2. SUPPLY AND UTILIZATION OF WATER RESOURCES FOR BIOPRODUCTION IN BANGLADESH

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Abstract

In this paper supply and utilization of water resources for bioproduction in Bangladesh emphasizing crop production, development of animal resources and development and production of fishery resources have been discussed.

Irrigation from the surface water is not feasible for crop production for most of the areas of Bangladesh during winter (October to April) which in turn has been occupied by groundwater. Total cultivable land in the country is 8.42 Mha out of which 4.48 Mha (53 per cent) is now under irrigation. Contribution of groundwater irrigation to total irrigated area is 73 per cent while that of surface water is 27 per cent. Shallow Tubewell (STW) technology covers 56 per cent of the total irrigated area.

About 59 per cent of the total land is used for agriculture. Out of the total area under cultivation rice alone occupies 75.35 per cent and cereal as a whole about 81.14 per cent. Total cereal production was 28.21 MT for 2003-2004 indicating that the country has reached near self-sufficiency in food grain and could fulfil the target set for 2025. Inland total fish production at present is 78 per cent and the annual growth rate of fish production was 5.70 in 2002-2003. Fishery resources contribute 5.24 per cent and livestock resources contribute 16.13 per cent in country's agricultural production. An annual average growth rate of 20 per cent has been achieved in the poultry sector in the past decade. Thus proper supply and efficient utilization of water resources is a must for bioproduction in Bangladesh.

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Introduction

Bangladesh is a country of about 130 million people with an area of 1,47, 570 sq.km., situated on the northeast of South Asia bounded by India on the west, north and east, a shorter border with Myanmar in the south-east and is bordered by Bay of Bengal in the south. The country is lying in the delta of three mighty rivers, the Ganges, Brahmaputra and Meghna (GBM) and a complex river network of 230 rivers occupying about 6 percent of the area. Of a total of 1.72 million sq.km. catchment area of the Ganges, Brahmaputra and Meghna basins, only 7 to 8 percent belongs to Bangladesh while the rest is accounted for by India, Nepal, Bhutan and China. The country is riverine and, by and large flat with flood plains constituting about 80 percent of its landmass (Ahmed, 2003). The excess of water during the monsoon causes wide spread flooding which damages a considerable amount of crop every year.

The economy of Bangladesh is essentially agrarian which in turn is critically dependent on water resources. Besides agriculture, water is also vital for other sectors such as domestic and municipal supply, industry, fishery, forestry, navigation and above all for ecology and environment (Rahman, 1995). Bangladesh has a total land area of 14.39 million ha of which 8.42 million ha are under cultivation. Out of total cultivable land only 4.48 Mha (53%) is now under irrigation (NMIC, 2001). It is also a flat delta built up by the alluvial deposit of the big rivers (GBM). It is located between 88° 10′ and 92° 41′ east longitude and 20° 34′ and 26° 38′ north latitude. Eighty percent of the people depend on agriculture, which contribute 45% of the Gross Domestic Product (GDP). Approximately 37% of GDP is derived

from crops of which rice accounts for 25 percent (BBS, 2001). Until 2000, the country faced a deficiency of 1.5 to 2.0 MT per year where the requirement was more than 20 MT. The population of the country is expected to rise to 181 million by 2025 and to 224 million by 2050 requiring an additional food grains although she faces many challenges ahead in an era of increasing globalization (Mozaddad Faruque, 2004).

Bangladesh has a humid, warm, tropical climate (sub-tropical monsoon) which is fairly uniform throughout the country with three main seasons, namely, hot season with high humidity (March to June), hot humid monsoon season with heavy rainfall (June to September) and a relatively cool and dry winter season (November to March). The country has good annual rainfall ranging from about 1500 mm in the western part to as high as almost 5800 mm in the north-east region with a mean annual rainfall of 2327 mm and favourable temperature and sunshine for crop production round the year. However, about 90 percent of the total rainfall falls during the monsoon months that results in high runoff. During the dry period from November to February the rainfall of 40 to 140 mm is too low to meet the crop water requirement (Talukder, 1996).

The recent discovery of the arsenic contamination of the shallow aquifer has set back past successes in bringing safe water supply to the rural people of Bangladesh.

