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Agrobiodiversity in Southern Bangladesh

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Abstract: The coastal zone of Southern Bangladesh covers an area of about 47,203 km^2 which is 32% of the country's total land area. Around 40 million people inhabit the coastal areas. Rapid population growth, coastal urbanization and exploitation of natural resources being major anthropogenic stressors on the resources and productive environments of the coasts. Increased salinity levels and climate variability also pose significant development challenges. The status of the on-farm and *in-situ* agrobiodiversity in Southern Bangladesh was reviewed, including the status of crops and plants, livestock and other animals, and fisheries and aquatic resources. Key development programs, notably traditional farming practices such as dhap cultivation and the sorjan system are discussed. Key organizations and institutes conducting agrobiodiversity research and development programs are presented, and gender related studies and policy studies are also explored. An assessment of agrobiodivrsity's and ecosystems' resilience to pressures as well as further research and assessment of endangered and key agricultural genetic resources is needed so as to make more informed and effective research in development (RinD) actions and policy decisions. The importance of community involvement, traditional farming and fishing practices, and gender related issues must not be overlooked in developing an integrated action. Opportunities for conservation and restoration of agrobiodiversity, potential research questions, and comprehensive lists of endangered plant and fish species are presented.
Keywords: Agrobiodiversity, key organizations and institutes, endangered plant and fish species, conservation and restoration.

Introduction

Bangladesh is a country located in Southern Asia between Myanmar and India, bordering the Bay of Bengal. Rivers and streams cover a length of about 22,155 km (CBD, 1992) and 12,600,000 ha (18% of total land surface, including village forests and tea gardens) is forest cover (Ahmed and Ali, 1996). About 53% of the land is arable, with permanent cropland constituting about 6% (CIA World Factbook, 2013). From March to September, the monsoon season brings tornadoes, floods, and tidal surges damaging lives and property (Choudhury, 1995). The current population is more than 150 million living in 14.47 million ha of the country's land. By 2015, the population is expected to reach more than 200 million people (Anonymous, 2011). Over the last two decades, there has been about a 6% average growth in the economy (CIA World Factbook, 2013). Despite this, the status of food security at the household level is poor throughout the country. In the coastal zone, the environmental status of all Upazilas (subdistricts similar to county subdivisions found in most Western countries) is poor (-0.5076 to -0.027 based on a quantitative method for computation of food security in grain equivalent based on economic returns) except for that of two Upazilas: Kalapara and Galachipa (Bala and Hossain, 2009).

The coastal zone of Southern Bangladesh contains 185 islands and chars, and is divided into the eastern, central, and western regions by the 2009 Government's Concept Note on Integrated Coastal Zone Management. A particular area is defined as "coastal" if it is comprised of tidal movements, salinity intrusion, and risk of cyclones and storm surges, as stated by the 2006 Coastal Development Strategy. The costal zone contains 133 costal Upazilas and is located in 19 districts, covering an area of about 47,203 km^2 (32% of the country's surface). Around 40 million people inhabit the coastal areas (28% of the total population), with 30.2 million of them living in rural areas and 10 million in urban areas (de Wilde, 2011). This paper reviews the current status of agrobiodiversity in Southern Bangladesh-on-farm, in homesteads and in the wild, and agrobiodiversity related development programs. Key organizations and institutes conducting agrobiodiversity research and development programs are presented. Due to the interdisciplinary nature of conservation and environmental studies, gender related studies and policy studies are also explored.

Key Development Challenges: Bangladesh has had a long-time focus on production at the expense of conservation and sustainable management (Anonymous, 2004). Miah *et al.* (2009) in their study identified nine anthropogenic activities that put stress on both resources and productive environments in the coastal regions: human population growth, coastal embankment, upstream withdrawal of Ganges River water, brackish water shrimp farming, salt production, industrial activities (i.e. use of agro-chemicals), commercial activities (i.e. ship breaking, brick burning, tobacco curing), exploitation of natural resources, and urbanization (i.e. settlement and transportation). Islam and Ahmad (2004) further mention some of the aforementioned anthropogenic stressors in their report for the Program Development Office for the Integrated Costal Management Plan, and in addition offer recommendations to the present challenges such as improved disaster preparedness, attention to growing costal urbanization, adaptation to declining natural resources, and area wise integrated planning.

Increased salinity levels pose significant threats to agro-biodiversity. From 1975 to 2006, indigenous rice varieties declined due to the cultivation of salt-tolerant rice varieties. Fruits and vegetables also declined significantly in the time period 1975-1990 (Rahman *et al*., 2011). A study at three unions of Kaligonj Upazila of Stakhira District found that high salinity and iron levels have made water unsuitable for drinking in the area. Salt accumulation in the topsoil during the dry season makes it difficult to plant crops, collect firewood, and collect fresh water for drinking and irrigation. There is also a scarcity in food for livestock due to the conversion of agricultural and grazing fields into shrimp-farming enclosures (Anonymous, 2010a). By 2050, there is an expected 7% increase in the area with unsuitable salinity levels for crop production (Anonymous, 2012a).

Vulnerabilities in climate change account for severe issues in the southern region of the country, which include

cyclones (notably cyclones Sidr in 2007 and Aila in 2009 damaged 9 million households), droughts, sea level rise, coastal flooding, saline intrusion into acquifiers, greater monsoon precipitation, wider temperature extremes, and riverbank erosion (Choudhury, 1995; Anonymous, 2009; Karim, 2011). The southern, southwestern, and coastal areas of Bangladesh already remain submerged for a large part of the year during the monsoon season (Hossain, 2010). Salinity intrusion, tidal flooding, drainage congestion and heavy siltation have made many southwestern areas unsuitable for cultivation and human settlement, while the conversion of farmland, mangrove and paddy to shrimp farms has resulted in social conflicts since the 1950s (Islam, 2006).

Gender Related Studies: Gender is an important aspect that is mentioned in agricultural studies but rarely assessed. In Bangladesh, women constitute around 46% of the farming population and hold the dual responsibilities of household production and farming (including significant contributions to fishing and livestock and poultry rearing) (Oxfam International accessed, 2013). As of 2010, 57.4% of working women in Bangladesh work in the agricultural sector as opposed to 37.3% of working men (FAO, 2010), with the ratio of female to male earnings is 0.55 and the female to male ratio of wage equality for similar work is 0.57 as of 2011 (BBS, 2011). A 2009 World Food Programme (WFP) report stated that 39% of non-pregnant women and 40% of adolescent girls suffer from anemia due to malnutrition and low levels of iron and folic acid. This in part increases the number of undernourished infants that are born and the dependency of women on men. Even higher incomes and increases in food resources may fail to better women's nutrition, as found in a study on fishpond yields (Kumar and Quisumbing, 2010). Oakley and Momsen (2005) found that in two villages, crop choices were highly based on women's preferences for local varieties (LVs) and improved varieties (IVs). IVs were mostly grown to produce high crop yields while LVs were preferred for cooking. Similarly, gender and education of the household head was found to influence the number and abundance of IUCN Red Listed Species in home gardens (Kabir and Webb, 2009). Rahman *et al.* (2011) performed a study on the gender roles of women in agriculture. They found a notable gender divide in the households studied, with women being more involved in home-based and small-scale agricultural activities (production of vegetables, poultry, and livestock, production of perishable foods, and everyday cooking). Also, women have less access to agricultural knowledge. Traditional gender roles are enforced throughout Bangladesh, but they vary by region and size of farm household. Smaller and more marginalized farms hold less enforcement of gender roles than do medium and larger ones. Rahman *et al.* (2011) suggested that women be targeted in groups and that they be linked to the market chain and their own personal incomes. The introduction of technology can be highly beneficial because it can increase efficiency and production as well as women involvement in agriculture. At the same time, greater efficiency allows for more leisure time for women and more time for household chores, possibly devaluating them and their roles. Careful assessment of new agricultural technologies and their effect on gender roles and norms should be considered before introducing them to farms and households.

