

Understanding the Role of Traditional Agricultural Knowledge in a Changing World Climate: The Case of Bandarban Region

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Abstract

The study demonstrates the indigenous farming techniques, which crops they are cultivating, the impact of a changing climate on their farming system, and how they manage their cope-up strategy with the changing climate by using traditional knowledge they have used for years. This study tries to address the relevance of indigenous knowledge systems to enhance the resilience of the agriculture system to combat climate change. Primary data were collected through semi-structured interviews, key informants' interviews, and focus group discussions. A systematic random sampling technique was used to collect data from 50 respondents (representing 15% of the community). A semi-structured questionnaire was prepared for the primary data collection process. A qualitative data analysis method was applied to evaluate the findings of this research. The result of this research indicates that by prioritizing indigenous agricultural practices in study areas, local communities are getting a chance to offer their cultivation systems in a more climate-smart way. In coping with the adverse effects of climate change like heavy rain, drought, and excessive winter, the ethnic agrarian community has been managing an effective sustainable agriculture system, which gives us the direction to implement this kind of traditional knowledge all over the countryside for a resilient agrarian society. Hence, the study recommends paying more attention to developing and encouraging the effectiveness of the current practices and adjusting the "where", "when", and "how" to apply the recommended practices and avoid the unsuitable ones by following the enhanced resilience of local agrarian people.

Keywords: Indigenous Agricultural Knowledge, Resilient Agrarian Society, Climate Smart Agriculture, Sustainable Agriculture

Introduction

The Chittagong hill tracts make up one-tenth of the total area of Bangladesh. Chittagong hill tracts consist of three districts: Rangamati, Khagrachari, and Bandarban. The total area of these three districts is 13,295 square kilometers. (Banglapedia, 2021), and the total population of this region is about 16, 50,159 (The Business Post, 2022). The inhabitants of small ethnic groups and ethnicities include Chakma, Marma, Tripura, Tanchangya, Mro, Lusai, Bom, Pangkho, Khumi, Chak, Kheang, etc. These small ethnic groups have their own language, culture, religion, tradition, customary laws, and diversified culture. Basically, their livelihood is run through their traditional approaches. They have a strong connection with their natural environment, which helps their community find a nature-based solution. At present, the impact of climate change caused by global warming and other factors is equally noticeable in their way of life and also in their occupation. The main occupation of these ethnic communities is agriculture, and for centuries they have been leading their livelihoods by practicing indigenous adaptive strategies in the adverse effects of climate change and natural disasters on the slopes of the hills. As they have been practicing many traditional practices related to agriculture over the years, their knowledge has a significant role in climate-resilient agriculture. As part of our ongoing research in this area, this study tried to analyze the traditional agricultural knowledge of the selected ethnic communities in and around Naikhongchhari Upazila of Bandarban district. The purpose of this study is to determine the effectiveness of traditional knowledge-based agricultural practices that are coping with climate change and offer them a nature-based solution.

Research Objectives

The study was conducted with the following aims and objectives in mind-

The broad objective of this study was to address the relevance of indigenous knowledge systems to enhance the resilience in the agriculture system to combat climate change.

- To identify the existing indigenous knowledge system on agriculture
- To assess the impact of Climate change in Hill areas
- To explore the potentiality of indigenous agricultural practices for the betterment of the landscape and for preserving crop variants.
- To find out a nature-friendly solution for sustainable, climate-resilient agriculture.

Research Methodology

This study aims to examine the indigenous people's traditional knowledge techniques and their relevance in combating the changing climate. To address the aim of this study, a qualitative approach was employed. This study was conducted in Lamar para, Head man para, and Bebsayi para Chakdalla under Shonaycchari villages in Naikkhongcchari Upazila of Bandarban district.

The sample size of this study was about 50 people, who are mainly farmers, and the sample was selected by the systematic random sampling method among the population. Data sources were both primary and secondary. Focus groups, KII, and interview methods were used to gather primary data. Secondary data was also reviewed that was gathered from earlier research, books, journals, reports, and local newspaper stories. Following the completion of an open-ended, semi-structured questionnaire, two FGDs with the villagers were held. The FGDs covered the main subjects of the study, such as indigenous knowledge of agricultural practices. Each focus group had between 8 and 10 participants. Both men and women who were members of FGD were primarily farmers. When forming groups, some fundamental principles were followed, including homogeneity, age, education, and gender. In addition, a key informant interview (KII) was also conducted with local authorities, such as members of the local government and non-profit organizations, imams, teachers, village chiefs, volunteers, and others.

