Climate Shocks and Kitchen Staples: How Extreme Weather Events Drive Food & Vegetable Inflation in India

Source: Shutterstock

September 2025

Executive Summary

This study analyzes how extreme heat and erratic rainfall are driving sharp price spikes in tomato, onion, and potato (TOP)—key household staples and major contributors to food inflation in India. Despite modest weight in the Consumer Price Index, their perishability and concentrated production make them highly vulnerable to climate shocks. Events such as excessive rains in Himachal Pradesh and Karnataka in 2023 damaged tomato harvests, while unseasonal rains and hailstorms in Maharashtra reduced onion yields by nearly 29%. Similarly, potato production in Uttar Pradesh and West Bengal declined by 7% in 2023–24 due to frost and heavy rains. In 2024, record-breaking heatwaves and erratic rainfall further strained TOP production, pushing wholesale prices of potatoes, tomatoes, and onions consistently above past averages. The study stresses the need for climate-resilient agriculture, better storage and transport infrastructure, timely weather advisories, and social protection measures to reduce volatility and safeguard food security in the face of intensifying climate risks.

I. Background

Climate change is intensifying extreme weather events, disrupting food systems, and threatening price stability—especially in India's vegetable markets. With 65% of cropped land unirrigated and agriculture dependent on the southwest monsoon for over 75% of annual rainfall, the sector is highly vulnerable to erratic rains, rising temperatures, and climate shocks like cyclones and hailstorms. Research by the **Reserve Bank of India** indicates that short duration crops like vegetables, being perishable and highly sensitive to sudden weather shocks, exhibit sharp price volatility and are major drivers of food and headline inflation. The second largest producer of vegetables and fruits in the world, the maximum supply of vegetables in India comes from small and marginal farmers with very little or no safeguard against such disturbances. Farmers generally base their agricultural decisions on normal weather conditions as well as prevailing market prices while deviations from these normal conditions can affect crop production, leading to price fluctuations. The temporary disruption in the supply chain and the physical losses accrued from erratic weather patterns can create short and medium term shortages of goods, subsequently raising the prices. As climate volatility intensifies, the connection between extreme weather and inflation is becoming increasingly direct and concerning. A study by the **Reserve Bank of India** suggests that on an average, rainfall changes raise vegetable inflation by about 1.24 percentage points, while temperature changes increase it by around 1.30 points. Temperature shifts tend to affect prices more quickly than rainfall changes.

II. Tomato Onion Potato (TOP) Vegetables: A Major Contributor to Food Inflation in India

India's Consumer Price Index (CPI-C) has a high food and beverage weight (45.9%), making it highly sensitive to food supply shocks. TOP with a combined weight of 36.5% in the CPI-vegetables basket, 4.8% in the food and beverages basket, and 2.2% in the overall CPI basket, are the major sources of supply shocks in food as they are highly sensitive to weather shocks. Irrespective of such a low weight in the CPI-C, they are a significant contributor to the volatility of CPI-C inflation as the range of movement of CPI-C distribution is around 3.5 percentage points higher on account of TOP.

Onions, tomatoes, and potatoes—staples in most households—are especially vulnerable to extreme weather, despite self-sufficient production levels. Weather shocks disrupt the supply-demand balance, reduce storage, and damage both standing and stored crops due to high moisture, increasing the risk of fungal infections. These vegetables face significant post-harvest losses during storage and transport, worsened by rain and temperature shifts. Their perishable nature and concentrated production in a few states make their prices highly volatile.

Around 85%–90% of the potato crop in India is raised in rabi (winter), while Himachal Pradesh, Karnataka, Maharashtra and Uttarakhand also produce potatoes in the kharif season. Tomatoes are produced throughout the year in states like Madhya Pradesh, Andhra Pradesh and Maharashtra while onions have three main harvesting seasons—kharif, late kharif and rabi. Uttar Pradesh and West Bengal are the top two potato producing states while Maharashtra and Madhya Pradesh rank highest in onion production. The top two onion- and potato-producing states contribute almost 50% of the total production in the country, while also making these commodities vulnerable to extreme weather events in these states. On the other hand, production of tomatoes is well distributed across states, making it comparatively less vulnerable. Deficit rain clearly impacts all the three vegetables reflecting the rain-fed nature of Indian agriculture. Besides, hailstorms in the case of tomatoes, excess rains in onions and cyclones in potatoes are the significant drivers of prices. With regard to onions, excess rain and floods, both have a significant impact on prices. In the case of potatoes, cyclones, hailstorms as well as floods have a positive impact on prices. In India, prices of vegetables, especially TOP, become the first casualty of such severe events.

