

POLICY BRIEF 01

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From Vulnerability to Resilience: Policy Insights on Climate Smart Coastal Agriculture

Sreejit Roy
Sridev Adak
Rishav Mukherjee
Mehedi Hasan
Saptarsi Chakraborty
Muhammed Irshad M
Achiransu Acharyya
Souvik Ghosh

Highlights

- Changes in rainfall pattern, decrease in crop productivity, frequent occurrence of storm surges, increasing incidence of crop loss, increase in pests and disease outbreaks are the major concerns due to Climate Change in the Coastal regions of India, with variation of impact in East and West Coasts.
- A noticeable shift from agriculture to other sectors has occurred across coastal India, shaped by a combination of contributing factors including exposure to better opportunities migration to the cities, risk from natural calamities, low profitability, and health concerns.
- To rejuvenate interest among rural youth and address long-term sustainability in agriculture, policies must focus on making agriculture more attractive and viable for the younger generation by promoting climate smart agriculture along with agri-entrepreneurship, agro-tourism, start-up incubation, and digital agriculture.
- To empower women's livelihoods within rural development frameworks, integrated policy must prioritize gender-responsive measures by enhancing livestock-based livelihoods while also addressing structural barriers and strengthening financial inclusion through SHG-bank linkages, microfinance, and capital support.



Agro-Economic Research Centre
Visva-Bharati, Santiniketan, West Bengal
(For the States of West Bengal, Sikkim and Andaman & Nicobar Islands)
Ministry of Agriculture & Farmers' Welfare, Government of India



Context

The mounting consequences of climate change on livelihoods have become a matter of worldwide concern. The Intergovernmental Panel on Climate Change (IPCC) identifies agriculture as one of the most vulnerable sectors due to its sensitivity to rising temperatures and extreme weather events. Observed declines in crop productivity across various regions underscore the adverse consequences of climate variability for global food security (IPCC, 2019). The challenges faced by rural communities, particularly those reliant on agriculture, encompass vulnerabilities across crop production, livestock, fisheries, and forestry sectors (Gitz et al., 2016). Unpredictable rainfall patterns, frequent occurrences of droughts and floods, and temperature fluctuations continue to drive agricultural productivity declines. These disruptions pose severe risks to food supplies, intensify malnutrition, and place millions at heightened risk of food insecurity, complicating global efforts to achieve Zero Hunger by 2030 (FAO, IFAD, UNICEF, WFP and WHO, 2024). Despite global concern, the adverse effects of climate change on agriculture are expected to be more pronounced in less developed and developing countries (Müller et al., 2010; World Bank, 2010) due to a large population relying on agriculture for their employment and livelihood and limited adaptive capacity to cope with the climatic variability (Stern, 2007).

One of the most alarming consequences of climate change is the rising sea levels, which pose severe risks to coastal regions. Since 1901, the global mean sea level has risen by 20 cm, with the rate doubling over the past decade. Under high greenhouse gas emission scenarios, sea levels could exceed 2.3 meters by 2100, posing significant threats to coastal cities and island nations, where flooding events may reach 165 days per year by the 2050s (United Nations, 2024). A possible one-meter global sea level rise (SLR) has been projected by the end of the twenty-first century with displacement of approximately 56 million people (Ghosh et al., 2019; Dasgupta et al., 2009). Approximately 194,000 km² of land would be submerged under a one-meter SLR scenario, threatening agriculture. An increase in sea level negatively affects the local agriculture of coastal areas, jeopardizes food security, diminishes freshwater supplies, and lowers the income and livelihood stability of coastal populations (Gupta & Sarkar, 2014).

The coastal zone is the most vulnerable region due to climate change. India, with its 11098.81 kilometers of coastline and a predominantly agrarian economy, is highly vulnerable to climate change. Projected climatic variations along India's coastal regions indicate significant environmental challenges in the coming decades. Abiotic stressors such as salinity intrusion, seawater flooding, cyclones, heatwaves, and prolonged droughts severely impact agricultural productivity and soil health (Das et al., 2024). Alongside these, biotic stressors like emerging pest infestations, invasive weeds, and disease outbreaks are intensifying under changing climatic conditions, further threatening coastal farming systems and livelihoods. To ensure the sustainable development of agriculture in these areas, climate-resilient practices must be adopted (Banerjee et al., 2018). In the initial stage, priority should be given to assessing vulnerabilities and identifying suitable adaptation options for coastal ecosystems. However, formulating effective adaptation strategies is challenging because it involves multiple disciplines, sectors, and stakeholders. The success of farm-level climate-resilient agriculture ultimately relies on the coordinated efforts and active participation of all stakeholders, where opinion of farmers, the primary stakeholder is of pivotal importance. The prioritization of climate smart agricultural interventions by the farmers will enhance the acceptance of those (Das et al., 2022; Azadi et al., 2021).

