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Floating Gardening in Bangladesh: a means to rebuild lives after devastating flood

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Floating gardening, a form of hydroponics using aquatic plants as the medium, is a traditional cultivation system in southern Bangladesh practiced for year-round seedling and vegetable production. The livelihoods of marginalized people of the wetlands in North-eastern Bangladesh (*haor* region) are often constrained by 7-8 months water stagnation due to floods. A pioneering attempt at scaling up floating gardening in this *haor* region coincided with repeated, devastated floods in 2007. This paper summarizes the endeavour of *haor* dwellers in overcoming post-flood situation by up-taking this indigenous farming-technique for the first time as a result of intense motivation, capacity development, and determination. Despite some limitations and challenges, floating gardening and subsequent winter vegetable cultivation on soil was found to be useful for improving nutritional security, household income, and land-use capacity of extreme poor, landless people, especially in the post-disaster months. Potentials of floating gardening to adapt to changing climate are also highlighted.

Keywords: Disaster management; Floods; Natural resources; Traditional knowledge; Wetlands

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Floating gardening is an age-old practice of cultivation in the southern floodplains of Bangladesh (Barisal, Gopalganj and Pirojpur districts)[1, 2, 3, 4]. In this hydroponics system, aquatic plants are used to construct a reasonable-sized floating platform or raft on which vegetables and other crops are cultivated, and seedlings are raised in the rainy season. In the following winter, the platform is dismantled and the residue is used to prepare beds on the soil for winter vegetable cultivation (Figs. 1 & 2). Being the most common aquatic plants of Bangladesh, water hyacinth (*Eichhornia crassipes* (Mart.) Solms) is now the major construction material for floating platforms. This traditional cultivation technique is, therefore, an environment-friendly means to utilize the natural resources of wetlands to grow vegetables and other crops almost all-the-year-round. There are quite a few social, economic, agricultural and ecological benefits associated with floating gardening (Table 1). Details of floating gardening technique could be found elsewhere[2, 5].

People in the *haor* regions of Bangladesh are mostly very poor. (*Haor* is a large back swamp or bowl-shaped depression located between the natural levees of rivers, and usually consisting of a number of saucer-shaped depressions that retain water all-the-year-around.) These vulnerable, marginalized communities are constrained by not having cropping space in terms of access to and/or ownership of land. In some cases, even when they do have the access, the land is submerged under flood water for 7 to 8 months, restricting its use for cultivation. As a result most of the local people have to depend only upon one crop per year. The situation aggravates if flood is greater than the usual intensity, and hits more than once in a year, which the country experienced in 2007. In regular monsoon, if the poor people of *haor* could prepare floating gardens, they would earn a number of socio-economic benefits in terms of food security, health, employment, and household income.

Since traditional and essentially confined in southern Bangladesh, floating gardening is a new concept for *haor* dwellers in the north-east. Community-based promotion of floating cultivation by different non-governmental organizations (NGOs), however, is a recent development in the country[2, 5, 6]. Recognizing the potentials of floating cultivation in the *haor* region, a pilot project was implemented in

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2005-2006 to introduce this environment-friendly, natural resource-based technique in several villages of Habiganj district of Bangladesh[5]. The lessons learnt from this phase inspired two international organizations to scale up floating gardening in other areas of the *haor* region in the view of nutritional security of the marginalized communities. In the first year, the scaling up phase envisaged to reach 1,500 people of 25 villages of Kishoreganj and Sunamganj districts. However, achieving these targets was impeded due to devastating, repeated floods of 2007.

