

Floating Garden Agricultural Practices in Bangladesh

**A Proposal for
Globally Important Agricultural Heritage Systems (GIAHS)**



**Ministry of Agriculture
People's Republic of Bangladesh**

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Appendix-1 **Error! Bookmark not defined.**

Preliminary list of significant agricultural biodiversity and associated biodiversity **Error! Bookmark not defined.**

SUMMARY INFORMATION

Name/Title of the Agricultural Heritage System: Floating Gardens
Requesting Agency/ Organization: Ministry of Agriculture, Government of Bangladesh
Country: Bangladesh
Location: South central districts of Bangladesh (Gopalganj, Pirojpur and Barisal)
Map : Figure 1-3
Geographical coordinates: Longitude:22°10´N to 23°30´ N and Latitude: 89° 40´E to 90°15´E
Accessibility of the site to capital city and major city: From Dhaka, the capital city of the country the district headquarters are accessible by well-developed road. From the district headquarters the specific locations is accessible via road and boat.
Approximate surface area: 2,500 hectares; Potential area for expansion could be around 2.0 million hectares.
Agro-ecological Zone/s: Tidal Floodplains
Topographic features: Extensive low-lying areas, , low-lying basins, with low ridges along rivers and creeks
Climate Type: Annual mean rainfall ranges between 1600mm and 2000mm. Annual mean temperature ranges between 26 degree Celsius and 26.7 degree Celsius. Sub-tropical humid climate. Monsoon season is from June to October (about 70% of annual precipitation during the season) and dry season is from November to March.
Approximate population: Total population of Gopalganj and Pirojpur district is 2.29 million
Main Source of Livelihoods: Agriculture (farming and fishing)
<p>Summary Information of the Agricultural Heritage System (about 200 -300 words):</p> <p>In some parts of Bangladesh, most affected by flood and where water remains for a prolonged period of time, farmers are using their submerged lands for crop production by adopting scientific methods which are similar to hydroponic agriculture practices, i.e. floating agriculture, whereby plants can be grown on the water in a bio-land or floating bed of water hyacinth, algae or other plant residues. This practice has traditional roots in practices dating back to the country's forebearers. According to their needs, people in different parts of Bangladesh have adopted, modified and named this practice differently (<i>baira, boor, dhap, gathua, gatoni, geto, kandi</i> and <i>vasoman chash</i> and floating agriculture).</p> <p>Actually, this practice is most successful in the coastal areas that are adjacent to the sea-bank areas, which remain submerged for long periods, especially in the monsoon season, as well as the wetland Haor Areas.</p> <p>Floating gardens are age-old practice of crop cultivation in the Southern floodplains of Bangladesh (Barisal, Gopalganj and Pirojpur districts). Floating garden agricultural practices (locally known as <i>Dhap</i>) for growing vegetables and spices prevail in the wetlands of the south central coastal districts of Bangladesh since immemorial times. With the use of available water hyacinth (<i>Eichhornia crassipes</i>) and other aquatic weeds, local communities have developed a technique to construct reasonably-sized floating platforms or raft on which vegetables and other crops can be cultivated. The unique hydroponics production system was developed in the hands of the locals by using their traditional knowledge for agricultural practice and livelihood. The production system is the major livelihood option for about 60-90% of the locals. Bio-diverse vegetables and spices crops are grown sustainably over the years on floating substrata made mainly of water hyacinth and other minor aquatic weeds on flooded water. The land with the water is used for production of fish in the open water and crops on the floating beds. Thus, ensures a sustainable utilization of agro biodiversity, natural resources and multiple use of the land. This traditional cultivation technique is, therefore an environmental-friendly means to utilize the natural resources of wetlands to grow vegetables and</p>

other crops almost all year round. With the floating gardens, numerous social, economic, agricultural and ecological benefits are provided to the local population.

DESCRIPTION OF THE AGRICULTURAL HERITAGE SYSTEM

I. Characteristics of the proposed GIAHS site

Bangladesh is situated in the lowest riparian region of the Ganges-Brahmaputra-Meghna River basins.

In the wetlands of southern Bangladesh (parts of Gopalganj, Pirojpur and Barisal districts), local communities have had difficulties in securing farmlands to provide food and livelihoods during the monsoon season (from June to October). These vulnerable, marginalized communities are constrained by not having cropping space in terms of access to and/or ownership of land. In that season, these areas have been repeatedly affected by cyclones, heavy rainfall, flooding, salt damage caused by sea level rise and snow melting from the Himalayas, resulting in extremely low agricultural production. Even when they manage to cultivate crops in limited farmland area, there is always a risk for the crops to be swept by flooding. Even after the flooding is over, farmlands remains submerged for a while due to poor drainage capacity. Farmers cannot manage to cultivate any crops on the submerged farmlands. For that reason, many local populations are in poverty and hunger during that time. In Bangladesh, yearly cyclical phenomenon of poverty and hunger is referred to “*Monga*”. In this context, local communities didn’t chose the way to conquer this sever environment, but chose the way to cope with the surrounding nature. Farmers have developed the unique floating garden agricultural practices (locally known as “*Dhap*”) to rear plants and crops in nutrient supplemented water without soil.

