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Commercially important seaweed cultivation and its potentials for the coastal areas of Cox's Bazar, Bangladesh

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Abstract
Bangladeshis a low-lying, riverine country located in South Asia (24°34' to26°38' North, 88°01' to 92°41' East). The total area of the country is 147,570 sq. km (56,977 sq. miles). Bangladesh is in the transitional zone for the flora and fauna of the Indian subcontinent and Southeast Asia, and is part of the Indo-Burma biodiversity hotspot. The country features a great diversity of natural ecosystems. Bangladesh has a coastal zone of 480 km coastline and 25,000 km^2 of coastal area with a huge population, supporting a variety of land use practices. This coastal area with sandy and muddy beaches, estuaries and mangrove swamps can be provided suitable substrate and habitats for various seaweeds cultivation. Bangladesh is rich with 133 species of seaweed and fourteen of them are commercially important. Seaweed farming is highly developed in many south-east Asian countries. Seaweed is also an ingredient for bio-chemicals, pharmaceuticals and cosmetics industries. However, the seaweed industry in Bangladesh is an initial stage. Seaweed, if systematically cultured and explored, could emerge as a vital agricultural product for coastal people, be consumed as dishes and used in the pharmaceutical and cosmetic industries and contribute to the national economy. Seaweed could grow on rocks, soft sediments, pebbles and even on other marine algae it was abundant in St Martin's Island, Inani Beach, Cox's Bazar and Sundarbans. Sea is a unique reservoir. There are resources with limitless possibilities. Seaweed is one such precious blessing of the sea. History says, in 1670, the first cultivation of seaweed started in Japan's Tokyo. Its commercial cultivation started in 1940. Along with Japan, Philippines, Vietnam, Thailand and many other Asian countries started cultivating it. Seaweed is a great source of various vitamins, minerals and iodine. Beside Cox's Bazar airport, on the beach of Nuniyachhara of Maheshkhali channel, recent growing unique activity of seaweed farming. Hypnea species of seaweed is being cultivated in tidal coastline of Nuniyachhara beach.

Keywords: Seaweed, blue economy, Sundarban, economic, cox's bazar

Introduction
Bangladesh has a 710-km-long coastline and a 25,000-sq-km coastal area, supporting a variety of land use practices. This coastal area, with both sandy and muddy beaches, estuaries and mangrove swamps, provides substrates and habitats for the cultivation of various kinds of seaweeds, according to experts. People in Bangladesh are still not aware of the seaweed potential area. A few people are involved in seaweed cultivation in the south-eastern and south-western coasts of Bangladesh. Seaweed culture can be introduced in areas suitable for their cultivation by familiarizing poor farmers with cost-effective technology. Seaweeds can be cultivated using indigenous materials such as bamboo and rope. As seaweed cultivation requires a low quantity of inputs provides good returns and also employs many people, seaweed culture can be a good industry for coastal communities in Bangladesh. The country has no less than 140 species of seaweeds, ten of which were commercially important. Efforts are needed to increase production through improving harvesting techniques, creation of artificial habitats and seeding of suitable coastal areas. Bangladesh should therefore promote the cultivation and consumption of seaweed among their people.
In addition, extensive surveys need to be conducted to identify suitable sites for large-scale seaweed culture. The technology for the cultivation of different commercially important seed stocks and their improvements should be developed through research.

Review of literature

The seacoast of Bangladesh is one of the unreached areas of the world in the field of psychology. There is lack of very fundamental information and statistics regarding seaweeds distribution, total seaweeds and commercially important species available, abundance, seasonal availability, status and approaches for utilization in Bangladesh (Majumder, 2010; Khan, 1990) [2]. Seaweed has plenty of essential nutrients, especially trace elements and several other bioactive substances.

History says, in 1670, the first cultivation of seaweed started in Japan's Tokyo. Its commercial cultivation started in 1940. Along with Japan, Philippines, Vietnam, Thailand and many other Asian countries started cultivating it. Seaweed is a great source of various vitamins, minerals and iodine. Japan produces seaweed worth two billion dollar every year. According to FAO, 25 thousand tones of seaweed is produced all over the world. Its commercial value is 6.5 billion dollar. Bangladesh, having a coastline stretching 710 km, bears a good prospect of blue economy revolution through seaweed cultivation. Bangladesh's Saint Martin Island is a great source of naturally produced seaweed. As far as we know, there are 215 species of seaweed of 102 groups. However, due to the crowd of visitors and local's negligence, many species of naturally produced seaweed are getting extinct gradually.

