Flood Tolerant Rice Cultivation as an Adaptation in Riverine and Floodplain Context

AGRICULTURAL ADAPTATION TECHNOLOGY FOR RIVERINE/ FLOODPLAINS
(FLOOD PRONE AND FLASH FLOOD PRONE AREAS)
# Table of Contents

1.0 INTRODUCTION TO THE AREA ........................................................................................................ 3  
1.1 Riverine/Flood plain ......................................................................................................................... 3  
1.2 Overview of flashflood 2017 ........................................................................................................... 5  
1.3 Impact of Flash Flood ....................................................................................................................... 6  
1.4 Direct exposure .............................................................................................................................. 6  
2.0 CURRENT ADAPTATION SITUATION IN AGRICULTURAL SECTOR ........................................... 7  
3.0 PROPOSED ADAPTATION OPTION IN THE FLOODPLAIN (HAOR REGION) CONTEX .......... 7  
4.0 CULTIVATION OF SHORT DURATION BORO RICE .................................................................... 8  
4.1 Soil type ........................................................................................................................................ 8  
4.2 Variety ......................................................................................................................................... 8  
4.3 Land preparation and fertilizer application ..................................................................................... 8  
4.4 Seedling raising ............................................................................................................................. 8  
4.5 Seed sowing time ........................................................................................................................... 9  
4.6 Transplanting ............................................................................................................................... 9  
4.7 Weeding ...................................................................................................................................... 9  
4.8 Pest management .......................................................................................................................... 9  
4.9 Irrigation ....................................................................................................................................... 9  
4.10 Harvesting ................................................................................................................................... 9  
5.0 MARKETING AND SALES OF RICE .......................................................................................... 10  
5.1 Cost Benefit Ratio ........................................................................................................................ 10  
5.2 Market opportunities: .................................................................................................................. 11  
6.0 THREATS AND CHALLENGES OF FLOOD TOLERANT RICE CULTIVATION ...................... 11
1.0 INTRODUCTION TO THE AREA

1.1 Riverine/Flood plain

Bangladesh is a floodplain deltaic country formed by the deposits of the three major river systems of the Ganges, Brahmaputra-Jamuna, and Meghna Rivers. Bangladesh is one of the most floodplain-dominated countries in the world and also one of the most densely populated. Including tributaries and distributaries there are around 700 rivers in Bangladesh stretching over 24,140 km, thousands of smaller channels, floodplain depressions (known as beels), and extensive seasonally flooded lands that collectively form the floodplain ecosystems (Akonda, 1989). Estimates of the area of floodplain in Bangladesh range up to 80% (Brammer, 1990), and about 25% to 33% of the country remains under water every year for four to six months during the monsoon (rainy season).

The floodplains are fed by various sources of water (rivers, groundwater, rainfall, and tidal water) and many of them have more than one water source. The contribution of each water source and its impact on livelihoods can change on a seasonal or annual basis, depending on water availability and changes in the water regime. Bangladesh is located at the mouth of the GBM basin. The entire GBM basin (an average of 1,350 billion m$^3$ of water flow per year) drains through Bangladesh. Hence, the timing, location, and extent of flooding depend not only on the 7 percent of precipitation that occurs within Bangladesh's borders but on that of the entire GBM basin. Increased rainfall in the upper GBM basin is expected to result in higher river flows from Nepal, India, China, and Bhutan into Bangladesh (IPCC 2007). Mirza and Dixit (1997) estimated that a 2°C warming, combined with a 10-percent increase in precipitation, would increase runoff by 19 percent for the Ganges, 13 percent for the Brahmaputra, and 11 percent for the Meghna.

