Netherlands Water Partnership
Netherlands Food Partnership

RESILIENT ROOTS:

LEVERAGING INDIGENOUS PRACTICES FOR SALINITY ADAPTATION IN SOUTHERN BANGLADESH

December 2024

CENTER FOR PEOPLE & ENVIRON
IVM Institute for Environmental Studies
VU
Farmers' Voice

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Disclaimer

This publication does not necessarily reflect the policy position of the CPE, IVM and KSFV. The information in this publication was based on available information at the time of preparation.

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List of abbreviations

ADB	Asian Development Bank
BARCIK	Bangladesh Resource Center for Indigenous Knowledge
BCCSAP	Bangladesh Climate Change Strategy and Action Plan
CHT	Chittagong Hill Tracts
FGD	Focus Group Discussions
IFAD	International Fund for Agricultural Development
IK	Indigenous Knowledge
IKS	Indigenous Knowledge Systems
ILK	Indigenous and Local Knowledge
LEDARS	Local Environment Development and Agricultural Research Society
NFP	Netherlands Food Partnership
NWP	Netherlands Water Partnership
SRDI	Soil Resource Development Institute
UNESCO	United Nations Educational, Scientific and Cultural Organization

Executive Summary

Bangladesh is one of the most vulnerable countries to climate change. The country is prone to climate-related extreme events like floods, droughts, salinity, etc. The livelihood of the country is mostly agrarian. The interaction with the ecosystem for livelihood and the presence of local disasters have given the community vast experience in coping with environmental factors, specifically climate change. From there, the community owned a rich Indigenous Knowledge. Indigenous Knowledge in Bangladesh comes in the form of expertise, which is in the form of verse, and practices, which are mostly tools and technologies. The study was conducted to identify and compile effective scaling-up potential Indigenous agricultural practices, local crop varieties, and tools to promote climate-smart agriculture in salinity-affected Shyamnagar, Khulna; Hatiya, Noakhali, Banaripara, Barishal of Bangladesh.

To meet the study objectives, the study has adopted multidisciplinary primary data collection tools including farmer survey, focus group discussion, and case story documentation in Shyamnagar, Banaripara, and Hatia. Primary information was collected through 300 farmer surveys (100 in each location), 12 Focus Group Discussions (FGD), and 32 case stories. It has reviewed the Bangladesh Climate Change Strategy and Action Plan (BCCSAP), the 8th Five-Year Plan of Bangladesh, The State of Indigenous Knowledge in Bangladesh, ADB Indigenous Knowledge Development in Bangladesh: Present and Future, Promotion and Preservation of Indigenous Knowledge Systems and the Traditional Environmental Knowledge of Bangladesh, Indigenous Peoples Planning Framework, UNESCO Indigenous Knowledge and Implications in Bangladesh, IFAD-The Traditional Knowledge Advantage reviews, etc. were studied. Book published by the Bangla Academy on folk literature and published and unpublished research papers by the Department of Anthropology and Department of Environmental Science from some universities. Soil salinity of different sources from the treatment area (homestead and agricultural land) was collected through cross-section and analyzed in the **CPE Soil Water and Environment Lab.**

Salinity in surface, ground, and soil in the coastal zone has become a very crucial matter on the southern coast of Bangladesh. In 2009, the salinity-affected total land area was 2502856 Ha, which was 1205931 Ha in 1973. Within these 36 years, the total salinity affected land increased by 1296924 Ha. Not only so but also in 2024 some of the locations were identified as high salinity affected that low or moderately salinity affected. Crop production loss is a common scenario along Bangladesh's coastal belt because of salinity and increasing pests and diseases. The study finds that the average homestead crop production losses are caused by salinity during the *Rabi* season, the average loss is 19.2 kg per household, while in *Kharif I*, it decreases to 8.34 kg. However, during *Kharif II*, losses increased significantly to 30.65 kg per household from homestead farming. The average field crop production losses caused by salinity across different seasons from crop fields were found to average 2.71 MT/Ha in the *Rabi* season, reducing to 1.70 MT/Ha in *Kharif I*. During *Kharif II*, losses rose again, reaching 3.32 MT/Ha**.** Three vegetable varieties were identified those are potential for scaling up in the salinity affected areas. These are Gima (*Glinus oppositifolius*) which is resistant to high salinity (6.38-7.5 ds/m); Kolui (*Pisum

sativum) are resistant to 7-9 ds/m salinity and Torul (*Luffa Aegyptiaca*) resisant to 2.2-3 ds/m salinity.

Traditionally farmers have adopted different farming technologies to adapt to climate-induced extremes like salinity, tidal inundation, waterlogging, and flooding along the coastal belt of Bangladesh. In the study area, the identified Indigenous farming technologies are **GHOR KRISHI which is** an innovative agricultural practice aimed at transforming waterlogged lands in coastal areas into profitable ventures. The GHOR KRISHI method is specifically tailored for medium-high to medium-low lands with a late draining phase. **DHAP KRISHI which** is a traditional indigenous farming technology marked a transformative approach to addressing the challenges imposed by climate change in Bangladesh, particularly suited for the wetland, submerged, salinity affected and flooded regions. **DYKE/Ail Farming i**s a climate adaptation technique that is commonly used in salinity-affected, flood, and waterlogged areas. **MACHA KRISHI is practicing in** waterlogged, and salinity-affected areas, securing water for agricultural purposes remains a constant struggle.

Traditionally farmers have adopted different water and irrigation management technologies to adapt to climate-induced extremes like salinity, tidal inundation, waterlogging, and flooding along the coastal belt of Bangladesh. In the study area, the identified Indigenous farming technologies. Among those Kol is an effective water management technology to prevent salt water from seeping into the crops' area. In coastal areas, Kongkona is a very effective technology in tackling water crises in the salinity-affected areas. Jolpotti is also an earthen-holed irrigation system for irrigation in vegetable fields. In the promotion of the kitchen garden, has a high potential to adapt to climate extremes, especially drought and salinity. Kuni is a water body created in the middle of or at the corner of a paddy field for climate adaptation agriculture, and is an adaptive practice in saline-affected areas. Kaite Bera is a barrier placed on farmed land in salinized regions to keep farms away from harvest. In the salinity-affected areas, whenever a storm surge hits the agricultural land, it destroys the cropland. Kaite Bera protects salt-mixed storm surges and reduces loss and damage. During summer, it also protects crops from the attack of livestock, especially goat and cattle.

Traditionally farmers have adopted different seed and food preservation techniques to adapt to climate-induced extremes like salinity, tidal inundation, waterlogging, and flooding along the coastal belt of Bangladesh. Those are Gobre Beej (the use of cow dung is often a natural method to protect seeds from pests), Barna (bamboo baskets for storing various food items), Kulhar (Earthenware traditional method of food storage), Kuthi Gola (an earthen pot where paddy and rice are stored to prevent damage during monsoon seasons), etc.

However, a more effective climate adaptive Indigenous Knowledge and practices should be identified by imperial research. Modern adaptation technologies must be blended with Indigenous technologies. However, there are many policies associated with or taking care of climate change. However, policies for Indigenous Knowledge conservation and protection are missing in Bangladesh. Necessary policy and institutional support are urgent.

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1. Introduction

The coastal zone of Bangladesh covers about 20% of the total land of the country and over 30% of the cultivable lands. Water-related hazards due to climate change are likely to become a critical issue for Bangladesh. Salinity in surface water, groundwater, and soil has become a dominant hazard in Bangladesh's coastal zone.

