Baseline Survey on Seaweed Culture, Processing and Marketing for Employment Generation of Coastal Poor Communities in Cox's Bazar






Submitted to
IDF

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Acknowledgement

This report is produced by **the consultant** for review by IDF; the lead implementer of Seaweed Project and the donor PKSF.

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Finally, acknowledgement is expressed to all the stakeholders and community members who dedicated their valuable time to participate in the study.

Acronym, Glossary, Elaboration and Explanation

Acronym / glossary	Elaboration
BARI	Bangladesh Agricultural Research Institute
BORI	Bangladesh Oceanographic Research Institute
BFRI	Bangladesh Fisheries Research Institute
DoF	Department of Fisheries
BARC	Bangladesh Agriculture Research Council
IDF	Integrated Development Foundation
RIC	Resource Integration Centre
NGO	Non-Governmental Organization
FGD	Focus Group Discussion
KIIs	Key Informant Interviews

Executive Summary

Seaweed is a group of marine plants with a growing prospect of economic growth across the coastal states of the world. Recently, Bangladesh is also marching towards reaping socio-economic benefits as well as ecological wellbeing to reinforce the blue economic progress. This marine biota has gained an increasing reputation for its magnitude of uses, like raw materials of bio-chemicals (agar, agarose, algin, and carrageenan), dyes, food, feed, enzymes, drugs and hormones etc. among the coastal communities and enterprises. This sub-sector provides a source of livelihoods, income and generates employment opportunities. However, the quality and safety issues are some of the serious apprehensions nowadays. In this regard, this study approached to identify the opportunities and constraints for effective seaweed farming and prospective seaweed economy establishment in Cox's Bazar in terms of cost-effectiveness and willingness-to-pay by the producers and traders. In order to conduct the study, thorough literature review was ensured and the study team had regular participatory observations in the farming sites and associated markets. Some of the tools used were producer level interviews, key informant interviews and focus group discussions to identify existing and prospective seaweed trade and value chains that have the potentials to deliver results as expected by the mandate of this project. The study site is potential and has prospects for establishing effective seaweed farming and marketing given that the government policies and control over the sector is ensured. Among the legal constraints and compliances, official demarcation or zoning of seaweed farming sites by the concerned authorities (e.g. BARI, BFRI, DoF, BORI) is essential prior to such establishment. Besides, the coordination among developing organizations should be ensured to minimize overlapping. To maintain standard of the seaweed quality, the crucial part is seaweed processing with scientific method. Apart from that, proper training and technical support should be continued equipped with better technologies, research efforts and robust interventions.

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1. Introduction

Seaweeds are photosynthetic and non-flowering marine plants, which are historically being harvested across the world through both wild collection and aquaculture. About 33 genera of seaweeds, mostly red and brown, are harvested and farmed commercially (McHugh, 2003). Most of the total seaweed production is used for direct human consumption due to its nutritional values or for flavoring in the form of sushi, salad, soup, dessert and condiments (Kılınç *et al*., 2013). The remainder of seaweed harvest is used in the cosmetic, medical and food industries, as well as for fertilizers, animal feed additives, water purifier, probiotics in aquaculture, and biotechnological applications.

Seaweed has plenty of essential nutrients, especially trace elements and several other bioactive substances. The protein in seaweed is of very high quality and has all the essential and non-essential amino acids. The lipids, which are present in very small amounts, are unsaturated and thus afford protection against cardiovascular pathologies. Seaweed has abundant vitamins, including beta-carotene, which is the precursor of vitamin A, the vitamins of the B group, including B12, vitamin C, D, E and K. The very high levels of enzyme activity in seaweed help the assimilation of all these vital elements.

Seaweed culture has gained popularity as a livelihood option among the coastal communities. The cultivation is largely dependent on the ecological suitability (Agyarko, 2017). Seaweed is usually farmed in shallow intertidal areas where there is frequent flushing of the water for good growth. Compared to other means of aquaculture, seaweed farming barely requires any application of feed or fertilizers and it needs minimum technological and capital supports. Moreover, grow-out cycles in this culture are brief – usually lasting less than sixty days or so. Given these exceptional characteristics, seaweed farming has generated substantial socio-economic benefits to marginalized coastal communities in developing countries. In some communities, seaweed farming has emerged as the most potential livelihood option (Valderrama, 2012).

The coast of Bangladesh spans about 710 km in length, facing the Bay of Bengal in the south. Till recent years, about 200 species of seaweeds belonging to red, green and brown algae have been recorded in the coastal and estuarine areas of Bangladesh (Aziz *et al*., 2015). Realizing its potential to encourage the socio-economic development of marginalized coastal communities, several efforts have come into being in Bangladesh especially during last two decades (Zafar, 2007; Islam *et al*., 2017). However, there are substantial knowledge gaps and scarcity of sufficient documentation of socio-cultural dimensions, economic opportunities and sustainability, potential risks and challenges, as well as prospective changes in resilience and livelihood of the coastal people regarding their involvement in seaweed production (Krishnan & Kumar, 2010).

2. Objectives of the Study

Major objectives of the study are listed below.

- To assess the socio-economic and historical context of the seaweed farmers.
- To identify the potential seaweed species and culture area
- To assess the present status of seaweed processing and market value
- To identify the risk factors and mitigation measures
- To evaluate intervention ideas for effective seaweed farming and marketing

3. Scope of Work

The assignment was carried out in Cox's Bazar where the project already started to work with the communities for their benefit in terms of livelihood, product quality and economic return. It was found that the target beneficiaries for the project are poor households including women and unemployed youth, fisherman dependent mainly on fisheries. Seaweeds are creating new hope in the growth curve of blue economy. Furthermore, climatic stressors are also threat for the communities. In this regard, ensuring smooth seaweed production throughout the value chain would be the best scope for economic return and sustainable livelihood for the seaweed farmers. Another scope of producing seaweed has a great demand in both the export and local markets. Considering the increasing production volume of seaweed and livelihood engagement of the local communities, it can create platform for the private sectors and micro-entrepreneurs to invest and enhance the economy in different aspects. The geographic scope of the study area is given below;

Table 1: Geographic Distribution of the Study

District	Farming Location	Types of Seaweed Culture
Cox's Bazaar	Nazirar Tek, near Cox's Bazar town, by the river Bakkhali,	Project based cultivation
	Nuniarchara in Cox's Bazar town near fishery Ghat	Project based cultivation
	Reju Khal	Small commercial, Project based
	Shah Parir Dwip,Teknaf	Small Commercial, Project based

4. Methods of the Study

Respondents from different segment of the seaweed value chain were selected to gather information. A total of 50 producers were directly interviewed in this study comprising mostly women members of IDF and other NGOs. In addition, traders, processors, entrepreneurs, academics and/or researchers, concerned government officials were consulted to acquire overall view of this sub-sector.

