National Climate Action on Adaptation: Monitoring, Evaluation and Learning Framework for Agricultural Sector

INDIA PHASE II

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National Report and MEL Framework for Agriculture in India

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Framework for Monitoring Evaluation and Learning for Climate Change Adaptation in Agriculture

1. Introduction

As a large developing nation, India is one of the most populous countries in the world, and is highly likely to surpass China over the next few years, imposing huge challenges with regard to meeting food and economic demands to support its growing population. The country is categorised as under Low and Low Medium Income Countries (LMIC) by the World Bank, a large proportion of its population is dependent on primary sources of employment, in addition, India's literacy rates have been very low. Infrastructure development though visible in certain pockets is not uniform throughout the country and many regions' people still face the challenge of accessing to the basic services for a quality life.

Changing climate and the associated risks make adaptation imperative for all countries. India, being a large developing country in the tropics with diverse agro-climatic regions and a long coastline, is extremely vulnerable to the consequences of changing climate. Climate change will affect all sectors such as agriculture, health, water resources, forests, biodiversity, and coastal regions. The extent of impacts would vary, largely based on local conditions and exposure factors, for instance, the number of people

exposed in a location, infrastructure development, etc. According to the studies cited by the International Panel on Climate Change (IPCC) in its *Sixth Assessment Report* (AR6), climate change and rising demand would lead to at least 40% of the Indian population living with water scarcity by 2050. The dual impacts arising from rising sea levels and groundwater scarcity will have a direct profound negative influence on the agriculture sector in coastal regions. Besides, the IPCC's AR6 estimates that yields of wheat, pulses, coarse crops, and cereals in India is likely to fall by almost 9% by 2050s, which has the potential to impact livelihoods and availability of food, apart from leading to other implications including price spikes. These price spikes would threaten food availability, affordability having huge implications to food security and overall economic development.

The construing risks as a result of climate change, necessitate adaptation and allocation of resources for designing activities and projects. In the long run, the objective should be to ensure that adaptation is integrated into the overall developmental planning of any country to further ensure scalability to achieve the desired results with regard to risk reduction.

Realizing the need to mitigate the climate change effects, India introduced the National Adaptation Fund for Climate Change (NAFCC). Under the NAFCC, India extended financial support to all states and union territories (UTs) in 2015, with the objective to

address climate risks and build climate resilience across the country. The priority areas for climate resilience under the NAFCC have been outlined along the lines of the Nation Action Plan on Climate Change (NAPCC) and its Missions and the State Action Plan on Climate Change (SAPCC) considering sub-national scale priorities. The Government of India designated National Bank for Agriculture and Rural Development (NABARD) as the National Implementing Entity (NIE) for implementation of the NAFCC projects—tasked with the identification of interventions, their appraisal, sanction, release of funds, monitoring, evaluation, and capacity-building of relevant stakeholders. Besides the NAFCC-supported interventions, some prominent programmes though central- and state-level initiatives for adaptation include the National Innovations on Climate Resilient Agriculture (NICRA), interventions identified in the State Action Plans on Climate Change (SAPCCs) and programmes supported under some Multilateral and Bilateral initiatives including the Programme on Climate Resilient Agriculture (PoCRA). While these projects have been established, monitoring and evaluation frameworks that indicate the progress in work related to these projects have not been developed.

The Initiative Climate Action and Transparency (ICAT) was established by the UN as a body to support the implementation of Article 13 of the Paris Agreement on improved transparency, to monitor the progress and assess the impacts of all climate actions—

both mitigation and adaptation. It seeks to focus on developing countries assisting them in the process of their reporting processes to the UN, indicating the pace at which actions are being taken. The frameworks so developed and capacities built in the developing world may allow many of these countries to become self-organise in data collation, synthesis, enhance on their accountability, strengthen monitoring and reporting processes for climate mitigation and adaptation, thereby contribute to the overall reporting in the global stock take. ICAT supports activities at the country, regional, and global levels to drive immediate and long-term impacts, resulting in sustained improvements to the administrative, legislative, and institutional transparency infrastructure within countries. ICAT thus seeks to identify mitigation and adaptation interventions implemented in countries to help develop frameworks for monitoring, evaluation, and learning (MEL) to assist in reporting.

The ICAT aims to support countries with custom-made tools and methodologies to create frameworks for effective reporting on climate action while adhering to the country's development priorities. Standardised tools are developed which assist in reporting outputs, outcomes, and impacts of a project and thus help in establishing accountability.

Monitoring and evaluation in adaptation projects not only helps in tracking the progress of interventions but also points out needs for adjustments. They aid countries

in arriving at understanding whether they are doing the right things, doing them correctly, and what could have been done differently. Effective frameworks can help governments understand:[1]

- Successful adaptation actions which reduce vulnerability
- Addressing urgent adaptation needs
- Progress of implementation of plans and policies
- Indicate actions being taken for risk reduction and resilience of communities

As per the 7th schedule of the Indian Constitution, there are division of powers between the Centre and the State, in the form of lists which indicate ultimate hold and decision-making over certain sectors/ areas of work. Both agriculture and water are included in the State List. Furthermore, as adaptation measures and development initiatives are implemented at the state level in India, there is a need not only to explore the implementation framework but also identify the key stakeholders at the state level. In order to capture the different contexts and policy landscapes throughout the country, the MEL framework is initially developed at the state level for a selected set of

[1] Details available at <https://www.adaptationcommunity.net/wp-content/uploads/2020/05/Adaptation-Briefings-2-Monitoring-and-Evaluation-of-Adaptation-An-Introduction.pdf>

adaptation and development initiatives. Learnings from the state-level frameworks were then embedded into the development of the national framework, in this case, the MEL framework for Agriculture.

2. Global Policy Context/ Landscape

2.1 Paris Agreement and the Enhanced Transparency Framework

The Paris Agreement of 2015 is considered a landmark in the global effort to address climate change. Member states gathered in order to suitably respond to the urgent need of climate action by establishing Nationally Determined Contributions (NDCs) which outline national and international actions (wherever applicable) to mitigate climate change, enhance adaptation, and extend support to countries in implementing mitigation and adaptation measures.

Under the Paris Agreement, procedures to track progress on climate action have been established to assess progress made by countries in meeting their goals and the collective impact of national-level contributions to keep global average temperatures below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels.

The Enhanced Transparency Framework (ETF) has been established to impart credibility and transparency in mitigation and adaptation actions. The ETF is to be implemented in a facilitative, non-intrusive, non-punitive manner that is respectful of national sovereignty.

The United Nations Framework Convention on Climate Change (UNFCCC) reference manual for ETF under the Paris Agreement, as well as Transparency under the Paris Agreement refer to "reporting of information by a Party in its BTR (including information on the national GHG inventory, the accounting approach(es) selected, and the indicators used for tracking progress and support provided and received) and the assessment of that information through a technical expert review and FMCP. Reporting, review, and consideration of information submitted contribute to enhance the integrity of the implementation of the Agreement."

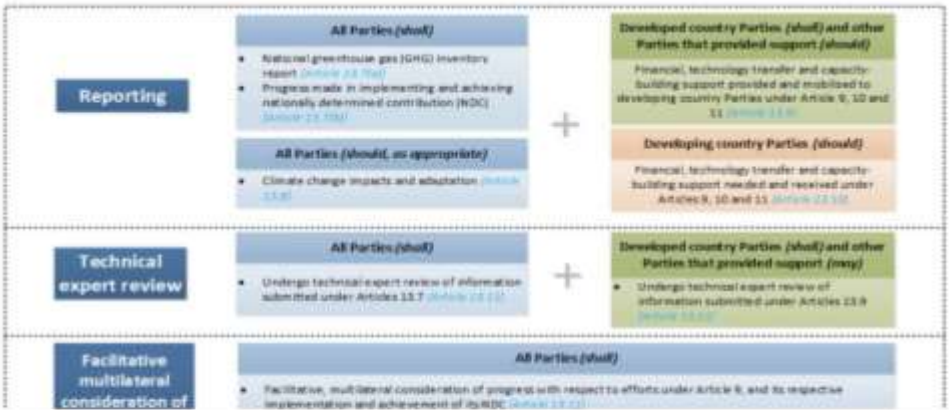

Figure 1: Article 13 of the Paris Agreement: Transparency of Action and Support (UNFCCC, 2019)

ETF provides guidelines to countries for reporting their GHG emissions, progress made on attaining NDCs, climate impacts, climate adaptation, support, and assistance mobilised and assistance required and received.[2] The principles of common but differentiated responsibilities and respective capabilities enshrined in the Kyoto Protocol are also reflected in the ETF design. It was envisaged that ETF will embolden ambition and action by improving access to information on implementing climate action and progress on NDCs under Article 4 of the Paris Agreement. However, the detailing of the guidelines in the ETF is needed for countries to be able to adopt uniform reporting requirements.

At 24th meeting of the Conference of parties (COP24), countries adopted guidelines which were deemed necessary for operationalizing the ETF. The first step in this regard involved reporting under the ETF through documents known as Biennial Transparency Reports (BTRs). The submission dates for first set of BTRs for developed nations and developing nations are 31 December 2022 and 31 December 2024, respectively. Several aspects of reporting provisions have been revised and enhanced for developing countries. A gist of key differences between the previous set of arrangements and new ETF requirements is listed in Table 1.

[2] Details available at <https://www.wri.org/paris-rulebook/enhanced-transparency-framework>

Table 1: Nationally determined contributions and the enhanced transparency

Existing UNFCCC arrangements	Paris Agreement's enhanced transparency framework
Different requirements for developed and developing countries	– Common set of guidelines and process – Flexible in terms of developing country requirements- and capacities, but this flexibility is bound by specific provisions in the guidelines Developed countries are required to report on finances provided and mobilized
Different reporting vehicles—Biennial reports for developed countries and biennial update reports for developing countries	Submission of a biennial transparency report Report is expanded to include voluntary information on climate change impacts and adaptation (including loss and damage) and a focus on tracking progress

	to achieve NDCs.
Different expert and in-person peer-review processes	All countries to participate in the same technical expert review and facilitative, multilateral consideration of progress.
Not existing process for planning improvements	Countries expected to have a draft improvement plan which outlines the road map on how the reporting systems will evolve over the years.

2.2 Linkages with Other Elements of the Paris Agreement

NDC mitigation elements: Parties are expected to account for their NDCs in the BTRs under the ETF, report their accounting approach, and use indicators to track progress made in achieving their NDCs.

Adaptation communications: Parties may also submit their adaptation communications as part of or in addition to other communications or documents. If the adaptation communications are submitted as part of the BTR, a clear identification of the adaptation communications must be provided.

Global Stocktake: Information flowing in from the ETF serves as input to the Global Stocktake (GST) under Article 14 of the Paris Agreement. The GST is a process involving stocktake of climate action under the Paris Agreement to assess the collective progress in meeting the goals of the Paris Agreement. The first GST will run from 2021–23 and will be conducted every 5 years. It will also consider the socio-economic consequences of corrective action and efforts to address loss and damages. The GST will assess progress on GHG emissions, adaptation efforts, and finance flows under Article 13.

3. India—Country Profile

India is the seventh largest country (32,87,263 sq. km/1,269,346 sq. mi) in the world, and the second most populous, home to over 1.36 billion people. Lying between the Himalayas and the Indian Ocean, the country is diverse in ecosystems and cultures. Its geography includes mountainous terrain, northern plains, peninsular plateau, coastal plains, island groups, and deserts, with many different climates, great biodiversity, and rich natural resources.

Figure 2: Political map of India (Maps of India (2019))

With a population of more than 1.36 billion, India is the world's largest democracy. Over the past few decades, the country's integration into the global economy has been accompanied by rapid economic growth. India's path to development is aligned with the United Nations' Sustainable Development Goals (SDGs) that comprise 17 targets that form the blueprint for a prosperous and sustainable future. Eliminating poverty lies at the core of India's national development agenda. Maintaining a high average annual GDP growth rate and developing industry are critical to create the remunerative jobs needed to absorb and benefit from India's growing labour force. Additionally, there are

targeted programmes to improve the income levels of the economically disadvantaged by developing agriculture infrastructure and support services, skills, and entrepreneurship. Social protection measures are also growing to mitigate risks from natural and other disasters. Programmes are also being implemented for ensuring access to education, health, and nutrition security, drinking water and sanitation, with a focus on vulnerable groups such as women and children.

The economy of India is a middle-income developing market economy, being the world's fifth-largest economy by nominal GDP and the third-largest by purchasing power parity (PPP). India is one of the world's fastest growing economies, with annual average GDP growth rates between 6% and 7% since the beginning of the 21st century. India exports several agriculture products, such as Basmati rice, wheat, cereals, spices, fresh fruits, dry fruits, buffalo beef meat, cotton, tea, coffee, and other cash crops, particularly, to the Middle East, Southeast, and East Asian countries. About 10% of India's export earnings come from the trade carried out in agricultural goods and commodities. The agriculture sector, along with its allied activities, such as logging, forestry, and fishing, is a vital sector of the economy. In addition, sector provides key inputs and products to all sectors of the national economy. Approximately, 43% of the population is dependent on agriculture as their main employment source, with the agriculture sector constituting 16% of the total GDP of India in 2019. As the Indian

economy has diversified and grown, agriculture's contribution to GDP has steadily declined from 1951 to 2011, yet it is still the country's largest employment source and a significant piece of its overall socio-economic development. Irrigation is also the largest consumer of India's water reserves, utilizing up to 78% of the total water reserve, making the agriculture sector the biggest user of water in the country, followed by domestic (6%) and industrial sectors (5%).

The growth stages and rates of India can also be affected by the performance of the agriculture sector. As a result, development of this sector can significantly contribute to the fulfilment of key national developmental priorities, such as food security, poverty alleviation and economic development. There is substantial evidence that agriculture plays a major role in poverty reduction. Agricultural development raises farm incomes, increases food supply, reduces food prices, and provides opportunities to add-value and generate jobs in both rural and urban areas, stimulating diversification and growth in the wider economy. Empirical research shows that growth in agriculture helps reduce poverty more than growth in other sectors and the poverty-stricken strata benefits the most from economic growth and development of the agricultural sector (Christiansen and Martin 2018).

Climate change is a major challenge for developing nations like India, threatening to enhance risks already elevated by high levels of social vulnerability and climate

variability. Through its 2016 NDCs, India is committed to achieving by 2030: a reduction in the emissions intensity of its GDP by 33%–35% below the 2005 levels; the share of renewables in power generation at 40% contingent on technology transfer and availability of finance; and an additional cumulative carbon sink of 2.5–3.0 $GtCO_2e$ by 2030 with increased afforestation and tree cover. Recently, during the 26th Conference of Parties (COP 26) in Glasgow, India committed to achieve a net-zero emission by 2070. India aims to source 50% of energy from renewable sources and hike renewable capacity of 500 gigawatt (GW) by 2030. India has also announced a green hydrogen mission to cut methane emissions.

Other commitments to better adapt to climate change include enhancing investments in development programmes in sectors vulnerable to climate change, particularly agriculture, water resources, Himalayan region, coastal regions, health, and disaster management. Furthermore, India aims to enhance investments in development programmes in sectors vulnerable to climate change, particularly agriculture, water resources, coastal economies, and health.

4. Climate Trends and Hazards in India

India's land surface can be divided into six physiographic regions: 1) Himalayan mountains in the north, 2) Peninsular Deccan Plateau, 3) the Indo–Gangetic Plains, 4) Thar Desert in the west, 5) coastal plain, and 6) the islands. All these regions have different climate profiles and vulnerabilities. The country's climatic conditions are highly influenced by the presence of the Himalayas in its northern part and the Thar Desert in the west. The Himalaya ranges of mountains act as a barrier to winds from Central Asia and China, enabling India's climate to be warmer than other countries at similar latitudes. The northern part of the country is characterised as a continental climate with hot summers and cold winters. The coastal regions of the country, however, experience warmer temperatures with little variation throughout the year and frequent rainfall. The average monthly rainfall varies across two monsoon seasons in the country. Southwest monsoon season experiences a monthly average rainfall of about 150 mm to 270 mm whereas northeast monsoon showers between 10 mm and 75 mm.

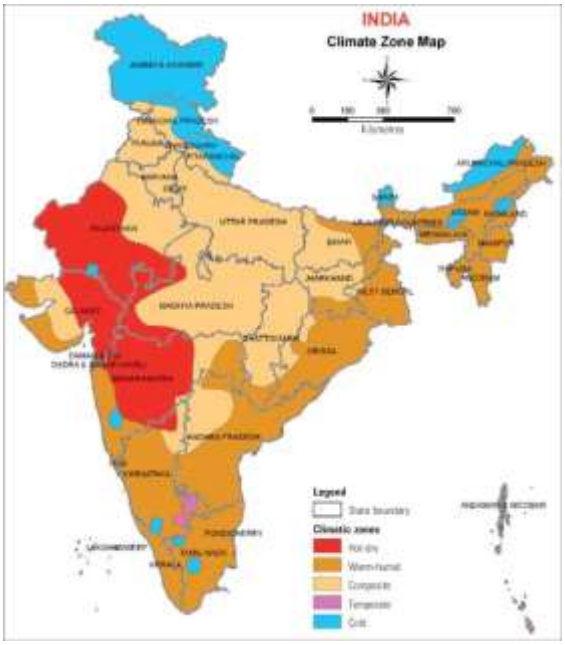

Figure 3: Climatic zones in India (Indian Meteorological Department (2020))

India is the seventh-most vulnerable country with respect to climate extremes (Germanwatch 2020). As per the IPCC report, the impact of this human-induced climate change on the Indian sub-continent leads to an increase in extreme rainfall events by more than 20%, increase in drought risks, and rise in heat waves and cyclones. Around 5700 km of the country's coastline is prone to cyclones and tsunamis; over 12% and 68% of its cultivable area is vulnerable to floods and droughts, respectively. More than 300 extreme events have hit the country in recent decades, causing losses of more than INR 5600 billion (5.6 lakh crore; Mohanty 2020).