Dhap is a kind of hydroponics. This system employs the floating beds on the surface of water as the foundation of growing plants and crops without soil. Aquatic plants such as Tapapana, Dulalilata, Khudipana were used to construct floating beds dated back a few thousand years. After the prevailing of water hyacinths, usage of water hyacinths for floating beds becomes dominant because of the availability. (Figure 8-11). In the following winter, the floating beds are discomposed and the residue is used to prepare beds on the soil for winter vegetable cultivation. This traditional cultivation is, therefore, an environment-friendly technique to utilize the natural resources of wetlands to grow vegetables and other crops almost all the year around. . The production system is the major livelihood option for about 60-90% (varies from community to community) of the people of local communities in this region.

The floating agriculture practice in the southern parts of the country represents a traditional/indigenous agriculture system for the water logged or the submerged area in Bangladesh. The people of the southern parts of Bangladesh adopted the practice based on their traditions and the community’s culture and wisdom.

Floating gardens are amongst the many options developed and promoted to address the needs of poor farmers in Bangladesh combining to make a real difference to production levels.

The floating-bed technique also has some positive social impacts. It involves both men and women, thereby improving the gender balance, as well as people’s perception of particular areas as suitable

places to live. People who are practicing floating-bed cultivation are enjoying a better life economically, than those in other flood-affected areas who have not yet adopted this practice.

People in Bangladesh have been practicing floating agriculture since a long time (three to four hundred years). It is a useful method considering the economic, environmental and as well as social aspects.

Farmers of the area have been practicing the method mainly for two reasons. First, during monsoons, when most of the land is flooded, floating agriculture is the only alternative method of cultivation. In the monsoon (mainly during June-August), farmers cultivate ladies finger (okra), cucumber, snake gourds etc. on the floating system. After the monsoon, farmers use this for cultivating spinach, aurum, spices and several other vegetables. During the monsoon, farmers use small boats to manage the floating agricultural land.

Second during the winter season, farmers carry the floating bed to higher grounds where they break it and mix it with the soil to enrich the soil.

The main objective of the practice is sustainable local natural resource management (submerged areas) through floating agriculture practices. A second objective is to cope with the climate change situation.



Figure 1: Map of Gopalganj District



Figure 2: Map of Pirojpur District

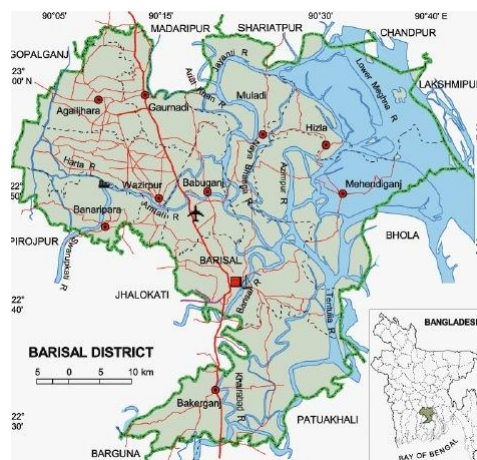


Figure 3: Map of Barisal District

1. Food and livelihood security

i) Food security

The floating garden agricultural practices production system is yearly generating vegetables and species for local communities. In summer, vegetables such as okra, ribbed gourd, Indian spinach, brinjal, cucumber, red amaranths, stem amaranths, wax gourd etc. are cultivated in floating beds. Among the spices crop, turmeric and chili are the major crops in this region. Because prime nutrients such as nitrogen, potassium and phosphorus are abundant in the floating beds, there is almost no need of fertilizer input. Additionally, because the water prevents vermination, almost no pesticides are applied. The productivity of floating vegetable cultivation is estimated ten times higher than on a similar sized land-based cultivation. In winter, with recession of flood water, the floating beds cover the ground. They are left as they are, and then used as compost for winter cultivation on land (Figure 5). In this way, floating garden agricultural practice enhances eco-friendly agriculture practice in following winter cultivation. Turnip, cabbage, cauliflower, tomato, red amaranths are grown on the land during winter.

Among them, okura is a high quality local product in this region. Okura is a popular health food due to its high fiber, vitamin C, calcium, potassium and folate content. Thanks to these contents, okura is said to good for human stomach and intestines. Okura is also known for being high in antioxidants. Ribbed gourd is another featured agricultural product in this region. After harvesting okura, vines of ribbed gourd coil around the stem of okra plants to grow. For that reason, ribbed gourd is usually intercropped with okura. This is a unique example of indigenous knowledge and adaptation of technology. Ribbed gourd is used not only for food but also for medicine.

