

# Climate Change and Its Impact on Agriculture and Employment Opportunity– A Case Study in Sundarban Delta of South 24 Parganas

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**Abstract:-** The Sundarbans exemplify the intertwined challenges of climate change, agriculture, and employment in vulnerable regions. A holistic approach, integrating sustainable agriculture, alternate livelihoods, and ecosystem conservation, is crucial to building climate resilience in South 24 Parganas. Present study evaluates the changing patterns of agricultural productivity due to climate-induced factors such as sea level rise, salinity intrusion, erratic rainfall, and cyclonic activity. This study also explores the socioeconomic repercussions on employment opportunities, particularly among marginal farmers, fishers, and daily wage laborers. The study utilized a mixed-methods approach, combining quantitative and qualitative data collection methods. A household survey was conducted across 350 households in 35 villages of the Sundarban Delta. Stratified random sampling ensured representation of various occupational groups, including farmers, fishers, and daily laborers. Structured questionnaires captured data on crop yields, income changes, shifts in occupational patterns, and adaptation measures. Over 75% of households reported a significant decline in crop yields due to increased soil salinity and unpredictable weather patterns. Traditional farming and fishing activities have witnessed a decline, forcing 40% of households to seek alternative livelihoods such as seasonal migration to urban centers. Women have increasingly joined informal labor markets to support household incomes. Community-based initiatives, such as mangrove plantation programs, were noted to mitigate flooding and storm surges. Investments in resilient agricultural practices, vocational training for skill development and infrastructural enhancements are critical for mitigating climate risks. This research contributes to understanding the nuanced interplay between climate change, agriculture, and employment, offering valuable

insights for policymakers, environmentalists, and development practitioners in coastal and deltaic regions globally.

**Keywords:-** Climate Change, Agriculture, Employment Opportunity, Sundarbans, Livelihood, Sustainable Development, Resilience Building

**Introduction:-** The Sundarban Delta, located in the South 24 Parganas district of West Bengal, India, is one of the most ecologically vulnerable regions globally due to its low-lying geography and high susceptibility to climate change impacts (Mondal & Mukherjee, 2020). Climate change has significantly affected the agricultural landscape and employment opportunities in this region, causing distress among local communities that depend primarily on farming, aquaculture, and allied sectors for their livelihoods. Rising sea levels, increased frequency of cyclones, erratic monsoons, and soil salinity intrusion have drastically altered agricultural productivity, leading to shifts in employment patterns and rural migration (IPCC, 2019).

The effects of climate change on agriculture in the Sundarban Delta are profound and multifaceted. Studies have shown that salinity intrusion caused by sea-level rise and storm surges has led to soil degradation, reduced arable land, and lower crop yields (Hazra et al., 2016). The shift from freshwater-based paddy cultivation to saline-resistant crops such as hybrid rice, pulses, and vegetables has been a notable adaptation strategy among farmers (Ghosh et al., 2018). However, these adaptive measures are often insufficient to counteract productivity loss, leading to food insecurity and economic hardship. Agricultural distress in the Sundarbans has had a cascading effect on employment. The decreasing profitability of farming has forced many rural inhabitants to seek alternative employment in non-agricultural

sectors such as construction, small-scale industries, and migration to urban centers for labor work (Basu et al., 2020). Studies have found that climate-induced displacement is rising, with significant seasonal migration from the Sundarbans to metropolitan cities such as Kolkata and Mumbai (Mukhopadhyay & Ghosh, 2019). However, these alternative employment opportunities often come with precarious working conditions and low wages. Promoting saline-resistant crops, introducing integrated farming systems, and encouraging alternative livelihoods such as aquaculture and agroforestry have shown some promise (Chowdhury & Danda, 2021). Additionally, financial support schemes such as MGNREGA (Mahatma Gandhi National Rural Employment Guarantee Act) have played a role in providing employment security for affected rural communities.