Supply and Utilization of Surface and Groundwater

Surface Water Resources :

Bangladesh has 230 rivers (big or small), out of which 57 are transboundary rivers-54 coming from India and 3 from Myanmar. The total length of the rivers is about 24,000 km. Rivers and inland water bodies cover nearly 6.7% of country's total area of 1,47,570 sq.km. The water ecosystem of the country comprises the tributaries and distributories of the above three major river systems and numerous perennial and seasonal wetlands like ponds, haors, baors and beels. The sources of almost all the rivers lie outside the country which constitutes a combined catchment area of about 1.72 million sq.km. of which only 7% lies within the country. In Bangladesh rainfall and transboudary river flows are the main sources of surface water. Being the lower riparian, Bangladesh has no control of the huge cross boundary flow causing recurrent flooding in about 25% of the area in average years. The percentage may be as high as 67 of the total area of the country as occurred in 2004. Surface water inflows of the country vary from a maximum of about 1,40,000 cumec in August to a minimum of about 7,000 cumec in February. Two main rivers, the Ganges and the Brahmaputra account for more than 80% of streamflows (BANGLAPEDIA, 2003). During the dry season, discharges in the rivers are significantly scarce to meet the need of agriculture, navigation, fisheries, forestry, environment and other water related sectors. The dry season discharge is now becoming more scarce due to the upstream unilateral withdrawal of the waters of the Ganges and other common rivers by India.

Bangladesh used to get uninterrupted flow in its river system from time immemorial. The silt carried by the river systems has developed the formation of the greatest delta of the world. The water has shaped the life and living of the people. The drastic reduction of the Ganges flow affected 40 million people in the south west region wholly dependent on the Ganges and has had disastrous effects on agriculture, industry, forestry, fisheries, navigation, salinity and domestic water supplies. India is also withdrawing water of the Mohanada, Teesta, Monu, Muhuri, Khowai and many other common rivers and streams thereby affecting the main crops and has started the process of dessertification in the region (Khan, 1995). Bangladesh has plenty of water but its uneven distribution, overabundance in monsoon often causes catastrophic floods and scarcity in dry season causes severe drought conditions leading to loss of crops, livestock, fisheries, public health problems and environmental degradation (BANGLADEDIA, 2003).

Groundwater Resources :

Heavy rainfall and floods during the monsoon season help the groundwater to be substantially recharged annually through the alluvium deposits constituting huge aquifer system throughout the country with reasonably good storage and transmission properties. According to

WARPO (2000) the total available recharge of groundwater within the country is 21 BCM which is about 22.8% of the total water requirement of the country. Irrigation from the surface water is not feasible for most of the areas of Bangladesh because of the limited quantity of water which can be safely drawn from the rivers or from perennial streams although many surface water irrigation facilities have been developed. Therefore, groundwater is the only constant source of water supply remained for the successful cultivation of crops. Bangladesh has become increasingly dependent on groundwater sources for meeting irrigation demands using tubewell tehnologies i.e. minor irrigations. Farmers have to use groundwater to grow Boro rice in the winter (Rabi season) when there is little or no rainfall as well as local rivers and water bodies dries up. Transboundary inflows of rivers are also diminishing alamlingly due to progressively increasing withdrawal in the upper riparian countries thereby hampering recharge to groundwater to a great extent (BANGLAPEDIA, 2003). The lowering of groundwater level in the northern region albeit all over Bangladesh together with less rainfall has intensified the phenomenon of drought affecting the main crops and has started the process of dessertification in this region.

Irrigation and Water Management (IWM) :

Total cultivable land in the country is 8.42 Mha out of which 4.48 Mha (53%) is now under irrigation coverage (NMIC, 2001). Rice is the largest irrigation user with over 75% of the total irrigated area. Utmost efforts are being made by the Government of Bangladesh to attain self-sufficiency in food production. Improved IWM practices along with farm mechanization, use of MV seed and fertilizers have made a major break through for increasing crop production. Present food grain production (rice) is 26.76 million MT of which 19.80 million MT is modern variety and the rest is local variety. Projected population in the country by the year 2025 will be about 181 million and food grain requirement will be more than 30 million MT which is 30% higher than the present production level. The increasing food grain demand will have to be met from our limited and shrinking land resources.

Growth in Irrigation at National Level :

Contribution of groundwater irrigation to total irrigated area has increased from 41% in 1982/83 to 73% in 2000/2001 while contribution of surface water has steadily declined from 59% to 27% over the same period (Fig. 1) (NMIC, 2001).