2. Indigenous Knowledge

Indigenous Knowledge (IK) is a body of observations, oral and written knowledge, innovations, practices, and beliefs that promote sustainability and the responsible stewardship of cultural and natural resources through relationships between humans and their landscapes (Subhrajyoti Chatterjee, 2020). Indigenous Knowledge cannot be separated from the people inextricably connected to that knowledge. It applies to phenomena across biological, physical, social, cultural, and spiritual systems. Indigenous Peoples have developed their knowledge systems over millennia, and continue to do so based on evidence acquired through direct contact with the environment, long-term experiences, extensive observations, lessons, and skills. Indigenous knowledge is rich and vast, with special references to Indigenous communities of India, where the given environment and the natural resources are viewed not only as a means of sustenance/livelihood but as a means of constructing their worldview and cosmology around it. As such, one may come across the concept of sacred grooves, sacred sites, sacred forests or trees; etc., which not only conforms to their religious faith and practices but promotes sustainable development by way of conserving the 'sacred' resources. In addition, indigenous knowledge is observed in day-to-day life, ranging from agricultural activities, food security, land use, water management, forest products, crop cultivation, waste management, food preservation, and so on. Today, the Indigenous knowledge of the local communities stands vulnerable not only to the elements of globalization, developmental programs, and environmental threats but also to the increasing concept of private property, issues concerned with land and forest rights, power conflict in natural resource management, gender disparity, the impact of modernization in traditional belief system, the non-transfer of knowledge to younger generations, etc. In this background, the following section shall shed light on some practical applications of Indigenous Knowledge and its contribution to environmental sustainability, with special reference to tribal communities and other ethnic groups in India, while bringing forth those structural elements and issues that are leading to the erosion of Indigenous Knowledge in the local communities at large.

Indigenous knowledge of coastal communities in Bangladesh plays a crucial role in addressing challenges posed by salinity, which significantly impacts agriculture, drinking water, and overall livelihoods as well. Salinization is a process when the salt content in the soil and/or water increases, having a negative impact on plants' growth and as a consequence agricultural yield. However, salt-affected soil can be effectively managed through a set of soil, water, and plant management practices known as saline agriculture. Saline agriculture often includes local and traditional measures but also new innovative methods. IK informs people about which crops and plants are more resilient to saline soils. For example, local varieties of rice and other crops that can tolerate higher salinity levels are often preferred, as they are better suited to the changing soil conditions caused by salinity.

Bangladesh is enriched with a lot of indigenous knowledge. Khonar Bachan[1] is prominent indigenous knowledge for agriculture (Bandyopadhyay *et al.,* 2017). There is plenty of indigenous knowledge of weather and disaster forecasting in Bangladesh (Paul & Routray, 2013). Indigenous knowledge is the result of human interaction with the local environment and climate. The climate is changing across the globe. Climate-induced extremes affect human life and livelihoods, including agricultural systems, health systems, water systems, sanitation systems, and social and human security, all over the world, including Bangladesh (Parvin *et al.*, 2015). Indigenous and Local Knowledge (ILK) is a term used to describe the wisdom, techniques, approaches, skills, practices, philosophies, and uniqueness of knowledge within a given culture, which is developed by local communities over years through the accumulation of experiences and informal experiments, and based on an intimate understanding of local contexts. ILK is generally transmitted via oral and practiced traditions (Leal Filho et al., *2022*). In climate change adaptation and mitigation, with multi-sectoral resilience, people traditionally practice different knowledge and skills (Karki et al., 2017). In various climate hotspots, different communities are practicing several Indigenous practices analyzed in this report and knowledge to adapt to changing scenarios of climate change as well as saline agriculture.

3. Project Objectives

1. **Screen and Document Indigenous Knowledge**: Identify and compile effective traditional practices, crop varieties, and tools used by communities in salinity-affected areas of Bangladesh.
2. **Feasibility Assessment**: Analyze the socio-economic, ecological, and cultural feasibility of these practices, varieties, and tools for broader application.
3. **Proposal Formulation**: Develop a comprehensive proposal for scientific validation, policy input, and partnership building to scale up successful practices. [Upon finding potential funding agencies]

Contribution to SW&FS Goals

By promoting sustainable agricultural practices and supporting knowledge sharing, this project aligns with the SW&FS Partnership's vision of developing impactful, community-driven solutions for salinity adaptation. The project aims to strengthen advocacy efforts to integrate these practices into national and international policy frameworks.

4. Methodology of the study

The study adopted a participatory and multi-disciplinary approach to data collection and analysis. Secondary information viz. soil salinity, Indigenous practices, and Indigenous crop varieties were collected through reviewing existing literature and secondary data sources related to indigenous knowledge and climate adaptation in Bangladesh. The study has developed a comprehensive database, or repository, of indigenous adaptation techniques. The research methodology of the study was designed to harvest indigenous knowledge practices as well as the climate crisis of the study area. The methodology also included an attempt to document countrywide Indigenous practices; the technologies and tools used in livelihoods and regular lifestyle practices that are considered Indigenous by the community themselves were also noted.

[1] "Khana's Words", is a collection of agricultural maxims and proverbs that are an important part of Bengali folk literature and oral tradition.

To meet the study objectives, the study has adopted multidisciplinary primary data collection tools including farmer survey, focus group discussion, and case story documentation in Shyamnagar, Banaripara, and Hatia. Primary information was collected through 300 farmer surveys (100 in each location), 12 Focus Group Discussions (FGD), and 32 case stories. It has reviewed the Bangladesh Climate Change Strategy and Action Plan (BCCSAP), the 8th Five-Year Plan of Bangladesh, The State of Indigenous Knowledge in Bangladesh, ADB Indigenous Knowledge Development in Bangladesh: Present and Future, Promotion and Preservation of Indigenous Knowledge Systems and the Traditional Environmental Knowledge of Bangladesh, Indigenous Peoples Planning Framework, UNESCO Indigenous Knowledge and Implications in Bangladesh, IFAD-The Traditional Knowledge Advantage reviews, etc. were studied. Book published by the Bangla Academy on folk literature and published and unpublished research papers by the Department of Anthropology and Department of Environmental Science from some universities.

Soil salinity of different sources from the treatment area (homestead and agricultural land) was collected through cross-section and analyzed in the **CPE Soil Water and Environment Lab.**

5. Indigenous knowledge and climate change adaptation in Bangladesh

Indigenous Knowledge Systems (IKS), which often rely on proverbs, stories, poetry, and practices offer a strength to the conventional knowledge transfer mechanism. This is because this knowledge is a long-standing record of adaptation strategies passed down through generations. Khanar Bachan, a significant part of oral literature in Bangladesh, is an extremely practical and useful agricultural guide in simple language and vocabulary, composed probably more than a thousand years ago. Khonar Bachan, which has been transmitted orally from generation to generation, has contributed to the local, traditional agriculture of the rural farmers of this region. It is also said in the local dialect, i.e., it is much associated with the community of that basin. IKS mostly the forms of proverbs, poetries, tales, and stories that originated based on the local ecosystem, weather, and livelihood patterns are not in use as it was earlier.

The practices of IKS in one area adopted for other areas are comparatively new. Like those the floating bed cultivation systems of Gopalganj and other areas were reported around two hundred years old in their cultural practices but which is not that old in the Pirojpur area (Irfanullah, 2022). That means the journey of an adaptation technology like the floating bed that starts from the Gopalganj area where the beel[2] ecosystem has a small form of water pool but downstream of this in Patuakhali where the beel has a wider area coverage has added some local ecosystem value; the form changes like the smaller water floating bed turn into a long-length water bed after many years when taken by a new community. According to the local community, the practices of Gopalganj and Pirojpur have been different for more than half a decade. Again, the practice of 'Bina' which is keeping distance between two lines of transplanted paddy in Jhenaidah is not older than 50 years. So those are comparatively new practices (Pal et al, 2021).