The study team deployed the following methodical steps to carry out the investigation.

Secondary Literature Review: Reading materials and documents on seaweed production were consulted thoroughly. Published and peer-reviewed materials were consulted sufficiently throughout the studies. These documents were supportive in collecting background information about study areas and helped to meet the empirical evidence gaps.

Interviews: Major part of the data were collected from in-depth interviews of the producers, traders, wholesalers etc. Apart from that, Key Informant Interviews (KIIs) were conducted to get the concept and operational issues in the contexts. The KIs were knowledgeable persons who had ideas about the facts. The interviews were with semi-structured checklists and conducted more than one session in some cases. Government, private and Non-government Organizations were consulted and interviewed to have the indications and implications. Focus Group Discussions (FGDs) were arranged to validate the primary data. Finally, scientific institutions were interviewed to get knowledge about laboratory arrangements and the cost and benefit ideas to prepare an economic analysis for it.

Participatory Observation: Fieldworks in farming sites and community were started with an observation of probable project beneficiaries' activities. This along with informal conversations helped to get acquainted with the people and their activities. Time was taken to perceive the daily activities of the communities. Nearest markets and forward market stakeholders were also consulted with to gain an insight into seaweed farming, processing, trade and quality control.

5. Literature Review

The natural abundance of seaweeds has been observed along the south-eastern coast, especially in the vicinity of St. Martin's island of Bangladesh. Sarkar *et al.* (2016) studied on current status of naturally occurring seaweed flora and their utilization in Bangladesh. This study found 193 seaweed species including 19 commercially important species, belonging to 94 genera in the coastal vicinity of Bangladesh. Aziz *et al.* (2015) investigated on the sub-

littoral seaweed flora collected from 0.5 to 10 m depth from six localities around the St. Martin's Island, Bangladesh and revealed the presence of 39 seaweed taxa, 12 under Rhodophyceae, 11 under Chlorophyceae and 16 under Phaeophyceae with some new records. Hoq and Islam (2016) analyzed physico-chemical parameters of seaweed culture sites and culture feasibility for a seaweed (*Hypnea sp.)* in Bakkhali and Inani of Cox's Bazar coast, Bangladesh and they found the sites suitable for seaweed culture.

Seaweed culture is regarded as an economically viable livelihood option in many coastal areas. To understand the appropriate potential of this growing industry as well as to encourage the socio-economic development of marginalized coastal communities, it is indispensable to understand socio-cultural dimensions, economic opportunities and comprehend prospective changes in resilience and livelihood of the coastal people regarding their involvement in seaweed farming. Namudu and Pickering (2006) identified socio-economic factors that can be used as predictors of project impact by using results of social survey techniques carried out especially for Pacific island communities to support decisions concerning the suitability of a community for farming seaweed. Narayanakumar and Krishnan (2013) assessed the socio-economic condition of seaweed farmers in Tamil Nadu, India, where significant structural changes took place in the socio-economic status of many fishermen who have taken up seaweed farming over the last decade. Krishnan and Kumar (2010) studied the socio-economic dimensions of seaweed farming in India with an emphasis on industry-institutional linkages and scale-up of community participation in seaweed culture and trade. Msuya *et al.* (2007) conducted a comparative economic analysis of two different methods for seaweed farming – the traditional peg and line off-bottom method and the deep-water floating line method – in Tanzania. Crawford and Shalli (2007) conducted an investigation of farming practices of two different varieties of seaweeds – 'cottonni' and 'spinosum' – in order to help promote the expansion of the seaweed sector along with assessments of the relative advantages and disadvantages of the two varieties of farmed seaweeds in Tanzania. Bindu (2010) observed the extent of empowerment of the coastal communities in cultivation and processing of *Kappaphycus alvarezii* in Kerala, India through a project-oriented capacity development initiative and correlated the results and outcomes of the scientific data to the development and welfare of the grass root level of the regional community.

The worldwide seaweed industry provides a wide variety of products for direct or indirect human uses. Kılınç *et al.* (2013) compiled a global review on historical background of seaweeds usage, major sources and nutritional values of seaweeds along with their versatile application in different industries. Siddiqui *et al.* (2019) investigated on the cultivation of commercially important seaweeds and its potentials for the coastal areas of Cox's Bazar, Bangladesh.

Rebours *et al.* (2014) observed different circumstances of seaweed exploitation in European, Canadian, and Latin American countries and reviewed the requirements of long-term and ecosystem-based management plans for sustainable utilization of their natural seaweed

resources with an emphasis on integrated and participatory governance regimes. Kambey *et al.* (2020) conducted a systematic analysis of policy frameworks including legislation, regulatory tools and national standards to assess current capacity for biosecurity in seaweed aquaculture in Indonesia and identified major challenges faced by the industry in order to implement biosecurity policies in practice for improving the health and sustainability of the seaweed culture sector. Alemañ *et al.* (2019) described the current status and prospects of seaweed aquaculture industry in Latin America with a discussion on regulations in the primary countries of the region and potential strategies encouraging new strains and culture methodologies, diversification of species, market expansion and growth of domestic demand. Zulham *et al.* (2018) provided information about seaweed cultivation in Nunukan, Indonesia for better management and planning for seaweed business sustainability and recommended the local government to develop seaweed cultivation zoning to avoid conflict of sea area utilization and to improve marine water quality as well as to ensure the sustainability of seaweed investment and business.

Campbell *et al.* (2019) highlighted the current knowledge gaps associated with a developing seaweed aquaculture industry and provided research priorities to address them. Grebe *et al.* (2019) discussed the environmental and social impacts of kelp farming in different temperate coastlines by conveying suggestions for defining ecosystem and management boundaries, evaluating ecosystem services and environmental carrying capacity, adopting socially justified eco-engineering, and protecting the health and genetic diversity of wild kelp beds. Eggertsen and Halling (2020) observed on potential direct or indirect negative effects of seaweed farming and provided a summary of the current scientific knowledge to address the adverse environmental impacts related to eucheumatoid seaweed farming such as alterations of benthic macrophyte habitats and loss of indigenous biodiversity in the Western Indian Ocean region.