The Feed The Future Zone (FTF Zone) of Bangladesh (Fig. 1) comprises of the southwestern and central coastal areas, and has been deemed a target area for a global hunger and good security initiative by the U.S. (http://www.feedthefuture.gov Accessed, 2013). In this area, only 36% of women show parity with men in household empowerment, with 'empowerment' being evaluated based on production, resources, income, leadership, and time and the term as a whole pointing to agricultural empowerment. More specifically, the Khulna region in the southwest holds 31% of women with parity to men household empowerment. In the southeastern coastal area, the Chittagong region also accounts for a low of 30% of women with parity. The statistics for areas of southern Bangladesh hold in contrast to other areas of the country such as Barisal (46%), Dhaka (41%), Rajshahi (45%), and Rangpur (42%), with the value for all of Bangladesh being around 39% of women with parity with men in household empowerment. Empowerment relationships with education, income, and household hunger levels exist. Households with higher hunger levels in the FTF Zone were found to correlate with lower levels of empowerment for both men and women (Sraboni *et al.*, 2013).

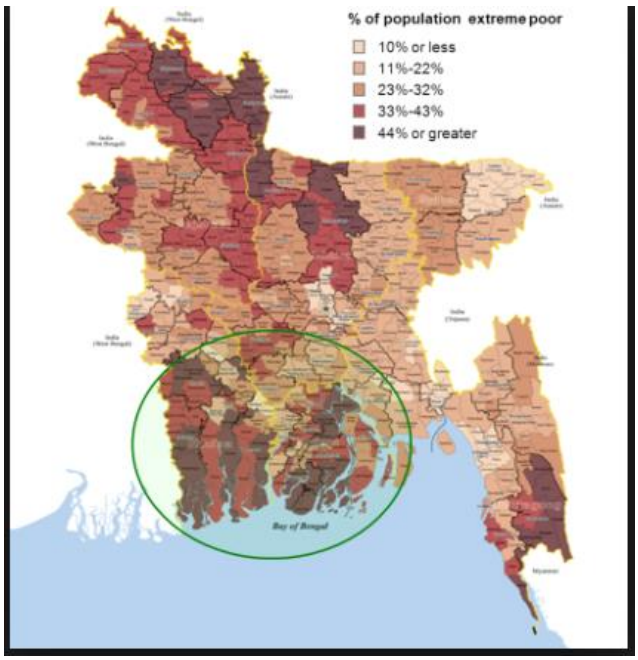

Fig. 1. Map highlighting the Feed The Future Zone (FTF Zone) of Southern Bangladesh. Retrieved from http://www.feedthefuture.gov

Policy Studies: On of the most difficult challenges that farmers, researchers, and organizations are facing is the management of the highly popular shrimp cultivation practice that has been adopted throughout Bangladesh. Variations of shrimp cultivation include shrimp-rice cultivation and shrimp-rice-vegetable integrated cultivation, the latter perhaps being the most sustainable (Talukder, 2012). Though, drawbacks are not lacking.

Crop lands and the mangrove forests of the Sundarbans ecosystems have been converted to shrimp farming systems, heavily impacting biodiversity and discouraging the cultivation of traditional crops and endangered agricultural genetic resources. This has urged organizations and concerned locals (who faced social issues in the 1990s when crop lands were being converted) to call upon policy makers to assess and help create management policies that encourage diverse land use that is not at the expense of traditional cultivating techniques or the environment (Islam, 2006). Further assessment of the economic benefits of various shrimp farming methods versus those of more traditional ones would also be of benefit so as to implement appropriate policy measures.

Adequate scientific research is vital for policy and management implementation. Even existing data is of little value if not analyzed or presented properly to policy makers. Schreckenberg *et al.* (2006) argued that existing data, such as the one on indigenous fruit, is hardly linked to simple policy recommendations, with preference placed on discussing the issues behind exotic fruits and introduced species. Overlooking indigenous species, and traditional practices in that case, forces policy makers to have a narrow view of the economics and environmental issues related to agro-biodiversity. Generally, policy studies are lacking on the use of agro-biodiversity in Bangladesh. Because of the poverty levels through the country, policy and other efforts appear to have a focus on development for poverty alleviation. A major gap exists between sustainable development and development solely for economic benefits. Social issues such as gender roles should be included on any agricultural policy census so as to properly take into account the unpaid family labor that women provide (OIYP, 2013).

Five prominent policies pertaining to coastal/southern Bangladesh exist: the Coastal Zone Policy, the Coastal Development Strategy, The National Water Management Policy and Plan, the Poverty Reduction Strategy Paper, and the Bangladesh Climate Change Strategy and Action Plan (de Wilde, 2011). The Coastal Zone Policy was approved in 2005 (CZPo, 2005) draws upon the goals of the Integrated Coastal Zone Management to improve sustainable livelihoods and reduce poverty in the coasts, while the Coastal Development Strategy was established in 2006 and focuses on environmental, economic, and social development in the coasts Development of surface and groundwater resources in targeted by The National Water Management Plan. Both the Poverty Reduction Strategy Paper (for the 2009-2011 time period) and the Bangladesh Climate Change Strategy and Action Plan aim at conducting research on climate change as well as policy implementations and strategies to counterattack adverse climate variability effects (MoWR, 2006; Van Schendel, 2009; de Wilde, 2011).

Key Organizations/Institutes Doing in ABD R&D: Numerous organizations and institutes are currently involved in agro-biodiversity research and development (ABD R&D). Amongst these organizations are IUCN (International Union for Conservation of Nature), WorldFish, FAO (Food and Agriculture Organization), UNDP (United Nations Development Program), IDE (International Development Enterprises-Bangladesh), CARE (Cooperative for Assistance and Relief Everywhere), BARC (Bangladesh Agricultural Research Council), BADC (Bangladesh Agricultural Development Corporation), and BARI (Bangladesh Agricultural Research Institute). Organizations focusing particularly on plants and crops include DAE (Department of Agricultural Extension), BARI (Bangladesh Agricultural Research Institute), BRRI (Bangladesh Rice Research Institute), BADC (Bangladesh Agricultural Development Corporation), various universities, and the National Herbarium. BLRI (Bangladesh Livestock Research Institute), DLS (Department of Livestock), and IUCN specialize in livestock conservation and management while those that specialize in fish and aquaculture include BFRI (Bangladesh Fisheries Research Institute), DoF (Department of Fisheries), and BARC (Bangladesh Agricultural Research Council). The addresses and contact information of some of these institutions and organizations can be found in Appendix-I (Rahim and Alam, 2013a).

Most of the organizations mentioned above have several common goals that include: research and conservation of agro-biodiversity, management and design of agricultural systems, research on socio-economic issues, reduction of poverty, and establishment of overall food security. Organizations like BARI (Bangladesh Agricultural Research Institute) stretch beyond crop variety development and into non-commodity areas like disease and insect management, irrigation and water management, and others previously mentioned (http://www.bari.gov.bd Accessed, 2013). The Social Programme for Food Security (SPFS) "advocates social mobilization for food security mechanisms". Many of these groups seek to establish an integrative method of cooperation that brings together scientists, policy makers, and governmental officials at an international level. Bala and Hossain (2009) proposed an integrated coastal zone management system that incorporates population, crop production, forestry, aquaculture, food security, and the environment (Fig. 2).