Owing to India's diverse climatological and agro-geographical conditions, the impacts of climate change tend to vary, both at regional and local scales. For instance, some

regions that are ecologically fragile are likely to experience more losses compared to others such as mountain areas, coastal, arid, and semi-arid areas. The sub-sectors of priority also tend to differ across states and local areas, depending on impacts posed by climate change and the socio-economic classification of the communities inhabiting the area. There is a need for climate action to be scaled up both at the sub-national and district levels to mitigate the impact of extreme events. Managing climate risks requires an enhanced understanding of the underlying drivers of hazards; the exposure of regions and populations; the sensitivity of regions and their resulting vulnerability; and the interactions between these components, as highlighted by the IPCC. While exposure to extreme events is linear, the impacts are non-linear, depending on the sensitivity and adaptive capacity of the affected systems. For some, it may entail adjustments and re-adjustments in livelihood options, but, for others, the impacts can be catastrophic, compounding beyond existing vulnerability thresholds.

4.1 Temperature Rise

India's average annual mean temperature during 1901–2020 showed an increasing trend of 0.62°C/100 years, with significant increasing trend in maximum temperature (0.99°C/100 years) and relatively lower increasing trend (0.24°C/100 years) in minimum temperature. This warming trend is highest during the post-monsoon season (0.88°C/100 years) followed by winter season (0.68°C/100 years). The rise of maximum

and minimum temperatures, during the past 30 years, is mostly confined to the northern, central, and eastern/north-eastern parts of the country. Temperature increases in India have been observed to be more pronounced in daily maximum temperatures than in daily minimums. Increases in both minimum and maximum temperatures have been observed across the majority of the Indian territory, with the exception of a small pocket of the north-western region, where cooling has been reported. The strongest warming has occurred in the northern and north-eastern regions.

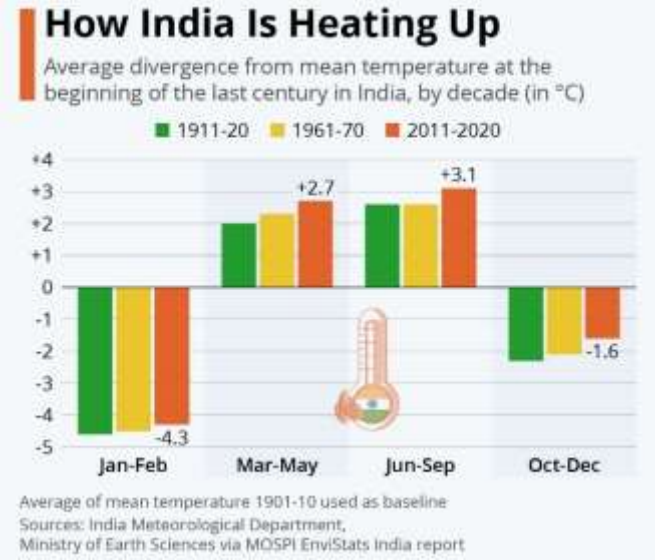

Figure 4: Temperature divergence from mean in India over the years (Indian Meteorological Department (2020))

India has been showing comparatively a lower historical trend of temperature rise than the global average. However, the anticipated projections for the temperature rise in India align with or higher than the expected temperature rise globally. As per projections, northern regions of India will be most hit by extreme temperature rise,

experiencing an increase in the magnitude of annual minimum and maximum temperature than the national average.

4.2 Precipitation

India's monsoon season occurs between June and October, arriving later in north regions, and covers over 80% of the territory's annual precipitation. A shorter rainy season occurs during the months of October through December following the summer monsoon and is referred to as the post-monsoon season. The south-west monsoon season (June–September) generates average monthly rainfall between 150 millimetres (mm) and 270 mm and the northeast monsoon season (October–December) generates average monthly rainfall between 10 mm and 75 mm. Large inter-annual variability is a key feature of the rainfall regime of India. This is due to both remote and regional climate influences of the El Niño Southern Oscillation (ENSO) and Indian Ocean Dipole on the monsoon.

Historical trends in precipitation are strongly influenced by ENSO, which increases sea surface temperatures and reduces monsoon rainfall in India. Although there is inter-annual variability, the total precipitation during the Indian summer monsoon has remained largely stable over the period of 1901–2020 and has shown a weak decreasing trend during the recent few decades. Based on the rainfall data from the India Meteorological Department (IMD) Observational Network, it is found that five states,

Bihar, Meghalaya, Nagaland, West Bengal, and Uttar Pradesh, have shown significant decreasing trends in south-west monsoon rainfall during 1989–2018. The annual rainfall over these five states and with the states of Arunachal Pradesh and Himachal Pradesh has exhibited significant decreasing trends. Other states do not show any significant changes in south–west monsoon rainfall during the same period.

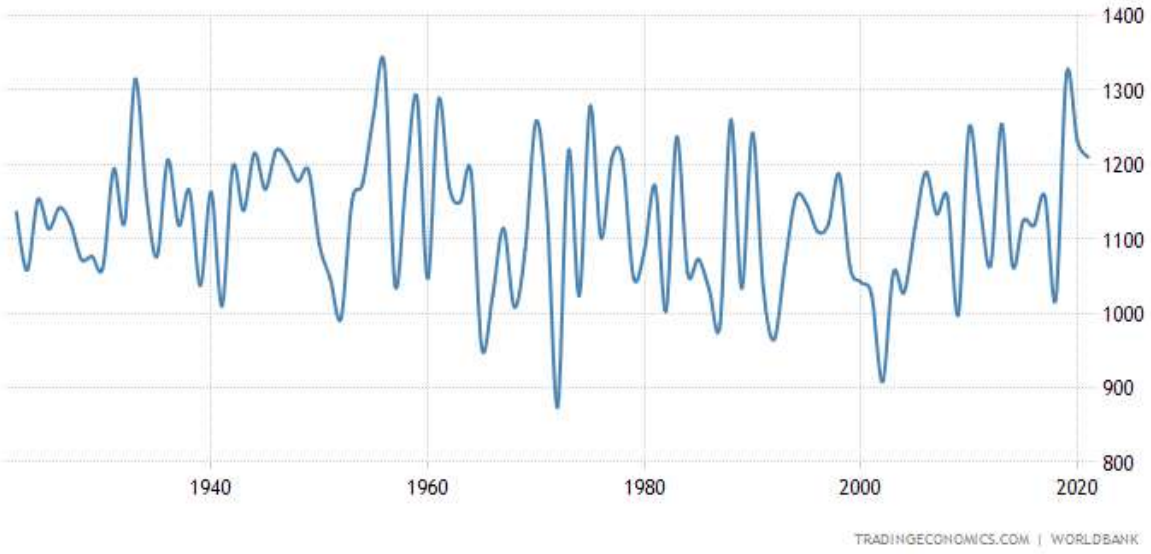

Figure 5: Precipitation trends in India over the years (World Bank (2019))

Considerable uncertainty characterises projections of local long-term future precipitation trends in India, this uncertainty is compounded by poor understanding of the relationship (teleconnections) between ENSO and the monsoon, and the impact climate change may have on this relationship. The intensity of sub-daily extreme rainfall events appears to be increasing with temperature, a finding supported by

evidence from different regions of Asia. Future changes in the seasonality of monthly precipitation at the national level are also highly uncertain under all emissions scenarios. A study by Li, *et al.* (2016), utilizing a subset of greatest common multiples (GCMs) and analysing annual trends suggested, northern India may experience a slight reduction in average annual precipitation by 2041–60.

4.3 Climate Hazards

India faces some of the highest disaster risk levels in the world, ranked 32nd out of 191 countries by the 2019 INFORM Risk Index. In 2022, India continued to have a high-risk rating (5.2). India has very high exposure to flooding (ranked jointly 13th), including, riverine, flash, and coastal, as well as high exposure to tropical cyclones and their associated hazards (ranked jointly 14th) and drought (ranked jointly 24th).

In the coming decades, climate change is likely to make rainfall erratic, cause sea-level rise, and accelerate the frequency and intensity of droughts, floods, and heat waves (IPCC 2018). CEEW estimates that over 75% of Indian districts, including 95% of coastal districts, are extreme event hotspots. As a tropical country, India is exposed to frequent cyclonic disturbances and monsoon-related extremes (IMD 2015). More than 300 extreme events have hit the country in recent decades, causing losses of more than INR 5600 billion (5.6 lakh crore; Mohanty 2020). Due to the varied geography and ecology, India is also exposed to heat waves and droughts. The Himalayan and mountainous

regions are further exposed to region-specific disasters like landslides, snow avalanches, glacial lake outburst floods (GLOF) and cloudbursts. Climate change is also altering the pattern of extreme events and, as a result, changing the vulnerability landscape of India. For example, traditionally flood-prone areas are becoming drought-prone and vice versa, with some districts witnessing multiple extreme events in the same season or across different seasons.

A large proportion of India's population is exposed and vulnerable to the impacts of climate change as their livelihoods are dependent on climate-sensitive sectors, such as agriculture and its allied sectors. Exposure to such climate hazards and disasters has resulted in enormous losses to life, property, and other infrastructure damages. Additionally, the challenges of rising temperature and the mounting need for water management will put pressure on the urban areas and key infrastructures. Climate change will also affect the investments of India in development, especially coastal infrastructure, housing, transport, and industries The cross-sectoral linkages and dependencies of the economy will also be impacted by climate change, leading to further impacts on the livelihoods of the people. For instance, since a sizeable section of India's population is dependent on agriculture and forestry for its livelihood, a change in the pattern of water availability can reduce productivity of crops and lead to loss of livelihoods.

4.3.1 Heat Waves

India regularly experiences some of the world's highest maximum temperatures, with an average monthly maximum of around 30°C and an average maximum of 36°C. The average total duration of summer heat waves is projected to increase to about 15 and 18 days per season during the mid and end of the 21st century, respectively. Heat wave probability increases are projected to be strongest along India's west coast. While heat waves refer to the periodic occurrence of exceptionally high heats, the incidence of permanent (chronic) heat stress is likely to increase significantly in India. The number of heat wave days in India has increased from 413 over 1981–90 to 600 over 2011–20 (India Meteorological Department (IMD), Pune). Mortality as a result of heat waves occurs because of rising temperature, lack of public awareness programmes, and inadequate long-term mitigation measures. According to the report of the Tata Centre for Development, the University of Chicago (2019), annually, more than 1.5 million people are likely to die due to extreme heat caused by climate change by 2100. IMD Pune atlas shows that 15% of the population in 13% of the districts is vulnerable to heat waves.

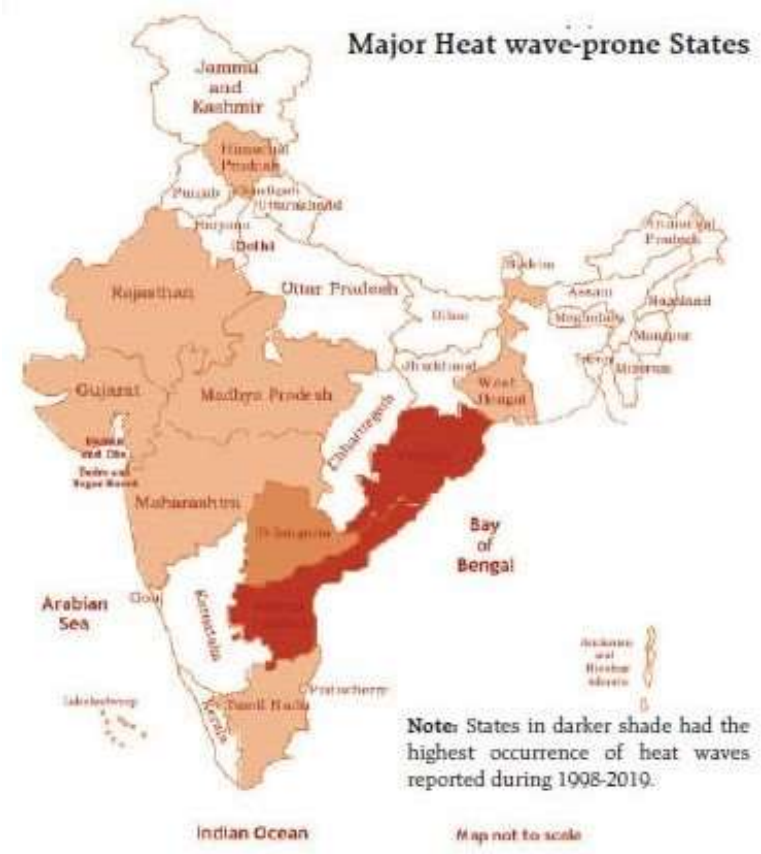

Figure 6: Heat wave-prone states in India (Indian Meteorological Department (2019))

Furthermore, the frequent occurrence of heat waves also adversely affects different sectors of the economy. For instance, the livelihood of poor and marginal farmers is negatively impacted due to the loss of working days. Prolonged heat waves adversely impact not only agricultural productivity but also largely affect the livestock sector as animals are more vulnerable to heat waves. Moreover, heat waves increase the risk of forest fires, causing a sudden rise in demand for electricity and irrigated water. According to the International Labour Organisation (2019) report, India lost around 4.3% of working hours due to heat stress in 1995 and is expected to lose 5.8% of

working hours in 2030. The report also shows that 9.04% of working hours are expected to be lost in each agriculture and construction sectors, respectively, due to heat stress in 2030.

Agricultural production in India is vulnerable to climate variability and change. The abnormal increase in maximum and minimum temperatures during 2022 impacted crops, fruits, vegetables, and animals in the states/union territories of Punjab, Haryana, Rajasthan, Jammu and Kashmir, Himachal Pradesh, Uttar Pradesh, Madhya Pradesh, Bihar, and Maharashtra. The heat waves led to a reduction of yields of the wheat crop by up to 15%–25%. High temperatures also resulted in moisture stress, sunburn, flower drop and less fruit setting in horticultural and vegetable crops.

4.3.2 Droughts

India is generally affected by three primary types of droughts: (1) meteorological (usually associated with a precipitation deficit), (2) hydrological (usually associated with a deficit in surface and subsurface water flow, potentially originating in the region's wider river basins), and (3) agricultural (soil moisture and rainfall are inadequate during the crop-growing season, causing extreme crop stress, and wilting). According to the Standardized Precipitation Evaporation Index (SPEI), India faces an annual median probability of severe meteorological drought of approximately 3%. Droughts have historically occurred most frequently in the Indo–Gangetic Plain region,

and it is estimated that between 2001 and 2013, approximately 19% of India's population was exposed to drought.

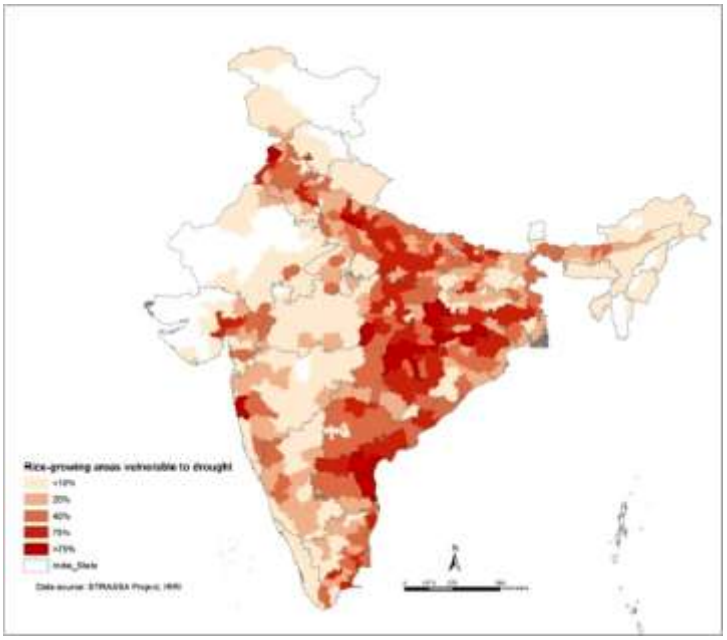

Figure 7: Drought-prone states in India (Indian Meteorological Department (2019))

Droughts in India are becoming yearly occurrences; they are characterized by increased dry spells and seasonal rainfall anomalies. The 2002 drought, one of the severest ever to hit the country, affected 56% of India's geographical area and impacted the livelihoods of 300 million people (WMO 2007). According to new predictive climate models, it is expected that in South Asia, there will be an increase in the frequency of drought events, with what is currently 'a 1 in 100-year event', returning approximately every 40–50 years under 1.5–2°C of warming, and every 20 years under 3°C of warming. According to a pentad decadal analysis of extreme hydro-met disasters, 68% of Indian

districts are exposed to extreme drought events. The southern and western zones of India are the most vulnerable to droughts; they are predominantly affected by agricultural droughts. The northern, eastern, and central zones are moderately vulnerable; an increase in the frequency of meteorological and agricultural droughts has been observed in these regions since the 2010s. The north-eastern region is the least vulnerable to extreme drought events.

The increase in drought vulnerability across regions will have forward-going ripple effects. This surge will directly impact the vulnerable region's agrarian sector and continue to cause microclimate changes, with increased dry spells and climatological anomalies. Drought severity can range from mild to extreme, depending on seasonal rainfall variations. Around 60% of India's fertile land (94 million ha) is rainfed, and about 300 million people live in these regions (Gupta, *et al*. 2011). Drought can reduce both water availability and water quality necessary for productive farms, ranches, and grazing lands, resulting in profound direct and indirect negative economic impacts to the agricultural sector. Drought can also contribute to insect outbreaks, increases in wildfire, and altered rates of carbon, nutrient, and water cycling—all of which can impact agricultural production, critical ecosystem functions that underpin agricultural systems, and the livelihoods and health of farming communities.