Total Land and River Areas :

The estimated distribution of total land together with river areas are given in Table 1. The area of rivers and other areas (including charlands) remains almost constant at 6 to 7%. Forest and mangrove increases slightly from 19 to 22%, while urban and rural settlements together increase from 11 to 15%. The biggest change affects agriculture and standing water bodies, which together reduce from 65 to 56%. Within this last pairing water increases from 5 to 9%, and agricultural land declines from 59% to 47% (WARPO, 2000). This is largely due to the expan-

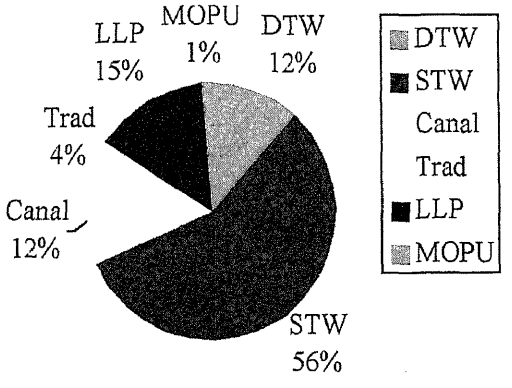

Fig. 1 Irrigated Area by Technology, 2000-01

Table 1. Estimated Land Distribution in 1995, 2025 and 2050

	Area in km²			Proportion of Bangladesh		
Classification	**1995**	**2025**	**2050**	**1995**	**2025**	**2050**
River & Other	7,999	8,903	9,682	5.7%	6.4%	6.9%
Forest & Mangrove	26,015	30,315	30,645	18.6%	21.7%	21.9%
Urban & Rural	15,431	21,123	20,798	11.0%	15.1%	14.9%
Water & Agriculture	90,368	79,552	78,836	64.6%	56.9%	56.3%

Table 2. Supply and Demand for Rice

Year	2000	2005	2010	2015	2020	2025
Total rice production, less HYV Boro (Mt)	11.96	11.19	10.84	10.40	9.48	9.32
HYV Boro Area (ha)	3.29	3.91	4.52	5.14	5.47	5.36
HYV Boro Yield (t/ha)	2.86	2.90	2.94	2.97	3.01	3.05
Total Rice Production (Mt)	21.35	22.50	24.12	25.69	25.95	25.69
Rice Demand, Gross (Mt)	21.60	24.10	26.50	28.80	30.60	32.10
Shortfall (Mt)	0.25	1.60	3.38	3.11	4.65	6.41
Required Boro Yield (t/ha)	2.93	3.31	3.46	3.58	3.86	4.25
Increased on predicted rates	103%	114%	118%	120%	128%	139%

sion of fish production on agricultural land once culturable waste has been used up.

Agriculture Land Availability :

Current land use depicted that 59% of the total land is used for agriculture followed by forest and mangrove (19%), urban and others (13%) and rivers and water bodies (9%) (WARPO, 2001). Per captia agricultural land has been reduced imposing additional requirements for crop production.

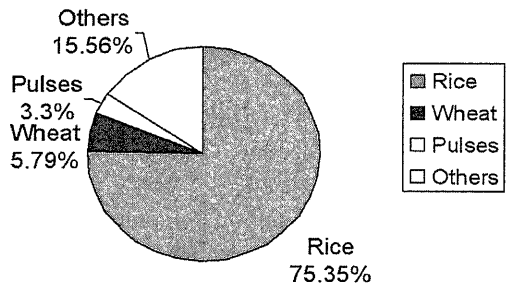

Fig. 2 Area under Cultivation in Bangladesh, 2000-01

Cereal Yields and Production :

Based on present trends and ignoring the potential for the introduction of new rice types (Hybrids, Super Rice or Genetically Modified crops) or of agronomic improvements beyond those experienced over the last 16 years, the yields and outputs are estimated and given in Table 2. An estimate is also made of the yield that would be required to meet demand on the assumption that only HYV boro has the potential for significant yield increase.

Thus, if all the irrigable area could be irrigated when required boro yields would still have to improve by almost 40% above current predicted yields to 4.25 t/ha (rice) to meet demand in 2025 (WARPO, 2000). This is not inconceivable, but will require considerable effort on behalf of researchers and disseminators of improved seed technology.