Status of On-farm and In-Situ Diversity: The conservation of agro-biodiversity and biodiversity as a whole is essential not only for food security but also for other ecosystem services such as nutrient cycling, breaking down and absorption of pollutants, protection of soil from erosion, and buffering from natural disasters and extreme weather (UNESCO, 1994). Bangladesh is home to nearly 10,000 species of animals, plants, and microbial organisms that have "potential for biodiversity-based sustainable development" (Anonymous, 2011). According to the Convention on Biological Diversity (1992), biodiversity is defined as: "the variability among living organisms from all sources including interalia, terrestrial, marine and other aquatic ecosystems, and the ecological complexes of which they are part; it includes diversity within and between species, and of ecosystems". Major threats to biodiversity include habitat fragmentation, industrial waste disposal, indiscriminate use of agro-chemicals, overexploitation of flora and fauna, change in land use patterns, and land use conflict (IUCN 2000). Table 1 provides a list of the number of species of flora

and fauna found in Bangladesh. Fig. 3 shows the sub sectoral contributions to the agricultural GDP.

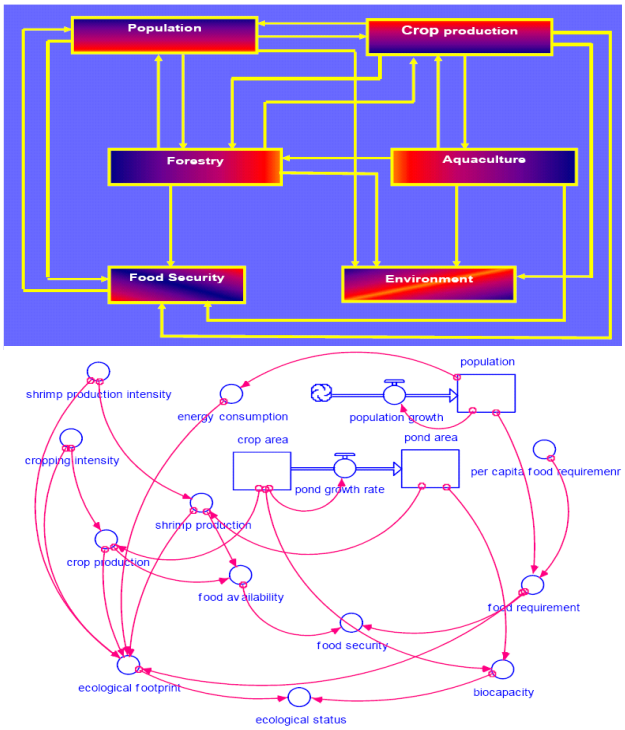

Fig. 2. Interrelationships and simplified flow diagram of integrated coastal zone management system (Courtesy: Bala and Hossain, 2009).

Table 1. Flora and Fauna Recorded in Bangladesh

Category	Number of Species
Flora	
Angiosperms	5000
Gymnosperms	5
Algae/seaweed	168
Fauna	
Sponges	3
Corals	66
(Marine + freshwater) Molluscus	(336+26) 362
Insects	2493
Mites	19
Shrimp/prawns	56
(Marine + freshwater) Crabs	(11+4) 15
Lobsters	3
Echinoderms	4
(Marine + freshwater) Fish	(442+266) 708
Amphibians	22
(Marine + inland) Reptiles	(17+109) 126
Birds	628
(Marine + inland) Mammals	(3+110) 113

Source: (Khan, 1991; Ahmed and Ali, 1996; Alam, 1967; IUCN, 2000)

Crops/Plants: Total forestlands in the country including plantations, gardens, and homesteads cover about 17.87% of the land (2,600,000 ha), with forests contributing 8.49% to the agricultural GDP and crops contributing 56% (Ahmed and Ali, 1996; Anonymous, 2011). About 45% of the people in Bangladesh work in the agricultural sector, with agriculture contributing about 17% of the GDP. Rice is harvested as the main crop (CIA World Factbook 2013). Around 300 of 5,000 species of angiosperms are cultivated, along with 224 species of timber yielding plants and 130 species of indigenous fiber plants (Khan and Mia, 1984; Mia and Haque, 1986). According to the Red Data Book on plants 96 seed-bearing plant species are listed as threatened (IUCN, 2000). Uses of plant species include food, timber, fuel, medicinal, and ornamental purposes, with native species more commonly used for all purposes except for food, commerce, and fiber (Kabir and Webb, 2008a). In the time frame 1961-2010, coastal forestry development efforts have accounted for net plantation establishments of 61-90% in various coastal areas (de Wilde, 2011).

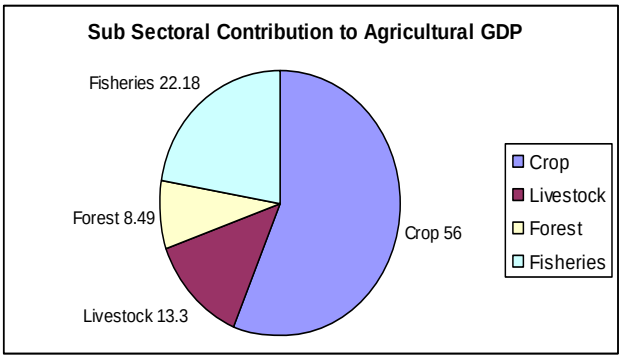

Fig. 3. Sub-sectoral contribution to agricultural GDP

One study by Alam and Masum (2005) on an island off the coast found that farmers prefer to plant fruit species followed by timber. Farmers also preferred to plant native over exotic species because of the better growth-performance of the native species. Recently, the abundance of more than 40 species of vegetation in the Satkhira district (western coastal region) has been in decline because locals are cultivating only a few select species for economic purposes (Anonymous, 2012b). Current agricultural data is limited to assessing the impact of a few select exotic fruits (i.e. mango, avocado, citrus) on the livelihoods of farmers, with data lacking on the contribution of domesticated indigenous fruits and their impact on farmers' incomes (Schreckenberg *et al.*, 2006). The main crops farmed in the coastal regions are *aman* rice varieties, which provide the bulk of the agricultural yields throughout southern Bangladesh. Double cropping is also practiced, providing harvests of *aman* varieties and various *rabi* varieties such as green chilies, sweet potatoes, tomatoes, cucumbers, watermelon, maize, soybean, sesame and sweet gourd (de Wilde, 2011). Cropping pattern of three southern districts namely Khulna, Satkhira and Barisal is given in Tables 2a-2c. A number of crop species being lost in these areas (Tables 3a-3b and Figs. 4-5). The major causes of species losses are increasing soil salinity, natural disaster (Figs. 6-7), shrimp monoculture, indiscriminate use of agrochemicals, industrial waste disposal, oil spills etc.

The Sundarbans, a block of tidal halophytic mangrove forest, has a higher percent of silt and calcium than that of sand, making it favorable for the growth of tidal plant species (Muhibulla *et al.*, 2007). Though, the saline conditions of the Sundarbans in the southwestern coast of Bangladesh make the area less diverse in forest flora than the eastern part of the country (Anonymous, 1997). In the

last five decades, a number of projects have supported the growth of 177,000 km^2 of mangrove deforestation in the coastal zones. Mangroves have served as buffers to cyclones and tidal surges. The Forest Department has been the leading organizer in the initial planting of various mangrove species along the coast (de Wilde, 2011).

