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ROLE OF FLOATING CULTIVATION ON RURAL LIVELIHOOD PRACTICE OF COASTAL BANGLADESH

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Abstract: The aim of the study is to find out the role of floating cultivation on livelihood practice of coastal people in Bangladesh. Floating cultivation, locally termed as *vashomanchash*, is an indigenous cropping technique that the farmers of the coastal belt are widely practicing in submerged land. This study is confined in Barishal district. Two unions namely *Illuhar* and *Bishwarkandi* from Banaripara Upazila of the district were selected as the study area. The sample size is 80 and all of them were purposively selected, who are engaged in floating cultivation in the study area. In measuring the role of floating cultivation on livelihood practice, Sustainable Livelihood Framework was used proposed by Ian Scoones (1998). In identifying the motivational factor to be engaged in floating cultivation, weighted mean index has been calculated. The study found that most of the surveyed farmers (60 percent) of the area learnt the floating cultivation technique as an indigenous practice. Half of the surveyed farmers opined that the land in the area remains submerged for 5-7 months a year. About one-third of the sampled farmers produce rice, while another one-third keep the land fallow when the water is drained out. The main reason for being engaged in floating cultivation, as identified by the farmers is that floating cultivation provides income during disaster when all other livelihood options are mostly unavailable. The cost incurred in a season is about BDT 1000 for10floating beds whereas the corresponding income is about BDT 2000 per month from 10 floating beds. This profitability induces the farmers to engage in floating cultivation. The sustainability of a livelihood can be measured by outcome variables like the capability of the livelihood in creation of man days, poverty reduction, adaptive capacity and the preservation of the natural resource base. Considering these outcome variables, it could be concluded that this indigenous practice of floating cultivation is creating man days during disaster and thus assuring certain and uninterrupted income for the rural people which ultimately might have notable impact on poverty reduction, specifically in disaster period. Accordingly, this practice of floating cultivation could be replicated in other waterlogged areas in the country.

Keywords: Floating cultivation, livelihood practice, natural disaster

Introduction

Agriculture is the main livelihood option in the coastal areas of Bangladesh. The altered climate over time is likely to have an adverse effect on the agricultural activities. Various adaptation actions have been taken to fight with the climate change in coastal Bangladesh. Due to overwhelming flood, arable land will decrease and may lead to relocation of people to other areas of the country. The US Environmental Protection Agency states that if polar ice continues to melt in step with global average temperature, sea levels could increase by 0.49 to 0.79 meters by 2100. The Intergovernmental Panel

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on Climate Change (IPCC) findings also states that a 45 cm sea-level rise will inundate almost 10.9 percent of the territory of Bangladesh and will displace 5.5 million populations of coastal regions. To adapt with the altered conditions, local knowledge based practices may be vital for sustainable livelihood. The coastal area of Bangladesh is vulnerable to frequent natural disasters which have an effect on the lives and livelihoods of the coastal people. After every notable natural calamities, agricultural behavior of the coastal area become stagnant for a long period, thus hampering the food security and socio-economic value of the coastal community.

During the monsoon period, much of the arable lands in the southern area of Bangladesh are submerged, and remain waterlogged for a notable time. Based on the analysis in Geographical Information Systems (GIS) techniques, waterlogged areas in Satkhira district along with temporal variations have been estimated. It is observed that waterlogged areas in Satkhira in 2014 for pre- and post-monsoon seasons are 830.09 km^2 and 1,355 km^2, respectively, where their area coverage enhances 524.91 km^2 due to monsoon rainfall. The percentage of waterlogged area changes from 21.74 percent in premon soon to 35.50 percent in post-monsoon and the seasonal variation is 13.75 percent. Similarly, in 2015, the corresponding waterlogged areas for pre- and post-monsoon seasons are 861.14 and 1386.54 km^2 (Mahmud et al., 2017). Water logging make it impossible for farmers to produce crops and to make any income, mainly when land is flooded and other cultivation options becomes unavailable. People in these areas have been coping with submerged or flooded conditions for generations. As agriculture is the main occupation, people of the area devised some alternative cultivation practice named as *Vasoman Chash",*i.e. floating cultivation. This method is alike to hydroponics, which is a scientific method where the plants are cultivated and grown in the water and they get their nutrients from the water instead of soil. The people of different area have adopted and modified the method for different locations of the country according to their needs. The main objective of the study is to evaluate the role of floating cultivation on rural livelihood practice.

The sustainability of livelihood is building up the capabilities, assets and activities required for the resources of living. A livelihood is maintainable when it can adapt and recover from stresses and shocks enhancing its capabilities and assets, without destroying the natural resource base (DFID, 1999). In this context, floating cultivation might be an effective adaptive option in the coastal region of Bangladesh. Floating cultivation could help keep on cultivation in unusually long post-monsoon period. There are a number of alternative methods of floating cultivation that are being practiced, for example, ridge cropping system and hanging vegetable gardening. However, this research focuses on the floating bed cultivation that are widely practiced in the coastal Bangladesh.

