation of Turmeric in the Kandhamal district of Odisha. *J. Bus. Manag.,* **17**: 1-5.

Keerthi, K. and Naidu, G. 2013. Seasonality in market arrivals and prices of tomato in Madanapalli market of chittoor district. *Andhra Agric. J.,* **60**: 152-56.

Kumar, V., Sharma, H.R. and Singh, K. 2005. Behaviour of Market Arrivals and Prices of Selected Vegetable Crops: A Study of Four Metropolitan Markets. *Agric. Econ. Res. Rev.,* **18**: 271-290.

Kumar, V., Sharma, H.R. and Sharma, R.K. 2006. Market arrivals and price behavior of potato: A study of four metropolitan markets. *Indian J. Agric. Market,* **20**: 78-89.

Kumbhar, J.S. and Amale, A.J. 2016. Trends in arrival and prices of Pulses in Maharashtra. *Int. J. Agric. Sci.,* **8**: 2417-19

Kundu, P., Adhikary, N.K. and Ghosal, A. 2019. Vegetable Marketing Scenario and Trends in Prices and Arrivals of Vegetables in Different Markets of South 24 Parganas District of West Bengal, India. *Int. J. Curr. Microbiol. Appl. Sci.,* **8**: 1821-40.

Latwal, M. and Kumar, A. 2017. Market arrival and price behaviour of potato in Uttarakhand. *Int. J. Dev. Res.,* **7**: 11219-225.

Meera and Sharma, M. 2016.Trend and seasonal analysis of wheat in selected market of Sriganganagar district. *Economic Affairs,* **61:** 127-134.

Mhatre, S., Bhosale, S. and Sharad, D. 2018. Prices behaviour of brinjal in South Region of Gujarat. *Indian J. Agric. Market,* **32**: 70-77.

Mishra, R., Kumar, D.A. 2012. Price behaviour of major vegetables in hill region of Nepal: An econometric analysis. *SAARC J. Agric.,* **10**: 107-20.

Murphy, B., Kathiravan, G., Ganpat, W., Saravana, D. and Churaman, J. 2017. An Economic Analysis of Volume and Price Behaviour of Vegetables in the Republic of Trinidad and Tobago. *British. J. Econ. Manag. Trade.,* **17:** 1-10.

Naidu, M. and Reddy, R. 2013. Arrivals and prices of onion in Kurnool market of Andhra Pradesh. *BIOINFOLET,* **10**: 1302.

Navadkar, D.S., Naik, R.B. and Amale, A.J. 2015. Trends in arrivals and prices of green gram in western Maharashtra. *Int. J. Soc. Sci. Dev. Agric. Technol.,* **10**: 2454-6003.

Prakash, B., Shirivastava, S.S. and Lal, S. 1995. Market Arrivals and Prices of Urdbean in Uttar Pradesh. *Indian J. Pulse Res.,* **8**: 56-61.

Preethi, V.P., Thomas, J., Anil, K. and Sachin, C.P. 2019. Price behaviour of coconut in major Markets of Kerala: A time series analysis. *Int. J. Chem. Stud.,* **7**: 148-54.

Rai, M. and Pandey, A.K. 2004. Hybrid vegetables –Meeting global trade. *The Hindu Survey of Indian Agric.,* pp. 129-131.

Rajlaxmi, A. and Gummagolmath, K.C. 2018. Temporal Analysis of Onion Prices in major Markets in India. *J. Agric. Ext. Manag.,* **19:** 77-92.

Rathore, Y.S., Varshney, J.S., Prakash, B. and Lal, S. 1995. A micro-level study on trend production, market arrivals and prices of mung bean in Etah district. *Indian J. Pulse Res.,* **8**: 50-55.

Reddy, B.S., Chandrashekhar, S.M., Dikshit, A.K. and Manohar, N.S. 2012. Price trends and integration of wholesale markets for onion in metro cities of India. *J. Econ. Sustain. Dev.,* **3**: 120-12.

Saha, N., Kar, A., Jha, G.K., Venkatesh, P. and Kumar, P. 2020. Market Arrival and Price Behaviour Analysis of Potato in Four Major Markets in India. *Econ. Affairs,* **65**: 529-33.

Shariff, A.R. and Ramappa, K.B. 2018. A Study on Behaviour of Market Arrivals and Prices of Selected Cereals in Mysore Region. *Int. J. Bus. Manag. Invent.,* **7**: 43-47.

Sharma, H. and Burark, S.S. 2015. A study of seasonal price the behaviour and concentration of maize in Rajasthan. *Int. Res. J. Agric. Econ. Stat.,* **6**: 282-86.

Sharma, R. 2011. Behaviour of market arrivals and prices of tomato in selected markets of north India. *J. Farm. Sci.,* **1:** 69-74.

Shukla, D.N. and Rai, J. 2014. An economic study of the behavior of market arrivals and prices of onion, garlic and turmeric in selected markets of U.P. *Int. Res. J. Agric. Econ. Stat.,* **5**: 235-240.

Singh, D.K., Pynbianglang, K. and Pandey, N.K. 2017. Market Arrival and Price Behaviour of Potato in Agra district of Uttar Pradesh. *Econ. Affairs*, **62**: 341-45.

Sreepriya, P. and Sidhu, J.S. 2020. An analysis of market arrival and the price behavior of Potato in India. *Econ. Affairs,* **65**: 09-15.

Tamilselvi, C., Naidu, M., Murthy, R. and Rajeswari, S. 2020. Behavioural Study of Market Arrivals and Prices of Tomato in Major Markets of Tamil Nadu - A Time Series Analysis. *Int. J. Curr. Microbiol. Appl. Sci.,* **9**: 3495-513.

Thakare, H.P., Daundkar, K.S., Rathod, S.R. and Bondar, U.S. 2017. Changes and trends in arrival and prices of agricultural commodities in APMC Kolhapur market. *Int. Res. J. Agric. Econ. Stat.,* **8**: 26-30.

Virender Kumar, H.R., Sharma, and Singh, K. 2005. Behaviour of market arrivals and prices of selected vegetable crops: A study of four metropolitan markets. *Agric. Econ. Res. Rev.,* **18**: 271-90.