In the year 2003-2004 the total rice production was 26.76 MT which was slightly higher than the rice demand set for 2005. The projected demand of rice estimated for 2025 is 32.10 MT. Total cereal production was found to be 28.21 MT for 2003-2004 which is adequate to feed her population (BBS, 2001 ; DAE, 2004). The cropping intensity was about 177 during 2000-2001. The net and total cropped area during this period were 8.09 and 14.31 Mha, respectively. Area under cultivation, in Bangladesh, 2000-2001 for various crops grown are depicted in Fig. 2. Rice alone covered a total area of 75.35% of all the crops grown in which Aus covered 12.28%, Aman 52.08% and Boro 34.84% of the total rice (BBS, 2001).

Fisheries Development :

Bangladesh has vast inland water resources in the form of ponds, beels and haors (natural depressions), baors (ox-bow lakes), canals, rivers and estuaries, flood plains, reservoirs and impounded brackish water.

It has marine fisheries too. An estimate of annual total catch and productivity area by sectors of fisheries for July 2002 to June 2003 is given in Table 3. It can be seen that the inland water bodies are highly productive and the capture and culture total catch under inland fisheries were 35.50% and 42.89%, giving an inland total fish production of 78.39%. Marine fisheries contributed only 21.61% of the total catch indicating that inland fisheries played a vital role in the total catch for consumption and export (FSYB, 2002-2003). The contribution of agriculture to the

Table 3. Annual Total Catch and Area Productivity by Sectors of Fisheries for July 2002-June 2003.

Sector of Fisheries	Water Area (Hectare)	Total Catch (Metric Ton)	Catch/Area (Kg/Hectare)
A. Inland Fisheries			
(i) Capture Total	4,047,316	709,333	35.50%
(ii) Culture Total	437,341	856,956	42.89%
Inland Total	**4,484.657**	**1,566,289**	**78.39%**
B. Marine Fisheries			
(iii) Marine Total		431,908	21.61%
Country Total		**1,998,197**	**100%**

country's gross domestic product (GDP) is 45%, of which 5.24% comes from fisheries. Fisheries sector contributes 4.76 % of the foreign exchange earning. Fish accounts for 13.5 kg per capita annual fish intake, about 6% of the per capita protein intake and contributes about 64% of the animal protein throughout the country. At present per capita annual fish demand is 18 kg and annual total fish demand is 2.4 million metric tons (Fishery Week, 2003). Annual growth rate of fish production varied with the highest (8.15) obtained in 1996-97 and the lowest (5.70) in 2002-2003.

Livestock Development :

The contribution of livestock in the economy of Bangladesh is enormous and multifarious. It's contribution in cultivating agricultural lands, threshing of crops, transportation of goods, production of organic manure and supply of fuel plays a very significant role. Milk, meat and egg production by livestock helps in meeting up the protein demand of the people. Millions of country's unemployed youth, young women, landless and marginal farmers have been trying hard to change their fate by rearing animals. The density of livestock in Bangladesh is comparatively higher than that of other countries of the world. The density of cattle per acre is 0.91 in the world, in Asia it is 0.95 and in Bangladesh it is 2.92. Although the density is high but the productivity power is very low even in comparison to the neighbouring countries. The annual milk production per cow in Bangladesh is only 206 kg compared to Asia (1220 kg) and the world (2190 kg). A revolutionary change has occurred in the world including Bangladesh during the last decade on the productivity of livestock due to different scientific and technological developments. The contribution of livestock sector in our national economy is shown in Table 4. The livestock contributes 16.13% in country's agricultural production, 3.12% in national economy, 20% in full time self-employment. The contribution of livestock from hide and skin in foreign exchange earning is 3.46% as estimated in 2001-2002. It also supplies 25% of rural fuel (AR, 2002-2003).