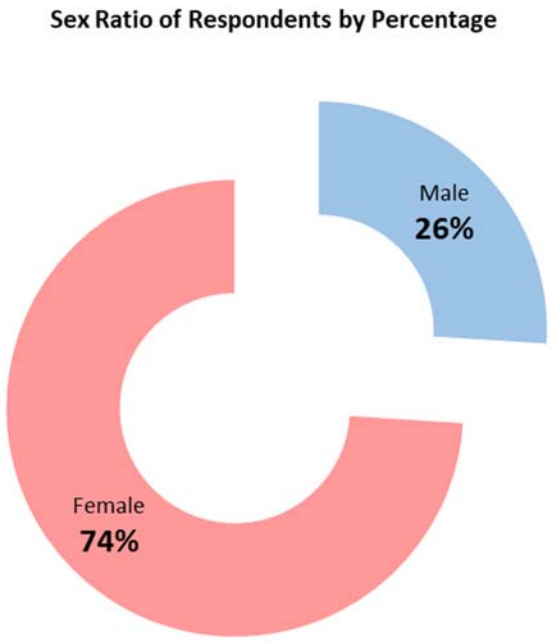
6. Results and Discussion

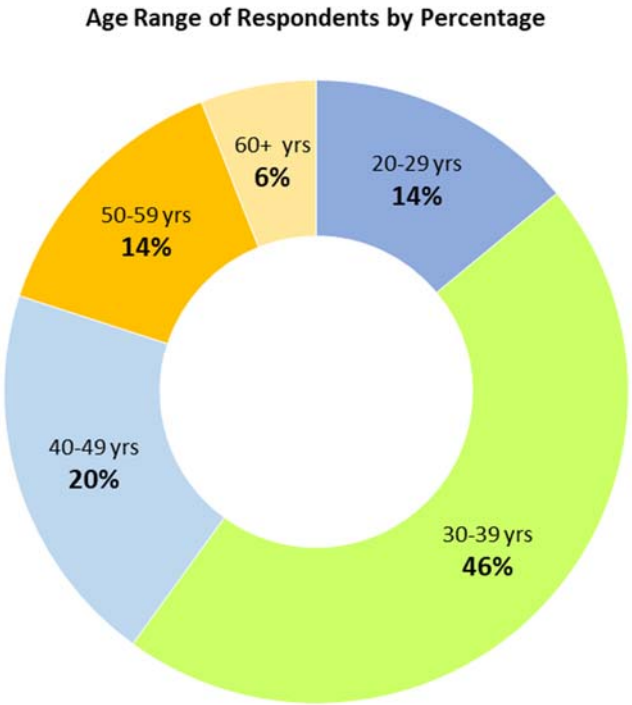
The present study came up with specific observations and discussions on various socio-economic factors related to seaweed farming in the coastal vicinity of Cox's Bazar. Following depiction of the findings are expected to provide a consolidation of strategic ideas with consistent institutional and financial support for the necessary interventions aiming to improve the livelihood of seaweed farmers as well as contribute to the blue economic growth in Bangladesh.

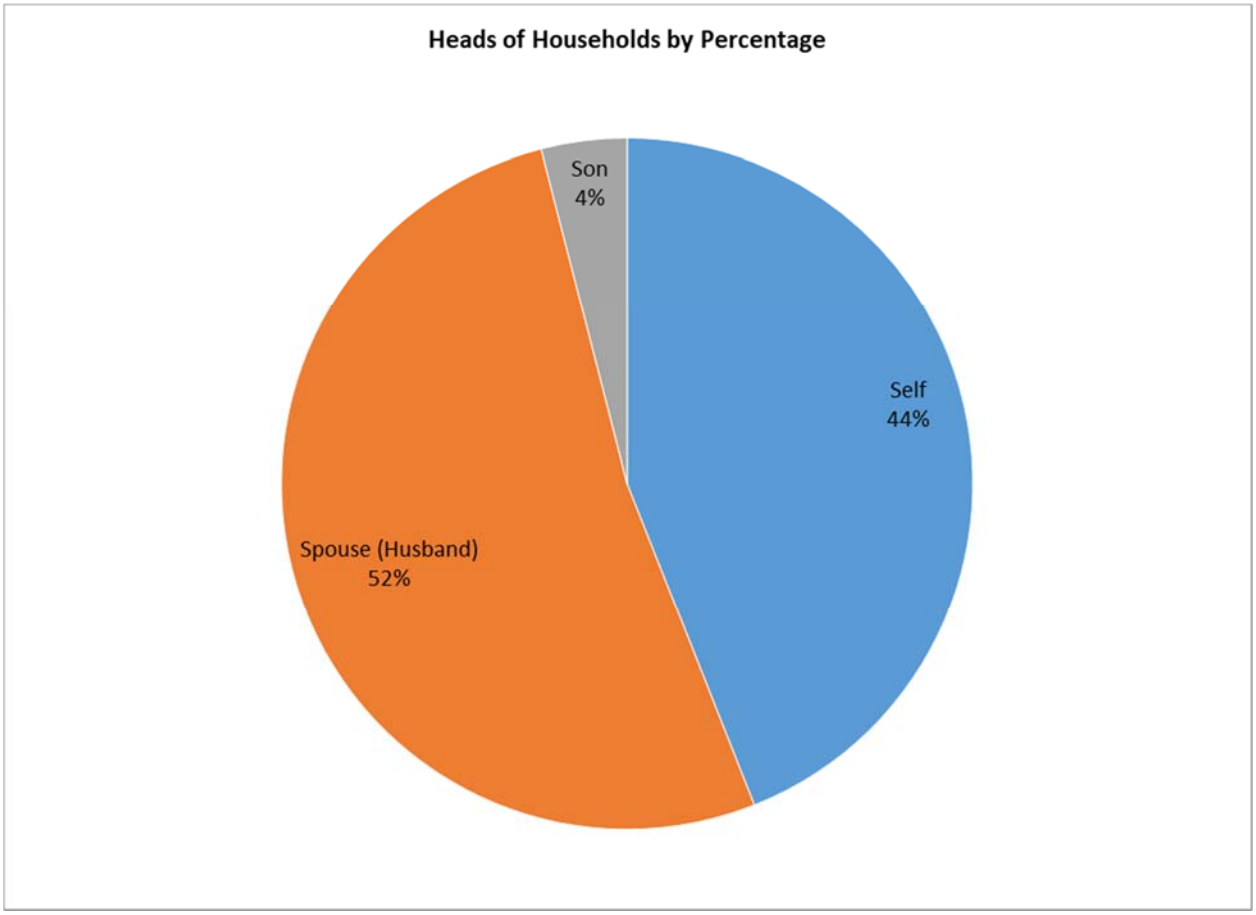
6.1. Demographics of the Seaweed Farmers

