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# Strategic Ground Water Management Planning for Rice Field in Rangpur Division, Bangladesh

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**Abstract**

Bangladesh is a land of agriculture and achieves self-reliance in rice production. In the last two decades, rice output has raised over 15 million tons nationally. For obtaining this self sufficiency, groundwater withdrawal is continuously increasing that results in an expansion of deep and shallow tube wells. We are currently giving preferences on "resource expansion", and not on "resource sustainability". This has resulted in serious problems; mostly deteriorate groundwater quality due to excessive withdrawal of ground water in intensively irrigated areas. Due to this, an extensive field survey was carried out in Rangpur division (Country's Northern part) during the year of 2018 to observe the ground water table depletion status in rice field and set up some top most strategies for reviving these problems in a sustainable way. It can be suggested to generate the attention of the expansion and development of surface water resources to relieve the pressure on groundwater withdrawal. Apart from that, focus should be given on optimizing crop water demand through increasing water use efficiency by adopting water conserving management strategies and practices. As per authors' suggestion, 6 basic strategies can be taken for long term sustainability of ground water management in Rangpur division. The strategies are: 1) Initiate right choice of rice varieties for the season 2) Implement innovative water saving technology (Alternate wetting and drying, AWD, cut off Ratio) 3) Adopting Irrigation scheduling 4) Introduce organic fertilization 5) Apply rain water harvesting and 6) reservoir management.

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Alternate Wetting and Drying;
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Resource Management;
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## Introduction

Strategic groundwater (GW) management is the continuous planning, monitoring, analysis and assessment of all that is necessary to make the best use of ground water in a sustainable way. Globally, 50% of present drinkable water, 40%

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of the industrial water demand, and 20% of the irrigation water have been supplied by groundwater (UNESCO, 2003[1] and Molden, 2007[2]). Rice is covered on 75% of the total cultivated land and is main staple crop in the country, comprising 90% of the total food grain (BADC, 2013).[3] Three seasonal rice are available in Bangladesh i.e. Aus, Aman and Boro. Aus are grown in early of rainy season and lower potential where as Aman is grown during the rainy season and is also lower potential of yield. But boro has high yielding potential and grown in dry season (January through June). Due to higher yielding potential, production of boro rice has been prolonged in the last 20 to 30 years (Talukder, 2008).[4] During 1991-2013, Prolongation of boro rice augmented from 6.8 to 18.8 million tons whereas the invention of aus and aman largely kept constant (BBS, 2013).[5] Boro rice has enthused Bangladesh to boost its total paddy production from 18.3 million tons in 1991 to 33.8 million tons in 2013. The vivid soaring of boro production was only the widespread withdrawal of GW. Now-a-days, almost 80% of GW is utilized for irrigation purposes, where 73% is owned solely by boro growers (Rahman *et.al.,* 2008).[6] Rangpur is a very fertile land and most of the delicious rice varieties are grown here like Balam, Katarivog, Najir shail, Pijar, Swarna etc (Brac, 2005).[7] Boro rice is particularly dominating and most of the land is irrigated with ground water. Situation is that GW table in the northern region is sequentially fallen down thus creating concern to extend irrigation system in this zone. This study is going to identify six major strategic decisions that are being suggested to sustainable use for groundwater at rice field in Rangpur division of Bangladesh.

## Methods

### Study Area

The investigated zone was in eight districts of Rangpur Division, Bangladesh (Map 1).

### Data Source

By using survey questionnaire, primary data were collected through extensive field visit. From an upazila (sub district), 20 families were selected under three major categories (minor, undersized and middle/outsized) covering all season rice crops from each district. Numbers of total sample were 160 (Eight upazilas) by covering three major farm categories. In each upazila, minor, undersized and middle/outsized farms were 20 in each group. Data were collected once in a cropping season. Secondary data were taken from different research paper and journals and then prepared the final report.

