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SEASONAL FLUCTUATIONS AND PRICE DYNAMICS IN TOMATO MARKETS OF EASTERN UTTAR PRADESH, INDIA

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ABSTRACT

The study investigates the seasonal and irregular fluctuations in tomato arrivals and prices across selected markets in eastern Uttar Pradesh from 2005-06 to 2019-20. Using secondary data from the Directorate of Agriculture Marketing, U.P. and Rajya Krishi Utpadan Mandi Parishad, along with primary data on constraints, the study employs moving average techniques to analyze price trends. The results indicate that tomato arrivals exhibit strong seasonality, with peak arrivals occurring between December and March, leading to a glut in the market and reduced prices. Conversely, prices tend to rise during the off-season due to lower supply and storage costs. The study finds an inverse relationship between arrivals and prices, where increased arrivals result in lower prices and vice versa. Among the selected markets, Ayodhya, Gorakhpur, Azamgarh, and Varanasi exhibit similar seasonal trends, although with slight variations in peak arrival periods. Additionally, irregular fluctuations were identified, attributed to factors beyond seasonality, including perishability and market uncertainties. The findings underscore the need for effective price stabilization measures and improved storage infrastructure to mitigate seasonal price volatility.

Key words : Price, Arrival, Tomato, Market.

Introduction

Tomato is one of the most significant horticultural crops in India, contributing substantially to agricultural GDP and playing a pivotal role in farmers' livelihoods (Kumar *et al*., 2020). However, its production and marketing are highly susceptible to seasonal fluctuations, leading to pronounced price volatility. The eastern region of Uttar Pradesh, known for its diverse agro-climatic conditions, experiences extreme variations in tomato prices due to factors such as production seasonality, post-harvest losses, inadequate storage facilities and market inefficiencies (Singh *et al*., 2021). Understanding the nature of these fluctuations is crucial for devising policies that enhance price stability and ensure farmers' economic sustainability.

Seasonal price variations in tomato markets are largely driven by supply-demand dynamics. During peak harvest seasons, surplus production often leads to price crashes, adversely affecting farmers' incomes (Sharma *et al*., 2019). Conversely, off-season shortages result in sharp price escalations, making tomatoes unaffordable for consumers. This cyclical trend highlights the pressing need for improved market intelligence, better storage infrastructure and effective price stabilization mechanisms (Meena and Gupta, 2022). Furthermore, the perishable nature of tomatoes exacerbates these fluctuations, necessitating robust interventions such as cold storage expansion and value chain integration (Jha *et al*., 2020).

In addition to supply-side constraints, institutional and policy factors significantly influence price volatility. The absence of an efficient price forecasting mechanism, coupled with asymmetric market information, often places farmers at a disadvantage (Patil and Deshpande, 2021). Studies indicate that structured market interventions, such as minimum support prices (MSP) and contract farming, could mitigate risks associated with seasonal price

variability (Reddy, 2020). However, the implementation of these measures remains inconsistent, necessitating a deeper empirical exploration of their effectiveness in the context of eastern Uttar Pradesh.

Moreover, global climate change and erratic weather patterns further exacerbate the unpredictability of tomato yields and market prices (Tripathi *et al.*, 2023). Extreme temperature fluctuations, unseasonal rainfall and pest infestations have been identified as critical factors affecting tomato production cycles (Yadav and Mishra, 2022). Consequently, price stabilization strategies must incorporate climate resilience frameworks to ensure long-term sustainability (Kumar *et al.*, 2023).

Given these challenges, this study aims to analyze the seasonal fluctuations and price dynamics in tomato markets of eastern Uttar Pradesh. By employing econometric modeling and time series analysis, the research seeks to identify patterns, underlying causes, and potential policy interventions that could mitigate price volatility. The findings will contribute to a better understanding of tomato market behavior, assisting policymakers in formulating strategies that enhance farmer profitability and market efficiency.

Materials and Methods

The study is based on monthly data on arrivals and price of the aforementioned crops pertaining to the time period 2005-06 to 2019-2020 were collected from the secondary sources from the Directorate of Agriculture Marketing, U.P., Rajya Krishi Utpadan Mandi Parishad and related market official records. For the collection of primary information relating to constraints, pre-structured schedules were employed.

Moving average is a method used for the measurement of trend by smoothing out the fluctuation in the data. Moving average of extent 'n' is a series of successive average (Arithmetic mean) of n terms at a time, starting with the 1st, 2nd, 3rd etc. Thus the first average is the mean of 'n' terms, the second is the mean of the n terms from 2nd to $(n + 1)^{th}$ term, the third is the mean of n terms from 3rd to $(n + 2)^{th}$ term and so on.

