

Climate concerns cloud crops

Multiplying extreme events magnify the vulnerabilities
of agriculture in India

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Research

Analytical contacts

Dharmakirti Joshi

Chief Economist

dharmakirti.joshi@crisil.com

Dipti Deshpande

Principal Economist

dipti.deshpande@crisil.com

Adhish Verma

Senior Economist

adhish.verma@crisil.com

Pankhuri Tandon

Economist

pankhuri.tandon@crisil.com

Media contacts

Aveek Datta

Media Relations

M: +91 99204 93912

B: +91 22 3342 3000

aveek.datta@crisil.com

Riddhi Savla

Media Relations

M: +91 98199 57423

B: +91 22 3342 3000

riddhi.savla1@crisil.com

Executive summary

- This year has been a wake-up call for India, as well as for others in the sub-continent and other parts of the world hit by intense heatwaves, erratic rains, floods, droughts, storms and cyclones causing wide-spread damage to life and property. In India, heatwaves pre-monsoon, patchy progress of rainfall during the monsoon, and excess rainfall post-monsoon have impacted several agricultural crops and swayed food inflation
- It is widely researched now that India is one of the countries in Asia most vulnerable to the physical risks of climate change. An analysis by the United Nations' Intergovernmental Panel on Climate Change (IPCC) indicates agriculture in India will come under greater pressure from increased frequency of heatwaves, more rainfall extremes (more frequent dry spells and extreme rainfall), water scarcity, and soil degradation
- India's problem is also unique, given its high reliance on agriculture for employment and output, repeated struggles with controlling food price inflation, high reliance on fossil fuel for power, high emission intensity of industrial production, and limited fiscal space to react and/or respond to climate change
- Climate change is primarily a fiscal challenge for the governments. At the recently concluded COP27 climate summit, India submitted its long-term low-carbon development strategy that aims at expanding renewables use, strengthening energy efficiency measures, rationalising fossil-fuel resource utilisation, and ensuring optimum energy mix while following on a development-focused transition. The damage from climate shocks, though, is visible already. Therefore, in the short term, the Indian government's climate action response should also more sharply focus on mitigating risks to the agriculture sector. While the government cannot control the physical climate risks to the sector, it can speed up other efficiency improvements, such as reducing crop wastage, improving irrigation, setting up warehousing facilities, and promoting research, development and introduction of weather-resilient, high yielding varieties of crops. Promoting investment in food processing and cold storage to reduce food wastage is another option that can help reduce losses

Macro snapshot

- This year, the unanticipated rise in food inflation has been a concern. Elevated global food prices amid supply shortages and input cost pressures due to the Russia-Ukraine war initially played spoilsport, but closer to home — truant weather aggravated pressure on domestic prices
- Full-year agriculture growth doesn't face much downside as rabi prospects appear bright, thanks to good soil moisture content and healthy reservoir levels. Yet, patchy rainfall during the southwest monsoon resulted in lower kharif sowing, especially for rice and pulses, while unusually high October rains led to some crop damage, leading to higher prices of foodgrains, fruits and vegetables
- In India, changing monsoon patterns and rising frequency of extreme weather events could largely be explained as offshoots of climate change. This highlights a bigger concern around the need to assess climate shocks and the impact on the Indian economy. Though there are learnings from other countries, which are first movers attempting to mitigate the impact of climate change, India's problem is also unique, given its high reliance on agriculture for employment and output, the repeated struggles with controlling food price inflation, high reliance on fossil-fuel for power, high emission intensity of industrial production and limited fiscal space to react and/or respond to climate change.

It's a haul

Two times is a brace, three is a hat-trick. Four times is a haul.

The southwest (SW) monsoon season, which runs from June to September and brings about three-fourths of the yearly rainfall, ended the season measuring slightly above normal¹ (6% above the long period average, or LPA) at the all-India level - the fourth straight season of good downpour.

But, while a normal monsoon typically bodes well for food production and prices, the pattern of rains in terms of distribution, intensity and timing this year has offset some of those benefits.