Haors with their unique hydro-ecological characteristics are large bowl shaped floodplain depression located in the north-eastern region of Bangladesh covering about 1.00 million ha of area and accommodating 19.37 million people. There are about 373 haors/wetlands located in the districts of Sunamgonj, Hobigonj, Netrokona, kishorgonj, Sylhet, maulvibazar anf Brahmanbaria. These 373 haors cover an area of about 858,000 ha which is around 43% of the total area of the haor region. It is a mosaic of wetland habitat including rivers, streams, canals, large areas of seasonally flooded cultivated plains, and beels.
The physical setting and hydrology of the haor region produce a unique hydrological regime, which creates a myriad opportunities as well as constraints for the inhabitants. Annual rainfall ranges from 2200 mm along the western boundary to 5800 mm along the north east corner and is as high as 12000 mm in the headwaters of some catchments extending to India. The region receives water from the catchment slopes of the Shillong plateau across the border in India to the north and the Tripura hills in India to the southeast.

About 21% of cultivatable areas are incorrectly drained, where floodwater recedes within 15 days and 61% of cultivatable areas are poorly drained and remain under flood water from 15 days to 8 months. About 10%
of cultivable land are very poorly drained, where floodwater stays more than 8 months keeping the area wet during most of the dry season. The rest of the area (8%) where rainwater recedes quickly from soil surface is well-drained.

Flashflood is the main disaster here which engulfs the primary production sector (e.g. agriculture) and thus threatens the lives and livelihoods of the inhabitants of the haor region. Excess rainfall in the upstream hilly areas and subsequent runoff, river sedimentation, unplanned road and water management infrastructures, deforestation and hill cuts, landslides, improper drainage, and last but not least the effect of climate variability can be viewed as the main reason for the devastation caused by flashflood. Rains or flash floods that come earlier than normal can damage dry-season crops just before harvest. Even if farmers are able to harvest their crops at such times, there will be a lack of places for drying crops, particularly paddy (rice); moreover, dry land for storing rice straw (used for livestock fodder) becomes scarce. In the regions near the hills on the eastern side of the country, the damage caused by flash floods (despite their short duration) can be more severe than that caused by slower-rising and longer-duration riverine floods because of sudden flooding without warning, high water velocity, and debris load. Nevertheless, it is the large-scale main river floods that draw international attention and with their wide scale impact were a significant setback to economic growth in the past when the national economy was heavily agriculture dependent (Benson & Clay, 2002). Since 1980, major floods occurred in Bangladesh in 1987, 1988, 1998, 2004, and 2007. Estimates of the numbers of people affected by this flooding vary considerably. The 1988 flood was a 1-in-100-year event that inundated 42% to 57% of the country (Rashid & Pramanik, 1993; Miah, 1988). Over 2,000 people died; 1,990 km of embankments were damaged; and total losses, including infrastructure and crop damage, were about US$1.3 billion (World Bank, 1990). In 2017 a devastating flashflood damages crops and livelihoods in haor regions of Bangladesh.

1.2 Overview of flashflood 2017
Heavy rain falls as well as onrush of water from the upstream Meghalaya hills in India have led to the inundation of a vast areas of croplands of Haors and low-lying areas of the northeast. Flood started on 28th March affecting six districts (Sylhet, Moulvibazar, Sunamganj, Habiganj, Netrokona and Kishoreganj) in the north east region. Rising water overflow and breeched embankment in many places and inundated vast areas of croplands. It destroyed nearly-ready-for-harvesting boro rice in about 219,840 hectares areas (details information in table 1).
1.3 Impact of Flash Flood
This flood caused huge damage to crop production. Potential loss of crops is estimated to be 879,360 MT.
The flood has severely affected 518 unions of the total 541 unions in the 62 upazilas under the 6 districts. About one third of the total households of these districts has suffered due to loss of their Boro crop. Also, many of them has lost their houses (partially or fully) as well as suffered due to the loss of fisheries and domestic animals and birds.

