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The Causes and Trends in the Arrivals of Apple and Tomato to some Selected Sub-Market Yards of Himachal Pradesh

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Abstract

Apple and tomato are important cash crops of Himachal Pradesh. Although, production of apple and tomato is very high but less arrival is coming in sub market yards (SMY). This paper attempts to identify the arrivals of apple and tomato in some markets namely Bandrol, Bhuntar, Kangra, Kullu and Solan of Himachal Pradesh in India. This study is based on secondary data sourced from government data records of agricultural arrival, production and heavy rainfall in selected places for ten years under study (2011-12 to 2020-21). The main motive of this study was to assess the trends in annual, main seasonal arrivals of apple and tomato with the help of tabular data, correlation and forecasting technique. The impact of climate change has been become a major reason in the state which affects the production of apple and tomato that states lesser the production lesser the arrival in the markets. After evaluating the data, it has been revealed that arrival in all the selected markets had showed scattered annual and main seasonal fluctuations during the period of ten years. Also, by using correlation method it was seen that only Bhuntar market was negatively impacted by heavy rainfall in the arrival of tomato and similar arrivals will come in next ten years.

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Cause of Less Arrival;
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Sub-Market Yards;
Trends in Arrival.

Introduction

Himachal Pradesh, commonly acknowledged as "the fruit basket of India," constitutes a significant contributor to both seasonal and off-seasonal crop cultivation within the Indian agricultural landscape. According to the 2011 census, the region encompasses 17,882 inhabited villages, with over 90% of its total population residing in rural areas. The primary occupation in Himachal Pradesh is agriculture, employing nearly 70% of the state's workforce directly (Planning Department, Government of Himachal Pradesh, 2020). Variability in the availability of fruits and vegetables has become a commonplace phenomenon in the market. This variability primarily arises due to factors such as insufficient production, natural influences and other assorted reasons. Reduced production serves as a direct determinant of limited supply.

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Himachal Pradesh enjoys the advantage of being home to four distinct agro-climatic zones: (I) Low hills, characterized by a sub-tropical climate (240-1000 meters above sea level); (II) Mid hills, with a sub-humid climate (1001-1500 meters above sea level); (III) High hills, featuring temperate wet zones (1501-3250 meters above sea level); and (IV) High hills, encompassing temperate dry zones (>3251 meters above sea level) (Department of Agriculture, Himachal Pradesh).

Certain fruits and vegetables cultivated in the region are temperate-based crops. Although India as a whole lacks a typical temperate zone, the elevated altitudes and the presence of the Himalayan ranges in Himachal Pradesh facilitate the cultivation of temperate crops. Temperature, soil quality and precipitation are critical determinants for crop growth and Himachal Pradesh is endowed with favourable conditions in these aspects. Nonetheless, the region is also exposed to natural factors that pose risks to crop cultivation and production. Rainfall in the low hills is both sparse and erratic, rendering this zone susceptible to droughts and floods. Consequently, the low hills are more prone to natural risks when compared to the mid hills and high hills (wet) zones.

The principal source of income and employment in Himachal Pradesh derives from the cultivation of fruits and vegetables, notably featuring the substantial production of apple and tomato. Apple, in particular, assumes a preeminent role as the flagship commercial temperate fruit crop in Himachal Pradesh, encompassing more than 48 percent of the total cultivated area dedicated to fruits (Niranjan, 2016). Notably, the districts of Shimla and Kullu emerge as the primary bastions of apple production during the primary growing season, albeit witnessing a marked reduction in apple arrivals during the off-season. The predominant apple season in Himachal Pradesh spans from July to October, with a noteworthy upswing in apple arrivals observed in Kullu district during the main season over the past four years, culminating in an arrival volume of 57,264.44 tons in the year 2020-21 (AgMarkNet). Himachal Pradesh boasts a diverse array of vegetable varieties, including tomato, green peas, cucumber, cabbage, cauliflower and potatoes. Among these, tomato and green peas jointly constitute a substantial 50 percent of the overall vegetable production share (Kumar *et al*., 2017).

