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Floating Vegetable Cultivation: A Sustainable Livelihood Strategy for Flood Prone Areas of Bangladesh

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I. Introduction

Climate change is the reality and Bangladesh is the most vulnerable country around the world, especially for floods. During the last 50 years, seven extreme floods affected 35-70% of Bangladesh (Irfanullah et al. 2011), which has an alarming impact on agriculture in the wetlands of southern Bangladesh (parts of Gopalganj, Pirojpur, and Barishal districts). These areas have been repeatedly affected by floods during monsoon season (from June to October), where water remains for long periods. At that time, advanced adaption strategies need to cope with adverse impacts. For that, local communities choose the way to cope with the surrounding nature but not opt for the way to conquer this severe environment. According to their need, Farmers have developed the unique floating garden agricultural technique (locally known as *"Dhap"*) in waterlogged areas, which is not common elsewhere in the country. Soilless agriculture or Floating hydroponic can help to mitigate this situation and reduce arable lands by turning the waterlogged areas into productive ones (Haq et al. 2004). People living within the wetland ecosystem utilizes locally available raw materials and various aquatic plants (such as Tapapana, Dulaliata, khudipana) for making a floating platform, the upper surface with mud or soil on which crops, seedlings, and vegetables are grown. This cultivation practice helps to supplement people's income, which contributes to the alleviation of poverty and provides greater food security. This technology can also provide a growing area for poor communities by allowing their landholding capacity to grow vegetables and crops with lower input costs. Through the hydroponic technique, it is also possible to harvest fish that reside in the beds.

The practice of floating agriculture is a useful method considering the economic, environmental as well as social aspects. It also serves as an alternative growing area to land lost through flooding. Both men and women are enjoying a better life economically than those in other flood-affected regions who have not yet adopted this practice. It has the potentials to provide employment opportunities within communities because the system is quite labor-intensive.

The study is significant that explores floating agriculture as a better way to produce enough vegetables for our people and a better way of earning for the people in low land areas. That's why it is a suitable agricultural practice for flooding areas of Bangladesh.

II. Methodology

a) Research Method and technique of data collection

Mixed method research was used as an investigative stance aimed to provide more useful picture of the livelihood of flood-affected people and a more holistic understanding of why people choose floating gardening as a way of their livelihood. A simple random sampling technique had been adopted to identify the respondents. For Survey, 120 farmers were selected randomly from the total sample. Three techniques had used for collecting primary data. A semi-structured questionnaire was used for survey data. FGD was used for qualitative data from the interviewers to generate information on farmer's experiences of flooding and problems in farming practice. FGDs Moderator used an FGD Guideline containing open-ended questions to explore various aspects of the research. Key informant interviews were also conducted through face-to-face interviews and telephone interviews

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using a checklist with people who know the relevant subject matters required for analyzing the issue in a flexible form.

b) Study area

The study was carried out in Nazirpur Upazila of Pirojpur District, which is situated in the south-western part of Bangladesh and also a part of the Barishal division. Nazirpur is located at 22.7461° N 89.9678°E. The total area of Nazirpur is 233.65sqkm. Most of the land is low-lying that is submerged underwater for 7-8 months of the year when the floating garden production system becomes the only alternative livelihood option for about 60-90% of the people of local communities in this region. And for this, the Study area (two unions) of this Upazila selected purposively for collecting information for this study.

