

Research article

Livelihood assessment of seaweed beneficiaries at Nuniachara, Cox's Bazar

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ABSTRACT

Fishing has been prioritized as the major economic activity of the coastal community and most of them are involved in livelihood earning from a very young age. Though they are primarily engaged in fishing, they are now involved in the recent seaweed culture trend. Seaweed culture is a feasible alternative livelihood for the coastal fishing population. In this study, an assessment of the socio-economic and livelihood status of seaweed beneficiaries was conducted at Nuniachara, Cox's Bazar as seaweed farming is thriving there. The study method included a questionnaire, survey, group discussion and public interview, and the findings revealed that almost 44% of the participants had never been to any school and only 3% had completed their S.S.C. Around 47% of respondents came from large families and most of the beneficiaries' economic status is poor (47%) according to their monthly income but almost 65% agreed that their financial condition has moderately improved after involving in seaweed farming. Despite fishing (78%) being their major occupation for decades, they are now opting for other side jobs during the off-season of fishing, though the percentage is exiguous. Approximately 36% of the respondents admitted that environmental changes along with ongoing airport construction and extension work have a significant impact on their livelihood through capture fisheries. From this study, we can claim that seaweed farming has reached tremendous success in initiating women empowerment; more than 70% of women in this community are involved in seaweed farming and contributing to their family income. This study indicates that it is the high time we took the initiative on seaweed beneficiaries as well as on the livelihood management strategy to mitigate the highlighted ecological and socio-economic difficulties they face.

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1. INTRODUCTION

Bangladesh is blessed with abundant water resources and is one of the world's leading fish

producers, producing 46.21 lakh M.T. in F.Y. 2020-21, with aquaculture contributing 57% of total fish production (DoF, 2021). The coastal

area is considered one of the world's highly productive areas because of its geographical position and climatic condition (Islam, 2003).

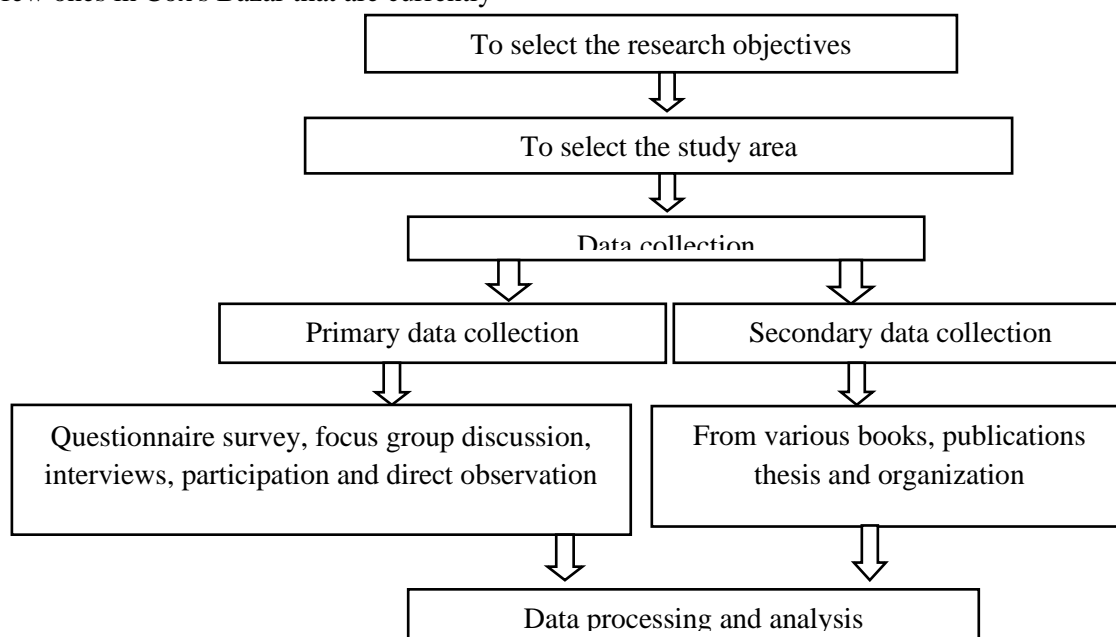
Bay of Bengal is home to many coastal and marine habitats supporting diverse species, including fishes, shrimps, molluscs, crabs, animals, seaweeds and more (FAO, 2014). Despite a wide range of resource diversification, the marine fisheries sector is under-explored and under-utilized. The coastal belt of Bangladesh extends over 19 districts where many people depend on fishing, fishery exploitation and fisheries-related other associated activities (Islam, 2008). As a result, overfishing and severe resource degradation becomes the coastal fisheries' major concerns. To protect our remaining coastal resources, alternative income generating source is essential and seaweed farming can play an important role here. Bangladesh has much potential for seaweed farming and seaweed business, considering the available resources and favourable conditions (Ahmed and Taparhudee, 2005). The coast is enriched with almost 140 seaweed species, and 10 species are commercially important (Siddiqui et al., 2019). Currently, around 300 households in Bangladesh are involved in seaweed growing, which will contribute as food, feed, cosmetics, and medicine industries (Hossain et al., 2020; Mohibullah et al., 2023). Nuniachara and Khuruskul fishermen communities are one of the few ones in Cox's Bazar that are currently