### The Physical Context

Bangladesh is the biggest deltas in the world which is surrounded by the alluvium deposition of major rivers in the country (Ganges, Brahmaputra, and Meghna) (Ahmad *et.al.,* 2001).[8] In Bangladesh, average precipitation rate varies about 1,200 mm to 4,000 mm depending on areas (Chowdhury, 2010).[9] In Rangpur division, most of the precipitation (>80%) occurs during in rainy season in the month of May to August (Fig. 1). In dry season (December–February), minimal amount of precipitation has been received in Rangpur (<20%). Therefore, seasonal water shortage is seen depending on the duration of the monsoon. Production of Rice is one of the most significant activities that help to enrich the economy at Rangpur division. Now almost 80% lands are now being cultivated for rice that have been shifted other crops over the period of time (Fig. 2). During winter, the allocation of fresh water is only 28% that is available for irrigation (Chowdhury, 2010).[9] In Rangpur, limitation of surface water availability and the painless access during GW withdrawal by using shallow tube wells (STWs) have stimulated growers to pull out GW for irrigation. Table 1 presented that Rangpur division is one the highest irrigation contributor for STWs and DTWs after Dhaka division (BADC, 2013).[3]

### Case Analysis

Situational and Environmental Analysis Data are presented in Area Map 01.

### Strategic Planning (What can be Done?)

Depending on situational and environmental analysis following strategic planning can be taken for ground water management.

### Strategy-1: Right Choice of Rice Verities

Alter the current cropping system with the crops that are drought tolerant. High yielding rice varieties are more water consuming crops. If drought tolerant rice varieties can be chosen in cropping pattern, the water consumption as well as the pumping of ground water can be minimized in dry season. The most common rice varieties are BRRI Dhan 56, 57, 66 and 71 that are recommended by BRRI[10] in late Aman (Monsoon) season which is drought tolerant variety.

**Table 1: DTWs and STWs status of different division in Bangladesh**

| Divisions | Deep Tubewells Population (No.) | Deep Tubewells Area Irrigated (ha) | Shallow Tubewells Population (No.) | Shallow Tubewells Area Irrigated (ha) |
|---|---|---|---|---|
| Dhaka | 6918 | 170,088 | 408,767 | 1,054,963 |
| Rajshahi | 16352 | 467,133 | 348,267 | 713,389 |
| **Rangpur** | **6515** | **157,798** | **414,546** | **785,944** |
| Chattogram | 2329 | 62,720 | 63,047 | 166,268 |
| Khulna | 3064 | 68,895 | 281,824 | 484,944 |
| Barishal | 1 | 20 | 45 | 240 |
| Sylhet | 143 | 7,688 | 6,534 | 36,692 |
| Total | 35322 | 934,352 | 1,523,609 | 3,242,440 |