Tomato cultivation, while occupying approximately 15 percent of the total vegetable cultivation area, significantly contributes to 30 percent of the aggregate vegetable production in the state. Consequently, it holds a pivotal position as a high-profit crop with widespread cultivation across the state (Virender, 2019). The primary tomato season in Kangra district spans from mid-April to the end of July, while in Kullu, it commences in June and extends through mid-October. In terms of tomato production, the district of Solan takes precedence within the state, followed by Sirmour and Kullu districts. Furthermore, the acreage and production of tomatoes in the state have exhibited notable increments of approximately 20 percent and 61 percent, respectively, during the period from 2005-06 to 2015-16 (Department of Agriculture, Government of Himachal Pradesh, Shimla). Himachal Pradesh has undergone a significant transformation in its tomato production landscape, largely attributed to the surging popularity of hybrid varieties in commercial cultivation (Seema *et al*., 2020). Given that only approximately 10 percent of the arable land has been dedicated to vegetable cultivation, there remains substantial untapped potential for the expansion of vegetable cultivation in the region (Kanika, 2020).

The state of Himachal Pradesh experiences significant variability in agro-climatic conditions, encompassing a range from sub-humid subtropical to dry temperate zones. These conditions encompass a wide spectrum of meteorological phenomena, including heavy rainfall, snowfall, high-speed winds, an extended winter season and frequent dry spells. Among these, climate change stands out as a pivotal and dynamic factor with profound implications for the production and yield of apples and tomatoes. Notably, climate change has emerged as the primary disruptor in crop distribution, surpassing the influence of other factors.

In the context of apple cultivation, the susceptibility to climate-induced challenges is evident. Hailstorms, in particular, inflict substantial damage to young apple trees, contribute to flower drop and adversely affect developing fruits at various stages of maturation (Randev *et al*., 2009). Moreover, escalating temperatures and alterations in weather patterns have begun to exert a discernible impact on apple production, thereby influencing the quantity of

apples arriving in Agricultural Produce Marketing Committees (APMCs). This emergent trend has assumed significant proportions and constitutes a matter of profound concern in the agricultural landscape of Himachal Pradesh. Consequently, apple cultivators have sought alternative crops, such as kiwi and pomegranate, in response to the challenges posed by climate change (Sharma, 2013). Although Shimla and Kullu have historically held dominant positions in apple production within the region, the progressive increase in temperatures over the years has cast a shadow over apple cultivation in various localities.

Literature Review

Apple farming practices in recent decades have confronted a multitude of environmental challenges, predominantly attributed to shifts in climatic patterns (Yasmin *et al*., 2023). These alterations in climate patterns exert a significant and far-reaching impact on crop production. Notably, the region faces a series of natural calamities, including heavy rainfall, floods, landslides and unpredictable hailstorms, which wreak havoc on crops at various stages of development.

Within the agricultural development strategy of Himachal Pradesh, the cultivation of vegetables has emerged as a pivotal occupation, with tomato alone contributing a substantial one-third of the total vegetable production in the state. Tomato cultivation has extended into the mid and low hills across various districts in Himachal Pradesh. For instance, in a study conducted in Bilaspur district, it was observed that tomato cultivation increased from 25,900 tonnes to 31,236 tonnes during the period from 2004-05 to 2016-2017 (Kumar, 2018). Despite this consistent rise in production, sub-market yards of the Agricultural Produce Marketing Committee (APMC) in Himachal Pradesh are receiving fewer arrivals. This discrepancy is attributed to factors such as pricing dynamics, storage limitations and other environmental influences.

Kullu, renowned for its apple cultivation in Himachal Pradesh, has been adversely affected by inadequate and improper chilling hours resulting from the steadily rising temperatures. The study by Singh in 2016 highlights that a climate characterized by less rain and a temperature of around 20°C is conducive to fruit set, whereas heavy rainfall and hailstorms have deleterious effects on apple production in the region. Consequently, reduced production automatically translates into diminished crop arrivals in the market.