cultivated on the tidal coast line of Nuniachara beach (Siddiqui et al., 2019). Seaweed has previously been highlighted as a facilitator of social improvement in coastal communities (Prado et al., 2012). Due to several ecological and socio-economic difficulties, along with the COVID-19 outbreak, the livelihoods of seaweed beneficiaries are in disarray. There is also a lack of precise and extensive knowledge on the socio-economic and ecological constraints seaweed beneficiaries face. With this goal in mind, the current research was carried out in Nuniachara, Cox's Bazar to learn more about the socio-economic and livelihood conditions of the participants and their alternative income-generating activities during the off-season and help them for their sustainable livelihood.

2.MATERIALS AND METHODS

Design of the experiment

To understand the socio-economic and livelihood conditions of seaweed beneficiaries, face-to-face personal interview with semi-structural questionnaire, focus group discussion and direct observation was carried out. The design of the research work is presented in Figure 1.



cultivating seaweed. Hypnea, Gracilaria and Ulva seaweed species are currently being

Figure 1. Design of the research work

Study area

The study focused on assessing the socio-economic and livelihood systems and assessing the alternative income-generating activities in off-season of seaweed beneficiaries at Nuniachara, Cox's Bazar in Bangladesh. From August to October 2022, the study was conducted and concluded using a random selection of 60 participants out of 100. Because of the maximum potentiality of seaweed production, marketing places and large group of people involved in seaweed farming the Uttar Nuniachara Panirkup Para, Nuniachara of Cox's Bazar was chosen as the research region (Figure 2).

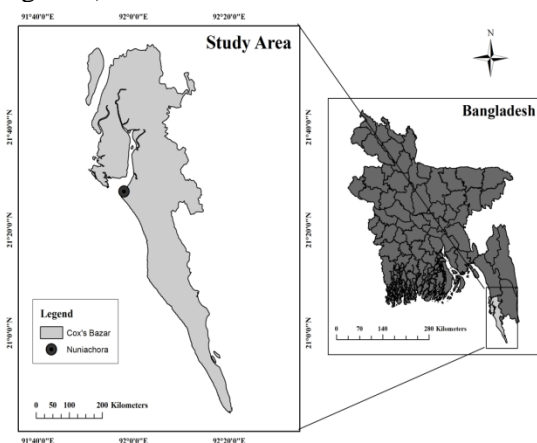


Figure 2. Study area

Data collection

Primary data collection techniques

Questionnaire survey: With the study's specific goal in mind, a semi-structured questionnaire was prepared, and it was further developed by conducting interviews on a pilot basis to construct the final questionnaire. The questionnaire was divided into some distinct categories, including ecological and environmental characteristics, seaweed farming information, socio-economic status of seaweed farmers and their off-season activities. Most of the questions related to ecological and socio-economic conditions were scored where 0 represents the lowest score, and 5 denote the highest score. These score-based questions were quite helpful in the case of data analysis mainly qualitative data which were easily analyzed according to scores given by the participants.

Focus group discussion: The purpose of the Focus Group Discussion was to identify the major problems, needs, and suggestions related

to the difficulties highlighted, so that an effective solution to the issues might be found out. Each time 6-7 participants were selected for a focus group based on their availability.