Some practices are new native innovations. Study found that the use of water hyacinths varies from region to region; the floating bed previously described for this beel region is called Dhap krishi or Gatua, such a water hyacinths bed is also found in a different form in the Haor areas

[2] *Beel* is a topographically low depression large surface waterbody that accumulates surface runoff water through internal drainage channels

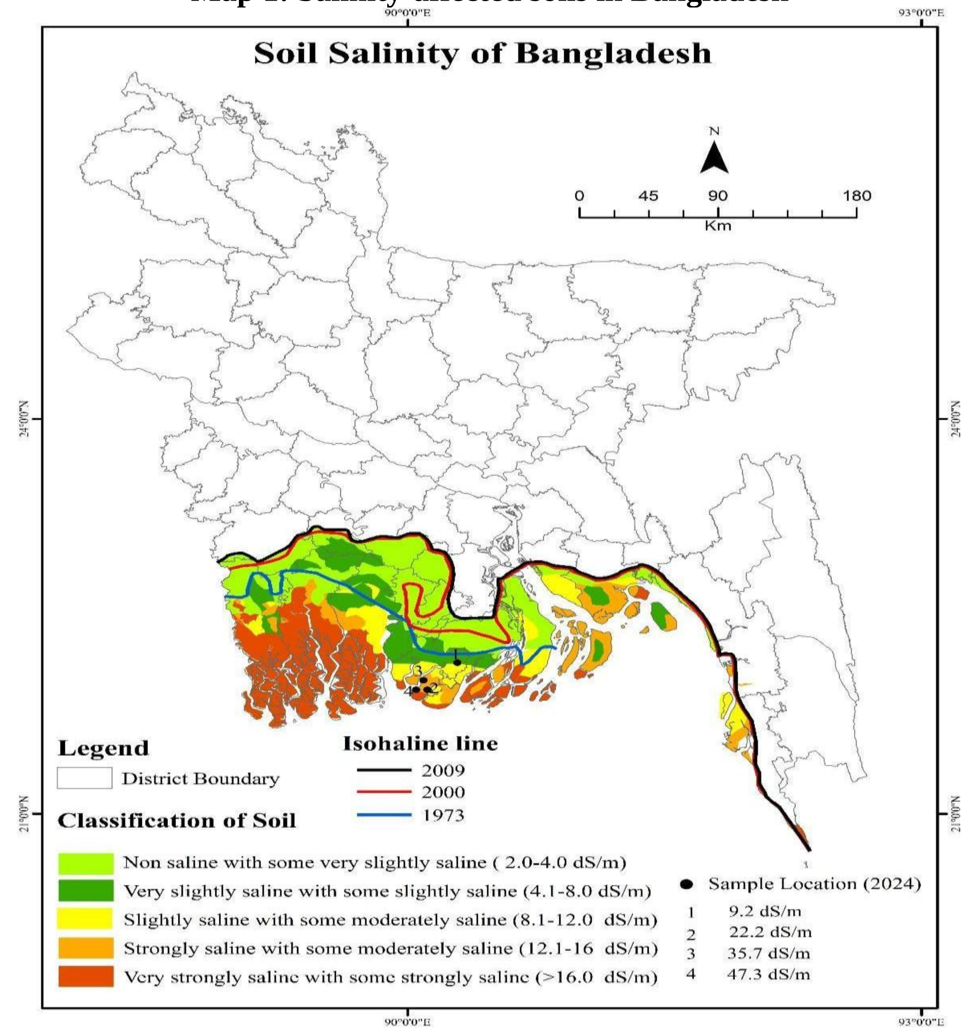
where the floating bed is quite small and round shape is locally called as Bhola (Pal et al, 2021). The form of a round shape is only because of its easy movement on the top of a wave, which is very strong in the Haor basin compared with the Beel basin.

This study found that there is a considerable evolution of IKS. Based on time, people, and ecosystem (Sen, et al 2006.). It was found that the local ecosystem has a good influence on the housing pattern. Most of the mud-made houses are recorded in the Barind Tract area. In this Barind Tract, the width of the wall of a mud-made house is found around one foot. But there was also a mud-made wall recorded in the study from Satkhira which is very thinner compared with the Barind Tract. This is significant in the Barind Tract to cope with the heat. The mud house feels comparatively cooler during the summer and in winter it is warmer. The wall of houses is mostly made of bamboo in the Charland and the Haor Basin. Though in Charland the availability of bamboo is much higher compared with the Haor Basin. Both the Charland and Haor villages have a risk of land erosion and shifting the house from one place to another place. The Bamboo walls of houses are easy to transfer, they are lightweight. Such a shifting requirement is not required for the Barind, a sunglass-made house or permanent structure is more fit. Here. Along the coastal belt of Bangladesh soil, surface, and groundwater salinity tremendously increased which restricts farming in the cropland and homestead due to the lack of irrigation caused by freshwater deficiency. In that case, traditionally *Kuni* is being practiced as an effective water management and irrigation in salinity-affected areas. Farmers usually dig small ponds which are called *Kuni* in the agricultural land and preserve rainwater during monsoon. Whenever salinity increases surface and groundwater, they irrigate their cropland from this preserved water and cultivate winter and summer crops.

6. Impact of salinity along the coastal belt of Bangladesh

Salinity in surface, ground, and soil in the coastal zone has become a very crucial matter in the southern coast of Bangladesh (Mondal, Bhuiyan, & Franco, 2001), SRDI, 2010) (Rahman, Majumder, Rahman, & Halim, 2011). When the soil salinity exceeds a plant's tolerance, growth reductions occur. Salinity intrusion in river water may cause economic loss in terms of crop yield reduction, hampering industrial production, increasing health hazards, and reducing the productivity of forest species (Haque, 2006). In 2009, the salinity-affected total land area was 2502856 Ha, which was 1205931 Ha in 1973 (SRDI, 1973, SRDI, 2019). Within these 36 years, the total salinity affected land increased by 1296924 Ha. Not only so but also in 2024 some of the locations were identified as high salinity affected that low or moderately salinity affected (Map 1).

Map 1: Salinity-affected soils in Bangladesh



Source: SRDI, 1973; SRDI, 2009; CPE, 2024

Crop production loss is a common scenario along Bangladesh's coastal belt because of salinity and increasing pests and diseases. In the study area, almost all the farmers experienced crop production loss in the last five years (2013-2023).

Table 1 shows the average homestead crop production losses caused by salinity across different seasons between 2018 and 2023. The data presents homestead crop production loss in kilograms per household. It shows that production losses vary by season: during the *Rabi* season, the average loss is 19.2 kg per household, while in *Kharif I*, it decreases to 8.34 kg. However, during *Kharif II*, losses increased significantly to 30.65 kg per household.

Table 1: Average homestead crop production loss by salinity and diseases in 2018-2023

Region-wise homestead production loss (Kg/household)		
Rabi	Kharif I	Kharif II

19.2	8.34	30.65

Table 2 shows the average field crop production losses caused by salinity across different seasons between 2018 and 2023. It provides the average field crop production loss in metric tons per hectare (MT/Ha) across the same seasons. The losses are recorded as 2.71 MT/Ha in the *Rabi* season, reducing to 1.70 MT/Ha in *Kharif I*. During *Kharif II*, losses rose again, reaching 3.32 MT/Ha**.**

Table 2: Average field crop production loss by pests and diseases in 2018-2023

Region-wise field crop production loss (MT/Ha)		
Rabi	Kharif I	Kharif II
2.71	1.70	3.32

5. The current state of Indigenous practices in the agricultural supply chain

5.1. Salt-tolerant crop and vegetable varieties

Along the coastal belt of Bangladesh, there are some salt-tolerant local rice varieties, and vegetable varieties were identified in the secondary literature and primary sources through farmer surveys (**Table** 3). These are the local varieties of rice and vegetable which are under the practice of salinity-affected soils of Bangladesh.