This study aims to analyze the effects of climate change on agriculture and employment in the Sundarban Delta, focusing on issues such as increasing salinity, erratic monsoons, cyclonic devastation, and employment shifts. The study also explores adaptation strategies adopted by local communities and policy recommendations to enhance resilience against climate-induced vulnerabilities.

**Study area:-** The study area includes multiple villages across different blocks of the Indian Sundarbans, providing a diverse sample of households affected by climate change. In India, the Sundarbans cover an area of 9,630 square kilometers, encompassing 19 administrative blocks in the districts of South 24 Parganas and North 24 Parganas (Figure 1). The delta is characterized by a complex network of tidal rivers, estuaries, mudflats, and small islands, making it a unique and ecologically sensitive region. The Sundarbans experience a tropical monsoon climate, with hot and humid summers, heavy rainfall during monsoons, and mild winters. The region is frequently affected by cyclones, storm surges, and coastal erosion, leading to land degradation, increased salinity intrusion, and loss of agricultural land. The average annual rainfall ranges between 1,500 mm to 2,000 mm, and the region remains highly vulnerable to climate change-induced sea level rise and extreme weather events.

Agriculture and fishing are the primary occupations in the Sundarbans, with rice being the dominant crop. However, soil salinity, erratic rainfall, and cyclonic storms pose significant challenges to farming, leading to declining yields and food insecurity. Due to these environmental stressors, migration to urban centers like Kolkata and other parts of West Bengal has increased in search of alternative livelihoods.

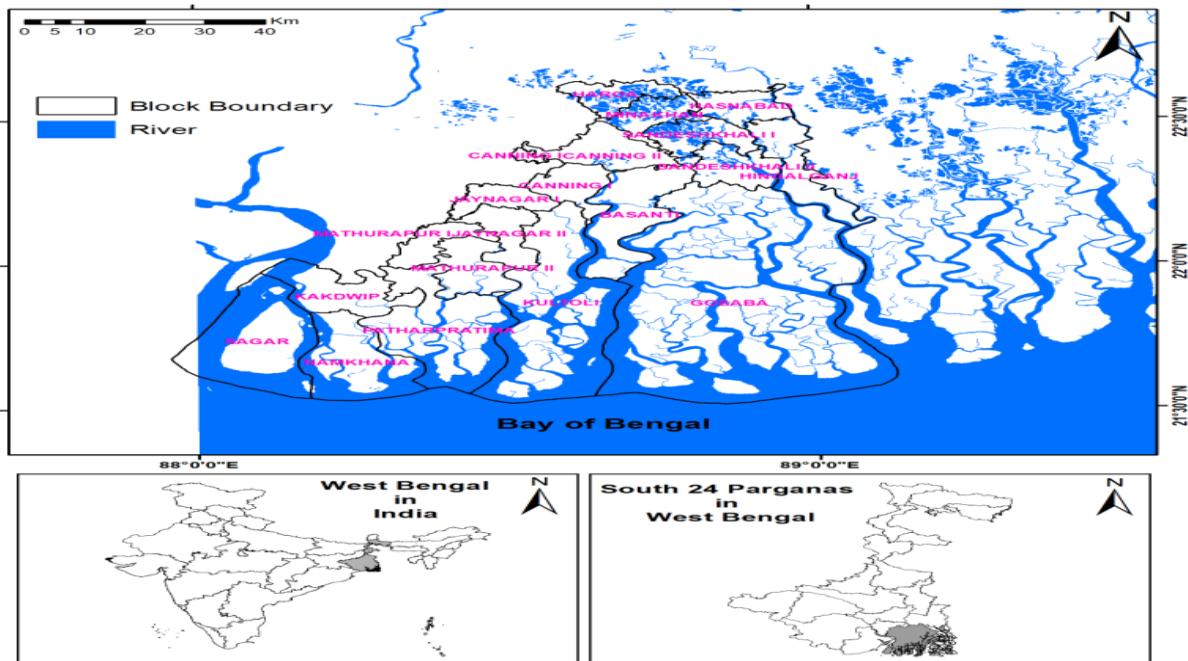


Figure 1: Location map of Sundarban delta in West Bengal, India.