III. Erratic Weather Patterns in India under Conditions of Climate Change

Climate change has made India's weather patterns increasingly unpredictable with a surge in the frequency and intensity of disasters. India witnessed extreme weather events in some form or the other on 93 per cent of days in the first nine months of 2024. In fact, the lethal heat waves which the country has witnessed in 2022 and 2023 were made 30 times more intense and more likely due to climate change. Meanwhile, rainfall patterns have become erratic. In the past 40 years during the southwest monsoon, approximately 30 per cent of India's districts witnessed a high number of deficient rainfall years while extreme rainfall events in the subcontinent are also on the rise. There has been a three fold increase in extreme rainfall events across a large area over Central India due to warming of Arabian sea and resultant moisture incursion, leading to extreme rain episodes across the entire central Indian belt. Climate change is also warming the atmosphere, increasing its moisture-holding capacity, which means increased frequency and intensity of heavy rainfall events, unpredictable shifts in their timing, such as out-of-season occurrences.

"Climate change has made India's weather patterns erratic, leading to an exponential rise in the frequency and intensity of disasters. Spells of heatwaves are more intense and prolonged, while rainfall patterns are erratic marked by extremely heavy rainfall in shorter duration and longer dry spells. Along with land temperatures, ocean temperatures have been rising exponentially due to global warming. This rise has increased the moisture-holding capacity of air, resulting in extremely heavy rainfall events. Agriculture is the primary victim of the rising extreme weather events. While heavy downpour results in landslides, mudslide, soil erosion and flattening of crops, rising temperature impacts soil moisture, shrivelled

grains, flower drop and heat stress. These effects potentially impact nutritional quality of food products and can reduce crop yield, threatening food security by increasing prices for household staples and the livelihoods of farmers," **said Mahesh Palawat, Vice President-Meteorology and Climate Change, Skymet Weather.**

According to research, between 15% and 40% of locations where rainfed rice is currently grown may be less suitable or even unsuitable for that method of agriculture by 2050. Food security will be increasingly affected by projected future climate change, according to a recent report by the United Nation led IPCC. Distributions of pests and diseases will change, affecting production negatively in many regions. Given increasing extreme events and interconnectedness, risks of food system disruptions are growing.

IV. How Extreme Weather Events Affect TOP Vegetables and Drive up Consumer Food Inflations

An attempt has been made in this section to relate extreme weather conditions to food inflation rates and wholesale prices in Azadpur Mandi, Asia's largest fruit and vegetable wholesale market. According to the Economic Survey of Delhi 2023-2024, Azadpur mandi does an annual trade of over 150 crore rupees in sale and purchase of 42 lakh tonnes of fruits and vegetables from several states, in three market yards spread across 100 acres.

Food inflation, which had eased post-2014 due to improved supply, spiked in 2019-20 owing to unseasonal and excessive rains. Key triggers included kharif onion crop damage in Maharashtra, Karnataka and Madhya Pradesh (Oct–Nov 2019), and rainfall and cyclone induced potato crop losses in UP and West Bengal (Mar–May 2020). The rising trend continued further in 2020-21 amid pandemic disruptions. It briefly moderated in 2021-22 but climbed again due to post-pandemic demand and the Russia-Ukraine war. Just as conditions began to stabilize, erratic weather in 2023-24 triggered new supply shocks, especially in vegetables, keeping inflation high. While the monetary policy reports by RBI indicated strong deflation of vegetable prices in December 2022, headline CPI inflation picked up to 4.8 per cent in June from a spike in vegetable prices. Sporadic food price shocks continued to impart significant volatility to the inflation trajectory, with headline inflation rising sharply in November and December 2023 due to a hike in vegetable prices. Food inflation remained persistently high in 2024-25, driven by high prices in cereals and pulses along with large shocks to vegetable prices triggered by recurrent adverse climate events of rising intensity.