Table 3: Identified salt-tolerant rice and vegetable varieties

Rice varieties	**Vegetable varieties**
Talmugur paddy, Nonakhochi paddy, Patnai, Kute, Gobindobhog, Charulota, Talmugur, Sylhet boro, Boro Rotna, Jotaibalam, Kachra, Noyon Moni, Terebala, Asan boro, Kajol lota, Koijuri, Kalibaro, Bepoy, Lotaibalam, Choitibaro, Rani Salote, Hoglapata, Vute Salote, Jamai Naru, Chor Balam, Pushbiruine, Pakbiruine, Kathali Biruine, Kuchmuch, Ghono tara, Mollika, Adubali, Islampuri, Maishabilli, Kumragor, Mohinisalote, Durgavog, Kalomona, Dudhkolom, Mohini Salote, Chapsayle, Kashfulbalam, Narajamainaru, Hatibojor, Lalmota, Hamai, Khejurchori, Bojromuri, Bousohagi, Sadagotal, Moynamoti, Mota, Khacra, Garoi, Somudrofena, Chinigura, Badol, Katarivog, Kalijira, Khaskani, Ranisalote, Morichsayle, Badshavoge, Noyonmoni, Abdulhigh, Noyontara, Kajol Lata, Vason, Bapi Auyush, Jiya, Kajollota, Bojromuri, Bousohagi, Moynamoti, Khejurchori, Mulagati, Hamai, Chorobalam, Darsayle, Katigoccha, Horgoja, Kumragore, Chapsayle, Kashful balam, Kalomona, Dudhkolam, Bashfulbalam, Noncha, Kolmilota, Noyonmoni, Noyontara, Porbotjira, Khacra, Begunbichi, Rayda, Chandrakuli, Akashpali, Chittorangi, Bonkamini, Magurdim, Mugibalama, Dudheshwar, Palakshail, Pankhiraj, Mayurlata, Kajal, Suryamoni, Parangi, Sonamukhi, Dadkhani, Kataktara.	Gima shak Kolui Torul.

5.2. Indigenous farming technology in the salinity-affected areas

Traditionally farmers have adopted different farming technologies to adapt to climate-induced extremes like salinity, tidal inundation, waterlogging, and flooding along the coastal belt of Bangladesh. In the study area, the identified Indigenous farming technologies are:

5.2.1. GHOR KRISHI

The GHOR KRISHI farming system stands as an innovative agricultural practice aimed at transforming waterlogged lands in coastal areas into profitable ventures. The GHOR KRISHI method is specifically tailored for medium-high to medium-low lands with a late draining phase.

The land is subdivided into plots with permanent water ditches in between, and each plot is elevated using soil from adjacent areas. The optimal plot size ranges from 8.0m X 2.5m to 4.5m, varying based on plot dimensions. Raised beds primarily support the cultivation of vegetables, sugarcane, and dhaincha, while local fish thrive in the ditches between plots. Beyond Gurguriya, the success of GHOR KRISHI farming has rippled to other regions in Bangladesh, including Subarnachar, Hatiya, Barisal, Patuakhali, Barguna, and Pirojpur districts. This technique has proven effective in salinity-prone zones, demonstrating versatility in addressing environmental challenges. The benefits of GHOR KRISHI farming are multifaceted. By raising soil levels and creating deep trenches, it safeguards crops from tidal surges and natural calamities. Additionally, the system promotes sustainable wetland use, preserving biodiversity by providing a habitat for fish and ducks. Shallow GHOR KRISHI facilitates year-round vegetable cultivation, while deeper versions support rice-fish or rice-duck farming alongside vegetables/nurseries.

5.2.2. DHAP KRISHI

DHAP KRISHI is a traditional indigenous farming technology marked a transformative approach to addressing the challenges imposed by climate change in Bangladesh. Particularly suited for the wetland, submerged, and flooded regions of the country, where agricultural lands endure prolonged submersion during the monsoon, this innovative technique involves cultivating crops on floating beds crafted from water hyacinth, bamboo, and locally available materials. Originating for thousand years ago, DHAP KRISHI found its foothold in the estuary of Shondya River, where seasonal flooding poses hindrances to farming. The primary objectives encompass utilizing waterlogged areas for prolonged food production, adapting to regular or extended flooding, preventing land loss through continued cultivation, expanding cultivatable areas, enhancing community self-sufficiency, and significantly boosting productivity compared to traditional farming—up to ten times more productive. Moreover, DHAP KRISHI cultivation aims to diminish reliance on chemical fertilizers or manure while simultaneously addressing environmental concerns, such as clearing water hyacinths to reduce mosquito breeding and improve fishing conditions. In essence, DHAP KRISHI cultivation emerges as a resilient and sustainable solution, providing a lifeline for communities grappling with the impacts of climate change in Bangladesh. After the initial month when water inundates the land, the construction of floating beds begins, utilizing water hyacinth, moss, water lettuce, and duckweed. A robust two-foot-thick bed is crafted by layering water hyacinths, followed by moss, duckweed, and dulalilata. Typically measuring 3-4 cubits in width and 120-130 cubits in length, these beds maintain a width of no more than 3-4 hands. This design allows for convenient planting, tending, and harvesting of crops from the sides without necessitating traversal over the floating beds. Direct seeding on the floating bed proves impractical, necessitating the preparation of a specialized reservoir, known locally as 'Doulla,' filled with water lettuce, dulalilata, and coconut flakes. Various seeds are buried in the 'Doulla,' germinating in a dry place before being transferred to the floating vegetable beds. This method facilitates the cultivation of vegetable seedlings like gourd, bitter gourd, wax gourd, snake gourd, bean, pumpkin, brinjal, and tomato. For crops such as cabbage, cauliflower, and kohlrabi, coconut shells are spread over the water hyacinth, serving as a medium for sowing seeds. Once the seedlings develop, they are planted in the floating beds. Cucumbers, okra, and even turmeric are cultivated through this method. These floating beds exhibit a lifespan of 2-3 years. In subsequent seasons, the replenishment process involves adding water hyacinth and moss in the necessary proportions. All raw materials required for this cultivation are locally sourced, with water hyacinth, moss, water lettuce, and duckweed abundantly available in the local wetlands. This cultivation cycle commences from Bangla Jayasthmas until Ashwin months. As the water recedes from the land, the space is reclaimed for boro cultivation. The floating beds, having served their purpose, are repurposed as compost. Additionally, these versatile floating beds prove instrumental in cultivating flowers such as marigolds and water lilies. Floating bed farming technology has emerged as a transformative solution for agriculturists in flood-prone or water-logged areas like Sunamganj, Habiganj, Bhramanbaria, and Pirojpur districts of Bangladesh. This innovative approach proves advantageous in mitigating the impact of climate change, particularly in regions susceptible to flooding. The floating beds, constructed from bamboo, water hyacinth, duckweed, and coconut shells, create a stable and nutrient-rich environment conducive to crop growth. Notably, the productivity of these floating beds surpasses that of traditional farming methods by up to ten times, eliminating the need for additional chemical fertilizers or manure. Farmers benefit from reduced vulnerability to climate-related challenges, and crops such as spinach and bitter gourd thrive in this unique cultivation system. Harvesting water hyacinth not only contributes to improved conditions for open-water fishing but also addresses the issue of mosquito breeding grounds, as areas covered by the weed are cleared. Despite these advantages, the technology presents certain challenges. Regular maintenance, a time-consuming and labor-intensive task, is necessary to ensure the longevity of the floating beds. Furthermore, susceptibility to damage from storms and strong currents poses a risk of crop loss. It is important to note that the technology may not be universally suitable for all crops, as some may not thrive in the floating beds. The adoption of floating bed farming technology in Bangladesh signifies a commendable climatic adaptation strategy. As a soil-free cultivation method, it has become instrumental in coping with the recurring floods triggered by global warming. The raft-like farms, ranging between two and four feet in length, demonstrate resilience in the face of volatile waters or inundation. Overall, this sustainable and resilient farming solution has played a crucial role in climate adaptation, offering a lifeline to farmers in flood-prone areas and contributing to the broader agricultural landscape.