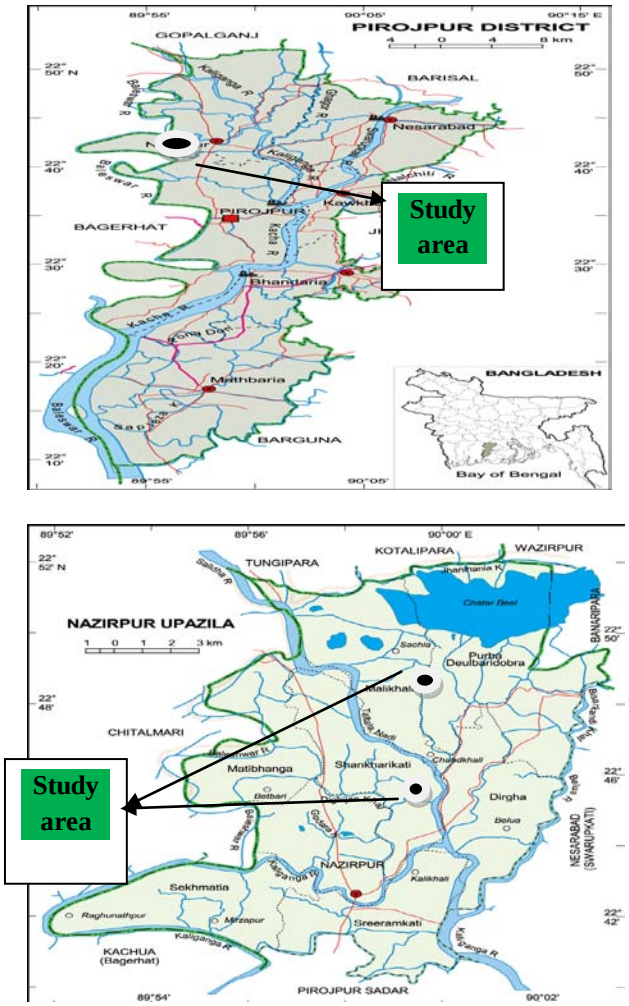


Fig. 1: Dots show the study area (two unions) of Nazirpur Upazila.

c) Data processing and analysis

After processing the data, it was analyzed and interpreted by software like MS Word, SPSS-16.0 (Statistical Package for Social Science), Microsoft Excel.

III. Results

a) Quantitative Data Analysis

Table 1: Percentage distribution of the age of the respondents

Age of the respondent (years)	Frequency	Percentage
20-49	62	51.70
50-79	55	45.80
79-above	3	2.50
Total	**120**	**100.00**

Source: Field Survey, 2019

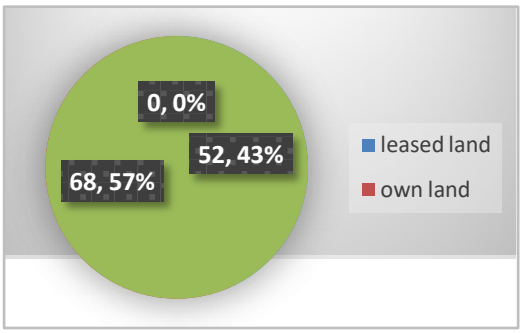
Table1 shows the percentage distribution of the age of the respondents. There are three age groups in this study. The table shows that most of the respondents belong to the age range 20-49 (51.70%). The second dominant age group is 50-79 (45.80%).

Table 2: Percentage of Family Size.

Family Size (persons)	Frequency	Percentage
1-4	18	15.00
5-9	90	75.00
10-14	12	10.00
Total	**120**	**100.00**

Source: Field Survey, 2019

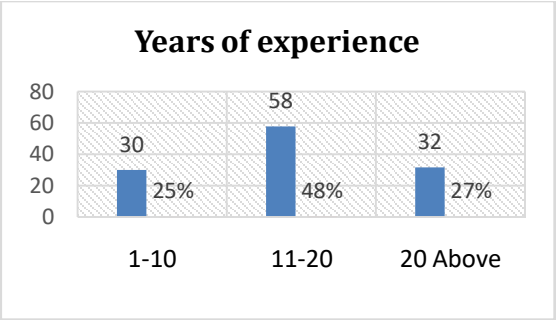
The above table represents that most of the respondents (75%) have family consisting with 5-9 members whereas 10%respondents have large family size comprises with 10-14 members.