Flood is a regular phenomenon for Bangladesh. During the last 50 yrs, at least seven big floods affected 35–70% of Bangladesh[7]. Although the intensity of 2007 floods (affecting 42.21% of the country) was not as severe as those of 1988 (61% area) and 1998 (68% area), they did huge damage to the country's economy and caused immense sufferings to people due to unusual two waves (Box 1). Bangladesh is situated in the lowest riparian region of the Ganges-Brahmaputra-Meghna River basins with a total catchment area of about 1.7 million sq km. and

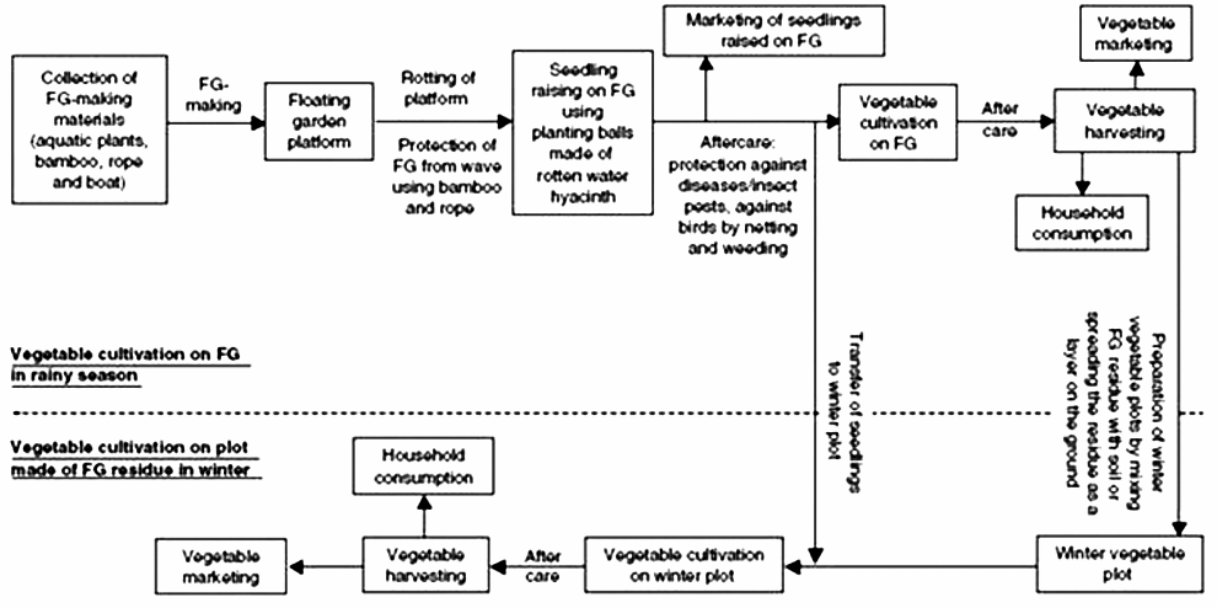

Fig.1—Flow-chart showing floating and associated winter vegetable gardening traditionally practiced in Bangladesh (FG, floating garden). (reproduced [5])

Table 1- Advantages of promoting floating gardening in Bangladesh (modified [2]).

Socio-economic benefits

i. Enhancement of nutritional security through year-round vegetables production
ii. Increase in quality food production positively influencing the health of local communities
iii. Increase in household income from the production units (floating platforms)
iv. Facilitation of employment in the wetlands like *haors* in rainy season
v. Promotion of a local technique, thus helping in conserving indigenous knowledge

Agricultural benefits

i. Additional space for vegetables cultivation and seedling raising in the wetlands
ii. Early production of seedlings of winter vegetables
iii. Increase in vegetables supply in the area and the surroundings
iv. Crops require shorter time to mature when cultivated on floating platforms
v. Prime nutrient elements, namely nitrogen, phosphorus and potassium are available in water hyacinth comparable with cow-dung
vi. When water recedes from *haor*, dismantled floating platforms are used as organic fertilizer. In this way it enhances eco-friendly agriculture practice in winter seasons to cultivate winter crops

Ecological benefits

i. Provides a good use of an invasive species like water hyacinth – a very effective way to control this notorious weed
ii. Platform residues could be used as organic fertilizer; this practice cuts down pollution from chemical fertilizers
iii. Chemical fertilizers are not used in floating cultivation in large amounts; this cultivation practice does not harm the environment by supplying chemical pollutants to the water