Food security is also ensured by the enhancement of nutritional security through year-round vegetables production; and increase in quality food production positively influencing the health of local communities.

Agricultural benefits of this practice, which contribute to food security, are:

- Additional space for vegetables cultivation and seedling raising in the wetlands;
- Early production of seedlings of winter vegetables;
- Increase in vegetables supply in the area and the surroundings;
- Crops require shorter time to mature when cultivated on floating platforms;
- Prime nutrient elements, namely nitrogen, phosphorus and potassium are available in water hyacinth comparable with cow-dung;
- 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.

Besides floating garden agricultural practices, crop cultivation in wetland is dominant because the main cultivation in Bangladesh is rice. In Bangladesh, there are several types of rice, classified and named according to the cultivation period: Aus rice (March-June), Aman rice (May – October) and Boro rice (November – May). From the point of reducing risks of natural calamities like flooding, Boro rice is becoming the popular pattern of rice production in this region.

Fishing is the second source of income in this region. In fact, floodplains represent a favorable living environment for aquatic living organisms. They offer not only fertile ground for growing and feeding larvae, hatchlings and fry, but also good place for reproduction. During the flooding period, rivers, floodplains and estuaries are connected with each other. Fish and prawns easily move across the rivers, floodplains and estuaries looking for their good habitat and place for reproduction. In this region, a variety of fish and prawn species as well as several species of mussels and snails are caught

and eaten as an important source of protein for local populations. Mussels and snails are caught not only for food but also for other use. Several species of freshwater mussels are famous for bearing pink pearls. Mussel shells are also crushed to make lime for use with betel leaves and nuts, to produce fertile hummus. Snails are harvested to use their meat for feeding *golda chingree* (freshwater giant prawn) under cultivation.

Animal husbandry is also key factor for local food security. During the monsoon season, livestock cattle, buffaloes, sheep, goats, pigs and poultry are usually reared in the homestead on highlands. After the flood water recedes from floodplains in winter, livestock are allowed to graze in the marshes and turfs. Livestock are utilized not only for edible use (meat, milk and eggs), but also for providing workforce for transporting products, , they are also used in oil mills for oilseed crushing, for the provision of manure as fertilizer and for farmland flattening.



Figure 4: Floating *Dhap* with crops



Figure 5: Winter cropping on dismantled *Dhap*

ii) Livelihood Security

This 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, due to the minimal infrastructure required.

The floating-bed technique also has some positive social impacts. It involves both men and women, thereby improving the gender balance, as well as people's perception of particular areas as suitable places to live. People who are practicing floating-bed cultivation are enjoying a better life economically, than those in other flood-affected areas who have not yet adopted this practice.

This technology can provide a growing area for poor communities who lack access to land, as many wetlands are submerged under water for 7-8 months of the year. As a result, there are various socio-economic, agricultural, environmental, and disaster risk management benefits. The socio-economic benefits include enhanced nutrition and food security, increased income, and employment benefits. Some of them make their livelihood directly from agriculture, fishery and husbandry. Some make their livelihood from relevant work (for example, marketing, processing, transportation, making fishing crafts or gears etc.).

Floating agriculture practices have minimal infrastructure and very little capital requirement. Costs can also be kept low because raw materials for the construction of floating beds are readily available

from local waterways. This gives the opportunity to many people living in this area to cultivate using this technique.

The use of floating agriculture as an adaptive measure also provides direct economic benefits. Vegetables and spices produced on the floating beds can be sold at markets and since the approach is fully organic, the product receives special attention from local buyers and consumers.

In the agricultural sector, this floating garden production system is the major livelihood option for about 60-90% (varies from community to community) of the people of local communities in this region. In fact, this system considerably mitigates the risks of natural disaster and climate change and the productivity of floating vegetable cultivation is estimated ten times higher than on a similar sized land-based cultivation. Materials for floating beds are affluent. In particular, water hyacinth is usually classified as one of the worst invasive species. For that reason, farmers can easily use it as floating bed or composts without any additional cost. Moreover, the use of chemical fertilizers and pesticides are minimal in this system. In addition, no cost for irrigation is required due to abundant water. For these reasons, labour for preparing the bed, sowing and harvesting mainly account for the total production cost in this system. Production cost of this system is estimated 30-50% lower compared to traditional land-based system.

Not only men but also women in each family are actively involved in (i) growing vegetables, (ii) making *Tema*, a structure for seedling growing, (ii) rowing boat to nursing the bed, (iii) harvesting and postharvest processing of vegetables, and (iv) seed processing and conservation.

Most agricultural products are domestically consumed. However, local populations sell surplus produce and earn cash to meet other household expenses. They also earn extra cash from homestead gardening, tree plantation and vegetables (for example, fruits such as papaya, banana, pineapple, guava etc. and vegetables such as sweet potato, yams, taro etc.)