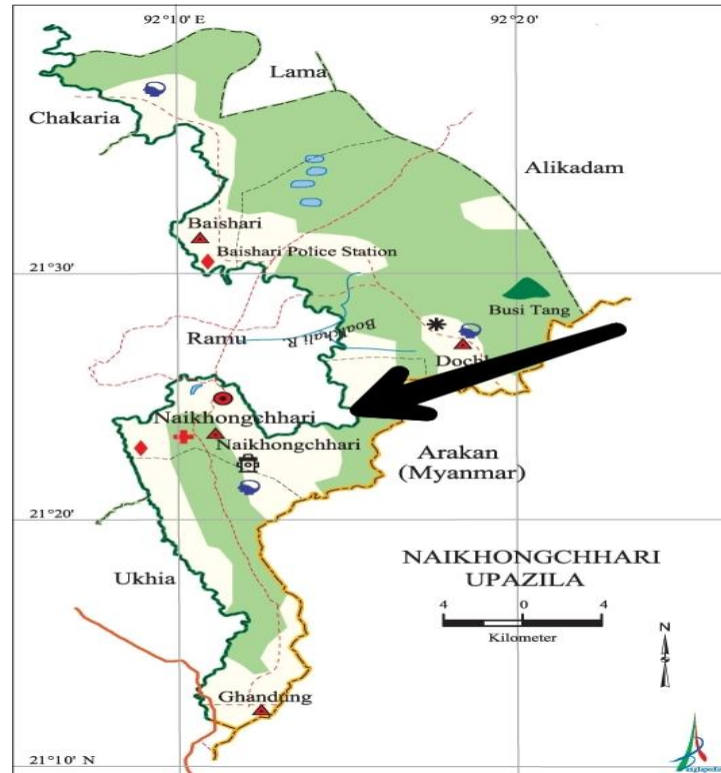
In addition, field observations were used to gain an in-depth understanding of the physical settings and everyday practices of village life. Following the content analysis approach, the team contextualized the content of interviews and discussions of indigenous agricultural knowledge, interpreting that information into narratives. Qualitative data were analyzed by coding the interview texts with initial concepts, grouping data to identify key themes, and finally analyzing the interview and focus group discussion findings related to each theme to draw out key findings. Hence, some other data collection tools are also used, such as Google Forms for questionnaires and the Learning Space Toolkit for FGD. Microsoft Excel was used as a data analysis tool to sort and analyze the collected data.

Study Area:

This study conducted in Naikhongcchari Upazila of Bandarban District. Naikhongchhari is located at 21.4167°N 92.1833°E. It has 6,882 households and a total area of 463.61 Km² with the population of 38350 people. The reason for choosing this place for research is the geographical location of the area and the hill agriculture of the various indigenous people living

here. This place has been selected to assess the effectiveness of their use of traditional knowledge in agriculture.

Figure 1: Map of Naikhongchhari Upazila



Research Findings and Discussion

Socio-demographic Information of the Respondent

This section illustrates the socio-economic status of the respondents. About 72% of the respondents belonged to the 25–40 age group, and only 6% of them are over 61 years old. A large number of respondents are male (94% out of 100), and 86% of them are married.

Table 1: Socio-demographic information of the respondents

Demographic Variables	Category	Frequency (N=50)	Percentage (%)
Age	25-40 years	36	72
	41-60 years	11	22
	61+ years	3	6
Gender	Male	47	94
	Female	3	6
Marital Status	Married	43	86
	Single	7	14
Ethnicity	Chakma	2	4

Demographic Variables	Category	Frequency (N=50)	Percentage (%)
	Marma	45	90
	Others	3	6
Education Level	No Institutional Education	33	66
	Up to Primary	12	24
	Secondary to Higher Secondary	5	10
	Graduated	0	0
Occupation	Farmer	43	86
	Laborer	6	12
	Jobs & others	1	2
Household Income (Per month)	Less than 10,000 BDT	13	26
	10,001-20,000 BDT	29	58
	More than 20,000 BDT	8	16
Land Ownership	Landless	5	10
	Small Farmer(less than 2 acres)	26	52
	Meddle class Farmer (2-5 acres)	15	30
	Large-level Farmer (more than 5 acres)	4	8
Access to Resources	Access to water	23	46
	Access to seeds	45	90
	Access to fertilizer	38	76
Climate Zone	Hilly	48	96
	Coastal	2	4
Residence	Hilly area	48	96
	Plain area	2	4
Practice of Traditional Agricultural System	Yes	43	86
	No	7	14

Source: Fieldwork 2023.