Study context, problems and significance: According to labor force survey 2013, around 45.1 percent of labor forces are engaged in agriculture which is highly affected by climate change (BBS, 2015). Bangladesh is one of the world's impoverished countries, crisscrossed by more than 230 of mostly unstable rivers. Flood affects over one million people in the country and more than 0.1million women, men, and children are forced to move as villages and livelihoods are literally washed away (Noble, 2006). Flooding is a recurrent problem in Bangladesh and has been a common feature over the years. A rise in the frequency of flood occurrence has been attributed to global warming and the large-scale climate change (IPCC, 2001). With the increasing frequency and intensity of flooding in Bangladesh, a greater proportion of the population is being affected each year, a majority of whom are resource poor. Mitigation measures taken by GOs and NGOs are mostly ineffective due to some distinctive regional features of the country. Since some parts of Bangladesh remain flooded for a prolonged period of the year, agricultural production is severely affected which has a serious impact on the livelihood of the farming community. Farming families often end up in relocating closer to urban areas, which results in overcrowding of those areas and gives rise to social volatility and other problems. Very often, in post disaster period, arable land becomes scarce as land becomes water logged and submerged. Sometimes waterlogging and submergence persist for several months which

worsen the poverty situation. Scarcity of food and water are the common during that time period. People go without any income and the overall situation becomes stagnant. Under such a background, floating cultivation could solve this twin problem of food scarcity and unemployment. This study tries to explore the role of the floating cultivation, an indigenous practice, and how it can be a means of improving rural livelihood of coastal area where people are suffered from catastrophic condition.

Different adaptation measures have been undertaken in the coastal areas of Bangladesh for decades in response to or in anticipation of the detrimental impacts of climate variability or climate change on agriculture. Cultivation of different stress tolerant, hybrid and short duration crop varieties, improvement in agricultural management, infrastructural development, disaster preparedness and rehabilitation and awareness building have been mentioned as potential adaptation options in coastal Bangladesh (Karim, 2011). Indigenous hydroponics is a viable practice in a flood-prone country like Bangladesh, which will most probably have less land available to feed its people from now on as sea level rises (Saha, 2010).Floating cultivationis a very suitable indigenous technology, especially for the poor as it requires minimum infrastructure, and that practice can be expanded in case of extreme climatic events. Floating cultivation practice helps to supplement people's income, which contributes towards the alleviation of poverty, and provides greater food security by increasing the landholding capacity of poor as well as landless people by allowing them to grow vegetables and crops with lower input costs and minimal infrastructure requirement (Irfanullah and Adrika, 2008). It is also argued that in floating bed cultivation, both male and female could take part that might improve the gender equity.

Institute for Global Environment Strategies suggested that developing countries should emphasize their indigenous knowledge and local coping strategies and use them in local adaptation plans (DFID, 1999). In future, floating cultivation could become an effective agricultural practice in the face of the increasing incidence of catastrophic flooding as a result of global warming, and could provide a model for other regions with similar problems. It could also lead to more sustainable use of natural materials, not only in flood-prone areas, thereby proving that people can sustain in an economically viable society in collaboration with nature.

A research conducted by BARC depicted that due to global warming induced sea level rise, more areas of Bangladesh might undergo water logging and more land will become unavailable for crop production. The research finds that farmers of the region identified floating cultivation as a profitable option. Hence, the study recommended that necessary steps need to be taken by GOs and NGOs for expanding floating agriculture practice in the southern part of the country through incorporating it in development strategy (BARC, 1991).A floating cultivation is built using aquatic weeds as the base on which vegetables can be grown. This approach is cheap and sustainable which can extend the earning capabilities of rural communities where land would otherwise be unavailable (Practical Action Bangladesh, 2005). The analysis of agricultural adaptation practices in literatures reveals that floating bed vegetable gardening has huge potentials to mitigate problems against flood. It is a very popular practice in south-western and south-central parts of Bangladesh, specifically in Gopalgonj, Madaripur, Barisal, Pirojpur and Jhalokathi districts where land remain submerged in most of the time in a year (Oxfam International, 2009).

Islam and Atkins (2007) states that as sea level rises and precipitation pattern changes, traditional farm fields may become more prone to flooding. Adaptation technologies to address the problem of flooding in agriculture are, therefore, likely to become more important. Floating agriculture, which has been used for years in places like Bangladesh, is undergoing a rebirth in the context of climate change. It is the main technology for adaptation practices. Floating cultivation involves planting crops on soil-less floating rafts. Historically, these rafts are made up of composted organic material, including water hyacinth, algae, straw, and herbs. The practice is related to hydroponics and is known as *vasomanchash, baira*, or *dhap* in Bangladesh, and *kaing* in Myanmar.