Specifically, there are two factors that are impacting agriculture this fiscal:

- Skewed distribution through the season, i.e., deficiency in some parts and excess in others impacted kharif sowing, especially of rice and, to some extent, pulses
- Delayed withdrawal and excess rains in October caused some crop damage

In October, rains were 49% above the LPA, with states such as Uttar Pradesh and Haryana recording 416% and 282% higher rainfall than LPA, respectively.

October is important because the standing kharif crop is in the last stage of being harvested.

Similar weather-related impact was witnessed earlier in the year as well. April and May are key months for the rabi crop and extreme heat around then had hurt the wheat harvest.

A key risk to agriculture is the damage from unseasonal rain and heat patterns to foodgrains, vegetables and other crops.

Such weather shocks have become more frequent, intense, and worryingly, remain unpredictable. For instance, October this year was one of the wettest in recent years at the all-India level.

The unevenness or lack of predictability of weather conditions highlights a bigger concern around the need to assess climate shocks and the impact on the agricultural economy. This is especially important in a 46% rain-fed, agriculture-dependent country like India.

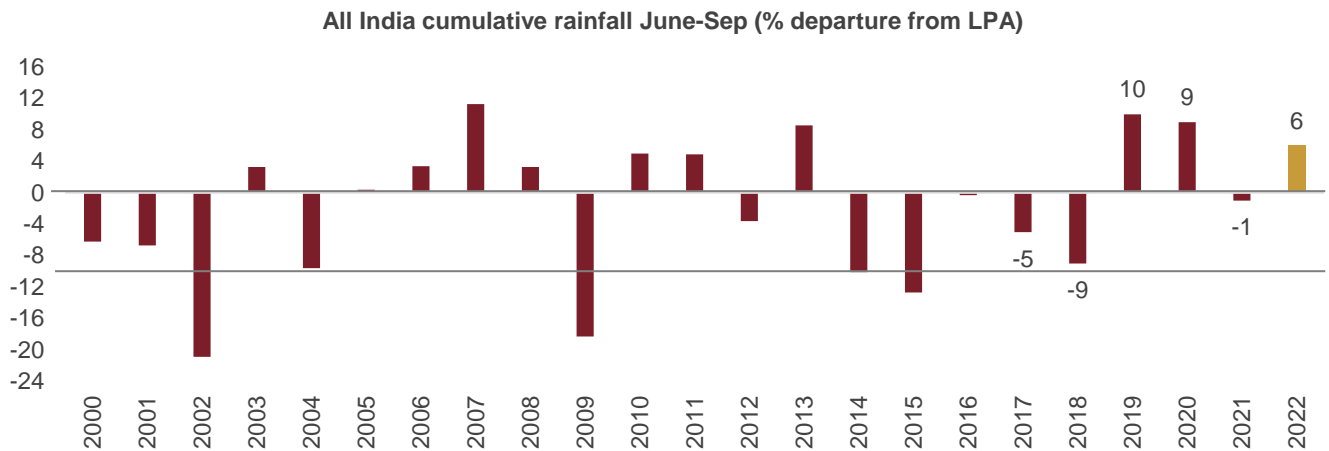
Weather disturbances hurt crops, swayed food inflation this year

Southwest monsoon 2022 turns out above normal...

Between June 1 and September 30, 2022, India received an average 92.5 cm rainfall against the LPA of 87.0 cm (based on data of 1971-2020). That is 106% of the LPA and makes the 2022 monsoon season the fourth consecutive one of normal/above-normal rainfall (see *chart 1 below*).

¹ Rains are considered normal if they are between 96-104% of LPA.