In terms of ethnic identity, about 90% of respondents were Marma, and 66% of the respondents have no institutional education certificate. About 86% of respondents were farmers; 58% of respondents monthly income belonged between 10,001 and 20,000 BDT; and 52% of them were small farmers who owned less than 2 acres of farming land. Furthermore, 96% of respondents cultivated in hilly areas because 96% of respondents lived in hilly areas, and 86% of respondents mentioned that they have practiced traditional farming systems.

Overview of Indigenous Agriculture

Indigenous people are the bearers of centuries-old cultures, usually living in mountainous or forest areas. The vast area in the south-eastern corner of Bangladesh is called the mountainous region. The total cultivated land in this hilly area is 1363 hectares. According to the different slopes of the hills, the total land area is 13, 24,428 hectares, and the total temporary fallow land is 85606 hectares. (FAO, 2019).

The method of farming in the foothills is called *jum* farming. *Jum* cultivation in the hills is a primitive practice, but it is the soul bond of the indigenous community. Cultivation in the hilly areas is completely different from that in the plains, and a variety of products are seen to be cultivated simultaneously. Indigenous agriculture in Bangladesh contributes significantly to food security, particularly in remote and disadvantaged areas where access to markets and modern technology may be limited (Haq et al., 2018; Islam et al., 2019). Women play a critical role in indigenous agriculture in Bangladesh, contributing significantly to crop production, animal care, and other farm activities (Ahmed et al., 2018; Kabir et al., 2019). The hill's soil is slightly acidic and sloping in nature, so sunlight gets in more. As a result, this hilly agriculture is more suitable for cultivating garden crops than field crops. The abundance of fruits is also noticeable among horticultural crops. Along with local fruits, foreign fruits have also taken place in recent times. Mango, banana, jackfruit, lemon, pineapple, malta, and dragon fruit are abundant in the mountains.

Figure 2: The diversity of hill agriculture, Naikhongchari



Source: Fieldwork 2023.

According to the information provided by the Department of Agriculture Extension in Bandarban, there are about a hundred small and big mango orchards. There are about 50 litchi gardens in Khagrachari. Most of these fruits are cultivated in gardens on hillside slopes. Many fruits are also grown around the homesteads. Rice is the main crop cultivated on hill slopes in

Bangladesh. Here, Ufshi varieties Bridhan 51, 52, and 49, as well as local varieties Payjam, Kalojira, Binni, Rajmani, etc., are cultivated.

Traditional Agricultural products

There are many crops that are produced by the indigenous people in the Chattogram hilly area. The soil of the hills is clayey loam, and the abundant rainfall during the monsoons makes the yield of any crop good. As earlier mentioned, the soil in the study area is slightly acidic and sloping in nature, so sunlight is more readily available. As a result, this hill agriculture is suitable for the cultivation of horticultural crops rather than field crops.

Among the various agricultural products cultivated in the hills are:

Table 2: Seasonal Crop Calendar of Hill Areas (Study Area)

Crops	Breeds	Crop harvest period
Bananas	<i>Bengal banana, Champa banana, Sarbi</i>	Dec-Feb
Dragon	<i>Yellow Pitay, American Beauty, Dark Star</i>	Jun-Oct
Paddy	<i>Beti, Bridhan-56, Bridhan-57, Bridhan-66</i>	All time
Mango	<i>Amrapali, Mallika, Ranguai, Thai Banana</i>	Apr-May
Tobacco	<i>flue-cured Virginia, cassava, and barley</i>	Jul-Aug
Papaya	<i>Red Lady, Red Reagan</i>	Aug- Nov
Betel leaf	<i>Bengal Pan, Mitha Pan, Sachi Pan</i>	Jan- Jun
Sugarcane	<i>Isd 1/53 (Nota Kushir), Isd 2/54, Isd 3/54</i>	Dec- Mar
Pine apple	<i>Honey Queen and Watermelon</i>	Jun-Sep

Source: Fieldwork 2023.