Although this practice has been used for centuries in some countries, it has become associated with new technologies giving it the potential for widespread growth. Floating agriculture can be extremely effective, especially in minimizing crop damage from flooding. Farmers can use raft garden beds to cultivate a wide range of vegetables for food and income during times when other activities are impossible due to inundation. This low- technology production system has the potential to improve productivity per unit of land with little or no chemical fertilization. In some cases, it shortens the production cycle of crops, which can now be harvested more frequently. Floating agriculture is best suited for areas where a plentiful supply of water is available, especially in coastal areas, and in freshwater lakes. It is a particular adaptive technology for areas that experiences heavy monsoon or is prone to flooding. Year-round availability of stagnant water and enough material to build rafts are the basic prerequisites for sustaining floating agriculture in an area (Pantanella et al., 2011; Irfanullah et al.,2011).

The prevailing literature focused on different agricultural practices as alternative adaptive techniques, but does not evaluate the role of floating cultivation in creating livelihood for coastal people in post-disaster period. This research tried to evaluate the practice using the sustainability indicators proposed by Ian Scoones' Sustainable Livelihood Framework (Scoones, 1998). Such an effort may contribute to the existing literature and thus may help the policy makers in the concerned field to design the adaptive techniques considering the socio-economic differentials of the region.

Materials and Methods

Human activities have already caused some irreparable changes to ecosystem. Hence, it is necessary to think about how we will regulate not only the specific changes but also the new improbability about our future climate. This is particularly pertinent for developing countries, where it will be necessary to attend many institutional and capability issues in order to ensure sustainable livelihood approach through entire state of climate change.

Since the objective of this research was to evaluate the role of floating bed cultivation practice on rural livelihood, Barishal district was selected as the study area because the area remain submerged for a longer period of time in post monsoon. Accordingly, to cope with this situation, floating cultivation is largely practiced as an indigenous method of cultivation in this region. Two unions of *Banaripara upzila* were selected purposively from Barishal district. The sample size was 80 taking 40 farmers from each union, namely *Biswarkandi* and *Illuhar*. During the pilot survey, the researchers observed that most of the people in this area concentrated in this traditional practice. A purposive sampling technique was adapted to fulfill the objective of the research. The sampling distribution has been presented in Table 01.

Table 01: Sample distribution

District	Upazila	Union	Sample Size
Barisal	*Banaripara*	*Biswarkandi*	40
	Banaripara	*Illuhar*	40
Total			80

The study was mainly primary data based and a structured questionnaire was used for data collection. To measure the sustainability aspect of floating cultivation as a livelihood option, Ian Scoone's Livelihood framework had been used. The framework identified vulnerability as the key issue of assessing sustainability of livelihood. There are two aspects of livelihood vulnerability: one is the

external threat to livelihood security i.e. stress and shock and the other is the ability to cope with them i.e. adaptation and resilient. The livelihood outcomes are the gauge of sustainability: if a livelihood option can create adequate income without risking the continuity, that livelihood can be considered sustainable (Scoones, 1998). The framework identified some outcome variables which could measure the extent of sustainability. The livelihood outcomes are the end results of the livelihood strategies, i.e. income, well-being, reduced vulnerability and improved food safety. The livelihood outcomes are altered from assets which depend upon the access to assets. Livelihood outcomes are not comparable, since assets change over point in time among people. Also some parts of the outcome are conceptual and subjective, which cannot be measured. Sustainable livelihood framework identifies five different kind of capital assets which are vital to make a livelihood sustainable: human, social, natural, financial, and physical (DFID, 1999). All these together form the building block of the livelihoods as described in Figure 1. Five livelihood assets are discussed below:

Human assets: Human assets refer to peoples' ability and knowledge, as well as good physical condition and ability to work, which together allow people to track different livelihood strategies and achieve their livelihood objectives (DFID, 1999). Human assets are necessary for making use of any other possessions available and are, therefore, required for creating revenue.

Social assets: Social asset consists of social resources (for example, networks, social claims, social relations, affiliations, associations). Social assets are important, since they create a safety net and a buffer against shocks (DFID, 1999). The livelihood strategies are beneficial when social capital building lump together.

Natural assets: Natural capital is the stocks, from which natural resources are being consumed. The natural assets represent the access to natural capital (DFID, 1999). Many people get their income directly from the natural resources, making the natural assets very important for their livelihoods. Floating cultivation is a natural resource based practice.

Physical assets: Physical assets incorporate infrastructure, production equipment and technologies. All infrastructure and equipment supporting the livelihood are physical assets. As for instance, floating cultivation is an adaptive technology which might be an effective physical asset to defend shocks during disaster.

