Indigenous floating cultivation: a sustainable agricultural practice in the wetlands of Bangladesh

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Abstract

Floating bed cultivation has proved to be a successful means of agricultural crop production in different wetland areas of the world. In fresh water lakes and wetlands, vegetables, flowers and seedlings are grown in Bangladesh using this floating cultivation technique, without any additional irrigation or chemical fertilizer. No detailed study of this indigenous cultivation technique seems hitherto to have been published, although the laboratory method, hydroponics, is well documented in the professional literature. Our study is focused on the nature and characteristics of the Bangladeshi system, where local farmers have demonstrated the potential for the sustainable use of such common property local water resources. We seek to establish a reference point for further research of this technique for its possible refinement and suitability assessment for replication.

Introduction

Rural Bangladesh is rarely portrayed positively in western academic literature, despite there being a large number of silent successes that deserve attention. Local self-help activities, facilitated by traditional social structures and solidarity in village communities, demonstrate the resilience of the people. All over the country, villagers are reproducing environmental, social and economic sustainability by caring for the basic prerequisites of their livelihoods (Duyne 2004). This paper discusses one example: how people with indigenous traditional knowledge have been raising plants and vegetables successfully for centuries in a remote marshy area in Bangladesh using technologies that have only recently caught the attention of western scientists. As Gene Wilken (1987) notes, peasant farmers rarely get the credit they deserve for such knowledge and the continuous experimentation and improvement associated with it.

There is a large literature about agricultural systems in which crops are grown surrounded by or close to open water. There are two broad categories. First, there are the raised or drained fields of the pre-Columbian civilizations of the Americas (Darch 1983), particularly the intensive food production of Tiwanaku on the shores of Lake Titicaca (Morris 2004) and the famous 'chinampas' in Mexico originated by the Aztecs (Coe 1964).(1) Second, there is soilless floating bed cultivation, a technique related to hydroponics, which has also been practised in different parts of the world since prehistory. This indigenous cultivation method is widely used in Lake Inle in south-eastern Burma, the Tonle Sap in Cambodia, and various fresh-water wetlands in

Bangladesh. The system is traditionally called ‘dhap’ in Bangladesh and ‘kaing’ in Burma, and in both countries it provides a living to people in marshy areas. It is this, second, category that we will concentrate on in the present paper, our purpose being to describe a system of long-term, sustainable potential in marshy and lacustrine environments.

Floating bed cultivation Bangladeshi-style

In the Bangladeshi dhap, a floating platform is made of decomposing heaps of water hyacinth, where the upper surface is stuffed with mud or soil. The size and shape of the floating beds varies from region to region. The platform is built to allow the easy penetration and spread of plant roots, facilitating uptake of water and nutrients. In Burma the floating beds are often natural accumulations of kaing grass, which farmers cut off and transport to appropriate locations, where they are staked to the lake bed with bamboo poles and vegetables and seedlings are raised (Win 1996).

Dhap cultivation is found in remote, waterlogged villages of Barisal, Pirojpur, Satkhira and Gopalgonj districts of Bangladesh, but is not common elsewhere in the country. According to local tradition, this indigenous system of ‘soilless cultivation’ has been used for growing different types of vegetables and seedlings for at least two centuries. The floating beds last for five to six months and then are dragged by country boats, using ropes and hooks, to shallow water to form ridge-type elongated platforms, called *kandi*. These are then used as permanent cultivation beds in the wetlands.

Nesarabad, in the north eastern part of Pirojpur district, is one of the main thanas where this indigenous type of cultivation is concentrated and for this reason it was chosen as our study area. According to Rashid (1981) over 76,000 hectares remain under water for about six to seven months in this thana, providing the ideal conditions for dhap and kandi agriculture.

Our field survey in 2001 involved participatory observation and intensive discussions with 30 farmers. In addition, we interviewed key informants in the local administration and representatives of the Ministry of Agriculture and also collected samples to investigate the nutrient status of the floating beds.

Dhaps and kandis in our field area are generally 50-60 metres long and 1.2-1.5 metres wide. The thickness of the beds is usually in the range of 25 to 50 cm, with approximately two-thirds submerged. A space of open water between two dhaps or two kandis is kept clear in order to ply small boats for sowing, weeding and harvesting. Plants derive nutrients mainly from the organic matter but also from any top dressings applied.