Figure 6: Women rowing boat to reach *Dhap* for nursing



Figure 7: Women harvesting vegetables from *Dhap*

Some of the socio-economic benefits of this system are the increase in household income from the production units (floating platforms); facilitation of employment in the wetlands like *haors* in rainy season; promotion of a local technique, thus helping in conserving traditional knowledge.

2. Biodiversity and ecosystem function

i) Biodiversity

Wetlands are invaluable components of the environment, ecology, resource in Bangladesh. The wetlands in Bangladesh contain very rich components of biodiversity of local, national and regional significance. It is estimated that up to 300 plant species and some 400 vertebrate species are considered to be dependent of wetlands for all or part of their life span. Also, the wetland could be

good habitat for a variety of resident and migratory waterfowl. Due to vast freshwater resources, some 260 species of fin fishes and 25 shell fish are confirmed in this region.

Agricultural biodiversity

Upland crops hardly grow out of floating beds during summer. In the monsoon season, mainly okra, ribbed gourd, Indian spinach, brinjal, cucumber, red amaranths, stem amaranths, wax gourd, bitter gourd, kang kong, melon, etc. are cultivated on the floating beds. With the recession of flooding in winter, turnip, cabbage, cauliflower, Tomato, red amaranths, cucumber, radish, coriander, spinach, mustard, arum, sour spinach, local potato, etc. are cultivated on the land. In addition to these, among the spices turmeric and chili are grown. Moreover, transplanted aman rice, broadcast aman rice and boro rice are cultivated in limited scale where there is suitable land for the crops. On the homestead, fruits such as papaya, banana, pineapple, guava etc. and vegetables such as sweet potato, yams, and taro are cultivated.

Aquatic biodiversity

The submerged land has a diversity of wetland species like water hyacinth, *Dulalilata*, *Tepapana*, *Khudipana* or duckweeds, *Kantashaola*, *Idurkanipana*, *Dulkalmi*, etc. (Scientific names of the crops and other aquatic species are presented in appendix-1). These wetland species are used to prepare the *Dhap* on which the crops are grown.



Figure 8: Water hyacinth (*Eichhornia crassipes*)



Figure 9: Dulalilata (*Hygroryza aristata*)



Figure 10: Tepapana (*Pistia stratiotes*)



Figure 11: Khudipana (*Lemna*, *Spirodela*)

Fish

The fish species found in the floodplains during the flood phase are mostly small sized such as *koi*, *kholisha*, *bele*, *mola*, *dhela*, *taki*, *puniti*, *meni*, *singi*, *magur*, *chanda*, *baim*, *pholi*, *darkina* etc. Fishes like *aire*, *boal*, *shol*, *gazar* and fry and fingerlings of river breeding major carps like *rui*, *catla*, *mrigal* and *kalbasu* also visit the floodplains to feed and grow. Besides fish, several species of freshwater prawn such as *kuccha chingree*, *gura icha*, *golda chingree*, *thengua chingree* etc. and their larvae and

juveniles also are found in the flood plains. In addition, several species of freshwater mussels and snails also occur in the floodplains.

Source of medicinal/herbal plants

Not only a wide variety of food, the wetlands provides but also a wide variety of herbal resources. A number of species of *polygonum*, locally known as *bishkatali* or *kukra* are used for antibacterial agents. The flowers and seeds of *paddo* (Indian lotus) are used for a cardiac tonic or remedy for ringworm. The flowers of water lilies are effective for heart ailments.

Tucked in between the Indian subcontinent and the Malayan Peninsulas, this region attracts both Indian and Malayan species. It is also conveniently located for the migratory birds heading from the Himalaya to Malaysia, Indonesia, India and Sri Lanka.

Because this region is located near Sundarban region which is one of the biggest habitats for wild Bengal Tigers, some wild Bengal Tigers are identified in this region. Besides Bengal Tigers, various mammals such as elephants, spotted deer, barking deer, sambar, clouded leopard, leopard cat, mongoose, jackal, rhesus monkey and so on are also found.

ii) Ecosystem function

Climate change adaptation

This region has suffered from repeated flooding. Floating garden agricultural production system has demonstrated that it largely contribute to local food security as well as local livelihood security under severe environment. Without this system, thousands of farmers would lose their farms and jobs every time they were affected by flooding. In recent years, weather events are intensifying drastically and weather patterns are shifting rapidly due to climate change. However, local communities find out that this system is resilient to increasing impact of climate change. That's why this system is spreading over a wide area in Bangladesh.

Eco-friendly agriculture

The advantages of floating garden agricultural heritage system are manifold. The floating beds are **made of free, locally abundant materials**, especially water hyacinth. Water hyacinth is considered to be one of the most dangerous invasive species due to its high reproduction speed but in this particular farming system, this dangerous invasive species are converted to most useful resources. Water hyacinth is utilized not only for the foundation of production system as floating beds during the monsoon season but also for compost especially during the winter cultivation on the ground. Because crops could absorb prime nutrients such as nitrogen, potassium and phosphorus from the floating beds and below water, there is almost no need for fertilizer input.