**Materials and Methods:-** To assess the changing climatic patterns in the Sundarban Delta and their effects on agricultural yield, crop productivity, employment, livelihood security, and migration, a structured household survey was conducted. The study targeted 350 households across different blocks of the Sundarban Delta, selected using a random sampling technique to ensure representation from diverse socio-economic backgrounds, landholding patterns, and occupational groups. A comprehensive questionnaire was designed, incorporating both closed-ended and open-ended questions to capture quantitative and qualitative insights. The closed-ended questions focused on measurable aspects such as changes in temperature, rainfall patterns, crop yield, employment status, and migration trends. Meanwhile, the open-ended questions allowed respondents to elaborate on their lived experiences, coping mechanisms, adaptation strategies, and perceptions of climate change impacts.

The data collection process involved face-to-face interviews conducted by trained field investigators fluent in local languages to ensure effective communication. The responses were

recorded digitally and manually to minimize data loss. The collected data was then analyzed using statistical tools to identify trends, correlations, and patterns across different blocks of the Sundarban Delta. By employing this mixed-method approach, the study aimed to generate a holistic understanding of how climatic changes are reshaping agriculture, livelihoods, and migration dynamics in one of the most ecologically vulnerable regions of India.

**Results:- Changing Climatic Patterns in the Sundarban Delta**

This climatic data represents the general temperature, rainfall, and humidity trends observed in the Sundarban Delta. The monsoon season (June–September) is characterized by high rainfall and humidity, while the winter months (November–February) experience lower temperatures and minimal precipitation. The region experiences a tropical monsoon climate with high humidity and significant seasonal variations in temperature and rainfall. The monsoon season, from June to September, brings heavy rainfall, while the winter months remain relatively dry and cool.

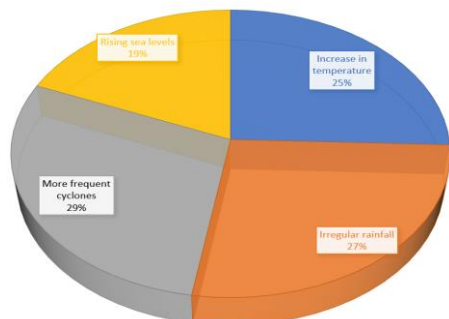
**Table 1: Monthly rainfall pattern of Sundarban delta.**

Month	Average High Temp (°C)	Average Low Temp (°C)	Average Rainfall (mm)	Average Humidity (%)
January	25.8	13.8	1	35
February	29.6	16.3	1	35
March	34.6	20.8	5	35
April	36.9	23.8	15	35
May	36.1	25.5	50	35
June	35.3	27.3	95	80
July	32.8	26.3	115	80
August	32.4	26.1	105	80
September	32.7	25.4	90	80
October	31.7	23.1	50	80
November	28.9	18.3	1	35
December	26.2	14.8	1	35

The survey results highlight the significant impact of changing climatic patterns on the Sundarban Delta communities. A vast majority of respondents (91.4%) have observed climate change over the past two decades, with key changes including increased temperatures (78.6%), irregular rainfall (82.9%), more frequent cyclones (88.6%), and rising sea levels (57.1%) (**Figure 2**).

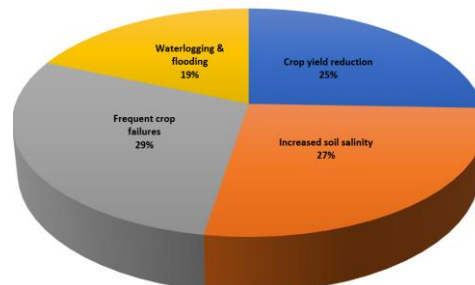
These climatic shifts have severely affected agricultural productivity, with 84.3% reporting negative impacts. The primary agricultural challenges include crop yield reduction (80.0%), increased soil salinity (70.0%), frequent crop failures (75.7%), and waterlogging/flooding (64.3%) (**Figure 3**).