Animals/Livestock: Livestock contributes about 13.3% to the agricultural GDP (Anonymous, 2011). Poultry and ruminants provide eggs, meat, and milk. According to the Department of Livestock Services (http://www.dls.gov.bd/index.php accessed 2013), livestock sources provide about 44% of the animal protein and a 4.31% of the total export from leather and leather goods. In one island, poultry constituted the main livestock per household (64%), followed by cattle (10%), buffalo (8%), and sheep (6%) (Alam and Masum, 2005). Although the role of livestock is secondary to that of agriculture, it is still crucial because livestock are used for cropping, transport, and their manure is used for fuel and fertilizer. Backyard farming is often financed by households and is less intensive than larger enterprises, with farmers having a very difficult time extending their livestock enterprises due to lack of access to capital markets (Siddiqui, 2004). The Sundurbans sanctuaries home 40 species of mammals including the Royal Bengal Tiger, which is a flagship species. Two hundred sixty species of birds and thirty five species of reptiles can also be found in these coastal ecosystems (Anonymous, 1997).

In the Greater Noakhali area (Feni, Lakshmipur, and Noakhali districts in the central coastal zone), about a third of the households own cattle and only 12% rear sheep. The average number of cattle is about 2.5 per household while that of goats is 2.1. Poultry rearing appears to be a more predominant practice, with 81% of households in the central coastal region rearing chickens and 63% rearing ducks. The use of artificial insemination has been established by the Department of Livestock services to improve cow breeds, but a cost includes traveling an average of 1.9 km to access the artificial insemination services. Income in the southern areas stems from the production and sale of cow and buffalo milk, cattle, poultry, and other livestock, account for about Tk.15,000-25,000 per household per year (de Wilde, 2011). Current issues in livestock production include inadequate feed and widespread disease epidemics like Foot and Mouth Disease, *Haemmorraghic septicaemia*, Anthrax, and Black Quarter (FAO, 2005).

Table 2a. Cropping pattern of Khulna practiced in 2011-2012

Sl. No.	Cropping pattern			Area (ha)	Percentage (%)
	Rabi	Kharif-I	Kharif-II		
01.	Fallow	Fallow	T. Aman	25640	22.58
02.	Fallow	Shrimp	Shrimp	12850	11.31
03.	Fallow	Shrimp	T. Aman	7000	6.16
04.	Boro	Fallow/*Sesbania*	T. Aman	24270	21.37
05.	Fallow	Sesame	T. Aman	10910	9.60
06.	Fallow	Sesame + Mung bean	T. Aman	1050	1.00
07.	Fallow	Mixed Aus	T. Aman	4000	3.52
08.	Boro	Fallow	T. Aman + Fish	4130	3.63
09.	Boro	Fallow	T. Aman	4835	4.22
10.	Fallow	Aus/Jute	T. Aman	4355	3.83
11.	Boro	Aus/Jute	Fallow	3940	3.46
12.	Wheat/Potato/Oilseed, Pulses and spices	Fallow	T. Aman	1535	1.35
13.	Vegetables	Vegetables	T. Aman	2200	2.00
14.	Vegetables	Vegetables	Vegetables	3000	2.63
15.	Fallow	Mung bean + Chilli	T. Aman	380	0.33
16.	Water melon	Aus	T. Aman	700	0.61
17.	Water melon	Fallow	T. Aman	1936	1.70
18.	Betel vine	Betel vine	Betel vine	555	0.48
19.	Sugarcane/ginger/turmeric	-	-	261	0.22
Cropping intensity: 198%		Total net cropped area		113547	100

Table 2b. Cropping pattern of Satkhira practiced in 2011-2012

Sl. No.	Cropping Pattern			Area (ha)	Percentage (%)
	Rabi	Kharif-I	Kharif-II		
01.	Boro	Fallow	T. Aman	101858	54
02.	Fallow	Fallow	T. Aman	39611	21
03.	Boro	T. Aus	T. Aman	11318	06
04.	Mustard, Boro	Fallow	T. Aman	9431	05
05.	Vegetables	Vegetables	Vegetables	9431	05
06.	Pulse	Jute	T. Aman	3773	02
07.	Potato	Jute	T. Aman	1886	01
08.	Others	Others	Others	11318	06
Cropping intensity: 191%		Total net cropped area		188626	100

Table 2c. Cropping pattern of Barisal practiced in 2011-2012

Sl. No.	Cropping Pattern			Area (ha)	Percentage (%)
	Rabi	Kharif-I	Kharif-II		
01.	Boro	Fallow	T. Aman	44240	25
02.	Fallow	Fallow	T. Aman	20963	12
03.	Boro	Fallow	Fallow	19360	11
04.	Fallow	Aus	T. Aman	14500	8.30
05.	Khesari	Aus	T. Aman	11500	6.50
06.	Khesari	Fallow	T. Aman	2762	1.60
07.	Pulse	Aus	T. Aman	7000	04
08.	Fallow	Fallow	B. Aman	4530	2.50
09.	Vegetable	Vegetable	Vegetable	5000	03
10.	Oilseed	Aus	T. Aman	3000	1.85
11.	Spices	Aus	T. Aman	2000	01
12.	Fallow	Jute	Fallow	4000	02
13.	Banana	Banana	Banana	4000	02
14.	Chilli	Fallow	T. Aman	4700	03
15.	Betel vine	Betel vine	Betel vine	2200	01
16.	Wheat	Fellow	T. Aman	1200	0.70
17.	Fallow	Jute	T. Aman	8000	05
18.	Vegetable	Vegetable	T. Aman	3000	1.85
19.	Oilseed	Fallow	T. Aman	3500	02
20.	Pulse	Fallow	T. Aman	4000	02
21.	Papaya	Papaya	Papaya	2500	1.55
22.	Sugarcane	Sugarcane	Sugarcane	1000	0.55
23.	Others	-	-	2734	1.60
Cropping intensity: 198%		Total net cropped area		175689	100

Table 3a. Plant species lost from Southern Parts of Bangladesh (Critically Endangered)

Sl.	Common name	Bengali name	Scientific name	Family	Planting material	Tree category	Utilization
1.	Uri Am	জংলি আম	Mangifera sylvatica Roxb.	Anacardiaceae	Seed/cutting	Evergreen tree	Fuel & Timber
2.	Kusum	কুসুম, জয়না	Schleichera oleosa (Lour.) Oken	Sapindaceae	Seed/cutting	Evergreen tree	Timber
3.	Sharpogondha	সর্পগন্ধা	Rauwolfia serpentina (L.) Bth. ex Kurz	Apocynaceae	Seed/cutting	Evergreen tree	Medicinal
4.	Morang Elachi	মুরং এলাচি	Amomum aromaticum Roxb.	Zingiberaceae	Seed/cutting	Evergreen tree	Food
5.	Kalomegh	কালোমেঘ	Andrographis paniculata Nees	Acanthaceae	Seed/cutting	Evergreen tree	Medicinal

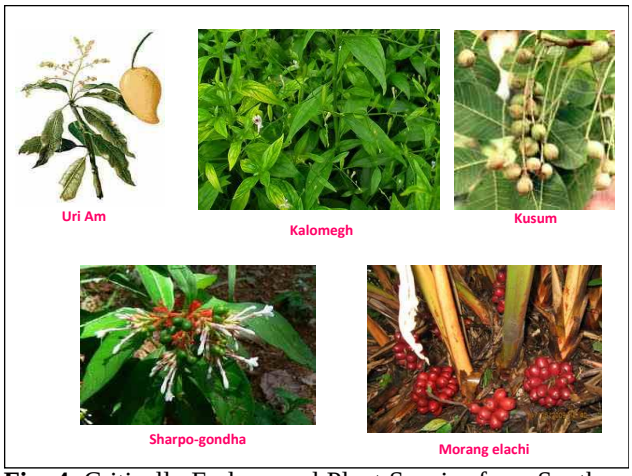

Fig. 4. Critically Endangered Plant Species from Southern Parts of Bangladesh

Aquatic Species/Fish: Bangladesh was ranked as the sixth largest aquaculture producing country in 2005. The per capita fish consumption is about 14 kg/year, with around 12 million people working in the fisheries sector. The most profitable aquaculture production systems include carp polyculture, tilapia monoculture, and integrated rice-fish culture. The main species harvested in the coastal regions are tiger prawn, brown shrimp, white shrimp, mud crab, giant sea perch, and yellow tail mullet. The freshwaters of the country are home to 260 fish species, with carps and catfish being some of the most commercially important species. Aquaculture accounts for about 43.5% of the total fish production and fisheries contribute about 22.18% to the agricultural GDP (FAO, 2005; Anonymous, 2011).