Seaweeds form a very important part of the marine ecosystem. Seaweeds can physically dominate the whole benthic environment and provide not only the primary food sources but also habitats for a whole range of other marine organisms. Seaweed is found throughout the world's oceans and seas, and none is known to be poisonous (Zemke-White and Ohno, 1999). Most seaweed species are red (6000 species), brown (2000 species) or green (1200 species) (Robinson *et al*., 1980) [4].

Seaweed has become a very versatile product widely used for food in direct human consumption. Therefore seaweeds are valuable sources of human food. Almost everywhere in the world, from ancient times, people have been consuming seaweeds. The Japanese, the Chinese, the Filipinos and the Hawaiians consider seaweed a food of great delicacy and have been using it in their diets for centuries (Armisen, 1995) [5]. Seaweeds are found in the coastal climatic zones throughout the world i.e. from the warm tropics to the icy Polar Regions. Seaweeds have been reported to be used for various purposes by the Romans, Egyptians, Japanese, and Chinese in the ancient time (Drugs.com, 2015 [8], National Ocean Service, 2015, Dillehay *et al*., 2008) [6]. The extent and scope of seaweeds utilization in this modern world is increasing (McHugh, 2003) [7]. Utilization of seaweed as human food was once confined only in Japan, China and Republic of Korea but now spread to mass people of North America, South America Europe and Australia (McHugh, 2003, Kılınc *et al*., 2013) [7]. Apart from conventional seaweed food products like Japanese Nori or Purple Laver and Korean Wakame, seaweed food products like burger, juice, sandwich, chocolate, ice-cream, cake, salad, biscuit, chips etc. are producing on commercial basis (Sarkar, 2015).

Therefore seaweeds are valuable sources of human food. Almost everywhere in the world, from ancient times, people have been consuming seaweeds. The Japanese, the Chinese, the Filipinos and the Hawaiians consider seaweed a food of great delicacy and have been using it in their diets for centuries (Armisen, 1995) [5]. Seaweed has been a staple food in many other countries for a very long time. The green seaweeds such as: Enteromorpha, Ulva, Caulerpa and Codium are utilized exclusively as source of food. These are often eaten as fresh salads or cooked as vegetables along with rice. Porphyra (Nori), Laminaria (Kombu) and Undaria (Wakame) are used for making fish curry and meat dishes as well as soups and accompaniments (Sajid and Satam, 2003) [14]. The seacoast of Bangladesh is one of the unreached areas of the world in the field of phycology. Seaweed has plenty of essential nutrients, especially trace elements and several other bioactive substances.

Objectives of the Study

1. To ensure that long-term food, water, health and nutritional securities of the people are met through the conservation of biological diversity
2. Maintain and improve environmental stability for ecosystems
3. Ensure preservation of the unique biological heritage of the nation for the benefit of the present and future generations;
4. To proper utilization of blue economic resource.

Approach of Methodology& Sampling

This study was designed and conducts to know the present status of naturally occurring seaweeds flora and its utilization pattern in 9 place of Cox's bazar District of Bangladesh (Uttar nuniarchara, Najirar Teck, Khuruskul, Cox's Bazar Sadar, Cox's Bazar; Pacher Dip of Ramu, Inani Beach Ukhiya, Samlapur, Shilkhali, Shah Parir Dip, Saint Martin's, Teknaf). Geographically these areas have been identified as the most important and promising areas for seaweed cultivation, because of the availability of coastal areas, favorable resources for seaweed cultivation, climatic conditions, cheap and abundant labour. Therefore the coastal district of Cox's Bazar was selected for the study (Figure: 1).

