Investigation of a Farming System Through the Indigenous Knowledge in Wetland Agriculture Sector in Patuakhali District, Bangladesh.

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Abstract: The coastal people of Bangladesh have been living with natural disasters from time immemorial and have developed their own coping strategies in facing the challenges of the natural calamities. Indigenous knowledge is unique traditional knowledge existing within and developed around the specific conditions of women and men indigenous to a particular geographic area. Indigenous knowledge of the local community practiced over time enabled them to withstand nature. This research examined to identify and reveal the practiced indigenous knowledge that are used as adaptive strategies in the wetland agricultural sector in Patuakhali district. The farmers of this region used indigenous and traditional knowledge for agricultural farming and that also increased rice production. The integrated fish technique is practiced in the small potential area of Patuakhali district. Three types of field designs are common digging ponds within the areas of rice field, ponds or swamp adjacent to the rice field, and deep water rice field. The fishing gear is also used in the study area that depends on the flood condition, target species, and fish size for fish production. The rural people create floating gardens using water hyacinth to grow seedlings. They also grow bulbous plants to increase soil fertility and protect against wave erosion. The cultivation of Baira promotes the development of a local hydroponic technique that helps to preserve indigenous knowledge. The people of the study area use Baira residue as an organic fertilizer for the winter crops. From the study we recommend some observations to cultivate such as; Variety Relay *Kheshari* or *cowpea* (*BARI Felon 1*), Fallow *T. Aman (BR 11, 23, 40* and *47), Boro* for salt tolerance and short duration, *T. Aman* for higher seedling heights and flooding tolerance for sustainable agricultural production even in the event of climate change. This paper emphasis on the local knowledge in the management of natural resources, biodiversity conservation, climate change adaptations, etc. The study also explores the local indigenous climate change adaptation strategies for the purposes of conservation, sustainability and reduction of vulnerability due to climate change in the wetland agriculture of southern coastal areas of Bangladesh.

Keywords: Indigenous knowledge, adaptation, disaster, agriculture, integrated farming.

Introduction

Agriculture, Bangladesh's main source of revenue, is highly reliant on the weather. And the globe's climatic condition is changing dramatically, with ramifications for agriculture, public health, as well as all forms of living plants and animals. Because of its geographic area, Bangladesh is one of the examples of highly vulnerable countries to the effects of climate change. Bangladesh's ability to feed its massive population and maintain economic growth is jeopardised by the impact of climate alteration on agriculture. Climate change is having a significant impact on global agricultural production.

In case of crop production, developing economies, particularly those in the tropics and subtropical zones, are supposed to lose ground (Howlader and Akanda, 2016). Indigenous knowledge is ideas, beliefs, values, norms, and rituals that are also the exclusive native for a

selected culture or society and more valuable resource that gives information to people on how communities have interacted with their dynamic surroundings (Michael, et al., 1995) (Akullo et al., 2007). Traditional societies rely on nature for their survival, and instead of attempting to alter it, they live a life based on indigenous, traditional, or local knowledge that is specific to a provided society or culture.

Before science, scientific knowledge, and technologies, they used it to practise local coping mechanisms. Indigenous knowledge has been considered as a vital tool for securing sustainable development via balanced resource management since the last century (Chowdhury, 2019). The study was conducted to understand the important state of affairs of the farmer, to adapt and mitigate the adverse result of climate change. The wetlands in Asian countries have nice ecological, economic, business, and socio-economic importance. Land is helpful for groundwater recharge, spring water discharge, storage of flood-water, bound stabilisation and reduction of erosion, sediment trapping.

It's conjointly used for the nutrient retention/removal support for food chains, fisheries production, and surround for wildlife, recreation, natural heritage values, biomass production, water transport, bio-diversity presentation, and micro-climate stabilization (Islam and Gnauck, 2009). It contains rich parts of the variety of local, national, and regional significance (Kundzewicz, 2003). In addition, it supports the biodiversity of *flora* and *fauna*, conducive considerably to the socio-economic lifetime of uncountable rural individuals in Bangladesh, providing opportunities for use, food and nutrition, fuel, forage, and irrigation (Nishat, 1993).