This technique brings many ecological benefits, such as the good use of an invasive species like water hyacinth – a very effective way to control this notorious weed; platform residues can be used as organic fertilizer (this practice cuts pollution from chemical fertilizers).

Invasive species control

Water hyacinth is generally considered to be a dangerous invasive species due to its high reproduction. Unless it is well controlled, flourished water hyacinth causes several problems. It shades sunshine into water and prevents photosynthesis of other aquatic plants. This leads to decline in dissolved oxygen in the water. It may also do harm to irrigation because it gets stuck in ditches or pumps. However, it is wisely utilized in this production system. Water hyacinth absorbs eutrophication nutrition such as nitrogen and phosphorus compounds from water. After it is used as

the material of floating bed, then it is used as compost during winter cultivation on grounds. This means crops and vegetables which grow on the floating beds absorb eutrophication nutrition from the water indirectly. Moreover, output of eutrophication nutrition is limited because most of them are absorbed. For that reason, utilization of water hyacinth is multiply beneficial to environment.

3. Knowledge systems and adapted technologies

i) Preparation of the floating beds

Knowledge of making the floating beds is completely local and indigenous. Paddy stub of local varieties of amon, ans and boro rices were the main material of floating beds until water hyacinth prevails in late 1960s. Since then, the water hyacinth has become the main material for preparation of floating beds. From June to July, the practitioners of the system stack the water hyacinths on water in 2-4 layers at 8-10 days interval (Figure 12). The first layer acts as the base of the floating bed and maintains the stability, buoyancy and thickness of the bed. Above layers are used as compost. When the stacked plants are partially decomposed, water hyacinth is again put on to the previous stack (Figure 10). Sometimes farmers use semi-decomposed aquatic plants such as water lettuce, duckweed and immature water hyacinth on the top of beds to speed up the decomposition. After 8-10 days of last stacking, farmers sow / transplant seeds/seedlings. General shape of the beds is rectangular. There are no fixed rules about the size and shape of the floating beds. They vary from location to location. Lengths of the beds are in the range between 60m and 10m and that of the breadths are between 1.25 m and 4.0 m. Although it seems effective to cultivate crops on large floating beds, they are usually narrow. That's because 1) it is easier to operate from the boats and 2) it is easier to move to desired place. The practitioners are occasionally skillful to use bamboo to shape floating beds.

After preparation of the beds, strong wind, storm, cyclone and tidal bore in the coastal areas of the country may drive the beds away or cause damage to the beds with crops. These threats are currently minimized or contained by fixing / anchoring the beds with bamboo poles.



Figure 12: Stacking water hyacinth on water for floating bed preparation



Figure 13: floating bed ready for transplanting seedling

Detailed description of the technique:

After collecting water hyacinth, bamboo is laid on a dense layer of water hyacinth to enable people to stand on it, and then more water hyacinth is piled on top to make it compact. The bed must then be left for several days to decompose before it is ready for cultivation. The eventual thickness depends on the duration of waterlogging, for it must be able to float during that time. To accelerate the process, the previous year's decomposed bed or raft can be used.

Floating cultivation can help to mitigate this situation and reduce the pressure on arable lands by turning the flooded and waterlogged areas into productive ones.

Further, floating cultivation does not need any additional water, nutrients, or chemical fertilizers, and the beds can be recycled as organic fertilizer in the newly prepared floating bed and also in the agricultural fields, which is economical as well as environmentally friendly.

As floating beds are mostly made of water hyacinth, a very invasive weed that doubles in area every week or two, they provide a means of using it in a beneficial way, reducing breeding grounds for mosquitoes, lessening the reduction in the carrying capacity of the water body that occurs when the weed breaks down the drainage system, and also having a positive impact on open-water fishing. Because it allows better control over this plant, some researchers have noted the greater productivity of floating bed practices compared with traditional land-based agriculture. This 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, due to the minimal infrastructure required.

ii) Cultivation on the floating bed.

In this system, seeds are rarely broadcasted directly on the floating beds. They are usually soaked and then germinate in containers (Figure 14). The practitioners prepare a special structure (locally called *Tema*) to hold the germinating seeds. *Tema* is prepared with peat soil or aquatic plants available locally. With the germinating seeds the *Tema* is wrapped in coconut coir (Figure 15). Seedlings grow in the *Tema*, and after few days, they are carried for transplantation to each floating beds (Figure 16). Seedlings are then planted in beds together with *Tema*. One of the important features of floating garden practice is that it shortens crop's life cycle. It takes only from 15 to 25 days from transplantation of *Tema* to harvesting. For that reason, two or three crop rotation cycles on floating gardens during one monsoon season are common on average in this region. At each cycle, mixed intercropping is the most prevailing system of crop production (Figure 17). Just as the size and shape of floating beds, there are no fixed rules about mixed intercropping. Farmers practice mixed intercropping based on traditional knowledge which has been transmitted from their ancestors. Technologies, specially the crops are adapted to the *Dhap* system of production and the *Dhap* system in totality is adapted to the constrained ecological situation of wetland condition and in broader sense to the future impact of climate change.