Box 1. Floods of 2007 in Bangladesh

The first spell of flood took place during 24 July-6 August 2007, and the second one – the worst of the year – during 5-15 September 2007[8]. More than 16 million people of 3 million households in 46 districts, out of 64 districts, were affected by these floods. The floods damaged crops particularly that were replanted after August floods, therefore country's food security was under threat[9]. It was estimated that 1.12 million ha of cropland were completely or partially damaged costing US$ 620 million[8]. Besides the deaths, casualties and sufferings of human lives, the total damage was estimated US$ 1066.69 million (including damages of infrastructures US$ 81.6 million, and losses in fisheries US$ 29 million, livestock US$ 9 million and forestry sectors US$ 0.6 million)[8]. The post-flood situation was also difficult in terms of rehabilitation of the people.

about 93% of it lies outside the country (Bhutan, China, India and Nepal). Rainfall situation analyses suggested that, the inland rainfall did not have much significant contribution to the flooding of 2007 in Bangladesh, but the heavy runoff from the upstream catchment had[7]. North-eastern Bangladesh (Meghna River basin) was one of the most severely affected areas where the scaling up of floating gardening was initiated.

Although this initiative was essentially a technology transfer project to improve nutritional security of the north-east by promoting a wetland-suitable agro-technique of the south, due to the floods of 2007, post-disaster scenario gave a new dimension to the whole venture. This paper summarizes the effort of *haor* people in tackling post-flood situation by up-taking a traditional agro-technique from the south which was new to them.

Materials and methods

Study areas

A total of 53 villages of Kishoreganj and Sunamganj districts of Bangladesh were visited in mid 2007 and 25 were found suitable for floating gardening. The repeated floods of 2007, however, left two villages totally devoid of water hyacinth in September, thus floating gardening was promoted in 23 villages in 2007. The selected households were near water bodies with sheltered side (not exposed to serious wave action from *haor*) and space to keep floating platforms, had access to sufficient water hyacinth, and had land within or adjacent to the homesteads for subsequent winter gardening with platform residues.

Data collection

Five major surveys were carried out between July 2007 and March 2008 involving all project participants i) to understand the pre-intervention scenario, ii) to document project implementation process, and iii) to record project outputs and impacts, and issues associated with the implementation. In all surveys, pre-tested, structured questionnaires were used. The major topics, frequency and time of these surveys are listed in Table 2. Analyses of quantitative data (iii & iv of Table 2) and subsequent comparison with the baselines were done to understand the impacts of floating/winter gardening on nutritional security, household level income, and land-use capacity of the participants in the post-flood months.

Project participants and the baselines

Initially 259 extreme poor families were selected for 2007, but due to the floods, the number came down to 174. The size of the family was on average 6 persons/household (about 55% <15 yrs old). In terms of occupation, rainy season was more diverse with 70% people engaged in day-labourer, fishing and/or agriculture, than winter which was skewed towards agriculture (48% people). On average, the number of earning persons was 1.5 per household and in 99% cases they were men. The average daily household income was almost 45% higher in winter (US$ 1.46) than in rainy season (US$ 1.04). Such difference showed vulnerability of target people in monsoon as expected in the *haor* region. The annual per capita cash income was calculated less than US$ 90, very low compared with the national per capita income of Bangladesh (e.g. US$ 520 in 2006-2007[10]). There was a tendency of seasonal migration of the earning persons both in rainy seasons (15%) and in winter (5%) in Sunamganj, but it was absent in Kishoreganj.

Most of the project participants were landless occupying small area of government-owned land (locally called *khas* land) to live in and do gardening. Household areas they possessed ranged from 0.5 to 10.0 decimal/household (average 3.6 decimal/household). Families possessing cultivable land adjacent to their

Table 2- Survey schedule (July 2007-March 2008) to collect data on baselines, floating platform making, monsoon and winter crop production, and participants' perceptions.

Survey	Major topic	Time (frequency)
i) Pre-intervention baseline	Socio-economic parameters (occupation & income including seasonal variation, and seasonal migration), land occupancy, vegetable production (consumption & marketing including seasonal variation) and its constraints, and nutritional status	July 2007 (once)
ii) Floating platform-making	Platform size, availability of materials/ inputs, time taken, input costs, and protection measures	October 2007 (once)
iii) Monsoon crop production	Consumption, sale and distribution of seedlings and vegetables (in taka)	October-November 2007 (every 10 days)
iv) Winter crop production	Garden size, and consumption, sale and distribution of vegetables (in taka)	February-March 2008 (every 10 days)
v) Participants' perceptions towards floating/winter cultivation	Benefits and difficulties of the technique; what message to be given to others	March 2008 (once)

homesteads ranged from 0 to 12 decimal/household (average 2.8 decimal/household).

