

## # Impact of the 2023-24 El Niño on South Asian Rainfall and Crop Production

The 2023-24 El Niño emerged as the second strongest event of the 21st century, following a rare triple-dip La Niña from 2020-2023. Despite initial concerns about significant negative impacts on South Asian monsoon rainfall and agricultural productivity, the actual outcomes revealed a complex interplay of climate factors that resulted in surprisingly resilient agricultural production across the region. This report quantifies the El Niño's impacts on rainfall patterns and crop yields across South Asia, analyzing both the meteorological and agricultural dimensions of this climate event.

### ## Characteristics of the 2023-24 El Niño Event

The 2023-24 El Niño officially began in June 2023, when NOAA's Climate Prediction Center issued an El Niño Advisory on June 8, 2023[3]. This event emerged after three consecutive years of La Niña conditions (2020-2023), making it particularly noteworthy for climate scientists. The event exhibited a distinctive two-step warming tendency with two warming centers in the Pacific Ocean[12]. It steadily intensified through 2023, reaching the strong El Niño category by December[12].

The event's strength can be measured through the Oceanic Niño Index (ONI), which peaked at +2.0°C in November-December-January 2023-24[17][1]. By February 2024, the ONI had decreased to +1.8°C, indicating the beginning of its weakening phase[17]. The evolution of this El Niño didn't follow typical patterns, as a series of unusual easterly anomalies over the tropical western-central Pacific persisted after the end of the preceding La Niña, which contributed to a slowdown in the event's growth rate by mid-2023[4].

Interestingly, this El Niño contributed to a significant global warming spike, with researchers finding that "the 2023 global warming spike was driven by the El Niño–Southern Oscillation"[15]. Global mean surface temperature rapidly increased by  $0.29 \pm 0.04$  K from 2022 to 2023, making 2023 the warmest year on record[15].

### ## El Niño's Impact on the 2023 South Asian Monsoon

### ### Forecast vs. Reality

Prior to the 2023 monsoon season, climate forecasts largely predicted below-normal rainfall for South Asia. The World Meteorological Organization (WMO)-backed South Asian Climate Outlook Forum (SASCOF) forecasted "normal to below normal rainfall" for most parts of the region during the 2023 southwest monsoon season[18]. This aligned with historical patterns, as El Niño conditions typically correlate with weaker monsoons in the region[6].

However, the actual rainfall deficit proved less severe than anticipated. The 2023 southwest monsoon in India concluded with a rainfall deficit of just 5.6% from normal, which is classified as "below normal" rainfall[7]. The India Meteorological Department (IMD) noted that "the impact of El Niño on the Indian monsoon in 2023 was among the lowest since 1901"[7]. This represents a significant departure from historical El Niño impacts, which have often resulted in more substantial rainfall deficits.

### ### Regional Rainfall Distribution

The monsoon's temporal and spatial distribution showed significant variations across South Asia:

- The monsoon onset over Kerala occurred on June 8, 2023, seven days behind its normal date[13].
- Out of 36 meteorological subdivisions in India, 26 recorded normal rainfall (covering 73% of the country's area), while 7 subdivisions recorded deficit rainfall (18% of the area), and only 3 subdivisions witnessed excess rainfall (7% of the area)[16].
- Major rainfall deficits were observed in Kerala (-36%), Jharkhand (-27%), and Bihar (-24%)[16].
- Unexpected excess rainfall occurred in typically drier regions like West Rajasthan (+42%), Saurashtra and Kutch (+48%), Himachal Pradesh (+19%), and Telangana (+15%)[16].

The irregular spatial distribution of rainfall represented a notable anomaly, with typically wetter regions experiencing dryness while drier western regions received excess rainfall. This pattern reflects increasing climate variability that some researchers attribute to rising sea-surface temperatures in the Indian Ocean[16].

### ### Moderating Factors

The milder-than-expected impact of El Niño on the 2023 monsoon can be attributed to counterbalancing climate factors:

1. A positive Indian Ocean Dipole (IOD) emerged during the monsoon season, which typically favors normal to above-normal rainfall in parts of South Asia[7].
2. The Madden Julian Oscillation (MJO) entered favorable phases during September 2023, which helped revive monsoon rains toward the end of the season[7][13].
3. These counteracting forces effectively moderated El Niño's typically suppressive effect on the South Asian monsoon.