These hill crops are main crops of hill tract areas. They earn their livelihood by producing these crops. Mountain crops are more nutritious than plain crops, and their taste is unmatched. There is a huge demand for these crops on the plains. The cost of producing hill crops is relatively lower than that of the plains, so the profit is higher. Officer of the Department of Agricultural Extension, Naikhongchari, showed the cost of paddy production per acre as below:

Table 3: Paddy's production cost per acre (BDT.)

SL.	Sector of cost of production	Average Cost(BDT)
1	Land preparation	4,500/-
2	Fertilizer	5,000/-
3	Seeds	720
4	Laborer	21,200
5	Irrigation	1,500
6	Pest Management	1,300
7	Threshing cost	3,000
8	Interest on loans	778

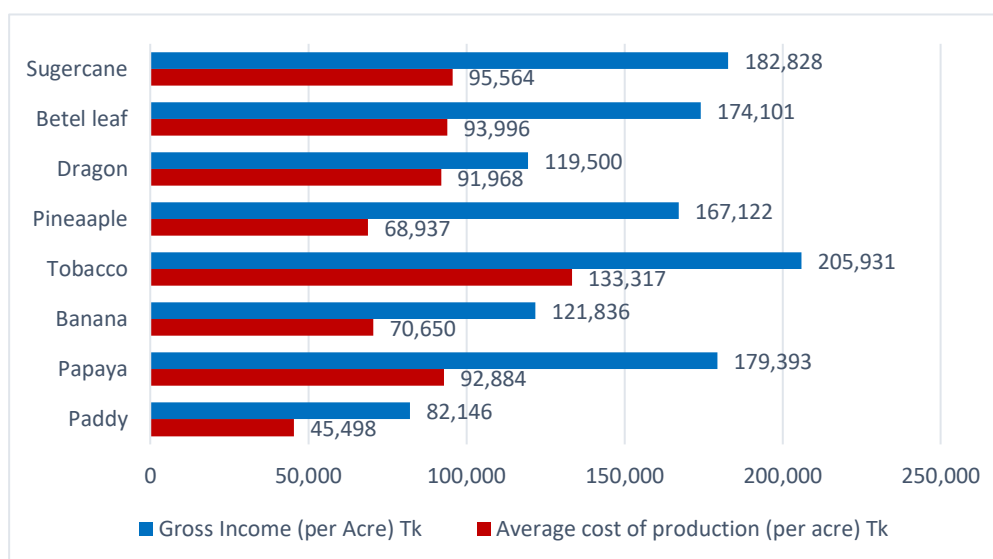
9	Land lease	7,500
Total cost of production per acre		45,498
Total Income		50,150
Net Profit		7,202

Source: Fieldwork 2023.

According to the above table, farmers spent 57% of their money on labor, 13% of their money on land preparation, 12% of their money on fertilizer, and 8% of their money on irrigation.

The Agriculture Extension officer also has mentioned the approximate profit per acre to compare the production cost. Here is a comparison between production cost and gross income (per acre) of these crops.

Figure 3: Comparison of production cost and gross income per acre (BDT.)



Source: Fieldwork 2023

Figure 1 demonstrates the approximate cost and gross income per acre in the study area as per the Agriculture Extension Officer from Bandanban District. The people of the study area spent more money on tobacco cultivation (approximately BDT 1,33,317/-), and they also got more return from tobacco, which was approximately BDT 2,05,931/- per acre. To compare with other crops that they usually cultivated around the year, they spent less money on rice cultivation (BDT 45,498/-) and got a lower return (BDT 82,146/- per acre) compared to the other crops. It is also interesting to note that recently they have cultivated more crops that are profitable for them, such as tobacco and dragon fruits. According to the respondents and Agriculture Extension Officer, farmers get more return compared to other crops like paddy, banana, papaya, pineapple, etc.