Source: Field Survey, 2019

Fig. 2: Categories of Cultivable Land

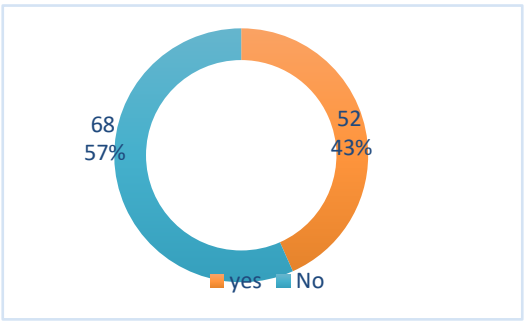
Fig 2 represents the distribution of the farmers based on their ownership of floating garden land areas. Chart shows that, 52.43% farmers cultivate floating gardens in leased land whereas68.57% farmers use their own land for this cultivation.



Source: Field Survey, 2019

Fig. 3: Years of experience of the farmers

Figure 3 shows the years of experience of the farmers regarding floating vegetable cultivation. Study shows that 25%respondents have1-10 years of experience, 48% of respondents have 11-20 years of experience, and 27% have more than 20 years of experience.



Source: Field Survey, 2019

Fig. 4: Skills development training

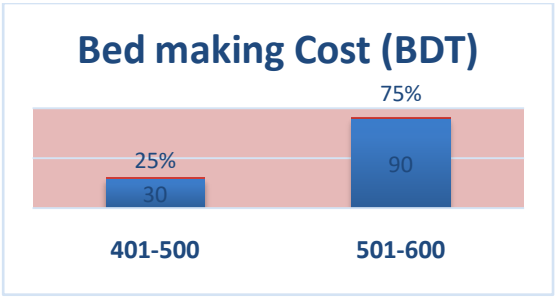
A training program is essential for farmers to develop their skills and knowledge. Fig.4 shows, 57% respondents never receive any kind of training related to floating vegetable cultivation. The figure also shows that 43% respondents receive training from government and non-government organizations.

Table 3: Sources of fund for vegetable cultivation

Sources of fund	Frequency	Percentage
Micro-credit	84	70.00
Own finance	36	30.00
Total	**120**	**100.00**

Source: Field Survey, 2019

Table 3 shows that about 70% farmers received loan to cultivate vegetables, whereas 30% of them invest their own capital.



Source: Field Survey, 2019

Fig. 5: Bed making cost

Fig. 5 shows that most of the respondents (75%) need BDT 501-600 to build a floating bed as labor cost.

Table 4: Time needed for vegetable production

Time(months)	Frequency	Percentage
2-3	18	15.00
3-4	38	31.67
4-5	64	53.33
Total	**120**	**100.00**

Source: Field Survey, 2019

Table 4 illustrates 53.33% of floating vegetables can produce within 4-5 months, and 31.67% vegetables can produce from 3-4months. Moreover, only 15% vegetables can be produced from 2-3 months.

Table 5: Selling mode of vegetables

Selling mode	Frequency	Percentage
Wholesale	104	86.70
Retail	16	13.30
Total	**120**	**100.00**

Source: Field Survey, 2019

Table 5 shows that 86.70% respondents wholesale their produced vegetables, and 13.30% retail their vegetables.

b) Qualitative Data Analysis

Four FGDs were conducted in the study area to understand the livelihood strategies of the farmers. Each FGD consists of ten people. The study sought to find out people's perception to take floating as a strategy to sustain their livelihood and to reduce the vulnerability of flood.

Motives to introduce floating bed cultivation: Lack of cultivable land is a vital concern in the Nazirpur Upazila, Pirojpur district. Floating gardening (locally known as *'Vasoman Chash'*) creates an alternative livelihood for the people. Some people answered that in the *Beel* (lake- like wetland with static water) area, they have no agricultural land for cultivation because the land area is submerged under water. One respondent said

"waterlogging induced by flood increase our vulnerability. Every year we lose our seedbed, crops, paddy, cow, goat, etc. Losing these resources, we are becoming more vulnerable and having no way to live. In this situation, floating cultivation brings a piece of a smile against all sorrows for a short time, and for that, we take it as a suitable option to maintain our life."