4.3.3 Floods

India's three major northern river basins—the Indus, the Ganga, and the Brahmaputra—all receive marked contributions from snow and glacier meltwater. A review by Nepal and Shrestha (2015) suggests that snow melt and glacier loss due to warming may result in increased winter flows and reduced summer flows. Increased peak flows are likely to contribute to increased flood risk, and the increase in floods, resultantly the impacts may be further compounded by future land-use changes within these major river basins.

Floods are, on an average, the greatest source of annual losses to disaster in India. The **United Nations International Strategy for Disaster**. **Reduction (**UNISDR) estimates that a combined GDP impact of all types of floods at $7 billion every year, which might be a low estimate due to underreporting of damage and loss due to low-level flood events. Flood events in India are becoming recurrent; associated flood events have surged six-fold since the 1970s (Mohanty 2020), with some models suggesting that more than 60% of Indian districts have become flood event hotspots. About 97.51 million people are exposed to extreme flood events in India (Mohanty 2020), and most districts are exposed to more than one extreme event.

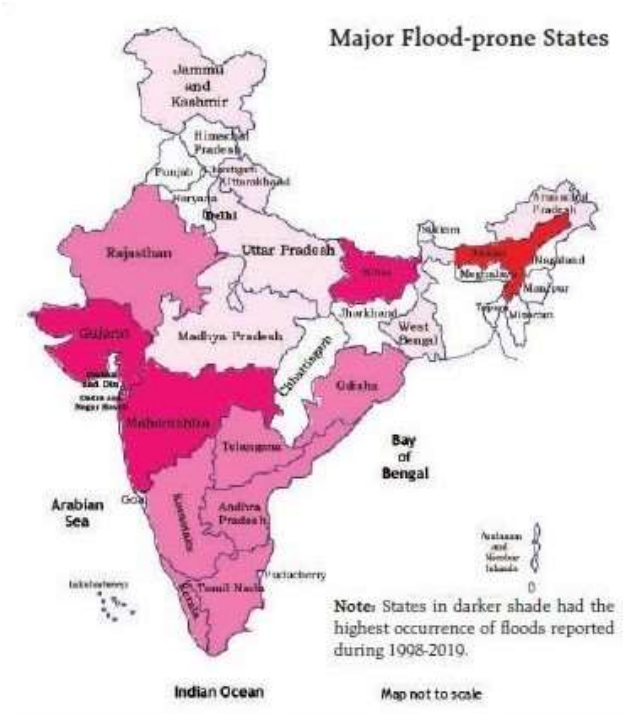

Figure 8: Flood-prone states in India (Indian Meteorological Department (2019))

A significant factor, contributing to the rise and intensity of floods, is the change in land use/land cover (LULC), which has significant effects on climate. For example, land-surface temperature and rainfall patterns have shifted in several districts due to land-use changes (Gogoi, *et al*. 2019). Bogner (2019) suggests that 54% of all flood hotspot districts underwent significant LULC changes between 2005 and 2019 across major landscape attributes, leading to an intensification of impacts from floods.

The southern zone of India is vulnerable to frequent floods and their compounding impacts. The north-eastern region is relatively more vulnerable because of the intensity of flash floods in the area. The eastern zone is also vulnerable to extreme floods;

recurring riverine and coastal floods occur in the region. Also, increasingly, non-flood hotspots are also experiencing increased incidences of urban flooding. In the north–eastern states, flooding is caused by landscape changes that in turn leads to microclimate changes and contribute to faster glacial retreat and sudden glacial lake outbursts.

Flood damage has severe adverse impacts on the agricultural sector. India has suffered crop losses on 18.176 million hectares (mha) of land, roughly 8.5% of the total gross cropped area due to floods from 2017 to 2019. Excessive rainfall and associated waterlogging can seriously impede plant growth and lead to significant yield losses in many crop species. Flash floods may wash away or ruin entire swaths of agricultural land and destroy crops. Besides the direct damage caused by flooding, waterlogging, resulting from heavy rainfall with a long duration also adversely affects crop production, mainly through restricting gaseous exchange in the soil. Consequently, crop yield subjected to soil submergence can decrease significantly.

4.3.4 Cyclones

Cyclone activity remains a large contributor to disaster risk in India, notably along the east coast. Further, the southern and western areas are more exposed than the northern and north-eastern zones. States like Andhra Pradesh, Karnataka, Bihar, Odisha, and Maharashtra are the most exposed to extreme cyclones and associated events. A total of

283 cyclones hit the Indian coastline between 1877 and 2005; as many as 106 of these were extreme cyclonic events that affected a 50-km long strip on the east coast of India, and 35 hit the west coast (ADRC 2012). Modelling of climate change impacts on cyclone intensity and frequency conducted across the globe point to a general trend of reduced cyclone frequency and increased intensity and frequency of the most extreme events. Balaguru, *et al*. (2014) report increased intensity of tropical cyclone activity in the Bay of Bengal over the period 1981–2010, representing an increased threat to communities living along India's east coast.

Since the 2000s, however, the west coast is experiencing extreme cyclone events with increasing frequency and intensity. The intensification of these extreme events can be attributed to changes in landscape attributes that contribute to microclimatic changes. Climate change trends are expected to interact with cyclone hazards in complex ways, and known risks include the action of sea-level rise to enhance the damage caused by cyclone-induced storm surges, and the possibility of increased wind speed and precipitation intensity. Storm surges and cyclones have also been known to induce episodes of rapid coastal erosion. Additionally, Mohanty (2020) indicates that drought hotspot districts have been more prone to cyclonic events in recent decades. Changes in forest management practices, increased in deforestation, reduced forest cover, and unsustainable agricultural practices aggravate the impacts of cyclones and prompt the

onset of associated hazardous events such as inland flooding and landslides (Srinivas and Nakagawa 2008).

Figure 9: Cyclone-prone states in India (Indian Meteorological Department (2019))

Cyclones in coastal areas severely affect all components of agriculture sector through direct damage by high-speed winds, torrential rain, and extensive flooding. Cyclones damage infrastructure, flood agricultural areas, destroy crops, injure cattle, threaten food security, contaminate water supplies, increase the incidence of water-borne diseases, and cause human injuries and sometimes deaths. Strong winds from tropical cyclones cause lodging, striping and induced water stress in cultivated areas (Blanc and

Strobl 2016), while flooding caused by high rainfall and storm surges may decrease photosynthesis and respiration in planted crops, leading to losses in crop yield. The high tides may bring in saline water and sand mass, decreasing the availability of groundwater and arable land through salinization. There are also further indirect impacts from cyclones, such as inducing infections and diseases of farm animals, fish, and crop plants, as well as reducing crop yields and food security of the coastal communities.

5. The Agriculture Sector and Need for Adaptation

5.1 Overview of Agriculture in India

The agricultural sector, along with its allied activities, plays a noteworthy role in the economy of the country, especially due to the large employment of the population in this sector. While the growth rate of agriculture and its allied sectors has declined from 6.6% in 2017–18 to 3.9% in 2021–22, the number of people employed in the agriculture is large. However, despite the decreasing contribution to the total economy, the agricultural sector requires resources and investment including aid as most of the people employed in the sector are dependent on uncertain incomes, and suffer from economic insecurity through the lack of assured incomes.

Majority of India's 138 million operational farm holdings is small, with about 85% of farmers operating on less than 2 hectares of land. This contributes to the poverty trap that most of the farmers in India suffer from, apart from increasing the vulnerability of the farming communities to the economic and societal shocks of climate change. These economic shocks and vulnerabilities are highly concentrated in landless agricultural labour households and marginal farm households, which account for more than 50% of the population still suffering from poverty in India. These vulnerabilities also exhibit a magnified impact on women, 84% of whom are dependent on agriculture for their livelihoods directly or indirectly. Women make up 33% of cultivators and 47% of agricultural labourers, leading to a situation where a large proportion of the population is dependent on uncertain incomes and receives the adverse impacts of climate change in a magnified and disproportionate manner. Empirical research confirms that growth in agriculture helps reduce poverty more than growth in other sectors, this proves beneficial for the poverty-stricken people (Christiaensen and Martin 2018).

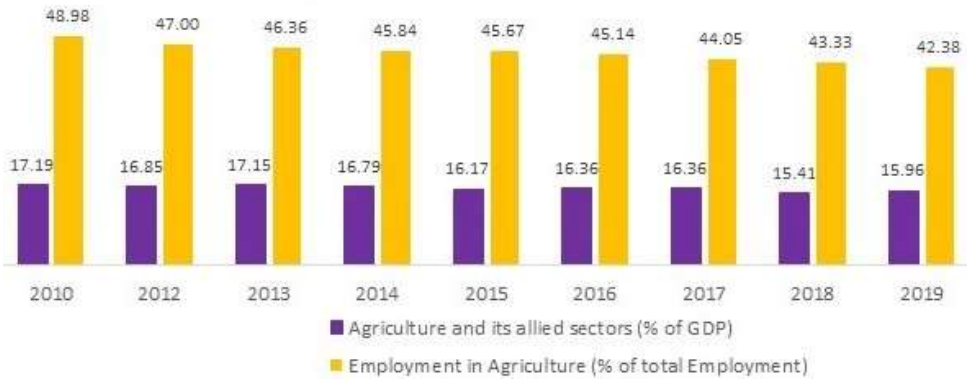

Figure 10: Agriculture GDP and employment (International Growth Centre (2019))

Changes in temperatures and rainfall are known to have critical impacts on the agricultural sector. As a result of higher temperature, there is a possibility of reduction in crop yield and increase in the growth of pests and diseases. Indian agriculture also remains highly dependent on rainfall, in particular, the south-west monsoons, with 67% of the cultivated area growing rainfed crops. This dependency on rainfall increases the vulnerability of the agricultural sector to the hazards of erratic rainfall patterns, and the resultant extreme events, causing crop losses and other economic damages (Venkateswarlu 2019). There are 20 agro-ecological regions in India with climatic conditions that will bear the negative impacts of climate change due to rise in temperatures, erratic rainfall pattern and changes in water availability. Additionally, increasing temperatures from the rise in levels of atmospheric carbon dioxide can directly affect the yield of crops. For instance, the yields of many horticultural crops, such as apples, are likely to decrease as most of these crops are already being grown at

higher temperature thresholds. The rising temperatures could also disproportionately impact rainfed areas much more than irrigated counterpart (Economic Survey 2017–18).

An increasing trend of temperature as evident from observed trends highlights the need for improving access to irrigation. A need for improved access to water through rainwater harvesting, soil moisture conservation, and recharge of groundwater has been recognised by the study. Improving access to irrigation facilities was deemed important in both irrigated and rainfed areas. Other climate risks highlighted include high incidence of droughts and floods, for which investments are required to strengthen forecasting and early warning systems and related infrastructure. Future climate projections indicate an increase in incidences of heavy rainfall events for which adaptation interventions such as tolerant crop varieties, investments in water management, storage infrastructure, creation of wind breaks, strengthening of riverbanks, etc. may minimise risks from agriculture.

Between 2014 and 2018, the level of real agricultural GDP and real agriculture revenues has remained constant, owing in part to weak monsoons in two of those years. Future projections indicate that in many parts of India, farmers will face more challenging conditions, characterised by a warmer environment, more erratic rainfall patterns, and more frequent extreme events. India's Economic Survey 2018 also states that based on projected long-term weather patterns, climate change could reduce annual agricultural

incomes in the range of 15%–18% on average and up to 20%–25% for unirrigated areas. Studies indicate that the 2017 floods in northern India led to extensive crop losses and infrastructural damage in states such as Bihar, Uttar Pradesh, Assam, and West Bengal. Likewise, southern India witnessed a decrease in the amount of rainfall, leading to droughts in 2017. As a result, many farmers lost their livelihoods since they were unable to sustain their agricultural land due to water shortages. The preliminary estimates from the Cyclone Fani in 2019 indicate huge damages were brought to both standing crops and irrigation equipment. Considering the dependence of the agriculture sector on water for irrigation purposes, changes in rainfall and its distribution have significant impacts on water availability.

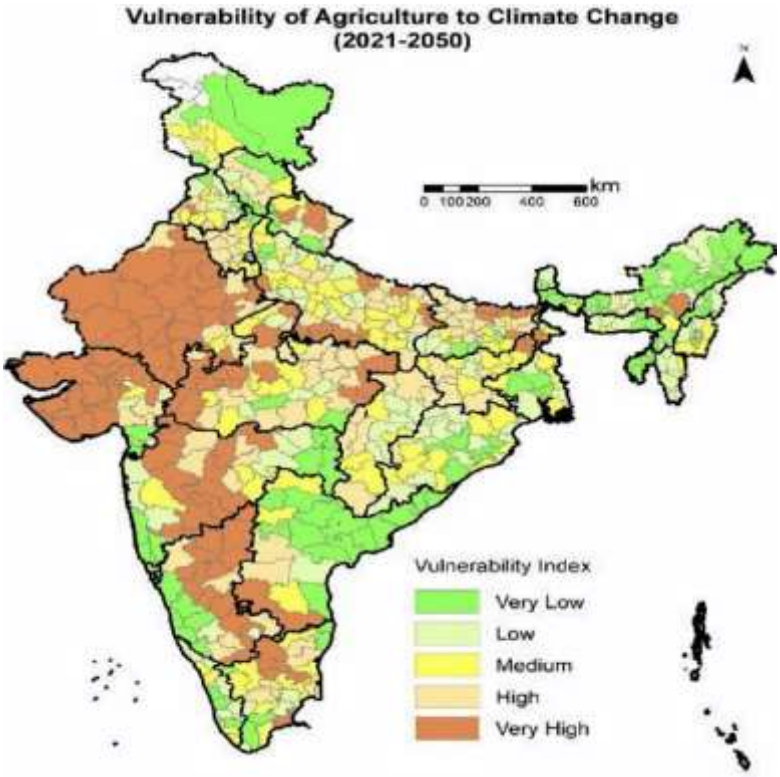

Figure 11: Projected vulnerability of agriculture to climate change (Observer Research Foundation (2020))

Given the prevalence of climate-related stress in the agricultural sector, adaptation is necessary to reduce the drastic effects of climate change, especially the impacts on human health, crop productivity, food security, and water resources. Agricultural policies and development initiatives should always aim to enhance uptake of adaptation mechanisms and reduce the impact of climate variability, as mainstreaming climate adaptation into the policy landscape is a must for achieving the pathway to sustainable development. There is a need to identify and implement transformational adaptations that can lead to substantial changes in land use, resource and labour

allocations, occupational pattern, and cropping systems. Apart from setting national and sub-national goals to address climate change, India also has a firm commitment to international processes in place that indicate addressing these challenges, while also seeking to balance its socio-economic development aspirations and targets.

5.2 Adaptation and the Need for Adaptation in the Agricultural Sector

The IPCC defines Adaptation as "adjustments in ecological, social or economic systems in response to actual or expected climatic stimuli and their effects or impacts." Adaptation includes changes in processes, practices, and structures to minimize possible losses or to accrue benefits from opportunities arising out of changes in the climate.

The objectives of adaptation measures and the effectiveness in achieving them are broadly categorized into the following three groups:

1) Reducing the development deficit by ensuring that communities are lifted out of poverty and can meet their basic needs. This would allow them to be in a position where they are able to withstand climate shocks and stresses.

2) Adaptation mechanisms can ensure that households are able to respond to climate risks in the short run.

3) Lastly, adaptation options aim to ensure developmental benefits of adaptation do help in mitigating and minimizing climate risks. This would include both infrastructure and sustainable livelihoods.

Adaptation and its monitoring are the key objectives of all three post-2015 agendas:

1) Climate change adaptation UNFCCC

2) Sustainable Development Goals, 2030 agenda

3) Disaster Risk Reduction using the Sendai Framework

Stakeholders in climate change adaptation span across different levels, ranging from farm household and community level to the international community. It is essential that adaptation decisions take cognizance of variables that span socio-economic, financial, climatic, institutional, and political contexts, and follow an integrated approach to avoid risks of maladaptation and ensure long-term sustainability. These factors are especially pertinent for a country as climatically and socially diverse as India where the need for massive adaptation-centric investments across different sectors, is constrained because of limited financial resources, with the financial needs of adaptation in India (2015–30) in key climate-sensitive sectors such as agriculture, forestry, fisheries, and water resources are estimated at US$ 206 billion (at 2014–15 prices). Such investments should also be geared towards building the capacity and resilience of farmers to adapt to the

impacts of climate change. In addition, adopting an integrated approach for assessing farmers' perception of and adaptation to changing climatic conditions and their outcomes is essential for effective policymaking, as fragmented and small land size reduces farmers' adaptive capacity to climate change.

Climate adaptation at national level is shaped and implemented through national schemes and policies, investments which suitably address the challenges and opportunities posed by the climate change. These interventions are mostly integrated in policies and planning in climate-sensitive sectors and development planning. As agriculture is a state subject under the Indian Constitution, planning and policy implementation falls substantially within the purview of respective states and local institutions, with the national government providing the broad policy framework, funds, technical resources, and guidelines based around the needs of the individual states. At the national level, the Ministry of Agriculture and Farmers' Welfare spearheads policies and regulations related to agriculture. Through the policies and regulations, the Ministry plans to manage food security issues, poverty in urban and rural areas, energy, and infrastructure. An example of this is the National Mission on Sustainable Agriculture (NMSA), formulated in 2010 under the aegis of National Action Plan on Climate Change (NAPCC), through a series of adaptation measures, aims at promoting location-specific improved agronomic practices that focuses on integrated

farming, water-use efficiency, soil health management and synergizing resource conservation, especially in rainfed areas.