Economic or financial assets: Financial assets mean capital base (for example, cash, credit/debt, savings and other economic assets). This research showed how this type of floating cultivation practice would help vulnerable people to cope with capital requirement.

To measure livelihood outcome of floating cultivation, three dimensions had been considered: environmental, social and economic dimensions (Table 02).

Table 02: Dimensions of Sustainability (Scoones, 1998)

Dimension	**Indicators**
Environmental	➢ Use of chemical fertilizer ➢ Water and nutrients requirements ➢ Nutrients recycling ➢ Weeding ➢ Use of local resources
Social	➢ Food security ➢ Working day ➢ Capacity building during disaster period
Economic	➢ Income(Production cost and return per month in BDT) ➢ Input cost ➢ Infrastructure requirement

To identify the main motivational factors of practicing floating cultivation based on the opinion of the farmers, Weighted Mean Index (WMI) had been constructed. The probable motivational factors to practice floating cultivation that have been incorporated in measurement of WMI which has been explained in Table 03.

Table 03: Farmer's Motivational Factors to Engage in Floating Cultivation

Statement	Scale of Rating				
	Strongly Agree	Moderately Agree	Agree	Disagree	Strongly Disagree
During water logging, floating culture is only method for vegetables production	5	4	3	2	1
Crops can be harvested shortly in floating method	5	4	3	2	1
No use of chemical fertilizers reduces production cost	5	4	3	2	1
Vegetables produced in floating bed assure higher market price for its better quality	5	4	3	2	1
Production intensity increases due to floating agriculture	5	4	3	2	1
Floating agriculture increase working hours per man-day's	5	4	3	2	1
Provide income during disaster	5	4	3	2	1
Provide food during disaster	5	4	3	2	1
Additional income is possible from floating agriculture	5	4	3	2	1

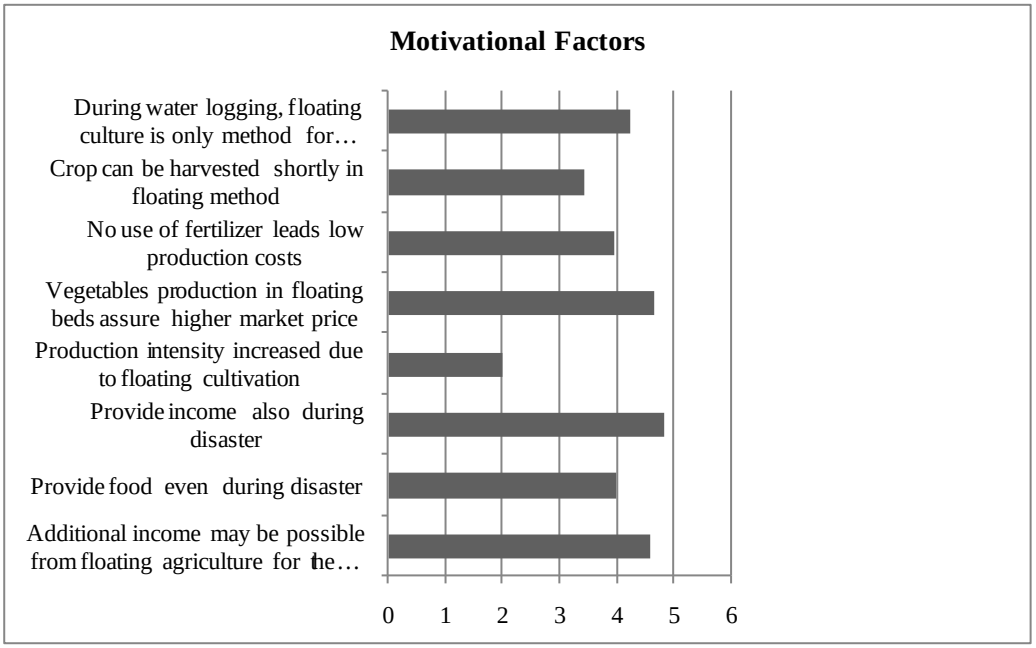
Results

Socio-economic features of the farmers: Through analyzing the ages of the farmers in the selected area, this study tried to ascertain the nature of active working force engaged in floating cultivation. The age distribution of the selected farmers who are involved in this indigenous practice depicts that a majority (around 44 percent) of the farmer's age lies between the age group of 30-40years.The ability to adjust to the existing opportunities in every modern society depends largely on one's level of education. Education enables people to acquire the necessary knowledge, skills and values which help them to cope up with the changed circumstances. The educational pattern of the farmers in the study area showed that 28.75 percent passed SSC and only 10 percent are illiterate. Access to basic infrastructural facilities is an important determinant of wellbeing. As the objective of the study is to find out the livelihood outcome of floating cultivation, access to basic infrastructure of the farmers has been studied. The study found that 62.50 percent of the farmers live in semi-pacca house. Among 80 respondents, 25 percent of them have *kancha* house. 56.25 percent of the respondents have access to deep tube well water, whereas 25 percent farmers drink from shallow tubewell. They informed that the water of shallow tube well is salty. About one-fifth of the respondents drink pond water. The tube-well are mostly provided from the government. The NGOs are also working in that area for providing safe drinking water to the coastal people. Electricity is an important factor which creates better living standard. About 70 percent respondents have access to electricity. However, the supply