The age of the seaweed farmers ranged between 24 to 60 years old. The average age of the respondents was found 38 years old. A maximum of the respondents (46%) fell into the age group of 30-39 years old. Almost three-fourth of the respondents (74%) were female while the males comprised 26% of the interviewed seaweed farmers.

Among the respondents, 44% represented their self-headed households (male 61% and female 39%), while the rest (all are females) stated that their household heads are their respective husbands (52%) and sons (4%). The average size of a household remained at 6.05, while the maximum number of a household was 12 and the minimum was 3.

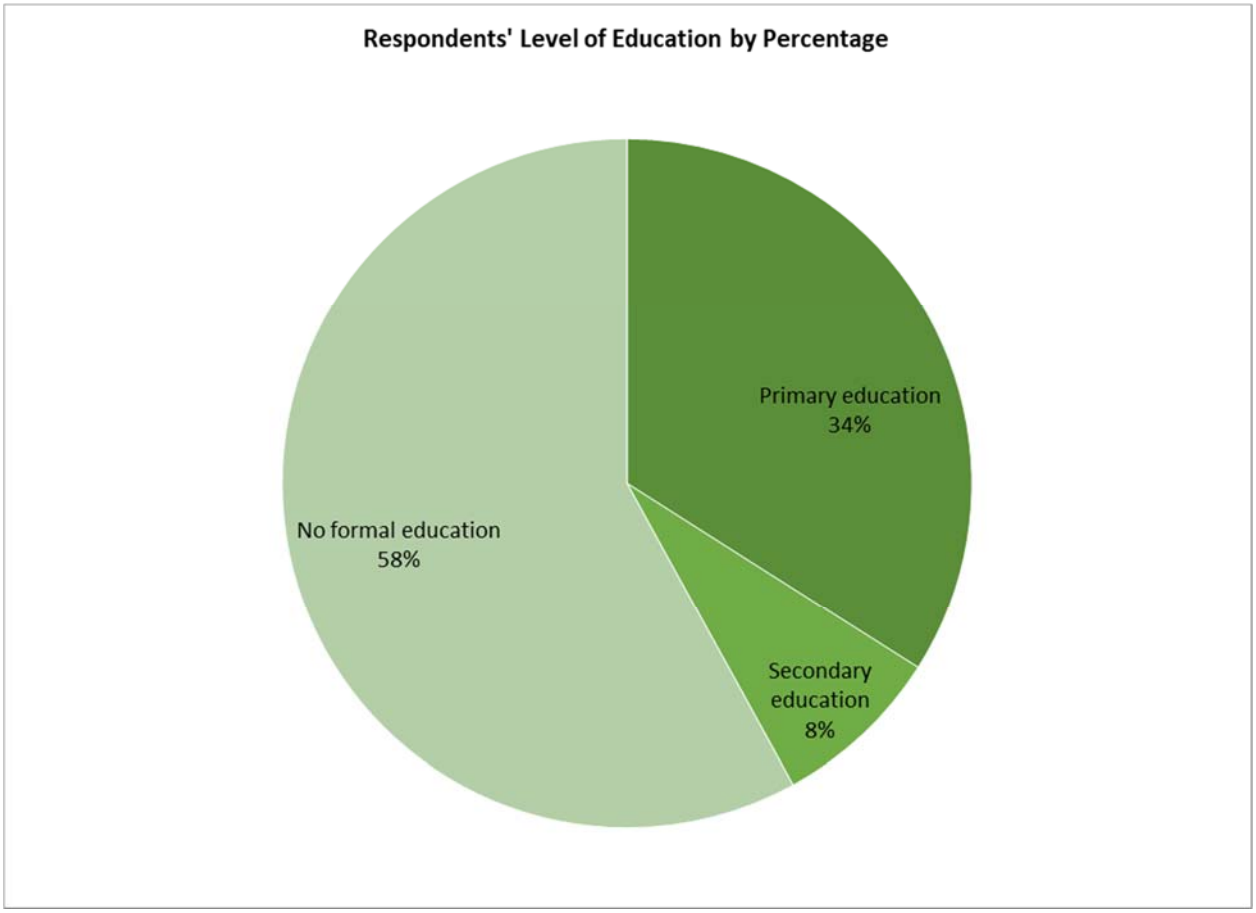






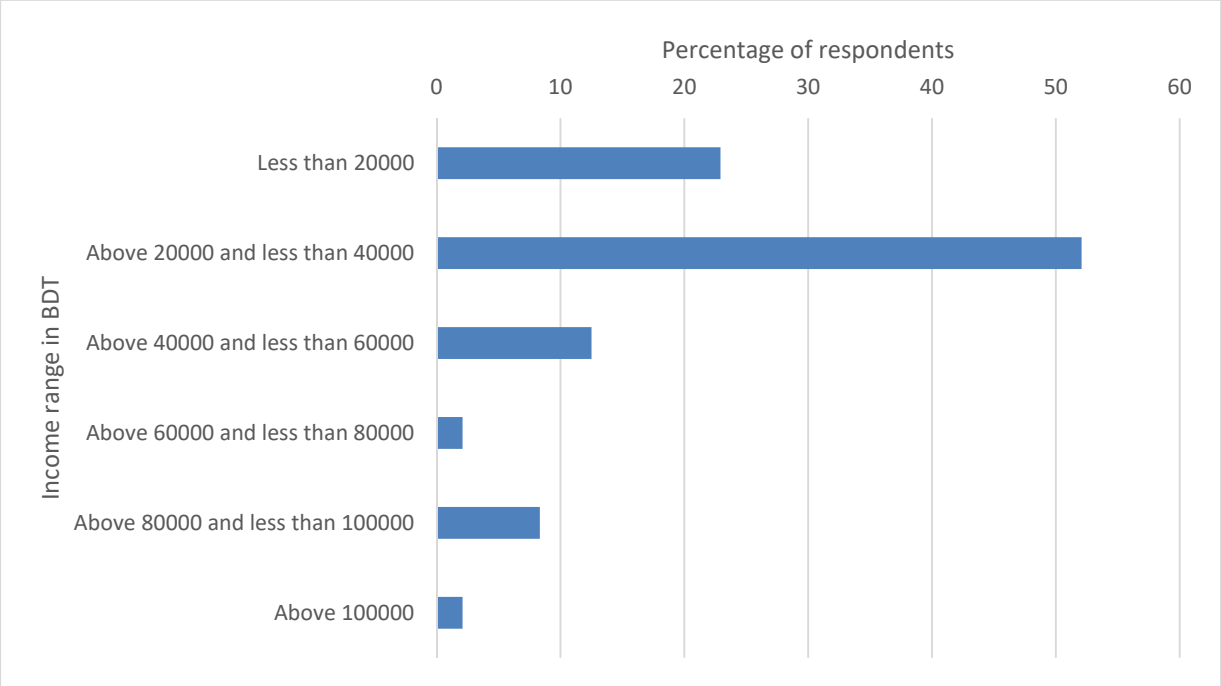
6.2. Level of Education

The educational infrastructure and facilities in the coastal rural areas of Bangladesh are not quite adequate. The current investigation also revealed that 58% of the respondents did not receive any formal education, while only 8% of them could avail the education up to different grades in secondary level. The levels of education of the respondents are presented here. On the other hand, it was observed that children from 32% of the studied households do not go to school mainly due to poverty.