Table 2: Adaptation and mitigation co-benefits of interventions in the agricultural sector

Intervention	**Methods**	**Adaptation benefits**	**Mitigation co-benefits**
Climate-resilient crop varieties	Crop varieties tolerant to drought, flood, and heat; of shorter duration with high yield	Increased and stable production	Reduced GHGs due to short duration
		Saving of water and energy	Reduction in carbon dioxide with less energy use for irrigation
		Increased income	
Water-saving technologies	Drip and sprinkler	Saving of water	Reduced carbon dioxide due to less water use
	Laser-aided land levelling	Increased nutrient-use	Reduced nitrous oxide with increased

		efficiency	Nitrogen efficiency
	Fertigation	Increased production and income	Reduced methane with no submergence in rice cultivation
Changing planting date	Adjusting planting dates to avoid heat stress during flowering and maturing	Reduced yield loss	Reduction in carbon dioxide with less energy use for irrigation
		Less water use and energy use	
Integrated farming system	Inclusion of crop, livestock and fisheries to improve livelihoods	Increased farm income	Reduced GHGs because of efficient use of agri-inputs in the life cycle
		Livelihood security	
Crop diversification	Growing suitable crops to adjust to adverse climate	Less water usage and energy use	Reduction in carbon dioxide with less energy use for irrigation
		Increased and stable production	

Integrated pest management	Combining physical, chemical, and biological methods of pest management	Increased yield due to reduced losses from pest infestations	Reduction in carbon dioxide with less energy use for pesticide manufacturing
Crop insurance	Incentives for farmers for covering risks from climate extremes	Livelihood security	NA
		Increase in risk-taking abilities	
Organic farming	Use of organic sources of nutrients	Less energy requirements	Reduction in carbon dioxide with less energy use for pesticide and fertilizer manufacturing
	Avoiding use of chemical pesticides	Improved soil health	Carbon sequestration
Conservation	Zero tillage	Less energy and	Reduced GHGs

agriculture		water requirements	because of efficient use of agri-inputs
	Crop rotation	Improved soil health	Carbon sequestration
	Residue cover of soil		

Agricultural policies in India have a direct bearing on the lives and livelihoods of roughly two-thirds of India's population. Despite the policies at the national level, the agriculture sector is complex and remains largely unorganized with various stakeholders including policymakers, scientists, agricultural research institutes, individuals engaged in value chain (e.g., food processing and transportation) and at the grassroots level farmer producer organizations (FPOs) and the farming community. In addition to the national-level policies and schemes, states across the country have their own agricultural policies and schemes which complement the national-level initiatives. This is done considering the state's agro-ecological zones, geographical locations, and priorities of the state. This can be understood through one of the major schemes in the agricultural sector—Rashtriya Krishi Vikas Yojana (RKVY). This scheme was launched in 2007 as an umbrella scheme for ensuring holistic development of agriculture and allied sectors by allowing states to choose their own agriculture and allied sector development activities as per the district/state agriculture plan. Under this scheme, states are allowed the flexibility to select, plan, and execute projects and programmes

related to agricultural development and adaptation as per their needs, priorities, and agro-climate requirements. In addition, states can draw funds for the same from the national government under RKVY. These funds are released to the state governments/union territories based on projects approved in the State-level Sanctioning Committee Meeting (SLSC) headed by the Chief Secretary of the concerned state.

Despite the critical role of various actors in the agricultural sector, policies and programmes tend to follow a top-down approach in the decision-making process. Since, adaptation interventions are localized, it is imperative to take due cognizance of the traditional knowledge and experiences of the farmers in designing policies and processes. The current top-down approach needs to be amended and integrated with suitable evidenced-based processes which cater to the needs of the farmers and other stakeholders. Given the complexity in implementing adaptation, for ensuring positive impacts from limited resources, there is a need for a monitoring and evaluation framework to track the national adaptation practices and policies in agriculture. However, the process of measuring adaptation is complex, attributable to the lack of clarity around what measurable impacts of the interventions entail; apart from the absence of holistic metrics/evaluation techniques that can directly quantify the impact of these adaptation measures.

6. Monitoring, Evaluation and Learning in India

Adaptation to climate change has been recognized as a policy priority for the Indian government, which has asserted the need for striking a balance between climate change mitigation and adaptation actions, while also following the economic and social developmental goals of the nation. This prioritization is reflected in money being directed to adaptation efforts while also simultaneously contributing to development indicators.

In order to justify this funding and sustain future adaptation finance flows, a clear process for verifying adaptation results is crucial. The current M&E framework in place includes the (1) Tracking Adaptation and Measuring Development Framework by **International Institute for Environment and Development (**IIED), (2) Results-based Monitoring System developed by GIZ, and (3) The Adaptation Monitoring and Assessment Tool by the GEF. These frameworks make use of indicators that capture different facets of measuring progress on adaptation. A common feature among these frameworks is the use of indicators to measure capacity to capture climate risk and measure reduction in climate vulnerability.

Being a large democracy with a multitude of programmes and schemes being implemented, monitoring and evaluation has been crucial to India since the very

beginning. Monitoring and evaluation of various programmes and schemes of the Central and State governments have been in process since the 1950s, with the Planning Commission playing a central role in administering the various monitoring and evaluation processes. The objective of all such monitoring and evaluation exercises and initiatives has been to assist the government in making informed decisions regarding programme operations and service delivery, promote efficient use of resources, and assess impacts. The limitations of these evaluations are the re-alignment of government priorities and objectives, and a lack of clarity and understanding regarding how these evaluation reports have contributed to decision-making.

In a 2013 report, published by the World Bank,[3] suitable discusses the lack of a robust evaluation data bank preventing an in-depth understanding of effective evaluations. The XIth Plan (2007–12) saw developments and updates of the evaluation system in the country. This was followed by setting up of Development Monitoring Unit in the Prime Minister's office in 2009, for regular monitoring of flagship programmes of the Central Government. In addition, the government decided to create a Performance Management and Evaluation System in the Cabinet Secretariat. The Planning Commission set up a new Independent Evaluation Office (IEO), which began functioning in 2013.

[3] Details available at <https://openknowledge.worldbank.org/handle/10986/19000>

The Development Monitoring and Evaluation Office (DMEO) is an attached office of the NITI Aayog, constituted in 2015 by merging the erstwhile Program Evaluation Office (PEO) and the Independent Evaluation Office (IEO). The DMEO works to fulfil the monitoring and evaluation mandate and to build the monitoring and evaluation ecosystem in India. The DMEO is tasked with the active monitoring and evaluation of schemes, programmes, and initiatives of the Government of India. The primary goal of this exercise is to strengthen the implementation and the scope of delivery. The NITI Aayog acknowledges the need for tracking progress, evaluating performance, and determining outcomes to gauge the overall impact delivered by the scheme. Such an exercise also helps to diagnose reasons for poor performance and generate recommendations for course corrections. These monitoring and evaluation systems enable a thorough understanding of the intended and unintended impacts on society in the short, medium, and long runs.

It must be noted that most existing monitoring and evaluation frameworks and practices do not consider climate risk components. The reasons for this include challenges related to understanding adaptation, and its distinction from development programmes. Absence of frameworks and building of capacities in this area has prevented appropriate action in the monitoring and evaluation of adaptation projects thus far. However, in its recent call in 2019, the NITI Aayog had requested for experts to

evaluate programmes and schemes of the Government of India with components clearly identified for reviewing performance of the project with respect to environment, climate, and sustainability.

In the Indian context, the existing frameworks for climate change adaptation have been developed at programme/project level. One of the examples is Watershed Organization Trust's attempt to track progress of watershed development projects in terms of climate change adaptation objectives. The monitoring and evaluation framework used a bottom-up approach that served as an input to a learning-based iterative adaptive management process. The National Innovations on Climate Resilient Agriculture (NICRA) is another example that includes monitoring and evaluation system primarily based on the use of indicators that capture the social, economic, environmental, and biophysical impacts of the interventions. The impacts are monitored by using a baseline established by collecting household-level information through surveys for both NICRA and non-NICRA villages.

In 2018, with the support of the World Bank, the Government of Maharashtra announced Programme on Climate Resilient Agriculture (PoCRA) for the Marathwada region. Parallel to the announcing of the call the government has appointed monitoring and evaluation experts to understand the progress of work being undertaken. The framework broadly includes collection of baseline data and information, a mid-term

review, and an end-line assessment to understand the overall achievements of the project. Concurrent monitoring processes have been put in place, two each year, to monitor that processes are being followed to help achieve the overall goals. Indicators have been identified based on components defined and overall goals defined.

The limitations of an MEL system in adaptation to climate change remain a priority area to be addressed in the implementation of various adaptation policies and programmes in the country. As mentioned, centrally sponsored schemes and programmes are slowly beginning to integrate monitoring of progress regarding climate indicators. However, other programmes and schemes introduced on a programmatic/ project mode, state projects and initiatives from other sources may not necessarily have such frameworks for monitoring and evaluation. Also, given that the government has introduced its own funds targeting adaptation, the National Adaptation Fund on Climate Change (NAFCC), there is a need to systematize a process wherein the progress of work undertaken is monitored and evaluated, learnings of which are then considered for drafting any future planning and implementation. While many of these centrally sponsored programmes and projects are evaluated from of the work is an expenditure point of view, the monitoring and evaluation of the work progress is left to the line ministries and local authorities.

6.1 Monitoring Evaluation and Learning Framework for Tracking Adaptation in Agriculture

The overarching goal of National Monitoring Evaluation and Learning Framework for tracking adaptation in the agriculture sector is to effectively assess the performance and progress of policies, projects, schemes, initiatives underway at the national and sub-national levels which cater to agriculture and allied sectors, thus facilitating gleaning learnings to be implemented on other adaptation initiatives. Monitoring evaluation and learning approach is an important component of the adaptation process which involves a detailed collection of information that enables stakeholders to check the progress of policies, schemes, and interventions. Evaluation is a systematic assessment of the performance utility of an intervention at a particular point of time. It helps in assessing the effectiveness of policies and schemes. The learning component of the monitoring evaluation and learning focuses on what can be changed based on the information received from monitoring and evaluation. Therefore, the MEL Framework in this document has been designed across the following objectives; while also considering the overarching goal of the framework:

- To create a platform which maps the climate adaptation initiatives in the agriculture sector at national level.

• To develop a national framework for the agriculture sector that takes cognizance of learnings from grassroots levels including experiences and knowledge of local stakeholders such as farmers, communities, local non-governmental organizations (NGOs), Civil Society Organizations (CSOs), and project managers

• To design a set of indicators against which the progress, performance, and effectiveness of agriculture sector initiatives and their contributions, in the light of the various components that reflect on strengthening adaptive capacities and addressing exposure to risks contributing to the overall goal of adaptation.

In addition to the above steps, three cases of adaptation interventions from the states of Telangana, Odisha, and the Union Territory of Puducherry were studied. Each of these areas faces a unique set of climate risks, ranging from salinity intrusion in groundwater in Puducherry to flood and droughts in the state of Odisha and rising temperature and variability in monsoon rainfall. In each of these states/UT the focus was on the projects supported by the National Adaptation Fund for Climate Change (NAFCC). The NAFCC projects in India are financed by National Bank for Agriculture and Rural Development (NABARD). Each of these projects have been tailored to meet the climate risks pertaining to the state/UT with interventions ranging from watershed management to livelihood diversification. In addition to this, the case study of Telangana, discussed two projects—Rainfed Area Development (a component of the

National Mission of Sustainable Agriculture (NMSA)) and the National Initiative on Climate Resilient Agriculture (NICRA). Both these projects are crucial to strengthening climate resilience and adaptation in agriculture.

An in-depth understanding of each of these projects as well as the actors involved in designing, financing, and implementing has helped in formulating the national-level framework. Outputs, outcomes, impacts, and their corresponding indicators were defined for each of the projects. These outputs, outcomes, and impacts have been used in building the national-level framework, as well as serving as an empirical source of information for the development of the data sources in the national framework.

In addition to the mentioned case studies of the two states and one UT, a desk-based review of literature was undertaken to gauge the policy context. The following section provides a detailed description of the agriculture sector policies considered under the ambit of the review.

MEL system for adaptation in agriculture aims to track progress of implementing adaptation interventions, and/or how these interventions can minimize vulnerability, enhance adaptive capacity, and support the overall development and well-being of populations affected by the impacts of climate change. However, despite the purpose of MEL systems there remain multiple challenges for monitoring and evaluation systems in adaptation. Some of these limitations are mentioned below:

1. Linking impacts assessments to measure the impacts of adaptation actions and policies in the long run
2. The complexity surrounding the interventions, largely due to socio-economic context that drives vulnerability (in addition to climate change), and the range of responses required to reduce overall vulnerability.
3. Since, adaptation is often localized and context specific, it is challenging to select a common set of indicators and to define what and how to measure.
4. The availability of data and information in an unstable format.
5. Strengthening of institutions and human resources to align for data collation and reporting

7. India's National Level Missions, Policies and Scheme with Respect to Agriculture

7.1 Overview of Government Policy Regarding Adaptation in Agriculture

The first ever National Agriculture Policy of India was announced in July, 2000, which aimed to actualize the vast untapped potential of Indian agriculture, while targeting a growth rate in excess of 4% per annum in the sector. The policy also seeks to achieve

growth with equity, i.e., growth, which is widespread across regions and farmers, emphasizing the need to cater to domestic markets and maximize benefits from exports of agricultural products.

The national adaptation plan (NAP) process was established under the Cancun Adaptation Framework (CAF). It enables Parties to formulate and implement NAPs as a means of identifying medium- and long-term adaptation needs and developing and implementing strategies and programmes to address those needs. It is a continuous, progressive, and iterative process which follows a country-driven, gender-sensitive, participatory, and fully transparent approach. India has not formulated an NAP yet, therefore, highlighting the scope for identification of adaptation interventions in all sectors including agriculture. As per revised NDCs in 2022, more investments will be created for better adaptation of agriculture sector to the climate change.

7.1.1 Review of Development Policies and Schemes for Building the National-level Monitoring, Evaluation, and Learning Framework in the Agriculture Sector

In 2016–17, several schemes in the agriculture sector were clubbed under one umbrella scheme, the Krishonnati Yojana. The scheme ran from the period from 2017–18 to 2019–20 with the Central Share of Rs33,269.97 crore. The key objectives of the scheme include:

- To create and strengthen the infrastructure for agriculture production.

- To reduce the crops' production cost.
- To market the agriculture and allied produce in efficient manner.

Some of the relevant adaptation policies/missions targeted at achieving these goals in the agricultural sector include the National Food Security Mission, Mission for Integrated Development of Horticulture, National Mission for Sustainable Agriculture, Paramparagat Krishi Vikas Yojana to promote organic farming practices, Pradhan Mantri Krishi Sinchayee Yojana to promote efficient irrigation practices, and National Mission on Agricultural Extension and Technology. The major schemes studied in the framing of the MEL Framework have been discussed below:

Rashtriya Krishi Vikas Yojana

The National Agricultural Development Plan (known by its Hindi name: Rashtriya Krishi Vikas Yojana, RKVY) is in operation since 2007–08 to encourage the formulation of state- and district-level plans and to induce the states to increase their own spending on a varied set of activities for the development of the agricultural sector. These activities could relate to crop development, horticulture, mechanization, natural resource management, marketing, animal husbandry, dairy development, and extension. The scheme aims to encourage each state government to enhance their public investment in agriculture and related services, encouraging them to be flexible and

autonomic in designing and implementing agriculture and related services programmes. By ensuring that districts and states make the agriculture plans, the initiatives can be tailored to the agro-climatic conditions, technological availability, and natural resources local to the state, also keeping these initiatives in line with the development priorities of individual states.

Until 2015–16, the Central Government provided all the funding for the mission. Recently, the funding model has been revised to reflect a shared 60 (centre):40 (state) allocation in most states. The states have full flexibility in their use of the mission funds. Several sub-schemes have been introduced under RKVY, targeting a variety of interventions in agriculture, such as crop diversification, reclamation of problem soils, shifting rice fallow area to pulses and oilseeds, and controlling foot and mouth disease in livestock.

Mission for Integrated Development of Horticulture

The Mission for Integrated Development of Horticulture (MIDH) aims to foster the holistic growth of the horticulture sector, covering fruits, vegetables, root and tuber crops, mushrooms, spices, flowers, aromatic plants, coconut, cashew, cocoa, and bamboo, with a view to augmenting farmers' income and nutritional security through the diversification of cropping and livelihoods. Under MIDH, Government of India contributes 60% of the total outlay for developmental programmes to all the states

except states in northeast and Himalayas while 40% share is contributed by the state governments. MIDH also provides technical advice and administrative support to state governments/ State Horticulture Missions (SHMs) for the Saffron Mission and other horticulture-related activities covered under the RKVY and NMSA initiatives.

The Department of Agriculture and Cooperation, Ministry of Agriculture and Farmers' Welfare has also launched a project called Coordinated Programme on Horticulture Assessment and Management using geo-informatics (CHAMAN) under the MIDH with an objective to develop and firm up scientific methodology for estimation of area and production under horticulture crops. The programme also uses geographical information system (GIS) tools along with remote-sensing data for generating action plans for horticultural development (site suitability, infrastructure development, crop intensification, orchard rejuvenation, aqua-horticulture, etc.). MIDH has also created HORTNET, which aims to accomplish e-Governance and transparency in all the processes of workflow involved in the path of providing financial assistance under MIDH.

National Food Security Mission

The National Food Security Mission (NFSM) operates since 2007–08 to increase the production of wheat, rice, and pulses apart from the promotion of commercial crops like cotton, jute, and sugar cane. The strategy is to provide financial assistance promote

and extend improved technologies regarding, e.g., seed, micronutrients, soil improvement, pest management, machinery, and irrigation, to effectively increase farmers' capacity-building. Until 2014–15 the Central Government provided all the funding, and more recently the funding has been shared between the central and state governments in 60:40 ratio.