Seaweed is a marine alga that is generally classified as a plant. Seaweed is a primitive type of plants lacking true roots, stems and leaves (Robinso *et al*., 1980) [4]. This study work period we have identified following species which have huge export market and medicinal values (Table 1, Figure: 4)

Methodology

The study was undertaken for six months from June to November 2011. A survey involving participatory approach, qualitative and quantitative data were collected using following methods:

1. **Primary Data Collection:** Primary data were gathered by field surveys. This information was also used to confirm the secondary data. A combination of the following survey techniques were used for primary data collection.
2. **Secondary Data Collection:** Data about seaweed cultivation, its potentials and constraints were collected from published and unpublished documents, relevant government and nongovernment organizations, research institutes and universities.

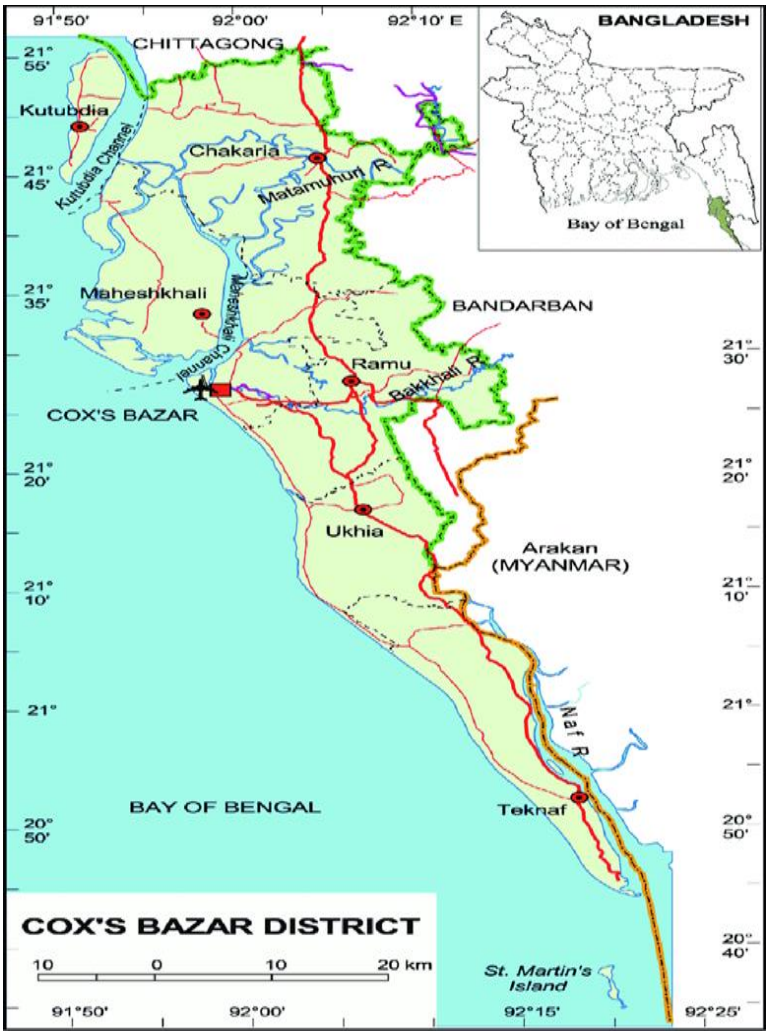


Fig 1: Selection of Cox's Bazar and St. Martians Island as study area of Bangladesh coast where seaweeds are naturally available every year from October to April.

The following culture method was used seaweed cutting/small piece attached with net or rope in floating or attached system for collection of sample from identified spot place. The study team tries to used planting system in the muddy beach of Naf river area and found that ways *Caulerpa* sp. grown were firstly then rope /net system.

Attached method

1. Long Line method
2. Long line with hanging line
3. Net method

Floating Method

1. Floating long Line method (Fig: 3 C)
2. Floating long line with hanging line (Fig: 3A)
3. Floating Net method (Fig: 3B)

Plantation Method

Participatory Rural Appraisal (PRA): PRA is a group of methods to collect information in a participatory fashion from rural communities (Chambers, 1992). The advantages of PRA over other methods is that it allows wider participation of the community, the information collected is likely to be more accurate. For this study, PRA tool such as focus group discussion (FGD) was conducted with fishermen and coastal communities in Coxsbazar of Bangladesh. FGD was conducted to get an overview of present condition of seaweed farming in Bangladesh, its potential and constraints. FGD sessions were held on front of village shops, under the big trees, fishermen's houses and school premises wherever there are spontaneous gatherings and where participants can sit, feel comfortable and are easily observed.