5.2.3. DYKE/Ail Farming

Ail Farming technology is a climate adaptation technique that is commonly used in flood and waterlogged areas. It is a low-cost and eco-friendly method that helps farmers to adapt to the changing climate conditions. The technology involves the use of a mixture of organic and inorganic materials to create a firm surface on which crops can be grown. The mixture is applied to the soil surface, and then it is compacted using a roller or other heavy equipment. The resulting surface is firm and stable, which helps to prevent soil erosion and waterlogging. The advantage of this method of farming is that vegetable seeds, bamboo poles, etc. materials can be easily collected and stored. Rice and vegetable cultivation in the area was often disrupted due to inundation, flash floods, and shrimp farming. Now there is no land left uncultivated as a result of this method of vegetable cultivation. Vegetables are being cultivated in this way in all lands. On the one hand, shrimp cultivation on the land, on the other hand, the cultivation of vegetables on the land has made it possible to use 100% of the land. Once the lands where shrimps were not cultivated but the water was stagnant, vegetables were being cultivated using mechas. No land remains fallow. Vegetables are cultivated here by applying this method for about twelve months of the year. The advantages of Ali Farming technology include its low cost, ease of use, and eco-friendliness. The technology is also effective in preventing soil erosion and waterlogging, which are common problems in many parts of the world. Additionally, the technology helps to increase crop yields, which is important for food security.

5.2.4. ZERO TILLAGE Practice

Zero Tillage, also known as no-till farming, is a conservation agriculture practice that eliminates or minimizes soil tillage. This technique holds significant promise for improving agricultural sustainability in Bangladesh. Zero tillage is still in its early stages of adoption in Bangladesh. Zero tillage involves planting crops directly into the residue of previous crops, eliminating the need for plowing or other tillage practices. It improves soil health by minimizing soil disturbance, zero tillage promotes the growth of beneficial soil organisms and increases soil organic matter content. This leads to improved soil structure, better water retention, and enhanced nutrient cycling. This practice reduces soil erosion because the soil surface remains protected by crop residue, reducing the risk of wind and water erosion. This helps conserve valuable topsoil and prevents the loss of nutrients. It also increases carbon sequestration because of un-disturbance of the soil in a zero-till system acts as a carbon sink, capturing and storing carbon dioxide from the atmosphere. This helps mitigate climate change. Zero tillage reduces evaporation from the soil surface and increases water infiltration, leading to more efficient water use by crops. This is particularly beneficial in areas with limited water resources.

5.2.5. MACHA KRISHI

In Bangladesh's waterlogged, and salinity-affected areas, securing water for agricultural purposes remains a constant struggle. The Macha Krishi is an indigenous technology. This technology offers a sustainable solution for water harvesting and conservation, empowering farmers to adapt to the challenges of a changing climate. In this technology, choosing a suitable location within the farmland, and considering factors like soil condition and drainage is the first step. Then dig a pond of the desired size and depth, adequate capacity for rainwater storage, proper drainage, and

slope stability. Raise embankments around the pond using excavated soil to prevent erosion and retain water. Then implement structures like channels or pipes to direct rainwater runoff into the pond. Finally utilize the fertile silt accumulated at the pond's bottom for growing vegetables, fruit plants, or other suitable crops. Macha krishi is the indigenous practice of growing crops in vertically stacked layers. It often incorporates controlled-environment agriculture, which aims to optimize plant growth, and soilless farming techniques such as hydroponics, aquaponics, and aeroponics. Some common choices of structures to house vertical farming systems include buildings, shipping containers, tunnels, and abandoned mine shafts. Bangladesh farmers in certain areas are already reaping the benefits of vertical farming. In the southwest of the country, most of the coastal belt suffers from salinity that renders the land useless. It is in this setting that vertical gardening is taking root among hundreds of villagers with the use of plastic sacks, giant containers made of plastic sheets bamboo, etc.

5.2.6. STRAW MULCHING

Straw mulching is an indigenous technique for adjusting to climate change that involves applying organic or inorganic materials to the soil's surface to shield it from the damaging impacts of global warming. It serves as a barrier, retaining moisture, controlling temperature, inhibiting the growth of weeds, and improving soil fertility. Mulching has been used for a very long time and in many different ways in many parts of the world. Grass, leaves, and straw were among the natural elements that ancient civilizations employed to cover and maintain the soil's surface. The methods for mulching have changed throughout time, and now organic waste, plastic film, and chips of wood are only a few of the materials that are used. In Bangladesh, mulching has drawn interest as a climate adaptation technology because it can reduce the effect of catastrophic weather conditions like droughts and floods, which are growing more common and severe in this region. Mulching ensures a more consistent supply of water for the crops during dry seasons by decreasing evaporation and boosting water infiltration, which helps to preserve soil moisture. This is especially crucial for a country where the agricultural sector is highly dependent on monsoon rainfall and susceptible to water constraints. Additionally, mulching improves the fertility of soil. Compost and crop leftovers are examples of organic mulches that slowly break down and replenish the soil with vital nutrients. This raises the amount of organic matter in the soil, strengthens the soil's structure, and makes more nutrients available for plant uptake. Higher agricultural yields, healthier plants, and a decreased need for chemical fertilizers are all results of increased fertility.

5.3. Water and irrigation management technology

Traditionally farmers have adopted different water and irrigation management technologies to adapt to climate-induced extremes like salinity, tidal inundation, waterlogging, and flooding along the coastal belt of Bangladesh. In the study area, the identified Indigenous farming technologies are:

5.3.1. Kol

To prevent salt water from seeping into the crops' area, this method has proved effective. Around the field, there are tall aisles. About 0.8 feet outside this first aisle, a second aisle is made from the earth. These two aisles in succession are the 'kol aile'. The second aisle on the outside is further layered with mud and allowed to dry, forming a firm wall that prevents saltwater from seeping in.

5.3.2. Chemot

Due to salinity, most agricultural tools are damaged by rust. To address this, bamboo, ropes, bamboo skin, or tin panels can be used to produce instruments that are resistant to saltwater. This canal tool is easy to make, cheap, and can be made from easily available materials. Bamboo or tin panels can be cut with their ends in triangular shapes, after which a system of nylon ropes and cords can be used to drag it along the ground to form canals.

5.3.3. Konkona

In coastal areas, salinity causes a water quality and usability crisis. This method, while differing across areas, is very effective in tackling the crisis. After the autumn harvest, an area in the field is chosen, and a square hole about 5-6 feet in depth and 60-70 feet in lateral dimension is cut in. Rainwater is stored here, and the water itself is enough to tend to about one bigha of crops. This does not fill up for about 10 years. If it does fill up, simply a larger area is dug out to extend the volume.

5.3.4. Jolpotti

An earthen-holed pitcher with a ribbon/rope. It is an irrigation system for water in vegetable fields. Jolpotti is a form of drip irrigation. In the promotion of the kitchen garden, has a high potential to adapt to climate extremes, especially drought and salinity. To reduce the evaporation the Jolpotti could have added cover. During winter and summer, due to a lack of irrigation, homestead farmers irrigate their home gardens to recover irrigation crisis. In the salinity-affected Shymanagr, this intervention is popular among the home gardeners in producing vegetables, and horticulture during winter and summer.

It is an ancient technique that has been practiced in many parts of the arid world. Pitchers, locally known as Kolosh, also known as the "Pitcher Irrigation System," is a traditional way of watering used in Bangladesh for years. This low-cost and effective technology has proven to be a valuable tool for farmers in overcoming salinity challenges and adapting to the changing climate. A normal-sized earthen pot should be collected. Pitchers are perforated to make a hole of about 1-inch diameter at the bottom, and a 0.5-1.0-meter-long jute ribbon is inserted in the hole. The pitchers are then placed in pits (locally made) at a depth of 5-9 cm, and the jute tapes spread at the same depth so that wet jute can moisten the soil and continuously decrease the soil salinity in the root zone. 3- 4 seeds of the crops planted in each pit around the Pitcher. Growing rabi crops in moderately saline areas is a deficient cost technology to produce watermelon, sweet gourd, and cucumber in the dry season in pits (Mada). The Koloshi offers low-cost, locally available materials, water efficient, and adaptable farming through reducing soil salinity.