Among the calculable 5,000 species of flowering plants and 1,500 vertebrates within the country, up to three hundred plant species and a few four hundred vertebrate species are judged to be passionate about wetlands for all or a part of their life (Abbas, 2010). Land conjointly surrounded the spread of resident and migratory waterfowl, a major variety of species of international interest, and an oversized number of commercially necessary ones. The landlocked capture piscary is predicated on the huge fresh resources with some 260 species of fin fishes and twenty five shell fish (Abbas, 2010).

Wetlands conjointly support a major variety of activities that resembles that extraction of reed, harvest of edible aquatic vegetation and their products, healthful herbs, shell (Khan, 1993). Asian country wetlands also play a crucial role for overflow management and storm surge protection. They also support fisheries, life, and forest resources. Wetlands are distinctive for their rich variety and cultural heritage. It's the mix of these functions, yields, and values that makes wetlands so important for society (Abbas, 2010). Wetlands are an integral part of the native system based on cultures regarding which 1/2 country of the world is considered as a wetlands.

This accommodates a wide selection of sorts starting from lakes, rivers, and coastal forest to deep paddy fields and ponds of these wetlands, a novel mosaic of habitats with extraordinarily wealthy diversity of flora and fauna, abundant of it yet biologically undiscovered. The wetland also supports numerous individuals by different activities such as fishing, to collect honey and materials for thatching, and fuel wood (Khan, 1993; Nishat, 1993). The particular objectives are to identify the practices of farmers on global climate change and adaptation, to explore the present agricultural state of affairs and order the issues and opportunities of the existing farming practice, and to suggest recommendations on how to extend agricultural production through indigenous knowledge in Agriculture in the southern coastal region.

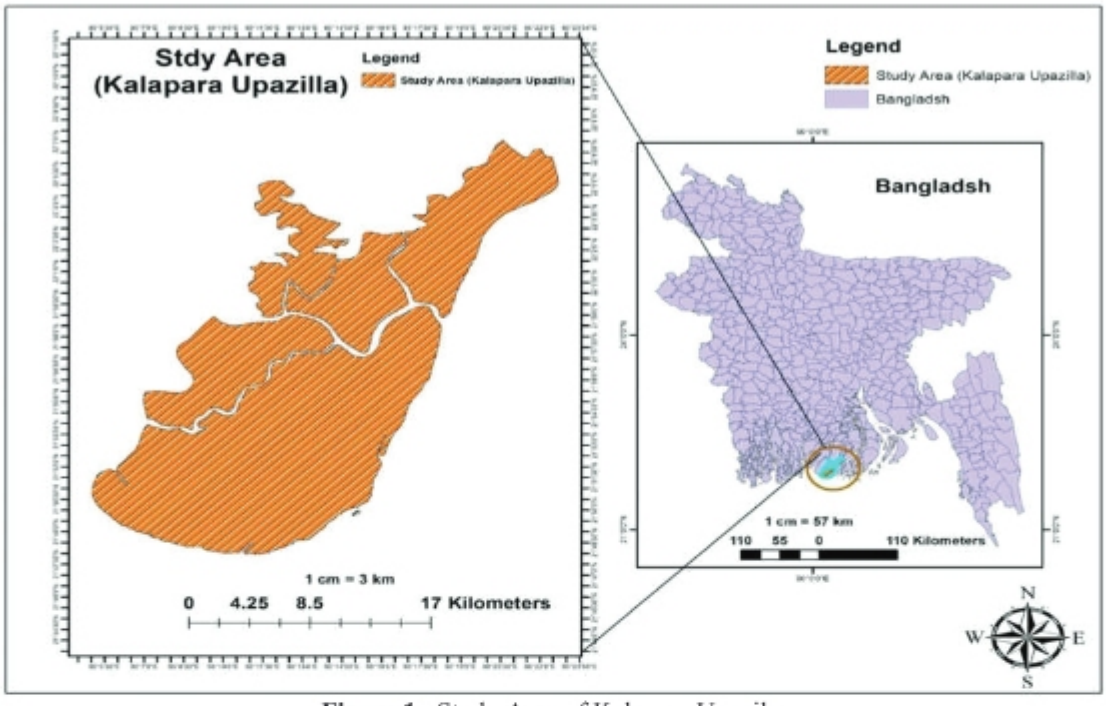

Figure 1. Study Area of Kalapara Upazila.