Since in the case of the 12-month moving average ($n = 12$), n is even, the moving average is placed between the two middle value of the time interval, *i.e.*, between $t = 6$ and $t = 7$. Thus, to synchronize the moving average arid the original data, a moving average of the extent 2 of these moving averages is taken, putting the first of these values against $t = k + 1$, *i.e.*, $t = 7$.

Numerically, Let the total number of minths be n and the wholesale price index be WPI_i, for month i. Hence the formula for 12 month moving average are given below:

$$MA_j^{12} = \left(\frac{1}{12}\right) \sum_{j=i-5}^{i+6} WPI_j$$

Where, j = 6, 7, …, (n-6) as $MA_j^{12} = 0$ for j = 1, 2, ..5 and i = (n-5), .., n.

And 2 month moving average

$$MA_j^{12} = \left(\frac{1}{12}\right) \sum_{j=i-1}^{i+1} MA_j^{12}$$

Where, j=7,8,.., (n-6) as $MA_j^2 = 0$ for j = 1, 2, ..5 and i = (n-5), .., n.

Results and Discussion

Tomato Seasonal fluctuations

The seasonal behaviour of arrivals and prices of tomato was studied for the selected three markets included in the study. The fluctuations in the arrivals and prices of tomato are mainly the result of such factors which uniformly and regularly fluctuate in magnitude. These variations are periodic and regular. From the study, it was found that in Ayodhya market, tomato started arriving at the end of September. Table 1 indicates that the concentration of the arrivals was the highest in the months of March. Arrivals in January, February, march, November and December were 10.46 per cent, 9.64 per cent, 24.96 per cent 6.80 per cent and 9.08 percent respectively, which accounted for 60.96 per cent of the arrivals during the year, the remaining year accounted for 39.04 per cent. It indicated that tomato marketing was seasonal. In the months of October to January, little less than half of tomato crop was marketed. There was glut of produce during these months in the market which resulted in low prices in these months.

From the study of Gorakhpur market, it was found that tomato started arriving at the end of December. Table 2 indicates that the concentration of the arrivals was the highest in the months of January and February. Arrivals in January, February and December were 12.24 per cent, 14.36 per cent and 14.05 per cent respectively which accounted for 40.65 per cent of the arrivals during the year, the remaining year accounted for 59.34 per cent. It indicated that in the months of February to March and December, more than half of the tomato crop was marketed in the Gorakhpur market. This creates gluts of produce during these periods in the market which resulted in low prices in these months.

Table 1 : Index of seasonal variation in arrivals of tomato in market of eastern Uttar Pradesh (Ayodhya) 2005-06 to 2019-20.

Year	January	February	March	April	May	June	July	August	September	October	November	December
2005							104.0289	73.92792	96.38352	117.7498	187.7984	441.8834
2006	157.2834	134.6655	157.1936	140.8808	62.4814	52.21884	52.09073	43.28744	54.64615	43.61659	125.261	90.89589
2007	94.73078	65.99826	67.76122	46.12083	89.67294	98.51015	97.90997	126.1236	230.1577	121.1312	130.5079	121.2131
2008	211.5951	107.9932	111.1569	118.2409	110.3537	82.0711	103.5167	149.7302	116.5049	125.2102	129.2194	175.9102
2009	153.1165	121.336	78.5918	129.329	128.102	131.2816	122.749	125.4447	127.314	119.2372	130.4174	173.9276
2010	116.7455	140.6882	161.0411	95.52698	99.85769	64.35095	65.99812	104.054	101.1942	91.57849	97.96984	106.6041
2011	93.71463	121.0084	115.8155	126.7115	128.7752	107.4897	109.5254	113.1626	121.5092	114.5734	137.1182	131.8174
2012	142.6144	89.16587	107.791	104.7416	110.9068	106.2158	112.9835	27.28146	112.3432	98.11915	101.3632	96.5734
2013	236.5941	290.5732	447.3087	245.1093	166.6261	91.25149	111.5318	206.9904	152.6513	210.2333	165.9315	155.3939
2014	258.4811	242.7936	230.484	165.3921	150.0222	145.547	117.6457	135.8859	102.8694	149.2591	107.5122	178.22
2015	250.8874	390.5325	293.8174	257.6759	196.0287	102.5006	382.5756	86.6062	83.45053	138.3122	280.6314	601.4917
2016	346.8411	687.0307	2358.007	472.4524	361.7263	406.3095	202.6205	237.338	269.2394	461.0745	931.751	913.2693
2017	1250.935	213.8896	837.0351	290.724	102.2673	87.60002	17.19479	17.18923	34.1833	61.72368	22.85301	98.34853
2018	58.50666	236.2816	1286.183	237.3043	147.2719	157.0803	21.61974	43.99899	128.0089	105.1767	46.61019	72.11875
2019	191.2411	410.6787	1752.98	529.5971	348.1693	363.7139	239.2009	100.2937	147.2669	64.0908	64.63332	195.9806
2020	530.6153	518.1131	1756.602	376.8089	168.9673	208.9138						
Average	**272.9268**	**251.3832**	**650.7846**	222.441	158.0819	147.0037	124.0794	106.0876	125.1815	134.7391	**177.3052**	**236.9099**
Adj value	125.6317	115.7149	299.5644	102.3924	72.7671	67.66764	57.11533	48.83347	57.62263	62.0221	81.61582	109.0526
Percentage	10.46931	9.642906	24.9637	8.532701	6.063925	5.63897	4.75961	4.069456	4.801886	5.168508	6.801318	9.087716