The participating families consumed, cultivated, bought and sold a total of 31 vegetable varieties. The number of vegetable varieties sold was always low compared with cultivated and bought ones. All families cultivated some vegetables in their homesteads both in the wet and dry seasons, but the extent varied significantly. The total average vegetable consumptions in the rainy season and winter were same – US$ 0.36/household/day. However, while the market value of self-produced vegetables was only US$ 0.12/household/day in the rainy season, it increased 2.3 times in the winter. Only 2% of the surveyed families sold vegetables in the rainy season. On the contrary, 21% families sold home-grown vegetables in the winter (highest sale US$ 0.43/household/day). Vegetables purchased from the market could be as high as US$ 0.57/household/day in the rainy season and US$ 0.43/household/day in the winter. Scarcity of land and expenses of seeds and fertilizers were the major constraints identified by the respondents hampering their vegetable gardening. Other reasons were damage by insects, diseases and rodents. In most of the cases, the vegetables were grown in very small amount and consumed totally by the concerned households, thus was not feasible to sell in the market.

Since floating gardening and associated winter gardening were completely new techniques for the project participants, four modes of capacity building were used: i) class-room training in groups, ii) on-site training for individuals, iii) cross-visit for selected participants visiting traditional floating gardeners in southern Bangladesh, and iv) exposure-visits for selected participants from one village visiting other village.

Floating and winter gardening in 2007

Floating platform making

A total of 200 floating platforms were prepared of which 23 were destroyed by repeated floods in August and September 2007. Thus in monsoon, seedlings were raised and vegetables were cultivated on 177 platforms made by 174 participants in 23 villages. Participants continued collecting water hyacinth from August to September for constructing platforms. Due to floods, as water hyacinth became less available, people had to collect water hyacinth from distant places using country-boat. On average 1 man day was needed to prepare a platform (average size: 4.5 m long X 2 m wide X 1 m high), but occasionally the preparation time was spread over as long as a week. Preparation of floating-platforms was completed in all villages by the early October – about two months later than the usual time. A platform took another 3 to 4 weeks to rot and ready for cultivation.

Seedling raising on floating platforms

As per the local demand, following six vegetable seeds, namely amaranth (*data shak*, *Amaranthus retroflexus* L.), amaranth (red) (*lal shak*, *Amaranthus retroflexus* L.), bottle gourd (*Lagenaria siceraria* (Molina) Standl.), hyacinth bean (*Lablab purpureus* (L.) Sweet), kang kong (*gima kolmi*, *Ipomoea* sp.) and pumpkin (*Cucurbita maxima* Duchesne *ex* Lam.) were supplied to the project participants. Some seeds, namely amaranths and kang kong, were sown directly on platforms, whereas the seedlings of bean, bottle gourd and pumpkin were raised in ball-like 'seed-germination structures' made up of rotten water hyacinth (Fig. 3). Amaranths and kang kong seeds took 3 to 4 days to germinate, whereas the other three took 3 to 6 days. These balls with seeds were kept in

shed for 5-12 days or until they attained 12-15 cm length then transferred to the floating platforms. Depending upon the variety, the seedlings were transplanted to soil after 8-25 days' (average 16 days) stay on the platforms. From 94 to 99% of these seedlings were transplanted by the participants in their homestead gardens, and the remaining ones were sold or given away to naighbours or relatives.

Vegetables cultivation on floating platforms

In monsoon 2007, most of the floating platforms were divided into three sections to cultivate red amaranth, amaranth and kang kong simultaneously (Fig. 4). In general, vegetable harvest was seriously affected by repeated devastating floods, which delayed floating cultivation and consequently allowed only one crop-cycle for almost all platforms instead of three cycles (see below for implications). Nonetheless, production of red amaranth was good in 77% cases, amaranth was moderate in 60% cases, and kang kong was good in 95% cases.