of electricity is irregular and very poor quality in terms of voltage. As a result, many of them set up solar panel, although the installation is expensive. Household income is an important determinant of living standard. In this study, the selected respondents are mainly dependent on agriculture for their livelihood. About 31.25 percent of the farmers' monthly family income ranges between BDT 16,001-19,000 whereas 21.25 percent have income ranging BDT 13,001-16,000 and 11.25 percent have income ranging BDT 7,000-10,000. The farmers who are mainly dependent on agriculture had been selected purposively to measure the impact of floating cultivation on livelihood. Some of them have some secondary occupation but the contribution of such secondary sources is nominal.

In explaining the expenditure pattern, the monthly expenditure on food have been evaluated where 38.75 percent of the framers spend BDT 500-1,000 monthly on food whereas 31.25 percent spend BDT 1,001-1,500 per month. Savings is another important indicator that safeguards the poor people from shocks. This study found that 80 percent of the respondents have some savings and 20 percent of them do not have any savings. The study also revealed that only 15 percent of the respondents save money in formal institutions, whereas 85 percent of the respondents having savings, deposit money in informal institutions like local cooperatives or associations. The land ownership pattern revealed that among the sampled farmers, 55 percent cultivate their own land and 45 percent cultivate own and leased land. The cultivated land area (either own or leased) varies from 0.165to 1.32 acre.

Motivations behind floating cultivation: This study tried to figure out the main motivational factors that made floating cultivation a hereditary practice in the region. The result of the Weighted Mean Index (WMI)has been presented in Fig. 01.



	Additional income may be possible from floating agriculture for the farmer family developme nt	Provide food even during disaster	Provide income also during disaster	Production intensity increased due to floating cultivation	Vegetables production in floating beds assure higher market price	No use of fertilizer leads low production costs	Crop can be harvested shortly in floating method	During water logging, floating culture is only method for vegetabl es product ion
WMI	4.6	4	4.85	2	4.65	3.95	3.45	4.25

WMI= Weighted Mean Index

Fig. 01: Motivational factors to be engaged in floating cultivation

Majority of the farmers opined that this type of indigenous practice provides certain income during disaster period. Second strong reason identified by the farmers is the assurance of getting higher price of the produce, as in this indigenous technique, nutrients like potassium, nitrogen, phosphorus are absorbed from the bed itself made up of water hyacinth and other organic materials. So, no chemical fertilizer is used. Availability of extra income had been identified as another important factor to be engaged in floating cultivation. The farmers also agreed that it is the only livelihood option to them during disaster and strongly recognized the importance of floating cultivation as an alternative livelihood option during disaster. A majority (56.25 percent)of the farmers informed that normally the area remains submerged for 5-7 months a year. About 31.25 percent farmers opined that the duration is from 3 to 5 months. So, if we consider the engagement of the farmers in floating cultivation, the duration is almost half of the year.

When the water is drained out, the land is used differently in the region. About 35 percent farmers cultivate rice and 25 percent produce vegetable afterward. But, 30 percent keep the land fallow. They do not cultivate because they think that if the land remains fallow, the production capacity of this land is increased for the next season. The farmers usually grow different types of vegetables on floating bed which could be of single or mixed varieties. The type of crop grown on floating bed in the area has been presented in Fig. 02.