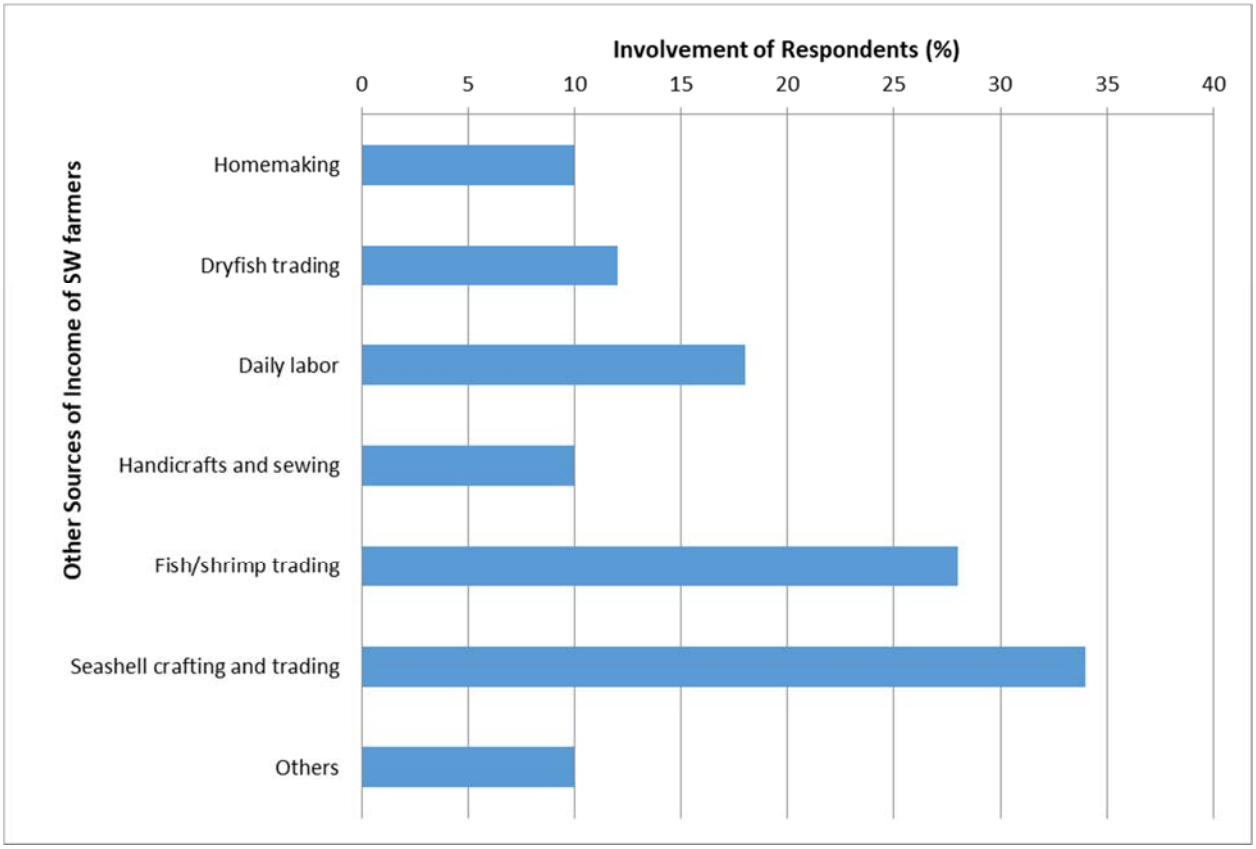


6.3. Income of the Households

On an average, approximately 35% of household members were found to be involved in income generating activities. In other word, the average number of earning members is 2.12 against the average number of total members in the studied households, which is 6.04. From the seaweed farming and trading only, the respondents earn an average amount of BDT 35,895 annually. The maximum and minimum income generated from seaweed was found to be BDT 3,000,00 and BDT 1,500 respectively from this study. It should be mentioned that respondents are involved in both farming as well as hand collection of seaweed. Those with highest income are engaged not only in farming but also in processing, trading, input supplies, relevant services etc. On the other hand, respondents in the lower income range are farmers engaged in seaweed culture for less than one year.



As the seaweed farming and relevant activities are season-driven in the coastal area of Bangladesh, most of the seaweed farmers were found to be involved with many other professions or income generating activities. Some major sources of income are presented here.