To cope with these changes, 62.9% of households have adopted adaptive measures, such as switching to climate-resilient crops (45.7%), improved irrigation techniques (34.3%), rainwater harvesting (28.6%), and migration for alternative income (51.4%) (**Figure 4**). Climate change has also

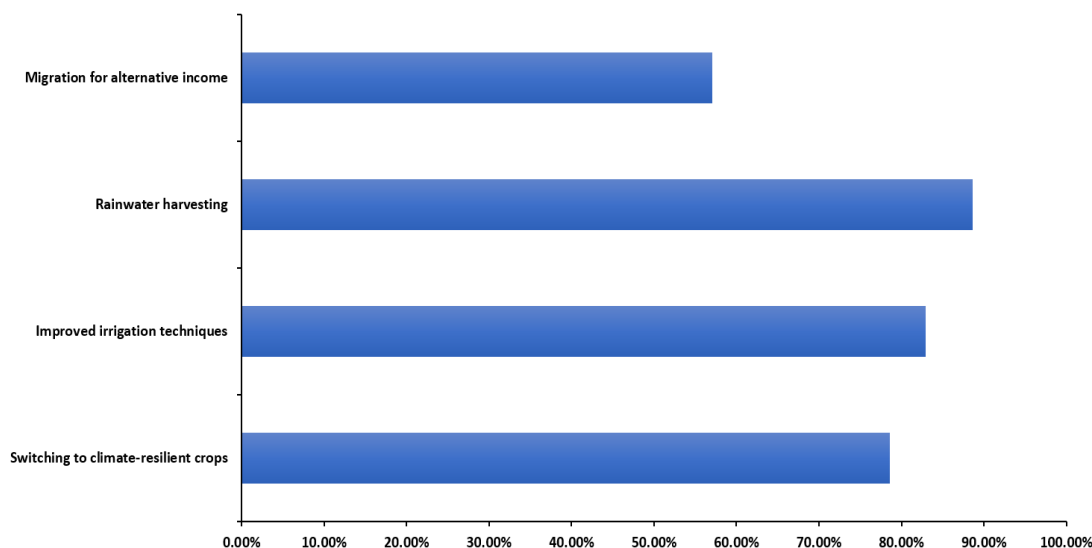


**Figure 2: Participant response on changes observed due to climate change**

significantly affected livelihood security, with 88.6% of respondents experiencing economic hardships. As a result, 71.4% of households reported at least one member migrating for work, mainly to Kolkata and nearby cities (57.1%), other states in India (34.3%), or internationally (8.6%).



**Figure 3: Participants faced agricultural challenges due to climate change**



**Figure 4: Adaptation strategy by local participants due to climate change**

Despite these challenges, only 42.9% of respondents receive government support to cope with climate-related adversities, leaving a majority (57.1%) without formal assistance (**Table 2**). The findings underscore the urgent need for climate

adaptation strategies, sustainable livelihood options, and improved government interventions to support vulnerable communities in the Sundarban Delta.