## ## Agricultural Production Outcomes

### ### Record Food Grain Production

Despite the below-normal monsoon rainfall, South Asia achieved remarkable agricultural outputs during the 2023-24 crop year:

- India's total foodgrain production reached a record 332.22 million tonnes in 2023-24, an increase of 2.61 million tonnes from the previous year's 329.6 million tonnes[14][11].
- Rice production in India hit an all-time high of 137.82 million tonnes, up from 135.75 million tonnes in 2022-23[14][11].

- Wheat output also achieved a record 113.29 million tonnes compared to 110.55 million tonnes the previous year[14][11].
- Telangana emerged as India's largest rice-producing state with 168.75 lakh metric tonnes (LMT), accounting for 12.5% of the country's total rice production[8].

This resilience in food grain production demonstrates the agricultural sector's adaptability to climate variability and improved agricultural practices across the region.

### ### Crop-Specific Impacts

While the overall foodgrain production picture was positive, certain crops did experience negative impacts from the irregular rainfall distribution:

- Pulses production in India declined to 24.24 million tonnes from 26.05 million tonnes in the previous year[14][11].
- Oilseeds output fell to 39.66 million tonnes from 41.35 million tonnes[14][11].
- Sugarcane production decreased to 453.15 million tonnes from 490.53 million tonnes[14].
- Cotton output declined to 32.52 million bales from 33.66 million bales[14].

These reductions were attributed to "drought-like conditions in southern states, including Maharashtra and prolonged dry spell during August especially in Rajasthan"[14][11], which aligns with the rainfall deficit patterns observed during the monsoon.

### ### Regional Agricultural Success Stories

Several countries in South Asia managed to achieve agricultural growth despite the El Niño conditions:

- Bangladesh continued its agricultural success streak, with rice production growing for the sixth consecutive year in FY 2022-23, reaching a record 3.91 crore tonnes (39.1 million tonnes), up 2.5% from the previous year[9].

- Pakistan's 2024 wheat harvest was expected to be a record, thanks to an increase in the area planted to 9.12 million hectares, up from 8.86 million hectares in the previous year[10], though the final yield was projected to be lower than the government's ambitious target due to fertilizer application issues.

## ## Quantifying El Niño's Agricultural Impact

### ### Rainfall-Yield Relationship

The 2023-24 El Niño presents an interesting case study in the relationship between rainfall anomalies and agricultural productivity. With a 5.6% rainfall deficit, India still managed to increase its foodgrain production by approximately 0.8% year-over-year[14][11]. This suggests that moderate rainfall deficits can be overcome through improved agricultural techniques, water management, and crop varieties.

The impact varied significantly by crop type and region:

- Rice, which requires substantial water, showed remarkable resilience with a 1.5% increase in production despite the rainfall deficit[14][11].

- Wheat, primarily grown in the winter season (rabi) when irrigation plays a more significant role than monsoon rainfall, saw a more substantial 2.5% increase[14][11].

- Pulses and oilseeds, which are often grown in rainfed conditions, experienced production declines of approximately 7% and 4%, respectively[14][11].

### ### Comparison with Previous El Niño Events

Historically, strong El Niño events have led to significant monsoon failures and agricultural impacts in South Asia. However, the 2023-24 event demonstrated unusual resilience.

While 2023-24 was the second strongest El Niño of the 21st century[12], its impact on the Indian monsoon was "among the lowest since 1901"[7]. This suggests evolving climate dynamics or improved agricultural adaptability in the region.

## ## Conclusion and Future Outlook

The 2023-24 El Niño produced less severe impacts on South Asian rainfall and agricultural production than initially feared. While the monsoon did experience a 5.6% deficit, counterbalancing climate factors like the positive IOD and favorable MJO phases helped moderate El Niño's impact. The agricultural sector demonstrated remarkable resilience, with record food grain production despite the rainfall anomalies.

As of May 2025, neutral ENSO conditions are prevailing in the Pacific, with an ONI value of 0.2°C[19]. The outlook for the 2025 southwest monsoon season indicates "above normal rainfall is most likely over most parts of South Asia"[5][20], representing a positive shift from the below-normal rainfall experienced during the 2023 El Niño season.

This case study of the 2023-24 El Niño demonstrates the complex interplay between global climate patterns and regional agricultural outcomes. It highlights the importance of considering multiple climate factors beyond just El Niño when predicting monsoon performance, and suggests that South Asian agriculture has developed significant resilience to moderate rainfall anomalies. However, the varying impacts across different crops and regions also emphasize the need for continued investment in climate-resilient agricultural practices and improved water management to sustain food security in the face of increasing climate variability.

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