<table>
<thead>
<tr>
<th>Districts</th>
<th>Affected Upazilas</th>
<th>Affected Unions</th>
<th>Affected HH</th>
<th>Fully Damaged Agricultural Land (Hec.)</th>
<th>Damaged House</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Fully</td>
<td>Partially</td>
</tr>
<tr>
<td>Sunamganj</td>
<td>11</td>
<td>88</td>
<td>172,617</td>
<td>102,436</td>
<td>2,600</td>
</tr>
<tr>
<td>Sylhet</td>
<td>13</td>
<td>105</td>
<td>212,570</td>
<td>26,715</td>
<td>20</td>
</tr>
<tr>
<td>Netrokona</td>
<td>10</td>
<td>86</td>
<td>167,180</td>
<td>19,566</td>
<td>0</td>
</tr>
<tr>
<td>Kishoreganj</td>
<td>13</td>
<td>56</td>
<td>148,687</td>
<td>45,256</td>
<td>0</td>
</tr>
<tr>
<td>Habiganj</td>
<td>08</td>
<td>64</td>
<td>74,440</td>
<td>15,953</td>
<td>46</td>
</tr>
<tr>
<td>Moulvibazar</td>
<td>07</td>
<td>60</td>
<td>74,594</td>
<td>9,914</td>
<td>194</td>
</tr>
<tr>
<td>Total</td>
<td>62</td>
<td>518</td>
<td>850,088</td>
<td>219,840</td>
<td>1,860</td>
</tr>
</tbody>
</table>

Source: DDM Report on Damage Information and Relief Distribution on Flash Flood, May 01, 2017

1.4 Direct exposure
   a) Flashflood
2.0 CURRENT ADAPTATION SITUATION IN AGRICULTURAL SECTOR

In the areas of major Haor district Sunamgonj and Kishoregonj, more than 80% of the total cropped areas were covered by Fallow-Fallow-Boro cropping pattern, Fallow-Fallow-Boro is a cropping pattern where crops are grown only in Rabi season (Nov-April) and land remains fallow during Aus (April-July) and Aman (July-Nov) season. Only winter crops can be practiced in this cropping pattern. Aus rice (summer rice sown in March or April and harvested during the summer) is not grown in the Haor areas of Sunamgonj, Kishoregonj, Sylhet and Hobigonj. Similarly, in Aman season rice is not grown profusely in the Haor areas of Sunamgonj, Kishoregonj and B.Baria. In Haor basin, a little amount of T. Aus and T. Aman are grown in comparatively higher elevated lands at the side or end of the Haor. Farmers prefer modern varieties over local varieties of rice. Most dominant rice varieties are BRRI Dhan29, BR-19, BR-14, Gochi, Rata etc. (Universal Journal of Agricultural Research 6(1): 40-49, 2018 http://www.hrpub.org).

Major cropping pattern of Sunamgonj is also Fallow-Fallow-Boro along with fallow-T. Aman-Boro, and Aus-T. Aman-Boro. In winter season they also cultivate different vegetable, mustard etc. In recent years, flashflood hit Sunamganj district and other Haor areas fifteen days earlier than thirty to forty years back. On the other hand, local farmers switched to cultivate HYV rice from local boro rice variety that are of longer duration (160 days). As for example, BRII Dhan- 29 takes about 30 days more time to harvest compared to the local boro rice variety and 15 to 20 days than other HYV Boro varieties. For this reason, farmer get ten to fifteen days less for boro rice cultivation than thirty years ago. This consequence often invites boro rice subject to flash flood.

3.0 PROPOSED ADAPTATION OPTION IN THE FLOODPLAIN (HAOR REGION) CONTEXT

Considering the change of time of flashflood Bangladesh Rice Research Institute (BRRRI) developed two boro varieties named BRRI Dhan28 and BRRI dhan 88 which is about 17-20 day shorter life span than BRRI Dhan29. Comparatively (BRRI Dhan29) short duration boro rice cultivation is a new practice in this region. The challenges of farmers are low quality seed, infertile land, hailstorms, flood, heavy wind and pest attack which cause serious negative impact on production. Farmers use high quality seed to get the highest yield. Modernization of agriculture implies the increased use of modern inputs such as chemical fertilizers, quality modern seeds etc.
4.0 CULTIVATION OF SHORT DURATION BORO RICE

4.1 Soil type
Clay loam, medium loamy clay is best for boro cultivation in haor region. It can be cultivate in low to medium low to medium high land prone to flood and flashflood. The plant requires well drained, moist, rich soil.