Figure 14: Germinating seeds





Figure 15: *Tema* preparation and seedlings growing in *Tema*

Figure 16: Seedling carrying for transplanting



Figure 17: Mixed Intercropping in summer

4. Culture, value systems and social organizations (Agri – Culture)

i) Festivals

'Nabanna' is a Bengali harvest celebration among Hindu rice growers, usually celebrated with food, dancing and music. It typically honors the Goddess Lakshmi, who symbolizes wealth and fertility and take place between November and December. According to folk custom, a community cannot enjoy the new rice crop until Lakshmi is first offered 'nabanna' (which means "new rice" in Bangladesh". Farmers typically offer a special variety of rice as rice porridge. In some cases, ancestral spirits and local deities are also the intended recipients of the offering. Other customs during the celebration include offering rice and other types of food to crow. That's because the flight patterns of crows which pick up the food can foretell the community's fortunes.

ii) Cuisine

Just as the other regions in Bangladesh, people in this region live on rice served with a large number of herbs, spices and roots on a hot palette. Due to its location within delta, causing the body of the land to be veined with rivers, fish is the dominant meat of choice for those who are not vegetarian. Although beef, mutton and goat are also popular, vegetable dishes are popular throughout. The flavours are distinctive and vibrant. The incorporation of spices and roots gives many of the sources and meats a strong and rich taste. 'Tehari' is one of the oldest foods existing within this region and has its own food culture that is deeply steeped in history. It is commonly cooked with beef, onions, cardamom, cloves and bay leaves, creating very aromatic flavor. 'Dal' is a thick stew like dish made from pulses. 'Chutney' is a separate course which is set aside for this sweet and sticky dish.

5. Remarkable landscape, land and water resources management features

i) Landscape

The landscape with colourful diversified floating gardens has a unique aesthetic view on a wide stretch of water and is a delight to the eyes and the mind. In some flooded localities 'Sorjon' - a type of alternate bed and ditch system is constructed to cultivate fruits and vegetables. In the ditches the *Dhap* is prepared and in the beds fruits and vegetables are cultivated. This system combines both *Dhap* and *Sorjon* system of intervention for cropping.

In summer, flowers of water hyacinth bloom on the water. Contrast between light purple of flowers and deep green of leaves creates beautiful scenery.



Figure 18: Land scape of floating gardens



Figure 19: Flowers of water hyacinth

ii) Land and Water resource management

Landless farmers can easily apply and follow this farming system. Farmers usually work while dipping their lower bodies in the water. If the floating garden is on the deep water, farmers use boats to access to the beds. However for harvesting and other care, they move the floating bed closer to the homesteads which belong to the farmer's family.

6. Other social and cultural characteristics pertinent to the management of the agricultural system

The management of floating bed has been based on individual effort. Thus, traditional knowledge has fundamentally been transmitted in the unit of family. For that reason, these knowledge systems have hardly spread beyond the communities. Although recognized social organization for the *Dhap* system is yet to emerge, sometimes some neighbors collaborate together to prepare the *Dhap* for one another without payment. Thus, agro-ecological management for resource access and benefit sharing on community basis are yet to develop, however, if they feel the necessity of organization, they will be able to establish the organization based on this spirit of mutual collaboration.

7. Historic relevance

Preparation of the Floating garden using aquatic plants of non - economic value is an indigenous knowledge based innovation for overtaking environmental and climatic disadvantages. Functions of the system generating goods and services sustainably for the locals and practitioners date back a few thousand years in southern Bangladesh. Over the years of timeline, the system has gone through environmental and socio-economic changes dynamically while adapting latest technologies of managing crops, selection of appropriate and tolerant varieties and cultivation techniques. Without

the system, cultivating only Aman rice in deep water would be still prevailing in this region. However, the system has established a considerable diversity of crops which align to the wetland ecosystem in monsoon and winter season as well as providing food and livelihood security for local communities. From 2000s, some local and international NGOs took initiative to disseminate this indigenous knowledge and technology through training farmers. Thanks to their effort, this agricultural practice spreads within whole Bangladesh. From 2011, government also takes part in dissemination collaborating with NGOs.

8. Contemporary relevance

i) Hydroponic farming

This region is located in low-lying wetlands surrounded by several unstable rivers. Ancestors established the floating garden agricultural system adapting to flooding environment. This system has been the key for local food and livelihood security for a long time.