From the study of Azamgarh market, it was found that tomato started arriving at the month of December. Table 3 indicates that the concentration of arrivals was the highest in the months of January and February. Arrivals in these December, January and February months were 11.07 per cent, 17.19 per cent, and 13.75 per cent, respectively, which accounted for 42.01 per cent of the arrivals during the year, the remaining year accounted for 57.99 per cent. It indicated that in these months, more than one third of the tomato crop was marketed, resulted in low prices in these months.

From the study of Varanasi market, it was found that tomato started arriving at the month of December. Table 4 indicates that the concentration of arrivals was the highest in the months of January and February. Arrivals in these October, November and December months were 7.68 per cent, 7.91 per cent and 13.81 per cent, respectively, which accounted for 29.41 per cent of the arrivals during the year, the remaining year accounted for 70.58 per cent. It indicated that in these months, more than one third of the tomato crop was marketed, resulted in low prices in these month

The seasonal nature of the production and supplies of tomatoes depresses the seasonal price index in the season (December-March) because of the local production as well as the commercial production in other parts. It can be observed. From Tables 5 to 7 that the seasonal price index and seasonal arrival index moved in opposite direction to each other in each market of Ayodhya, Gorakhpur, Azamgarh and Varanasi. Corresponding to the month of January to May, seasonal arrival index was maximum whereas, seasonal price index was minimum for each market, respectively. Similarly, seasonal price index was lowest for market situation of eastern U.P.

From the end of May to December, although there was a more or less same supplies of tomatoes in Ayodhya, Gorakhpur Azamgarh and Varanasi markets, yet the price index went on increasing in these months from 55.86 in May, 78.37 in June, 218.50 in July, 126.00 in August for Ayodhya Market.

The price index for Gorakhpur market was 68.21 in May, 97.89 in June, 136.45 in July,

Table 2 : Index of seasonal variation in arrivals of tomato in market of eastern Uttar Pradesh (Gorakhpur) 2005-06 to 2019-20.

Year	January	February	March	April	May	June	July	August	September	October	November	December
2005							54.007	22.04549	82.55105	91.02193	65.21318	150.7092
2006	61.31453	131.2758	100.9759	256.1413	148.496	41.90349	34.88401	29.15461	54.74751	82.16601	159.6702	163.0786
2007	169.5854	107.4867	91.5884	83.74207	70.13126	84.37811	56.45454	69.84805	98.82991	66.98415	126.4125	136.3361
2008	321.3309	47.02613	120.1137	68.72495	80.38648	47.79719	28.25489	48.93703	36.99456	26.55687	37.56898	356.3839
2009	194.1234	266.9289	47.32617	52.46769	70.39486	32.51904	20.02628	31.68402	53.84507	110.417	62.2074	187.3024
2010	178.7504	300.2782	56.25398	36.95504	56.76583	74.09121	36.28496	66.4117	27.44388	79.31178	157.8863	160.7435
2011	170.0072	89.26377	51.42758	186.1677	207.8702	60.4098	27.22248	19.6164	15.3732	10.56054	21.52666	138.8817
2012	200.4691	501.1935	132.4451	54.4703	32.29047	16.08443	6.30007	42.54818	169.6694	88.19535	121.6908	310.7857
2013	83.62428	75.51553	64.73215	102.1257	134.7304	71.11789	45.76227	97.97167	84.72518	55.86482	43.572	89.20011
2014	42.58405	220.7594	141.8155	93.9492	107.743	73.11828	65.84115	59.85933	66.55294	108.4787	126.2306	107.1807
2015	204.9237	146.2036	85.37668	81.89377	111.5497	85.98583	72.99969	69.70284	84.84103	15.51646	58.10534	100.6165
2016	195.9775	214.4935	222.4079	72.36296	52.09484	48.63437	44.04335	63.26292	57.79452	44.44433	43.15342	92.84269
2017	194.9984	229.7586	242.631	103.3884	56.1719	42.71739	16.89316	23.48481	105.9631	117.4566	211.4856	148.015
2018	116.5423	67.52402	50.83029	108.1903	87.89824	51.61254	91.73174	88.62733	165.0061	98.99414	88.99551	254.7231
2019	15.43653	110.5167	60.53096	49.24912	36.43438	49.44604	63.23394	351.5687	97.44485	116.0638	157.769	128.8798
2020	50.21913	73.4783	81.05565	49.86669	70.35212	68.76527						
Average	146.6591	172.1135	103.3007	93.31301	88.22065	56.57206	44.26264	72.31487	80.11882	74.13551	98.76584	168.3786
Adj value	146.8849	172.3785	103.4598	93.45668	88.35647	56.65915	44.33078	72.4262	80.24217	74.24964	98.91789	168.6378
Percentage	12.24041	14.36487	8.621648	7.788056	7.363039	4.721596	3.694232	6.035517	6.686847	6.18747	8.243158	14.05315