4.2 Variety
BRRI dhan28 (1994), BRRI dhan88 (20170. Life span of BRRI dhan28 is about 140 days and BRRI Dhan88 is about 140 to 143 days. Seedling and rice plant are tolerant to flood and it can withstand after 12-15 days of submergence at seedling stage and in other growing stages. These varieties are suitable for flood and flash flood prone areas of Bangladesh. BRRI and IRRI jointly developed this variety and released on 2007.

4.3 Land preparation and fertilizer application
The selected area or plot should be sunny and wind sheltered. After irrigate plough 3-5 times with mowing. Make the land level. Apply 100 kg urea, 40 Kg. TSP, 60 kg MOP, 45 kg Gypsum, 5 kg Borax and 4000 kg compost fertilizer or cow dung is required for one acre land. All compost fertilizer, all TSP, , Gypsum and 50% of urea and MoP should be applied on the last phase of tillage as basal dose. Rest 30% urea fertilizer should be applied after 25-30 DAT and rest 20% urea and 50 % MoP should be applied 40-45 DAT as top dress.
Seed rate: 8-10 kgs / acre

4.4 Seedling raising
About 80 -100 gms of seed is required to in 1sq.m. of seed bed. After soaking seed 12 hours in water then it should be kept about 48 hours in a basket covered by straw for germination. Sandy loam and clay soil is suitable for seed bed preparation. Land should be ploughed 2-3 times after keeping 5-6 cm of water above the seed bed and it should be kept for 7010 days for proper decomposition of weed and straw. Seed bed will be prepared one meter wide after paddling and ploughing seed bed. About 80 -100 gm of seed is required to in 1sq.m. of seed bed. Germinated seed should be broadcasted equally and cover it to protect from birds. To control weed and protect germinated seed keep 2-3 cm. of water above seedbed. If the seedling becomes yellow colour then apply 7gm of urea fertilizer/1 sq. meter. Before uprooting apply
water in the seed bed so the soil of the bed would be soft would be easy to uproot seedling after 25 – 30 days old.

4.5 Seed sowing time
Appropriate time for seed sowing is 15-30 November (1st-15th Agrahayan)

4.6 Transplanting
About 30-40 days old seedling of Boro rice is suitable for transplanting. Suitable time for seedling transplanting is 20 December -10 January (26 Agrahayan- 6 Poush). Transplant 2-3 seedlings per hill. Spacing of seedling is plant to plant-15 cm. (6 inch.) and row to row is 25 cm. (10 inches.). Fill-up gaps if seedling dies within 7-10 days.

4.7 Weeding
Keep the field weed free up to 40-45 day after transplanting (DAT). After any flood remove aquatic weed and damaged leaves. Japanese rice wider is suitable equipment for weeding in line sown rice instead of manual weeding. Minimum 2 times weeding is required for rice cultivation. Two times weeding is required for rice production if we always keep 10-15 cm. (4-6 inches.) water in the field. Weedicide can be applied for weed control as pre-emergence and post emergence of weed within 3-6 days and 10-15 days after transplanting.

4.8 Pest management
After transplanting observe field regularly. If required apply pesticide according to suggestion of Upazila Agriculture Officer (UAO), Additional Agriculture Officer (AAO), SAAO, SAPPO. Practice Integrated Pest Management (IPM) approach for crop production.

4.9 Irrigation
Provide irrigation based on soil condition. It is better to use Alternate Wetting and Drying (AWD) method for irrigation to maintain soil moisture of the rice field. Keep appropriate soil moisture after penile initiation to milking stage of grains.