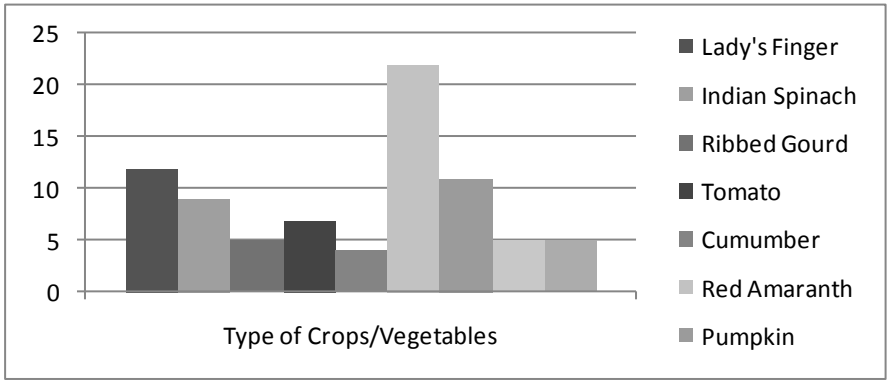


Fig. 02: Type of crops grown in floating bed

Vegetables that are produced mainly include lady's finger, Indian spinach, ribbed gourd, tomato, cucumber, red amaranth, pumpkin, black chili and papaya. All of the nine crops could be grown as mixed crops. But tomato, lady's finger and red amaranth are grown as single crops in the area. Among the vegetables, the farmers largely produce red amaranth, pumpkin and lady's finger.

Estimated income and cost: Normally multiple beds are constructed keeping gaps in between two beds which is necessary for harvesting. To figure out monthly income, monthly harvest from 10 beds has been considered as representative unit. The size and shape of the *dhap* (the bed made up of composted organic material, including water hyacinth, algae, straw, and herbs) is not fixed. Farmers make the *dhap* as their desired size and shape. About 26.25 percent respondents opined that maximum size of the *dhap* is 720 square feet. Estimated income from floating bed locally referred to as '*Baira*' has been presented in Table 04.

Table 04: Income from 10 floating bed (BDT/month)

Vegetable	Monthly harvest (Kg)	Price (BDT)	Income (BDT)
Lady's finger	500	7/ Kg	3,500
Indian spinach	100	8/Kg	800
Ribbed gourd	60	16/Kg	960
Tomato	80	10/Kg	800
Cucumber	40	12/Kg	480
Red amaranth	600	10/Kg	6,000
Pumpkin	550	9/Kg	4,950
Black chili	70	15/Kg	1,050
Papaya	50	12/Kg	600
Total income			19,140

Table 04 depicts that the highest income comes from red amaranth, because the germination time of this type of product is low compared to other product. So, from 10 floating bed, the approximate income is BDT 19,140 in one month. The time and frequency of harvesting of vegetable crops depend on their nature and life span. The time and frequency of harvesting of some vegetable are presented in Table 05

Table 05: Starting period and frequency of harvesting

Crops	Starting Period (DAP/DAS)	Frequency of harvesting
Lady's finger	40-65 days	2 times per week, 3 times per week
Tomato	50-70 days	1-2 times per week
Pumpkin	60-70 days	1-2 times per week
Indian spinach	40-55 days	1-2 times per week
Cucumber	40-60 days	2-3 times per week
Black chili	40-60 days	2-3 times per week
Ribbed gourd	40-55 days	1-2 times per week
Red amaranth	25-35 days	2-3 times per week
Papaya	40-65 days	1-2 times per week
Rice (other option when water drained out)	120-150 days	Harvested for one season

Note: DAP= Days after Planting DAS= Days after Sowing

Table 05 indicates that harvesting time ranged from 25 to 70 DAP/DAS for different vegetables where red amaranth could be harvested within least possible time (25-30days after sowing), while pumpkin required the highest time to harvest (60-70days after planting). Lady's finger, cucumber, red amaranth and tomato could be harvested more frequently (1-3 times/week) than other vegetables. The cost of floating bed cultivation in one season has been presented in Table 06.

Table 06: Estimated cost for making 10 floating beds in single season

Coast Heads	Required man days	Unit Cost (BDT)	Total Cost (BDT)
Floating bed preparation	60 man days	100	6,000
Raw materials(water hyacinth and other aquatic weed)	20 man days	100	2,000
Seed and seedlings	10 man days	60	600
Nursing/ maintenance, purchase of bamboo, and harvesting	10 man days	200	2,000
Total			10,600

Where labor cost has been identified as the major cost. The bed has to be constructed in each production season and when the water is drained out, the residual of bed could be used as organic fertilizer in producing rice or other crops. In measuring the cost, cost of preparing 10 floating bed has been considered as a representative unit (like earlier). The study found that the area remains submerged for five to seven months (May to November) a year when rice cropping is impossible. In floating bed preparation, 60 man days of labor are needed for 10 floating beds, that is 6 labors per *dhap* (floating bed)in one season and the total cost is BDT 6,000. For raw materials collection, 20 man days are needed for 10 floating beds and total cost is BDT 2,000. The cost of seed and seedlings accounts for BDT 600 in one season for 10 floating bed. In floating bed agricultural practice, no additional fertilizer is needed as major nutrients are absorbed from the bed made up of water hyacinth, straw, bamboo all of which contains natural nutrients like potassium, phosphorus and nitrogen. Irrigation cost is zero. The total cost of nursing, maintenance, purchase of bamboo and harvest cost for 10 floating beds is BDT 2,000 in one season. So the average cost in one season incurred from 10 beds is BDT 10,600 approximately.