Smallholder farmers in the fragile coastal ecosystems are particularly vulnerable due to their exposures to recurring climate change induced abiotic and biotic stressors (Das et al., 2025). The government has given stronger emphasis on climate change adaptation in coastal zones that can safeguard productivity while restoring ecological balance. Community-led and gender-responsive initiatives will ensure inclusive and sustainable outcomes of such initiatives. This policy brief highlights key challenges and opportunities, offering actionable insights for policymakers to foster resilience, strengthen adaptive capacities, and mainstream climate-smart strategies into coastal agricultural systems.

Coastal Livelihood

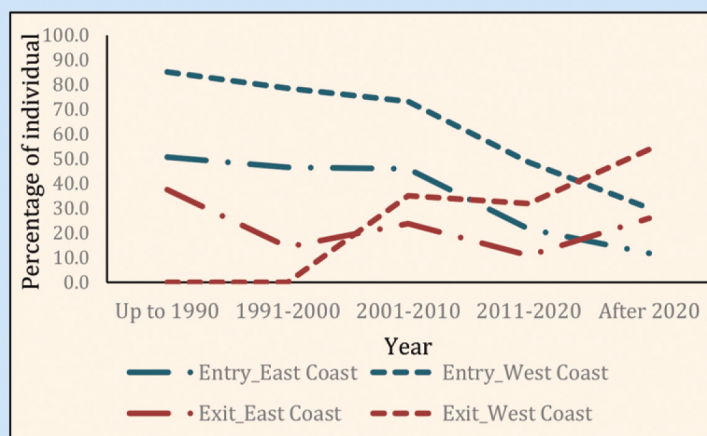


Figure 1: Coast-wise Percentage of individuals who entered or exited agriculture over the years
(Source: Primary survey)

despite the heavy reliance on agriculture, the percentage of individuals entering the agricultural sector has shown a consistent decline over the years (Figure 1). While exit trends on the East Coast are erratic, the West Coast shows a consistent rise in agricultural disengagement. PostCovid-19 marks a critical shift; exit rates have overtaken entry, signalling waning interest in farming as a livelihood. The individual-level analysis also shows that the average age of the individuals engaged in agriculture is 47.6 years, with an average educational attainment of eight years of formal schooling. This demographic profile also advocates a notable absence of younger and more educated individuals in the sector. Health-related challenges account for 32.9 per cent of exits, while 35.6 per cent are driven by exposure to better livelihood opportunities. These findings highlight a dual dynamic of physical strain associated with farming and a desire to move toward more promising livelihood options. Additionally, natural risks (9.6 per cent) and low profitability (6.8 per cent) are cited as contributing factors to agricultural disengagement.

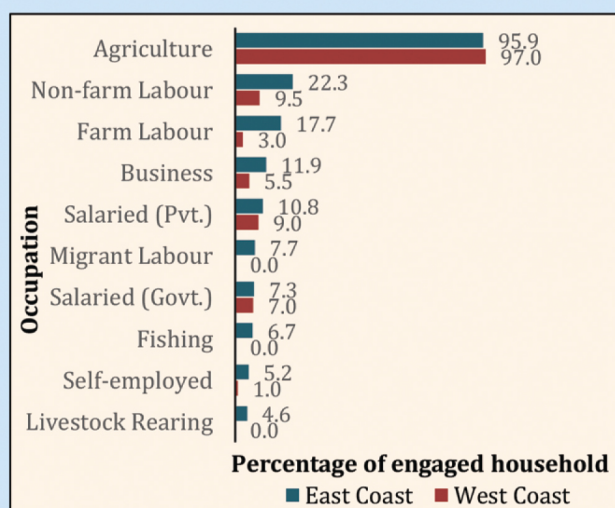


Figure 2: Occupation-wise distribution of sample households across East & West Coasts
(Source: Primary survey)

Agriculture is the backbone of rural economy that plays a pivotal role in supporting income of the household. A study¹ undertaken by the Agro-Economic Research Centre (AERC), Visva-Bharati, focused on the agricultural households of the coastal region of India, covering states along both the eastern and western coastlines. The final sample included households with and without exposure to the National Innovation on Climate Resilient Agriculture (NICRA) and the Project on Climate Resilient Agriculture (PoCRA) initiatives. It revealed that

As the study is particularly focused on the agricultural households, the survey sample comprises only such units. Data show that 40 per cent households rely on a single income source, of which 95 per cent depend solely on agriculture. As Figure 2 illustrates, among the sample households, 96 per cent of the east coast and 97 per cent of the west coast remain actively engaged in farming. Yet, a small share, despite owning land, has moved away from cultivation, signalling emerging livelihood divergence even among landholders.

