

BANGLADESH

1. PHYSIOGRAPHY

The People's Republic of Bangladesh lies in the north eastern part of South Asia between latitudes $20^{\circ} 34' N$ and $26^{\circ} 38' N$ and between longitudes $88^{\circ} 01' E$ and $92^{\circ} 41' E$. It has a gross area of about $147,570 \text{ km}^2$ and is bounded on its west, north and north-east by India, on its south-east by Myanmar, and on its south by the Bay of Bengal.

The landmass of Bangladesh is extremely flat built by the delta-building activities of the three major rivers - the Ganges, the Brahmaputra and the Meghna with some upland in the north-east and the south-east. The great plain lies almost at sea level along the southern part of the country and rises gradually towards north. Land elevation in the plain varies from 1 to 90 metres above sea level from south to north. The maximum elevation is 1230 metres above sea level at Keocradang hill in Rangamati hill district. The geo-morphology of the country comprises of a large portion of flood plains (79.1%), some terraces (8.3%) and hilly areas (12.6%).

2. CLIMATES AND RAINFALL

Bangladesh enjoys generally a sub-tropical monsoon climate. While there are six seasons in a year, three namely, Winter, Summer and Monsoon are prominent. Winter, which is quite pleasant, begins in November and ends in February. In Winter there is not usually much fluctuation in temperature which ranges from minimum of 7.22° - 12.77° Celsius to maximum of 23.88° - 31.11° Celsius. The maximum temperature recorded in Summer months is 36.55° Celsius although in some places this occasionally raises up to 41° Celsius or more. Monsoon starts in June and stays up to October. This period accounts for 80% of the total annual rainfall. The average annual rainfall varies from 1429 to 4338 millimetre. The maximum rainfall is recorded in the coastal areas of Chittagong and northern part of Sylhet district, while the minimum is observed in the western and northern parts of the country.

Cyclonic storms with winds of more than 120 km/hr occur with the advent of the monsoon season. These are particularly severe just before and after the monsoons, in May and October; winds of over 160 km/hr velocity, heavy downs pour and tidal surges of over 6 m above the normal level have brought devastation to life and property more than once in the recent past.

Maximum evaporation in Bangladesh occurs during the summer months (March-May), the highest evaporation generally occurs during April. The mean monthly evaporation varies from the minimum of 51 mm in winter to a maximum of 183 mm in summer. The rate of evaporation in the eastern part is generally lower than in the western and northern-western parts. Humidity ranges between 60% in the dry season and 98% during the monsoon.

3. POPULATIONS AND SIZE OF HOLDINGS

Bangladesh is one of the most densely populated country in the world with an average of about 842 persons/km² on average over the country. In January, 1996, the population of Bangladesh was estimated at 124,300,000 inhabitants, of which 78% are rural. The annual demographic growth rate is estimated at 1.75%. The agriculture sector continues to play a very important role in the economy of the country. It accounts for about 32% of the GDP and 68.5% of the national employment.

The average holding size per farm-household in 1996 was 0.7 ha. Nearly 28% of farm households own very little land; less than 0.2 ha and another 51% own up to 1.0 ha.

4. LAND RESOURCES

Of the total land area of 14,757,000 ha. in Bangladesh the total cultivable area is estimated at 8,774,000 ha, which is about 59% of the total area. In 1996-97, the total cultivated area was amounted to 7,860,000 ha. of which 490,000 ha was under permanent crops. Of the total area cultivated annually, about 37% was under single cropping, 50% was under double cropping and the remaining 13% was under triple cropping. In 1996-97, due to double and triple cropping, the total area of crops amounted to about 13.80 million ha, giving an average intensity of 175%. The total forest area covers about 14% of the land area of Bangladesh.

SOILS

The greater part of Bangladesh lies within the delta of the combined Ganges-Brahmaputra-Meghna River System, and is endowed with fertile soils capable of sustained high yields. On the basis of their geological origin and properties the soils of Bangladesh have been broadly classified into seven tracts. Soils of each tract have some common characteristic properties different from those of other tracts. Characteristics of each tract together with the nutrient status of its soils are given below:

Red soil tract or Madhupur tract comprises parts of greater Dhaka and Mymensingh districts and extends through isolated tracts in Comilla and Noakhali towards south in Chittagong. This tract represents red later tic soils of Madhupur Jungle area - a high land tract above the flood level intersected by numerous gentle depressions locally known as "Beels" which are highly valued for aman paddy. The soils are very clayey containing numerous ferruginous concretions. The soils are deficient in nitrogen, organic matter, phosphate and lime, i.e., they are low in plant nutrients. The analytical figures for these nutrients in these soils are below the standard of the Bangladesh average. These soils are, however, relatively rich in iron and aluminum and are highly aggregated. They have low base exchange capacity and high phosphate fixing capacity. Addition of organic matter is always helpful. For rice cultivation these soils give good response to the application of nitrogenous and phosphatic fertilizers. For aus bulky organic manures, such as cow dung, compost and town compost, make better response than chemical fertilizer. For sugar cane cultivation in addition to nitrogenous and phosphatic fertilizer, lime has to be added to these soils. Potassic fertilizers are in addition required for fibre crops. For vegetables, combinations of bulky organic manures, lime and chemical fertilizers supplying nitrogen and phosphorous are necessary for successful and profitable agriculture. The PH value lies between 5.5 and 6.