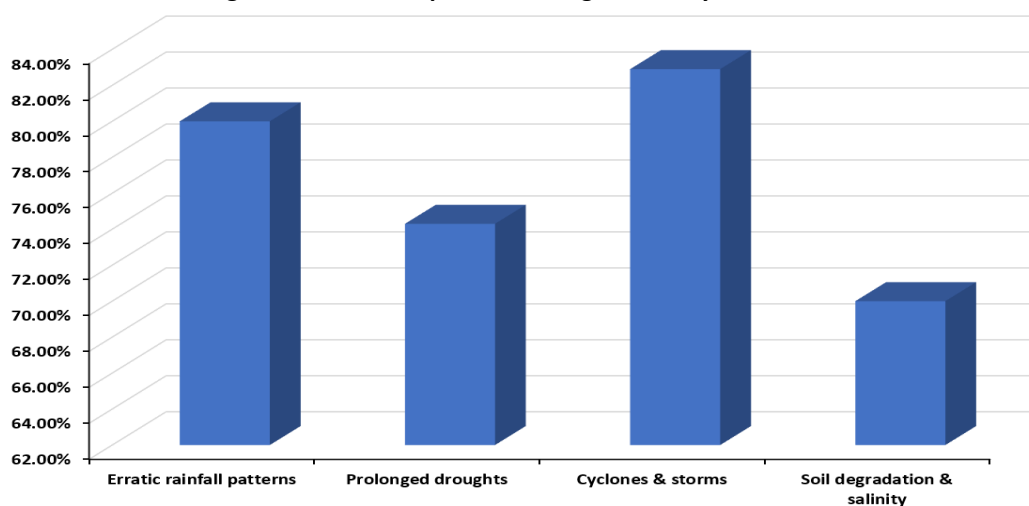
**Table 2: Changing Climatic Patterns in the Sundarban Delta**

Question	Response Option	Number of Responses	Percentage (%)
Changes in climate over the past 20 years	Yes	320	91.40%
	No	30	8.60%
Climate change affected agricultural productivity	Yes	295	84.30%
	No	55	15.70%
Adaptive measures in response to climate change	Yes	220	62.90%
	No	130	37.10%
Climate changes affected livelihood security	Yes	310	88.60%
	No	40	11.40%

Question	Response Option	Number of Responses	Percentage (%)
Climate change forced household member to migrate for work	Yes	250	71.40%
	No	100	28.60%
Main destinations for migration	Kolkata & nearby cities	200	57.10%
	Other states in India	120	34.30%
	International (e.g., Bangladesh)	30	8.60%
Receive any government support to cope with climate-related challenges	Yes	150	42.90%
	No	200	57.10%

**Effects on Agricultural Yield and Crop Productivity:-** A significant 88.6% of respondents reported experiencing a decline in agricultural yield over the past 20 years, while only 11.4% stated otherwise. The primary reasons cited for the yield decline included erratic rainfall patterns (80.0%), prolonged droughts (74.3%), frequent cyclones and storms (82.9%), and soil degradation and salinity (70.0%) (Figure 5). These findings highlight the vulnerability of agriculture in the Sundarbans to extreme weather events and changing climatic conditions.

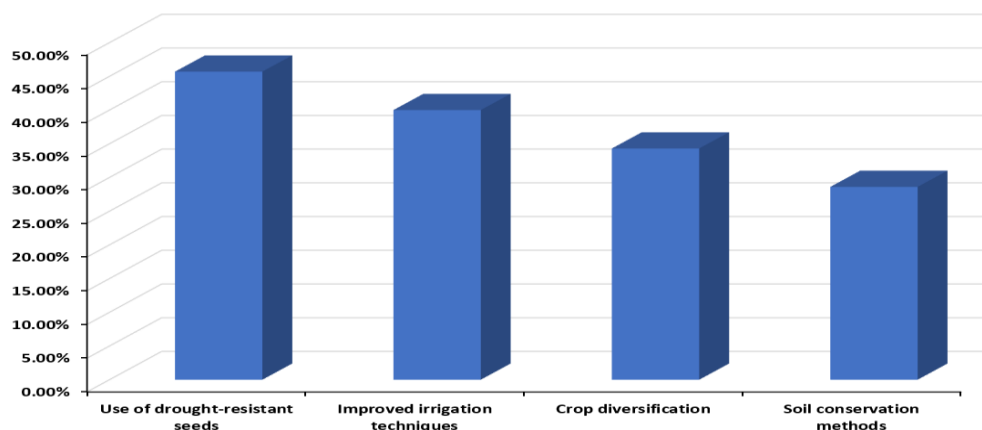
**Figure 5: Factors responsible for agricultural yield decline**



More than 85.7% of respondents acknowledged that climate change has negatively affected specific crops. Among the most impacted crops, rice (80.0%) was identified as the worst affected, followed by vegetables (65.7%), pulses (54.3%), and fruits (48.6%). These trends indicate the challenge farmers face in sustaining staple crop production, which directly impacts food security in the region.