Interviews: Interview allows access to the in-depth information from the participants. Interview facilitates the researcher to examine all aspects and understand participants' responses, feelings, opinions, beliefs. As a result, in-depth interviews provide a significant portion of the empirical data. Interviews were conducted in a semi-structured format, which gave interviewees more freedom.

Direct observations: Field observations and on-field surveillance were the most valuable and meaningful ways to learn about the culture procedure of seaweed production and marketing, as well as beneficiaries' livelihood, work practices, vulnerabilities, and indigenous knowledge in a social context (Hossain et al., 2014; Deb and Haque, 2011). Through a little chit-chat, this form of observation helps familiarize the neighbourhood. All of these actions contributed to gain insight into their everyday activities and earnings, hence increasing the data's validity.

Off season activities: In the off-season of seaweed culture, the beneficiaries of the men and women are involved in various activities. Men work as day labour, most go for fishing in the sea, some collect P.L. of shrimp and many are involved in net and boat making and mending. Sometimes they go distant places for these types of work. Women contain shell, and their children help them for managing those. They make various ornaments by those and sell them in the local market.

Preparatory activities: Before starting the culture, they must be prepared for the culture. In this period, they mend their net and rope. They settle down the frame in their culture site. Various organizations under which they work give them some training periodically.

Culture period: At the end of September, the culture started, and they tied up the seeds in each knot. It grows faster and is ready to collect within 2 to 3 weeks. In the favourable condition, it takes 15 days to grow and become properly

ready for collection. Seaweed can be collected repeatedly in 15 days intervals.

Secondary data collection

Further relevant information on socio-economic and livelihood condition of seaweed beneficiaries' were collected from the related books, publications, thesis papers, journals and Govt. organizations like Bangladesh Fisheries Research Institute (BFRI), Cox's Bazar, Bangladesh.

Data processing and analysis: A pre-prepared semi-structured questionnaire was used to collect data depending on the needs. The information gathered from the participants was promptly written down after every survey. After returning from the sampling location recorded and handwritten data were transcribed shortly in the majority of cases. Such structures aided in the prevention of data loss as well as the verification of data. Microsoft Excel 2016 was used to analyze the factors described under the natural, ecological, and socio-economic crises that have occurred previously.

Ethical considerations: During the interview, a pleasant environment was created, and the participants' rights were protected by maintaining ethical behavior throughout the study. To minimize any kinds of rivalry and interviewee hesitancy, sensitive subjects such as respecting privacy, religious prejudices, information about income, and cultural differences were ignored (Yin, 2009). From the experience of previous wrangle the research goal was explained before the session began. It was also done to avoid data manipulation and consent was obtained before data was recorded.

3. RESULTS AND DISCUSSION

Bio-geological system of Nuniachara is an important ecosystem in seaweed cultivation. According to the interviewee, Nuniachara has around 200 residents, with roughly 100 active in seaweed activities, and 60 chosen as participants. The majority of the residents in that area were Muslims.

Socio-economic information of seaweed farmers

Overall social status

The overall socio-economic condition of coastal people is poor despite having access to significant water resources. The socio-economic situation of Uttar Nuniachara Panirkup Para participants is poor as well. But people are diverting in many alternative livelihoods particularly seaweed culture to improve their livelihood. Women are considered a dominating group engaged in seaweed culture, drying and selling seaweed to the local market.

According to the study's findings, most participants are between the ages of 31 and 40 and they occupied 37%. The lowest portion belongs to the age group of fewer than 20, only 7% (Table 1). In a study, Espaldon et al. (2010) showed that the ages of seaweed growers in Calatagan, Batangas, Philippines range from 27 to 68 years, with an average of 44 years. According to Supendy et al. (2018), farming and fishing are mostly done by farmers aged 15-55 in Lemo, Indonesia.

It is found that the percentage of people who had never been to any school is very high, it is 44% which occupies almost half of the beneficiaries in this study and only 3% somehow complete their S.S.C. and this is shown in Table 1. Shamsuddoha (2007) reported that most of the coastal belt people are involved in fishing-related activities and do not know how to write; some of the people can put their signature only, and a few S.S.C and H.S.C holders were found in different chars. Supendy et al. (2018) also discovered that all respondents at the research location had at least a basic elementary school education. The current investigation revealed that the majority of the participants were illiterate. This could be from the lower financial status, lack of education awareness and lack of motivation.