Since 2016–17, several new such initiatives were undertaken to increase the production of pulses. The interventions covered under NFSM include demonstrations on new cropping systems, cropping system-based training of farmers, HYV seed distribution, and introduction of bio-fertilizers. NFSM also includes the National Mission on Oilseeds and Oil Palm (NMOOP), which seeks to increase the production of vegetable oil through support for many kinds of improvements in inputs and practices, such as seeds, nutrient management, and sprinkler irrigation.

National Mission for Sustainable Agriculture

The National Mission for Sustainable Agriculture (NMSA) has been operating since 2014–15, with the goal to make agriculture more productive, sustainable, remunerative, and climate resilient. With a total central share of Rs3980.82 crore, NMSA focuses on integrated farming, appropriate soil health management, and synergizing resource conservation technology. NMSA has two major components—rainfed area development and soil health management. One prominent element of the NMSA is the

introduction of a scheme to provide information to farmers on soil analysis and related nutrient recommendations. The scheme is designed to provide this information in the form of a 'soil health card' once every two years.

The Rainfed Area Development (RAD) initiative adopts an area-based approach for the development and conservation of natural resources along with farming systems, in a 'watershed plus framework' model. RAD also seeks to explore the potential utilization of natural resources base/assets available/created through watershed development and soil conservation activities/interventions. RAD introduces appropriate farming systems by integrating multiple components of agriculture such as crops, horticulture, livestock, fishery, forestry with agro-based income-generating activities and value addition, while driving farmland development through resource conservation and crop selection conducive to local agro-climatic conditions, eventually seeking to replicate the development of cluster areas into a larger area scale.

Since 2015–16, an additional scheme is in place to mitigate the effects of drought and increase the area under irrigation: the Pradhan Mantri Krishi Sinchayee Yojana (PMKSY; Prime Minister's Agricultural Irrigation Plan). This sub-scheme aims at providing end-to-end solutions in irrigation supply chains, with respect to water sources, distribution network, and farm-level applications. Under PMKSY, ongoing canal and water surface schemes are targeted for adaptation interventions in

conjunction with climate-resilient practices such as watershed development, rainwater harvesting, micro-irrigation, etc. Under this initiative, the programme 'More Crop Per Drop' is a focused mission that prioritizes end-to-end solutions on irrigation source creation, distribution, management, field applications and extension activities.

Paramparagat Krishi Vikas Yojana

Parampragat Krishi Vikas Yojana (PKVY), set up in 2015–16, encourages farmers to adopt traditional and organic farming in India. The scheme stresses on end-to-end support to organic farmers, from production to certification and marketing. Post-harvest management support includes processing, packing, and marketing and therefore has been made an integral part of the scheme to encourage organic farmers.

Under the PKVY, the Government of India provides financial assistance to the farmers of Rs50,000 per hectare every three years for organic inputs, certification, labelling, packaging, transportation, and marketing of organic produce. The scheme focuses on reducing the ill effects of overuse of fertilizers and agrochemicals by promoting organic manures, bio-fertilizers, and bio-pesticides. It helps improve the soil fertility by improving organic carbon in the soil which results in enhancing moisture-holding capacity in the field too.

National Mission on Agriculture Extension and Technology

The National Mission on Agricultural Extension and Technology (NMAET) seeks to restructure, strengthen, and promote agricultural extension to enable use of appropriate agro-technology and improved agronomic practices. NMAET supports a vast array of extension activities, both through central schemes and centrally sponsored schemes. NMAET also promotes extension education, training, and agricultural mechanization. The Mission also provides financial assistance for individual ownership of farm machinery, and several components of the Mission also support the production and distribution of certified and quality seeds, apart from addressing plant protection, plant quarantine, pesticide management, and food safety.

From 2014–15, the Sub-Mission on Agricultural Mechanization (SMAM) has also been promoting the use of farm machinery and providing financial assistance to acquire and hire farm machinery.

Integrated Scheme on Agricultural Marketing

With a total central share of Rs3863.93 crore, Integrated Scheme on Agricultural Marketing (ISAM) aims to develop agricultural marketing infrastructure besides promoting innovative and latest technologies to update the agricultural marketplace. The ISAM also seeks to identify competitive alternatives for the agriculture marketing infrastructure and also to set up infrastructure facilities for grading, standardization, and quality certification of agricultural produce. The overall goal of ISAM is to integrate

markets through a common online market platform to facilitate pan-India trade in agricultural commodities, and establish a nation-wide marketing information network for trade in agricultural produce and goods.

National Agriculture Market

In order to connect the existing rural agricultural markets, also known as mandis, on a common online market platform to facilitate the trading of agricultural produce and commodities, the Government of India, launched a pan-India portal, e-National Agriculture Market (eNAM) on 14 April 2016. The Small Farmers Agribusiness Consortium (SFAC) is the lead agency for implementing eNAM under the aegis of Ministry of Agriculture and Farmers' Welfare. The initiative seeks to promote uniformity in agriculture marketing by streamlining of procedures across the integrated markets, in addition to removing information asymmetry between buyers and sellers, promoting real-time price, discovery based on actual demand and supply.

On the eNAM platform, farmers can opt to trade directly on their own or through registered commission agents. The eNAM is linked with 1000 markets (APMCs) in 18 states and 2 union territories, connecting over 50 lakh farmers. The government plans to connect over 22,000 rural agriculture markets and local farmers markets with the platform. The platform is also looking to provide grading and assaying services in order to add further value to agricultural products.

Pradhan Mantri Fasal Bima Yojana

From 2016 the PMFBY (Pradhan Mantri Fasal Bima Yojana, Prime Minister Crop Insurance Scheme) is being implemented in association with the state governments. Buying crop insurance remains compulsory for indebted farmers and voluntary for others, which effectively involves agricultural lending institutions, such as banks, in farmers' crop insurance decisions. In contrast to other insurance schemes there is no limit on the government's premium subsidy (Government of India, 2016d). Producers pay a premium of 2% and 1.5% of the 'sum insured' of the kharif and rabi crops, respectively, and 5% for annual commercial and horticultural crops. The actuarial premium may be several times larger, with the central and state governments sharing the cost of paying the difference in premium. A crop loss is determined on the basis of the yield shortfall in the producer's local administrative area, such as a village, i.e. not specifically on the producer's own land. Electronic technology is expected to be used for estimating yield losses and for depositing payments in producers' bank accounts.

The PMFBY is implemented along with a Restructured Weather Based Crop Insurance Scheme (RWBCIS). About 30% of India's cropped area was covered by crop insurance schemes in 2016–17. The premium rates paid by farmers in the most recent scheme, the PMFBY, are generally lower than in earlier schemes, especially the Modified NAIS Although the PMFPY premiums are calculated on an actuarial basis, farmers pay 1.5%

of the sum insured for rabi crops, 2% for kharif crops and 5% for horticulture and commercial crops. The remaining amount of premiums is paid by the central and state governments in 50:50 ratio.

Kisan Credit Cards

The Kisan Credit Card (KCC) scheme was introduced in 1998 so that farmers may use the credit cards issued by banks to readily purchase agriculture inputs such as seeds, fertilizers, pesticides, etc. and draw cash for their production needs. The issuance of cards was based upon the land holdings of individual farmers, and was further extended for the investment credit requirement of farmers for allied and non-farm activities in the year 2004. The scheme provides broad guidelines to banks for operationalizing the KCC scheme.

The KCC scheme aims at providing adequate and timely credit support from the banking system under a single window with flexible and simplified procedure to the farmers for their cultivation and other needs, such as to meet the short-term credit requirements not only for cultivation of crops; but also, post-harvest expenses. KCCs can also be used to procure marketing loans, consumption requirements of the households of farmers and even for working capital for maintenance of farm assets and activities allied to agriculture.

National Livestock Mission

National Livestock Mission (NLM) is an initiative of the Ministry of Agriculture and Farmers' Welfare. The Mission, came into being in 2014–15 has the objective of sustainable development of the livestock sector. This includes the development of production of species, such as sheep, pigs, and poultry, as well as developing livestock feed and addressing issues in livestock production. NLM aims to generate employment through entrepreneurship development in small ruminant, poultry, and piggery sector and fodder sector, to increase per animal productivity through breed improvement, and increase the production of meat, egg, goat milk, wool, and fodder.

NLM also offers a subsidy on the premium for insurance for loss of high-yielding cattle or buffalo by death. Five animals per beneficiary are eligible for coverage. Insurance is offered by private insurance companies. NLM also includes an extension component that seeks to build capacities of all stakeholders, and encourages more farmers to take up livestock rearing to diversify incomes.

7.1.2 Review of Climate Adaptation Specific Policies Schemes for Building the National Monitoring, Evaluation, and Learning Framework in Agriculture

National Adaptation Fund for Climate Change

The National Adaptation Fund for Climate Change (NAFCC) was established in August, 2015 to meet the cost of adaptation to climate change for the states and union territories of India that are particularly vulnerable to the adverse effects of climate change. The projects under NAFCC prioritize the needs that build climate resilience in the areas identified under the SAPCC (State Action Plan on Climate Change) and the relevant missions under NAPCC (National Action Plan on Climate Change). Currently, 30 projects have been sanctioned in 27 states and union territories under NAFCC.

NABARD has been designated as the National Implementing Entity (NIE) for implementation of adaptation projects under NAFCC by the Government of India. Under this arrangement, NABARD performs roles in facilitating identification of project ideas/concepts from SAPCC, project formulation, appraisal, sanction, disbursement of fund, monitoring, evaluation and capacity-building of stakeholders including state governments.

NAFCC seeks to fund outcome parameters that work towards to reducing key risks and adverse impacts of climate change in the water and agriculture sectors, also maximizing multi-sectoral and cross-sectoral co-benefits to meet the challenges of food and water security. The projects related to adaptation in sectors such as agriculture, animal husbandry, water, forestry, tourism, etc. are eligible for funding under NAFCC.

National Innovations in Climate Resilient Agriculture

National Innovations in Climate Resilient Agriculture (NICRA) is a network project of the Indian Council of Agricultural Research (ICAR), and was launched in 2011. The project aims to enhance resilience of Indian agriculture to climate change and climate vulnerability through strategic research and technology demonstration. The research on adaptation and mitigation covers crops, livestock, fisheries, and natural resource management.

NICRA focuses on the critical assessment of different crops/zones in the country for vulnerability to climatic stresses and extreme events, and seeks to find innovative and technological solutions for the same. Examples of such solutions include the installation of the state-of-the-art equipment like flux towers for measurement of greenhouse gases (GHGs) in large field areas apart from the rapid and large-scale screening of crop germplasm. NICRA also emphasizes new research and study areas, such as the dynamics of the crop-pest/pathogen relationship, the emergence of new biotypes due to climate change and focussing on the livestock and aquaculture sectors.

NICRA also has an extension component, which is focussed on the simultaneous up-scaling of the research and technological outputs, and their dissemination through both KVKs and the National Mission on Sustainable Agriculture for wider adoption by the farmers.

National Mission on Sustainable Agriculture

India prepared its National Action Plan on Climate Change (NAPCC) in 2008, formulating eight missions on varied sectors including the National Mission for Sustainable Agriculture (NMSA). The overall aim of the NMSA is to promote sustainable agriculture through a series of adaptation and mitigation measures focusing on identified key dimensions encompassing Indian agriculture, namely, improved crop seeds, livestock and fish cultures, water-use efficiency, pest management, improved farm practices, nutrient management, agricultural insurance, credit support, markets, access to information, and livelihood diversification. Within the NMSA, there are three sub-missions—National Bamboo Mission (NBM), Rainfed Area Development (RAD), and Sub-Mission on Agro Forestry (SMAF). Besides, other national-level initiatives focussing on climate-resilient agriculture include National Initiative on Climate Resilient Agriculture (NICRA), targeting natural resource management, improving crop production, livestock and fisheries, and institutional interventions.

8. National Monitoring, Evaluation, and Learning Framework for Agriculture

Agriculture incorporates intensive use of water, large-scale usage of soil and land resources, cultivation of monocultures of crops and extensive use of artificial fertilizers,

herbicides, and pesticides. There are many specific agri-environmental linkages which are targeted for adaptation measures for the preservation of the ecosystem and environment, as well as the incorporation of agriculture into the scope of sustainable and economic development. The introduction of adaptation interventions also has impacts on the people engaged in the agricultural sector; and it is imperative to understand the socio-economic and behavioural changes in the workforce employed in the agricultural sector. Climatic risks and hazards affecting the agricultural sector result in a varied range of impacts such as depletion of non-renewable resources, soil degradation, environmental effects of agricultural chemicals, inequity, declining rural communities, loss of traditional agrarian values, farm worker safety, decline in self-sufficiency, and decreasing number and increasing size of farms, which reflect the need for adaptation measures to incorporate ecological, financial and socio-economic components.

A set of national adaptation indicators was developed for realizing agriculture and food security. The process included identifying relevant climate information and climate threats, underline potential socio-economic threats, and recognize key adaptive measures undertaken through agricultural policies. The system is based on a multi-dimensional analysis of climate change risk.

Initially, the MEL framework looks at the various environmental factors that impact the agricultural sector. The framework also proposes indicators to map and measure the impacts of the various climatic hazards that have been highlighted in the document. Additionally, the framework also proposes to look at key socio-economic indicators that can help in the better understanding of the climatic sensitivity and vulnerability of the people engaged in the agricultural sector.

Apart from highlighting the various climatic factors that affect the agricultural sector, the MEL framework seeks to also highlight the adaptive capacity component of the framework, by highlighting the initiatives undertaken by the government to strengthen the resilience of the agricultural sector.

The framework aims to divide the practices, results, and learnings of various adaptation interventions by impacts, outcomes, and outputs. On impacts, the framework seeks to identify the larger goal and perspective of the national agricultural policies. These indicators are designed to reflect the changes in the adaptive capacity of farmers and the environment to mitigate any potential losses from climate change.

The framing of these impacts along with the categorization of the various components allows the framework to move to the outcomes, which highlight the outcomes and outcome indicators of the MEL framework. These outcomes are devised based on the individual goals that the various adaptation interventions in agriculture seek to achieve

within each component of the framework. While the outcomes remain relatively general at this point, and are developed based upon the objectives of the programmes initiated by the Indian government, the framework can be tailored and made more specific to suit the requirements of specific interventions of the programmes as well.

The identification of the outcomes and the outcome indicators then further informs the framing of the outputs of the national framework, which comprise the outputs and the output indicators. The outputs in the framework will identify the direct interventions taken on the ground in order to achieve the goals and targets; while the output indicators quantify the level of achievement and outreach of these interventions.

8.1 Monitoring

The Indian agricultural sector is highly vulnerable to climate change. Hence, the adoption of appropriate adaptation measures by stakeholders is crucial for reducing the adverse effects, and it is expected that farmers with higher adaptive capacity would be better equipped to respond to the rapidly changing climatic conditions. Nearly 86% of Indian agriculture is small-holder agriculture, of which most households engage in subsistence agriculture, where adaptation is an issue of survival.

The Monitoring, Evaluation and Learning (MEL) framework covers the various components and practices defined in various development policies in the agricultural

sector and policies/ plans that are specifically designed for adaptation. The framework seeks to devise and categorize impacts, outcomes, and output indicators based on the adaptation interventions.

On the basis of a review of the nature of indicators that are likely to emerge for mapping progress, it is concluded that they may fall on either of the components defined below and therefore have been categorized into the following components:

(1) Biophysical

(2) Socio-cultural

(3) Technological

(4) Economic

(5) Financial

(6) Regulatory components

8.1.1 Biophysical

Agricultural activities produce a diverse range of both harmful and beneficial impacts on environmental quality. Farming can lead to a deterioration in soil and water quality, increased GHG emissions, and the loss of habitats and biodiversity. But agricultural activity can contribute to environmental benefits such as acting as a sink for GHGs,

conserving and enhancing biodiversity and landscape, and preventing flooding and landslides. The impact of agriculture on the environment can occur from both on-farm and off-farm activities. While the state of the environment in agriculture encompasses a wide range of different elements, it can be broadly categorized to the impacts of agriculture on soil and water; as well as the introduction of climate-resilient crops in order to mitigate the impacts of climate risks on agriculture.

India was identified as one of the most highly vulnerable countries to climate change by the IPCC, and climate change has added a new dimension to the challenges faced by the agricultural sector. Recent climatic studies and trends have shown a significant increase in temperature, frequent heat waves, droughts, extreme precipitation events, and intense cyclonic activities; all of whom cause massive economic losses to farmers, thus contributing to food and water scarcity. Saha, *et al*. (2014) report that there would be a weakening of the Indian summer monsoon from the latter half of the 20th century; which would reduce the primary source of water in the Indian agricultural sector. The crop water demand is also likely to upsurge with prolonged global warning and decline in soil fertility, leading to an increased burden on the alternate sources of water in the country. Irrigation and overexploitation have already led to a substantial decrease of the groundwater table; and adaptive measures need to be undertaken to rejuvenate the groundwater resources of India (Zaveri, *et al*. 2016). The impacts of climate change have

already been felt by the agricultural sector, with Aufhemmer, *et al*. (2012) reporting that the rice yield of India since 1966 would have gone up by nearly 4% if warmer nights and less rainfall had not occurred. Guiteras (2009) also found that in the short-run (2010–39), climate change would lower the yields between 4.5% and 9%, whereas, in the long-run (2070–99), it will drastically reduce the yields at least by 25% in the absence of adaptation measures.