Table 3 : Index of seasonal variation in arrivals of tomato in market of eastern Uttar Pradesh (Azamgarh) 2005-06 to 2019-20.

Year	January	February	March	April	May	June	July	August	September	October	November	December
2005							715.2682	454.866	327.9033	206.0713	148.2091	127.8611
2006	93.86407	76.56968	95.57359	85.62866	90.53187	201.7624	131.2149	138.9898	189.1762	177.3369	103.9014	68.14725
2007	85.38899	103.2369	139.8764	135.3553	139.1304	226.6094	515.9959	835.3293	750	586.625	633.5119	310.6509
2008	244.5985	382.5937	408.3009	419.5804	351.706	458.221	707.2776	684.6999	684.2737	1224.088	1058.495	566.4465
2009	363.5403	232.0779	323.1552	199.5192	251.7483	640	802.2539	723.0272	558.1489	428.0434	559.8668	305.124
2010	218.3859	92.54948	552.3973	145.4545	150.9667	250.9015	72.67159	332.7973	313.3556	272.9992	166.7441	147.9047
2011	169.9057	158.8764	121.4801	243.2892	126.7044	200.0499	386.8382	389.1654	328.9947	495.7346	599.6691	242.5007
2012	147.2432	132.9621	264.5902	280.0218	259.5478	441.4879	625.6667	7323.249	388.6912	332.208	273.5725	197.9357
2013	146.006	101.7744	132.7601	136.8352	109.3911	148.1562	311.2437	246.9474	199.3376	196.4176	245.1391	187.915
2014	96.78484	92.30769	117.7036	124.6753	99.20298	64.55371	171.8665	395.2625	128.2519	194.9544	125.1248	107.1448
2015	118.6763	107.2281	113.4372	127.0874	113.3172	109.6873	112.431	116.8424	93.04239	94.3804	92.33134	69.92968

Table 3 continued...

Table 3 continued...

2016	59.35553	44.83765	30.07458	27.67143	27.96634	50.57329	98.10468	37.48505	41.27148	44.53342	38.09818	32.76066
2017	21.54911	15.14008	17.9062	21.31301	64.18371	20.76579	29.92465	83.01392	256.3022	298.1967	133.697	402.08
2018	434.2327	423.1821	263.5617	209.5323	144.7955	60.10142	70.39239	67.19679	170.667	190.1617	160.7846	148.2432
2019	135.136	144.385	107.1218	107.7363	73.17376	83.98409	47.88412	74.72527	79.81575	41.48789	58.54732	19.90021
2020	530.6153	518.1131	1756.602	376.8089	168.9673	208.9138						
Average	191.0188	175.0556	296.3027	176.0339	144.7556	211.0512	319.9356	793.5731	300.6155	318.8826	293.1795	195.6363
Adj value	67.10184	61.49422	104.0864	61.83789	50.8503	74.13888	112.3882	278.7695	105.6014	112.0183	102.9892	68.72388
Percentage	5.59182	5.124518	8.673865	5.153157	4.237525	6.17824	9.365685	23.23079	8.800114	9.33486	8.582436	5.72699

Table 4 : Index of seasonal variation in arrivals of Tomato in market of Varanasi 2005-06 to 2019-20.