It showed majority of the participants belong to the large family, and they hold 47%, and the small family occupies only 16%. According to Zaman et al. (2010) when a family consists of 2-4 members, it is regarded as a small family. In the case of 5-10 and more than 10 members, it is considered as medium and large family. This study categorizes how many people are involved in seaweed farming from each family. From our findings, we identified that from each family,

almost 4-7 persons are involved in seaweed farming they occupied 60% in terms of percentage (Table 1).

From Table 1 it is observed that most of the beneficiaries' economic status is poor (47%), lower poor and extreme poor are 33% and 20% accordingly. According to Das et al. (2015), due to poor economic conditions and several natural calamities the socio-economic position of small-scale fishermen in Bangladesh's coastal area is

still lagging. This research found that the financial situation of the participants is poor, focused by their living conditions which is strongly agreed by Das et al. (2015). In this study, we tried to estimate how many beneficiaries economic condition has improved than their previous condition. In Table 1 we ranked them as less, moderately and highly improved and they pose 25%, 65% and 10% accordingly.

Table 1. Socio-economic information of seaweed farmers (N=60)

Parameters	Category	Percentage (%)
Age	<20	7
	21-30	23
	31-40	37
	41-50	20
	51-60	13
Educational status	No schooling	44
	Under class 5	33
	Under class 8	20
	SSC	3
Family size	Small	16
	Medium	37
	Large	47
Involvement in seaweed farming	0-3	17
	4-7	60
	>8	23
Economic condition	Extreme poor	20
	Poor	47
	Lower middle	33
Improvement of economic condition	Less improved	25
	Moderately improved	65
	Highly improved	10
Occupation	Fishing	78
	Net making and mending	11
	Day labour	7
	Boat making	4
Source of credit	NGO	36
	Co operatives	27
	Self savings	20
	Relatives	14
	Bank	3
Types of house	Tinshed	40
	Hut	30
	Semipucca	20
	Earthen	10
Types of latrine	Hung	60
	Bush	30
	Open field	10

Through this study, it is found that fishing is their principal occupation which they are practising year after year by following their ancestors. Still they are now moving into different sectors though it's not many. In the off-season of seaweed farming, the beneficiaries involved in net making and mending (11%), boat making (4%), and some of them also work as day labourers (7%). This is shown in Table 1. However, Narayanakumar and Krishnan (2013) found that fishing and seaweed farming are India's Ramanathapuram District's two most prominent vocations.

In Table 1 it is identified that their primary sources of credit is from different NGOs from where they take loans and they have to pay it back weekly or monthly. The tendency of taking loan from bank is somehow very low (4%) because of the long term procedure of the bank which they thought to be troublesome for them.

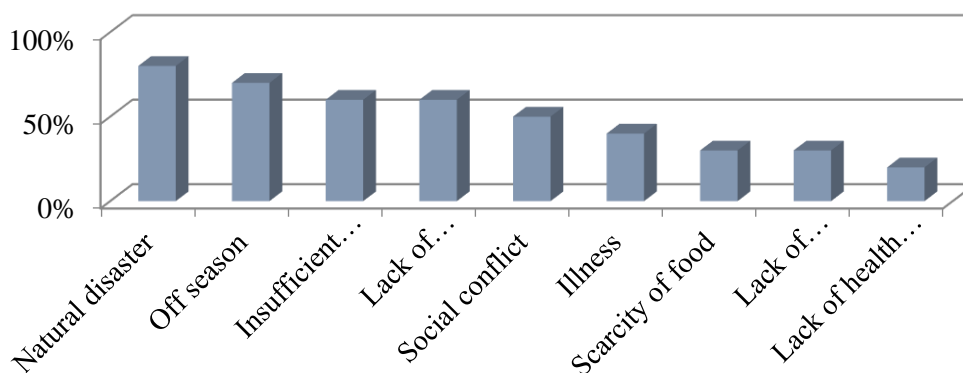


Figure 3. Common problem faced by farmers

Conflicts have been a typical occurrence in the fishing community as a diverse individual with different occupations living together in the same society. According to the findings of this survey, half of the population believed that there has been a lot of conflict among the fisherman. This is illustrated in Figure 3. These conflicts include clash between seaweed farmers with fishermen, fishermen with fishermen, seaweed farmers with boat owners and seaweed farmers with other seaweed farmers. These clashes occur because sometimes seaweed tangled with the net of the fishermen and due to the seaweed culture sometimes boat navigation hampers. For this, clashes take place with the boat owners. Illness has been identified as another issue for the fishing community and two-fifths of the