Barind tract comprises parts of greater Rajshahi, Dinajpur and Bogra districts. Barind tract belongs to an old alluvial formation, which is usually composed of massive argillaceous beds of pale reddish brown, often turns yellowish on weathering; kankar and pisolitic ferruginous concretions occur throughout the mass. In the numerous depressions transplanted winter paddy is grown; the soil is deficient in lime, nitrogen and phosphorous like the red soils of Madhupur Jungle tract. The nutrient status is below the average standard for Bangladesh. The manurial responses are the same as for the red soils of Madhupur Jungle tract. The PH varies from 6 to 6.5.

Gangetic alluvium comprises parts of greater Rajshahi, Pabna, Kushtia, Jessore, Faridpur and Dhaka districts. This tract represents the riverine lands of the Gangetic plains. The soils are rich and are characterised by high lime content and are well supplied with potash and phosphate, though a small area in the district of Kushtia is rather poor in phosphate. The texture varies from clay loam to light sandy loam according to its formation from the silt of the various tributaries of the Ganges. The soil is generally fertile but responds to the applications of nitrogenous and occasional phosphatic fertilizer. The PH varies from 7 to 8.4.

Teesta silt comprises parts of greater Dinajpur, Rangpur, Bogra and Pabna districts. This represents a sandy loam similar to the ordinary silt soil of Bangladesh. The soil is fertile and is well supplied with potash and phosphate though rather poor in lime. Paddy, tobacco and sugar cane are the main crops. The soils respond to the application of nitrogen and phosphatic fertilizers. The PH ranges from 6 to 6.5.

Brahmaputra alluvium comprises the districts of greater Comilla. Noakhali, parts of Mymensingh, Dhaka, Chittagong and Sylhet districts. The soil is sandy loam, very fertile and rich and is replenished every year by fresh deposits of silts carried down by the flood water. Almost all kinds of crops are grown of which jute and rice are the most important ones. The PH varies from 5.5 to 6.8. For low-lying areas, where broadcast winter paddy is grown, application of manures is unnecessary, but on high and medium lands good response is obtained from the application of nitrogenous and phosphatic fertilizers.

Coastal saline tract comprises greater Barisal, Khulna, parts of Noakhali and Chittagong. This tract comprises a flat low-lying area. From the south, near the sea is the Sunderban tract - a region of morasses and swampy islands most of which clothed with dense evergreen forest, while some are covered with salt water of flood tide. The soil is saline and salt efflorescence occurs in many places. The soil is well supplied with potash and phosphate.

Unclassified hilly soils in greater Chittagong Hill Tracts - The soil is brown sand loams to clay loams, slightly to strongly acid, sometimes shallow over Shale/Sandstone bedrocks on very steep high hills. Mostly these types of soil are used for "Jhum" cultivation.

5. WATER RESOURCES

Surface Water

Most of Bangladesh is located within the flood plains of the three great rivers: the Ganges, the Brahmaputra and the Meghna, and their tributaries, such as Teesta, Dharla, Dudkumar, Surma and Kushiara. The three major river systems drain to the Bay of Bengal through Bangladesh.

1. The Brahmaputra river enters Bangladesh from the north and flows to the south for about 270 km to join the Ganges river at Aricha, about 70 km west of Dhaka in central Bangladesh.
2. The Ganges river flows east-south-easterly for about 212 km from the Indian border to its confluence with the Brahmaputra, then as the Padma it flows for about a further 100 km to its confluence with the Meghna at Chandpur.
3. The Meghna river flows southwest, draining eastern Bangladesh including the hills of Assam, Tripura and Meghalaya to join the Padma at Chandpur. The Meghna then flows southward as lower Meghna for 160 km and discharges to the Bay of Bengal.

The combined discharge of the three main rivers is among the highest in the world. Peak discharges are of the order of 98,600 m³/s in the Brahmaputra in 1988, 76,000 m³/s in the Ganges in 1987, 19,800 m³/s in the upper Meghna in 1988 and around 160,000 m³/s in the lower Meghna in 1988.