Table 3: Indicators for bio-physical components

Outcome	**Outcome indicators**
Outcome 1 Water management and water efficiency for irrigation activities in agriculture	Change in amount of irrigation water used per unit of cropped land (kL/ha)
	Change in quantity of groundwater available for irrigation (mbgl)
	Change in quality of groundwater available for irrigation (TDS levels)
	Change in community water storage capacity (kL)
Output	**Output indicators**
Output 1.1 Introduction of efficient	No. of farmers adopting efficient irrigation systems

irrigation practices, like micro-irrigation	(N)
Activity 1.1 Introduction of efficient irrigation practices, like micro-irrigation	No. of projects implemented for enhancing irrigation practices (N)
	Total area covered under efficient irrigation systems (ha)
Output 1.2 Recharging of groundwater table	No. of water harvesting structures and water recharge structures built under watershed development (N)
Activity 1.2 Recharging of groundwater table	No. of initiatives undertaken for groundwater management (N)
Output 1.3 Enhancing quality of groundwater available through practices like desalinization	Activities undertaken to rejuvenate groundwater in coastal regions (N)
	No. of ponds and lakes rejuvenated from water management activities (N)
Output 1.4 Increasing water storage capacities and structures	No. of tanks and other storage facilities constructed under water management projects and policies (N)

Activity 1.4 Increasing water storage capacities and structures	No. of community associations such as water user association, pani panchayats, etc. in the country (N)
	No. of farmers joining community water user associations (N)
Outcome	**Outcome indicators**
Outcome 2 Increasing resilience of crops to climate risks and hazards	Reduced economic losses from adoption of climate-resilient varieties and cropping practices (INR)
	Change in crop yield from the adoption of climate varieties and resilient cropping practices (tonnes/ha)
Output	**Output indicators**
Output 2.1 Introduction of climate-resistant crop varieties	No. of households adopting climate-resistant crop varieties (N)
Activity 2.1 Introduction of climate-resistant crop varieties	No. of agriculture extension initiatives undertaken to develop awareness regarding climate-resistant crop varieties (N)
Output 2.2 Introduction of different cropping practices to reduce climatic	Proportion of land under mono-cropping versus multi-cropping (%)

risks	Change in cropping intensity (%)
Activity 2.2 Introduction of different cropping practices to reduce climatic risks	Change in crop diversification due adoption of diverse cropping techniques (%)
	Farmers/households adopting integrated farming system practices (%)
Outcome	**Outcome indicators**
Outcome 3 Soil health management	Change in crop yield through the adoption of soil management practices (kg)
	Area under soil treatment practices (ha)
Output	**Output indicators**
Output 3.1 Adoption of practices to increase soil productivity and enhance soil health	Amount of worm biomass produced (kg)
	Change in soil water retention capacity through *in-situ* moisture conservation (%)
Activity 3.1 Adoption of practices to increase soil productivity and enhance soil health	Farmers/households adopting soil health management activities (%)
	Initiatives undertaken for soil health management (N)

Output 3.2 Reclamation of problem soil	Area under alkali/saline soil treated for improved soil health (%)
	Area under acid soil treated for improved soil health (%)
Impact	**Impact indicators**
Maintenance of ecological balance and environmental quality through sustainable use of water and soil resources	Change in water availability (kL)
	Change in soil health (pH)
	Change in farmer's incomes through introduction of new practices (INR)

8.1.2 Socio-cultural

Climate-related issues and farmers' livelihood strategies are different in different parts of India. For instance, many farmers in north east India suffer from droughts and intermittent floods, whereas coastal India suffers from extreme weather events like cyclones and the salinization of groundwater. As an attempt to overcome some of the climatic and non-climatic challenges, farm households are adopting new practices, such as diversifying their livelihood sources and moving to organic and 'greener' practices such as using organic pesticides and fertilizers. Several researchers (e.g. Bhatta and

Aggarwal 2015; Teweldemedhin and Kapimbi 2012; Hailu and Hasan 2012; Barrett *et al*., 2006; Marschke and Berkes 2006; Barrett and Reardon 2001) offer the reason that farm households follow agricultural diversification as a prominent coping strategy under uncertainty caused by climatic and non-climatic factors. Similarly, the strategies that have been shown to increase agricultural productivity and adaptation to climatic variability include integrated plant management practices and integrated farming systems (Hesterman and Thorburn, 1994), expansion of areas under cultivation to compensate for reduced yields during droughts, and switching to more drought resistant crops (Mongi, *et al.* 2010), resource-conserving technologies (Harington and Hobbs 2009; Ladha, *et al*. 2009; Gupta and Seth 2007), and enhancing water-use efficiency. In addition, other farming practices that are important in response to the climatic risks are better management of the pasture lands, adoption of drought-tolerant pasture species, better livestock management practices, cultivation of drought- and flood-tolerant varieties of the crops, disease- and pest-resistant cultivars, shorter cycle varieties, introduction of crop cover, planting trees, among others.

Meanwhile, organic agriculture has gained prominence among the agricultural sector due to the increasing dispersion of community knowledge gained by experimentation and adaptation to local conditions. Organic agriculture provides Indian farmers affordable, practical, and accessible opportunities to build their farm's resilience to

climate risks, and has been highlighted as such sub-nationally. For example, in 2015, Sikkim became India's first fully organically farmed state, and many national and sub-national agricultural initiatives now seek to provide farming households with production, technical, policy, and marketing activities to take up organic farming.

Table 4: Indicators for socio-cultural components

Outcome	**Outcome indicators**
Outcome 1 Farmers adopting various livelihood diversification activities like high-value crops, poultry, horticulture, fisheries, etc.	Increase in percentage of area under horticulture-based farming system (ha)
	Increase in percentage of area under livestock-based farming system (ha)
	Increase in percentage of area under dairy-based farming system (ha)
	Increase in percentage of area under fishery-based farming system (ha)
	Increase in percentage of area under agroforestry (ha)
	Increase in percentage of area covered under saline reclamation with farming system (ha)
	Increase in percentage of area under silvi-pastoral

	system/NTFP (ha)
Output	**Output indicators**
Output 1 Promotion of various livelihood diversification activities for farmers under various national initiatives **Activity 1** Promotion of various livelihood diversification activities for farmers under various national initiatives	No. of beneficiaries under horticulture-based farming system (N)
	No. of beneficiaries under livestock-based farming system (N)
	No. of beneficiaries under dairy-based farming system (N)
	No. of beneficiaries under fishery-based farming system (N))
	No. of beneficiaries under agroforestry (N)
	No. of beneficiaries under silvi-pastoral/NTFP (N)
	No. of Livelihood diversification initiatives and projects carried out at sub-national level (N)
Outcome	**Outcome indicators**
Outcome 2 Greening the growth: Use of organic fertilizers and pesticides,	Total area cultivated using organic farming practices in India (ha)
	Increase in net income of farmers from adoption of

vermicomposting, integration of traditional knowledge	organic farming practices (INR)
Output	**Output indicators**
Output 2 Promotion of organic cultivation in India through national policies	No. of farmers availing financial assistance under organic farming initiatives (N)
	No. of demonstrations and workshops conducted to raise awareness of organic farming practices among farmers (N)
	No. of households adopting vermi-composting practices (N)
	No. of farmers adopting organic pesticides and integrated pest management practices (N)
Impact	**Impact indicators**
Increase in income and climate resilience of farming households through livelihood diversification and organic farming	Change in dairy, livestock, and fishery products on market from increased production (descriptive)
	Change in crop yield through organic farming (kg)
	Change in farmer's incomes through introduction

	through livelihood diversification (INR)

8.1.3 Technological

The natural environment is changing as a result of rapid digitization and introduction of new technologies. It is altering how we view, comprehend, and interact with our environment. It is also affecting the way we deal with environmental challenges in agriculture. For example, through the introduction of weather advisory apps, it is now possible for farmers to adapt to real-time changes in weather and climate; and thus, prevent crop losses from climate change. New technologies and the integration of increased digitization holds the potential to substantially assist in the efforts to combat the adverse impacts of climate change on agriculture. It is imperative to mainstream innovative technologies and processes in India that can help farm output, farmers' livelihood, and food security as the impacts of climate change and the probability of extreme weather events begin to increase.

A key example of such new technologies is Meghdoot, a mobile application that can access location-specific weather-based agro-advisories pan India. Timely agricultural advisories to farmers can enhance their decision-making and reduce production risk under challenging weather conditions. Building on the Indian Meteorological Department's District Agrometeorological Advisory Service (DAAS) which issues crop-

specific weather-based agro-advisories twice a week for all districts in India, the Meghdoot app makes available observed weather recordings, forecasts, and warnings generated during this time.

The **Food and Agriculture Organization's (**FAO) 2020 World Food Day stressed innovation-based changes for climate-resilient agriculture. Some innovative technologies and processes are already demonstrating value, placing them well to be scaled up and replicated. They pertain to different aspects of the farming chain, but all of them help tackle climate threats to agriculture.

Table 5: Indicators for technological components

Outcome	**Outcome indicators**
Outcome 1 Innovation and technological updating of agricultural practices and technologies	No. of new agricultural tools and methodologies introduced/developed (N)
	No. of new practices piloted in the agricultural sector (N)
	Policies and projects initiated on development of technological solutions in agriculture (N)
Output	**Output indicators**

Output 1.1 Research and development of new agricultural methodologies in various fields, like irrigation, crop management, etc.	Area covered under real-time data capture on crop health through satellite data reception system (ha)
	Practices developed for enhancing crop management, water productivity and nutrient-use efficiency (N)
	Development of new climate models-based around different regions, species, and climatic conditions (N)
	Area under real-time monitoring of GHG emissions through the deployment of flux towers (ha)
	Genetic enhancement of tolerance to climatic stresses in major food and horticultural crops through phenomics-assisted and field phenotyping (descriptive)
Output 1.2 Knowledge development and integration of existing adaptation strategies with digital solutions	Development of integrated systems modelling involving crops, natural resources, fisheries, and livestock for impact assessment (descriptive)
	Mapping of [est and disease dynamics in changing climate (descriptive)
	Mapping of unique genes and proteins for use as

	biomarkers of climate resilience (descriptive)
	Development of new climate maps and models for livestock, crop and species variabilities and vulnerabilities (N)
Outcome	**Outcome indicators**
Outcome 2 Digital solutions and ICT for enhanced access to climate information	No. of ICT and digital solutions developed in India for the agricultural sector (N)
	No. of policies and initiatives undertaken for development of ICT and digital solutions in agriculture (N)
Output	**Output indicators**
Output 2.1 Development of knowledge products for dissemination with farmers	No. of real-time district/block-level agro advisories established for minimizing risk due to climate variation (N)
	Development and validation of new pest forewarning models and mobile applications (N)
	Total area covered under weather-based advisory

	systems, and real-time weather warning apps (ha)
	No. of farmers practising digital and ICT solutions while undertaking agricultural practices (N)
Output 2.2 Capacity-building of farmers and stakeholders in ICT products	Development and testing of contingency plans based on real time data to cope with monsoon variability / extreme weather events (descriptive)
	No. of farmers/households aware of ICT solutions, like apps (N)
	No. of capacity-building workshops initiated on raising awareness of ICT products among farmers/households (N)
Impact	**Impact indicators**
Increase in incomes of farmers and reduction in crop and economic losses of farmers from the incorporation of new technologies in agricultural activities	No. of new farmers adopting new technologies into farming activities (N)
	Change in crop yields of farmers incorporating new technologies in farming practices (kg)
	Change in incomes of farmers incorporating technological practices into their farming activities

	(INR)

8.1.4 Economic

Despite introduction of adaptation and technological measures in the agricultural sector, farmers continue to face major challenges ensuring that the generated agricultural products fetch fair prices as well as suffering from low connectivity to markets. The farm-to-fork value chain is excessively long and contains multiple stakeholders, resulting in low-value realization for farmers. On the downstream, lack of infrastructure and the mandi (agri-commodities market) system result in farmers being denied a fair price for their produce and a large volume of post-harvest loss. Improved access to infrastructure facilities and services will play a key role to reduce the vulnerabilities and enhance adaptation capacity in India's agriculture.

Several government initiatives seek to remodel the whole supply chain through efficient distribution systems and reduce the number of intermediaries involved in the value chain to increase the farmer's profit. There is also a drive to increase market linkage of farmers by setting up online trading platforms to directly connect farmers and consumers instead of going via the state-run mandi system. The adverse impacts from climate events often affect transport infrastructure and reduce the connectivity of farmers to agricultural markets, leading to crop losses in transit.

There are also initiatives to improve cold storage and processing facilities available to farmers in order to ensure post-harvest crop losses are kept to a minimum, also enabling farmers to create varied goods from the agricultural produce. Such crop losses would potentially increase as the weather becomes warmer, and the frequency of extreme weather events increase due to the adverse impacts of climate change. Other initiatives also seek to reform the standardization and quality control processes, through the introduction of grading and quality certifications as well as pricing goods based on agricultural certifications.

Table 6: Indicators for economic components

Outcome	**Outcome indicators**
Outcome 1 Value-addition to harvested crops, through cold storage facilities, enhanced processing capacities, product certifications, better last-mile connectivity	Change in crop losses of farmers post-harvesting activities (kg)
	Change in food losses due to enhanced storage and shelf life of products (kg/INR)
	No. of new products available in the market from increased access to facilities for farmers (N)
	No. of new practices and digital solutions introduced in order to enhance final agricultural products (N)

Output	Output indicators
Output 1.1 Promotion of grading, standardization, and quality control of agricultural produce to improve marketability	No. of new quality certifications introduced for enhancing farmer income (N)
	No. of farmers having access to quality certifications for final produce (N)
	No. of new regional and local-quality grading facilities set up (N)
	Creation of national and sub-national databases regarding quality certifications (descriptive)
Output 1.2 Creation and strengthening of post-harvest agricultural infrastructure	No. of new cold storage facilities built (N)
	Increased capacity for storage of harvested crops due to creation of new godowns and other storage facilities (kg)
	No. of farmers using new machines and tools for post-harvest processing, drying, and refining of agricultural products (N)
	No. of farmers having access to facilities for creation

	of processed products (N)
Output 1.3 Improved connectivity to markets, such as e-markets, mega food parks etc., with fair price practices	No. of farmers having access to transportation methods and facilities (N)
	No. of rural agricultural markets developed and upgraded in villages and districts (N)
	No. of agricultural produce market committees (APMCs) set up (N)
	No. of agricultural market events conducted at sub-national and national levels (N)
	No. of new mega food parks established (N)
	No. of farmers having access to e-markets and digital payment solutions (N)
Impact	**Impact indicators**
Increase in incomes of farmers, along with diversification in livelihoods, from increased access to markets and	Change in incomes of farmers due to increased access to markets and infrastructure (INR)
	No. of farmers diversifying incomes and livelihoods

infrastructure	from increased access to infrastructure (N)

8.1.5 Financial

The development, commercialization, and climate proofing of agriculture requires financial services that can support larger agriculture investments, agriculture-related infrastructure, procurement and implementation of newly introduced methods and practices. There is also a need to address systemic risks through insurance and other risk management mechanisms and lower operating costs of smallholder farmers. It is important to increase the financial inclusivity of small farming households through opening of new lines of credit and new credit initiatives; which can enable farmers to invest in new climate-resilient methodologies; also diversifying their incomes by taking up other agricultural-related activities such as horticulture and livestock farming. Such investments can help make the agricultural sector much more resilient to climate shocks, in addition to lifting farmers out of poverty by reducing the risks they face from climate change.

Farmers are also particularly at risk from unexpected changes in the climate, from extreme weather events and would benefit from robust crop insurance programmes. Crop insurance is an important tool for risk transfer in the current climate and it has

clearly played an important role in supporting Indian farmers through the losses incurred during drought years. However, it is increasingly becoming clear that crop insurances should also seek to include developmental measures and initiatives, so that farmers are able to develop their products better and cover risks under insurance initiatives.

Table 7: Indicators for financial components

Outcome	Outcome indicators
Outcome 1 Increased access of farmers to financial markets and instruments through the introduction of new initiatives and policies	Money availed by farmers and other beneficiaries under government credit schemes (INR)
	Amount of money loaned by government and state banks to small and medium farmers (INR)
	Introduction of concessional interest rates for increased financial access to farmers (descriptive)
	No. of new businesses set up under various entrepreneurship schemes (N)
	No. of new funds being introduced and disbursed to

	agricultural start-ups (N)
	No. of climate insurance policies and initiatives introduced in the agricultural sector (N)
Output	**Output indicators**
Output 1.1 Introduction of bank instruments like credit cards and loans for agriculture-based investments of farmers	No. of farmers holding Kisan Credit Cards (N)
	No. of Pashu Kisan Credit Card holders (N)
	No. of farmers having access to bank accounts (N)
	No. of farmers holding insurance policies (N)
	No. of farmers having access to pension and remittance facilities (N)
	No. of farmers aware of various credit and financing initiatives of the government (N)
Output 1.2 Increased opportunities for farmers to engage in agri-entrepreneurship through the setting up of start-up funds, incubators, and	No. of farmers/rural households enrolled in government entrepreneurship initiatives (N)
	No. of training workshops conducted at rural areas for entrepreneurship activities (N)

accelerators	No. of farmers aware of entrepreneurship initiatives and policies (N)
Output 1.3 Increased risk management for farmers, through weather, climate, and crop insurance	No. of farmers insured against climate and weather risks (N)
	Total amount of money insured against climate risks for farmers (INR)
	No. of claims settled for climate and weather risks for farmers (N)
Impact	**Impact indicators**
Increased income of farmers and development of farming infrastructure through increased financial inclusion	Change in incomes of farmers from increased financial inclusion and livelihood diversification (INR)
	No. of farmers investing in new infrastructure due to increased financial inclusion (N)
	No. of farmers taking loans to adopt climate-resilient practices and methodologies (N)

8.1.6 Regulatory

The first ever National Agriculture Policy was announced in July, 2000. The Policy seeks to actualize the vast untapped potential of Indian agriculture and aims at achieving a growth rate in excess of 4% per annum in the agriculture sector. It also seeks to achieve growth with equity, i.e., growth, which is widespread across regions and farmers. It also emphasizes the need to cater to domestic markets and maximize benefits from exports of agricultural products. Various measures have been taken to operationalize the policy. In pursuance of the policy, national policies on sectors like cooperation, seeds, and extension have been framed.