Protection of floating platforms

There were a number of traditional options promoted in the intervention areas to protect the platforms from wave damage and/or drifting. None of the measures were, however, useful in protecting platforms from devastating floods. In monsoon 2007, even at the end of the floods when platform-making attained its optimum pace, more than 77% farmers did not take any measures to protect their platforms from wave actions since those were placed in shallow, sheltered ditches or canals. The remaining platforms were protected by erecting bamboo sticks in the submerged mud in regular intervals around the platform (Fig. 2) or by inserting a bamboo pole as an anchor in the middle of a platform.

Winter gardening in 2007

All the 174 participants who prepared floating gardens also performed winter gardening. Most of the winter gardens were made by the homesteads of concerned participants. The average size of the land where floating platform residue was used was 0.80 decimal/household (ranged from 0.25 to 2 decimal/household), which was <33% of average homestead cultivable land. The initiative supplied five types of seed, namely amaranth, amaranth (red), broccoli (*Brassica oleracea* var. *italica* Plenck), kang kong and okra (*Abelmoschus esculentus* (L.) Moench) to the participants after a quick assessment. The winter harvest was relatively better (see below).

Impacts of floating and winter gardening

The year 2007 was a very difficult year for Bangladesh because of repeated, destructive floods in August and September, and the super-cyclone Sidr in the mid November. The north-eastern *haor* region experienced little damage from the cyclone compared with the south-western coastal area, but the devastation of floods was immense in *haor*. Despite that the participants of floating gardening worked hard in the post-flood months to practice this traditional agricultural system introduced to them just before the flood. Given the short time they had to exercise floating gardening and subsequent winter gardening, the initiative had encouraging impacts on participants' nutritional security, household income, and land-use capacity – all showing resilience to the devastation of floods – as described below.

Nutritional security

In monsoon 2007, the production from floating gardening over 45 to 60 days was low. It could be much higher if the delay due to floods could be avoided and more than one crop-cycle could be managed by the families. More than 10% household produced US$ 7.15 or more worth of vegetables with maximum US$ 10.60. Monsoon production of about 85% household ranged between US$ 3.00 and 7.14. About 90% of the produced vegetables were consumed by the participants indicating improved nutritional security in the post-monsoon months. A modest amount of vegetables and seedlings were also given away to relatives and neighbours, and only a limited amount was sold. In the subsequent winter, on the other hand, the vegetable production was modest over 4 to 5 weeks since the late January 2008 (Fig. 5). About 25% household produced US$ 15-30 worth of vegetables per household and about 10% household produced US$ 30.01-50.00 worth of produce (maximum US$ 70/household). About 83% of the produce was consumed by the participants, 12% was sold and remaining 5% was distributed to relatives and neighbours. It was also estimated that, floating cultivation, through only one crop-cycle in the very first year, covered 30 to 40% of daily average vegetables purchase by the participants in the rainy season. On the other hand, in 4 to 5 weeks of winter gardening, the participants produced around US$ 0.43 worth of vegetables per household per day, exceeding their daily demand. Therefore, despite devastating floods, the traditional farming technique has managed to increase food availability at the project sites, mainly

Figs.2-5—Floating platforms for seedling raising and vegetable cultivation, 3 Bean seedlings in ball-like structures made of rotten water hyacinth are raised on a floating garden, 4 Vegetables grown on floating gardens, 5 Bottle gourd seedlings raised on floating gardens in monsoon gave rise to healthy plants with good yield in early winter.

at the household level, and upheld potential nutritional security of the *haor* people all-the-year-round.

Household level income

Despite the delay due to floods, the moderate vegetable production indirectly helped the target families by partially covering their household expense for food. It was estimated that the monsoon vegetable production was 8 to 11% of the average daily household income of the participants, whereas it was 26 to 35% in case of the winter production. Therefore, a significant sum of daily expenditure was saved by the target families in the post-flood months.