In terms of housing and toilet facilities, the most prominent house type is tin shed (40%) and only 10% of earthen houses are noticeable there more than half of the participants' latrines are constructed of bamboo, and they want the government to provide latrines at the cultural site as well (Table 1). But the majority of buildings in Mandapam and Rameswaram, India, were "Kutchha" and "Pucca," as discovered by Narayanakumar and Krishnan (2013).

Social problems faced by seaweed farmers

Small-scale fishermen are faced with a variety of ecological and socioeconomic difficulties. According to fishermen's perspectives, they are particularly exposed to environmental dangers such as cyclones, floods, saline intrusion, and socio-economic and ecological crises such as reduced fish catch, illnesses, accidents, theft, robbery, social disputes and dowry.

participants confessed to being sick due to poor health care. The study revealed that health facilities were not well provided to the local people, including small-scale fishermen, which is similar to the study of Rabbani (2007), which revealed that 45% of Korotoa fishermen were dependent on village doctors, while 11.67% and 3.33% received health service from upazila health complex and MBBS doctors, respectively, indicating that health facilities were inadequate. This result more or less resembles the present study due to research conducted on similar types of communities.

Another issue that the fishing community faces is lack of pure drinking water facilities and they demand it from the government. Despite these

problems they also face challenges such as lack of electricity, education, poor working facilities, and food scarcity. According to Hossain et al. (2020), among social challenges, respondents rated land/water use conflict first (33%), followed by a lack of technical support to farmers.

Ecological feature and challenges associated with the Nuniachara community

According to farmer's perceptions, various activities such as urbanization, human encroachment, airport development, and coastal pollution have generated substantial ecological concern. Temperature rises, salinity changes, changes in rainfall pattern and intensity, differences in bottom topography, and rising water levels are all environmental conditions that cause ecological change.

According to the findings of this study, which has shown in Table 2, temperature, rainfall pattern, rainfall intensity and basin depth in Nuniachara's Moheskhal Channel have moderately changed whereas basin size and salinity have changed slightly. Plastic pollution is identified by them as an ecological problem. According to their perspective, 52% participants believed that it has high impact on that ecosystem. On the other hand, 28% participants focused on plastic pollution, according to them it has moderate impact while dumping from boat and municipal, household waste, street drainage have little and very little impact on that ecosystem.

Another burning issue is the ongoing construction and extension work of the airport. For this ongoing construction, their movement to their cultural site has been restricted. 36% of the respondents admitted that it has very high impact in the ecological changes and because of the dust, cements and others components the turbidity is also increasing. 42% respondents identified that it has high impact and rest of the participants supposed it has moderate impact in the ecological change. Overfishing, according to 48% of respondents, has had a significant influence on fish population and distribution.

Fishermen also admitted that these sorts of intensive fishing operations are to blame for the steady loss of fish stocks. Similar problem has

also been identified in the study of Coll et al. (2006). 36% participants admitted that urbanization has a strong influence on the Moheskhal channel while 28% confessed that urbanization has moderate impact respectively. According to Putera and Muthalib (2017), climate/weather, money, local government laws, and environmental degradation by mining industries are among the issues encountered by seaweed growers in Southeast Sulawesi, Indonesia. While unfavourable weather patterns (19.6%), poor quality planting materials (16.7%), distortions in the purchasing system (14.7%), inappropriate aquatic environments (13.7%), poor postharvest handling (11.5%), and predator damages (10.1%) are the major issues and challenges for seaweed farming in Sri Lanka reported by Ginigaddara et al. (2018).