Cross-Check Interviews: Cross-check interviews were conducted with key informants such as school teachers, local leaders, seaweed researchers from different universities and research organizations, and relevant NGO workers and local people. Where information was contradictory further assessment was carried out.

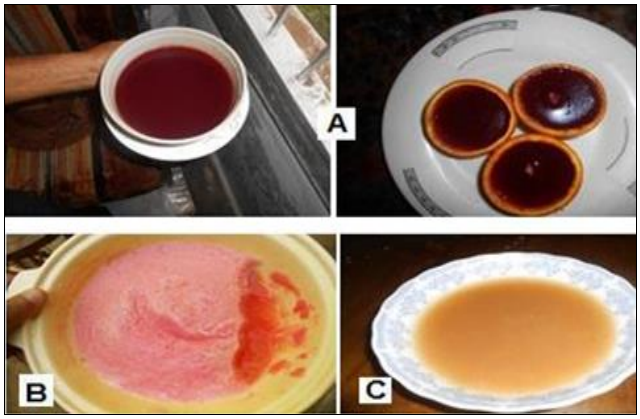


Fig 2: Different seaweed products A Seaweed jelly. Seaweed ice cream, C. Seaweed soup

A. Seaweed Cultivation of Attached Net System B. Net Culture System C. Long Line Rope System

Fig 3: Sample collection and harvest from Saint Martin Island & Cox's bazar

Discussion

Present status of naturally occurring seaweed in Bangladesh

Distribution of seaweeds

In Bangladesh, seaweeds have been traditionally utilized as human food by the tribal people. There is no regular seaweed industry in Bangladesh. Some local collection of seaweed can occur for two to three months from November to January in the year. There is good growth of the edible green, red and brown seaweeds in the Sundarbans mangrove forests, on the pneumatophores. Defying the government ban, the poor people in St. Martin Island used to collect seaweed in a limited scale for their livelihood during April-May season which are being exported to Myanmar, China and Singapore.

Seaweeds are generally seen in the littoral and sub-littoral zones of Sundarbans Mangrove Forestto St. Martin Island of Bangladesh (Islam, 1976; Islam and Aziz, 1987; Islam, 1998). Salinity of 2-34 ppt, P^H 7.5-8.5 and 20-30 °C is required for seaweed growth and Sundarbans offer a favorable condition by fulfilling the criteria (Satpati *et al*., 2012; COAST Trust, 2013) [12]. Nine species of seaweeds were reported from the Indian Sundarbans mangrove forest namely *U. lactuca*, *U. intestinalis*, *Catenellarepens* and *C. nipae* followed by *Gelidium*, *Polysiphonia*, *Ceramium*, *Bostrychia* and *Compsopogon* (Satpati *et al*., 2012) [12]. McHugh, 2001 reported good growth for the edible red alga, *Catanella*, in the Sunbarbans mangrove forests, on the pneumatophores. These species were also found in the present study. Comparatively less seaweed species is expected in Sundarbans than other places where seaweeds are naturally available in Bangladesh due to the presence of suspended solids from tidal silt, rotten leaves etc. in water which hinder light penetration causes low growth of seaweeds in Sundarbans (Satpati *et al*., 2012) [12]. One hundred forty seaweeds species from St. Martin's Island, 10 species from planted mangrove region and 5 species from Backkhali-Moheshkhali channel estuary of Cox's Bazar was reported by DoF (2014) [15]. Seaweed species are abundant Shaplapur coast, Shahparirdip area of Teknaf, Nuniarchara, Nazirartek of Bakkhali-Moheshkhali river estuary Jaillapara of Teknaf and in planted mangrove forest or Parabon region (Haque, 2013) [11].