Various types of local materials are used for building the floating layers. The single most important component is water hyacinth (*Eichhornia crassipes*) but 'topapana' *(Pista stratiotes)*, 'son ghash' *(Imperata cylindrica)*, 'noll ghash' *(Hamerthria protensa),* ash twigs, and dissected coconut fibres are also used. Farmers initially make a layer of water hyacinth and leave it for a few weeks to decompose. When decomposition has started, a 15 cm layer of ash and fibre mixed with sliced topapana is spread on top. Farmers do not generally use any kind of frame, metallic or otherwise, to support the layer but the integrity of the dhap is important and farmers use their experience to avoid disintegration. Next, seeds are sown in small balls locally known as 'mada'. Madas have two constituent parts and are assembled by women and children. Initially spherical pots are made by coiling aquatic weeds such as 'del loita' *(Amaranthus viridis)* and 'khudipana' *(Lemna perpusilla)*, and these are then stuffed with decomposed topapana, which holds moisture, and also sawdust and algae.(2) Once the madas are ready, they are planted with the sprouting seeds of bottle gourd, country bean, bitter gourd, snake-gourd, cucumber, lady's finger, and placed in the floating beds. The seeds are usually germinated elsewhere but farmers also plant seeds directly on the dhap after spreading a layer of sawdust on the floating platform. The seedlings are irrigated by hand at first to prevent them from drying out but a few days after sprouting they penetrate through the mada and later the upper, dry portion of the raft. They stay on the dhap until they are sufficiently mature to sell, at a height of about 12-18 cm. This region is one of the main seedling supply zones of Bangladesh.

Various seedlings are grown on the floating beds of Nesarabad thana, such as those of chili, water melon, musk melon, different beans, cauliflower, cabbage, radish, tomato, egg plant, bottle gourd, sweet gourd, and turnip. These seedlings meet a demand that exists throughout the country. Dhaps are used for raising these seedlings but some leafy vegetables, especially spinach, are also grown on kandis, in crop combinations such as the following:

- Potato + Cabbage + Egg Plant + Bitter gourd + White gourd
- Potato + Brinjal + Bitter gourd + Cucumber

- Potato + Cabbage + Brinjal + Bitter gourd + Cucumber
- Onion + Brinjal + Cucumber +Bitter gourd
- Garlic + Chili + White gourd + Bitter gourd
- Tomato + Water Arum + Sweet gourd
- Sugar cane + Tomato + Brinjal + Chili
- Jute and/or 'Dhaincha' (*Sesbania aculeata*) in the first year only.

Dhaps are created mainly in the rainy season because in winter many wetlands dry out. In a number of locations water is stagnant all year round and dhaps are therefore perennial. Generally, as the water dries up in winter, the dhaps are used to make kandis.

A 60 metre floating water hyacinth raft costs about Tk1500 (equivalent to US$ 23) to make.(3) This includes the cost of the water hyacinth, the topapana, grass, seed and the daily labourers (Table 1). For each hectare of wetland about seven floating rafts are generally built, costing about Tk11,000. In return, our survey showed that farmers can expect profits of about Tk55,500 (about one-third from selling vegetables and two-thirds from seedlings) per hectare in one season.

The system also contributes to the reclamation of some wetlands for permanent cultivation through the creation of kandis. Here farmers often produce irrigated vegetables all year round on the ridges, and the soil is very rich from the organic matter of the decomposed floating beds. However, one hectare of kandi does not equate to the equivalent area of dry land. The cyclical flooding and drying of the marshes is predictable only within certain limits and farmers may have to pile up further used dhaps before they can be sure of a firm, raised platform for planting fruit orchards, but the gradual accumulation explains why Nesarabad thana is also a major supplier nationwide of guava. An environmental impact assessment is required to judge whether this is a positive benefit in the long-term but our best guess is that it is, given the vast areas of underutilized wetlands in a country where widespread rural poverty demands solutions.

Nutrient status of the organic material in dhaps

Eight samples of organic matter were collected from different dhaps in order to determine the chemical properties of the floating beds. Decomposed floating water hyacinth layers were analysed. The ammoniacal-nitrogen content ranges from 60 to 282 ppm against a critical value of 150 for growing healthy vegetables (SRDI 2001). The values were low in four samples, a surprise to us because we were expecting that decomposing water hyacinth would contain high levels (SRDI 2001). This is probably because the samples were analysed in the laboratory of the Bangladesh Soil Resources Development Institute in Dhaka after they had dried out and, in retrospect, it would have been preferable to have performed this part of the assay closer to the point of collection.

Potassium was found in excess in some samples and at optimum levels in others. Phosphorus was low in all samples, as were manganese and iron, but levels of other micro-nutrients were satisfactory. Organic matter ranges from 20.76 to 42.88 percent, a very high proportion for any growing medium. The observed pH ranges from 6.9 to 7.4, neutral and therefore favourable for most crops.