The Sundurbans mangrove ecosystems are home to five species of marine turtles and two endangered reptiles: the estuarine crocodile and the Indian python (Anonymous, 1997). The marine water bodies stretch about 200 nautical miles along the coast and are home to 442 species of fish, 36 species of marine shrimp, and 336 species of mollusks. The inland water bodies contain 266 species of indigenous fish, 13 species of exotic fish, 56 species of prawns, 26 species of freshwater mollusks, and 150 species of birds (Sarker and Sarker, 1988). A number of fish species being lost in these areas (Tables 4a-4c and Fig. 8).

Three types of coastal fisheries exist: offshore fisheries, inshore harvesting of shrimp and prawn, and inshore crab harvesting. The marine catches saw an increase of around 65% from 1995/1996-2002/2003 (Islam and Ahmad, 2004). The fish and prawn species caught vary by season throughout the year. Because most fishermen don't own their own boats for nets, investments have to be made for fishing amenities. Harvesting and catching of post-larvae shrimp and prawn has grown due to economic need, with involvement of women and children. *Bagda* and *Golda* are the two most common types of post-larvae species (de Wilde, 2011). The peak catching season for *Bagda* is from

December-January and that of *Golda* is from mid-March-June. In the coastal areas, shrimp farming is predominant in the districts of Cox's Bazar, Khulna, Bagerhat, and Satkhira (Islam and Ahmad, 2004).

Table 3b. Endangered plant species

Sl. no.	Common name	Bengali name	Scientific name	Family	Planting material	Tree category	Utilization
1.	Chhatian	ছাতিয়ান	Alstonia scholaris (L.) R. Br.	Apocynaceae	Seed/cutting	Evergreen	4
2.	Amoor	অমর	Amoora cucullata Roxb.	Meliaceae	Seed/cutting	Evergreen	6
3.	Pitraj	পিতরাজ	Aphanamixis polystachya (Wall.) R.N.Parker	Meliaceae	Seed/cutting	Evergreen	4, 6
4.	Dewa	ডেউয়া	Artocarpus lakoocha Roxb.	Moraceae	Seed/cutting	Evergreen	1, 2, 4, 6
5.	Hijal	হিজল	Barringtonia acutangula (L.) Gaertn.	Lecythidaceae	Seed/cutting	Evergreen	4,5
6.	Simul	শিমুল	Bombax ceiba L.	Bombacaceae	Seed/cutting	Evergreen	2,8
7.	Sagu	সাগু	Caryota urens L.	Palmae (Arecaceae)	Seed/cutting	Evergreen	5
8.	Shonalu	শুনালু	Cassia fistula L.	Leguminosae, Caesalpinioideae	Seed/cutting	Evergreen	4
9.	Jafran	জাফরান	Crocus sativus L.	Iridaceae	Seed/cutting	Evergreen	2
10.	Chalta	চালতা	Dillenia indica L.	Dilleniaceae	Seed/cutting	Evergreen	1, 2, 4
11.	Kao	কাউ	Garcinia cowa Roxb.	Guttiferae (Clusiaceae)	Seed/cutting	Evergreen	1, 2
12.	Jarul	জারুল	Lagerstroemia speciosa (L.) Pers.	Lythraceae	Seed/cutting	Evergreen	8
13.	Nageshwar	নাগেশ্বর	Mesua nagassarium (Burm.f) Kost.	Guttiferae (Clusiaceae)	Seed/cutting	Evergreen	1, 4
14.	Potka	পটকা	Microcos paniculata L.	Tiliaceae	Seed/cutting	Evergreen	4
15.	Ashok	অশুক	Saraca asoca (Roxb.) De Wilde	Leguminosae, Caesalpinioideae	Seed/cutting	Evergreen	6
16.	Kalo Jam	কালো জাম	Syzygium cumini (L.) Skeels	Myrtaceae	Seed/cutting	Evergreen	2, 4,6, 7
17.	Puti Jam	পুটি জাম	Syygium fruticosum DC.	Myrtaceae	Seed/cutting	Evergreen	1,4
18.	Golap Jam	গোলাম জাম	Syrygium jambos (L.) Alston	Myrtaceae	Seed/cutting	Evergreen	1,4
19.	Khudi Jam	ক্ষুদি জাম	Sy:ygium sy:ygioides (Miq.) Merr. & L.M. Perry.	Myrtaceae	Seed/cutting	Evergreen	1,6
20.	Bohera	বহেরা	Terminalia bellirica (Gaertn.) Roxb.	Combretaceae	Seed/cutting	Evergreen	3,4
21.	Horitoki	হরিতকি	Terminalia chebula Retz.	Combretaceae	Seed/cutting	Evergreen	1,3,6
22.	Hargaja	হরগাজা, আজুলি	Acanthus ilicifolius L. **	Acanthaceae	Seed/cutting	Evergreen	3,5
23.	Pati Lebu	পাতি লেবু	Citrus aurantifolia (Christen.) Swingle	Rutaceae	Seed/cutting	Evergreen	1
24.	Tok Lebu	টক লেবু	Citrus aurantium L.	Rutaceae	Seed/cutting	Evergreen	1,2
25.	Daton Gach	দাতুন গাছ	Glycosmis pentaphylla (Retz.) DC.	Rutaceae	Seed/cutting	Evergreen	4
26.	Bashok	বসাক	Justicia adhatoda L. Nees * *	Acanthaceae	Seed/cutting	Evergreen	3
27.	Kika	কাইকা	Adina cordifolia	Rubiaceae	Seed/cutting	Evergreen	5
28.	Bailam	বৈলাম	Anisoptera scaphula	Dipterocarpaceae	Seed/cutting	Evergreen	5
29.	Agor	আগর	Aquilaria agallocha	Thymelaeaceae	Seed/cutting	Evergreen	5
30.	Chapalish	চাপালিশ, চাম্বল	Artocarpus chama (Syn. A. chaplasha)	Moraceae	Seed/cutting	Evergreen	5
31.	Mahua	মহুয়া	Madhuca indica	Sapotaceae	Seed/cutting	Evergreen	5
32.	Cevit	আম চুন্ডল, সিভিট	Swintonia floribunda	Anacardiaceae	Seed/cutting	Evergreen	5
33.	Jamun	ঢাকি-জাম	Syzygium grandis	Myrtaceae	Seed/cutting	Evergreen	5
34.	Budha narikel	বুদ্ধ নারিকেল	Pterygota alata (Syn. Sterculia alata)	Sterculiaceae	Seed/cutting	Evergreen	5
35.	Punnal	পনিয়াল, পূননাল	Calophyllum inophyllum	Calophyllaceae	Seed/cutting	Evergreen	5

Note: Plant species list from southwestern Bangladesh homegardens. F is the frequency of homegardens from where species was recorded. A is the abundance of each species. RIV is the relative importance value computed by summing up the relative values of frequency and abundance of the respective species. RF is the relative frequency. For uses, 1 = food, 2 = commercial, 3 = medicinal, 4 = fuel wood, 5 = ornamental, 6 = timber, 7 = fodder, 8 = fiber, and 9 = religious/ceremonial. * indicates IUCN red listed species for Bangladesh. ** indicates the species planted as hedgerow. RIV for the species of trees and shrubs that have planted as hedgerow and for the species of herbs and woody and non-woody climbers was not computed as the abundance for those species was not measured. Thus, the importance value for the species of herbs and woody and non-woody climbers was calculated based on the relative frequency of the respective species. Individuals of red listed species of herbs and woody and non-woody climbers were counted. Only one individual for *Amomum aromaticum* and *Mangifera sylvatica* each, 79 individuals of *Andrographis paniculata,* 49 individuals of *Calamus guruba,* and four individuals of *Rauwolfia serpentina* and *Schleichera oleosa* each were recorded.