Present status of seaweed farmers

Nuniachara farmers perceived importance toward seaweed farming

The majority of individuals in coastal areas are directly involved in fishing. Overfishing, destructive fishing, and resource degradation are all serious concerns about coastal fisheries as a result. Many fishermen are now moving into other livelihoods, notably seaweed farming, as an alternative to fishing. Because of increasing productivity in a short period of time, the majority of the population of Uttar Nuniachara Panirkup Para is now active in seaweed farming. It has a significant impact on their economy and way of life. The majority of respondents in this survey ranked seaweed first or second in significance, which matches the findings of Ginigaddara et al. (2018) in Sri Lanka, where 94% of participants ranked seaweed first or second in importance.

Women empowerment in seaweed cultivation

All of the women stated that seaweed farming had boosted their income and the cash had helped them in their daily activities at home and because of this, they can now make savings. In comparison with the male, involvement is higher in the female participants. The majority of the women acknowledged their pleasure at being able to contribute to the family's financial well-being.

Table 2. Ecological challenges according to farmer's perspective (N=60)

Parameters	Impact	Percentage (%)
Basin size change	Very little	28
	Little	72
Basin depth change	No	8
	Very little	21
	Little	25
	Moderate	46
	High	0
Change of bottom topography	No	7
	Very little	20
	Little	40
	Moderate	23
	High	10
Temperature increase	Little	20
	Moderate	48
	High	32
Salinity	No	16
	Very little	48
	Little	36
Change in rainfall	No	12
	Very little	16
	Little	24
	Moderate	48
Change in rainfall intensity	No	12
	Little	20
	Moderate	40
	High	28
Water level rise	Little	12
	Moderate	36
	High	52
Pollution	Very little	8
	Little	12
	Moderate	28
	High	52
Airport construction	Very little	36
	Moderate	22
	High	42
Overfishing	No	16
	Moderate	36
	Very high	48
Urbanization	No	12
	Little	24
	Moderate	28
	High	36

"I was so excited because I knew I was going to gain money that may better the livelihood of my family," Rejia Begum (participant) replied when it was asked how she felt when she first started growing seaweed. Espaldon et al. (2010) also found that 60% of participants in seaweed farming are male, while the current study found that more than 70% are female. This indicates the women's empowerment in Bangladesh. They are actively involved in seaweed farming, particularly in harvesting, drying, and selling the seaweed to the local market. Some of them are giving lead to other participants with the help of different organizations.

Rubi Akter (30) and Rejia Begum (35) are one of them and they admit that it improves their socio-economic and livelihood status, and they are pleased doing it. According to the findings of Tobisson (2013); Abowei and Ezekiel, (2013), another popular view among interviewees was that seaweed farming is important in empowering women in Sri Lanka's coastal areas, which is comparable to the current study.

Seaweed culture status

Perceptions of the new technique and its impacts on livelihoods

All participants in this research considered the new seaweed farming approach beneficial. They were thrilled because they could now cultivate the more valuable seaweed species. According to them, this would be more beneficial than the traditional method. The women were enthusiastic about the new procedure, and they expressed that their families were happy. According to them, the new seaweed culture technique is the floating technique, superior to the previous approach off-bottom. According to the findings of this study, 80% of participants believed that the floating culture technique gives better production than off-bottom culture technique, which resembles with Hossain et al. (2020) where respondents gave long line 44% highest scores than other techniques (Figure 4).

Conflict of interest

The most prevalent examples in coastal communication are conflicts between fishermen and fishermen, fishermen and boat owners,

fishermen and farmers, and so on. Participants of this study acknowledged that they had a strong disagreement with the boat owner, fishermen, development worker, and other seaweed farmers of different organizations (Figure 5).