Socio-economic Advantages: Floating vegetable cultivation has some socio-economic benefits. During flood, most of the poor landless farmers remain idle. So, they can start floating bed cultivation as it is not expensive. Farmers prepare the bed with available local resources and produce different kinds of vegetables (tomato, cauliflower, cucumber, radish spinach, mustard, ladies finger, etc.). The vegetables are grown without using pesticides.

Local people also come to buy vegetables from the cultivators. By selling vegetables, farmers earn a good profit. Thus they can able to meet their household demands, nutrition, and food security. Growing vegetables also influence the public health of the communities. Besides, Floating bed cultivation creates job opportunity as well as reduce internal migration of poor people to urban areas.

Women play an important throughout the cultivation process (making *dhap,* preparing *tema,* nursing bed, seed conservation, and processing).They work in their fields as well as casual labor for other farmers. The participation of both men and women in the practice increases gender equity, empowered women, and leads to capacity building and excessive social interaction of women (Chowdhury and Moore 2015; Islam and Atkins 2007). It also cuts down fertilizer expenses. One female respondent said *"we are working on this agricultural system at all stages. Thus we can be able to change our economic position and maintain our family."*

Agricultural Advantages: During floods or rainy season, farmers use this practice and it's a good adaption technique to reduce the damage of extended flooding. The essential raw materials of this cultivation are often easily found. Floating vegetable growers said they prepared floating beds with aquatic plants such as Tapapana, Dulalilata, Khudipana, and covered with soil and cow dung on which vegetables can be cultivated. Just after harvesting vegetables, a floating platform use as hummus for the soil for growing winter vegetables. Most of the farmers use locally preserving seeds (bottle gourd, pumpkin, wax gourd, beetroot, cabbage, chili, tomato, etc.). The use of water irrigation, extra nutrients, or chemical fertilizer is also minimal to grow vegetables. Respondents of the FGDs replied, floating cultivation can provide a growing area for them to access land, especially during the rainy season, when their cultivatable land submerged underwater for seven-eight months each year. The rafts can be moved from place to place and also suitable for families that have temporarily homes. During maintenance and management of floating beds, farmers use small country boats for sowing, weeding, harvesting, and carrying the products. Floating cultivation involves low agricultural cost and higher returns and also requires a shorter time to mature crops. Respondents opined that the productivity of floating agriculture is higher compared to the land-based system. Thus the agricultural facilities of floating cultivation help to secure farmer's livelihood in low-land regions.

Ecological Advantages: Floating cultivation is an eco-friendly agricultural practice without soil where no chemicals and pesticides are used. This innovative technology helps to restore a healthy water ecosystem by using water hyacinth in the floating gardens. Clearing water hyacinth which is, therefore, helps keep the water clean, decreases mosquito outbreaks and creates an opportunity for open-water fishing (Saha 2010). Farmers said that there is almost no need for chemical fertilizer input. This practice does not produce any waste or byproducts that can pollute the environment. It can have a positive impact on biodiversity conservations (e.g. open water fisheries) by reducing weed congestion and using nutrients in the water (Alam and Chowdhury 2018). During floods, it can also use as a shelter for the poultry and cattle. The fisherman can cultivate crops and fish at the same time. All these activities are environmentally friendly and potential for both poverty alleviation and food production.

Economic development: Farmers utilize their income in various ways. The Majority of the respondents of FGDs use their profit for rearing duck, hen, cow, and goat for extra income and meeting family needs. Through these agricultural resources, the woman can also participate in the economic development of households. From selling milk, duck, eggs, most of the householders earn BDT 1600 per month. Two of them said that they use their income only for their household development (repair their house, education, and health development of the family). Some of the respondents said that through floating vegetable cultivation, our economic status has been changing. And the profit of floating bed cultivation helps us to deposit and purchase land. One marginal cultivator said *"the extra money I earned, I used it for my children's education."*

Problems and prospects of floating cultivation: Floating bed cultivation has been considered an alternative livelihood strategy. However, it has different problems that the farmers cannot remove easily. Most of the farmers replied that they haven't sufficient money and they don't get any government credit to practice floating cultivation. Few respondents get training opportunities and others don't.