The decline in agricultural yield has had severe economic consequences, with 78.6% of respondents reporting a significant decrease in

income, while 17.1% noted a slight decrease. Only 4.3% of respondents reported no economic impact. These findings underscore the critical role of agriculture in household livelihoods and the extent to which climate variability affects economic stability in farming communities.



**Figure 6: Strategies used in Land productivity in the study area**

Regarding adaptation measures, 62.9% of respondents stated they have adopted strategies to counteract yield loss, whereas 37.1% have not taken any adaptive actions. Among the adaptation measures employed, the most common strategies included use of drought-resistant seeds (45.7%),

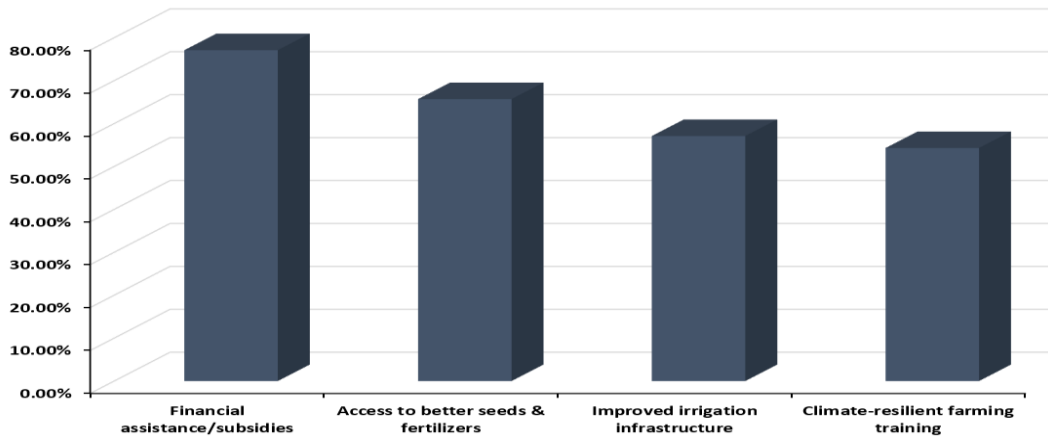
improved irrigation techniques (40.0%), crop diversification (34.3%), and soil conservation methods (28.6%) (Figure 6). These findings suggest that while farmers are attempting to adapt, the adoption of climate-resilient farming practices is still limited.

**Table 3: Changing climate patterns impact agricultural yield and crop productivity in the Sundarban Delta**

Survey Response	Response Option	Number of Responses	Percentage (%)
Experienced a decline in agricultural yield in the past 20 years	Yes	310	88.60%
	No	40	11.40%
Changing climatic conditions affected specific crops	Yes	300	85.70%
	No	50	14.30%
Crops most affected	Rice	280	80.00%
	Pulses	190	54.30%
	Vegetables	230	65.70%
	Fruits	170	48.60%
Decline in yield affected income	Significantly decreased	275	78.60%
	Slightly decreased	60	17.10%
	No change	15	4.30%
Adopted measures to mitigate yield loss	Yes	220	62.90%
	No	130	37.10%
Government support for agricultural adaptation	Yes	140	40.00%
	No	210	60.00%

60.0% of respondents stated that they have not received any assistance, while only 40.0% reported having access to some form of aid. The most requested forms of government support included financial assistance and subsidies (77.1%), access to better seeds and fertilizers (65.7%),

improved irrigation infrastructure (57.1%), and climate-resilient farming training (54.3%) (Figure 7). These responses indicate a strong demand for institutional support to enable sustainable agricultural practices and enhance climate resilience.