The occupational engagement across the East and West Coasts reveals distinct livelihood patterns and degrees of diversification. The East Coast exhibits significantly greater occupational diversity.

¹ Study Number-195 [Impact of Climate Change on the Livelihood of Agricultural Households in the Coastal Region of India], Agro-Economic Research Centre, Visva-Bharati, Santiniketan, West Bengal

Farm and non-farm labour jobs are notably higher than their West Coast counterparts. Business activities are also more prevalent on the East Coast compared to the West, indicating stronger entrepreneurial engagement. Self-employment, livestock rearing, migrant labour jobs and fishing, all found on the East Coast, are negligible on the West Coast, pointing to ecological, infrastructural, or socio-economic constraints that limit diversification. Interestingly, salaried employment, both private and government, is relatively balanced across regions, with only marginal differences. This suggests that formal employment opportunities, while limited, are similarly distributed and may reflect shared aspirations for income stability and social mobility. Overall, the data suggest that while both coasts are heavily dependent on agriculture, the East Coast demonstrates a more adaptive livelihood structure, whereas the occupational profile of the West Coast reflects a more singular dependence on farming, which may heighten vulnerability in the face of Climate Change.

Gender Participation

While rural households exhibit diverse livelihood strategies across both coasts, gender-disaggregated analysis reveals stark differences in male and female participation across various occupations. Figure 3 illustrates distinct regional and gendered patterns of occupational participation across the East and West coasts. Farming on the East Coast emerged as a family-based activity, with nearly half of households involving both men and women, while in the West, it is still male-dominated. The inclusion of agricultural labourers is higher on the West Coast, where men and women share equal representation, indicating higher gender equality in the agricultural wage labour market. Non-farm labour exhibits contrasting dynamics, with mixed participation seen in the eastern region and predominantly female-driven in the western region. Fishing on the East Coast is predominantly male-dominated, reflecting the physical intensity and traditional male dominance in capturing fish. In contrast, animal husbandry is female-centric, especially on the East Coast, highlighting its role as a key livelihood managed by women. Businesses and migrant labour across both coasts are overwhelmingly male-led, underscoring the structural barriers for women in these sectors. In salaried employment, government jobs remain male-dominated, especially in the West, though on the East Coast, women show comparatively higher representation. Interestingly, gender inclusion is more prevalent in private sector jobs, with a substantial share of females on the West Coast. Self-employment on the East Coast is mainly male-led; however, on the West Coast, it is entirely female-led, indicating regional differences in women's entrepreneurial roles. Overall, the findings highlight significant gender disparities in occupational structures not only between men and women but across the two coasts, with relatively higher joint participation in the East while the West reflects sharper gender divisions and occupational polarization.