Fig. 5. Endangered plant species from Southern Parts of Bangladesh

Fig. 6. Aila damaged habitat & local people household security in Bangladesh

Fig. 7. Sidr damaged poor people security, biodiversity and destroyed mass people life in Bangladesh

Table 4a. Fish species lost from Southern Parts of Bangladesh (Endangered species)

Sl. No.	Local Name	Bangla Name	Scientific Name
1.	Chitra	চিত্রা	*Scatophagus argus*
2.	Krati hagor	করাতি হাঙ্গর	*Pristis microden*
3.	Gang Magur	গাং মাগুর	*Plotus canius*
4.	Sea horse	সমুদ্র ঘোড়া	*Hippocampus kuda*
5.	Thunus	থুনাস	*Thunus obesus*
6.	Kala Hagor	কালা হাঙ্গর	*Carcharhinus limbatus*

Table 4b. Fish species lost from Southern Parts of Bangladesh (Vulnerable species)

Sl. No.	Local Name	Bangla Name	Scientific Name
1.	Gang Magur	গাং মাগুর	*Plotus canius*
2.	Sea horse	সমুদ্র ঘোড়া	*Hippocampus kuda*
3.	Thunus	থুনাস	*Thunus obesus*
4.	Kala Hagor	কালা হাঙ্গর	*Carcharhinus limbatus*

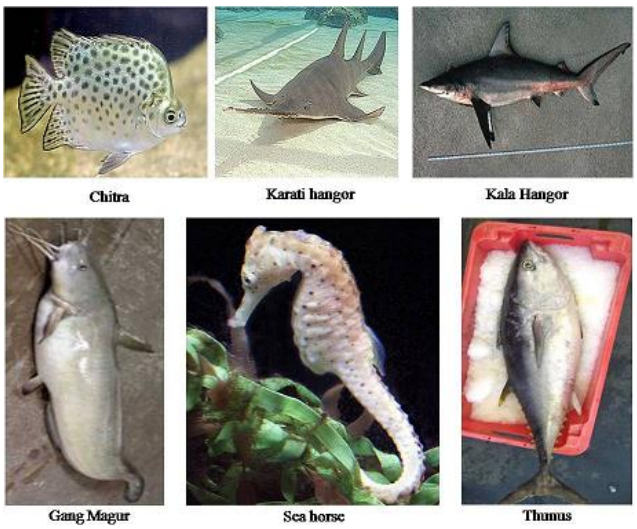

Fig. 8. Fish species lost from Southern Bangladesh (endangered species)

Table 4c. Status and distribution of threatened inland fishes of Bangladesh (Total number of threatened species: 54, Class: Osteichthyes)

Sl. No.	Order	Family	Scientific Name	English Name	Local Name	Local Status	Global Status	Distribution
1.	Osteoglossi-formes [Clupeiformes]	Notopteridae	Notopterus chitala (Hamilton-Buchanan, l822)	Humped Featherback/Clown Knife Fish	Chital	EN	..	W
2.			Notopterus notopterus (Pallas, 1769)	Bronze Feather back	Foli/Pholoi	VU	..	W
3.	Anguilliformes	Anguillidae	Anguilla bengalensis (Gray, 1831)	Grey Featherback	Bamosh/ Banehara/ Bao Baim/Telkoma	VU	..	Et, R
4.	Cypriniformes	Cyprinidae	Barilius bendelisis (Hamilton-Buchanan, 1822)	Indian Longfin Eel	Joia/HiralulKoksl Tila/Chedra	EN	..	R (N)
5.			Barilius vagra (Hamilton-Buchanan, l822)	Hamilton's Barila	Koksa/Khoksa	EN	..	R (Dinajpur)
6.			Bengala elanga (Hamilton-Buchanan, 1822) [Rasbora elanga (Hamilton-Buchanan, 1822)]	Vagra Bard	Along/Sephatia	EN	..	R
7.			Chela laubuca (Hamilton-Buchanan, 1822)	Bengal Barb	Laubuca/ Kash Khaira	EN	..	W
8.			Cirrhinus reba (Hamilton-Buchanan, l822) [Cirrhina reba Day, 1877]	Indian Glass-barb/ Indian Hatchet Fish/Winged Danio Reba Carp	Raiklfatkinil Bata/Laacho/ Bhagna	VU	..	W
9.			Crossocheilus latius (Hamilton-Buchanan, 1822)	Gangetic Latia	Kalabata	EN	..	Et, R
10.			Labeo Bata (Hamilton-Buchanan,1822)	Bata Labeo	Bhangon Bata/Bata	EN	..	R
11.			Labeo boga (Hamilton-Buchanan,1822)	Boga Labeo	Bhangan/Bhangan Bata	CR	..	R
12.			Labeo calbasu (Hamilton-Buchanan, 1822)	Black Rohu/Kalbasu	Kalibaus/Baus/Kalia	EN	..	W
13.			Labeo gonius (Hamilton-Buchanan,1822)	Kuria Labeo	Goni/Kurchi/Ghannya/ Ghonia/Ghainna	EN	..	W
14.			Labeo nandina (Hamilton-Buchanan, 1822)	Nandi Labeo	Nandina/Nandil/Nandi	CR	..	R, FP
15.			Labeo pangusia (Hamilton-Buchanan, 1822)	Pangusia Labeo	Ghora Muikhai/Ghora Maach/ Longu Rui	CR	..	R
16.			Osteobrama cotio (Ham ilton-Buchanan,1832)[Rohtee cotio (HamiltonBuchanan, 1822)]	Cotio	Dhela/Dhipali/ Keti/ Mauwa/Lohasura	EN	..	W
17.			Puntius sarana (Hamilton-Buchanan, 1822)	Olive Barb	Sarpunti/ Samapunti/ Saralpunti/Kurti	CR	..	W
18.			Puntius ticto (Hamilton-Buchanan, 1822)	Firefin Barb/ Two-spot Barb/Ticto Barb	Tit Punti	VU	..	W
19.			Raiamas bola (Hamilton-Buchanan,1822) Barilius bola (Hamilton-Buchanan,1822)	Indian Trout	Bhol/Bol	EN	..	R
20.			Rasbora rasbora (Hamilton-Buehanan,1822)	Gangetic Scissortail Rasbora	Darkina/Leuzza Darkina	EN	..	W
21.			Tor tor (Hamilton- Buchanan,1822)	Tor Mahseer	TorMahaseer/Mahashol/ Mohal/ Mashol Maach	CR	..	N, SE
22.	Cypriniformes	Cobitidae	Botia dario (Ham ilton- Buchanan, 1822)	Necktie Loah	Rani/Beti/Botya	EN	..	W
23.			Botia lohachata Chaudhuri, 1912	Y-loach	Rani/Putul/Beti	EN	..	R
24.	Siluriformes	Bagridae	Aoriehthys aor (HamiltonBuchanan, 1822) [Mystus aor (Hamilton-Buchanan, 1822)]	Long-whiskered Catfish	Ayer/Aor	VU	..	W
25.			Aorichthys seenghala (Sykes,1841) [Mvstus seenghala (Sykes, 1841)	Giant River-catfish/ Tengara/ Seenghari	Guizza/Guizza Ayer	EN	..	W
26.			Batasio tengana (Hamilton-Buchanan, 1822)	Assamese Batasio	Tengra	EN	..	R
27.			Mystus cavasius (Hamilton-Buchanan,1822)	Gangetic Mystus	Kbashi-tengra/Golsha/ Golsha- tengra	VU	..	W
28.			Rita rita (Hamilton- Buchanan, 1822)	Rita	Rita	CR	..	Et, R
29.		Siluridae	Ompok bimaculatus (Bloch, 1797)	Indian Butter Catfish	Kani Pabda/Boali Pabda/Pabda	EN	..	W
30.			Ompok pabda (Hamilton-Buchanan,1822)	Pabdah Catfish	Modhu Pabda/Pabda	EN	..	W
31.			Ompok pabo (Hamilton-Buchanan, 1822)	Pabo Catfish	Pabda	EN	..	R, B
32.		Schilbeidae	Ailia punctata (Day, 1871) (Ailiichthys punctata Day, 1871)	Jamuna Ailia	Kajuli/Baspata	VU	..	R
33.			Clupisoma garua (Hamilton-Buchanan,1822)	Garua Bacha/ Guarchcha	Ghaura	CR	..	W
34.			Eutropiichthys vacha (Hamilton-Buchanan, 1822)	Batchwa Bacha	Bacha	CR	..	W
35.			Silonia silondia (Hamilton-Buchanan, 1822)	Silondia Vacha	Shillong	EN	..	Et, R
36.		Pangasiidae [Schilbeidae]	Pangasius pangasius (Hamilton-Buchanan, 1822)	Pungas	Pungus	CR	..	Et, R
37.		Sisoridae	Bagarius yarrellii Sykes, 1841 [Previously referred as Bagarius bagarius (Hamilton-Buchanan,1822)]	Gangetic Goonch	Baghair	CR	..	W
38.			Sisor rhabdophorus Hamilton-Buchanan, 1822	Sisor Catfish	Sisor/Chenua	CR	..	R (N)