As a traditional agricultural practice, floating garden is often associated with specific indigenous communities who gave these floating bodies different names; '*radh*' in Kashmir, India, '*pontha*' in southeast of India, '*kaing*' in Myanmar, '*chinampas*' in Mexico and '*dhap*' or '*baira*' in this region. This means that floating garden systems are developed and rooted in the communities which have suffered from cruel disasters. This system is not suitable for all open waters and cannot withstand devastating floods or strong waves. Nevertheless, this production system can be very useful in many wetlands during normal floods and also for rebuilding lives after disastrous floods through vegetable production.

Being an overpopulated country, Bangladesh can ill afford to remain dependent on its ever-shrinking areas of arable land to feed the population. Floating cultivation can help to mitigate this situation and reduce the pressure on arable lands by turning the flooded and waterlogged areas into productive ones.

Further, floating cultivation does not need any additional water, nutrients, or chemical fertilizers, and the beds can be recycled as organic fertilizer in the newly prepared floating bed and also in the agricultural fields, which is economical as well as environmentally friendly. As floating beds are mostly made of water hyacinth, a very invasive weed that doubles in area every week or two, they provide a means of using it in a beneficial way, reducing breeding grounds for mosquitoes, lessening the reduction in the carrying capacity of the water body that occurs when the weed breaks down the drainage system, and also having a positive impact on open-water fishing.

ii) Climate change adaptation

In recent years, floating garden has become widely talked about climate change adaptation option – almost a “climate celebrity”. Climate variability is changing the rainfall and hydrogeological patterns in deltaic, sub-tropical countries, like Bangladesh. This would consequently cause extended flooding and waterlogged conditions more frequently. Floating garden offers additional arable space under such adverse conditions. Different types of vegetables and spices can be grown on these floating beds in order to meet the needs of people living in the wetlands. In addition, these beds provide space to raise seedlings of rice and vegetables. As a result, farmers can get ready with the seedlings of winter crops and get on with agriculture as soon as flood water recedes from farmlands.

9. Threats and challenges

i) Increasing number of landless farmers

In this region, most of farmlands are already fully utilized and there are almost no new available farmlands to develop under increasing population pressure. Moreover, land tenure of each farmer was segmentalized when farmlands were succeeded because it was usual that they were succeeded equally to successors. Since it is hard for farmers to secure enough food and livelihood from these segmentalized farmlands, they give up their farmlands. If they could manage to continue farming, they lose their farmlands when a big natural disaster hits. Thus, the number of landless farmers is increasing. Although floating garden agricultural production system is available for landless farmers, they turn back to be landless farmers again when monsoon season is over. Then they need to find another earning.

ii) Inappropriate market, infrastructure and institution

Most of rural regions consisting primarily of poor and vulnerable people, including small farmers, are often the last regions to get investments in infrastructure and, partly for that reason, market in these areas are poorly developed. If rural people continue to be excluded from participation or fair competition in the mainstream market economy, they will lose their motivation to go along with farming practices.

iii) Large-scale developments

In order to protect human settlements from flood as well as to convert the seasonally flooded coastal wetlands into reclaimed land for permanent agricultural production, large-scale development projects have been carried out and many embankments was established since early 1960s. While these embankments successfully safeguard human settlements and farmlands within the coverage area from floods, they also prevent deposition of silt in the reclaimed farmlands. The reclaimed farmlands are isolated from rivers and cannot receive any silt to improve their fertility. To make matters worse, the silt is deposited in the rivers instead of farmlands and then blocks the drainage of the area, resulting in flooding or waterlogging to surrounding and downstream areas.

iv) Increasing salinity intrusion

Owing to climate change and tidal flow, higher salinity is penetrating inside the country through the rivers and creeks. Salinity affects not only crops but also floating beds. Growth of water hyacinth is generally disturbed in saline water. Thus, it is likely that availability of water hyacinth in future may be reduced. Unavailability of water hyacinth may pose threat to the production system. On the other hand, water hyacinth is considered to be a dangerous invasive species due to its high reproduction in non-saline water. Appropriate quantity control plan should be considered.