The nature of policy planning for the agricultural sector of India has always been primarily determined by its unique nature of consisting of millions of independent producers. Hence, agricultural planning in India prioritizes creation of a rural infrastructure combined with the provision of modem inputs and a framework of incentives for the farmers to enable them to increase output through the adoption of modem technology.

During the post-independence period, agricultural policy was determined by the prevailing socio-economic conditions. The land reforms were initiated during the mid-80s with a view to abolish the semi-feudal barriers to agricultural modernization. The acute food shortage and dependence on food imports resulted in major emphasis on

accelerating food grains growth through large investments in infrastructure and in new agricultural technology during the mid-60s. This technology was successful in raising food output and in making India self-sufficient by the end of 80s.

More recently, the globalization of Indian agriculture offers both opportunities and challenges to the policymakers. While large benefits can be accrued through the export of high-value, labour-intensive agricultural products, the diversification of Indian agriculture for both domestic consumption and exports can only take place after achievement of self-sufficiency in food grains' output and the generation of large surpluses. The other important challenge is to undertake specific policy measures to enable the mass of peasantry including the small and marginal farmers and agricultural labourers, in all parts of India to partake in the gains from development and increased export opportunities likely to become available with multilateral trade liberalisation (Bhalla 1995).

Table 8: Indicators for regulatory components

Outcome	**Outcome indicators**
Outcome 1 Legislative activities around farmer assistance, development and finance	Increased government engagement and support for farm and farmer policies (descriptive)
	Change in financial assistance provided to the

allocation	agricultural sector by the central government (INR)
	No. of bills related to agriculture and development introduced in the parliament
Output	**Output indicators**
Output 1.1 Legislation introduced around agriculture support	No. of bills introduced in parliament to enhance technological support to farmers
	No. of bills introduced in parliament to enhance economic support to farmers
	No. of bills introduced in parliament to enhance financial support to farmers
Output 1.2 Legislation introduced around promotion of 'green' practices	No. of bills introduced in parliament, announcing support for 'greener' agricultural practices such as organic farming, vermicomposting, etc.
	No. of state bills introduced around 'greener' agricultural practices
Output 1.3 Allocation of financial assistance to the agricultural sector	Amount of money allocated under the union budget for the agricultural sector (INR)
	Average financial allocations by state budgets for the

	agricultural sector (INR)
	Average financial funding granted to the various national missions and policies for the agricultural sector (INR)
Outcome	**Outcome indicators**
Outcome 2 New policies and schemes introduced around the development of the agricultural sector	No. of agricultural schemes and policies introduced by the national government
	Amount of financial assistance allocated by the national government for agricultural schemes and policies (INR)
Output	**Output indicators**
Output 2.1 Introduction of new agricultural schemes by national and line ministries	No. of new agricultural schemes introduced by national and state governments
	No. of new development schemes with agriculture components introduced by national and state governments
Output 2.2 Establishment of new	No. of new institutions and agencies set up to

institutions to implement policies and strengthen farmer capacities	implement agriculture initiatives
	No. of regional institutions introduced for developing farmer capacities
	No. of new farmer and community-led established as part of agriculture policies
Outcome	**Outcome indicators**
Outcome 3 Building of monitoring and compliance frameworks around the agricultural sector	Establishment of MEL frameworks by implementing entities of agricultural policies (yes/no)
	Updating of progress reports of various projects in agricultural sector (yes/no)
Output	**Output indicators**
Output 3.1 Introduction of regulation to ensure the implementation of new bills and policies	Establishment of monitoring and evaluation activities within agricultural activities (yes/no)
	Training activities conducted for line officials of implementing agencies in reporting activities
	No. of progress reports submitted to donor and implementing agencies regarding project interventions

Output 3.2 Introduction of financial monitoring frameworks	Average amount of money disbursed by implementing agencies for project interventions (INR)
	Establishment of financial monitoring guidelines by donor and implementing agencies (yes/no)
Impact	**Impact indicators**
Enhanced legislative and financial support to the agricultural sector, with corresponding monitoring and evaluation	Change in yield of farmers under various agricultural assistance programmes (tonnes/ha)
	Introduction of new legislation targeting varied and specific issues in the agricultural sector (N)
	Change in incomes of farmers under various agricultural assistance programmes (INR)
	Allocation of finance targeting varied and specific issues in the agricultural sector (INR)
	Identification of emerging issues and targeting problems through MEL frameworks (descriptive)

9. Linkage to Sub-national/State-level Cases (Telangana, Puducherry, and Odisha)

Owing to the varied climate and geographical conditions experienced in India, the climate risks and impacts tend to vary from region to region within the country. For example, the mountainous regions in the country face very different climatic conditions and risks, to the hazards faced by the coastal regions. Agriculture and its allied activities are also practised differently, along with variable socio-economic and developmental priorities in different regions of India. Therefore, it is essential to understand the varying contexts and challenges faced by farmers in a variety of ecological landscapes; and identify and formulate the adaptation actions. Accordingly, a robust set of indicators can be identified for the MEL frameworks of the adaptation actions. By adopting a bottom-up approach, the framework can be tailored to cover a wide range of adaptation actions in varying contexts and landscapes, enabling its scaling-up to a robust and flexible national MEL framework.

In India, adaptation measures are implemented at sub-national level by the state governments and other entities. Therefore, in order to properly understand the varied contexts and landscapes as well as identifying the different stakeholders involved in the process of implementation of the adaptation initiatives, three different case studies were

undertaken in different states in the country. The learnings from the stakeholder interactions from sub-national scale interventions can also be incorporated for the development of the national level framework. These projects are enumerated here:

1. Telangana

   In Telangana, three different projects were considered, targeting different priority sectors in the region to target the climate risks such as increases in temperature, heat waves, variable monsoons, and droughts.

   Rainfed Area Development, funded by the NMSA, aimed to increase the resilience of local farmers and agricultural communities to climatic risks and decrease their vulnerability by promoting diversification in cropping practices and livelihoods. One of the major components of the project aimed to promote integrated farming systems, emphasizing on multi-cropping, inter-cropping, and mixed cropping practices. Other components aim to encourage value addition to agricultural products, as well as promoting on-farm development activities.

   Resilient Agricultural Households, which was planned and funded under the NAFCC, looked at understanding household level adaptation interventions, as well as assessing the knowledge outreach and understanding of agricultural households of the impacts of adaptation interventions. These assessments would feed into the knowledge management and capacity-building components of the

projects, especially building the technical capacities of the implementing line departments and communities regarding adaptation interventions. Also, certain technological innovations were included in the project components, such as the development and implementation of an information system for climate forecasts and weather advisories.

The final project was undertaken by NICRA, which aims to develop and promote climate-resilient technologies in agriculture in order to address the increasing vulnerability of the farming communities in the region. NICRA has four key focus areas in the project, which deal with strategic research on mitigation and adaptation interventions in agriculture, demonstrating new technology, undertaking knowledge management and capacity-building activities, a[art from sponsoring competitive grants for projects in the region. For the development of resilience in the agricultural sector, NICRA also looks at the environmental components and developing allied activities to agriculture, through modules on natural resource management, crop production, livestock, fisheries, in addition to developing the capacity for institutional interventions.

2. Odisha

This project, funded under the NAFCC, seeks to conserve water through enhancing water management of the run-off in the river basin, and hence, reduces vulnerability and enhance resilience for the traditional livelihoods in Nuapada district in Odisha. This project addresses certain key climate risks in the state of Odisha, such as floods, droughts, and heat waves.

The project has several livelihood diversification and capacity-building components, such as the protection of natural streams near the river basin, undertaking structural measures such as check dams, diversifying livelihoods through the introduction of horticultural crops, link livelihoods to fisheries and poultry, as well as introducing solar pumping systems for increasing efficiency of water usage.

These interventions also include research and extension components, such as fostering linkages between local water associations, known as Pani Panchayats, besides developing resource and research material for understanding the co-benefits of adaptation and mitigation.

3. Puducherry – Integrated Surface Water Management

Funded under the NAFCC, this project envisages increasing the recharge capacities of tanks and ponds in villages in order to combat the climate risks

posed by heavy rains and coastal erosion. Such climatic events can lead to hazards such as floods and cyclones; besides gradual disasters such as the salinization of the groundwater table.

This project led to the rejuvenation of 186 village ponds and 39 irrigation tanks in the Puducherry and Karaikal regions. Such measures would lead to an increased surface water run-off; contributing to the revitalization of the groundwater table. It would also ensure a steady water supply for farmers during periods of intermittent rainfall.

Through a capacity-building component, the project also seeks to build the capacities of local tank user associations (TUAs) and encourages more farmers to become members of TUAs in order to ensure water conservation and management.

Through the implementation of these sub-national projects and via designing of MEL frameworks for the sub-national case studies, we were able to develop a better understanding regarding the nature of adaptation interventions throughout the country, also identifying the key stakeholders and implementing entities in varied policy and ecological contexts. Such an understanding of the policy and intervention landscape in India was crucial in the selection of adaptation interventions at the

national level, for which the MEL framework can be further developed. Additionally, through the selection of varied sub-national case studies, we were able to identify a wide range of adaptation measures for different climate risks and climate settings, as well as further developing indicators for the MEL frameworks of the same. By identifying and developing indicators for such a wide range of adaptation interventions, we can combine and further scale up these indicators into a robust and comprehensive national framework that is able to cover the wide variety of adaptation interventions required for a climatically diverse country as India.

10. Evaluation

Despite the terms 'monitoring' and 'evaluation' being used together, they refer to distinct tasks. Monitoring is a continuous and on-going process whereas evaluation is a scheduled at regular periodicities and may be ex-ante, ex-post or be conducted mid-term. However, it must be noted that both monitoring and evaluation are complementary activities. The **Organization for Economic Cooperation and Development (**OECD) defines evaluation as "the systematic and objective assessment of an on-going or completed project, programme or policy, its design, implementation, and results. The aim is to determine the relevance and fulfilment of objectives, development efficiency, effectiveness, impact, and sustainability. An evaluation should

provide information that is credible and useful, enabling the incorporation of lessons learned into the decision-making process of both recipients and donors."[4]

For adaptation projects, evaluation activities include tracking of actions to provide feedback to relevant stakeholders to gauge the progress and make any necessary adjustments. The evaluation process seeks to assess whether a programme or a project has attained its objectives; while also evaluating the results and learnings during the project period for identifying co-benefits and challenges for future projects. The data involved in the proper evaluation of the MEL framework and the individual indicators can be collected by the implementing and evaluation bodies of the line officers of the programs, and the respective ministries. This collected data can then be aggregated at the national level to develop a comprehensive picture of the impacts of the various interventions in the agriculture sector.

Outcome indicators of the proposed MEL framework include both qualitative and quantitative indicators which can be evaluated through various available ladder-based approach, scorecards and narratives/expert judgement periodically.

Indicators that identify the continuous progress achieved in terms of the goals and objectives of the adaptation intervention are evaluated through ladder-based approach. These can be either qualitative or quantitative. These indicators tend to be iterative in

[4] OECD (2021)

nature, and periodic evaluation processes seek to understand if these indicators show positive progress over time. They also help us identify challenges and shocks to the project, by assessing if certain indicators are not progressing as anticipated, and enable us to carry out course correction actions to ensure the success of the project.

Evaluation of more permanent changes from the impacts of the project, such as behavioural or landscape changes, may be qualitative or quantitative. For instance, a quantitative method may involve the number of people adopting a certain type of behaviour. This may also be measured using a scorecard which helps in mapping the result as 'Yes,' 'No' or 'Partial' and may be represented using '2', '1' or '0' for evaluation purpose and may be analysed using a weightage. On the contrary, qualitative techniques for mapping behavioural change would involve use of expert judgement/narratives or use of pre and post surveys. In case of narratives, scoring for each sub-indicator is aggregated to produce an overall score for each outcome indicator. This method then provides a quantitative interpretation of the score. Such a scorecard approach enables us to understand the impact of the project, and whether the outcomes envisaged by the theory of change have been achieved by the project. Scorecard approaches can also help in course-corrections or for expanding the scope of the project, by identifying barriers, co-benefits, and opportunities during the project.

Other tools and techniques of evaluation would include economic assessments such as a cost–benefit analysis, social evaluation methods like surveys and other technical methods such as geo-tagging or photo verifications of achieved targets. Economic assessments would also help in prioritization of adaptation options, whereas other methods help drive accountability and course correction regarding the achieved targets of the projects. Social evaluation methods can similarly assess the impact of the project on local stakeholders, establishing if positive impacts have been felt by the local communities and helping drive tangible change at the grassroots level.

Based on the above techniques, we can provide the following classification for the indicators.

Table 9: Evaluation Methods for bio-physical components

Outcome	**Outcome indicators**	**Evaluation method**
Outcome 1 Water management and water efficiency for irrigation activities in agriculture	Change in amount of irrigation water used per unit of cropped land (kL/ha)	Ladder method
	Change in quantity of groundwater available for irrigation (mbgl)	Ladder method
	Change in quality of groundwater available for	Ladder method

	irrigation (TDS levels)	
	Change in community water storage capacity (kL)	Ladder method
Output	**Output indicators**	**Evaluation method**
Output 1.1 Introduction of efficient irrigation practices, like micro-irrigation	No. of farmers adopting efficient irrigation systems (N)	Ladder method
	No. of projects implemented for enhancing irrigation practices (N)	Ladder method
	Total area covered under efficient irrigation systems (Ha)	Ladder method
Output 1.2 Recharging of groundwater table	No. of water harvesting structures and water recharge structures built under watershed development (N)	Ladder method
	No. of initiatives undertaken for groundwater management (N)	Ladder method

Output 1.3 Enhancing quality of groundwater available through practices like desalinization	Activities undertaken to rejuvenate groundwater in coastal regions (N)	Ladder method
	No. of ponds and lakes rejuvenated from water management activities (N)	Ladder method
Output 1.4 Increasing water storage capacities and structures	No. of tanks and other storage facilities constructed under water management projects and policies (N)	Ladder method
	No. of community associations such as water user association, pani panchayats, etc. in the country (N)	Ladder method
	No. of farmers joining community water user associations (N)	Ladder method
Outcome	**Outcome indicators**	**Evaluation method**
Outcome 2 Increasing resilience of crops to climate risks and	Prevention of economic losses from adoption of climate resilient cropping practices (INR)	Ladder method
	Change in crop yield from the adoption of	Ladder method

hazards	climate resilient cropping practices (kg)	
Output	**Output indicators**	**Evaluation method**
Output 2.1 Introduction of climate-resistant crop varieties	No. of households adopting climate-resilient crop varieties (N)	Ladder method
	No. of agriculture extension initiatives undertaken to develop awareness regarding climate-resilient crop varieties (N)	Ladder method
Output 2.2 Introduction of different cropping practices to reduce climatic risks	Proportion of land under mono-cropping versus multi-cropping (%)	Ladder method
	Change in cropping intensity (%)	Ladder method
	Change in crop diversification due adoption of diverse cropping techniques (%)	Ladder method
	Percentage of farmers/households adopting Integrated farming system practices	Ladder method
Outcome	**Outcome indicators**	**Evaluation method**

Outcome 3 Soil health management	Change in crop yield through the adoption of soil management practices (kg)	Ladder method
	Area under soil treatment practices (ha)	Ladder method
Output	**Output indicators**	**Evaluation method**
Output 3.1 Adoption of practices to increase soil productivity and enhance soil health	Amount of worm biomass produced (kg)	Ladder method
	Change in soil water retention capacity through *in-situ* moisture conservation (%)	Ladder method
	Percentage of farmers/households adopting soil health management activities	Ladder method
	Initiatives undertaken for soil health management (N)	Ladder method
Output 3.2 Reclamation of problem soil	Percentage of area under alkali/saline soil treated for improved soil health	Ladder method
	Percentage of area under acid soil treated for improved soil health (%)	Ladder method

Impact	Impact indicators	Evaluation method
Maintenance of ecological balance and environmental quality through sustainable use of water and soil resources	Change in water availability (kL)	Ladder method
	Change in soil health (pH)	Ladder method
	Change in farmer's incomes through introduction of new practices (INR)	Ladder method

Table 10: Evaluation Methods for socio-cultural components

Outcome	Outcome indicators	Evaluation method
Outcome 1 Farmers adopting various livelihood diversification activities like high-value crops, poultry, horticulture, fisheries, etc.	Increase in percentage of area under horticulture-based farming system (ha)	Ladder method
	Increase in percentage of area under livestock-based farming system (ha)	Ladder method
	Increase in percentage of area under dairy-based farming system (ha)	Ladder method
	Increase in percentage of area under fishery-	Ladder method

	based farming system (ha)	
	Increase in percentage of area under agro-forestry (ha)	Ladder method
	Increase in percentage of area covered under saline reclamation with farming system (ha)	Ladder method
	Increase in percentage of area under silvi-pastoral system/NTFP (ha)	Ladder method
Output	**Output indicators**	**Evaluation method**
Output 1 Promotion of various livelihood diversification activities for farmers under various national initiatives	No. of beneficiaries under horticulture-based farming system (N)	Ladder method
	No. of beneficiaries under livestock-based farming system (N)	Ladder method
	No. of beneficiaries under dairy-based farming system (N)	Ladder method
	No. of beneficiaries under fishery-based farming system (N)	Ladder method