Chart 1: All India southwest monsoon turns out above normal



PS: Red lines marking +/-4% of LPA are normal monsoon activity bands

Source: IMD, CRISIL

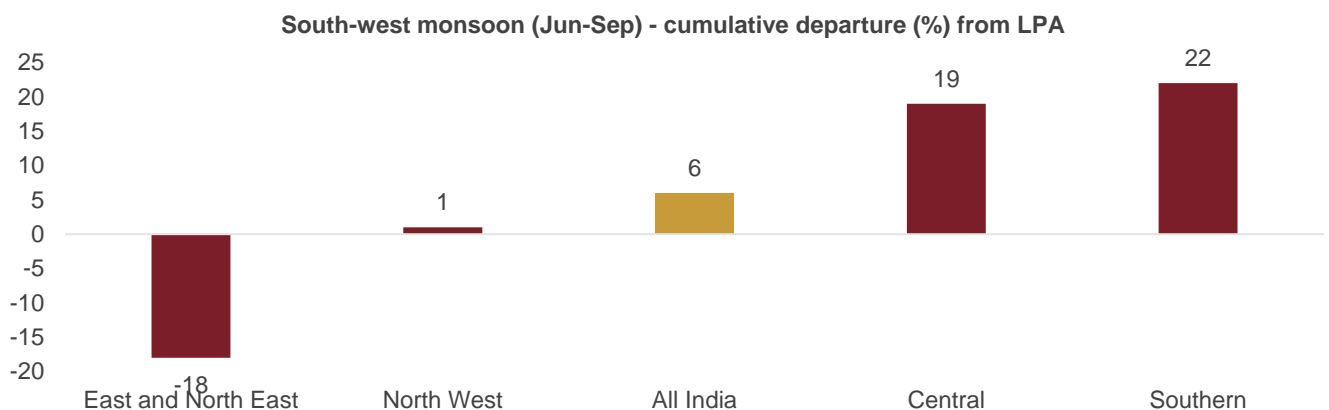
...but some areas flash red

Patchy rainfall distribution and the hit to crops are a worry given already high food inflation

While the aggregate rainfall activity appeared normal, the temporal and spatial distribution of the rainfall activity was patchy. For instance, even as the monsoon arrived three days ahead of the schedule on 29 May, precipitation was poor in June, with peak deficiency of -43% of the LPA. Rainfall activity started picking up towards the month-end and while the all-India situation remained near-normal since, there were large regional (state/division wise) disparities throughout the south-west monsoon season.

While parts of east and north-east India (Bihar, Jharkhand, West Bengal, Manipur, Tripura) and northwest India (Uttar Pradesh) received consistently poor rainfall, others in central (Madhya Pradesh, Gujarat, Maharashtra) and southern India (Tamil Nadu, Telangana, Karnataka, Kerala) were parched with excess rainfall for the entire season. For the south-west monsoon season, out of the 36 sub-divisions, only 18 received normal rainfall, with 12 receiving excess rainfall and 6 deficient. The *chart 2* below shows the variation in rainfall activity at the regional level.

Chart 2: Large regional variations in the monsoon activity



Source: IMD

Uneven rains put pressure on agri output, keep inflation elevated

Due to tardy rains in the beginning of the monsoon season and patchy progress thereafter, first kharif sowing was impacted. Thereafter, excess rains in October and delayed withdrawal of monsoon hurt standing crops.

At the end of the south-west monsoon season (i.e., as on September 30, 2022), overall kharif sowing stood at 1,102.79 lakh hectare, compared with 1,112.16 lakh hectare last fiscal. This is largely due to lower rice and pulses acreage, which are down ~5% and ~4%, respectively on-year.

Preliminary estimates suggest a likely hit to rice production by 6-7%. Pulses, which saw lower acreage this year (because of some shift to oilseeds which became more lucrative), was also affected by excess rains. This has immediately impacted inflation in these two segments. Compared with a 0.4% on-month² rise in overall CPI food inflation during August-September, cereals and pulses saw larger increase of 2.2% and 1.3% on-month, respectively. Wheat inflation is already in double digits, thanks to the heat wave in the early part of this year.

We will learn about their impact on agriculture over the next few weeks, as details of damage — from both, excess and deficiency — on agriculture output becomes clearer.

Rabi prospects this year appear good

It is important to note that the annual agricultural output is shaped by rabi production. So excess rainfall after the southwest monsoon season bodes well, as it increases soil moisture, which will facilitate healthy germination of crops.