The problems and potentialities of floating bed cultivation

Floating bed cultivation provides employment for both men and women and, as a result, according to the locals and government officers, people in this marshy region are economically better off than their neighbours in adjoining floodplain areas. This is a compensation for the area being out of touch of most development initiatives and where several hours in country boats is the only means of communication with nearby towns. In addition to farming, the supply chain provides further employment and there is added value in bartering and transporting raw materials and green products. The production cycle is short, so there is need of a fast and efficient transport system to carry products to market. At present there are no storage facilities to keep the produce fresh and the frequent politically-motivated national strikes (‘hartals’) bring hardship because there is no institution (governmental or non-governmental) with advice or assistance to offset their loss.

Women are very active in the system at all stages. They work their own fields as well as acting as casual labour for other farmers. They sometimes work in teams, providing as much as anything a meeting place, not an inconsiderable benefit in a society where women are often house-bound. They described these gatherings to us as recreational opportunities and means of information exchange about better marketing, access to small-scale capital, and improving techniques of cultivation.

In the perennial marshlands, this floating bed cultivation is the only available method of cultivation. The local people would probably long since have migrated to the urban slums if this way of life was not possible. Floating bed cultivation has been practised in the *khas*, common property, wetlands, locally known as *jalmahals*, for centuries without any major conflict, but in recent years local elites and politically powerful people have begun to ‘capture’ the area. Elsewhere in Bangladesh, khas property is auctioned out or leased by local authorities at the thana level, but there is no such formal process in this area, leaving openings for aggressive tactics. These people establish title for themselves and then lease out areas to small farmers for large rents on the lands situated near the canals, where transportation is much easier.

Conclusion

The total area of the wetlands in Bangladesh has been variously estimated at seven to eight million hectares, or about fifty percent of the total land surface (Khan 1993). This includes 5.4 million hectares of open and closed lakes on floodplains that are inundated every year (Ali 1990). At river peak flow during the rainy season, thirty percent of the floodplain area is flooded deeper than one metre for five months (June to October) and a particularly heavy monsoon may see this rise to sixty percent (Brammer *et. al.* 1993), restricting normal agricultural activities. The soilless cultivation method that we have described provides an opportunity for income generation during this normally slack season. Our waterlogged villages in the southern coastal wetlands of Bangladesh have proved its viability and the same or similar methods could be used elsewhere. Women seem to find it particularly advantageous, a progressive aspect of development that is generally agreed to be essential for the future of Bangladeshi society.

A final thought is that Bangladesh is well-known to be prone to the sea-level rise that is predicted to be associated with global warming. The best estimate (Warrick et. al. 1996) is that by 2080 there will be a rise of 38 cm and that up to 22 percent of world's coastal wetlands will be inundated as a result (Nicholls et. al. 1999). Scholars and institutions such as the Intergovernmental Panel on Climate Change are attempting to evaluate the socio-economic and ecological implications of such a rise in sea-level (Hoozemans and Hulsbergen 1995) and it is clear that a portfolio of adaptive measures will be needed to cope with the situation. Some authors are proposing large-scale migration (Nicholls and Mimura 1998) and structural measures, which might not be feasible for a poor country such as Bangladesh. Perhaps it is more realistic to propose that coastal populations might be best able to deal with sea-level rise if their vulnerability to economic shock is minimized. Floating bed cultivation could be one such measure in those areas that avoid salt water intrusion because it offers new opportunities using indigenous knowledges and techniques that are well adapted to local environmental conditions (Chowdhury 2004). Dhaps and kandis are not a panacea – just one amongst the many possibilities that are available from the ingenuity and entrepreneurship of Bangladeshi people. Already a number of aid organizations have recognized their scope and are encouraging their replication.(4) Among the advantages is the provision of employment due to the labour-intensive nature of the traditional technologies involved, but this should not be thought of as a substitute for rapid agricultural development, which ultimately must have at its core the use of advanced technologies to raise productivity and so provide adequate human nutrition per unit area.

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Table 1: Costs of preparing a floating bed of 60 metres

Sl. No.	Materials	Unit	Cost (Tk)
1.	Water hyacinth	0.75 Tonne	300
2.	Topapana	0.50 Tonne	200
3.	Seeds	Needed for one bed	100
4.	Sheola	One country boat	100
5.	Tall grass	One country boat	200
6.	Labour cost	Per bed	500
7.	Miscellaneous	---	100
		Total cost	**1500 (US$ 23)**

Source: fieldwork.

Notes

1. There has long been a myth, repeated even by Alexander von Humboldt, that chinampas were originally floating gardens. According to Wilken (1985), this is never likely to have been the case.
2. There are striking similarities to the chapines (root cubes) of Xochimilco, Mexico.
3. Exchange rate in November 2005.
4. For instance, Care International (Bangladesh)'s CIDA-funded project 'Reducing Vulnerability to Climate Change'. See http://www.carebd.org/coping_change.html (retrieved 15 August 2005).