Year	**January**	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**
2005							41.47	46.81472535	72.58097201	57.85679802	111.8704757	200.2601671
2006	225.13	120.2	70.6327	98.74	106.63	21.94	59.42	56.23677829	85.18382494	69.52516804	151.2550063	248.5379028
2007	156.58	62.59	56.3723	126.8	85.354	41.7	35.905	34.91819908	65.99652256	113.7395795	86.92310508	238.524426
2008	235.48	87.81	102.884	96.07	90.23	39.05	36.024	54.26929245	51.75550913	27.48203703	55.18821263	190.9393564
2009	174.83	241.6	99.3399	19.05	156.13	70.35	50.868	40.07074637	62.01414588	107.5548518	98.52216749	210.4947796
2010	122.16	173.3	82.3764	121.3	76.04	44.19	48.585	71.48672531	87.92841884	57.43616741	95.06629301	196.9263587
2011	134.98	205.6	104.042	62.21	71.912	52.5	52.829	91.09660096	82.43415514	48.67336657	101.0356855	187.3458775
2012	147.6	111.2	68.2896	98.17	75.839	54.89	53.586	57.46587503	52.23200117	184.5749107	74.55082064	212.9944862
2013	152.85	131.9	103.164	45.06	55.085	46.23	46.555	286.3199408	112.1495327	95.29403472	65.52453089	78.97909968
2014	149.64	74.11	38.7792	33.51	45.145	63.24	80.367	185.6665429	116.4876899	145.5514709	106.9859408	115.7484267
2015	36.266	117	112.451	129.7	144.39	77.31	48.548	41.50021555	33.70868144	90.53052582	89.0286356	88.02263439
2016	85.795	303.3	75.1499	66.53	110.51	84.86	78.794	80.13638086	85.58556705	77.88859018	86.67051571	104.6883205
2017	167.16	170.4	132.253	126.6	98.024	45.28	37.585	73.40350877	103.7018472	90.48388378	80.19633127	135.5158786
2018	122.38	121.5	110.586	105.9	88.452	77.16	78.808	86.5934556	103.9155465	113.3941094	93.88630676	128.6137666
2019	126.35	108.7	88.9999	100.2	76.131	68.46	95.707	100.5388632	112.134317	90.94794783	115.5278452	126.8891765
2020	121.25	115.3	87.0458	89.21	100.09	90.73						
Average	143.9	143	88.8244	87.94	91.998	58.53	56.337	87.10119004	81.85391542	91.39556278	94.14879151	164.2987105
Adj Index	145.19	144.3	89.624	88.74	92.826	59.05	56.844	87.88527	82.59075972	92.21830044	94.99631357	165.7777181
Percentage	12.099	12.02	7.46866	7.395	7.7355	4.921	4.737	7.3237725	6.88256331	7.68485837	7.916359465	13.81480984

Table 5 : Index of seasonal variation in price of tomato in market of eastern Uttar Pradesh (Ayodhya) 2005-06 to 2019-20.

Year	January	February	March	April	May	June	July	August	September	October	November	December
2005							39.27699	68.90559	89.46913	106.1059	105.2937	67.83036
2006	52.8508	35.92668	33.20318	32.91709	24.10995	65.91549	109.0282	80.16055	97.81949	1042.393	82.20422	48.46276
2007	47.85024	53.86121	60.64558	49.51566	67.13176	73.89321	91.01843	97.91478	80.06763	64.8978	60.65411	35.76012
2008	245.7447	35.09537	65.54989	61.48054	55.85238	61.02529	97.44943	87.12754	81.46334	118.5527	121.993	77.58699
2009	59.16724	40.03446	40.24019	35.10638	37.36025	75.91912	135.5333	114.8235	104.2966	68.27133	113.7829	71.17685
2010	54.27001	47.94702	46.71106	58.31874	57.33908	93.92713	196.7228	168.9051	183.3031	109.7315	75.31498	69.88443
2011	117.9374	62.17939	60.79452	58.96367	44.63102	57.61269	111.5483	105.733	92.30769	127.3904	138.5994	56.66399
2012	54.75483	45.99463	65.07731	79.36	74.92456	127.1567	148.1967	133.8586	65.34385	53.21729	55.22946	48.27282
2013	40.89793	31.56444	32.52033	34.56623	32.35124	42.78887	82.67282	77.12509	47.93814	66.00414	107.8735	74.13982
2014	44.66227	30.41798	35.84795	43.51615	41.68219	27.01839	68.13611	130.719	78.52482	70.59918	33.39435	37.26637
2015	33.28239	34.46331	35.0256	34.14662	34.78261	30.85832	56.20578	40.66123	22.94378	23.44681	28.38627	20.60357
2016	19.90645	13.29613	6.791935	10.43827	13.06086	23.21376	31.27334	15.77743	13.85315	13.48734	9.130158	7.397852
2017	5.471217	4.520654	4.187113	4.531311	6.098823	16.98565	607.6325	52.52416	27.61274	30.77236	46.8463	27.8686
2018	15.73461	10.99293	6.876757	8.325502	7.221557	17.13204	332.3934	25.41559	22.48836	21.3522	21.3214	13.09119
2019	12.74553	9.624884	18.91241	22.88428	38.26417	33.973	39.04955	38.2152	25.98776	39.19278	35.93323	21.17767
2020	24.13497	20.29796	12.17622	19.30088	13.935	22.46663						
Average	55.29404	31.7478	34.97067	36.89142	36.58303	51.32575	143.0758	82.52442	68.89464	130.361	69.06381	45.14556
Adj Value	84.43149	48.47746	53.39863	56.33153	55.86063	78.3721	218.4703	126.0111	105.199	199.0553	105.4573	68.93522