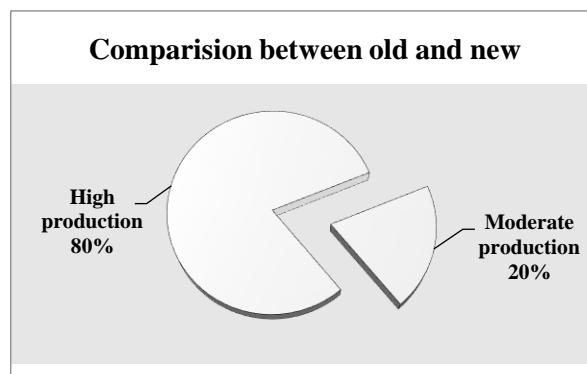


Figure 4. Comparison between old (off bottom) and new (floating) technique

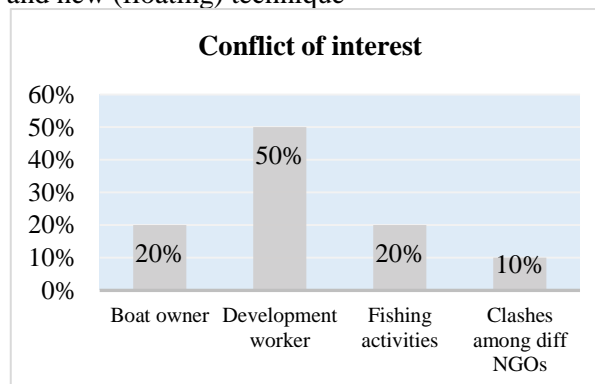


Figure 5. Conflict of interest according to farmers perspective

Boat owner

Maximum time rope of seaweed culture are tangled with boat and teared up, 20% participants agreed with that statement which tends to economic loss. According to their confession this situation creates a strong clash between them.

Development work

There is a very strong conflict between seaweed farmer and Govt. development worker. Due to development work of government such as airport construction, the area of seaweed culture are becoming less which tends to less production of seaweed and around 50% beneficiaries among participants strongly agreed with this statement.

Fishing activities

Clash between seaweed farmer and fishermen were the another most common phenomena in their community and 20% participants agreed with that. Fisherman destroys the ropes of seaweed while trying to free the seaweed which is entangled with their fishing net.

Clashes among different NGOs

In Bangladesh, maximum seaweed farmers are working under different NGOs and projects, so clashes between farmers under different NGOs also occur in coastal communities. According to the confession of 10% participants, sometimes they had to face such situations which ultimately hampers seaweed cultivation. The results of this study are dissimilar with Ginigaddara et al. (2018) where there was no conflict among the northern coastal communities in Sri Lanka.

4. CONCLUSION

From the respective study, the perceived importance of seaweed culture as a vital livelihood option proves that the system is socially and economically acceptable among the Nuniachara community. Most of the people in that community are involved in seaweed farming related activities (harvesting, processing, drying, selling and so on). Women are also dominantly involved in seaweed farming activities. Both men and women agreed that seaweed farming has improved their livelihood through improving their income status. So we can say that seaweed culture is one of the most viable solutions to face with the ongoing economic and environmental challenges; as per the 'Sustainable Development Goal'. However, seaweed farmers' livelihood is susceptible due to multiple factors such as environmental degradation, human encroachment and water pollution, social conflict and few employment opportunities. After studying their socio-economic condition, vulnerable factors and overall livelihood status we can suggest that by training local communities in seaweed cultivation techniques along with the collaboration of government and non-government facilities it will ensure sustainable practices and high quality output nationally and internationally; thus flourishing the blue economy of Bangladesh.

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REFERENCES

- Abowei, J. F. N., and Ezekiel, E. N. 2013. The potentials and utilization of Seaweeds. *Scientia Agriculturae*, 4(2): 58-66.
- Ahmed, N., and Taparhudee, W. 2005. Seaweed cultivation in Bangladesh: problems and potentials. *Journal of Fisheries and Environment*, 28: 13-21.
- Coll, M., Palomera, I., Tudela, S., and Sardà, F. 2006. Trophic flows, ecosystem structure and fishing impacts in the South Catalan Sea, Northwestern Mediterranean. *Journal of Marine Systems*, 59(1-2): 63-96.
- Das, M. R., Ray, S., Kumar, U., Begum, S., and Tarafdar, S. R. 2015. Livelihood assessment of the fishermen community in the south west region of Bangladesh. *Journal of Experimental Biology and Agricultural Sciences*, 3(4): 353-361.
- Deb, A. K., and Haque, C. E. 2011. 'Sufferings Start from the Mothers' 'Womb': Vulnerabilities and Livelihood War of the Small-Scale Fishers of Bangladesh. *Sustainability*, 3(12): 2500-2527.
- DoF. 2021. Yearbook of Fisheries Statistics of Bangladesh, 2020-21. Fisheries Resources Survey System (FRSS), Department of Fisheries, Bangladesh : Ministry of Fisheries and Livestock, 2022: 38, 138.
- Espaldon, M. V. O., Sumalde, Z. M., Rebanco, C. M., Villanueva, J. D., and Mercene-Mutia, M. T. 2010. Sustainable livelihood and seaweed farming in Calatagan, Batangas, Philippines.
- FAO. 2014. Background paper for preparation of The 7th Five Year Plan, Opportunities and Strategies for Ocean and River Resources Management, Dhaka, Bangladesh.
- Ginigaddara, G. A. S., Lankapura, A. I. Y., Rupasena, L. P., and Bandara, A. M. K. R. 2018. Seaweed farming as a sustainable livelihood option for northern coastal communities in Sri Lanka. *Future of Food: Journal on Food, Agriculture and Society*, 6(1): 57-70.
- Hossain, M. S., Sarker, S., Chowdhury, S. R., and Sharifuzzaman, S. M. 2014. Discovering spawning ground of Hilsa shad (*Tenualosa*