In **July 2023**, excessive rains and floods inundated fields and reportedly damaged standing tomatoes in Himachal Pradesh and scorching summer followed by heavy rain spelt a doom on tomato production in Karnataka. These two states are the top suppliers to the Delhi market in the summer-monsoon season. According to APEDA (Agriculture and Processed Food Products Export Development Authority) data, nearly 10.9% and 12.9% decline in crop production in Himachal Pradesh and Karnataka respectively in 2023 propelled consumer food inflation which peaked in July 2023. As per AGMARK (Agricultural Marketing) data, prices of tomatoes were anomalously high while supply was abysmally low in Azadpur Mandi in July 2023. The wholesale price of tomatoes reached ₹6,743.58 per quintal (or ₹67.4 per kg) at Azadpur Mandi in July 2023 from 18 rupees/kg in June. This was also a substantial hike as compared to the prevailing price of ₹15–16 per kg in July of previous years. The

supply stood at 318 tonnes, significantly lower than the average monsoon-season trend of 400–500 tonnes in previous years.

Citing similar trends, IPCC's Special Report on Climate Change and Land suggests that the crop yield studies focusing on India have found that warming has reduced wheat yields by 5.2% from 1981 to 2009, despite adaptation. In India, farmers are changing sowing and harvesting timing, cultivating short duration varieties, inter-cropping, changing cropping patterns, investing in irrigation, and establishing agroforestry. These are considered as passive responses or autonomous adaptation, because they do not acknowledge that these steps are taken in response to perceived climatic changes.

Table 1: Tomato Production in Haryana and Himachal Pradesh

Tomato Production in Haryana and Himachal Pradesh (in tonnes)			
	2022	**2023**	**% Decline**
Himachal Pradesh	532340	474340	10.9
Karnataka	2303790	2007330	12.9

Source: Agriculture and Processed Food Products Export Development Authority, GoI

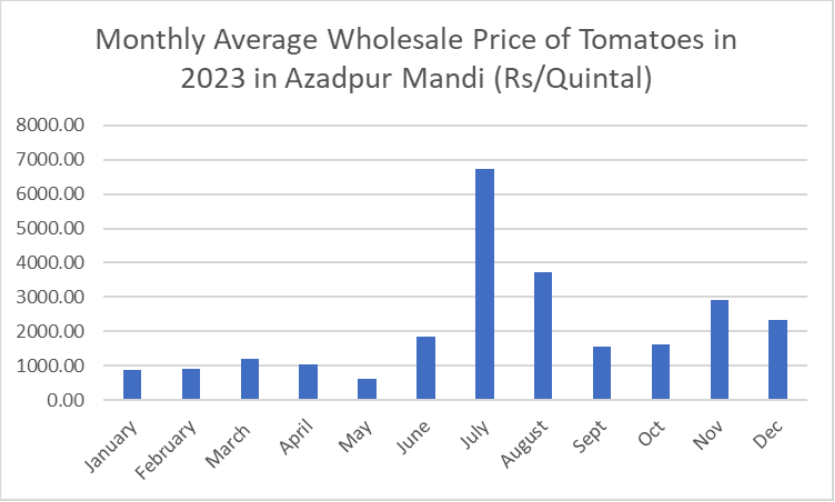


Figure 1: Monthly Average Wholesale Price of Tomatoes in Azadpur Mandi in 2023
Source: Agricultural Marketing (AGMARK)

While food inflation started to stabilize September-October, unseasonal rain and hail storms in Maharashtra caused extensive damage to the standing late kharif crop of onions in **November 2023** again pushing up vegetable prices. There was a 28.5% decline in onion production in 2023 in Maharashtra as compared to 2022. The wholesale price of onions in

Azadpur Mandi in the first week of November remained between 30-39 rupees per kg and came down to 15-20 rupees/kg only later in the month.

Table 2: Onion Production in Maharashtra

Onion Production in Maharashtra (in tonnes)			
	2022	**2023**	**% decline**
Maharashtra	**12033040**	**8602000**	**-28.51**

Source: Agriculture and Processed Food Products Export Development Authority, GoI

2024 emerged as the hottest year on record. Above average winter temperature exacerbated by climate change and El Nino, erratic rainfall patterns and prolonged periods of record breaking heatwaves affected the TOP vegetables.