**(BADC 2013)**

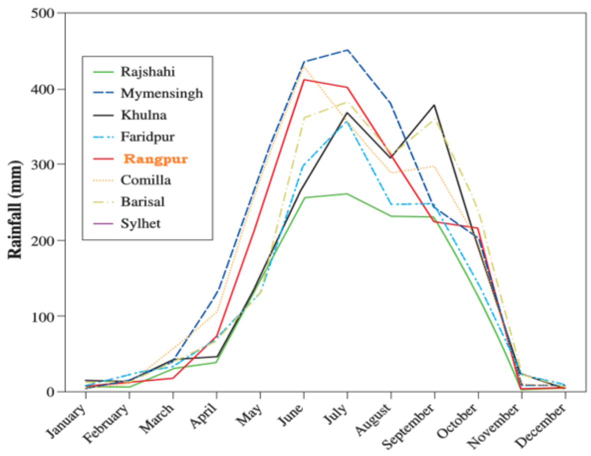



**Fig. 1: Average rainfall monthly and annually in Bangladesh over 2002- 2012 (BBS, 2013)**

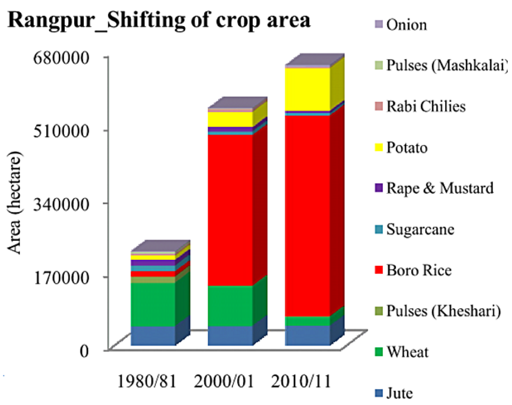
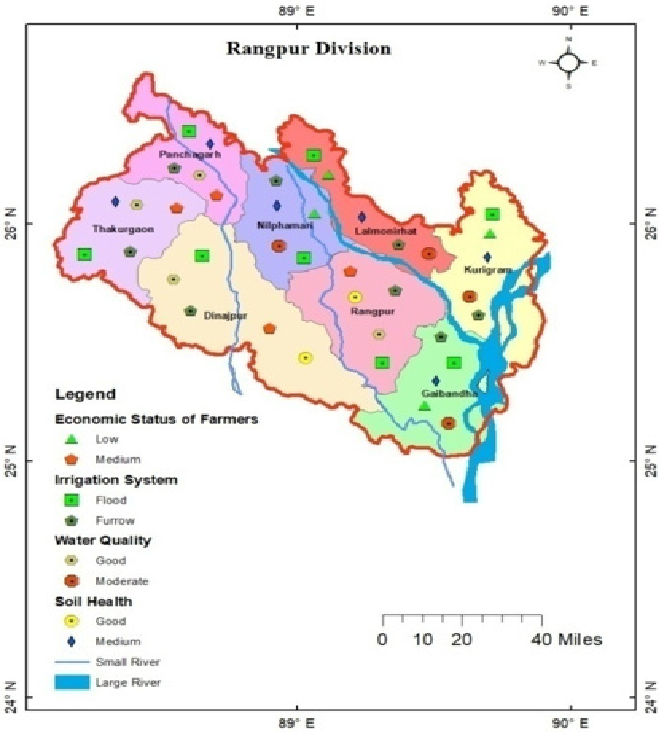



**Fig. 2: Crop diversity in Rangpur Division (Brac, 2013)**




**Map 01: Situational and Environmental Analysis Data on Area Map**

**Strategy-2: Innovate Water Saving Technology**

**Tactic-1: Alternate Wetting and Drying (AWD)**

Alternate Wetting and Drying (AWD) is a water-saving technology that farmers can use to implement for maximizing their irrigation water demand in paddy fields without declining its yield (Fig. 3). In AWD, periodic cycle is maintained and been flooded and non-flooded alternately. Depending on soil type, weather or climatic condition and stage of crop growth, the flooding or drying cycle may be varied (1 to 10 days). This method is generally appropriate in low land rice cultivation. Exception is that if rainfall can exceed the evapotranspiration or seepage, therefore, this method cannot be applied thus the method is applicable for dry seasonal rice cultivation. Hasan *et.al.,* (2016),[11] Majeed *et.al.,* (2017)[12] got the tremendous result by adopting AWD technique as of water saving technique for rice cultivation.

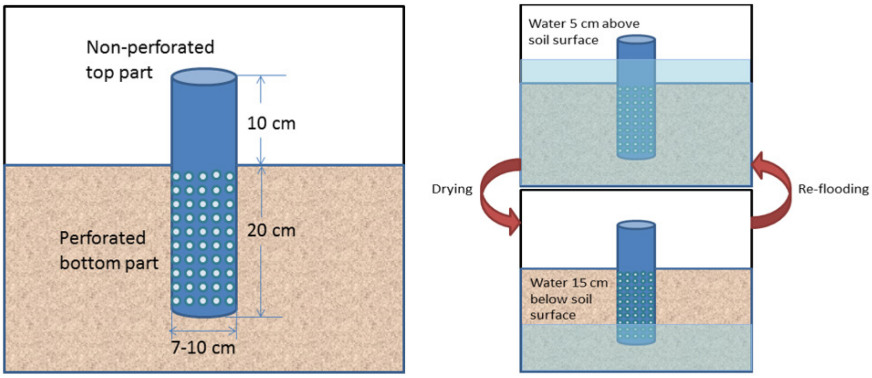



**Fig. 3: Implementation method and operation technique of AWD technology**

**Tactic-2: Cut Off Ratio**

Cutoff ratio is decided by the slope of the border and texture of the soil. The inflow stream can be cutoff when it reaches a certain percentage of the total length of the border. The value of the cutoff ratio lies generally in the range of 65 to 80%. Younts (2008) demonstrated a project where he found that clay soil had the best water saving range betweem 0.1 to 3.2 ace-inches with an avarage of 1.4 acre-inches by adopting cutoff ratio. This process was also economical that saved almost $14 per acre.