Materials and Methods

The study was carried out in the villages of Badurtoli and Gamaritala in Kalapara Upazilla in the Patuakhali district. The information gathered about the agricultural production system, physical profile, options for adaptation to climate change, the social dimension, the resources available and their use, the gender segregation, the limitations and potential for production and priority was meticulously documented, modified, organized, and summarised. This research was conducted from January to May of 2018. For the primary data collection different participatory tools like direct site observation, in depth household surveys, face to face interviews, focus group discussions (FGD), key informant interviews (KII) were followed for this research. Secondary data were collected from various secondary sources. Total 5 focus group discussions were held. Necessary details from mainstream press including journal articles, scientific thesis, recorded data, and research from multiple local governmental offices, and additional secondary data were collected from OFRD, Patuakhali, DAE for the study. The collared data were interpreted and correlated with the previous study.

Table1. PRA (Participatory Rural Assessment) activities in Badurtoli and Gamaritala, Kalapara.

Date (2018)	Activities	Output	Tools
14 Aug.	Brief discussion with affected community among conducting personnel	To primarily and mainly prepare disaster management in Agriculture by Indigenous Knowledge. Date of final preparation	Briefing Discussion
15-16 Aug.	Prepared checklist of information, base map, review secondary and other materials needed	General information Livestock & fisheries information Institutional participation	FGD
	Reconnaissance for transect	Maps Agro-ecosystem Transect Generation information about biophysical, socioeconomic characteristics Way of resource utilisation knowledge	Observation
	KII	Validation of map Identification of problems Agricultural practices SWOT analysis Labour flow analysis Income and expenditure analysis	Interview Discussion Brown paper Stones Marker pen
	Validation of preliminary results to selected farmers	Comments from farmers about problem-cause analysis and preference matrix to agricultural development	Presentation & discussion
17 Aug.	Final presentation to the community	Proposed action plan Feedback from farmers	Presentation & discussion

Results and Discussion

The indigenous knowledge system in the agriculture and fish sector is used for management of the natural resources. Akullo et al.,(2007) revealed about indigenous knowledge of the crop and livestock production sector that is enclosed with our study. Wetlands are one of the most productive and resourceful areas that provide food and aquatic non-food resources and maintain ecological balance for the residents of Patuakhali. Due to the availability of a large number of harvestable products, people in wetlands are traditionally self-sufficient and have a subsistence-oriented economy and livelihood. Rice cultivation is a significant action of the floodplains of Patuakhali district. During the dry season, domestic cattle can graze on swamps and lawns. Recently, wetlands have been also used as duckery. The adaptation process of livelihoods is often sustained by traditional and indigenous knowledge systems. To cope with climate change impacts the indigenous knowledge is being utilised for sustainable adaptation (Chowdhury et al., 2021). Modern research and expansion is also used for adaptation. Flooded wetlands are covered with plants that can resist waterlogging and flooding. Before the introduction of mechanised dry-season irrigation in the 1960s, deep water rice or Aman round rice was the main crop in wetlands in the rainy seasons. This crop was mixed with short-lived

out-of-rice that harvested in June, allowing Broadcast Aman to grow through November. Due to the irrigation, boro rice of the high-yield variety (HYV) has changed. Preference to the transmission of Aman and Aus. Changing rainfall patterns cause significant damage to these crops. Fruits such as papaya, banana, pineapple, guava, and various vegetables such as sweet potatoes, yams, and taro are grown in the household areas. In the last few decades, wetlands have been used for HYV boro rice cultivation during the dry season in the Patuakhali District. The owner is involved in growing plants in the different seasons of the year.