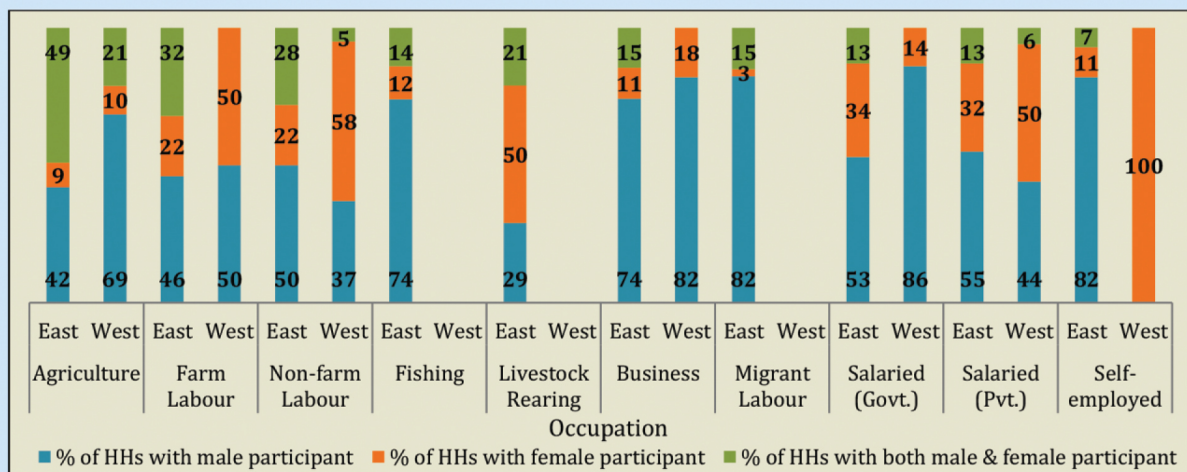


Figure 3: Distribution of sample households by gender-participation across earning sources and coasts
(Source: Primary survey)

Multiple Stressors

Although the proportion of respondents citing climate change-induced risks as a reason for exiting agriculture is relatively low, Figure 4 reveals that a substantial number of agricultural households have suffered due to various biotic and abiotic stressors due to climatic aberration over the past five years in relation to their farming activities. The East Coast is predominantly affected by abiotic stressors, including frequent storm surges, flooding, and significant soil degradation, manifested through erosion, salinity, and declining fertility, which collectively undermine agricultural productivity and long-term sustainability. Although water scarcity is present, it remains comparatively less severe than in western

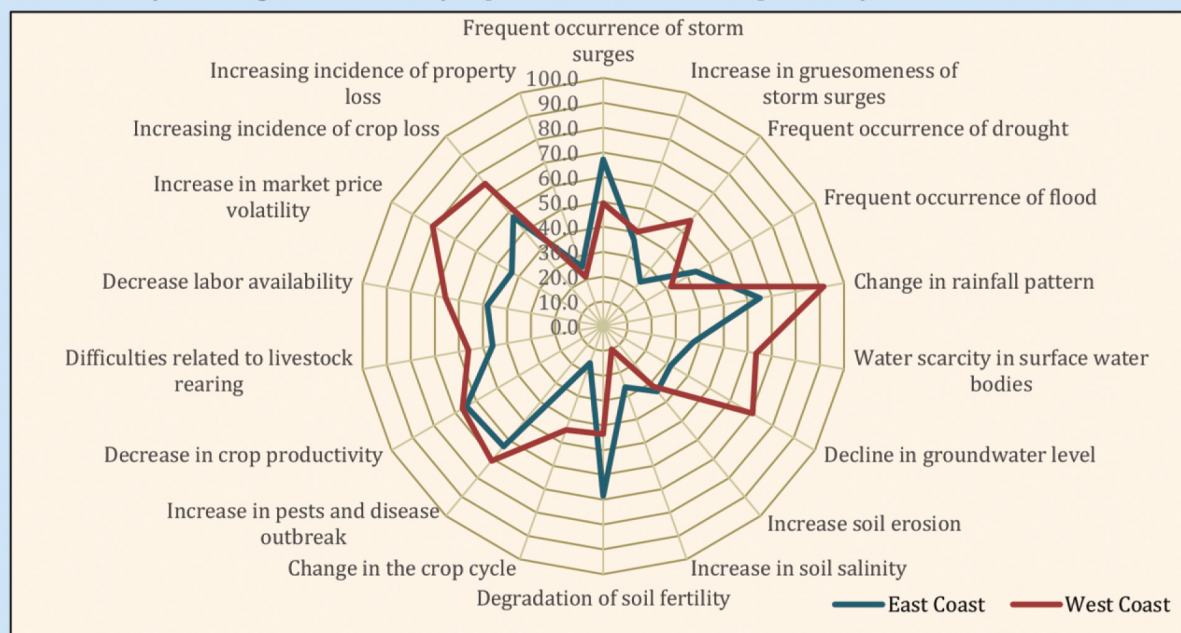


Figure 4: Coast-wise percentage of households affected by climate-induced stressors in the past 5 years
(Source: Primary survey)

regions. Conversely, the West Coast experiences more intense abiotic pressures related to drought conditions, acute water shortages in both surface and groundwater sources, and pronounced variability in rainfall, all of which exacerbate agricultural uncertainty. In addition to these environmental challenges, biotic stressors are more prevalent on the West Coast, where households report higher incidences of pest and disease outbreaks and difficulties in livestock rearing. These factors contribute to frequent crop losses, labour shortages, and market price volatility. While the East Coast also contends with biotic stressors, their impact is relatively moderate. This regional disparity underscores the necessity for differentiated climate adaptation strategies that address the specific vulnerabilities of each coast, integrating both ecological resilience and socioeconomic support mechanisms.