Table 6 : Index of seasonal variation in price of tomato in market of eastern Uttar Pradesh (Azamgarh) 2005-06 to 2019-20.

Year	January	February	March	April	May	June	July	August	September	October	November	December
2005							39.27699	68.90559	89.46913	106.1059	105.2937	67.83036
2006	83.97436	121.7573	83.50394	38.12155	22.68227	82.47978	41.95509	87.60611	69.88581	114.6919	223.9502	195.6954
2007	45.60099	34.51537	26.98225	17.44578	23.48228	35.67073	19.46698	13.03842	10.79545	12.50398	15.4316	20.9797
2008	21.64502	29.38816	24.68548	21.96247	30.10721	11.84407	6.558756	11.32399	7.718994	11.50844	8.988091	18.55097
2009	29.71103	33.51032	14.51009	14.02854	22.07284	12.45892	15.2455	11.32749	16.97725	25.46381	18.76115	25.31284
2010	34.73684	24.77946	46.42563	26.41184	21.29082	19.39097	249.2447	19.80795	31.68468	32.88672	26.52562	38.71949
2011	32.6749	41.25932	68.36248	48.43528	25.80752	26.86869	34.6256	23.41516	29.44401	19.94778	22.67398	39.89794
2012	36.77951	15.51125	11.5204	10.09727	10.2514	11.64021	7.898074	10.28726	10.33424	7.152533	8.533462	12.15761
2013	13.70961	81.19022	54.31527	42.91008	50.2947	57.26405	45.36241	71.81789	55.52651	60.35102	65.18097	75.03126
2014	92.96469	80.56112	56.8029	62.82236	71.30156	71.04941	51.38064	29.81584	42.08665	70.10236	65.85789	83.87452
2015	114.2951	88.80427	82.07395	32.99659	45.83428	26.96113	27.89505	73.16229	89.67005	176.3331	234.4895	292.2526
2016	124.0318	223.0699	232.9707	177.0108	138.0531	95.32228	335.4194	506.6734	382.6938	137.0507	286.2647	350.1082

Table 6 continued...

Table 6 continued...

2017	326.2497	358.4609	163.7729	43.33572	26.84797	49.00487	138.7263	119.5666	57.79075	46.48201	70.35074	47.28854
2018	30.55781	23.53041	22.82277	21.7052	17.08185	25.39933	94.34929	119.7578	82.41035	78.46707	79.64708	61.24532
2019	61.37958	46.49836	55.74543	75.48015	147.0161	180.0188	126.7155	113.3917	76.67939	92.97149	91.73912	70.22182
2020	58.16456	36.93138	34.76788	40.40565	23.91712	25.64262						
Average	73.76503	82.65118	65.28413	44.87795	45.0694	48.73439	82.27469	85.3265	70.21114	66.13459	88.24585	93.27777
Adj value	104.6495	117.2561	92.61774	63.66776	63.93936	69.13884	116.722	121.0516	99.60762	93.82428	125.1932	132.3319

Table 7 : Index of seasonal variation in price of Tomato in market of Varanasi 2005-06 to 2019-20.