6.4. Living Standard and Assets

Seaweed farmers in Nuniarchara and Nazirartek are not local resident and majority of them came as migrant from Kutubdia, Moheshkhali and other parts of the region in search of livelihood opportunities. The people here are basically living on government khas land near the coast on a temporary basis. As they do not hold any legal rights on the land, they have the risk of being removed from this place by the authority any time. This harsh reality has created uncertainty for future of seaweed farming activities in these areas.

Most of the households' dwelling places were constructed with bamboo, mud and corrugated sheets. Some of them use tarpaulin as the roof or shade. Their living houses were comprised of rooms numbering between 2 and 5 per household. 79% households had electric fans in their houses, while most of them (about 95%) possessed cellular (mobile) phone. Televisions were owned by 30% of the interviewed households. Only very few households were found having refrigerator and stereo system at their homes.

Some of the studied households owned vehicles like rickshaw van, battery-driven auto rickshaw, CNG-driven auto rickshaw, bicycle and motorcycle. Most of the respondents source

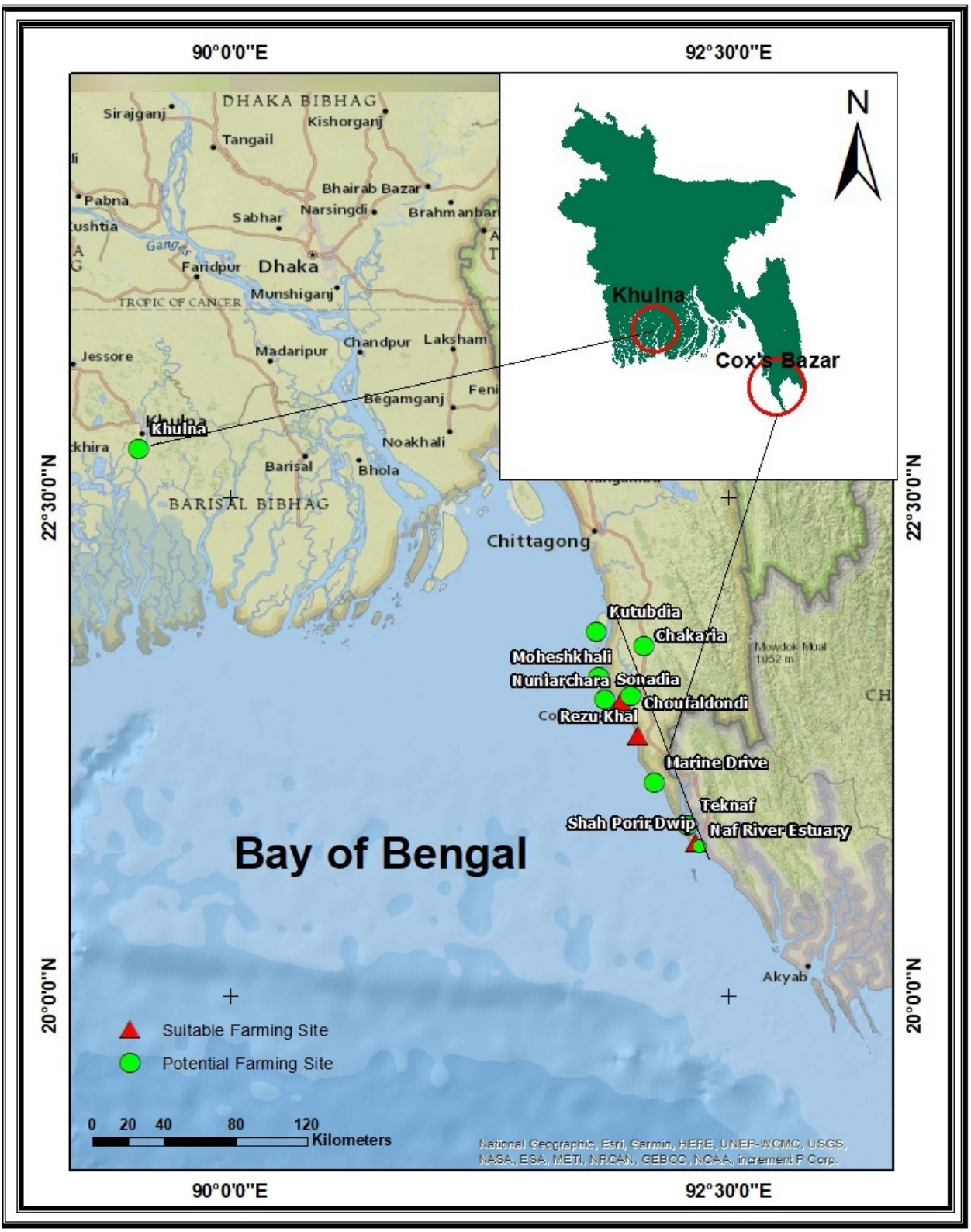
their drinking water from tube wells, while a few of them occasionally have boiled water. All of the respondents were found using sanitary latrine, most of which are pit type.

6.5. Seaweed Farming Sites and Resources

Seaweed culture sites were observed at St. Martin's Island, Shah Parir Dwip, Reju Khal estuary, Inani, Nuniarchhara, Charpara and Chaufaldandi of Cox's Bazar along the coast of Bangladesh. According to the key Informants, the suitable and potential sites for seaweed farming are located both on the south-east (Cox's Bazar) and south-west region (Khulna) with suitable salinity regime and ecological parameters. However, this requires extensive investigation and research efforts.

Among the species of seaweed being cultured in Bangladesh, the most common one is *Hypnea sp.*, followed by *Enteromorpha sp., Ulva sp., Hypnea sp.* etc. Although, there are a number of potential seaweed species in Bangladesh for aquaculture, the farmers are yet to explore the opportunities of farming these species beyond their well-adapted choices stated above.