For the forthcoming rabi season, it is also reassuring that water reservoir situation is reasonably healthy. The current reservoir storage as a percentage of storage capacity across four of the five regions in the country is not only above last year's levels, but also above the corresponding 10-year average. The pan-India (143 reservoirs) ratio printed at 86% as on November 17, compared with the long-term average of 72%.

To be sure, rabi sowing is majorly dependent on groundwater situation as irrigation is not done during sowing for major rabi crops like wheat, gram and mustard. But irrigation for these crops start after 20-30 days after sowing. So, healthy water reservoir levels will drive the acreage and cropping pattern. For example, high reservoir levels would drive acreage under water guzzling crops, such as wheat and barley. This is a good development as wheat reserves this year have come down and greater acreage in the upcoming rabi season will help replenish the stocks.

Climate change is here, and its impact is becoming clear

Long-term trends on wider rainfall variations call for action

Two points stand out when we study regional and temporal data for the past six fiscals:

- The number of subdivisions³ receiving normal rainfall seem to be coming down in the recent years, whereas those receiving excess rainfall have increased (see chart 3).
- Delayed catch-up followed by delayed withdrawal of rains has been the norm rather than an exception in recent

² In seasonally adjusted terms

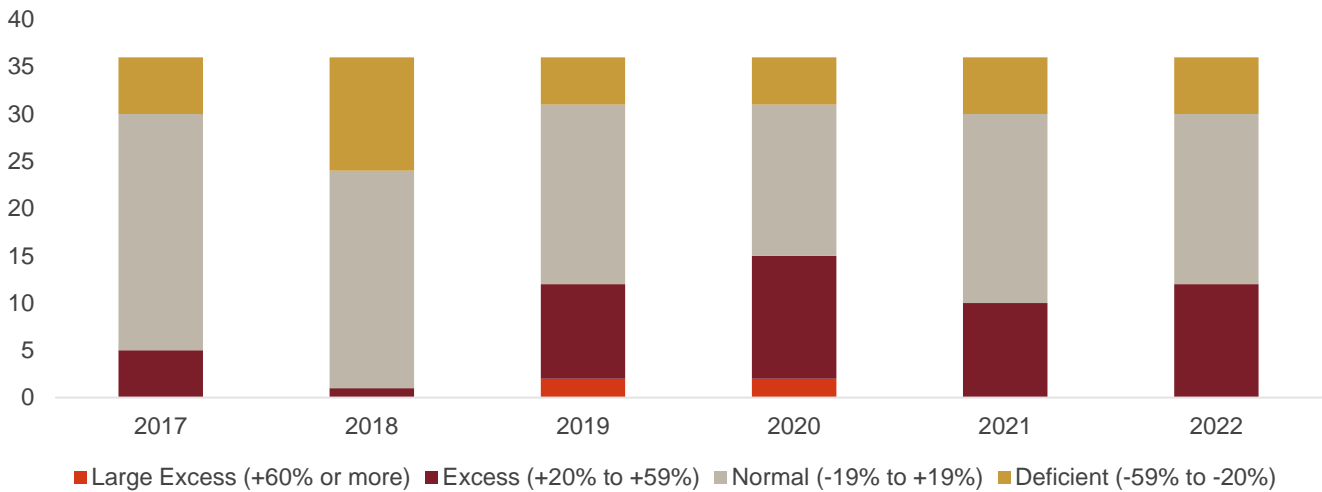
³ According to IMD, the whole country is divided into 36 sub-divisions from the rainfall perspective

years. This year post-monsoon rains were aplenty with October recording rainfall 47% above the LPA and complete withdrawal of monsoon happened by 23 October 2022. Last year too, complete withdrawal of south-west monsoon was similarly delayed.

Even though there doesn't seem to be much variation in rainfall during the south-west monsoon at the all-India level (as seen in chart 1 above), regional variations are much more apparent, something that could be attributed to rising impact of climate change.