Moreover, female respondents said that the unavailability of qualified seedlings is one of the barriers

for them for cultivation. They also said that they work with men in the same way, but they don't get any kind of training to enrich their knowledge and skill. One respondent said *"we are not able to bear the initial cost of floating vegetable cultivation. The initial cost is high, which is not possible for us to carry."*

Despite the problems, vegetable cultivation on floating gardens brings good prospects for marginal farmers at villages in Nazirpur Upazila, Pirojpur district. The system would improve the production of quality commodities and make profits. The society would find more opportunities to invest in assets development, and marketing value addition, and tourism (FAO 2017). And it would be a helpful practice to remove poverty, food insecurity, and vulnerability through the flooding of these areas. At present, the system is a potential solution for the poor farmers.

Facilities and supports of government and non-government organizations: Floating bed cultivation has proved to be a successful means of agricultural crop production in different wetland areas. Its effectiveness and charm are spreading rapidly, but facilitation for its development isn't mention worthy.

Most of the respondent claimed that they didn't get any kind of government assistance including training, fertilizer, seeds etc. Moreover, most of the male and female farmers said that the attempt of the government is not enough to reduce the adverse impact of the flood in the study area. So, they suggest that the government and non-government organizations should provide proper facilities and support to develop this indigenous cultivation system.