The genera Hypnea are agarophytes used for commercial purposes. Hypnea is used for those applications in which the strength of the gel is not critical, e.g., food products. In other cases, Gelidium or Gelidiella, separately or mixed with Hypnea, is utilized for the manufacturing of bacteriological-grade agar. Enteromorpha, a bright green filamentous seaweed, is commonly seen on many of our shores. The seaweed may dominate some shores at certain times of the year, to form a bright green furry, short-pile carpet over rocks and stones. Clumps are sometimes seen on sandy areas. Some species are eaten by people, the fine mossy ones used to garnish dishes in Japan and some parts of China. They are also used as animal feed, fertilizer and as medicine for their antibacterial properties. Ulva is an edible green alga in the family Ulvaceae. It is used in cooking, soups, with meats and fish, and salads.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6.6. Seaweed Culture Method

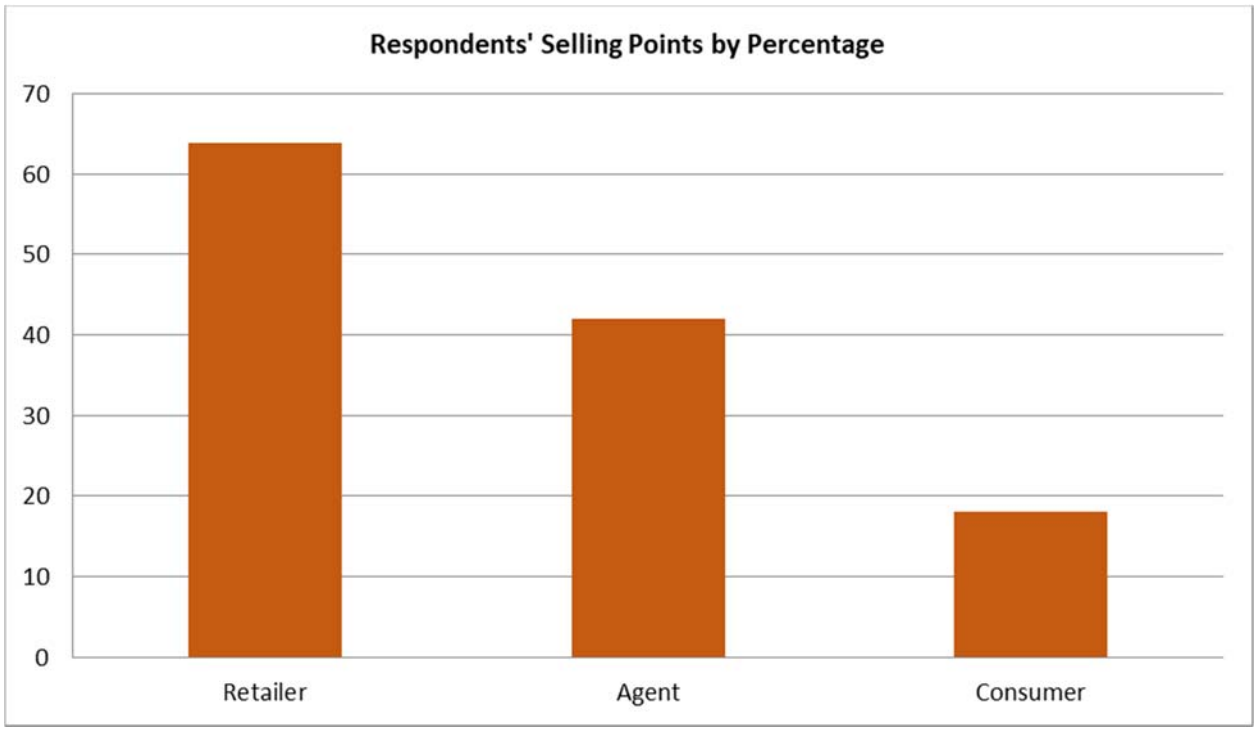
Most common practices in seaweed culture were observed as net method (floating or submerged) and long-line method. During the study, it was seen that the long-line method is the most dominant practice among the seaweed farmers in Cox's Bazar. In this method, at first, seaweed seeds are collected from natural habitat and then approximately 50 gm of the wild seeds are planted in a twisted rope (long-line) of 25-30 meter length with a distance interval of 10 inches (25 cm) from one seed to another along the rope. Then the ropes are tied to bamboo poles in the low tide zone so that the ropes can be submerged during the high tide. In net method, a square frame made of coir or nylon ropes – usually measuring 5×5 m^2 – with a mesh size of 25 cm is placed in the lower intertidal zone using the support of bamboo poles and the wild seeds are planted between the twists of the net ropes with the same distance interval maintained in the long-line practices. Depending on the species diversity and growth in mass, the seaweeds are harvested in an interval of 15-30 days during the production season.

6.7. Harvesting and Processing of Seaweed

Seaweeds are usually handpicked from the culture sites. Sometimes farmers use knife or sickles to cut the harvests. Then the products are sun-dried after washing with clean water. Some farmers use the air-drying method if enough sunlight is not available during the processing. Then the products are packed in polyethylene bags. Both fresh and dried seaweed products are sold depending on the type of consumption and demand.

6.8. Seaweed Market Systems

Seaweed farming or collection, marketing and processing still take place in a disorganized manner in the coastal vicinity of Bangladesh. For collection of seaweed from wild and trading of the same, there is no legislative obligation. Usually, instances of the seaweed farmers or collectors become an intermediary entity of trading or agent, who ultimately play the vital role in the seaweed supply chain and market systems. Seaweeds are sourced in the market through three basic channels – 1) collection of seaweed from the wild stocks by local individuals; 2) independent/ contract farming of seaweed with the support of different culture methods and, 3) enterprise/ commercial farming of seaweed by engaging wageworkers. Multiple responses were found from the farmers regarding their selling points of seaweed. Most of the seaweed farmers (64%) sell their products to the retailers. While some agents (42%) and local consumers (18%) also appear as the buyers of seaweeds.



The selling rate of fresh seaweed at farmers' end was BDT 30-50 per kilogram, while the same of dry seaweed was 200-300 per kilogram. Seaweed farmers' harvested products were sold

to retail customers, local stores and markets, agents in Cox's bazar, Bandarban, Barishal and Bhola. Some products were also exported to Myanmar, China, India and South Korea.