Adaptation

The analysis of adaptation measures reveals a spectrum of household engagement with climate-resilient agricultural practices across the East and West coasts. Figure 5 reveals that households on the West Coast are adopting a more diversified set of adaptation measures compared to the East. While the East coast shows higher reliance on changes in crop seed variety (64.4%) and rainwater conservation (38.4%), the West coast demonstrates broader adoption across multiple strategies, including crop insurance (42.5% vs. 7.8%), change in cropping pattern (50.5% vs. 29.1%), organic farming (47.0% vs. 6.9%), and increased use of pesticides and fertilisers. Overall, the East appears to prioritise seed- and water-related measures, whereas the West is engaging in a wider range of technological, institutional, and market-oriented adaptations.

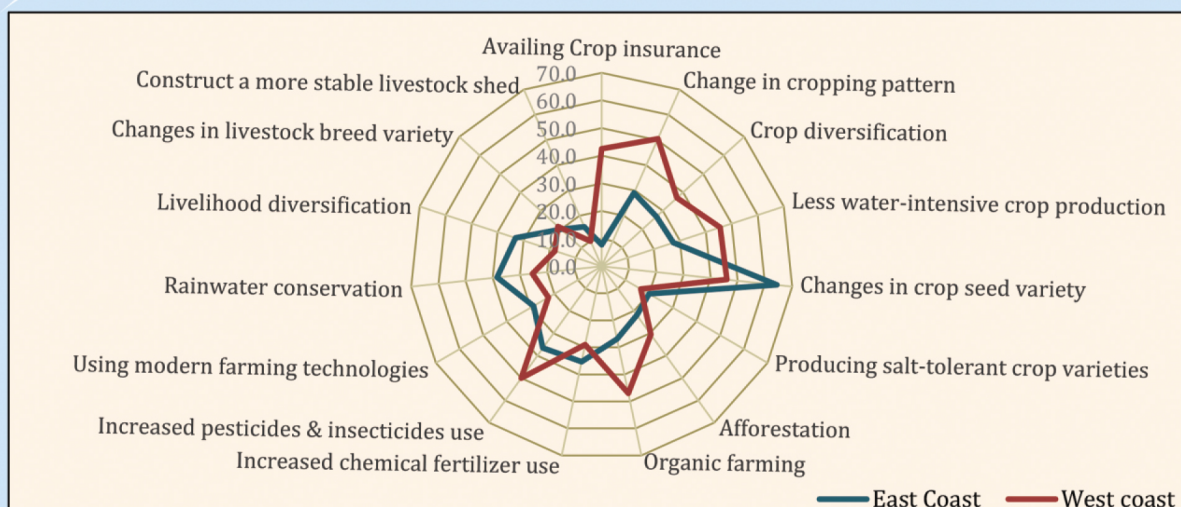


Figure 5: Household participation in various adaptation measures across the East and West Coasts
(Source: Primary survey)

Regional Contrast

A closer examination of the profile across the East and West Coasts of India reveals a distinct scenario of vulnerability, as shown in Table 1.

Table 1: Comparative Scenario of East and West Coast

Aspect	East Coast (Odisha, West Bengal, Tamil Nadu, Andaman & Nicobar Islands)	West Coast (Maharashtra, Kerala)
Climate Exposure	High exposure to cyclones, storm surges, saline water intrusion, and frequent flooding.	Higher rates of sea-level rise, coastal erosion, and humidification are affecting rainfall patterns.
Agricultural Vulnerability	Greater incidence of crop loss due to cyclones and erratic rainfall (especially in Odisha & West Bengal).	Water stress and soil salinity are rising concerns, especially in Maharashtra's vulnerable districts.
Livelihood Diversification	Limited diversification; more dependence on mono-cropping and traditional farming.	Greater uptake of diversified livelihoods, including fisheries, plantation crops, and allied activities.
Institutional Support Coverage	National Innovations on Climate Resilient Agriculture (NICRA) presence is stronger in the East Coast states.	Maharashtra benefits from both NICRA (non-coastal) and Project on Climate Resilient Agriculture (PoCRA), though coastal districts lag in coverage.
Adoption of Climate Practices	More adoption of traditional coping strategies (e.g., changing sowing dates, seed varieties).	Higher adoption of technical adaptations like water-efficient irrigation and improved crop systems.
Livelihood Asset Base	Lower average natural and financial capital; more vulnerable marginal and smallholders.	Slightly better financial and physical capital; cooperative models and SHGs are more active in Kerala.
Social Capital and Networks	Stronger informal networks but limited institutional engagement.	Better linkages with institutions and higher FPO/SHG participation in Kerala.
Perception of Agriculture	Farming is seen as increasingly unviable due to repeated disaster losses and youth out-migration.	Mixed perception; youth engagement in allied sectors is more visible.