Year	**January**	**February**	**March**	**April**	**May**	**June**	**July**	**August**	**September**	**October**	**November**	**December**
2005							137.4725	157.2927	153.0259	174.889	108.1316	64.10095
2006	45.82915	48.57727	68.42987	73.99514	60.42995	152.9698	157.6496	158.0036	138.7229	138.7256	90.13639	55.04677
2007	56.921	57.77353	94.76376	81.14158	54.49591	122.3402	152.8213	157.4896	128.5885	123.7225	103.6151	52.19723
2008	48.09669	75.17822	86.98561	108.587	86.07277	89.99853	94.51102	113.6275	101.6081	148.3821	200.5461	84.54253
2009	44.84983	34.63497	54.0607	150.3555	44.84838	125.5394	147.3029	148.7434	125.0265	99.94361	123.4136	77.01523
2010	62.19696	38.68784	66.29055	74.45521	85.11591	108.9601	173.5601	156.9368	137.951	130.173	85.09532	75.571
2011	85.84687	51.22132	75.35601	102.3928	76.18037	83.46565	124.3435	115.374	108.6447	143.9911	185.8469	81.39373
2012	45.27067	33.51268	79.50509	69.82466	66.22485	91.66357	151.9176	210.2466	155.9336	127.4734	95.9213	69.47096
2013	24.72231	38.13915	52.87904	66.68557	65.31369	110.7388	152.5666	139.2865	129.0138	124.1234	139.6726	113.7993
2014	54.41313	120.2942	56.7757	68.70305	52.85464	46.80911	129.7091	268.2306	175.7113	129.0702	50.34519	47.87193
2015	47.59936	50.15102	79.62957	100.6291	95.92499	97.61751	140.7204	106.6207	107.1777	151.4547	136.1084	125.0035
2016	66.30384	54.4806	52.32981	55.84451	60.09496	131.2577	200.3072	144.0394	119.0599	138.3894	108.6792	78.33317
2017	33.87693	31.05651	41.7501	33.79416	40.26653	137.7632	255.8868	173.6111	85.25942	140.9308	161.2134	57.806
2018	49.93065	53.49361	57.63508	43.31897	52.94118	148.2132	214.3807	139.58	110.7751	121.1538	66.13392	68.39378
2019	35.08592	36.9515	101.336	102.1033	143.6963	126.2739	147.5626	93.56725	111.5796	167.6647	110.9531	67.29811
2020	49.40664	51.73587	71.21662	44.61888	31.05823	118.4252						
Average	50.02333	51.72588	69.2629	78.42996	67.70125	112.8024	158.7141	152.1767	125.8719	137.3392	117.7208	74.52295
Adj Index	50.17841	51.88624	69.47763	78.67311	67.91113	113.1521	159.2062	152.6484	126.2621	137.7649	118.0858	74.75398