In a research investigation centered on the marketing operations of vegetable growers and market intermediaries in Kangra district, Himachal Pradesh, it was revealed that practices related to grading, auction procedures, market charges and the recording of sale proceeds did not conform to the standards stipulated in the Market Regulation Act (Sharma, 2014). The improper recording of sale proceeds has the potential to introduce errors and omissions in data, which can undermine the validity of conclusions and reduce the statistical robustness of a study.

Moreover, a study titled "ICT System for Increasing Efficiency of Apple Value Chain" highlighted that while India accounts for nearly 8 percent of the world's fruit production and approximately 15 percent of global vegetable production, the lack of essential harvesting infrastructure such as transportation, storage and processing facilities results in substantial losses, ranging from 25 to 40 percent of fruits produced. In practical terms, India discards quantities of vegetables and fruits annually that are equivalent to the entire annual consumption of the United Kingdom (Pandey *et al*., 2009). The challenges posed by transportation, particularly in the initial stages following crop packaging, are exacerbated by the geographical terrain of Himachal Pradesh, characterized by its mountainous landscape and perennial exposure to natural factors like heavy rainfall, floods and landslides. These challenges, at times, lead to crop spoilage and rot in rural areas, including on roads, in small storage facilities and in fields after harvesting and packaging, resulting in reduced arrivals of crops at Agricultural Produce Marketing Committees (APMCs).

Objectives

- To study the annual changes in arrivals of apple and tomato independently in the selected markets during the period under study (2011-12 to 2020-21)
- To find out the trends in arrivals of tomato and apple independently during the main seasonal months under study period (2011-12 to 2020-21)

- To understand some causes of less arrivals for both tomato and apple

Hypothesis

- H_{01} Heavy rainfall (>70 mm) during the peak season does not impact the arrival of tomatoes
- H_{11} Heavy rainfall (>70 mm) during the peak season impacts the arrival of tomatoes
- H_{02} Heavy rainfall (>70 mm) during the peak season does not impact the arrival of apples
- H_{12} Heavy rainfall (>70 mm) during the peak season impacts the arrival of apples

Methodology

Correlation Coefficient

In statistical measure correlation describes the extent to which two variables are related. The correlation was used to analyse the relationship between heavy rainfall and arrival of tomato and apple in selected markets. This study was carried out on three districts, where five markets were selected purposely due to higher arrival of tomato and apple in these markets. The following formula was used:

$$r = n\sum(xy) - (\sum x)(\sum y) / (n\sum x^2 - (\sum x)^2)(n\sum y^2 - (\sum y)^2)$$

Where,
r = correlation coefficient
n = number of observation
x = heavy rainfall in the selected area of study
y = arrival of tomato and apple during the heavy rainfall

Furthermore, to investigate the correlation between heavy rainfall and the arrival patterns of tomatoes and apples, secondary data were procured from government data sources. This dataset comprised information pertaining to specific seasonal months, corresponding years and the specific days on which heavy rainfall occurred, in conjunction with the corresponding arrival amounts for tomatoes and apples during the primary growing season.

Results and Discussion

The correlation coefficient analysis reveals a weak positive relationship between heavy rainfall and the arrival of apples, suggesting that increased rainfall did not impact apple arrivals on a large scale in the market (Table 1). Conversely, the data show a weak negative correlation between tomato arrivals and rainfall in the Kangra and Kullu markets, indicating that heavy rainfall did not significantly impact tomato arrivals in these regions. However, in the Bhuntar market, heavy rainfall is negatively correlated with tomato arrivals, suggesting that there is a notable adverse effect on tomato arrivals in this specific market when rainfall is high.