Water quality parameters of the St. Martin's Island, which situated in the extreme South-eastern corner of Bangladesh, appear to be very positive for seasonal abundance (Khan, 1990; Tomascik, 1997; Zafar, 2005; Haque, 2013; COAST Trust, 2013) [1, 19, 16, 11, 13]. Rocky substrates, which are crucially required for seaweed habitat are available around the St. Martin Island except the north coast (FAO/NACA, 1996; Hossain, 2004) [21]. Therefore, St. Martin Island is an extraordinary place for natural availability of seaweeds

Favorable climatic, environmental conditions and interconnected network of waterways make natural availability of seaweeds throughout whole Sundarbans mangrove forest where benthic forms of seaweeds naturally grow in inter-tidal areas on pneumatophores of mangrove tree, other wooden logs and barks of trees. Around 60 seaweed species are found from Sundarbans and amongthose, Boodliopsissun darbanensis, Ulvalactuca and *U. intestinalis*, Catenellarepen, *C. nipae*, Gelidium, Polysiphonia, Ceramium, Bostrychia, and Compsopogonetc.are available. About 155 seaweed species are found in Cox's Bazar. In Cox's Bazar region, seaweeds are very abundant at Shilkhali/Shaplapur coast, Jaillapara, Shahparirdip area of Teknaf, Nuniarchara, Nazirartek of Bakkhali-Moheshkhali river estuary, Moheshkhali and and at planted mangrove forest or Parabon region. In Cox's Bazar, natural seaweed beds are found at Nuniarchara to Nazirartek areas of Bakkhali River and Moheshkhali Channel estuary and in Moheshkhali Island. *Hypnea musciformis* and *Enteromorpha intestinalis* are the main seaweed species of seaweed beds. About 140 seaweed species are found at St. Martin's Island. The St. Martin's island has four coasts: Western, Eastern, Southern and Northern coast. Seaweeds are not available at northern coast. *Sargassum coriifolium*, *Chaetomorpha moniligera*, *Gracilaria verrucosa*, *Colpomenia sinuosa* etc. seaweed species are found from southern coast. In eastern coast, *Sargassum coriifolium*, *Hypnea musciformis*, *H. pannosa*, *Hydroclathrus clathratus*, *Colpomenia sinuosa*, *Padina arborescens*, *Chaetomorpha moniligera*, *Gracilaria verrucosa* etc. seaweed species are found, whereas in western coast, *Gracilaria textorii*, *Hypnea musciformis*, *H. pannosa*, *Petalonia fascia*, *Dictyopteris divaricatum*, *Sargassum coriifolium*, *Enteromorpha compressa*, *Colpomenia sinuosa*, *Gracilaria verrucosa*, *Chaetomorpha moniligera*, etc. species are found. Seaweeds are more abundant in western coast of St. Martin Island than eastern coast.

Commercially important seaweed species

Among the available seaweed species, 19 species of 14 genera are considered as economically important (Table 1) Natural production of seaweeds: Approximately, 5,000 metric ton seaweed biomass is annually available throughout the whole Bangladeshi coast from October to April.

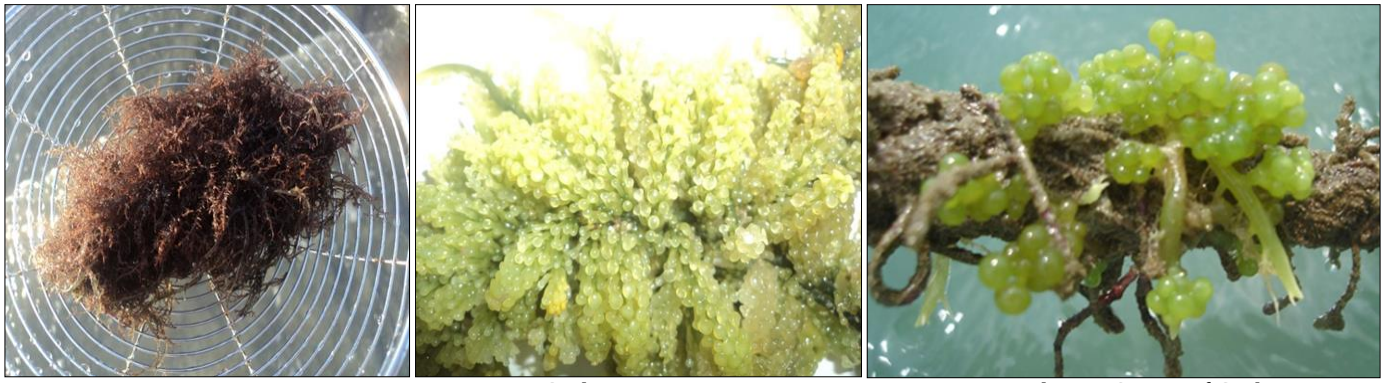
Table 1: Different Commercially important Seaweeds of Bangladesh