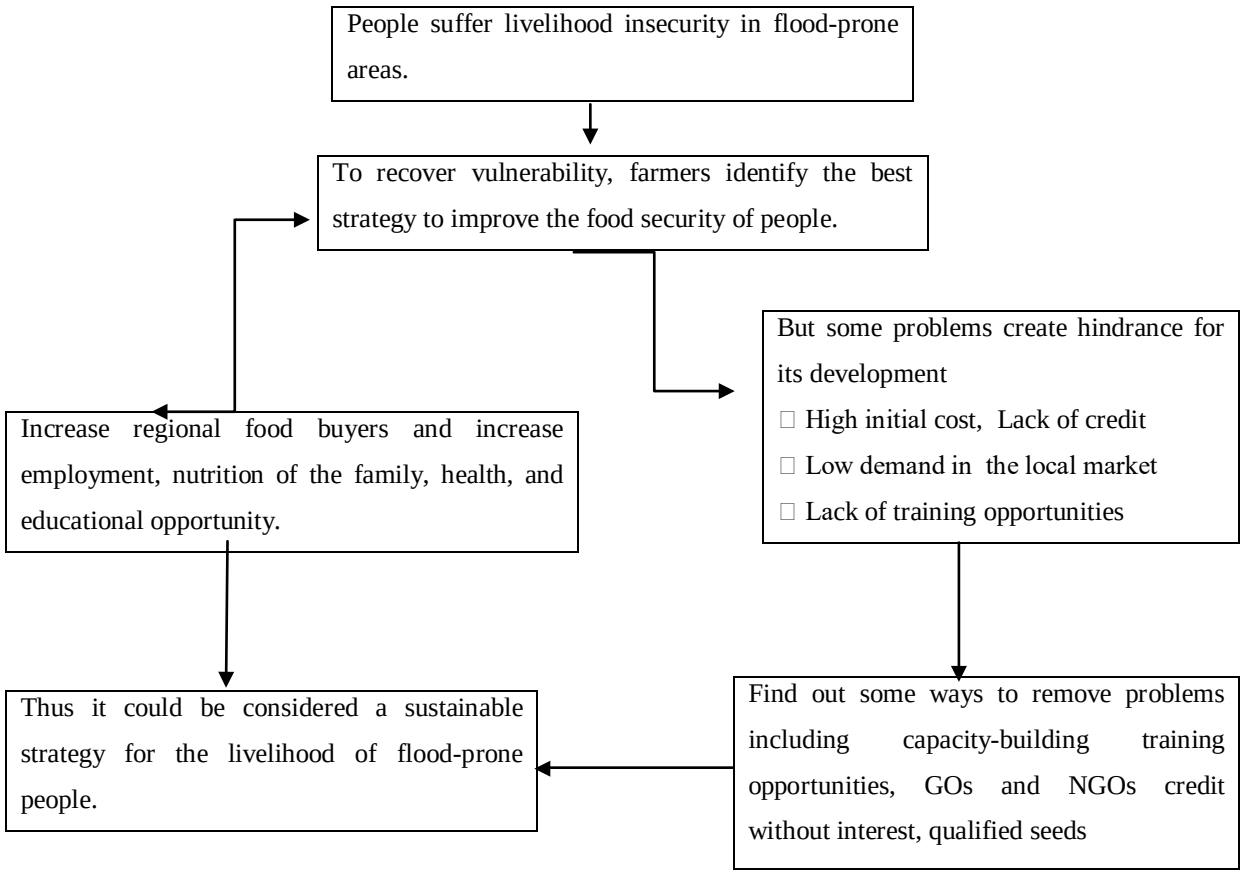


Fig. 6: Based on the findings and review of literature, this framework has been formulated

IV. Discussion

Findings of the study showed that the aged of farmers consists of the highest proportion of 51.70 percent and the lowest proportion of 2.50 percent. The medium family size constituted the highest proportion of 75.00 percent, whereas the lowest 10.00 percent in the large family size category. The highest proportion of 57 percent of the floating vegetable growers cultivates vegetables in their land, and 43 percent of respondents cultivate in leased land. Years of experiences of farmers in floating cultivation, the highest proportion consists of 48%, whereas the lowest is 25%. The highest proportion of 57.00 percent of the vegetable farmers says that they are not receiving any training related to floating vegetable cultivation, whereas 43.00 percent say that benefits of floating agriculture by using FGDs of two

selected unions. Most of the respondents of FGDs argue that floating bed cultivation provides the rural poor with self-employment opportunities. Most told that it is an eco-friendly farming system that is not creating any environmental deterioration, and they also argue that the agricultural benefit of this cultivation is praiseworthy. After all, they told us with satisfaction that floating bed cultivation helps us to reduce our vulnerability during flooding and helps us to secure our livelihood and remove poverty. So floating agriculture may be an effective way to combat the scarcity of cultivable land by increasing cropping intensity in wetland areas of Bangladesh. Key informant interviews of this study also appreciate with farmer's opinion. Key informant interviewers (Upazila agriculture officer, Sub-Assistance Agriculture Officer, Block agriculture supervisor) opined that GOs and local NGOs are playing an active role in the diffusion of floating cultivation practice, which is especially beneficial for poor and unemployed women but the support and facilities for vegetable cultivation are not enough. They also recommended that technical knowledge on the production and preservation of their seeds, increase institutional support from government and non-government organizations, sufficient training programs, etc. would be helpful to increase floating vegetable cultivation.

V. Conclusion

The present study identified that flood disaster is responsible for increased a vulnerable crisis on the rural livelihood in coastal areas of Bangladesh. To recover this situation, Farmers depend on traditional floating bed cultivation which acts as a way to fight against all climate changes. Therefore, it can also help farmers to increase their household income, generate employment opportunities, nutrition, and food security. Finally, this study suggests that GOs and local NGOs should come forward to promote these adaptation strategies on a large scale which can help to mitigate the adverse impacts and vulnerabilities of flood in the study area. Thus this traditional technique could be a sustainable and profitable practice not only in flood-prone areas of Bangladesh but also in other countries with a similar problem.

Acknowledgement

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