Media reports indicated that adverse weather conditions (unseasonal rain during sowing and harvesting in West Bengal and frost in Uttar Pradesh) have led to a drop in the output in the 2023-24 crop year (July-June) resulting in a rise in retail prices throughout the year till the new stock arrived in December. According to APEDA (Agriculture and Processed Food Products Export Development Authority) the output dropped by 7% from 34634560 (three crores forty six lakhs thirty four thousand five hundred and sixty) tonnes in 2022 to 32173000 (three crores twenty one lakhs seventy three thousand) tonnes in 2023 keeping both the vegetable and consumer food inflation rates high throughout the year. Extreme heat reportedly increased the prices of tomatoes. Onion prices remained higher than average.

In fact, wholesale prices in Azadpur Mandi remained consistently high (as compared to previous years) particularly in the second half. For example, the average wholesale price of potatoes in Azadpur in August 2024 was 21.6 rupees per kilogram as against the 10-14 rupees prevailing in the same month in the past 3 years (2021-2023). Tomato was sold at 40 rupees/kg on an average in Azadpur Mandi in July 2024. Onion prices peaked at 37 rupees/kg on an average in September.

Table 3: Potato Production in Uttar Pradesh and West Bengal

Potato Production in Uttar Pradesh and West Bengal (in tonnes)			
	2022	**2023**	**% decline**
Uttar Pradesh	20126000	19173000	-4.7
West Bengal	14508560	13000000	-10.4
Total	34634560	32173000	-7.1

Source: Agriculture and Processed Food Products Export Development Authority, GoI

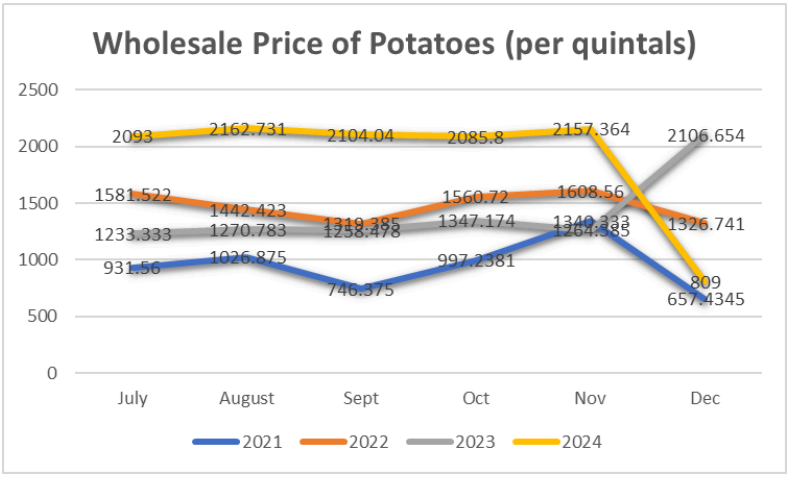


Figure 2: Wholesale Price of Potatoes (2021-2024)
Source: Agricultural Marketing (AGMARK)

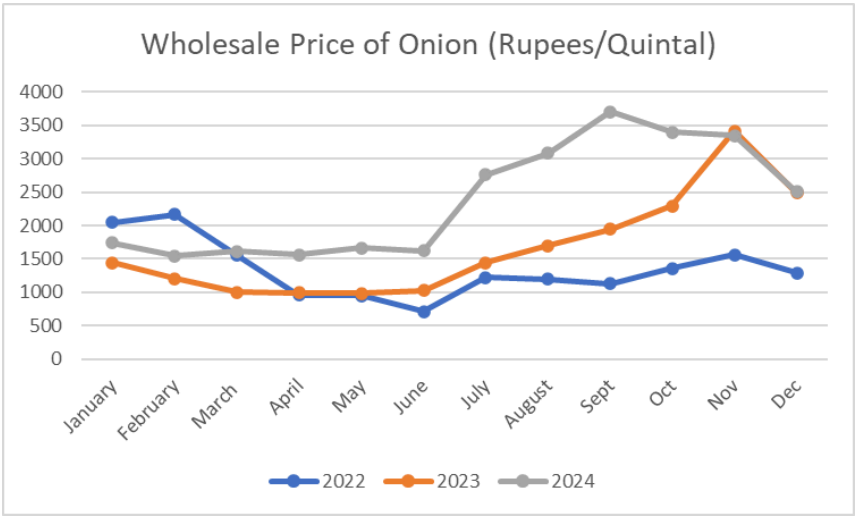


Figure 3: Wholesale Price of Onions (2022-2024)
Source: Agricultural Marketing (AGMARK)