Indigenous Knowledge of Water Resources Management and Conservation

Irrigated agricultural production

Irrigation has been practiced in some parts of the world for several thousand years. In Bangladesh, the irrigation system is important for the production of rice. There are three indigenous practices used by the peoples of the area to extract water for irrigation. The Seuni or Swing Basket is a system that is operated by two to four people which is balanced with ropes in its four corners. It allows the water to be raised about five metres, each time about nine litres, which is about eight equivalent to cubic metres. The Lata or Dhenkli are used to extract water from shallow wells. They work through a bamboo stick that acts on a pivot point at the end that is tied with another smaller bamboo. A tin is fitted at the bottom. The larger bamboo has a lower weight in the end so that it can dip into the water when it is lifted and released. The technology is similar to the Shadoof that is used in the Middle East. Dhenklis system can raise water to five metres. Traditional knowledge about irrigation is used to adapt the water scarcity to face the climate change((Mutambara et al., 2016) but this research explains irrigation systems used for agricultural production.

Indigenous knowledge for integrated fish farming

Lightfoot et al. (1992) provide an overview of existing and potential integrated fishing areas and characteristics of the rice fish system in various Asian countries including Bangladesh. Small and large irrigation reservoirs, the irrigated fields themselves, as well as adjacent ponds are all potential sites for grow-out of fish (Fernando, 2000). Similarly the integrated fish technique is practiced in the small potential areas of Patuakhali district. Three types of field designs are common: digging a pond within the rice field area, ponds or swamp adjacent to the rice field area, and deep water rice field . Integrated fish farming can expect the increasing production of rice to be 10 to 20 percent. (Saiful Islam et al., 2015) give explanation about rice-fish farming in the northern part of Bangladesh has been adopted by relatively few farmers but this study identifies many farmers of southern part of Bangladesh use this technique.

Figure 2. (a) Raised homestead in coastal tidal flow due to survival from high tide in Lalua, Kalapara, (b) Fish fingerling distribution by the NGO in the affected area in SIDR and Aila.

Indigenous fishing technologies

People use various types of fishing equipment including hands, spears, traps, and nets. Some adapted technologies are originally provided by fishing projects that began in the 1980s. The study found that about 51 fishing mechanisms were used during the survey period. Depending on the flood conditions, the target species, and the size of the fish the adapted appliance can be changed.

Indigenous knowledge of farmers

Over the years, farmers of the coastal floodplains in Patuakhali have found various ways to improve the cultivation techniques to adapt their situation. (Rekha Nianthi & Dharmasena, 2009) Demonstrated local indigenous knowledge for management of natural resources where this study reveals indigenous practices for climate change adaptations. Two indigenous techniques are used by farmers in coastal tidal floodplains. Farmers in various floodplains areas have adopted the practice of creating floating gardens of water hyacinths for growing seedlings. They also grew nodular plants to increase soil fertility and protect against wave erosion. The water hyacinth floating garden, locally called baira, is an ancient practice used in some parts of Patuakhali district. Farmers also cultivate vegetables on the tin roof top of their house to avoid effects of floodwater and water logging impacts on vegetables. They also plant vegetables on nets that are placed over the pond.

Figure 3. Vegetables on nets that are placed over the pond at Kalapara Upazila.

Indigenous practices for salinity intrusion

In the study area local people remove the upper layer of soil crust that is affected by salinity that is also consequent with the exploration (Shammi et al., 2020) that concludes the adaptation measures of salinity intrusion of farmland is levelling of land for planting crops. Furthermore, they have taken the initiative to cultivate kewra, which can be grown well in saline soil. It is now considered a cash crop for its fruit, and its wood can be used to make furniture or as fuel. They also cultivate golpata (a tree variety) which can grow in saline soil. Nowadays, golpata is also considered as crop for its molasses that is produced from golpata trees. They also cultivate vegetables on their homestead in plastic pipes, bags or bottles, which they can move or lift up to avoid salinity intrusion into the soil.