Chart 3: Spatial distribution of rainfall

Number of subdivisions and their % departure from LPA during June-Sep

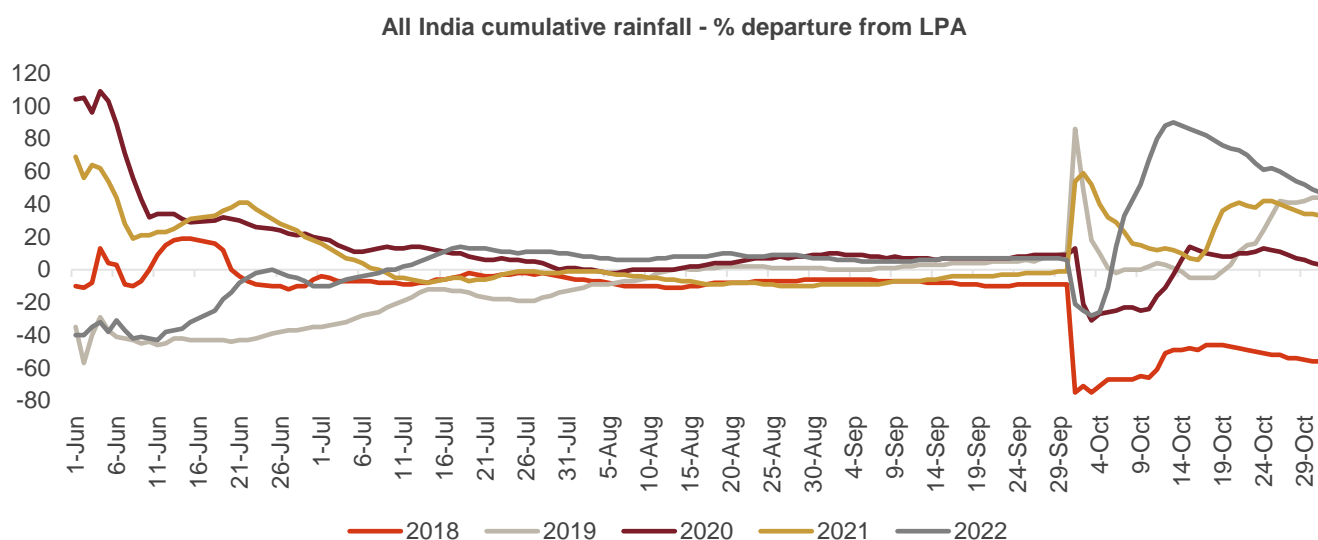


Source: IMD, CRISIL

The temporal distribution, too, especially in the beginning and end of the south-west monsoon season, has shown wide variation. A healthy temporal distribution of rainfall is important from both sowing and harvesting perspective. Sufficient rains in the initial half of the south-west monsoon season are favourable for sowing, especially for paddy (a key kharif crop). At the same time, excess rainfall doesn't bode well post the monsoon season for kharif harvesting, as it can damage standing crops.

Chart 4 shows that rainfall has shown wide variations in the recent years during June to October months. Both this year and in 2019, rains were in deficient in the beginning, though this year the catch-up at the all-India level was faster. The problem at the fag-end seems to have become more pronounced, with October receiving sudden bouts of excess rainfall as seen in 2019, 2020 and this year.

Chart 4: Temporal distribution of rainfall in recent years



Source: IMD, CRISIL

Extreme weather events highlight a bigger challenge on climate change

Not only are rainfall patterns undergoing changes, but extreme weather events in general also seem to be on the rise, largely as a result of climate change. For instance, March this year was India's hottest in recorded history (1901-2022) according to the Indian Meteorological Division. Temperatures were high across India, especially in the northwest, which saw a scorching heat wave. The average maximum temperature over northwest and central India in April this year has also been the highest in 122 years.

Experts say climate change caused by greenhouse gases from burning fossil fuels has made global warming about 30 times more likely.⁴ Indeed, 11 of the 15 warmest years since 1901 in India were during the past 15 years (2007-2021), as per IMD. If average global temperature rise is not contained, such heatwave episodes could become more frequent.