5.3.5. Kuni

Kuni is a water body created in the middle of or at the corner of a paddy field for climate adaptation agriculture, is an adaptive practice in the saline-affected area of Shyamnagar, Satkhira. It is also used for the cultivation of fish, which is visible on grazing land. It is the source of water for cultivation in the dry season. This integrated farming system has been practiced since ancient times. Rice, fish, ducks, chickens, cows, buffaloes, and vegetables are cultivated in every ideal farmer's house. In any disaster, one is affected, the other is supported.

Kuni is a very effective adaptation practice in the coastal region. To preserve water for irrigation during summer and winter, the farmers are practicing this system. Kuni is also effective for the protection of fish species. During summer, all of the lowlands dry up where local fish wander. In this period, the local fish take shelter in this Kuni and grow up. During the rainy season, these fishes spread over the land and protect themselves. This is high potential in summer for irrigation in cropland and homesteads.

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5.3.6. Kaite Bera

It is a barrier placed on farmed land in salinized regions to keep farms away from harvest. In the

salinity-affected areas, whenever a storm surge hits the agricultural land, it destroys the cropland. Kaite Bera protects salt-mixed storm surges and reduces loss and damage. During summer, it also protects crops from the attack of livestock, especially goat and cattle.

5.4. Food and Seed Preservation

Traditionally farmers have adopted different seed and food preservation techniques to adapt to climate-induced extremes like salinity, tidal inundation, waterlogging, and flooding along the coastal belt of Bangladesh. In the study area, the identified Indigenous farming technologies are:

5.4.1. Gobre Beej

The use of cow dung is often a natural method to protect seeds from pests, enhance soil fertility, and support sustainable farming practices. Seeds might be mixed with cow dung and dried, which can help keep them safe from insects and improve germination rates when they are eventually planted.

5.4.2. Barna

Indigenous communities often use bamboo baskets for storing various food items. These baskets are woven and have good ventilation, allowing air circulation that helps in keeping the stored food items fresh.

5.4.3.Kulhar

Earthenware is another traditional method of food storage. Clay pots and containers are used to store grains, pulses, and other food items. The porous nature of clay helps in maintaining a cool temperature inside, preserving the quality of the stored items. Kulhar is made of clay. The porous nature of clay helps in maintaining a cool temperature inside, preserving the quality of the stored items. That has a good potential in the preservation of food and seeds in hot weather.

5.4.4. Kuthi Gola

It is an earthen pot where paddy and rice are stored to prevent damage during monsoon seasons. It is often constructed using bamboo, thatch, and mud, which are locally available. Materials.

5.4.5. Sutki Sobji

Due to salinity, in winter and summer, vegetable cultivation in salinity-affected areas is restricted. Only monsoon and post-monsoon are suitable for vegetable cultivation. The

vegetables that are cultivated in post-monsoon, people dry up and meet the demand for vegetables in winter and summer. This dried vegetable is locally known as Sutki Sobji like dried fish. These Sutki Sobji are also effective in recovering the demand for food and nutrition during cyclones and floods.

5.4.6. Auri

A traditional pot used for storing rice. This earthenware vessel is used in rural areas. Auris are typically made of clay and have many porous for keeping the rice dry and fresh. Its design often features a rounded belly that provides stability when placed on the ground.

5.5.7. Gola

Some indigenous groups have traditional granaries constructed on stilts. These structures help protect stored seeds, and rice from pests and floods, as well as provide ventilation to prevent mold.

5.5.8. Dole/Duli

Bamboo-made paddy stirring pot which is coated with soil with straws on top. It is also used to store seeds for a longer period.

5.5.9. Mite Harai/Beral

A container specifically for storing rice seeds. It refers to a traditional rural practice used at the household level in Bangladesh for preserving agricultural produce like rice and other grains. It preserves harvested crops from pests and spoilage. It is typically made from natural materials like bamboo and straw, that allow airflow to keep grains dry and safe from rodents and pests. Also helps in maintaining the quality of the harvest over time.

5.5.10. Dol

The "Dol" is a unique pot, shaped with a mold and coated in a mix of clay and straw. This versatile container serves two purposes. Soaking Rice: Before planting, rice seeds are soaked within the Dol to facilitate germination. Long-Term Seed Storage: Its construction allows the Dol to effectively store rice seeds for extended periods, maintaining their quality. An interesting practice involves placing the Dol-containing seeds in direct sunlight, potentially for further drying or disinfection.

5.5.11. Dharma Gola

Dhama Gola is a cylindrical container made of Bamboo in the coastal areas. It is made in the yard, i.e., outside of the house. Share is an independent small single-room house with a tin sheet roof. The Bamboo wall has two layers. The Dhama Gola is set on a platform usually made of wood. Dharma gola is the traditional food and seed storage on the west coast of Bangladesh. It is made of bamboo in a platform. The well is made of two layers. The two layers keep the Dhamra gola dry during the rainy season and cool in hot weather. The round shape helps dry food and seeds to survive on high wind. This a very good technology for the coastal areas.

5.5.12. Motka

Food is stored in clay pots or 'Motka', which are porous and allow for some air circulation while keeping out moisture and pests. Earthenware is also naturally cool, helping to keep food fresh.

5.5.13. Mati Khondi

This traditional method utilizes earthenware pots made from clay and baked in a kiln. The inherent properties of clay offer excellent insulation, keeping food warm or cool for extended periods. After cooking, the food is carefully transferred to the pre-heated earthen pot. The pot's mouth is then covered with a piece of cloth, followed by a tight-fitting lid, often made of dried leaves, straw, or even another clay pot inverted on top.

5.6. Soil health management

Traditionally farmers have adopted different soil health management technologies to reduce salinity and increase soil fertility along the coastal belt of Bangladesh. In the study area, the identified Indigenous farming technologies are:

5.6.1. Dhibi

Dhibi is a method to utilize mustard husk/ decrease salinity 'Khoil' to decrease salinity. If the ground dries up in the sun's heat to reveal white dust on top, it is a signal of excessive salt in the ground. Without lowering this salinity, cultivating or farming on this soil is not possible. This method has been adapted to tackle this salinity issue. After rice crops have been planted, the grass from the fields is piled up together. This pile is the 'Dhibi', which is kept on the field until the harvest season. After harvest, this pile is dried out and spread out on the soil. The mustard 'khoil' or husk is also spread out along with the dried grass. After drying, black dust can be observed on top of the soil, in place of white. This signals that salinity has somewhat been curbed. Agriculture and cultivation can now succeed here.

5.6.2. Vermicompost

Vermicompost, also known as worm castings or worm manure, is a nutrient-rich organic fertilizer produced through the process of vermicomposting. Vermicomposting involves using earthworms to break down organic materials, such as food scraps and yard waste, into fine, dark, and crumbly materials. The adoption of vermicomposting supports sustainable agriculture, reduces waste, and improves soil fertility, reduces soil salinity making it an essential practice for local farmers.

6. Scaling up of Potential Indigenous rice varieties for agricultural resilience

6.1. Salt-tolerant rice varieties

6.1.1. Talmugur

In coastal areas, this Talmugur rice variant is known to be a salt-tolerant crop. In the hot months of July-August, if there is about a foot and a half of water in the field, this crop can be planted. To start the process, a jute bag is stored with the seeds and kept in water for 24 hours. The next day, the wet bag is placed in a warm place for about 2 days. This step jumpstarts the seeds' growing processes. These seeds are then aired out for an hour in the open. Raised levels of the earth are pre-prepared in lines, and the seeds are planted by spreading them around. 20-25 days later, the shoots/seedlings are transferred to the fields and similarly planted there. These crops don't go bad in salinity-high soil and also suffer from diseases much less. Each bigha yields about 12-40 mon (1 mon = 40kg)

6.1.2. Nonakhochi

Because this rice variety grows in salty or 'Nona' water, it is called Nonakhochi. In the summer months of June and July, the seeds/seedlings are planted. Even in extremely salinity-high regions (6.58-7 ds/m), this crop can survive. Similar to the last crop, the seeds are kept in a jute sack and kept in water for a day. The next day the wet sack is removed from the water and kept in a warm place for two days after that. After that, the seeds are brought out and kept in water at room temperature for about 30 minutes so the seeds all separate from each other. The seeds are spread on seed bases (fertile soil layer) and transferred to the field after about 25 days once they have seedlings.