Table 1: Correlation between heavy rainfall and arrivals of apple

	Rainfall (mm)	Arrival (tonnes)
Bandrol		
Rainfall (mm)	1	0.19
Arrival (tonnes)	0.19	1
Solan		
Rainfall (mm)	1	0.23
Arrival (tonnes)	0.23	1

Source: India Meteorological Department Ministry of Earth Sciences Govt. of India,

Table 2: Correlation between heavy rainfall and arrivals of tomato

	Rainfall (mm)	Arrival (tonnes)
Bhuntar		
Rainfall (mm)	1	-0.48
Arrival (tonnes)	-0.48	1
Kangra		
Rainfall (mm)	1	-0.2
Arrival (tonnes)	-0.2	1
Kullu		
Rainfall (mm)	1	-0.33
Arrival (tonnes)	-0.33	1

Source: India Meteorological Department Ministry of Earth Sciences Govt. of India.

Furthermore, employing forecasting techniques, predictions for arrivals over the next decade, which suggest that both tomato and apple arrivals will

exhibit continuous fluctuations in the coming years. Additionally, analysis using the Statistical Package for the Social Sciences (SPSS) has identified some unusually high peaks in apple and tomato arrivals, which may be attributed to special causes. These unexpected results have pushed the data below the lower control limit, warranting further investigation. This can be because of improper recording of sale proceeded data by corresponding sub-market yard.

Reasons for Choosing Bandrol, Bhuntar, Kullu, Kangra, Solan Markets for Study

In the agricultural landscape of Himachal Pradesh, two predominant crops stand out: apples and tomatoes. The principal objective of this study centered on the assessment of the volume of tomato and apple arrivals within various markets situated across Himachal Pradesh. Specifically, this research encompassed five distinct markets distributed across three distinct districts within the Himachal Pradesh region. The selected markets for the investigation comprised Bhuntar and Kullu markets, both situated within the geographical boundaries of the Kullu district, along with the Kangra market located within the Kangra district. These three markets were purposely chosen as representative samples for the evaluation of tomato arrivals.

Conversely, for the examination of apple arrivals, the Bandrol and Solan markets were deliberately excluded from consideration. Bandrol and Solan markets were exclusively selected as sample markets for studying the arrival patterns of apples within the Kullu and Solan districts, respectively.

Profile and Annual Changes in the Arrivals of Tomato and Apple in the Selected Markets of Himachal Pradesh

The Agricultural Produce Market Committee (APMC) in Kangra commenced its operations in the year 1981, establishing its principal market yard in Kangra. It oversees six subsidiary market yards (SMY) and plays a significant role in the production of vegetables. Kangra market receives arrival of tomato throughout the year, but it showed adverse shift of arrival over the ten years period under study. The annual arrival of tomato in 2011-12 was 885.4 tonnes but till 2020-21 it decreased to 525.22 tonnes. The arrival of tomato in Kangra market during the main seasonal months was also fluctuating every year in the period under study (2011-12 to 2020-21) (Table 5).

Table 3: Arrivals of tomatoes in three markets of Himachal Pradesh for a ten years period (in tonnes)

Market	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21
Kullu	354.8	441.8	376.33	419.6	587	535.81	342.2	401.5	431.4	659.5
Bhuntar	3777.3	2644.8	3411.66	2539.9	4684.7	3744.22	1035.1	2201.5	1280.9	2522.5
Kangra	885.4	608.8	652.4	353.5	249.2	249.2	592.1	407	357.8	525.22

Source: Government portal AgMarkNet

Table 4: Arrivals of apple in Bandrol and Solan markets of Himachal Pradesh for the ten years period (in tonnes)

Market	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21
Bandrol	4387.6	4096	9521.8	6239.7	17456.8	6439.9	7776.3	8986.46	17419.3	15706.4
Solan	13001.05	25548.7	59893.84	23242.4	24433.85	8077.48	18606.4	15925.39	30486.82	16529.53