Sl No	Genus	Species	Type
1	*Caulerpa*	Caulerparacemosa	Green Seaweed
2	*Enteromorpha*	Enteromorphasp	Green Seaweed
3	*Gelidiella*	Gelidiellatenuissima	Red Seaweed
4	*Gelidium*	Gelidiumpusillum	Red Seaweed
5	*Halymenia*	Halymeniadiscoidea	Red Seaweed
6	*Hypnea*	Hypneapannosa	Red Seaweed
7	*Hydroclathrus*	Hydroclathrusclathratus	Brown Seaweed
8	*Sargassum*	Sargassumsp	Brown Seaweed
9	*Enteromorpha*	*Enteromorphaintestinalis* Enteromorphamoniligera	Green Seaweed
10	*Padina*	*Padinatetrastromatica*	Brown Seaweed
11	*Catenella*	*Catenellaspp*	Red Seaweed
12	*Porphyra*	*Porphyraspp*	Red Seaweed
13	*Gelidium*	*Gelidiumamansii*	Red Seaweed
14	*Codium*	*Codium fragile*	Green Seaweed

Table 2: Micronutrients in normal salad and salad with seaweed

SL.	Treatment Type	Ca(ppm)	Fe(ppm)	K(ppm)	Na(ppm)	Za(ppm)
1	Normal Salad	833.05	16.29	6507.82	17,663.24	4.93
2	Salad with seaweed	1,565.14	154.17	6031.64	15,636.07	8.85

(Sarkar MSI, M Kamal, MM Hasan and MI Hossain, 2016) [10]



Hypnea sp Caulerpa sp Long Line Floating System of Caulerpa sp

Fig 4: identified spp from Saint Martin Island & Cox's bazar

Seasonal variation in seaweeds' availability

Seaweeds in Bangladesh are available in winter, spring and summer seasons and unavailable in rainy or autumn season. On that basis, in Bangladesh generally seaweeds are available from October to April, but highest abundance occur from January to March. About 193 seaweed species of 94 genera belonging to only three major divisions i.e. Chlorophyta-green algae, Phaeophyta-brown algae, Rhodophyta-red algae are available in Bangladesh (Sarkar MSI, M Kamal, MM Hasan and MI Hossain, 2016) [10].

Utilization of naturally occurring seaweed in Bangladesh

Conventional utilization of seaweed

Seaweeds are almost unknown to Bangladeshi people. Seaweeds in Bangladesh have been utilized only by Mog or Rakhyine tribal community and people of St. Martins' Island. Traditionally, as a marine plant, seaweeds are respected by Mog. Seaweeds are known to them as 'Hejla'. Like different non-conventional food items seaweeds are taken by them. Seaweed salad and sauce is prepared by Mog people. Seaweed species used by Mog people is black in color; resemble shape like a thin thread.

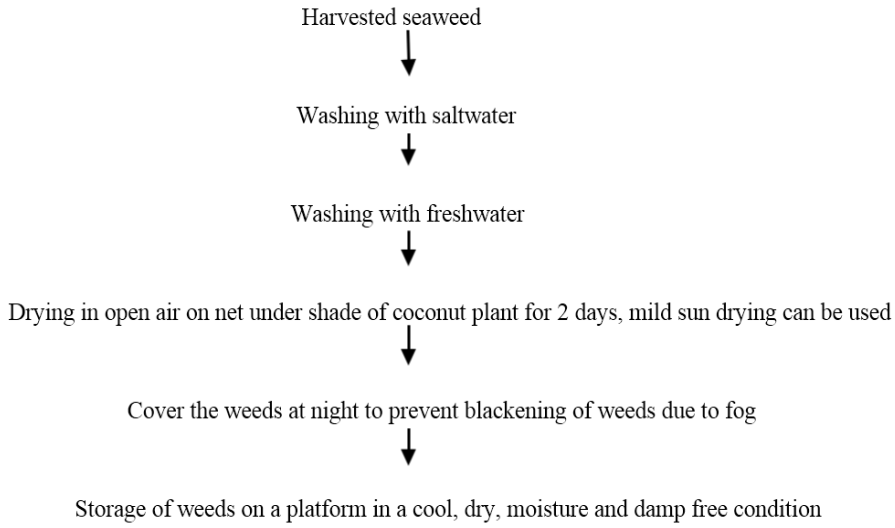
Seaweeds are most significantly utilized in St. Martin's Island as seaweeds are only harvested and processed here for marketing to Myanmar. Beyond this type of utilization, seaweeds are sometimes used there as medicinal food for young ladies and post-pregnant females. Traditionally boiled seaweeds are taken sometimes by adult female for good health. Rotten seaweeds are used there as plant manure for vegetable production.