Table 07 represents the revenue pattern of the sampled farmers from floating cultivation.
Table 07: Revenue earned from of floating cultivators *per* month

Total Revenue (per month per 10 beds in BDT)	Farmers
6,000-9,000	12
9,000-12,000	15
12,000-15,000	25
15,000-18,000	20
18,000-21,000	5
21,000-24,000	3
Total	80
Average	13,100
Minimum	6,000
Maximum	23,000
Standard Deviation	3905

About 31.25 percent respondents opined that revenue from floating cultivation in one month ranges from BDT 12,000 to BDT 15,000. On the other hand, 25 percent respondents opined the revenue varies from BDT 15,000 to BDT 18,000 in one month.

Discussion

The study found that the land area cultivated by the farmers varies from 0.165 to 1.32 acre. About 35 percent farmers have 0.165- .33*acre*whereas 31.25 percent have .33- .495 acrel and available for cultivation. Farmers having larger amount of land produce rice. But, farmers having smaller amount of land prefer floating cultivation to rice as return from floating cultivation is relatively larger. Floating cultivation is less expensive and the return is higher as the price of the produce is higher. Only 35 percent farmers respond that they cultivate rice when water is drained out. They postulate that harvesting time of rice is the highest that take 120-150 days after planting/days after sowing. The price of rice very often falls in harvesting season and the farmers often could not even cover the cost. Considering the scale of production, most of the farmers (55 percent) are producing both for household consumption and commercial sale, whereas 45 percent are producing for commercial purpose only. Floating cultivation helps the coastal people survive during disaster when there is no employment opportunity and acute unavailability of food. In case of domestic consumption, the daily need is 3 kg of vegetables for a single family on average. Apart from selling the harvest, they also sell saplings which generates additional income. Whenever they had been asked which produce, rice or vegetables is giving the higher return, 85 percent respond that vegetables is giving higher return than rice. The following section tries to evaluate the cultivation technique as sustainable livelihood option for the coastal people.

Evaluation of production practice in light of sustainability framework: 'A livelihood option might be sustainable when it can cope with and recover from stresses and shocks, maintain or enhance its capabilities and assets without undermining the natural resource base' (Scoones, 1998). This study tried to evaluate the floating cultivation as an alternative livelihood option for rural households in the light of sustainable livelihood frame work. Under the framework, three alternative livelihood strategies have been identified through which sustainable livelihood could be created, agricultural intensification/extensifiction, livelihood diversification and migration. Here, agricultural extensification refers to the capability to bring more land under cultivation. Intensification refers to more output per area through adding capital or labor inputs. Diversification refers to the creation of off-farm income earning opportunity. Floating cultivation could be considered as both the intensification and extensification of agriculture. Intensification in that sense, this is increasing the output per area as this cropping technique enabled the farmers to use the land when the land otherwise be kept fellow. How many times a land could be harvested simply refers to the intensity of production. In absence of this technique, the land would be fellow for this 5-7 months on average and only a single harvest could be produced in one season. This production technique enabled the farmers to get produce during the waterlogged period (5-7 months a year) and in that sense this technique assures more output *per* area. Extensification in that sense, through this technique, if we consider the waterlogged period, the land is not arable, this indigenous technique has made the land arable and thus brings about more land under cultivation. This also assures the diversification, not through creating off-farm activity but through creating the option of multiple cropping, rice and vegetables in dry season and vegetables when the land is submerged. Thus, floating cultivation is increasing the intensity and also extending agricultural production in the area.

The framework identified five capital resources, the access to which could generate sustainable livelihood options which includes natural capital (soil, water, air and genetic resources), economic and financial capital (cash, credit, savings, infrastructure, and technology), human capital

(skill, knowledge, and physical capability), social capital (networks, social claims, social relations, affiliations and associations). Institute for Global Environment Strategies suggested that developing countries should emphasize their indigenous knowledge and local coping strategies and use them in local adaptation plans (DFID, 1999). This technique is an indigenous practice where indigenous knowledge is being transferred from generation to generation which is a type of human capital. The natural assets like water, soil are being used alternatively and are also conserving the natural resource base as it does not require any irrigation or chemical fertilizer. Again, here the knowledge is transmitted through a social relation like from the ancestors to the predecessors which is a part of social capital. As a technology, this is a use of economic capital. So, this technique used the capital resources in such a way which has been considered as sustainable for the economy according to the sustainable livelihood framework.

To measure the extent of sustainability, the framework identified some outcome variables like the capability of the employment option in creating gainful man days for a certain period of a year, certain income that will reduce poverty, ability to cope with shocks and resilience to vulnerability and the preservation of the natural resource base.