Source: Government portal AgMarkNet

APMC Kullu with a principal market at Kullu, consisting five more sub market yards under it, Kullu district is a great producer of fruits and vegetables. The yearly arrival of tomato in Kullu market fluctuated every year but a positive shift had been seen in the arrivals. Specifically, in the 2011-12 period, tomato arrivals amounted to 354.8 tonnes, while by the conclusion of the 2020-21 period, this figure had risen to 659.5 tonnes. In the Bhuntar market, when analyzing the entire study duration, tomato arrivals exhibited significant variations. An exception occurred in the 2015-16 period, where in there was a noteworthy increase (4684.7 tonnes) compared to the 2011-12 arrival figure (3777.3 tonnes). This positive shift was followed by continued fluctuations, ultimately resulting in a decline to 2522.5 tonnes in the 2020-21 period. Bandrol experiences the majority of its apple arrivals during the months spanning from July to October annually. Notably, there has been an increase in apple arrivals over the past five years, surging from 6439.3 tonnes in 2016 to 15702.4 tonnes in 2020 (Table 4).

Similarly, APMC Solan has six sub market yards under it. Solan is a great producer of mushroom and tomato, also known for its off seasonal production of vegetables. Solan market was selected for the arrival of apple, where it was found that Solan market had the arrival of apple throughout the year and most random arrivals had been seen over the period of study (Table 4).

Trends During the Main Season of Tomato and Apple Harvesting

Bhuntar and Kullu market had its maximum arrival of tomato in the July, August and September months, as these months come under seasonal period of tomatoes so it is clear that these are the highest harvesting months in the regions (Table 5). The highest arrival in Kangra market was seen in April, May and June months (Table 5). Although the season of apple harvesting starts from July month but high arrivals of apple in Bandrol and Solan markets were seen in August and September (Table 6). It is the monsoon period in Himachal Pradesh and there are high chances of rainfall and floods every year during the seasonal months.

Table 5: Total seasonal arrival of tomato in Bhuntar, Kangra and Kullu markets of Himachal Pradesh for a ten years period (in tonnes)

Market		2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21
Bhuntar	Jun	273	102.5	101.1	59	33.3	142.4	85	128.5	36.9	78.1
	July	1911.6	853.9	993	1063.7	2151.9	887.5	283.4	797.5	195.1	706.7
	Aug	1162	1108.3	1854.9	710	1648.1	1873.52	188	907	530	952.7
	Sept	361.1	218.5	355.96	533	482.6	567.8	172	177.5	280.8	386.9
	Oct	69.1	218	77.3	41	89.2	85.2	37.8	28.6	19.4	73.5
	Total	3776.8	2501.2	3382.26	2406.7	4405.1	3556.42	766.2	2039.1	1062.2	2197.9
Kangra	April	47.6	71.7	61.5	52	39.2	44.8	46.6	52.8	40.1	38.6
	May	73.8	77.6	62.7	65.3	15.8	40	55.1	70.8	32.2	-
	June	64.4	76.2	60.7	77.1	47.7	45.4	55.5	42.8	23.1	39
	July	66.3	41	49.1	45.7	59.3	30.9	46.5	12.5	34.2	41.06
	Total	252.1	266.5	234	240.1	162	161.1	203.7	178.9	129.6	118.66
Kullu	Jun	33.2	30	43.6	34.63	40.4	49.1	30.2	33.9	33.2	42.5
	Jul	40.6	43.6	32.3	34.3	118.2	54.7	24.1	33.4	39.4	52.5
	Aug	55.4	90.3	44.9	52.6	63.4	108.01	33.7	40.3	52.6	71.5
	Sept	41.6	23.4	57.6	81.8	172	115	29.9	33.6	44.8	92
	Oct	23.2	73.5	36.6	33.9	63.4	53	23.8	32.9	27.5	53.5
	Total	194	260.8	215	237.23	457.4	379.81	141.7	174.1	197.5	312

Source: Government portal AgMarkNet

In the selected data to study, variations were seen in both tomato and apple arrivals. Arrivals of apple in Bandrol market were fluctuating every year but after seeing data for alternate years for the ten years period it was found that there were positive shift in the arrival even after arrival were fluctuating (Table 6). In Solan market from 2011-12 to 2013-14 arrivals were increasing enormously, 59852.82 tonnes (2013-14) were the highest ever arrival in this market that was almost four times more than the arrival in 2011-12 (12935.94 tonnes) but after 2013-14 it again started fluctuating and experienced its lowest arrival in 2016-17 (8063.52 tonnes) (Table 6).