Sl. No.	Order	Family	Scientific Name	English Name	Local Name	Local Status	Global Status	Distribution
39.		Chacidae	Chaca chaca Hamilton-Buchanan, 1822)	Indian Chaca	Cheka/Chaga	EN	..	W
40.		Plotosidae	Ptvtosus canius Hamilton-Buchanan, 1822	Canine Catfish-eel	Gang Magur/ Kan Magur	VU	..	Et, B
41.	Cyprinodon-tiformes [Beloniformes]	Hemiram phidae	Dermogenys pusillus van Hasselt, 1823	Wrestling Halfbeak	Ek Thota	EN	..	R (Karnaphuli)
42.	Syngnathi-fornies	Syngnathi-dae	Microphis deocata (Hamilton-Buchanan, 1822)	Deocata Pipefish	Kota Kumirer Khil/ Kumirer Khil	EN	..	R (N)
43.	Synbranchi-formes	Synbranc-hidae	Monopterus cuchia (Hamilton-Buchanan,1822)	Gangetic Mudeel/ Cuchia	Kuicha/Kuchia/ Kunche	VU	..	W
44.	Perciformes	Ambassidae [Centropom-idae]	Chanda nama Hamilton-Buchanan, 1822	Elongate Glass-Perchlet	Chanda/ Nama Chanda	VU	..	W
45.			Pseudambassis ranga (Hamilton-Buchanan,1822) [Chanda ranga HamiltonBuchanan,1822]	Indian Glassy Fish	Chanda/ Ranga-chanda/ Lal Chanda	VU	..	W
46.		Scatophagi-dae	Scatophagus argus (Linnaeus, 1766)	Spotted Scat	Bishtara	EN	..	Et
47.		Nandidae	Nandus nandus (Hamilton-Buchanan, 1822)	Mottled Nandus/ Mud Perch	Meni/Bheda/ Bhedary	VU	..	W
48.		Nandidae (Pristole-pidae)	Badis badis (Hamilton-Buchanan, 1822)	Badis/Dwarf Chameleonfish	Napit Koil/Koi Bandi	EN	..	W
49.		Belontiidae [Anaban-tidae]	Ctenops nobilis McCIelIand,1845	Indian Paradisefish	Neftani	EN	..	W
50.		Channidae	Channa barca (Hamilton-Buchanan, 1822)	Barca Snakehead	Pipla Shol/Tila Shol/ Tila	CR	..	B (Mymensingh, Sylhet))
51.			Channa marulius (Hamilton-Buchanan,1822)	Giant Snakehead	Gajar/Gajal	EN	..	B
52.			Channa orientalis Bloch & Schneider, 1801	Asiatic Snakehead	TeloTaki/Gachua/ Raga/Cheng	VU	..	
53.		Mastacembe-lidae	Macrognathus aral (Bloch and Schneider,1801) {Not Macrognathus aculeatus (Day, 1876)}	One-stripe Spinyeel	Tara Baim	VU	DD	W
54.			Masracembalus armatus (Lacepede, 1800)	Tire-track Spinyeel	Baim/Sal Baim/Bam	EN	..	W

N.B. Previous names are given in square brackets. Clarifications are given in braces. Status code: CR - Critically Endangered, EN - Endangered, VU – Vulnerable, Distribution code: W-Wide; N-North; NE-Northeast; SE-Southeast; B- Beels, Haors, Baors, Ponds, Ditches (closed water bodies of different sizes); R-Rivers, Streams, Canals, Et-Estuaries, Tidal Rivers, Creeks; FP-Floodplains

Agro-biodiversity Related Development Programs: Millions of years of selection of crops that can sustain humans have resulted in resistant crops that can withstand natural disasters (Choudhury, 1995). In Bangladesh, as in many parts of the world, there is a rich system of indigenous knowledge that has contributed to the production of innovative agricultural techniques and traditions. UTTARAN, a social development organization in Bangladesh that seeks to "empower poor communities and reduce poverty", plans to use traditional knowledge to establish income-generating activities in the coast and plan sustainability designs in the Stakhira district (Anonymous, 2010b; http://www.UTTARAN.net, Accessed 2013). The cultivation of plants around homesteads has been a longstanding tradition, improving livelihoods by providing a source of income and subsistence (Alam and Sarker, 2011). Home gardens allow for the cultivation of plants in a stratified vertical position, optimizing space use and production, and exhibiting around 419 plant species in southwestern Bangladesh (Kabir and Webb, 2008b; Talukder, 2012).

Other innovative methods of cultivation include Vasoman Chash (dhap cultivation), the zero tillage system, the Sorjan system (Kandi system), and rainwater harvest. "Vasoman Chash" or "Dhap Cultivation" (Fig. 9) translates to floating agriculture, and is used in flooded and submerged areas. The technique is similar to that of hydroponics, the growth of plants in water without soil. These floating beds are made using water hyacinth,

Fig. 9. Different stages of Dhap Cultivation in Southern Bangladesh (Photo courtesy: Hossain, 2010)

aquatic algae, straws, and other plants and plant residues. The waterbeds of each region vary in their size, shape, and structure (Sen., 2004; Anonymous, 2010b; Hossain, 2010). The zero tillage system (no till system) reduces the amount of erosion on soil, the amount of pesticide needed, as well as fuel and labor requirements (http://www.cropwatch.unl.edu Accessed 2013). The sorjan system (Fig. 10) is an integrated farming system that uses water-filled lowlands to plant rice and the higher areas to plant dry crops (http://www.ati.da.gov.ph Accessed 2013).