Impact of Climate Change on Hill Agriculture Nowadays, hill people are facing enormous problems in farming. Climate change is the main problem facing indigenous agriculture. Among the various problems related to climate change are floods, droughts, lack of rain, landslides, tidal waves, and global warming. The main problem in tribal agriculture is water scarcity, or drought. Tribal farmers farm in the foothills using the *jum* system and therefore depend on rain for water. But crop production is disrupted in all areas due to climate change. According to Mongkhing Marma, a farmer in Naikhongchhari upazila of Bandarban,

“Last year, I planted 13 pots of seed rice on hilly and low land. The yield is good that year because the weather is favorable and it rains. I made a profit by selling 500 pounds of green rice, sweet pumpkin, jum pumpkin, sesame, corn, and pepper. But due to a lack of rain and drought this year, rice and other crops are dying and turning red.”

Naikhongchhari Agriculture Officer of Bandarban said that due to lack of rain and drought, it will take till September-October to ripen the paddy, which is supposed to be harvested in August, and it will take till November-December to bring home the *jum* produce. Many farmers depend on mountain streams, springs, ponds, rivers, and canals for cultivation. But during the dry season, all sources of water become empty, forcing many to depend on irrigation water. Irrigation costs are high in hilly areas due to lower groundwater levels, which increase the cost of production. Yunong Marma, a farmer from Bandarban Sadar, said that water is not available in the Sangu River, even at 250–300 feet deep. Again, due to climate change, soil fertility is decreasing, and farmers are using pesticides, which is damaging the environment. As a result of cutting down the hills and killing the trees, the agricultural fields are affected by calamities like landslides.

The harmful effects of climate change on the global environment are no exception in our country. The impact of climate change on tribal society and tribal agriculture in the southeastern region of our country is obvious.

i) Harmful effects of drought Ukchana Marma, a farmer from Sonaichari, Naikhongchhari Upazila of Bandarban district, spoke about the horrors of climate change in the mountains. Ukchana Marma said that he is not able to plant paddy due to a lack of water. There is no water on the land; he does not know if her family will get any water for drinking tomorrow. The Agriculture Extension Department Officer of Naikhongchhari said that because the level of arsenic in the underground water here is high, it is entering the human body through crops.

Also, due to the decrease in groundwater level, sufficient water is not being supplied to the crops, due to which crop production is falling below the target.

ii) Harmful effect of temperature Afsar Kamal, the garden owner of Nisargo Agro Farm in Naikshyongchari, said that this time all the buds in his garden fell before fruiting due to the intense summer heat. He suffered a loss of 3 lakhs Tk. Rising temperatures in hilly districts have reduced the yield of upland rice and increased the incidence of wheat diseases. Excess heat and humidity play a role in promoting fungal diseases in plants and likewise increase the number of insects and various disease-carrying insects. During the Boro season, if there is fog at night and water accumulates on the rice leaves and it is hot during the day, i.e., the temperature increases, then the attack of blight disease increases. High humidity and temperatures increase the incidence of sheath blight.

iii) Harmful effects of warm and cold currents In the hilly areas, the current winter warm flow has reduced the yield of more sensitive crops such as wheat and made wheat production unprofitable. As a result of the sudden, severe cold, it is having an adverse effect on cultivated crops like mustard, lentils, chickpeas, etc. Due to long periods of fog with cold flow, many crops, especially wheat, were not pollinated and fertilized, partially or completely, and insect infestations increased.

Effectiveness of traditional agricultural knowledge in combating climate change

Traditional agricultural knowledge refers to the practical skills, experiences, and practices passed down through generations that help farmers adapt to local environmental conditions and produce food sustainably (Zoysa et al., 2013). It has also been shown to play a crucial role in preserving biodiversity, which is essential for maintaining healthy ecosystems and supporting sustainable agriculture. These knowledge systems include techniques for managing soil fertility, water harvesting, pest control, and crop management that have been developed and refined over centuries (Goldemberg et al., 2014). Many traditional farming practices, such as crop rotation and intercropping, help to maintain soil fertility and promote the growth of beneficial insects and other organisms that can help control pests and diseases (Zhao et al., 2018). Additionally, traditional agricultural knowledge can help farmers adapt to climate change by providing them with strategies for coping with extreme weather events, such as droughts and floods (Kjellén et al., 2016). Another study found that these practices, such as crop rotation and agroforestry, can help to reduce soil erosion and improve soil fertility, which can make agricultural systems more resilient to climate change (Girma et al., 2021). It often