- ilisha) in the coastal waters of Bangladesh. *Ecological Modelling*, 282: 59-68.
- Hossain, M., Alamgir, M., Uddin, S., and Chowdhury, M. 2020. Seaweeds for Blue Economy in Bangladesh. Food and Agriculture Organization of the United Nations.
- Islam, M. R. 2008. ICZM initiatives and practices in Bangladesh. *Integrated Coastal Zone Management*. Research Publishing Services, Singapore, 81-82.
- Islam, M. S. 2003. Perspectives of the coastal and marine fisheries of the Bay of Bengal, Bangladesh. *Ocean & Coastal Management*, 46(8): 763-796.
- Mohibbullah, M., Talha, M. A., Baten, M. A., Newaz, A. W. and Choi, J. S. (2023). Yield optimization, physicochemical characterizations, and antioxidant properties of food grade agar from *Gracilaria tenuistipitata* of Cox's Bazar coast, Bangladesh. *Food Science & Nutrition*.
- Narayanakumar, R. and Krishnan, M. 2013. Socio-economic assessment of seaweed farmers in Tamil Nadu-A case study in Ramanathapuram District. *Indian Journal of Fisheries*, 60(4): 51-57.
- Prado, V. V, Junio, I. C., Tepait, E. V, Galvez, G. N., Bisco, L. P. and amp; Rivera, R. N. 2012. 2 in 1 plus mariculture farming system: A livelihood management strategy for coastal families. *International Scientific Research Journal*, 4(3): 204-213.
- Putera, A. and Muthalib, A. A. 2017. Business development study seaweed community based in order revenue improvement in the coastal fisherman Southeast Sulawesi. *Proceeding of the 1st Seminar on Sustainability in the marine fisheries sector 2017*. Faculty of Fisheries and Marine Sciences University of Halu Oleo, Kendari, Indonesia.
- Rabbani, M. G. 2007. Fisheries and socio-economic condition of fishermen of Karatoa river (M.S. Thesis, Department of Fisheries Management, Bangladesh Agricultural University, Mymensingh).
- Shamsuddoha, M. 2007. Supply and value chain analysis in the marketing of marine dried fish in Bangladesh and non tariff measures (N.T.M.s) in international trading (No. 691-2016-47361).
- Siddiqui, A. A. M., Kashem, M. A., Mondal, M. A. I. and Shafiuddin, M. 2019. Commercially important seaweed cultivation and its potentials for the coastal areas of Cox's Bazar, Bangladesh. *International Journal of Fisheries and Aquatic Studies*, 7(5): 463-470.
- Supendy, R., Taridala, S. A. A., Hafid, H., Sifatu, W. O., Sailan, Z. and Niampe, L. 2018. Income of seaweed farming households: a case study from Lemo of Indonesia. In *IOP Conference Series: Earth and Environmental Science*, 175(1): 012221.
- Tobisson, E. 2013. Coping with Change: Local Responses to Tourism and Seaweed Farming in Coastal Zanzibar, Tanzania. *Western Indian Ocean Journal of Marine Science*, 12(2): 169-184.
- Yin, R. K. 2009. *Case study research: Design and methods* (Vol. 5). Sage.
- Zaman, S., Uddin Siddiquee, S., and Katoh, M. 2010. Structure and diversity of homegarden agroforestry in Thakurgaon District, Bangladesh. *The Open Forest Science Journal*, 3(1): 40-41.