Doincha cultivation

The doincha *(Sesbania sp.),* also called Shola, belongs to the *leguminose* family and plays an important role in increasing soil fertility. In the nodules of the roots of this plant, nitrogen is fixed by bacterial action. Most of the farmers at the project site grow these plants together with rice and vegetables. Besides increasing soil fertility, it controls soil erosion against waves, is used as a shed for pumpkins, gourds, etc, and can also be used as fuel. The rotten leaves of this plant are also sometimes used as compost (Figure 4).

Figure 4. Doincha/Shola cultivation practiced in Patuakhali district.
Figure 5. Photographs of Baira Farming in Kalapara and Golachipa Upazilla in Patuakhali.

Prospects of Baira farming extensions in Bangladesh

The cultivation of baira is a useful technique to be widely practiced in the floodplains of Bangladesh. This technique is easier to promote because it has been practiced in the country for a long time, albeit to a limited extent. Expertise is needed in the floodplains area to influence people to cultivate baira. Some benefits associated with the practice of baira are listed below.

Socio-economic benefits

Baira platform cultivation facilitates jobs in floodplain areas in the rainy season. It indirectly helps to produce food that fulfils the deficit of nutrition of local communities. Baira cultivation promotes the expansion of local hydroponic technology to preserve the indigenous knowledge.

Farm benefits

The Baira platforms provide additional space for growing and planting seedlings in the floodplains, especially during the rainy season. The main nutrients of plants, namely nitrogen, potassium, and phosphorus, are available in the water hyacinth. A comparative study of water hyacinths and cow dung has shown more or less similar concentrations of these elements (Nasima et al., 1997). Baira significantly reduces fertilizer costs. It can be said that the baira improves organic farming to grow rabi crops.

Ecological benefit

Since Baira residues could be used as organic fertilizer for winter crops, this practice reduces contamination from chemical fertilizer and environmental pollution. Baira has a good use for an invasive species like the water hyacinth. This is a very effective way to control these notorious weeds.

Table 2. Existing and proposed cropping pattern in study area.

Existing cropping Pattern:	**Proposed improved cropping pattern:**
• Fallow-Fallow- *T. aman* (40 % HYV/60 %local) • *Kheshari /cowpea*-fallow- *T. aman* • Fallow-*B. aus- T. aman* (40 % HYV/60 %local) • *Kheshari/cowpea-B. aus- T. aman* • Vegetables-Fallow/seed bed-*T. aman* (local/HYV)	• Relay *Kheshari* (local)/ *Cowpea (BARI felon 1)-fallow- T. Aman (BR 11, 23, 40 and 47) + PVS* T_2, T_5 (5 lines) from IRRI (Dr. Glen will provide the materials) • Relay *Kheshari (local)/ Cowpea (BARI felon 1)– B. Aus (BR 27* and PVS short duration)-*T. aman (BR 11, 23, 40 and 47)* • Vegetables (winter)-Vegetable(summer)/seed bed – *T. aman (BR 33, BINA 4* and *7*)

Note: : (Vegetables-Fallow/seed bed-*T. Aman* (local/HYV) Participatory variety could be selected as; Boro for salinity tolerance and short duration and *T. Aman* for higher seedling height and submergence tolerance produced in this region.)

The existing cropping pattern of the study is Fallow-Fallow- *T. aman* (40 % HYV/60 %local), *Kheshari /cowpea*-fallow- *T. aman*, Fallow-*B. aus- T. aman* (40 % HYV/60 %local) and *Kheshari/cowpea-B. aus- T. aman* Vegetables-Fallow/seed bed-*T. aman* (local/HYV) Participatory variety could be selected as; Boro for salinity tolerance and short duration and *T. Aman* for higher seedling height and submergence tolerance produce in this region. (Nasim et al., 2018) Provide explanations about cropping patterns for increasing productivity of crops that do not conclude the indigenous cropping pattern for production increasing where this study explains the indigenous adaptations practices of cropping pattern for crop production.