10. Practical considerations

a) Ongoing efforts to promote GIAHS

Based on the merit of the present production system to generate goods and benefits and foreseeable future role to sustainably generate livelihood for the communities in a disadvantage ecosystem and withstand the impact of climate change, both Research and Development (R&D) initiatives to improve the production system and transfer the system of production to other similar wetland ecosystem has been initiated. Bangladesh Agricultural Research Institute (BARI) and Department of Agriculture Extension (DAE) recently have initiated projects for further development of the system. A baseline survey should have been conducted to grasp the totality of the production and development of the system. The research should be location specific and participatory and based

on the finding of the survey. Physical communication facilities require priority attention. The baseline survey should identify the supports (training, credit, input and marketing facilities etc) for further improvement of the practices. Future research program may focus on nutrient management, pest and disease control and system improvement.

b) Potentials and opportunities for sustainability and management of GIAHS

The floating garden agriculture system is low-input system. Basic and essential materials for preparing floating beds are water hyacinth and other aquatic weeds which are available in plenty.. Water hyacinth absorbs eutrophication nutrition such as nitrogen and phosphorus compounds from water and then it turns compost after preparation of floating bed, almost no chemical fertilizer input is requested. Thus labor and seed mainly constitute of the production cost. In that sense, women engagement in agricultural practices ensures sustainability of the system. From the environmental viewpoints, good water environment is sustainably maintained through adequate control of water hyacinth; water-purification and low output (return) of eutrophication nutrient.

c) Expected impact of GIAHS on society and ecology

This system has great potentials for local food and livelihood security and climate change adaptation. At present, the floating garden agricultural practices have been spreading within Bangladesh due to the effort of NGOs and governments. Designation of this system would promote further dissemination of it within Bangladesh, contributing to local food and livelihood security and climate change adaptation. Moreover, upon recognition and designation of the floating garden agricultural practices as GIAHS, public and private sector initiatives in the improvement of the areas of technicality of production system, physical communication to the site and marketing and value addition of the product may be strengthened. These efforts would improve production of quality commodities (organic) and fetch profit commensurate to the desire of the practitioners. The society would find more opportunities to invest in assets development, production and marketing, value addition and tourism. On to the ecology, the production systems would have control on water hyacinth and other aquatic weeds. Water hyacinth sometimes poses great threat to the water bodies /rice fields. Water hyacinth congests the canals and creeks when navigability becomes difficult. Sometimes, large mass of water hyacinth, under the influence of strong wind/wave, overruns the rice field, thus, damage the rice crop. Ecologically, using water hyacinth in the *Dhap* not only controls it, but also restores healthy environment to the water bodies.

d) Motivation of the local community, the local/national authorities and other relevant stakeholders

Public and private stakeholders very recently are at work to motivate the local practicing communities to continue with the production system. There is initiative on the part of the public sector to transfer the production system to other similar wetland ecosystem.

Seminars and workshops are at offing to educate the local and national stakeholders on the merit of the floating garden agricultural practices in areas constrained with flooding.

Dynamic Conservation plan for GIAHS selected site

1) A baseline description of activities, policies and experiences, which are already ongoing in the area to promote GIAHS and that the new initiative could build upon:

- To strengthen current farm level activities, Department of Agricultural Extension (DAE) in the government of Bangladesh is very recently implementing a project in 42 upazilas to improve

the production system and transfer the system in similar wetland ecosystem, collaborating with NGOs.

- Research approach is also in the offing to develop production packages for the system. A research project is under active consideration of the government.
- New initiatives which are under active consideration of the government of Bangladesh would further strengthen the current activities of GIAHS.

2) Activities that would foresee necessary for dynamic conservation of the system (obtained through participatory and community driven approach)

- Updated crop production packages would be of high demand for dynamic conservation of GIAHS.
- Development of road communication, marketing and value addition facilities would be required.
- Training of the practitioners on the modern crop production technologies would be necessary.

3) How these activities will respond to the threats as described in this proposal?

- Governments are taking measures against the landless farmers such as agrarian reform. However, the agrarian reform isn't fully in effect. Floating garden agricultural production system is surly effective for landless farmers during the monsoon season. Landuse system during winter season needs to be addressed.
- Participation in the mainstream market economy will improve livelihood of farmers and motivate them to continue farming practices.
- Research on salinity impacts on agricultural products and floating beds (water hyacinth) would be undertaken. Additionally, research on how to control water hyacinth would be undertaken.

4) How these activities can be used to leverage funding or attract national funding (and international donors, in case of developing countries)?

- In the "Outline perspective Plan of Bangladesh 2010-2021", agricultural and rural development is the first priority. This plan also put emphasis on development in the south-east area, increasing food sufficiency rate and poverty alleviation. The development of the floating agricultural production system aligns with the objectives of the plan. The output obtained out of the floating garden agricultural production system will be useful to draw attention of the planners and policy makers.
- The floating garden agricultural production system has demonstrated its capability of climate change adaptation/resilience. Because climate change has become one of the global problems, international donors would be interested to fund the activity.

5) Institutional involvement (support and involvement of institutions that carry responsibilities or are otherwise involved in this initiative)

- Because Bangladesh is a highly centralized country, national government takes initiatives to develop this system. Due to the lack of farmers association and of functionality of local government, NGOs take an important role to bridge between national government and local communities/farmers.
- Bangladesh Agricultural Research Institute (BARI) very recently implementing a base research of floating agricultural production system. Department of Agricultural Extension (DAE) is also implementing a project to transfer the production system in the similar ecosystem.