V. Field Insights from Azadpur Mandi

Vegetable sellers in Azadpur Mandi also shared how extreme heat and rainfall imperils transportation and sale of vegetables in the summer monsoon season. Tomatoes in Azadpur in New Delhi come from Bengaluru and Himachal in monsoons. Wholesalers reported that due to the heavy rains in Himachal, tomatoes got damaged both in the field leading to poor quality and low supply to Delhi.

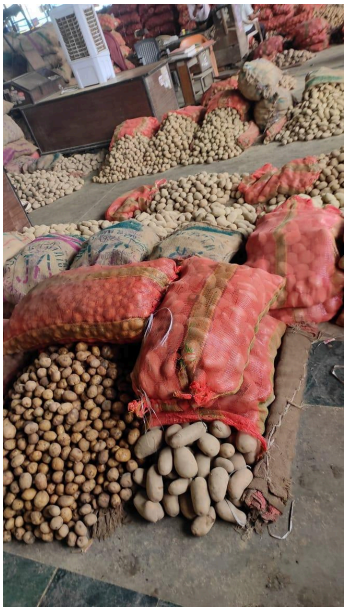
Quotes from Wholesalers in Azadpur Mandi:

"The produce from Himachal got damaged due to the rain. The tomato season in Himachal usually starts around June 15–20, but this time the rains destroyed standing crops. The ones which reached Delhi are poor in quality and are fetching very low prices,"

"*On days of extreme rainfall, supply of vegetables to the market is low, prices are higher, fewer retailers come to get their stock from Azadpur Mandi. Unsold vegetable rot in the market,*"

Adverse weather conditions lead to losses during transportation.
"When it rains, moisture gets trapped inside the vegetable crates, which causes them to rot during transportation. Even during summers tomatoes travel long distances, tightly packed in crates. The ones in the bottom of the crate break and crumble under pressure and heat."

Tomato and Onion Markets in Azadpur Mandi



Water Logged lanes of Azadpur Mandi in Monsoons

VI. Major Drivers of Food Inflation in 2023-24

Table 4: Impact of Extreme Weather Event on Crop Yield and Food Inflation

Year	State	Extreme Weather Event	Impact on Crop	Total Crop Loss	Impact on CFPI	Impact on Vegetable Inflation	Impact on wholesale price
2024	UP & WB	Unseasonal rainfall in West Bengal	**Potato**	Combined production of potato in UP and	CFPI remained consistently high in 2024 with consumer	Vegetable inflation peaked at 42.18 in	Wholesale prices remained consistently high particularly in

		and frost in Uttar Pradesh in late 2023 and early 2024 have led to a drop in the output in the 2023-24 crop year (July-June) resulting in a rise in retail prices lasting till the end of November		West Bengal fell by 7% in 2023-24 as compared to 2022	food inflation peaking at 10.87 points in October	October 2024	the second half of the year
2023	Karnataka and Himachal Pradesh	In July 2023, excessive rains and floods inundated fields and damaged standing tomatoes in Himachal Pradesh Scorching summer and heavy rain spelt a doom on tomato production in Karnataka. These two states are chief suppliers of tomatoes to Delhi Market in monsoons	**Tomato**	10.9% decline in tomato cultivation in Himachal Pradesh in 2023 as compared to 2022 12.9% decline in Karnataka in 2023 as compared to 2022	Consumer food inflation reached 11.51% in July 2023, highest for the whole year Delhi CPI rose From 1.53 in May to 2.04 in June 2023 to 3.72 points in July	Vegetable inflation stood at 37.34%	Wholesale price rose to 67 rupees/kg as compared to 18 rupees/kg prevailing in June 2023
2023	Maharashtra	Unseasonal rain and hail storm in Maharashtra caused extensive damage to standing late kharif crop of	**Onions**	28.5% decline in onion production in 2023 in Maharashtra as compared to 2022	After the peak in July-August owing to loss in tomatoes, CFPI soared again to 8.7 and 9.53 in Nov and Dec 2023	Vegetable inflation stood at 17.7 and 27.64 in Nov and December 2023	Price reached 39 rupees/kg in Azadpur Mandi on 1st December