The average income from floating bed is BDT 13,100per month and the data found that 80 percent of the farmers have some savings. So, the technique is providing a certain flow of income, specifically for the small farmers which must have positive impact on the poverty scenario of the region. The technique is creating employment for the farmers when all other common livelihood options are not available, which ranges from 5-7 months. If we compare the working hour, the farmers respond that the daily working hour required for floating bed is 3 hours but for rice cultivation, it requires 7 hours on average but the return from floating cultivation is higher than rice.

In floating cultivation, female notably takes part. So, the technique is creating an opportunity of income for the woman in the family which sustains even during disaster. The sustainability of livelihood is highly tied to the capability to cope with stresses and shocks and stresses which are fundamental to livelihood adaption and coping (Davies, 1996). Flooding is a very common natural disaster to the coastal people when cropping, the normal employment option is completely disrupted for several months. In such a background, floating cultivation could cope up with such situation and may provide certain income. The practice has been regarded as adaptive technique to combat climate change impact that's why this practice is considered as an essential livelihood pattern for coastal people (Irfanullah et al., 2011).To be sustainable, a livelihood option should not destroy or degrade the natural resource base. Floating cultivation is preserving the natural resource base in a number of ways; First of all, this is assuring the use of land in a more efficient way, through this process, the land could be cultivated even in waterlogged situation without which the land could be kept fallen. The materials used for constructing bed are collected from natural sources like water hyacinth, straw and bamboo, all of which are natural elements. Water hyacinth is available in ponds and canals which grows so fast and have to be removed periodically for the growth of fish. Straw is used as fodder for cattle but also very often the straw residue are burnt which emits carbon in the air. The alternative use of straw and water hyacinth thus purifies water and air. In recent years, fertilizer consumption increased exponentially throughout the world, causes serious environmental problems as fertilization may affect the accumulation of heavy metals in soil and plant system, plants absorb the fertilizers through the soil and thus chemical can enter the food chain and may lead to water, soil and air pollution (Savci, 2012). No chemical fertilizer is required in floating cultivation and the residue of the bed could be used as organic fertilizer when the water is drained out. So, the practice is playing an effective role in preserving the environment. The capability to cope with shocks and stress is a feature of sustainable livelihood. Through creating man days during disaster, this practice is providing productive and remunerative employment to the coastal people in the time of disaster and at the same time providing nutritious vegetables for self-consumption. If we examine the major produce of

floating beds, red amaranth is rich in iron, lady's finger is rich in both calcium and iron, pumpkin is full of vitamins and minerals, papaya, tomatoes all are rich in food value that could meet up the dietary needs and also could generate income to meet other basic needs during disaster. So, analyzing the outcome, floating cultivation could be considered as a sustainable livelihood option for the coastal people. The DFID reaffirms that floating cultivation is an innovative technology to cope with the shock (DFID, 1999).

The three dimensions of sustainability identified by Ian Scoones (Table 02). Floating cultivation does not need any chemical fertilizer, no irrigation is required, and nutrients are absorbed from bed. The bed could be used as organic fertilizer at the end of the season when water is drained out which could be considered as recycling and all the raw materials are produced and collected from local sources. So, environmentally this could be considered as sustainable. This technique is providing food during disaster which is rich in food value and also generating income through creating man days as this is a labor intensive technology and overall it is enhancing the capacity of the farmers during disaster to cope up with the vulnerability. So, socially it could be considered as sustainable. From economic dimension, the production cost is lower than the available alternative cropping, assures higher income as the produce is organic, and hence the return is higher. Inputs are locally produced, cheaper and the infrastructure requirement is minimal. So, it could be concluded that, this technology should be defused as a sustainable livelihood option to other coastal parts of the country.

Conclusion

Floating cultivation is a useful method considering the economic, environmental as well as social aspects. But being a potential technology, this practice is deprived of sufficient attention from the policy makers. Though the cultivation technique would be a vulnerability resilient adaptive cropping mechanism, it is still largely practiced among the farmers as an inherited technology learnt from the ancestors, not largely spread in other parts of the country with similar water logging problem. Some GOs and NGOs are providing training but mostly confined in the study area. But the technology has to be diffused in other submerged areas of the country and research should be made to develop and spread this indigenous practice so that it could be replicated in other parts of the country. The availability of the basic raw inputs like water hyacinth sometimes become a concern as this input is collected from canals and ponds where they are produced naturally. Tragedy of commons may occur in that case as no one is responsible to care for that. Availability of bamboo and straw are also important for the cultivation technique. Over harvesting may be a threat to the production technique and the ecology. So, the sustainability of this probable sustainable livelihood option itself could be threatened due to the unavailability of raw materials. So, researcher should concentrate how the raw materials could be conserved and how this indigenous technique could be modified considering the regional requirements.

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