To be sure, excessive/unseasonal rainfall-led floods, cold waves, and cyclones (high wind speeds) are also extreme weather events. Such events have been on the rise globally, including in India.

Last year, India experienced five cyclones, three of which were 'severe' and higher in intensity. According to a recent CEEW report⁵, "India experienced an exponential increase in extreme events during the period 1970–2019, with a marked acceleration in 2000–2019". The report also found that "the pattern of extreme events is changing across some regions (districts) in India – some drought-prone districts are becoming flood-prone and vice versa."

It is worrying that — according to the Germanwatch Global Climate Risk Index (CRI), which is based on extreme weather events, such as storms, floods, and heatwaves in a particular year — India is one of the most vulnerable countries for the extreme weather events. Compared with 31 in 2010, India ranked 7 on CRI in 2019. In fact, India has been ranked in top 20 in almost all the years in the past three decades.

⁴ Research study by Grantham Institute – Climate Change and the Environment, Imperial College London

⁵ Preparing India for extreme climate events, Council on Energy, Environment and Water, India, December 2020

How climate change is contributing to weather disruptions

The change in monsoon patterns, and rising frequency of extreme weather events could largely be explained as offshoots of climate change. According to United Nations' Intergovernmental Panel on Climate Change (IPCC), rise in global temperatures is leading to changes in the water cycle and the frequency of extreme weather events.

The IPCC estimates temperatures to increase by more than 2 degrees in the 21st century, missing the target set in the 2015 Paris agreement of limiting global warming to under 2 degrees. At 2 degrees, the IPCC expects heat extremes to reach critical tolerance thresholds for agriculture and health.

India has already experienced a greater rise in temperature than global average between 1951-2014. It will continue experiencing a sharper rise in temperature than global average in rest of 21st century, according to a report by India's Ministry of Earth Sciences⁶.

Climate change is intensifying the water cycle, causing heavier rainfall, and flooding in some regions⁷. Rainfall during summer monsoon decreased 6% between 1951 and 2015. However, the Ministry of Earth Sciences expects the average rainfall to increase going ahead. Monsoon variability is also on the rise, along with more extreme events. The ministry has observed an increase in frequency of dry spells and more intense wet spells during summer monsoon over 1981-2011.

Global warming will cause more extreme events. The IPCC expects rising temperatures to increase heatwaves across Asia; droughts in arid and semi-arid areas of West, Central and South Asia; and floods during monsoons in South Asia. In India, frequency of summer heatwaves is expected to increase to 2.5 events per season by 2040-2069, and 3.0 events by 2100 under RCP 4.5 scenario⁸. The average duration of heatwaves is expected to increase as well.

Climate change and initial signs of impact on Indian agriculture

In addition to the risk to human lives and damage to property, climate change has implications on food security as the immediate impact of climate change is on food production and its prices.

For India, climate change is worrying, particularly for the following two reasons. One, the Intergovernmental Panel on Climate Change (IPCC) 2022 report identifies India as highly vulnerable to climate change. Second, agriculture (which faces immediate threat from climate change) is a significant part of the economy in terms of its share of GDP and livelihood provision.

From a longer-term perspective, these developments hint at challenging times for a country with the second-largest population and soon to become the most populous as per the United Nations population projections.

Risks to India's growth stem majorly from the vulnerability of agriculture

Agriculture — which accounts for ~15% of India's GDP and 43% of employment — is the most vulnerable to climate change. Frequent heatwaves, extreme rainfalls, water scarcity and soil degradation directly impact the

⁶ Ministry of Earth Sciences, Government of India (2020): *Assessment of Climate Change over the Indian Region*

⁷ United Nations (2021): *IPCC report: 'Code red' for human driven global heating, warns UN chief*. Retrieved from: <https://news.un.org/en/story/2021/08/1097362>

⁸ Representative Concentration Pathway, or RCP refers to a climate change scenario, which models the quantum of greenhouse gas emissions that will result in a given rise in temperature. At present, government to reduce GHG emissions are broadly in line with RCP4.5 scenario. Estimates on frequency of heatwaves are reported by Ministry of Earth Sciences

agriculture output and incomes in India. Decreased output, in turn, results in weaker rural income and consequently, lower demand. Heatwaves also reduce labour productivity.