		onions in November 2023					

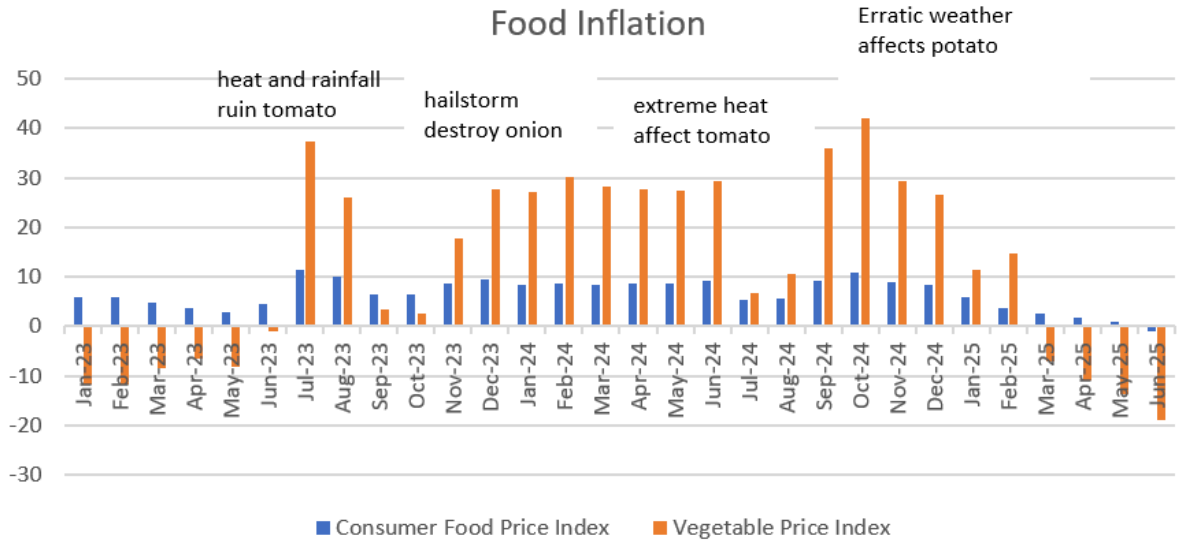


Figure 4: Impact of Extreme Weather Event on Food Inflation in India
Source: Ministry of Statistics and Program Implementation

VII. Way Forward

Climate change-driven food price shocks disproportionately affect low-income households, Heightened prices of staple vegetables lead to reduced consumption of nutritious foods and worsening health outcomes. With one disaster occurring nearly every day between January and September 2023, climate change is clearly intensifying the frequency and severity of extreme weather events. Extreme weather events have a strong, immediate impact on vegetable prices, particularly for perishable crops like tomatoes, potatoes and onions. This highlights the need for improved weather monitoring, adoption of climate-resilient crop varieties, and risk-mitigating policies. Weather-informed price forecasting can enhance resilience. Targeted social protection measures, such as index-linked social security and nutritional safety nets, are also vital to cushion vulnerable groups against inflationary shocks.

"While natural Calamities are on a rise their impacts cannot be fully controlled. Perishable commodities like tomato, chilli and capsicum are suitable for protected cultivation and can be maintained under green house management technology to shield from extreme weather conditions. This technique will not work for potatoes or onions.
We need to build our strength in the forward operations in the supply chain with prompt warehousing, inventory management, use of refrigerated vans for transportation to adapt better. Initiatives like I-Kisan provide weather related information to farmers. For example, excess moisture leads to scabbing in onions destroying the produce soon after harvest. If

farmers have timely weather advisories about rainfall they could delay harvest and avert the risk of damage.

Big farmers can absorb weather shocks, but small landholders are disproportionately affected. They often do not have the means to cope with losses incurred from adverse weather conditions while adaptation entails additional costs for them. Cluster farming can build collective resilience. For easily perishable crops like tomatoes, transporting and selling the produce immediately after harvest can reduce the post harvest losses from weather conditions. To prevent spoilage from increasing heat, farmers in the same area can pool their produce together and transport them in a refrigerated van to the nearest mandis. This is an economical option for small farmers to safeguard their produce from heat induced losses.