Out of the 230 rivers in the country, 57 are transboundary coming from India (54) and Myanmar (3). About 93% of the catchment area of the river systems is located outside the country. On average 1,009,000 Mm³ of water cross the borders of Bangladesh annually, 80% of it occurs between June and October. Of the annual total, 50% is contributed by the Brahmaputra at the border, and another 5% by its tributaries, 38% by the Ganges and another 1% by its tributaries, 6% by the Meghna and its tributaries, and the balance of 1% by the rivers of the Southeast.

The estimated global renewable surface water resources are 1,174,000 Mm³ of which the total average annual runoff generated within the country is 165,000 Mm³.

Ground Water

Besides surface water, ground water is the other major source of water in Bangladesh for agricultural, drinking, municipal, and industrial uses. Ground water plays a very vital role during the dry season and drought periods.

Unconsolidated sediments ranging in age from tertiary to recent mainly underlie Bangladesh. The sediments are generally thick over most of the country. In general, there are two aquifer in the country: the upper aquifer and the main aquifer. In most areas, these two aquifers are probably hydraulically interconnected. The main aquifer in most parts occurs at depths ranging from less than five meters in the northwest to more than 75 meters in the south.

Ground water levels are highest from August through October and lowest in April and May. A sharp rise in water level generally begins in May and continues until July. The range of fluctuation is from three to six meters in most areas. After July, the rate of rise decreases, and in many areas ground water levels remains almost stationary from August to October, indicating rejection of recharge because the aquifer is filled to capacity. The rejected recharge varies from place to place and depends upon several factors, including permeability of surface materials, rainfall amount and intensity, and the time factor.

Recharge to ground water occurs primarily through direct infiltration of rainfall. Actual recharge is considerably less than potential recharges. Highest potential recharge occurs in Dinajpur, Mymensingh, Sylhet, Noakhali and Chittagong. The lowest potential recharge occurs in western Bangladesh in Rajshahi, Kushtia and Pabna.

The estimated total annual renewable ground water resources are about 21,000 Mm³ which are used for dry season irrigation, drinking, municipal and industrial requirements.

6. BRIEF HISTORY OF IRRIGATION AND DRAINAGE

IRRIGATION

A system of water control and use existed in the Gangetic delta for centuries. It consisted of broad shallow canals, which carried the top waters of the river floods, rich in fine silt, to the lands. They were so spaced that water could be distributed with reasonable facility to the rice fields, by means of cuts in the banks called 'Kunwas', which were closed when the flood season had passed. During the monsoons, much of the land was covered with water. To avoid inundation, villages were located on the higher ground generally made higher by earth obtained from the excavation of tanks, which had the double advantage of retaining the monsoon water for use during the dry season.

The system of water control and use was managed and maintained by the Zamindars (landlords) and the tenants, on a more or less forced co-operative basis, known as 'Pulbandi'. The long-drawn campaign of the Mahrattas and the Afghans, marking the decline of the Moghal Empire, brought about disorganisation and negligence in the proper maintenance of the system. Nonetheless, 'Pulbandi' persisted up to 1947 although in a less positive and effective manner. After 1947 reforms in land tenure were initiated and Government assumed the responsibility for maintenance of the works.

No major organized irrigation development was, however, carried out. The farmers have employed irrigation on a very small scale for many years. Water has been lifted from wells and streams by primitive methods to irrigate vegetables, chillies, boro rice and betel leaf. More recently, small pumps have been employed for irrigating larger areas of boro rice and sugar cane. Irrigation projects to serve large areas have been unknown until the first half of the present century. Since 1955 a number of irrigation, drainage and flood control projects have been initiated.

To boost agricultural production a programme for development of irrigation by the use of small portable pumps was taken up in the 1960s. These pumps are put to use on purely temporary and seasonal locations along the smaller streams and waterlogged depressions to irrigate small areas upto 40.5 ha.

In Bangladesh, pending major surface water development, the expansion of minor irrigation (small-scale irrigation) has formed a vital component of the Government's strategy in agriculture. Irrigation through major canals (large scale-irrigation) covered only 4% of the total irrigated area in 1996-97, the remainder being classified under minor irrigation consisting of low lift pumps (LLP's: power operated centrifugal pumps drawing water from rivers, creeks and ponds), shallow tubewells (STW's: with a motorised suction mode pumping unit), deep tubewells (DTW's: with power operated force mode pumping unit), manually operated shallow tubewells for irrigation (MOSTI's : extracting water from a shallow tubewell) and traditional systems. At the end of the dry

season, the water level can fall beyond the suction limit of the centrifugal pump. In these situations, it is possible to draw water by placing the STW in a pit. Lowering of a STW in a pit is called a deep-set shallow tubewell (DSSTW) or a very deep-set shallow tubewell (VDSSTW). When the static water levels fall further (over 10.7 m), submersible or vertical turbine pumps (FMTW's : force mode tubewells) are needed.