6.1.3. Patnai

In some coastal areas, the salinity is comparatively low (3-3.5 ds/m). Patnai paddy is an important crop there. This crop can be planted in the monsoon month (July 15- August 15). For germination, the seeds are placed in a jute bag in water for 24 hours. The bag/sack is then placed in a warm place for about 2 days. The seeds are then brought out and separated inside room temperature water for one hour. They are spread out on the seedbeds, and allowed to grow into seedlings. After 25 days, they are transplanted to the fields. Since this crop grows to be about 3 feet (0.9144 meters), the plants do not lean over easily. In each bigha, about 16-18 mounds (1 mound= 40kg) can be harvested.

6.1.4. Kute Patnai

In mild salt water (4.5-5.53 ds/m), these 'Kute' Patnai crops grow well without even much care. Due to being taller than 5 feet, they also survive being waterlogged. For germination, the seeds are kept in a jute sack and placed into water at 7 AM, and the water is then drained out at 7 PM, 12 hours later. The sack is then closed at the mouth and placed in a warm place for 24 hours. After that, the seeds are then dunked thrice into water and checked to see germination progress. If needed, they are kept in the sack for another day, and then again put in water for 2-3 hours. The water is then drained out, and the seeds spread out on the seed bed. About 20-25 days later, the seedlings are transferred to the field. In the field, compost or dung fertilizer is used.

6.1.5. Gobindobhog

After the cyclone, many areas became waterlogged with salt water. In these waterlogged areas, however, Gobindobhog rice paddy grows very well. Germination is done in a jute sack/bag, in which the seeds are kept and put in water for 24 hours. The next day the sack is kept in a warm place for about 2 days. These germinated seeds are then kept in room temperature water for 40 minutes where the seeds are allowed to separate. For this crop's seed bed, however, extra care needs to be taken. A 3 X 15 seedbed which is increasingly tall is needed, on which worm-fertilizer is spread out before planting. Each line of seed needs to be separated from the next one by 1 foot of space. About 25 days later, they are transferred to the field. Each bigha yields about 15-20 mounds (1 mound = 40kg).

6.1.6. Charulota

The farmer's efforts in crossbreeding have led to the innovation of this salt-tolerant variety of rice paddy. In July and August, this crop's plants can be planted even in 1.5-2 feet of water. For initial germination, the seeds are placed in a sack and kept in water in a warm place under shade for 18 hours. For two days after that, the wet sack is kept warm among other sacks. After this germination, the seeds are spread out in the open for a while. They are planted in a seedbed. They are transferred to the field after 25 days. This crop does not rot in salt water and is also resistant to pests. Each 'bigha' yields about 21 'mon's (1 mon= 40kg) of rice.

The feasibility study depicts a comparison with different high-yielding local salinity-tolerant rice varieties in terms of production which is depicted in **table** 4.

Table 4: Production comparison of some local salt-tolerant rice varieties

Variety	Type	Season	Height (cm)	Lifespan (days)	Characteristics	Yield (T/ha)
Patnai	High-yielding	Boro	100-120	140-150	Long slender grains, good for cooking	4-5
Kute Patnai	High-yielding	Boro	100-120	140-150	Short bold grains, good for making puffed rice	4-5
Rotna	High-yielding	Boro	100-120	140-150	Long slender grains, good for cooking	4-5

Charulata	High-yielding	Boro	100-120	140-150	Short bold grains, good for making puffed rice	4-5
Govindavog	High-yielding	Boro	100-120	140-150	Long slender grains, good for cooking	4-5
Nonakhochi	High-yielding	Boro	100-120	140-150	Short bold grains, good for making puffed rice	4-5
Talmugur	High-yielding	Boro	100-120	140-150	Long slender grains, good for cooking	4-5

Case story
Rotnai Dhan
An example of salinity-tolerant local variety

Faced with water scarcity in Teknarghat village, Ramzannagar union, Satkhira Farmer Mr. Rafiqul invented the drought-resistant Rotna paddy variety. This high-yielding (30 maunds/1119.72 kg per bigha or *14,400 sq ft* (1,337.8 sq m land) variant requires minimal water, making it ideal for the region. Though promising, Rafiqul seeks further research and verification of its consistent yield before wider distribution. He also cultivates and promotes ancient and traditional varieties like Khutepatna and Jamainadu paddy, known for their low fertilizer needs and decent yields (22 maunds per bigha). In 2024, Rafiqul planted 119 different paddy varieties within an 8x8 feet area for experiments. He practices sustainable pest control by creating his organic fertilizer using Mathfol, and to make resistance to paddy fungus he uses mixtures of Tute and Boiddo. Additionally, he observes the natural ecosystem within his farm, noting the role of birds like Kocha and Finge, in controlling insect populations. Raiqul learned an agricultural technique from Ispahani Company training from Jhenaidah, employing a raised central line in his fields (oriented north-south) to reduce water pressure on both the paddy and the fish he farms alongside. This technique has been successful in protecting his pond's water pressure. Initially questioned and facing skepticism, Rafiqul's successful implementation of these techniques has earned him praise and the name "Gher Jomi" (Homeland Farming) for his approach. Despite initial investment costs for pond digging, Rafiqul's integrated farming system generates significant profit from pond fish, trees surrounding the pond, and the paddy itself.

Case story
Charulata Paddy

: Farmer Mr. Dilip Tarafder, from Chandipur, Uttorpara, Syemnagar Pourashava, is the inventor of Charulata paddy, a unique crossbreed. This high-yielding variety (22 maunds per bigha in the Aman season) requires no chemical fertilizers, making it a sustainable option for farmers. He created Charulata 2007, using Khazitchori (tall, flood-resistant) and Khutepatnai (stronger, lower-yielding) as parent varieties. While Khazitchori and Khutepatnai struggled with strong winds, Charulata boasts robust stems, even surpassing hybrid paddy in this aspect. This medium-tall (130cm) variety also demonstrates moderate salt tolerance (up to 8ppt). Charulata takes five months to mature, offering harvest from the Bengali month of Shrabon to the start of Agrahayan. Recognizing its potential, he distributed Charulata seedlings to 37 farmers in Shyamnagar during the 2023 Aman season. Additionally, Dilip generously shared his invention with farmers across four upazilas, including Manikganj and Netrokona. Notably, feedback suggests that the hard stems even deter rats from attacking the crop. His efforts have earned him recognition, including the Upazila Independence Day Medal. He even shared Charulata seeds with farmers in seven countries, including China, Vietnam, and India, during a visit to Nepal. Dilip's dedication to sustainable agriculture extends beyond Charulata.

7. Scalin-up potential salt-tolerant vegetables

7.1. Gima

The ‘Gima’ (*Glinus oppositifolius*) is grown on roadsides, banks of ponds and streams, and also in the softer soil in vegetable gardens/fields. It is resistant to high salinity (6.38-7.5 ds/m) to a large extent. In areas that suffer from these issues, this can therefore satisfy a family's nutritional needs to some extent. The leaves are numerous and thickly spread, the leaves themselves being green and quite small. The plant is 31-40 cm in height, with the dimensions of the leaves being about 2.4 cm by 1 cm. The taste of the leaves themselves is bitter, while the flowers are white at the ends of their petals with white-green pigmentation at the bottom. The fruit looks somewhat like jira or cumin. Seeds develop around spring. People who suffer from nausea or lack of appetite can benefit by consuming the juice of these Gima leaves mixed with Amlaki-infused water. Liver health is also improved by having Gima. Furthermore, a paste can be made by boiling the leaves and blending them with onions, salt, and spice/chili to add flavor. This can be eaten with rice. It has been observed that Gima's consumption also aids with Jaundice recovery.