In order to get a fair price for their produce farmers also need to know the market demand for the crop they are growing. We need updated horticulture statistics to periodically inform farmers of prevailing market demand so that they can base their sowing decisions on market requirements to avoid a glut in the market later" – **Dr Ashutosh Singh, Professor, College of Agribusiness Management, G.B. Pant University of Agriculture and Technology.**

Annexure

Table 5: Inflation Data (2019-2025)

Month	**Consumer Food Price (year-on-year) inflation**	**Vegetable Inflation**	**Extreme Weather Events affecting Vegetable Supply**
Jan-19	-2.17	-4.18	
Feb-19	-0.66	-7.69	
Mar-19	0.3	-1.49	
Apr-19	1.1	2.87	
May-19	1.83	5.46	
Jun-19	2.17	4.66	
Jul-19	2.36	2.82	
Aug-19	2.99	6.9	
Sep-19	5.11	15.4	
Oct-19	7.89	26.1	

Nov-19	**10.01**	**35.99**	**Rainfall damaged onions in Maharashtra, MP and Karnataka**
Dec-19	**14.12**	**60.5**	
Jan-20	**13.63**	**50.19**	
Feb-20	**10.81**	**31.61**	
Mar-20	**8.76**	**18.63**	**Unseasonal Rainfall damage potatoes in UP and West Bengal**
Apr-20			
May-20			
Jun-20	7.87	1.86	
Jul-20	9.62	11.29	
Aug-20	9.05	11.41	
Sep-20	10.68	20.73	
Oct-20	11.07	22.51	
Nov-20	9.43	15.63	
Dec-20	3.41	-10.41	
Jan-21	1.89	-15.84	
Feb-21	3.87	-6.27	
Mar-21	4.94	-4.83	
Apr-21	2.02	-14.18	
May-21	5.01	-1.92	
Jun-21	5.15	-0.7	
Jul-21	3.96	-7.75	
Aug-21	3.11	-11.68	
Sep-21	0.68	-22.47	

Oct-21	0.85	-19.43	
Nov-21	1.87	-13.62	
Dec-21	4.05	-2.99	
Jan-22	5.43	5.19	
Feb-22	5.85	6.13	
Mar-22	7.68	11.64	
Apr-22	8.38	15.41	
May-22	7.97	18.26	
Jun-22	7.75	17.37	
Jul-22	6.75	10.9	
Aug-22	7.62	13.23	
Sep-22	8.6	18.05	
Oct-22	7.01	7.77	
Nov-22	4.67	-8.08	
Dec-22	4.19	-15.08	
Jan-23	5.94	-11.7	
Feb-23	5.95	-11.61	
Mar-23	4.79	-8.51	
Apr-23	3.84	-6.5	
May-23	2.91	-8.18	
Jun-23	4.49	-0.93	
Jul-23	**11.51**	**37.34**	**Rainfall and heat affect tomatoes in Himachal and Karnataka**
Aug-23	**9.94**	**26.14**	
Sep-23	6.56	3.39	

Oct-23	6.61	2.7	
Nov-23	**8.7**	**17.7**	**Hailstorm and flood ruin onions in Maharashtra**
Dec-23	**9.53**	**27.64**	
Jan-24	8.3	27.03	
Feb-24	8.66	30.25	
Mar-24	8.52	28.34	
Apr-24	8.7	27.8	
May-24	8.69	27.33	
Jun-24	**9.36**	**29.32**	**High temperatures led to high prices of TOP vegetables in the second half of the year**
Jul-24	**5.42**	**6.83**	
Aug-24	**5.66**	**10.71**	
Sep-24	**9.24**	**35.99**	
Oct-24	**10.87**	**42.18**	
Nov-24	**9.04**	**29.33**	
Dec-24	8.39	26.56	
Jan-25	6.02	11.35	
Feb-25	3.75	14.82	
Mar-25	2.69	-7.04	
Apr-25	1.78	-10.98	
May-25	0.99	-13.7	
Jun-25	-1.06	-19	

Source: Ministry of Statistics and Program Implementation