Role of Agro-environmental Education:

The role of agro-environmental education in the supply and utilization of water resources for bioproduction is manifold. The Government of Bangladesh has established a good number of academic institutions, Government, semi-government and nongovernment organizations (NGO) which are also playing vital roles for this purpose. People's participation in bringing success to

Table 4. Livestock Resources in Bangladesh

Contribution of Livestock Resources in National Economy	3.12%**
Contribution of Livestock Resources in Agricultural Production	16.13**
Contribution of Livestock Resources in Self-Employment (Full time)	20%
Production of Livestock Products (in Million US $)	20.34
Land Cultivation	75%
Rural Transport	50%
Organic Manure Production	80 MT (million metric ton)
Rural Fuel Supply	25%

major and minor water resources projects for bioproduction is a must. Syllabuses and curricula with respect to soil-water-plant-atmosphere in every phases of education are updated time to time in order to impart appropriate knowledge about these aspects. Trainings are arranged for to those who are basically involved with soil-water-plant-atmosphere right from top level policy makers to bottom level farmers. Seminar, symposium and workshop for the rural youth, stakeholders, scientists, researchers, academicians and policy makers on water resources for bioproduction are also arranged by the appropriate agencies/institutions/ organizations for disseminating knowledge from top to bottom. Bangladesh Agricultural University is playing a pioneering role in agro-environmental education involving water resources for bioproduction from early sixties.

Conclusion :

a) Abundantly available surface water during monsoon should be stored in canals, ponds, beels, haors, baors and rivers for supplemental irrigation to rice crop.

b) Groundwater, the only constant source of water supply during winter, should be judiciously used for irrigating rabi crops including boro rice using tubewell technologies.

c) In order to feed the taming million of the people of Bangladesh, rice yield specially boro yield need to be increased.

d) Availability of water for rearing livestock resources should be made which in turn will develop this sector.

e) Surface water in ponds & ditches, beels, haors, baors, lakes & reservoirs, flood land and river & estuaries should be adequately available for the development and production of fishery resources in the country.

f) Academic, research and training programmes should be updated as necessary for proper utilization and management of water resources for bioproduction.

g) Awareness among the end users should be created in using the limited but costly irrigation water through utilizing modern tubewell technologies for increasing winter crop production.

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BANGLADESH: DISCUSSION

Question: Is there a conflict between India and your country regarding the construction of the dam/ reservoir on Ganges River?

Answer: There is a always a conflict between India and Bangladesh regarding the sharing of the Ganges water as India already constructed a barrage called "Farakka barrage" across the Ganges river and thus diverting the flow of the Ganges. The Ganges water sharing treaty/agreement has been signed in 1996 by the government of Bangladesh and India and is very vague, but India does not release the water as per agreement whenever Bangladesh needs the water.

Question: Is there any salinization problem in your country resulting from the use of ground water?

Answer: So far no salinity problems of groundwater have been observed in Bangladesh, meaning to say that the groundwater is good for irrigation purposes.

Question: How deep are the shallow and deep tube wells in Bangladesh?

Answer: Generally, the depth of shallow tube well (STW) is less than 30 m (100ft) and the depth of deep tube wells (DTW) varies from 60 to 90 m (200 to 300ft) all over Bangladesh. In the coastal areas, for example, the southern part of the country, the depth of DTW may be up to 300m (1000ft) in order to get fresh irrigation and safe drinking water.

Question: What about the water for irrigation of the agricultural lands, is it free of charge?

Answer: No, it is not free of charge; the farmers have to pay water charges to the owner of the tube wells (STW and DTW).

Question: What is the real reason for the utilization of underground water? Is it the lack of surface water or the lack of delivery structure? Normally, the utilization of underground water is expensive. River flow is abundant even in dry season, so is it true that to catch river water and to distribute water to agricultural lands is the real problem? Or is it simply because the farmers want to be independent in terms of the use of water resources?

Answer: The reason for the underground water utilization is due to the non-availability of adequate amount of surface water during the winter (dry) season for growing the rabi (winter crops). Utilization is no doubt costly; however river water during dry season is not abundant because the river dries up in this season. As the price of the shallow tube well is much lesser than that of deep tube well, the individual farmer either a small or medium or large-scale farmer can afford to have one of his own and can use it independently without having to rely on others.

Question: Are there programs for controlling the floods in your country?

Answer: Bangladesh is normally flooded every year. The government has taken up various measures to control floods. The traditional approach is structural interventions i.e. construction of dams and barrages together with embankments, polders, river draining, canal re-excavation, river bank protection and dredging to control floods.

Recently, increasing emphasis is given to other kinds of management interventions such as flood warning systems; flood proofing and adopting responses to hazardous conditions. Anyway, it is true that people of Bangladesh have to live with flood.