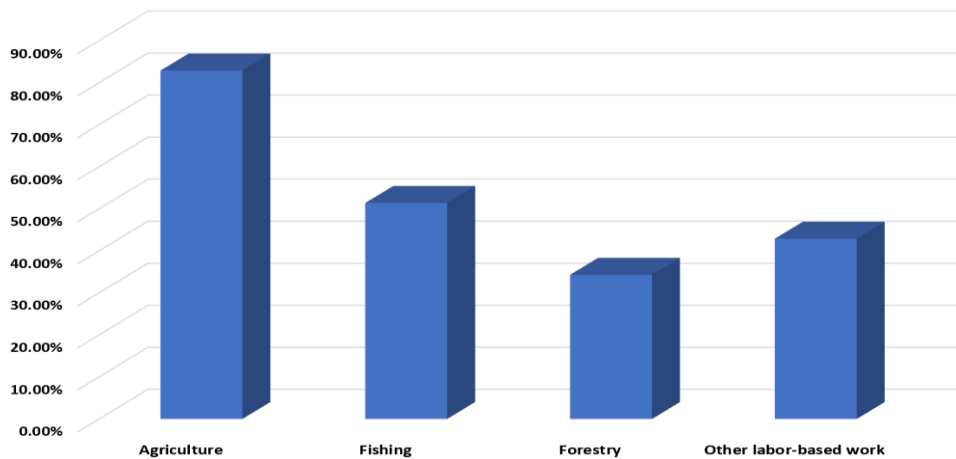


**Figure 7: Participants response on types of Government support required**

**Impact on Employment and Livelihood Security:-**

The impact of changing climatic patterns on employment and livelihood security in the Sundarban Delta is significant, as revealed through the household survey conducted among 350 respondents. A vast majority of respondents (88.6%) reported that climate change has affected their livelihood security, with 81.4% stating that they have experienced job losses or reduced income opportunities. The most affected sector is agriculture, where 82.9% of households have witnessed declining economic stability, followed by fishing (51.4%), forestry (34.3%), and other labor-based work (42.9%) (Figure 8).

The adverse climatic conditions have forced a significant portion of the population to migrate in search of better opportunities. Around 71.4% of households reported that at least one family member had migrated due to climate impacts. Kolkata and nearby cities remain the primary migration destinations (57.1%), while 34.3% have moved to other states in India, and 8.6% have sought opportunities internationally, including in Bangladesh and Gulf countries.



**Figure 8: Sectors most affected by climate-related livelihood loss.**

Several livelihood challenges have emerged due to climate-induced economic distress. The most commonly reported issue is the loss of stable income (78.6%), followed by an increasing debt burden (60%), lack of alternative employment (65.7%), and rising cost of living (68.6%) (Figure 9). Despite the severity of these

issues, only 40% of households have received any form of government support to cope with the crisis, leaving 60% without assistance.

The majority (77.1%) expressed the need for financial assistance and subsidies. Additionally, 71.4% highlighted the importance of job creation programs, 54.3% requested skill development and

training, and 62.9% emphasized the need for alternative livelihood opportunities. These findings indicate an urgent requirement for targeted interventions, including economic diversification,

employment generation schemes, and capacity-building initiatives to enhance climate resilience in the region.