The comparative analysis of the East and West Coasts clearly shows that while both regions are highly exposed to climate-induced risks, their vulnerabilities manifest themselves in different ways, necessitating distinct policy and programmatic responses. The East Coast, which is frequently hit by cyclones, storm surges, saltwater intrusion, and recurrent flooding, is facing acute livelihood insecurity, especially among marginal and smallholder farmers dependent on monoculture farming and traditional agricultural systems. Hence, strengthening disaster resilience through asset-based support, improved natural capital management, and greater institutional coverage to address recurrent agricultural losses should be prioritized here. In contrast, the West Coast is characterized by chronic stresses such as sea level rise, coastal erosion, and water scarcity, which require more structural solutions. Given a relatively stronger financial and physical capital, this region demands investments in advanced irrigation systems, and institutional consolidation through cooperatives, SHGs, and farmer organizations. Thus, while immediate and protective interventions aimed at reducing disaster-related vulnerability are needed in the eastern region, long-term, capacity-building strategies are needed to address the gradually but firmly established challenges in the western region.

Policy Recommendations

Insights from the above discussion point to a range of strategic measures that could prove beneficial in helping coastal farmers to address climate-related challenges and achieve sustainable livelihoods.

- Encourage community-led coastal afforestation and bio-shield initiatives, including mangrove and shelterbelt plantations, to enhance ecological protection and livelihood support. Such measures can help mitigate storm surges, sea-level rise, and soil erosion, which are pressing abiotic stressors in coastal zones. Integration with schemes like the Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) can strengthen local participation, provide employment, and build resilience against climate shocks.
- Promote gender-responsive climate adaptation by strengthening women-centric groups, livestock enterprises, and skill development through the National Rural Livelihoods Mission and Rural Skill Mission. Women's livelihoods require support to cope with biotic stressors such as pest outbreaks and livestock diseases, as well as abiotic stressors like salinity intrusion and water scarcity. Improved access to veterinary care, insurance, and credit through SHGs and microfinance, coupled with training in climate-smart livestock management, digital tools, and cooperative market access, will enhance resilience and inclusive rural growth.
- Adopt a comprehensive approach to climate-resilient agriculture by prioritising salt-tolerant, flood-tolerant, and short-duration crop varieties suited to the east coast, along with drought- and heat-tolerant varieties relevant for the west coast. Institutional innovations like custom hiring centres, village seed bank, and ICT-based advisories, can help farmers manage abiotic stressors like drought, floods, and soil salinity. To counter biotic stressors such as invasive pests, weeds, and crop diseases—which are expected to intensify under climate change—integrated pest management, organic inputs, bio-control agents, and ecosystem-based approaches must be promoted. Efficient irrigation methods, soil-moisture conservation, and micronutrient management will further strengthen farm-level adaptation. Local-level adaptation planning should integrate traditional knowledge, foster community-based adaptation strategies, and ensure last-mile delivery of extension services, insurance, and market intelligence.
- Policies should aim for youth engagement and intergenerational continuity in agriculture to ensure long-term sustainability. Encouraging digital innovations in climate, pest and disease surveillance systems will enable youth to address both biotic and abiotic stressors in farming. Involving youth in eco-restoration activities along the coasts can also reinforce resilience-building efforts.

- Strengthen and expand the coverage of programmes like the National Innovation on Climate Resilient Agriculture (NICRA) and the Project on Climate Resilient Agriculture (PoCRA) to address location-specific climate risks. Scaling these interventions to more coastal villages, with a stronger focus on monitoring biotic stressors (emerging pests, diseases, and weeds) and abiotic stressors (salinity, cyclones, heat waves, droughts, and floods), will enhance adaptive capacity. Ensuring universal access to agro-advisory platforms with early warning systems for pest outbreaks and extreme weather events will empower farming households to make informed, context-specific decisions.

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E-mail: dir.aerc@visva-bharati.ac.in

Web: https://www.visvabharati.ac.in/visva_bharati/agro-economic-research-centre/