4.10 Harvesting
Generally harvesting time BRRI dhan88 is from 08-16 April (25 Chaitra—3 Baishakh) and BRRI dhan28 is from 03-18 April (20 Chaitra—08 Baishakh)). Harvest rice grain when it turns in to golden colours and ripen about 80% of grains.

Yield: In normal condition it can produce 7.00 tons (BRRI Dhan88) tons and 5.50 -6.00 tons (BRRI Dhan28).
## 5.0 MARKETING AND SALES OF RICE

### 5.1 Cost Benefit Ratio

Table: Cost- Benefit ratio of Wheat cultivation

<table>
<thead>
<tr>
<th>Sl.#</th>
<th>Items (unit)</th>
<th>Quantity</th>
<th>Unit cost</th>
<th>Total cost (Taka)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Labour for cleaning and land preparation (man days)</td>
<td>12</td>
<td>300</td>
<td>3600</td>
</tr>
<tr>
<td>2</td>
<td>Land preparation cost for Power tiller/Tractor or country plough hiring (excluding labour cost) (tk.)</td>
<td>2-3 times</td>
<td>2400</td>
<td>2400</td>
</tr>
<tr>
<td>3</td>
<td>Labor for weeding, fertilizer application, irrigation, harvesting, threshing etc. (man days)</td>
<td>46</td>
<td>300</td>
<td>13800</td>
</tr>
<tr>
<td>4</td>
<td>Seed (kg)/seedlings</td>
<td>10</td>
<td>40</td>
<td>400</td>
</tr>
<tr>
<td>5</td>
<td>Cow dung (kg.)</td>
<td>2000</td>
<td>0.5</td>
<td>1000</td>
</tr>
<tr>
<td>6</td>
<td>Urea (kg.)</td>
<td>100</td>
<td>11</td>
<td>1100</td>
</tr>
<tr>
<td>7</td>
<td>TSP (kg.)</td>
<td>40</td>
<td>22</td>
<td>880</td>
</tr>
<tr>
<td>8</td>
<td>MOP (kg.)</td>
<td>60</td>
<td>15</td>
<td>900</td>
</tr>
<tr>
<td>9</td>
<td>Gypsum (kg.)</td>
<td>45</td>
<td>10</td>
<td>450</td>
</tr>
<tr>
<td>10</td>
<td>Zink (kg.)</td>
<td>5</td>
<td>150</td>
<td>750</td>
</tr>
<tr>
<td>11</td>
<td>Pesticide (liter/kg.)</td>
<td>lumpsum</td>
<td>1000</td>
<td>1000</td>
</tr>
<tr>
<td>12</td>
<td>Irrigation (times.)</td>
<td>4</td>
<td>500</td>
<td>2000</td>
</tr>
<tr>
<td>13</td>
<td>Total cost of production</td>
<td></td>
<td></td>
<td>28280</td>
</tr>
<tr>
<td>14</td>
<td>Yield (ton/ac)</td>
<td>2.6</td>
<td>25000</td>
<td>65000</td>
</tr>
</tbody>
</table>

**Profit** = (65000-28280)=36720 BDT.
5.2 Market opportunities:
Farmer can sell rice to their rice to the local market and wholesaler at upazila level. It may require a small amount of transportation cost. The road transportation system is very cost and time effective now. Wholesaler come to the local market so farmer’s can sale their produces in the local market during hat day. Instead of individual sale if they sell their produces in group approach they can get higher price. As a result farmers can earn a big profit.

6.0 THREATS AND CHALLENGES OF FLOOD TOLERANT RICE CULTIVATION

   a. Crop may be damaged if flashflood affect earlier .
   b. River bank erosion may affect the rice field.
   c. early flooding may damage yield of Boro rice significantly.
   d. Unavailability of seeds of rice verities at local level may increase the cost of production or limits expansion of this variety.

The scope to increase the production of flood tolerant rice to its potential need for promotional activities like; capacity building, demonstration, input support (seeds, fertilizers etc.) in the farmer's field. Creating market facilities can increase rice production in large scale.