Approaches for seaweed utilization by government organization

Different types of seaweed food products such as salad, soup, pickle, cake, Chanachur, jelly sauce etc. has manufactured by them. In this case, a comparative analysis of micronutrient content in seaweed salad and conventional salad is known (Table 2).

Approaches for seaweed utilization by private entrepreneur and non-government organization

Several seaweed foods, functional and personal care products have been developed by the study team (Figure 2). The post-harvest handling procedure followed by that private entrepreneur is presented at following process:



Seaweed cultivation and coastal communities

A few people are involved in seaweed cultivation in the south-eastern and south-western coasts of Bangladesh. Seaweed culture can be introduced in areas suitable for their cultivation by familiarizing poor farmers with cost-effective technology. Seaweeds can be cultivated using indigenous materials such as bamboo and rope. As seaweed cultivation requires a low quantity of inputs provides good returns and also employs many people, seaweed culture can be a good industry for coastal communities in Bangladesh. According to a survey, seaweed can be cultivated in suitable areas stretching from Cox's Bazar to the Sundarbans.

Apart from its export potential, introduction of seaweed cultivation in the country's coastal areas could provide an alternative source of income for the people. Many edible seaweed species are available on the coast. Attempts should be made to develop products suitable for the Bangladeshi palate and to popularize this amongst the public.

Medicinal value of seaweeds in Bangladesh

The protein contains in seaweed are of very high quality and have 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. More than one million people are exposed to goiter and related diseases in Bangladesh. Through iodine deficiency alone, people suffer severe mental and thyroid problems. Most seaweed contain more iodine than sea water and are a much better alternative than iodized salt or drugs in regulating the production of thyroid hormone. Besides iodine, seaweed is a perfect source of calcium, phosphorus, iron, sodium, potassium, magnesium, sulphur, copper, zinc, cobalt and iodine. Medicinal use of seaweeds was also reported by Majumder, 2010 [2]. The content of calcium in seaweed is not only up to 10 times higher than that in cow's milk but is also much easier for the body to assimilate. Pregnant and lactating women, as well as malnourished children, should thus consume some seaweed daily to ensure that they get enough of the element that is found in the greatest quantity in human bodies (Leyman, 2002) [18]. From the above point of view, seaweed should be cultured suitability in Bangladesh for providing nutritional food to the women, children as well as men (Table-3)

Table 3: Seaweed culture suitability criteria.

Parameters	Criteria*		
	Unsuitable	**Unsuitable**	**Strongly suitable**
Depth (m)	<2 or >15	1-2	2-15
Wave (cm)	0.10->0.40	0.10-<0.20	0.20-0.30
Water Transparency(cm)	<30	30-100	>100
Salinity (ppt)	<24or >37	24-37	28-34
Water Temperature (oC)	<20 or >30	20-24	24-28
pH	<6.5 or >8.5	6.5-<7.5	7.5-8.5
DO (mg/L)	<4 or >7	6.1-7	4-6
Alkalinity (ppm)	<45 or >130	80-120	100-130

***Source*:** (Zafar M., 2005, Zafar M., 2007) [16].

Seaweed uses for supplementary feed

Supplementary feed is one of the most prime exogenous requisite for proper fish culture. The supplementary fish feeds are either be vegetable foods (e.g. pulse, cereals, grains, yeast, plant parts etc.) or animal origin (e.g. fish meal, meat meal, blood meal, meat and bone meal, internal parts of animal body etc.). Whatever the feeds type, the criteria for a successful fish feeds are, (i) readily acceptable, (ii) having high conversion rate (iii) availability (iv) highly keeping quality and (v) low cost. Several studies are directed to an efficient and cost-effective seaweed supplementary fish feed because of the importance of fish as a protein source for human and animal's diet. Seaweed plays an important role in efficient aquaculture production as it gives high influences not only to the production costs, but also to the fish health, growth and immunity. Aqua feed is the major determinant that influences the successful growth and intensification of aquaculture production.