involves the use of natural resources such as water and fertilizer, which can help reduce greenhouse gas emissions and mitigate the impacts of climate change (Smith et al., 2013). Traditional crops and cropping practices are becoming extinct, to which modern farming practices are major contributors. Farmers' knowledge of local weather patterns, soil types, and pests and diseases can help them adapt their practices to changing conditions (Thorpe, 2018). For instance, a study in Uganda showed that farmers who used traditional rainwater harvesting techniques were able to maintain higher levels of agricultural productivity during periods of drought (Nabatanzi et al., 2018). Similarly, research in Nepal found that traditional wisdom related to soil conservation helped farmers mitigate the negative effects of land degradation (Pandit et al., 2018). The 2001 Intergovernmental Panel on Climate Change Third Assessment Report concluded that current knowledge on adaptation to climate change is limited and emphasized the need for research on viable adaptation measures. Bangladesh is vulnerable to climate change as the majority of its population depends on agriculture, which is climate-sensitive. Agriculture in Bangladesh is involved in domestic food supply, employment, and cash income. Recognizing the challenges to mitigating climate variability promotes more sustainable and resilient agriculture. Traditional knowledge for ecosystem management and use of natural resources is gaining credence as a key weapon to fight against climate change. Local and indigenous knowledge systems contribute to the achievement of Sustainable Development Goal 13 on climate action by observing changing climates, adapting to impacts, and contributing to global mitigation efforts (UNESCO, 2020).

With collective knowledge of the land, sky, and sea, these people are excellent observers and interpreters of change in the environment. The ensuing community-based and collectively held knowledge offers valuable insights, complementing scientific data with chronological and landscape-specific precision and detail that is critical for verifying climate models and evaluating climate change scenarios developed by scientists at a much broader spatial and temporal scale. Moreover, indigenous knowledge provides a crucial foundation for community-based adaptation and mitigation actions that sustain the resilience of social-ecological systems at interconnected local, regional, and global scales.

At present, as a result of the excellence of science and technology, there has been a revolution in agriculture. The agriculture of every country in the modern world is now affected by technology. Even if it appears to be a profit, it is a threat to future generations. The use of modern technology is causing many damages, including climate change. These are: soil pollution, water pollution, and greenhouse effects.

On the other hand, the traditional knowledge used by the tribal people for their agriculture does not cause any damage to the environment. They make agricultural machinery from bamboo, cane, and wood collected from the environment. All these machines are hand-operated and require no fuel, for example, a spade, blade, plough, or yoke etc. They use organic fertilizers to grow crops without harming the environment. Agriculture works by using water collected from river canals and dog ponds instead of groundwater.

As crop production has increased using modern technology, the environment is being severely degraded, which poses a threat to future generations. So, there is a need to re-emphasize agriculture using traditional knowledge. This will result in crop production, no damage to the environment, and no impact on climate change. Although indigenous peoples' "low-carbon" traditional ways of life have contributed little to climate change, indigenous peoples are the most adversely affected by it. This is largely a result of their historic dependence on local biological diversity, ecosystem services, and cultural landscapes as a source of sustenance and well-being.

However, indigenous peoples are not mere victims of climate change. Comprising only 4% of the world's population (between 250 and 300 million people), they utilize 22% of the world's land surface. In doing so, they maintain 80% of the planet's biodiversity in, or adjacent to, 85% of the world's protected areas. Indigenous lands also contain hundreds of gig tons of carbon, a recognition that is gradually dawning on industrialized countries that seek to secure significant carbon stocks in an effort to mitigate climate change.

Traditional knowledge is a potential instrument in climate change assessment and adaptation efforts. Indigenous communities have historically had the potential to live within the area and adapt to environmental changes. Hill indigenous people have been cherishing their traditional knowledge for generations, which they also use in their agriculture. They use this knowledge, from saving and sowing the seeds to harvesting the crops at home. The agriculture-based traditional knowledge, customs, and folk beliefs practiced by the indigenous people as they mentioned below:

Traditional knowledge of preparing seeds

- Soak paddy seeds in water at night for sprouting.
- Raising a nursery in an isolated place in the field.
- In the nursery area, no other crop is grown in the field.
- Maintaining water during the flowering stage.

Afsar Kamal of Nirsago Agro Farm assistant manager in Naikshyongchari Upazila said that they can understand the changes in the crops due to the effects of climate change and grow suitable crops.