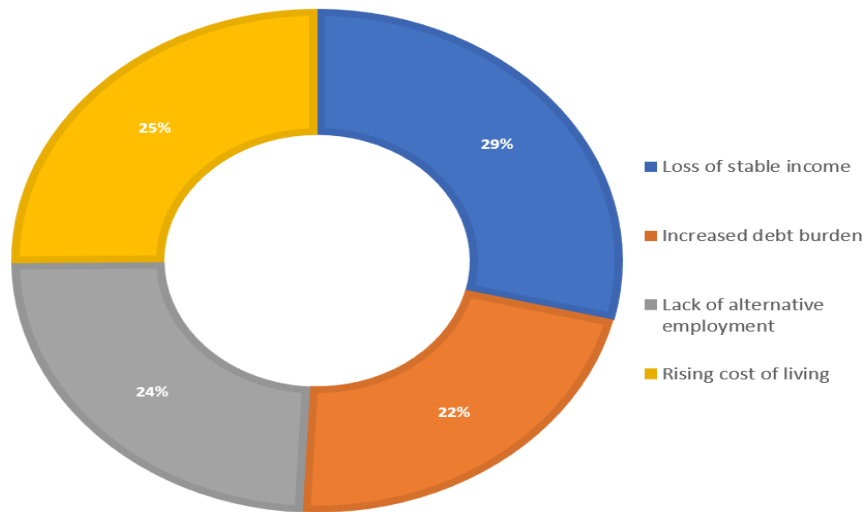


Figure 9: Major livelihood challenges due to climate change.

Table 4: Survey response on the Impact on Employment and Livelihood Security in the Sundarban Delta

Survey Response	Response Option	Number of Responses	Percentage (%)
Climate changes affected livelihood security	Yes	310	88.60%
	No	40	11.40%
Climate change led to job losses or reduced income opportunities	Yes	285	81.40%
	No	65	18.60%
Household member migrated for work due to climate impacts	Yes	250	71.40%
	No	100	28.60%
Main migration destinations	Kolkata & nearby cities	200	57.10%
	Other states in India	120	34.30%
	International (e.g., Bangladesh, Gulf countries)	30	8.60%
Received government support for employment and livelihood security	Yes	140	40.00%
	No	210	60.00%
Type of government support need	Financial assistance/subsidies	270	77.10%
	Job creation programs	250	71.40%
	Skill development & training	190	54.30%
	Alternative livelihood opportunities	220	62.90%

**Summary:-** The Sundarban Delta in South 24 Parganas is highly vulnerable to climate change, with significant impacts on agriculture, employment, and overall socioeconomic stability. The study reveals that 91.4% of respondents have noticed climatic changes over the past two decades, primarily characterized by increasing temperatures, irregular rainfall, frequent cyclones, and rising sea levels (Hazra et al., 2016). These climatic variations have led to a decline in agricultural yield and crop productivity, affecting both staple and cash crops. 88.6% of surveyed households reported a decrease in agricultural output, citing erratic rainfall (80%), prolonged droughts (74.3%), and soil salinity (70%) as major factors. Among the most affected crops were rice (80%), pulses (54.3%), and vegetables (65.7%). This decline has significantly reduced household incomes, with 78.6% reporting a substantial drop.

Climate change has also disrupted employment opportunities, with 81.4% of respondents experiencing job losses or reduced income, particularly in agriculture (82.9%) and fishing (51.4%). As a coping mechanism, 71.4% of households had at least one member migrate, primarily to Kolkata and nearby cities (57.1%) and other Indian states (34.3%). Rising socioeconomic challenges, including loss of stable income (78.6%), increased debt burden (60%), and lack of alternative employment (65.7%), have intensified economic hardships in the region (Ghosh & Mistri, 2021).

Although some farmers have adopted climate-resilient crops (45.7%), improved irrigation techniques (40%), and crop diversification (34.3%), a lack of adequate government support (60%) remains a critical issue. The study corroborates findings from previous research, such as Hazra et al. (2016), which identified climate-induced salinity intrusion and soil degradation as key factors behind declining productivity. Additionally, Danda et al. (2017) reported that increased frequency of extreme weather events has exacerbated rural-urban migration patterns, aligning with the findings of this study.

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