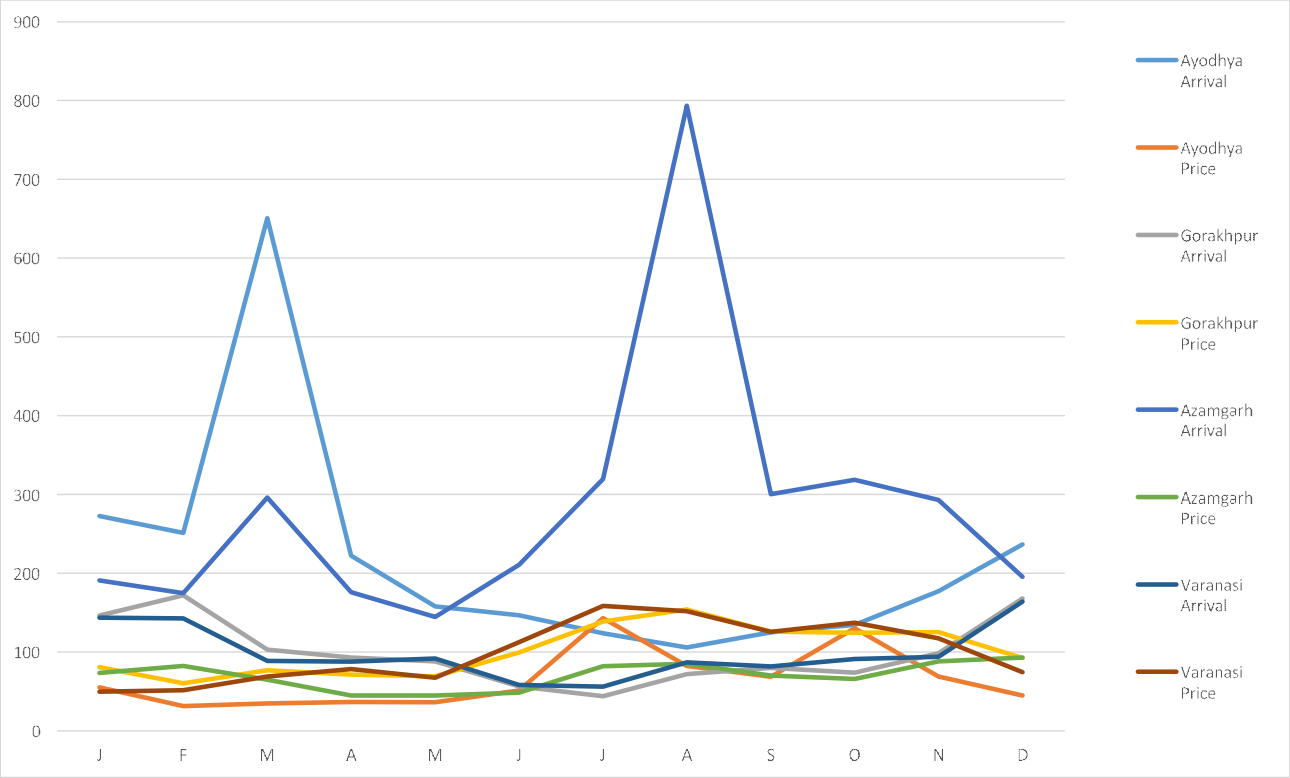

Fig. 1 : Seasonal Index of arrivals and prices of tomato in market of Eastern Uttar Pradesh 2005-06 to 2019-20.

Table 8 : Irregular fluctuation in arrivals of tomato in market of eastern Uttar Pradesh 2005-06 to 2019-20.

Year	Gorakhpur	Ayodhya	Azamgarh	Varanasi
January	-0.22579	147.2952	123.917	-1.295
February	-0.26498	135.6684	113.5614	-1.287
March	-0.15904	351.2202	192.2164	-0.7996
April	-0.14366	120.0486	114.1961	-0.79
May	-0.13582	85.31482	93.90526	-0.828
June	-0.0871	79.33602	136.9123	-0.53
July	-0.06815	66.9641	207.5474	-0.507
August	-0.11133	57.25415	514.8037	-0.78408
September	-0.12335	67.55889	195.0141	-0.73684
October	-0.11414	72.71698	206.8643	-0.82274
November	-0.15206	95.68938	190.1903	-0.84752
December	-0.25923	127.8573	126.9124	-1.47901

151.59 in August, 123.38 in September, 151.21. The price index for Azamgarh market was 53.66 in April, 63.96 in May, 69.13 in June, 116.72 in July, 121.05 in august and 99.69 in September while for Varanasi it was 67.91 in May, 113.15 in June, 159.20 in July, and 152.64 in august. This increase in the price Index was observed even after the receipt of the local *rabi* season produce. This increase in price was due to carry over costs of produce and off-season. Similarly, in overall situation of eastern U.P., was found continuous decrease in the arrivals of the tomatoes from May to end of November, as a result of which increasing seasonal price index was observed for these months.

It is evident from the graphs (Fig. 1) that arrivals and prices were inversely related with each other. If arrival increases price decreases and vice-versa. It is also evident from the graph that price movement tended to be less than average from January to end of May as the index of the price variations was less than 100. From the months of June to mid of November, the prices tended to be more than average as the index of price variations was higher than 100.

Irregular Fluctuations

After deducting the seasonal fluctuations in the arrival of tomato from the moving averages irregular fluctuations have also been estimated. The irregular fluctuations in the arrivals of tomato in different selected markets of eastern U.P. is shown in Table 8. It may be seen from Table 8 that in Varanasi market the arrival of tomato was mainly influenced by seasonal nature of arrival from January to December. In Gorakhpur market the arrival of tomato was quite low, -0.2649 quintals in the month of February followed by -0.2592 quintals in December and -0.22579 quintals in December, respectively. In Azamgarh market the arrival of tomato was quite low 93.90 in may followed by 113.56 in February and 114.19 in April.

In other months, the fluctuations in the arrivals were also found somehow low except for the month of February. This means the less arrivals were not due to seasonal behaviour but some other irregular factors were also responsible for the situation. Irregularity may cause due to perishability of the crop. In Faizabad market the arrival of tomato was quite low, *i.e.*, 57.25 quintals in the month of August followed by 66.96 quintals in October and 67.55 quintals in September, respectively. In other months the fluctuations in the arrivals were also found somehow low. This means the less arrivals were not due to seasonal behaviour, but some other irregular factors were also responsible for the situation. Irregularity may cause due to perishability of the crop.

Conclusion

The study highlights significant seasonal and irregular fluctuations in tomato arrivals and prices in eastern Uttar Pradesh markets. The findings confirm that tomato marketing is highly seasonal, with peak arrivals between December and March leading to low prices, while off-season months witness a sharp price increase due to limited supply. The inverse relationship between arrivals and prices suggests the necessity for market interventions to regulate supply and reduce post-harvest losses. Irregular fluctuations indicate additional challenges such as perishability and market inefficiencies that further affect price stability. The study emphasizes the importance of developing cold storage facilities, promoting staggered production through controlled cultivation practices, and implementing price support mechanisms to enhance farmers' income stability. Addressing these constraints can lead to a more resilient and efficient tomato market in the region, benefiting both producers and consumers.

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