	No. of beneficiaries under agro-forestry (N)	Ladder method
	No. of beneficiaries under silvi-pastoral/NTFP (N)	Ladder method
	No. of livelihood diversification initiatives and projects carried out at sub-national level (N)	Ladder method
Outcome	**Outcome indicators**	**Evaluation method**
Outcome 2 Greening the growth: Use of organic fertilizers and pesticides, vermicomposting, integration of traditional knowledge	Total area cultivated using organic farming practices in India (ha)	Ladder method
	Increase in net income of farmers from adoption of organic farming practices (INR)	Ladder method
Output	**Output indicators**	**Evaluation method**
Output 2 Promotion of organic cultivation in	Number of farmers availing financial assistance under organic farming initiatives	Ladder method

India through national policies	(N)	
	No. of demonstrations and workshops conducted to raise awareness of organic farming practices among farmers (N)	Ladder method
	No. of households adopting vermi-composting practices (N)	Ladder method
	No. of farmers adopting organic pesticides and integrated pest management practices (N)	Ladder method
Impact	**Impact indicators**	**Evaluation method**
Increase in income and climate resilience of farming households through livelihood diversification and organic farming	Change in dairy, livestock, and fishery products on market from increased production (descriptive)	Scorecard/narratives
	Change in crop yield through organic farming (kg)	Ladder method
	Change in farmer's incomes through introduction through livelihood	Ladder method

	diversification (INR)	

Table 11: Evaluation Methods for technological components

Outcome	**Outcome indicators**	**Evaluation method**
Outcome 1 Innovation and technological updating of agricultural practices and technologies	No. of new agricultural tools and methodologies introduced/developed (N)	Ladder method
	No. of new practices piloted in the agricultural sector (N)	Ladder method
	Policies and projects initiated on development of technological solutions in agriculture (N)	Ladder method
Output	**Output indicators**	**Evaluation method**
Output 1.1 Research and development of new agricultural methodologies in various fields, like irrigation, crop	Area covered under real-time data capture on crop health through satellite data reception system (ha)	Ladder method
	Practices developed for enhancing crop management, water productivity and	Scorecard

management, etc.	nutrient-use efficiency (N)	
	Development of new climate models based around different regions, species, and climatic conditions (N)	Ladder method
	Area under real-time monitoring of GHG emissions through the deployment of flux towers (ha)	Ladder method
	Genetic enhancement of tolerance to climatic stresses in major food and horticultural crops through phenomics-assisted and field phenotyping (descriptive)	Scorecard/narratives
Output 1.2 Knowledge development and integration of existing adaptation strategies with digital solutions	Development of integrated systems modelling involving crops, natural resources, fisheries, and livestock for impact assessment (descriptive)	Scorecard/narratives
	Mapping of pest and disease dynamics in changing climate (descriptive)	Scorecard/narratives

	Mapping of unique genes and proteins for use as biomarkers of climate resilience (descriptive)	Scorecard/narratives
	Development of new climate maps and models for livestock, crop and species variabilities and vulnerabilities (N)	Scorecard
Outcome	**Outcome indicators**	**Evaluation method**
Outcome 2 Digital solutions and ICT for enhanced access to climate information	No. of ICT and digital solutions developed in India for the agricultural sector (N)	Ladder method
	No. of policies and initiatives undertaken for development of ICT and digital solutions in agriculture (N)	Ladder method
Output	**Output indicators**	**Evaluation method**
Output 2.1 Development of knowledge products for dissemination with farmers	No. of real-time district/block level agro advisories established for minimizing risk due to climate variation (N)	Ladder method
	Development and validation of new pest	Ladder method

	forewarning models and mobile applications (N)	
	Total area covered under weather-based advisory systems, and real-time weather warning apps (ha)	Ladder method
	No. of farmers practising digital and ICT solutions while undertaking agricultural practices (N)	Ladder method
Output 2.2 Capacity-building of farmers and stakeholders in ICT products	Development and testing of contingency plans based on real-time data to cope with monsoon variability / extreme weather events (descriptive)	Scorecard
	No. of farmers/households aware of ICT solutions, like apps (N)	Ladder method
	No. of capacity-building workshops initiated on raising awareness of ICT products among farmers/households (N)	Ladder method

Impact	Impact indicators	Evaluation method
Increase in incomes of farmers and reduction in crop and economic losses of farmers from the incorporation of new technologies in agricultural activities	No. of new farmers adopting new technologies into farming activities (N)	Ladder method
	Change in crop yields of farmers incorporating new technologies in farming practices (N)	Ladder method
	Change in incomes of farmers incorporating technological practices into their farming activities (INR)	Ladder method

Table 12: Evaluation Methods for economic components

Outcome	Outcome indicators	Evaluation method
Outcome 1 Value addition to harvested crops, through cold storage facilities, enhanced processing	Change in crop losses of farmers post harvesting activities (kg)	Ladder method
	Change in food losses due to enhanced storage and shelf life of products (kg/INR)	Ladder method
	No. of new products available in the market	Ladder method

capacities, product certifications, better last-mile connectivity	from increased access to facilities for farmers (N)	
	No. of new practices and digital solutions introduced in order to enhance final agricultural products (N)	Ladder method
Output	**Output indicators**	**Evaluation method**
Output 1.1 Promotion of grading, standardization, and quality control of agricultural produce to improve marketability	No. of new quality certifications introduced for enhancing farmer income (N)	Ladder method
	No. of farmers having access to quality certifications for final produce (N)	Ladder method
	No. of new regional and local quality grading facilities set up (N)	Ladder method
	Creation of national and sub-national databases regarding quality certifications (descriptive)	Scorecard/narratives
Output 1.2 Creation and	No. of new cold storage facilities built (N)	Ladder method

strengthening of post-harvest agricultural infrastructure	Increased capacity for storage of harvested crops due to creation of new godowns and other storage facilities (kg)	Ladder method
	No. of farmers using new machines and tools for post-harvest processing, drying, and refining of agricultural products (N)	Ladder method
	No. of farmers having access to facilities for creation of processed products (N)	Ladder method
Output 1.3 Improved connectivity to markets, such as e-markets, mega food parks, etc. with fair price practices	No. of farmers having access to transportation methods and facilities (N)	Ladder method
	No. of rural agricultural markets developed and upgraded in villages and districts (N)	Ladder method
	No. of agricultural produce market committees (APMCs) set up (N)	Ladder method
	No. of agricultural market events conducted at sub-national and national levels (N)	Ladder method
	No. of new mega food parks established (N)	Ladder method

	No. of farmers having access to e-markets and digital payment solutions (N)	Ladder method
Impact	**Impact indicators**	**Evaluation method**
Increase in incomes of farmers, along with diversification in livelihoods, from increased access to markets and infrastructure	Change in incomes of farmers due to increased access to markets and infrastructure (INR)	Ladder method
	No. of farmers diversifying incomes and livelihoods from increased access to infrastructure (N)	Ladder method

Table 13: Evaluation Methods for financial components

Outcome	**Outcome indicators**	**Evaluation method**
Outcome 1 Increased access of farmers to financial markets and	Money availed by farmers and other beneficiaries under government credit schemes (INR)	Ladder method

instruments through the introduction of new initiatives and policies	Amount of money loaned by government and state banks to small and medium farmers (INR)	Ladder method
	Introduction of concessional interest rates for increased financial access to farmers (descriptive)	Scorecard
	No. of new businesses set up under various entrepreneurship schemes (N)	Ladder method
	No. of new funds being introduced and disbursed to agricultural start-ups (N)	Ladder method
	No. of climate insurance policies and initiatives introduced in the agricultural sector (N)	Ladder method
Output	**Output indicators**	**Evaluation method**
Output 1.1 Introduction of bank instruments like	No. of farmers holding Kisan Credit Cards (N)	Ladder method
	No. of Pashu Kisan Credit Card holders (N)	Ladder method

credit cards and loans for agriculture-based investments of farmers	No. of farmers having access to bank accounts (N)	Ladder method
	No. of farmers holding insurance policies (N)	Ladder method
	No. of farmers having access to pension and remittance facilities (N)	Ladder method
	No. of farmers aware of various credit and financing initiatives of the government (N)	Ladder method
Output 1.2 Increased opportunities for farmers to engage in agri-entrepreneurship through the setting up of start-up funds, incubators, and accelerators	No. of farmers/rural households enrolled in government entrepreneurship initiatives (N)	Ladder method
	No. of training workshops conducted at rural areas for entrepreneurship activities (N)	Ladder method
	No. of farmers aware of entrepreneurship initiatives and policies (N)	Ladder method
Output 1.3 Increased risk management for farmers, through weather, climate,	No. of farmers insured against climate and weather risks (N)	Ladder method
	Total amount of money insured against climate	Ladder method

and crop insurance	risks for farmers (INR)	
	No. of claims settled for climate and weather risks for farmers (N)	Ladder method
Impact	**Impact indicators**	**Evaluation method**
Increased income of farmers, and development of farming infrastructure through increased financial inclusion	Change in incomes of farmers from increased financial inclusion and livelihood diversification (INR)	Ladder method
	No. of farmers investing in new infrastructure due to increased financial inclusion (N)	Ladder method
	No. of farmers taking loans to adopt climate resilient practices and methodologies (N)	Ladder method

Table 14: Evaluation Methods for regulatory components

Outcome	**Outcome indicators**	**Evaluation method**
Outcome 1	Increased government engagement and	Narratives

Legislative activities around farmer assistance, development and finance allocation	support for farm and farmer policies (descriptive)	
	Change in financial assistance provided to the agricultural sector by the Central Government (INR)	Ladder method
	No. of bills related to agriculture and development introduced in the parliament (N)	Ladder method
Output	**Output indicators**	**Evaluation method**
Output 1.1 Legislation introduced around agriculture support	No. of bills introduced in parliament to enhance technological support to farmers	Ladder method
	No. of bills introduced in parliament to enhance economic support to farmers	Ladder method
	No. of bills introduced in parliament to enhance financial support to farmers	Ladder method
Output 1.2 Legislation introduced around	No. of bills introduced in parliament, announcing support for 'greener' agricultural	Ladder method

promotion of 'green' practices	practices such as organic farming, vermicomposting, etc.	
	No. of state bills introduced around 'greener' agricultural practices	Ladder method
Output 1.3 Allocation of financial assistance to the agricultural sector	Amount of money allocated under the union budget for the agricultural sector (INR)	Ladder method
	Average financial allocations by state budgets for the agricultural sector (INR)	Ladder method
	Average financial funding granted to the various national missions and policies for the agricultural sector (INR)	Ladder method
Outcome	**Outcome indicators**	**Evaluation method**
Outcome 2 New policies and schemes introduced around the development of the	No. of agricultural schemes and policies introduced by the national government	Ladder method
	Amount of financial assistance allocated by the national government for agricultural schemes	Ladder method

agricultural sector	and policies (INR)	
Output	**Output indicators**	**Evaluation method**
Output 2.1 Introduction of new agricultural schemes by national and line ministries	No. of new agricultural schemes introduced by national and state governments	Ladder method
	No. of new development schemes with agriculture components introduced by national and state governments	Ladder method
Output 2.2 Establishment of new institutions to implement policies and strengthen farmer capacities	No. of new institutions and agencies set up to implement agriculture initiatives	Ladder method
	No. of regional institutions introduced for developing farmer capacities	Ladder method
	No. of new farmer and community-led established as part of agriculture policies	Ladder method
Outcome	**Outcome indicators**	
Outcome 3	Establishment of MEL frameworks by implementing entities of agricultural policies	Scorecard

Building of monitoring and compliance frameworks around the agricultural sector	(yes/no)	
	Updating of progress reports of various projects in agricultural sector (yes/no)	Scorecard
Output	**Output indicators**	
Output 3.1 Introduction of regulation to ensure the implementation of new bills and policies	Establishment of monitoring and evaluation activities within agricultural activities (yes/no)	Scorecard
	Training activities conducted for line officials of implementing agencies in reporting activities (N)	Ladder method
	No. of progress reports submitted to donor and implementing agencies regarding project interventions (N)	Ladder method
Output 3.2 Introduction of financial monitoring frameworks	Average amount of money disbursed by implementing agencies for project interventions (INR)	Ladder method
	Establishment of financial monitoring	Scorecard

	guidelines by donor and implementing agencies (yes/no)	
Impact	**Impact indicators**	**Evaluation method**
Enhanced legislative and financial support to the agricultural sector, with corresponding monitoring and evaluation	Change in yield of farmers under various agricultural assistance programmes (tonnes/ha)	Ladder method
	Introduction of new legislation targeting varied and specific issues in the agricultural sector (N)	Ladder method
	Change in incomes of farmers under various agricultural assistance programmes (INR)	Ladder method
	Allocation of finance targeting varied and specific issues in the agricultural sector (INR)	Ladder method
	Identification of emerging issues and targeting problems through MEL frameworks (descriptive)	Narratives

11. Learnings Drawn

Within the MEL framework, the learning component is viewed as an iterative process both within and between different projects. Given the complex and often, shifting nature of the impacts from adaptation interventions, it is essential to understand and identify key learning outcomes that can enable opportunities to ensure better impacts and enhanced benefits from the implementation of projects. The learning process enables us to identify critical information from the M&E process and analyse this information to continuously improve the ability of researchers and implementing stakeholders. The learning component of the MEL framework is central to remain adaptive and flexible to identify opportunities, bypass barriers and enhance positive outcomes in an iterative manner, ensuring continuous improvement in the efficacy and efficiency of the implementation of adaptation projects.

In the development of the MEL frameworks for the sub-national projects, a bottom-up approach was followed, keeping in mind the need for understanding the varied ecological, climatic and policy contexts in different parts of India. It was essential to identify adaptation interventions on the ground, before building the MEL framework up to the larger impacts being targeted and suitably addressing climate risks at policy

levels, given that India is a large country. Such an approach enabled us to understand the process of adaptation implementation on the ground, and the learnings from these case studies now enable us to undertake a top-down approach for the development of the national framework. By understanding the implementation and impact of national policies on the ground, we were able to iterate back to the national scale, and frame indicators to address the key outcomes and outputs based on ground realities. Such an approach, combining the top-down and bottom-up methodologies, enables the framework to be robust and comprehensive, as well as being flexible to reflect and adapt to different contexts and landscapes within the country.

Such learnings can also be drawn from the development and framing of the indicators, which have been tailored to the varied policies and initiatives being undertaken in the adaptation sphere. While most of the indicators were developed to provide quantitative data in order to account for process-driven outcomes and outputs, the understanding developed from the case studies also enabled the framing of qualitative and narrative-driven indicators that can contextualize the local impacts and co-benefits of these interventions. The learnings from the collection of data and the reporting of these indicators can help in further iterative refinement of more comprehensive indicators in the future as well as the capacity and knowledge requirements of the same.

Finally, the process of designing the MEL indicators provided a unique opportunity to interact with government and policy stakeholders, as well as understand their requirements and needs for the implementation of the MEL framework at national level. By tailoring the indicators for the policy needs of the requisite government agencies and framing the plans for the future implementation of the national MEL tool in a co-operative manner, there is the chance to provide institutional handholding and build the capacity of the implementing government agencies, ensuring that the MEL tool is piloted and introduced with a cohesive plan for future upscaling, further development and ensuring that any gaps with the tool are identified for future research.

12. Conclusion and Way Forward

Agriculture is a vital sector of the economy, given that the sector contributes key inputs and products to all sectors of the national economy. The growth stages and rates of India can also be affected by the performance of the agriculture sector, and the development of the agricultural sector can contribute to the fulfilment of key national developmental priorities, such as food security, poverty alleviation and economic development. Agricultural development raises farm incomes, increases food supply, reduces food prices, and provides opportunities to add-value and generate jobs in both rural and urban areas, stimulating diversification and growth in the wider economy.

There is a need for India to drive necessary and timely interventions at industry, institution, and individual (farmer) levels for the constant development and evolution of the agricultural sector. It is also imperative to monitor the impacts of climate change on the large part of the Indian population that practices/are employed in the agricultural sector and the need for development of robust and focused adaptation measures targeted to mitigate the increasing risks from climate change for the agricultural sector.

Given the localized nature of climate impacts and the adaptation needs in the agricultural sector, it is essential to downscale adaptation interventions to the district or village level, and ground them on scientific evidence generated through collaborative research. A proactive adaptation approach in agriculture is needed, streamlining efforts and resources on climate and disaster resilience to reduce risk exposure, limiting impacts, and preparedness in coping with disasters. Given the finite resources available and the need for effective adaptation strategies, it is imperative to understand the importance of monitoring and evaluation processes and introduce MEL for specific regions in the country to ensure the efficacy and efficiency of adaptation interventions. There is also an urgent need to scale these measures up to the national level and include MEL components at the inception and planning stages of adaptation programmes.

The national MEL framework developed in this project is a result of multiple interactions with varied stakeholders and incorporating the learnings of the sub-national case studies. The integration of both bottom-up and top-down approaches in the design of the national framework has ensured that the varied policy and ecological contexts involved in designing adaptation interventions in a diverse country like India are wholly recognized, while also being tailored to the needs and requirements of the implementing governmental agencies on the ground. There is a need for continuous stakeholder engagement for further enhancing the efficacy of the MEL framework and for conducting capacity-building and training programmes for stakeholders and implementing agencies for the large-scale adoption of the framework in adaptation projects in the country. In the future, the learnings from such stakeholder consultations and capacity-building workshops can be implemented at departmental levels to be incorporated at the inception stage of all adaptation projects and activities at the sub-national and national levels, ensuring the availability of base-line, interim and final data to monitor and assess the impacts of such projects. By having a robust and inclusive MEL framework in place, that can be tailored to fit all requisite projects and activities, we can ensure that the impacts of various interventions and policies are properly monitored; along with providing key learnings about any further requirements to

ensure inclusive and complete development and building climate resilience across the agricultural sector.

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