7.1.2. Kolui

In the moderate and high salinity-affected soils (above 6.38 ds/m),'Kolui' (*Pisum sativum*) can be grown. Along the aisles, these plants' vines grow well in the salinity-high soil (7-9ds/m). No extra care is needed for these plants, either. Later on, other plants/crops grow well in this same region where the 'Kolui' grew.

7.1.3. Torul

Due to the lack of enough space for agriculture in salinity-affected areas, in a small piece of land, Torul (*Luffa Aegyptiaca*) grows well. After heavy rain in the monsoon, the aisle is dug into, and the soil/earth is raised into a high 'mada' or linear seed base. Seeds are planted here, and dung fertilizer is used. Over the water of the shrimp farm and these bases, bamboo and cotton threads are used to make a net of sorts, and the vines grow up into this net and get support. In this mildly saline (2.2-3 ds/m) condition, these crops grow well.

8. Recommendation and Conclusion

The study was conducted through a farmer survey, key informant interviews, and field observation in three coastal upazilas (Shyamnagar from West coast, Banaripara from the coast, and Hatiya from East Coast). Due to time constraints, it was not possible to capture all the indigenous knowledge and practices from the coastal belt of Bangladesh. To develop a holistic scenario and feasible eco-friendly and economically beneficial climate resilient potential indigenous knowledge and practice, an integrated study should be conducted in different climate hotspots including coastal districts, Barind Trach, Haor, flood plains, and Chittagong Hill Tracts (CHT). This study will help to explore the highly potential climate adaptive indigenous practices in different agro-ecological zones and micro-ecosystems.

The study finds that some traditional rice varieties and vegetable varieties are salt-tolerant and farmers are practicing to revive the salt-degraded soils and ensure food security. There are also adaptive farming technologies, water conservation, and irrigation technologies, and food and see preservation technologies that are popular among farmers to adapt to climatic stress and salinity. However, there are some limitations of the Indigenous technologies and varieties to ensure effective and sustainable solutions for climate adaptation.

The following recommended actions have been formulated based on data collection and documentation.

1. A more detailed countrywide study is necessary. Since the practices of the application of Indigenous knowledge are reduced detailed documentation is a must for the protection of the knowledge;
2. Action required for knowledge management, i.e., promotion of the Indigenous knowledge through action research, field demonstration, and capacity building of farmers by the involvement of the Department of Agriculture Extension, Soil Resource Development Institute;
3. Scientific explanation and necessary empirical study and action research of existing Indigenous practices should be done to find cost-benefit and climate adaptive co-benefits in climate resilient agriculture, food security, water security, etc.
4. Any attempt towards adaptation action on livelihood and agricultural promotion must incorporate location-specific Indigenous practices along with scientific practices to scale up ecological benefits;

5. Necessary advocacy is required to consider the potential of indigenous knowledge in policy documents including strategy planning and action plans.
6. Community perspective should be further included in the studies through community-led adaptation plots in different agro-ecological zones and salinity levels.

During the study, it was found that many of the individuals in the community were interested in adopting these indigenous practices however due to lack of finances and lack of awareness; knowledge, and capacity they are not able to adopt indigenous practices and local varieties.

Since efforts are made to rebuild community resources, people are turning back to their own indigenous knowledge and local lore to determine which options would provide the greatest outcome. Due to the constant threat of natural catastrophes, the local community has acquired various traditional knowledge and customs through the decades. In where modern varieties and technologies fail to adapt to climate change, traditional knowledge, practice, and wisdom are working well. Locally-led adaptation keeps the local people at the heart of any decisions by valuing their local and ancestral knowledge. Local communities' lived realities and intergenerational wisdom are effective in resolving issues of the triple crisis – climate change, poverty, and nature. In pursuing locally led adaptation, local actors' leadership, inclusivity, and agency are crucial and need to be actively supported at several stages of an intervention's design and implementation. Additionally, scientific knowledge needs to be incorporated into the selected IKS to replicate and scale up in similar ecosystems and climate-vulnerable areas of Bangladesh and globally to ensure climate justice and food security.

Scaling-up activities

A limited number of farmers are practicing indigenous technologies and crop varieties due to a lack of knowledge and capacity. The practices are also limited with a small number of farmers in different agroecological zones. There is also a lack of access to crop varieties. Most of the farmers in Bangladesh depend on the market for access to seed. To scale up the technologies, and varieties, there need to replicate these technologies with other farmers in another agroecological zona with similar contexts of the ecosystems. Plot-to-plot piloting, capacity building, community-based seed bank establishment, and involvement with business actors for seed availability are important. Need to invest in systematic and scientific studies on IK, adaptation, and mitigation of climate change in the local context. There also needs to encourage the selection and use of indigenous varieties and seedlings that produce high-yielding and high market demand, suitable for the land conditions, and farming techniques of local people, and adapt to climate change. Farmers don't have access to climate information, soil health, and fertilizer recommendation services. There is also a need to establish an information service center to provide location-specific real-time climate information, soil health, and fertilizer recommendation services. There is no specific policy to promote indigenous knowledge and practices, local varieties. Policy advocacy with government agencies will help promote IK. The policies should encourage the use of indigenous varieties and techniques along with advanced science and technology to generate sustainable development and conservation of genetic resources and knowledge to use for modern scientific studies. There is no funding support for systemic scientific knowledge, conservation of local varieties, and genetic resources in Bangladesh. There are no clear financial mechanisms nationally and internationally in place to support the development of IK-based livelihoods adapted to climate change.

Table 5: Scaling up activities and responsibilities

Scaling up activities	Sub-activities	Responsible partner/organization
Knowledge and capacity building on Indigenous knowledge	Training module development on capacity building	Vrije University of Amsterdam, and Center for People and Environ
	Training and workshop for farmers	Vrije University of Amsterdam, and Center for People and Environ
	Awareness and capacity building meeting-	Center for People and Environ, and Farmer Voice
	IEC materials development, and distribution	Vrije University of Amsterdam, and Center for People and Environ
Piloting on Indigenous knowledge and practices	Piloting design	Vrije University of Amsterdam, and Center for People and Environ
	Piloting execution, monitoring, and evaluation	Center for People and Environ, and Farmer Voice
	Piloting data analysis	Vrije University of Amsterdam, and Center for People and Environ
Community-based seed bank establishment	Seed bank designing, and variety selection	Vrije University of Amsterdam, and Center for People and Environ
	Seed bank establishment, management, and monitoring	Center for People and Environ, and Farmer Voice
Soil health assessment	Salinity, physical, and chemical properties assessment	Vrije University of Amsterdam, and Center for People and Environ
Fertilizer recommendation	Fertilizer dose recommendation	Vrije University of Amsterdam, and Center for People and Environ
	Application of recommended fertilizer dose, monitoring	Center for People and Environ, and Farmer Voice
Climate information service	Establishment of a climate information service center	Vrije University of Amsterdam, and Center for People and Environ
	Climate information generation	Vrije University of Amsterdam, and Center for People and Environ
	Dissemination of real-time climate information	Center for People and Environ, and Farmer Voice
Linkage development with business actors	Workshop with market actors	Vrije University of Amsterdam, and Center for People and Environ
Policy Advocacy	Development of policy framework	Vrije University of Amsterdam, Center for People and Environ, and Farmer Voice
	Policy dialogue with policymakers	Vrije University of Amsterdam, and Center for People and Environ
Securing	Searching funds, proposal	Vrije University of Amsterdam, and

funding	development	Center for People and Environ, NFP, and NWP

There need to develop a linkage with international donors (Green Climate Fund, KfW, Asian Development Bank, World Bank, IFAD, FAO, BMZ, Netherland Embassy, Sweden Embassy, IDRC, FCDO, Efficient Fertilizer Consortium, USAID, etc.) for scaling up and replicating community-innovated and practiced IK and local varieties. As a whole, at the farmer level, need to raise awareness about climate change and community-based adaptation using IK, traditional agricultural practices, and local crop varieties.

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