Between 1950 and 1987, public tubewells, regulations of private installations and public monopolies in the supply of pumps, motors and other equipment were a constraint to the development of irrigation. Since 1972, emphasis has been placed on minor irrigation through low lift pumps and mainly by tubewells (Shallow tubewells (STWs), Deep tubewells (DTWs) and Force mode tubewells (FMTWs)).

From 1979 to 1984, there was a liberalised expansion of minor irrigation with STWs in the private sector. In 1981-82, about 0.20 million ha of land was under irrigation with 43,000 operating STW's. The rate of installation of STW's development was 10,000 per year from 1981-82 to 1984-85, but numbers were reduced from 73,000 in 1984-85 to 47,000 in 1988-89. Several reasons are cited for this decline: private sector STW sales were limited by Government; some agricultural subsidies were removed; there was official concern over reported declines in groundwater levels where STWs operated; the concept of DSSTW had not been introduced by that time.

In 1991, the National Minor Irrigation Development Project (NMIDP) was established in response to the needs of farmers and the requirement of increased private sector investment in minor irrigation technologies. The project activity mainly concentrates on VDSSTWs and FMTWs technology, whereas irrigation by STW (shallow tubewell) is mainly controlled by the private sector. In 1995, 583 VDSSTWs and 135 FMTWs were in operation by farmers due to the promotional action of the project. There has been a general reduction of the area irrigated by DTW due to problems with management and finance, but this has been more than compensated by the rise in STW (including DSSTW). There has been an increase in salinity intrusion in the south-western part of the country which is related to the reduction of freshwater entering the area through the Ganges distributaries, especially the Gorai. There is some evidence for increased soil salinisation in the extreme South West (Sathkira area), which may be due to increased groundwater abstraction.

Currently, the potential for irrigation is estimated at 7,550,000 ha, of which about 3,690,000 ha had been brought under irrigation by 1996-97. Irrigation through major canals covers about 4% of the total area, the remainder being classified under minor irrigation consisting of surface water (low lift pumps and traditional systems) and groundwater (shallow tubewells and deep tubewells).

Irrigation by type of water control in 1996-97

Type of water control	Irrigation area in ha	% of the total
Surface water		
Gravity (canal)	156,000	4%
Low lift pumps	690,000	19%
Traditional (manual pumping)	363,000	10%
Sub-total	1,209,000	33%
Groundwater		
Deep tubewell	670,000	18%
Shallow tubewell	1,770,000	48%
Hand tubewell (non-mechanised)	32,000	1%
Sub-total	2,481,000	67%
Total	3,690,000	100%

At present, irrigation is practiced for boro rice (71%) and wheat (9%), which occupy together 80% of the irrigated land. Irrigation is mainly used in the dry season, although supplementary irrigation could appreciably increase transplanted aman rice production. The total harvested irrigated area is estimated at 3,690,000 ha, which does not account for wet season crops on area equipped with full or partial control irrigation. The national average irrigated paddy yield in 1996-97 for HYV boro was moderately high at 4.0 t/ha. In 1996-97, the total HYV boro rice production amounted to 7.10 million tones, which represents about 38% of the total grain production.

Keeping in view the target of raising the cereal production level to 25 million tons by the year 2002 the fifth five-year plan seeks an overall accelerated growth in agricultural production and productivity. Agricultural Development is still synonymous with economic development of Bangladesh.

FLOOD CONTROL AND DRAINAGE

Because of its low-lying topography, at least 20% of the area of the country is flooded in a normal year. Flood control and drainage is used to reduce the depth of flooding or eliminate, through "controlled flooding", untimely floods so as to provide greater security for the crop production.

In 1964, a master plan for water resource development was developed which envisaged the development of 58 flood protection and drainage projects covering about 5.8 million ha of land. Three types of polders were envisaged: polders with gravity drainage, tidal sluice drainage and pump drainage.

Flood control and drainage projects have accounted for about half of the total funds spent on water development projects since 1960 they include :

- Major projects such as the Coastal Embankment Project (949,000 ha), the Brahmaputra Right Flood Embankment (226,000 ha), the Pabna Phase 1 Project (197,000 ha), the Ganges-Kobadak Project (141,600 ha), and the Chalan Beel Project (125,000 ha).

- Medium-scale project such as the Satla-bagda, Chenchuri Beel and Barnai-Salimpur-Kulabasukhali Project implemented under the drainage and flood Control Projects (DFC 1 to DFC IV). These projects typically cover areas of 10,000 to 30,000 ha and involve flood control and drainage with limited irrigation development.
- Small-scale projects such as those implemented under the Early Implementation Project, the Small-scale Irrigation Project and Small-Scale Drainage and Flood Control Project.

In 1993, the total area of wetlands was 3,140,000 ha of which 1,545,000 ha were cultivated and 1,383,000 ha were drained through surface drains. In addition, the irrigated areas equipped for drainage represent about 114,400 ha. The flood-protected area in 1990 was estimated at 4,200,000 ha.