Cereal production is particularly vulnerable. The IPCC has estimated a 10-30% decline in rice production and a 25-70% fall in maize production in India with a 1-4-degree rise in temperature in the 21st century.

The 2018 Economic Survey⁹ estimates that losses because of climate change could reduce annual agricultural income by 15-18% by the end of the 21st century. In the unirrigated areas, the losses could be a sharper 20-25%.

S&P Global has estimated¹⁰ that India, along with Bangladesh, will have greater share of their economies among their peers exposed to physical climate risks such as heatwaves, flooding, wildfire etc. That said, the country is assessed to be better prepared than most of its South Asian peers to face these risks owing to stronger economy and institutions.

Food inflation could structurally rise and become more volatile

Food inflation faces upside risks from agriculture's vulnerability to physical climate risks. This is a significant issue for India, as food occupies 39% of an average consumer's basket. In the current fiscal, food has been the biggest factor contributing to the rise in retail inflation.

Increased frequency of extreme weather events has also added to the volatility in food prices, especially that of fruits and vegetables

How policy can mitigate some of the climate change impact on the agriculture sector

There are some learnings from measures that other countries have been adopting. But India's problem is also unique, given its high reliance on agriculture for employment and output, the repeated struggles with controlling food price inflation, high reliance on fossil-fuel for power, greenhouse gas (GHG) emitting industrial production processes and limited fiscal space to react and/or respond to climate change.

Climate change is primarily a fiscal challenge for the governments.

While India submitted its long-term low-carbon development strategy — aimed at expanding renewables, strengthening energy efficiency measures, rationalising fossil fuel resource utilisation, and ensuring an optimum energy mix while following on a development-focused transition — at the recently concluded COP27 climate summit, the damage from climate shocks is visible already.

In the short term, therefore, the Indian government's climate action response should also focus on mitigating risks to the agriculture sector. These could include:

- Accelerating efforts towards improving agricultural productivity: The Indian government's climate action response should also focus on mitigating risks to the agriculture sector. While the government cannot control the physical climate risks to the sector, it can speed up other efficiency improvements, such as reducing crop wastage, improving irrigation, setting up warehousing facilities and promoting higher yielding varieties of crops
- Promoting investment in food processing and cold storage to reduce food wastage: This will augment the

⁹ *Economic Survey (2018). Climate change and agriculture*

¹⁰ S&P Global (2022). *Weather Warning: Assessing Countries' Vulnerability To Economic Losses From Physical Climate Risks*

supply and help smoothen price fluctuations. Almost one-third of fruits and vegetables produced in the country is wasted. Investment in storage infrastructure can help agriculture adapt to climate risks as well (for instance, early harvesting of crop to protect against heatwave or unseasonal rains)

- Research and development (R&D) in developing crops resistant to extreme weather events: The government is encouraging research on climate-resilient rather than only high-yielding varieties of crops. In late 2021, it released 35 varieties of crops — including varieties of chickpea, soybean, paddy, wheat, and maize — that are tolerant to diseases, pests, drought, flooding, and deficient rains, and mature early, yielding a good harvest within a short period after planting. Such R&D, though, needs a bigger push.

At a broader level, going beyond agriculture, action points could include

- Encouraging move to cleaner technologies. The government has already taken steps in this direction by promoting solar power generation under its production-linked incentive (PLI) scheme. It can further support clean technology industries through targeted tax incentives
- Embarking upon a nation-wide approach involving all states to combat climate change shocks and to adopt climate practices

In addition, given its inflation-targeting mandate, the RBI's Monetary Policy Committee will also have to take heed of the increasing role of climate change-led weather disturbances in influencing consumer price inflation. As inflation faces upside risks and higher volatility due to climate change, there is a greater need to maintain credible monetary policy, to keep inflation expectations under control.

Policymakers not only need to work together to reduce long-term effects of climate change, but also need to respond to the short-term effects of climate change on the economy.

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