The agriculture-based traditional knowledge, customs, and folk beliefs practiced by the indigenous people in Naikkhongchari and Sonaichari upazilas of Bandarban district are mentioned below:

Traditional knowledge in seed treatment

- Paddy seeds are treated with ash to control seed-borne diseases.
- Neem oil water is used to treat the seeds before sowing.
- Cow dung treated with seeds control seed-borne diseases
- Mixing naphthalene powder with seeds for better germination.
- Keeping rice seedlings under shed for 1-2 days before transplanting for the purpose of increasing tolerance.

Nuthwai Marma of Lamar Para in Sonaichari said that he uses natural fertilizers. Natural fertilizers are made from vegetable waste. Manure is made from dung and used on land. Hills are burned to ashes for cultivation, and ashes are sprinkled to kill harmful insects for crops.

Marma from Lamar Para said that the seeds are kept in packaging for storage. No pesticides are used during packing. These seeds are pressed with straw during the winter. The seeds germinate within three days. Hay is not required during the summer. If placed in water, the seeds germinate within 24 hours.

Cockpits are made to protect the birds from the insects in the paddy fields. Crops are sometimes staked so that birds can sit and eat insects. The colored paper is cut so that the birds are scared away from the land, said Lalthanab Marma.

Traditional knowledge in soil fertility management

- Pulling ropes across the 'Boro' rice field early in the morning to keep the soil moist by falling dew drops
- Applying fish-cleaning water to bean and cucurbit plant bases
- De-topping 'Aus' rice plants when the vegetative growth is vigorous

- Deep plowing by thorn-made wooden ploughs in the summer season
- Decomposed leaves, crop residues, and forest waste materials are decomposed in the field.
- Forest residue and soil are broadcast over the field during the rainy season to increase soil fertility.

Afsar Kamal said that those who work in agriculture throughout the year use leftover food as fertilizer on the land. Gives dung to the ground. Fertilizers are not required, as hilly land is fertile.

Traditional knowledge in water conservation and irrigation

- Water conservation is done through canals and groundwater for irrigation.
- Farmers irrigate fields with the help of a bucket made of leather.

Mohiuddin, a farmer from Naikkhongchari Upazila, said that if there is too much sun, they tie a bottle to the tree and water it with a hole in the bottom. From this, the water falls, and the tree is protected from the sun.

Wingmong Marma said that water problems arise due to the effects of climate change. So the indigenous people built a dam between the two hills to conserve water. Sufficient water for drinking and agricultural use is collected from there.

Traditional knowledge in plant protection

- Application of *neem* oil and castor cake to control termites before seed sowing
- Summer plough in the crop field for control of termite caterpillars, grasshoppers, and animals.
- Using traps in the wheat and rice fields to control rodents
- Drawing straw-made kerosene rope across the *Aman* rice fields to control insects.
- Farmers use the ash in the early morning on the paddy crop for aphid control.
- Rice bran and kerosene mix pellets were kept in the field for protection from the yellow rice stem borer.

Traditional Knowledge in the Detection of Underground Water

- The availability of frogs below the soil indicates sources of water.
- The plants, like bamboo, growing 10 meters in the north and west directions indicate water.
- Water availability will be found to be closer to the termitarium.

Traditional knowledge in weather prediction

- Farmers forecast the intensity of rain by observing the direction of the wind, which is east to west-less rain or west to east-more rain.
- Clouds of a dark brown color cause heavy rain for a fortnight.
- Based on vast experience, farmers generally believe that if thick, dark clouds are seen at the last *Shukla paksha*, it indicates heavy rain.
- Termites and dragonflies near the ground are indications of rain.
- If the moon is shining, clear at night in '*Sawan*' month indicates no rain.
- Thick clouds in the day but a cloudless night and the blowing of wind from the east are indications of no rain.
- Wind blowing from the north-west direction is an indication of more rain.
- Frog portends sound at night in '*Sawan*' month indicates no rain.
- The forecasting of the intensity of rain is done by the size of the moon and the sun that appeared in the sky.

Mongthoiching Marma said that if he sees grasshoppers flying in the sky, he can understand that there will be a lot of rain in a few days.