Land-use capacity

Through floating farming, people of the project sites used shallow, stagnant waters near their homesteads, which would otherwise remain unutilized in monsoon. The floating platforms in fact increased their land-use capacity without much expense. It was estimated that the area offered by floating gardens was up to 42% (on average about 6%) of participants' household areas. Further, these platforms were about 8% of their cultivatable land adjacent to their homestead. But it should be mentioned here that 27% project participants had no or less than 1 decimal of cultivable land by their homestead, thus floating platforms offered 20 to 40% (in a few cases 100%) additional arable land to them in the monsoon. For extreme poor, marginal, landless people of the study areas enhanced land-use opportunity, although for monsoon only, created significant social impact.

Floods of 2007 and resilience of the *haor* communities

The repeated, devastating floods affected the scaling up initiative and its outputs in a number of ways. Firstly, the floods seriously hampered the pace of project implementation, specifically delaying floating garden construction in almost all villages. Secondly, after the floods, the availability of water hyacinth was very low in most of the villages. Moreover, villagers not involved in floating cultivation were reluctant to give away water hyacinth in their possession to the project participants because of other use of water hyacinth like fodder for cattle in monsoon and saving homestead plinths from the wave in flood. Thirdly, floods destroyed 23 floating platforms. Repeated making/repairing of platforms by the participants was also needed due to damage by waves in many villages. This consequently reduced

the interest of some participants. Fourthly, due to the late start in floating cultivation, participants managed only one crop instead of three on their floating gardens before getting ready for winter. This caused less output in monsoon 2007. Finally, delayed monsoon cultivation also delayed winter cultivation, thus resulting into overall moderate production.

Despite these challenges and limitations, the participants from *haor* showed immense courage, enthusiasm and will-power to continue with an indigenous agricultural option new to them after post-disaster situation, and they effectively tried to tackle the delay due to floods through proper planning. At the beginning of this project it was strongly appreciated that introduction of a new technique like floating cultivation needs sufficient time to motivate target communities. The present initiative has successfully shown that if properly motivated, people can accept a new technology and knowledge, and adapt to changes (e.g. shortage of water hyacinth) despite natural calamities (e.g. repeated devastating floods). In spite of many constraints, the outputs of floating farming and associated winter gardening – both in terms of nutritional security and financial security – were encouraging. Moreover, many neighbours of project participants, who were initially skeptical about the success of floating gardening, were convinced and appreciated the usefulness of this technique at the end of the season.

It was, however, realized that only one year is not sufficient to ensure that all families will practice the farming technique in subsequent years if natural calamities hit again. Two to three years' follow-up is necessary to make this technique a regular agricultural activity in the areas. Existing community-based organizations and local government in respective villages would be a good force to guide this initiative to sustainability.

Floating gardening and climate change adaptation

An overview of floods since 1954 indicates that although there are no significant changes in the trend of normal floods in Bangladesh[7], scientists reckon that extreme floods like those of 2007 would occur more frequently in the coming decades probably as a consequence of changing climate[11, 12]. Thus the importance of adaptive measures is being appreciated increasingly[13, 14]. Floating gardening could be a useful option to tackle extended water logging by improving food security[2, 4, 6, 15, 16]. The National Adaptation Programme of Action (NAPA)[17] of Bangladesh also listed floating gardening as one of the 15 major projects, but no pragmatic steps have been taken to implement this.

As shown in this and other study[5], given the physical structure of the platforms, floating cultivation is not suitable in all open waters and cannot withstand devastating floods or strong waves. Nonetheless, this production system can be very useful in many wetlands during normal floods and also for rebuilding lives after disastrous floods through vegetable production, and by raising rice and vegetable seedlings to save time for subsequent winter cultivation. There is a scope to make the platforms stronger, for example by using bamboo cage/raft. But such measure will increase the input costs significantly and the extreme poor may not afford it to meet household vegetable demand.

In addition to on-going, sporadic non-government initiatives[6, 15], involvement of government's agricultural extension system is essential to promote this technique at wider scale. Local community as a whole and local government need to be involved in such extension system to ensure access to common resource pool (e.g. water hyacinth, water bodies, fallow land) and access to market to sell the produce, thus for sustainability of the promoted technology. But before such scaling up, assessment is needed to ascertain the vulnerability of this agro-technique to possible climate change and variability[4].

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