**Strategy-3: Irrigation Scheduling**

Scheduling irrigation is a process to apply water for a particular crop on suitable amount in a definite stage for growth and development of that crop. The basic rationales for irrigation scheduling are know the soil moisture, root zone depth, soil water holding capacity, effective precipitation rate and amount of daily water use. In a nutshell, the key factors for managing irrigtion are to find the rate of water that enters into the soil, rate of water that can hold by the soil and the rate of water that is being used by the plants.

**Strategy-4: Introduce Organic Fertilization**

Organic fertilization is used to improve soil fertility by increasing soil organic matter content and providing micronutrients and other growth factors not normally supplied by inorganic fertilizers. Shil *et.al.,* (2016)[14] stated that the soil organic matter content for different soil series in Rangpur division varied between 1.53 to 1.86%. But this should be at least 5% for ensuring as a good healthy soil. So, application of organic manure not only improves soil fertility but also ensures the protection of ground water.

**Strategy-5: Rain Water Harvesting (RWH)**

RWH is a process of collecting and conserving the natural runoff water for reuse in home or paddy field for irrigation purpose. It can also be used for ground water recharge. Though implementation of RWH is very simple in principle, lots of issues arise during implementation like climatic pattern, weather condition, available funds etc. Recharging groundwater aquifers by bore wells, dug wells and pits are the best example of rain water harvesting.

**Strategy-6: Reservoir Management**

Need to excavate of major rivers and canals like Bramaputra, Atrai, Tista, Dhorola, Dudkumar, Korotoa, Ghaghot, Akhira, Jamunasshori etc because river water flow rate has a significant relationship with GW. Brac, (2013)[15] reveals a positive relationship (R =0.6) between declining trend of river water level and groundwater table (Fig. 4). This graph states that GW depleted gradually by depleting river water flow in Teesta river. Teesta is a major river in the studied area that is playing as a major contributor in recharging GW. Since surface water and groundwater are generated from one singular source and interconnected physically in the hydrologic cycle that's why, reservoir management is necessary to protect GW in Rangpur area.

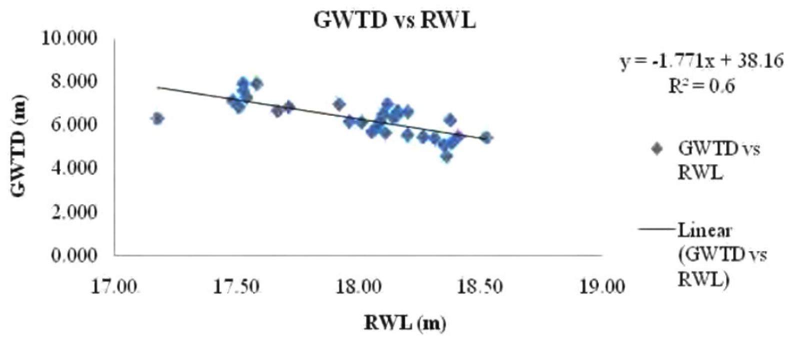



**Fig. 4: Statistical relationship between groundwater and river water (Brac, 2013)**

**Conclusion**

Sustainable use of groundwater for irrigation in Rangpur is a matter of concern due to climate change. Over exploitation of GW, soaring of boro cultivation, digging more tubewells, interruption of normal river water flow, plunging of wetland areas, plummeting average rainfall over the year are the key barriers in ensuring sustainability of GW that has been identified through the study. To achieve goal of food security, we have to produce more rice by protecting our ground water resources. So, sustainable technology needs to implement for protection of our future. The study has identified six key strategies that need to adopt in field basis for protecting GW in Rangpur. The study has some limitations like geography and topography analyses are further requirement which is not done here due to finance issue. Hopefully, this study has created a new platform how we can ensure GW sustainability by achieving the objectives of food security at Rangpur in Bangladesh.

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**Conflict of Interest**

The authors declare that they have no conflict of interest.

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