In the case of tomato, Bhuntar market experienced its higher arrivals from 2011-12 to 2016-17, but it had fallen downward from 2017-18 to 2020-21 (Figure 1). Kullu market had its maximum arrival in 2015-16 (457.4 tonnes) but after that sudden fall was seen for two years, later from 2017-18 arrival were increasing every year (Figure 2).

Furtheremore, Kangra market had its highest ever arrival in 2011-12 (252.1 tonnes) but after that it was fluctuating every year and had a negative shift as compared to other two markets (Figure 2). Bhuntar and Kangra markets had experienced less arrival in the last 10 years period, both markets had higher arrivals in 2011-12 as compared to 2020-21. Those seasonal arrivals in the both markets were less than the average arrivals of 10 years (Tables 5 and 7). Kullu market had got continuous increase from 2017-18 and the arrival in 2020-21 (312 tonnes) was more than the main seasonal average arrival of last 10 years (Tables 5 and 7). Kangra market had less arrival of tomato as compared to Kullu and Bhuntar during the main season, comparing these markets together it was seen that Bhuntar market had the highest arrival every year (Table 5).

Table 6: Total seasonal arrivals of apple in Bandrol and Solan market (2011-2012 to 2020-21)

Market		2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21
Bandrol	July	80.9	44.5	342.3	32.8	259.5	158	92.8	71.96	23.1	167
	Aug	3045	270	2782	204	485	283	284	620	521	494
			6.5		3.9	4.9	4.6	7.5	3.7	3.1	8.9
	Sep	124	1094	6081	3703	1031	276	425	2187	103	9183
		8.2				1.6	2.3	0.9		54.2	
	Oct	13.5	251	316.5	458.3	201	684.	583.	522.9	182	140
						4.5	4	6		1.4	3.5
	Total	438	4096	952	6238	1744	643	777	898	174	1570
		7.6		1.8		0.5	9.3	4.8	5.56	11.8	2.4
Solan	July	756.1	82.42	774	223	934.9	396	959	432.	126	24.78
				8.3	.08		.54	.58	68	2.08	
	Aug	714	989	2750	937	1115	271	848	768	1221	445
		8.46	3.61	4.63	6.28	0.88	9.3	8.56	3.34	2.24	6.44
	Sep	462	1391	2227	1226	911	494	804	622	1359	8714
		4.54	4.23	2.81	2.18	8.76	7.68	7.4	7.28	3.26	.59
	Oct	406	156	232	1202	314	-	981.1	1379	317	300
		.84	2.26	7.08	.64	1.12			.78	1.28	7.38
	Total	129	2545	5985	2306	2434	806	1847	1572	3023	1620
		35.9	2.52	2.82	4.18	5.66	3.52	6.64	3.08	8.86	3.19

Source: Government portal AgMarkNet

Similarly for apple, seasonal arrival of Bandrol market in 2020-21 was higher than the average arrival, where Solan market had less arrival in 2020-21 as compared to average arrival of 10 years (Tables 6 and 7). It interprets that some markets were facing less arrival every year for both apple and tomato with the time and it will continue in future.