Indigenous customs and folk beliefs

- Shoes are tied to the coconut tree so that they do not get tangled.
- White polythene is tied between the papaya trees so that no one can damage the crop.
- Praying to the deity named '*Ashshao Upko*' to stop the storm, the storm stopped.
- Ten to twenty people are invited and fed after harvesting new paddy.
- When there is new fruit, prayers are offered to the temple. If the paddy is good, prayers are offered.
- Marma people have their own calendar where auspicious and inauspicious days are written. On auspicious days, the seeds are sown and the harvest is reaped. The name of the calendar is '*Pragitik*'.
- Any one tree is worshiped for the good or bad of the crop, or all the bad. Especially the jam tree is considered a deity.

Crop Taboos

- If the tree named Buck Tree is around the land, then the crops cannot escape there.
- Bad things do not happen if there is a '*Dosi*'. '*Dosi*' is a very large egg-shaped fruit that is hung in front of the door to prevent evil spirits from entering.
- One cannot go to the crop field with shoes on. It is bad luck.

- Crops are not sown or reaped on the day someone dies.
- Saturday and Tuesday are auspicious for harvesting.
- Everyone prays together in the Buddhist temple after harvest.

Recommendations

To combat climate change in indigenous agriculture, this study recommends:

- **Awareness-raising:** Hill tribes need to be made aware of the impact of climate change. District-wise, the Department of Agriculture Extension (DAE) can organize regular meetings, seminars, and workshops in this regard. Also, they can go to the fields and warn the farmers. They shouldn't get used to modern machinery and carbon emissions.
- **Use and preservation of traditional knowledge:** The traditional knowledge received by the indigenous from generation to generation should be officially preserved, and they should be advised to use it. Care should be taken that it is not lost due to the passage of time and the touch of modernity and technology. The loss is high. Farmer Wingmong Marma said, "*Many of the tribal youth generation do not know their agricultural traditional knowledge; even if they do, they have forgotten it*". This knowledge must be protected from extinction. In this case, this knowledge can be taught in the schools and colleges of the tribal areas to the new generation.
- **Preservation of tribal culture and heritage:** The tribal culture must be preserved for thousands of years. Because traditional knowledge has emerged from this culture. If they are not preserved, no traditional knowledge will emerge in the future.
- **Save the mountains:** All the agricultural activities of the indigenous people are in the hills. But lately, the incidence of land robbers and forest robbers has increased in the hills. They illegally dug the soil from the hill and cut down trees. This is damaging arable land. Legal action should be taken against the land robbers and forest robbers.
- **Government Sponsorship:** The government should take steps to combat climate change, and long-term plans and projects should be adopted. All the problems facing agriculture due to climate change should be solved. Must be done. Water flow should be ensured by placing ring wells and tube wells in the middle of the land.
- **Agricultural assistance:** crop varieties suitable for mountain climates should be developed. Crop seeds should be provided free of charge. Financial assistance should be provided to farmers if their crops are affected by various natural calamities, including drought and a lack of rain. A separate Department of Agriculture may be opened for hill agriculture. Weather and

according to the climate, when to grow a crop, the yield will be good, and when a crop cannot be grown, advice should be given. In short, hill agriculture should be monitored all the time.

All in all, if these decisions are taken, hill agriculture can play a role in enriching the economy of Bangladesh.

Conclusion

The indigenous people of the south-eastern part of Bangladesh require more attention from us. Many of the indigenous practices in the world have been eliminated over the years due to rapid urbanization, and the Chittagong hill tracts are no exception. Hence, it is utmost essential to document all the information related to traditional knowledge-based agriculture and the environment available among the indigenous communities before it is lost.

This research clearly demonstrates that indigenous people and their traditional knowledge are capable of facing the world's changing climate. Planners and policymakers have yet another tool and dimension from which to formulate a participatory research agenda by seeking the opinions and participation of indigenous populations. Assessments of indigenous knowledge suggest an urgent need for building on local and traditional knowledge relating to agriculture and climate risk. Successful amalgamation of the knowledge and practices of indigenous people requires their consideration together with other developmental aspects in a holistic manner.

Conflict of interest

The participants were assured that the information they provided during the discussions was confidential and would not be traced back to them. Anonymity and confidentiality were observed using pseudonyms to protect the participants' identities. All participants consented to participate in the study by signing the consent form. The authors declare that there is no conflict of interest.

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