Table 3. Proposed adaptive trial for fallow land utilization in the study area.

Fallow land utilisation (Adaptive trial)	Other Adaptive trials
Mustard (*BARI sharisa 9, 11* and *14)*	Homestead vegetables-training (informal), development of ownership, nurseryman/seed businessman
Wheat (BARI variety, based on previous trial knowledge)	Year round vegetables production and quick growing fruit trees in the homestead
Maize (BARI hybrid and others commercial hybrid)	Backyard fisheries- Training (informal) on pond and feeding management, population density, fingerling nurseryman/ businessman, introduction of GIFT, Prawn and Rajputi, introduction of pellet machine (handmade).
Mungbean (BARI Mungbean 6 and *BM 01)*	Improvement of livestock systems- introduction of fodder (Napier, German), training on feeding and disease management, Vaccination on duck plague, *FMD* and *Ranikhet,* deworming, development of technician (LSP), Development of indigenous chicken through exotic breeding.
Sesame (BARI till 3 and *4)*	Monitoring of soil and water salinity
Chilli (*BARI 1* and Local)	
Water melon (hybrid)	
Sweet potato (BARI mistialu 7 and *8)*	
Sweet gourd (BARI 1 and *local*	

This table express the fallow land utilisation adaptive yield that is used in the area and those are Mustard (*BARI sharisa 9, 11* and *14),Wheat (BARI* variety, based on previous trial knowledge),*Maize (BARI hybrid* and others commercial hybrid), *Mungbean (BARI Mungbean* 6 and *BM 01),Sesame (BARI till 3* and *4), Chilli (BARI 1* and *Local*),Water melon (hybrid),*Sweet potato (BARI Mistialu* 7 and *8),Sweet gourd (BARI 1* and *local*). It also evolve other adaptive trials that can produce in the fallow land. The salinity problem could be managed by pyramid cropping in rice fields with country, yard long bean, bottle gourd, cucumber, and raised bed with straw mulching. On Farm water conservation through judicious use of natural lake water following digging drain/rubber pipe for rice vegetables can also be used.

Conclusions

Bangladesh is dependent on agriculture due to its geographical location, flat and low topography, high population density, and poverty rate of the population. With regard to local people, indigenous knowledge practices for adaptations are very important considering both management and coping issues of climatic variability. The indigenous knowledge used in agriculture increases the crop yield per unit area and *dhoincha* replenishes the soil fertility. The integrated fish technique is practiced in the small potential area and also increases

the production of the rice. Integrated fish farming as well as integrated sustainable farming system resulting would be optimum utilisation of resources, provide nutrition, enhancement of rice production, food security and increment in the income of the farmers. The indigenous integrated fish farming is adaptive techniques that can alleviate poverty, food and nutrition insecurity in this area. The water hyacinth floating garden, locally called *baira,* is an ancient practice and was used in some parts of Patuakhali district. (*Sesbania sp.*), also known as Shola, fixed nitrogen by bacterial action in the roots that increased the soil fertility. From the study it can be recommend some observations such as; Variety Relay *Kheshari* (local) / *Cowpea (BARI Felon 1) Brache T. Aman (BR 11, 23, 40*, and *47), boro* for salt tolerance and short shelf life, T. Aman for higher seedling height and tolerance to immersion. The expansion of a local hydroponics technique helps to preserve indigenous knowledge. The Baira platforms provide additional space for growing and planting seedlings in the floodplains, especially during the rainy season when arable land is scarce. By providing knowledge about the environmental and economical importance's of indigenous practices can enhance the adaptive capacity of the community to disaster. Indigenous knowledge and scientific seasonal forecast integration can be a key possible way to reduce vulnerability, enhance resilience of rural farmers and increase their adaptive capacity of Patuakhali region. Effective indigenous adaptive strategies would reduce the adverse effects of climate change on agriculture and the environment particularly in the coastal areas.

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