Table 7: Average seasonal arrivals of tomato and apple from 2011-12 to 2020-21

Tomato		Apple	
Market	**Average**	**Market**	**Average**
Bhuntar	2609.38	Bandrol	9799.77
Kangra	183.536	Solan	23435.64
Kullu	256.954		

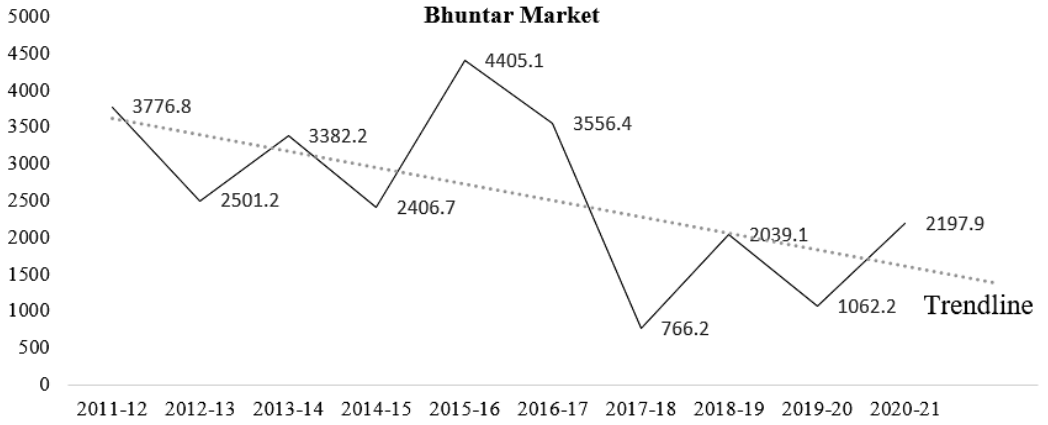

Fig. 1: Trend in total seasonal arrival of tomatoes in Bhuntar market from 2011-12 to 2020-21

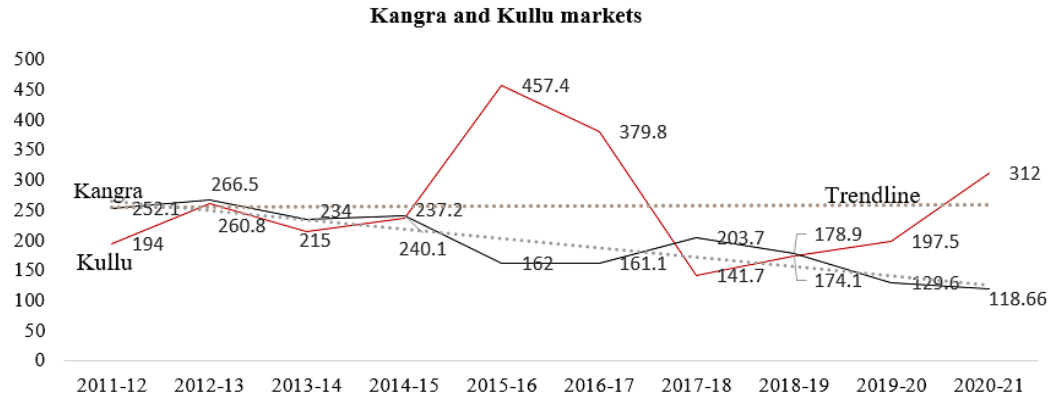

Fig. 1: Trend in total seasonal arrival of tomatoes in Bhuntar market from 2011-12 to 2020-21

Source: Government portal AgMarkNet

Causes of Fluctuations in the Arrivals of Apples and Tomatoes at the Selected Sub-Market Yards
Climate Change During the Development of Crops

Climate change poses a substantial challenge to agricultural practitioners in Himachal Pradesh. The region has observed irregular fluctuations in temperature, which have had discernible consequences. Specifically, apple cultivation necessitates a temperature range of 7 degrees Celsius and below to fulfil the requisite chilling hours, as stipulated by the Intergovernmental Panel on Climate Change. Unfortunately, the deficiency in the accumulation of chilling hours has had a detrimental effect on apple production, subsequently exerting a direct influence on crop arrivals.

Furthermore, elevated temperatures and reduced moisture levels have also had a noteworthy impact on the density and growth patterns of vegetable crops. Consequently, climate change emerges as a pivotal determinant in the production and arrival dynamics of crops within the state.