Social and economic issues for seaweed

The development of seaweed cultivation and need to be taken into account in fostering and planning it. Even if biological, technological and environmental conditions are favorable for the development of seaweed production, it may fail if social and economic factors are unfavorable. Such issues are equally important for the successful development of seaweed culture in Bangladesh. Seaweed could easily be a new item on the country's limited export basket and would contribute greatly in reducing poverty and persistent unemployment problem. At

present, Japan, Korea, Philippines, China, India and Taiwan have been producing the seaweed commercially (Sahood *et al*., 2002) [20]. On the other hand, USA, Japan, Singapore and some European countries are importing seaweed and Bangladesh could explore the markets. The development of seaweed cultivation is also market-driven. If demand is low and natural resources are adequate, artificial cultivation is unnecessary. As demand increases, however, attempts may be made to increase production using resource management techniques. Improvements can be made to harvesting methods and artificial habitats, competing species can be removed and cleared areas seeded.

Seaweed supplementary feed for growth performance of fish

The effect of seaweeds as feed supplements in fish diet which shows significant results on growth performance, feed efficiency anybody composition of fish. Different studies indicate that the seaweed Supplementary feed for growth performance of fish was higher and effective than commercial feed.

Future directions for seaweed aquaculture

Seaweed aquaculture technologies have developed dramatically over the last several decades, but there are still challenges to overcome. New strain development by advanced breeding tools is the most urgent challenge. Superior strains will allow the growers to expand growing seasons and enhance production. Considering the global climate challenges, development of thermo-tolerant strains may be needed. Also the strains with disease resistance, fast growth, high concentration of desired molecules and the reduction of fouling organisms also need to be developed. Development of advanced cultivation technologies which are more robust and cost efficient farm systems is very important. This new system will be even more critical for highly exposed, off-shore environments since most seaweed aquaculture have occurred near shore.

With offshore aquaculture, new designs and approaches to macro algae cultivation will be required, including strain development, harvesting, transport and processing. The offshore aquaculture system may leverage new material and engineering solutions, autonomous and robotic technologies, as well as advanced sensing and monitoring capabilities.

Benefits of a strategic approach to human resources management

- Facilitates development of high-quality workforce through focus on types of skilled people
- Facilitates cost-effective utilization of labor, particularly in service industries where labor is generally greatest cost by culture time
- Facilitates proper planning, monitoring, culture techniques& assessment of environmental uncertainty & adaptation of different organization to external forces.

Conclusion

Seaweed can meet our need of nutrition. Alongside, it can be a great source of earning foreign currency. Cultivating seaweed can be an alternative employment source along with catching sea fish. Especially for women, it can be a profitable sector. A huge industry with limitless possibilities can grow. Along with the government, if industrial entrepreneurs of related fields come forward, they can open a possible door of a new world in blue economy which will enrich our national economy.

It is very necessary to use modern technology to increase the production of non-traditional marine resources. Almost three crore people live in 19 coastal districts, and most of them depend on the sea for their daily livelihood. Promoting seaweed cultivation techniques among coastal people can change their livelihood.

Seaweeds have potential to emerge as an individual export oriented industry in Bangladesh. More comprehensive studies on present status of naturally available seaweeds and their present status of utilization should be conducted and a long-term scheme for utilization of this resources required establishing. Despite the great potential of seaweed culture, no attempts to grow seaweed have been made in Bangladesh so far.

This study has identified that Efforts are needed to increase production through improving harvesting techniques, creation of artificial habitats and seeding of suitable coastal areas of Bangladesh. The technology for the cultivation of different commercially important seed stocks and their improvements should be developed through research. For better opportunity must be implementation latest technology, technology transfer, global demand, skilled manpower training, opportunity creates and evaluation by strategic management for Bangladesh perspective.

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