6.9. Socio-economic Impacts

The socio-economic impacts of seaweed farming were observed by assessing the changes in livelihood assets of the respondents. Among them, 74% seaweed farmers achieved membership in different community groups for savings and/or credit benefits facilitated by various NGOs, research and development agencies or projects such as BARC, IDF, RIC, Coast Trust, Asha, Shakti Foundation, BARI, ECOFISH etc. Some of them were able to purchase or restore their existing house using the income earned from seaweed, while very few of the studied group managed to purchase or lease lands for agricultural farming or kitchen-gardening. Seaweed farming also had a great positive impact on the ability of the seaweed farmers to purchase livestock, quality clothing and consumer durables. The respondents also became confident to use different electronic appliances. Some households were found relieved to settle marriage issues, family disputes or prevent children's school drop-out through the income generated by seaweed culture. Seaweed farming has indeed emerged as a new, sustainable livelihood option for the coastal communities in the study area. The respondents also showed their improved awareness regarding the health benefit of seaweeds. 82% of the interviewed farmers were found quite familiar with the positive impacts of seaweeds on different health complications related to gastric system, cardiovascular issues, hormonal imbalance, diabetic episodes and other deficiencies. They stated that more aggressive promotions on the benefits of seaweed would accelerate the dynamics of this prospective enterprise. So, seaweed aquaculture with appropriate policy, financial, technical and institutional supports is expected to avert the pressure on and overexploitation of marine fisheries and other natural resources. The socio-economic impacts of seaweed farming on various livelihood assets the farmers are shown here.

Livelihood Assets	**Socio-economic Impacts**
Financial	- Membership in community groups for savings and/or credit benefits by NGOs
Physical	- Purchase livestock, quality clothing and consumer durables - Purchase or restore existing house - Purchase or lease land for agricultural farming
Human	- Confidence in using different electronic appliances. e.g. Android phone etc. - Awareness raised on health benefits of seaweeds
Social	- Relieved to settle marriage issues

	- Able to settle family disputes - Prevent children's school drop-out
Natural	- Vast coastal area suitable for seaweed farming offering a sustainable livelihood option

7. Constraints Analysis

The study team consolidated the constraints of seaweed aquaculture and its economy by categorizing the same according to their association with different market actors along the value chain.

Market Actors	Function	Constraints
Farmers/ collectors	• Cultivate seaweed using rope and net method • Collect naturally grown seaweed • Process seaweed to make them suitable to sell	They have no proper knowledge about the processing method of seaweed. Most of them are unaware about the fact that seaweed is the green gold of our country. They cultivate them effortlessly, but do not get enough pay-off from the buyers.
Buyers/wholesalers/ retailers	• Buy seaweeds from producers (both in raw and dried form)	They do not get the proper market place to sell the product. The transportation cost restrains the selling process.
Development agency/ enterprises	• Provide essential loans and farming instruments to the farmers • Provide adequate training to the farmers to farm seaweed	They provide essential equipment and loans to the farmers for seaweed cultivation, but do not provide any marketplace or solution to sell the product.
Government research institutions	• Deploy advanced culture methods (pilot project) to make seaweed farming popular among mass people • Take initiatives to train farmers to adapt essential processing methods • Initiate interventions to encourage seaweed farming among the coastal people	Several projets on seaweed cultivation are commissioned by BFRI, DOF in Cox's Bazar (Reju khal, Shah Parir Dwip, Nuniarchara). But there are no steps on seaweed processing and marketing yet. The entire journey is limited to farming so far.

Consumer	• Local ethnic (tribal) communities consume seaweed in edible form (such as salad, pickles, soup) • Local community consume seaweed with betel-leaf and makes salad, curry and soup	Local ethnic (tribal) communities consume seaweeds occasionally for its medicinal value. The local people of Nuniarchara take seaweed in raw and cooked form. But it is not popular among the people in other regions of the country.

8. SWOT Analysis of Seaweed Farming and Marketing

Strength	Weakness
• Signature product from the coastal area • Requires less effort • Cheap to cultivate • Cheap labor cost • Suitable environment for vast growth • Grows naturally in our coastal area • An asset to add medicinal advancement • Takes short life cycle to mature • Easily grows in integrated environment • A breeding ground for marine biodiversity • Grows naturally in salt-bed	• Prone to damage caused by natural or anthropogenic action • Lack of awareness among the farmers • Cheap product value • Expensive processing method • Absence in regular diet at national level • Comparatively unfamiliar among seafood • Small domestic market • Line up with industry yet to establish
Opportunity	**Threats**
• A new hope in blue economy • A GDP product of our coastal area • Can be a rising employment sector • Will be a sector for women empowerment • An alternate employment sector for coastal community • Scope to expand market both national and internal level	• Land use conflicts (e.g. Extension of Airport, Falcon Intl.) • Environmental pollution • Lack of knowledge in local community • Volatile and unfair farm gate price • Lack of technical know-how and training • Lack of stability in supply chain • Limited buyers • Farming/zone not demarcated

• Investment opportunities on research for product development	

9. Recommendations

The study team realized that some enthusiastic activities based on pragmatic strategies should be implemented to ensure the growth and sustainability of seaweed aquaculture and its market in Bangladesh. All the capable stakeholders need to come forth to initiate necessary planning for successful accomplishment of the potential interventions in this regard. Some key suggestions are briefly mentioned below.

- Expansion of existing capacity development efforts
- Development of field trials and experiments with new/ alternative technologies of seaweed production
- Technical improvement and effective knowledge transfer for seaweed processing and value-added product manufacturing
- Establishing stronger market linkages and sustainable modes of communications among the seaweed producers, traders, manufacturers and other value chain actors
- Regulating and monitoring the farm gate price of seaweed products and ensuring fair trade across the supply chain
- Developing designated sales center or outlets with farmers' access
- Strengthening the promotional initiatives and dissemination of right information emphasizing on the nutritional, medicinal, industrial, social and ecological benefits of seaweeds
- Arranging affordable financial schemes and relevant incentives for better access to finance
- Ensuring appropriate coordination and synergy among the policy makers, research and development partners, producers and other stakeholders

10. Conclusion

Seaweeds are renewable natural resource abundant in our coastal vicinities. The aquaculture of seaweed has been proved to be an economically viable livelihood option for the rural communities projecting a special hope for women empowerment along the coastal belt. In this regard, a sustainable market system can boost the seaweed cultivation process. The coast of Cox's Bazar is suitable enough to support stable seaweed cultivation and marketing-based industry to contribute to the blue economy. The socio-economic benefits and environmental resilience of seaweed farming can be achieved by the mechanism of good governance which should ensure synchronized interaction among the policy makers, research and development partners, producers and other stakeholders. Therefore, the seaweed subsector in Bangladesh has adequate potential to grow with prosperity.

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