Hailstorm, Rainfall and Floods

In the elevated terrain of Himachal Pradesh, adverse weather phenomena, including hailstorms, excessive rainfall and flooding, have emerged as significant contributory factors to reduced agricultural yields and arrivals. Hailstorms, in particular, pose a substantial threat to the growth and development of crops such as tomatoes and apples during their critical growth stages. These meteorological events inflict damage on the flowers and nascent fruit formations at various phases of their maturation (Randev, 2008).

Moreover, it is imperative to acknowledge that both tomatoes and apples are highly perishable commodities. When there is a surfeit of rainfall in the mid and high-altitude rural areas, the propensity for floods and landslides increases, significantly hampering transportation logistics. Consequently, there are instances wherein crops succumb to rot while awaiting transport, either on roadsides, in modest storage facilities, or still in the fields, post-harvest and packaging procedures.

Private Agricultural Agencies

In addition to the established entities within the market, small private agencies constitute another significant cohort of participants. These agencies maintain direct links for the sale of agricultural produce in states beyond Himachal Pradesh's borders. Rather than opting for transactions within the Agricultural Produce Marketing Committees (APMCs) of Himachal Pradesh, these agencies procure crops directly from local farmers. Their preference lies in seeking alternative markets and engaging with larger corporate entities, where they can secure more favourable returns for the sale of vegetables and fruits. The practice of selling crops outside the state's confines contributes to the diminished volume of arrivals within the APMCs of Himachal Pradesh.

Price

Price considerations have consistently occupied a central position in the deliberations of policy stakeholders. Frequently, the marketing of agricultural commodities occurs through auction mechanisms or under the purview of predefined price structures established either by the local market dynamics or by the state government. On occasion, these stipulated prices fail to align with the profit expectations of farmers. Consequently, farmers may opt for alternative avenues that offer more lucrative returns for their agricultural produce, thus diverting their participation away from these predefined pricing mechanisms.

Conclusion

The major findings developed from the study signified that the peak arrivals of tomato and apple are in the main seasonal period i.e. August, September for apple and July, August, September months for tomato in Bhuntar and Kullu markets but because of different agro climatic zone the peak time for arrival of tomato in Kangra market was noted in April, May and June months. As both apple and tomato are the important crops in the state but examining annual and seasonal arrival, fall has been noted in arrival for the both crops. Tomato and apple crops have been cash crops for the growers of Himachal Pradesh because of their dominance in the market so farmers would produce apple and tomato continuously in the future and markets will receive arrival every year. But discussed causes in the results articulates that arrival will fluctuate continuously in coming years, it can be an increase or decrease in the annual and seasonal arrivals. In the hypothesis, it is clear that these selected

markets do not have any large impact of heavy rainfall and also variations will be there in arrival of tomato and apple for next ten years. Seasonal production has been found to be a big factor of change in arrival for both apple and tomato. In this study sudden falls in arrival have been discovered, these falls were not minor falls but almost half of the previous year. Considering these changes and trends in the arrival, Agricultural Produce Marketing Committees (APMCs) in Himachal Pradesh ought to take a proactive approach by exploring additional agricultural marketing strategies to efficiently manage the influx of agricultural produce into the markets. Previous studies within APMCs have primarily focused on commodity prices and their impact on arrivals. Future research may delve deeper into understanding the disparities between annual production and arrivals of agricultural commodities within APMCs. This approach would facilitate a more comprehensive examination of various high-yield vegetables and fruits produced in Himachal Pradesh, offering valuable insights for future agricultural marketing initiatives.

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Data Availability Statement
Data was collected from Govt. Agricultural portal Agmarknet, which provides weekly price trend report for important markets in respect of major agricultural commodities.

Ethics Approval Statement
Authors clear that this study was not performed on any human and animal.

Authors' Contribution
First author did literature review, study design, data collection, data analysis, data interpretation, and writing of manuscript, while co-author assisted and advised in read early drafts, data interpretation and final manuscript submission of the project.

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