Fig. 10. Crop cultivation through sorjan method in Southern Bangladesh (Photo courtesy: Rahim and Alam, 2013b)

Many challenges like natural disaster (Aila, Sidr, Mohasen), salinity, poverty, climate change, political interventions are faced by organizations that have aimed to establish and implement projects that ensure environmental sustainability. Organizations such as WorldFish and the Bangladesh Forest Department are working to manage natural resource use and put a dent on current stressors. An approach that aims to conduct research through participatory action has proven to be worthwhile, generating higher crop yields, better income, and resilience to climate change (Anon. 2009). The introduction of microfinancing techniques is a development effort that also helps farmers better manage their crops, produce greater yields and gain a higher income (Siddiqui, 2004). Shrimp cultivation has been taken up in vast amounts in recent years (Talukder, 2012). More sustainable approaches include shrimp-rice cultivation and a shrimp-rice-vegetable integrated system. Polders provided by the World Bank in the 1960s-1980s were later utilized for shrimp farming (Islam, 2006).

Significant development efforts are being made in the central active delta area. Throughout the entire coastal zone, the public sector contributed an estimated $145 billion dollars for development efforts in the time frame 2007-2011. Major efforts stem from the Estuary Development Programme (EDP), Char Development and Settlement Project (CDSP), Regional Fisheries and Livestock Development Component (RFLDC), and the "Promotion of Adaptation to Climate Change and Climate Variability in Bangladesh" project. The EDP focuses on erosion control, dam design, and estuary control. CDSP works on development and management of island chars, notably those that were converted to polders (artificial low-lying tract of land enclosed by dikes). The RFLDC is based on the districts of Feni, Lakshmipur and Noakhali and aids in community development of aquaculture and animal husbandry. The project "Promotion of Adaptation to Climate Change and Climate Variability in Bangladesh" spanned from 2004-2008. It focused on development efforts for resilience and adaptation to climate change, including the establishment of disaster-resilient homes and sturdy wave-withstanding boats (de Wilde, 2011).

Opportunities for Conservation, Restoration, and Use of Agrobiodiversity: One of the toughest challenges in environmental studies is mediating the conversation between development and conservation. In Bangladesh, there exists countless opportunities for conservation and restoration of agro-biodiversity through community involvement. Public awareness and education would pave the way for the establishment of partnerships between local farmers, scientists, and policy makers. One major aspect that must always be kept in mind is the use of traditional farming techniques. The people of this country have developed innovative methods that if exploited at a larger scale would help improve the chances of food security. An evaluation of each traditional and introduced agricultural and fishing method should be assessed in order to decipher which methods are the most sustainable. After an assessment of each method, education programs and public awareness should be established so as to teach the local people as to why new and old methods should be either disregarded or established. A careful approach must be taken so that suggestions do not cross cultural and traditional boundaries that may negatively impact established norms. Through public awareness and communication, women involvement in conservation and use of agro-biodiversity is an indispensable asset. As stated above, women form part of the strong backbone of laborers both in the field and at home. Overall, education of sustainable practices, as well as of the use of exotic, native, and endangered species should be one of the first steps taken towards the conservation of agricultural genetic resources.

Scientific and political views tend to focus on exotic species and species that yield the most economic benefits. In Bangladesh, many native species of plants may be lost if a careful census is not conducted and their uses exemplified throughout communities. Though a deviation from harvesting current crops is not encouraged, research on the conservation of other agricultural resources should be a major focus. At the same time, scientific programs should continue to work on developing salt-resistant crops as well as species that provide resilience to ecosystems from natural disasters and anthropogenic pressure. De Wilde (2011) notes that there is great potential for aquaculture maintenance in southern Bangladesh, as well as a need for quantification of fishery resources. Livestock development is constrained by the difficulty of access to key resources, such as providing animal health care and feed to isolated areas. This highlights the need for the

government to provide policy change for livestock development. Most importantly, there exists the need for research and development of water availability, soil salinity levels, and new technology that would allow for the conservation and restoration of crop genetic resources.

Agrobiodiversity Related Research Focus: There is an expanse of research opportunities in the area of agro-biodiversity. The first issue to tackle deals with the key development challenges in Bangladesh, notably those near the coastal areas. Natural disasters, increased salinity levels, and multiple anthropogenic factors pose as a barrier to the conservation and restoration of agro-biodiversity and other ecological systems. A set of questions to address is the following: what are the likelihoods of extinctions of various *in situ* species and ecosystems given their current statuses and pressures? Are there *in-situ* species for new polders created out of saline areas and what are their conservation statuses? How resilient are local plant and animal populations to pressures such as climate change? Which species account for sustainable yields and improved food security? Surely, further research on the impact of specific genetic resources is needed.

Research and development of *in situ* and on-farm management approaches yields opportunities for various research focuses. How can productivity of agricultural and aquaculture genetic resources are enhanced and sustainably intensified? Which traditional practices and current technologies account for the most productive and sustainable yields, and which other methodologies and tools should be introduced to communities? What are the costs and benefits of current management practices? Which ecosystem services are threatened and can these services be quantified?

Key organizations and agrobiodiversity related development programs are currently addressing issues that seek to form an interdisciplinary approach to conservation that incorporates the natural and social sciences. Questions dealing with social and political issues include: what are the impacts that different members of local communities (based on gender, age, social status, etc.) have on the production and maintenance of agro-biodiversity? How can the works that women and men do be better understood and taken into account when looking at economic figures? How can NGOs, governments, and other institutions provide education programs and enhance public awareness on endangered species and sustainable practices? What sources of funding exist for such key organizations and how can the funds is distributed in a socially ethical manner? Generally, a major goal that these questions seek to arrive at is the identification of a more comprehensive and effective way of establishing food security.

Concluding Statement: The coastal zone of Southern Bangladesh covers an area of about 47,203 km2, 32% of the country's surfaces. Around 40 million people inhabit the coastal areas, with rapid population growth, coastal urbanization, and exploitation of natural resources being major anthropogenic stressors on the resources and productive environments of the coasts. Increased salinity levels and climate variability also pose significant development challenges. While government and non-government institutes and organizations are putting forth great efforts to tackle issues of sustainable development in the area, these challenges persist.

The conservation of agro-biodiversity for its further research and development is of vital importance for solving issues of food security in Bangladesh and improving peoples' livelihoods. The status of the on-farm and *in-situ* agrobiodiversity in Southern Bangladesh was reviewed, including the status of crops and plants, livestock and other animals, and fisheries and aquatic resources. Key development programs, notably traditional farming practices such as dhap cultivation and the sorjan system are discussed. Key organizations and institutes conducting agrobiodiversity research and development programs are presented, and gender related studies and policy studies are also explored.

An assessment of agrobiodiversity's and ecosystems' resilience to pressures as well as further research and assessment of endangered and key agricultural genetic resources is needed so as to make more informed and effective research in development (RinD) actions and policy decisions. The importance of community involvement, traditional/innovative farming and fishing practices, and gender related issues should not be overlooked in developing an integrated RinD action. Such integrated RinD approach that will aim to enhance sustainability, productivity, livelihoods, health, markets, and development is much needed with the rapidly growing population and increased environmental and economic pressures in Southern Bangladesh.

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Appendix-I

Address of Key Organizations/Institutes Doing in ABD R&D

WorldFish – Bangladesh Office: Contact : Dr. Craig A. Meisner, Mail: House 22B, Road 7, Block-F, Banani, Dhaka 1213, Bangladesh, Tel: (+880-2) 881 3250, (+880-2) 881 4624, Fax: (+880-2) 881 1151, E-mail: worldfish-bangladesh@cgiar.org, In collaboration with AAS, Worldfish Offices in Khulna

The **IUCN** Bangladesh Country Office has now moved to a new location. Our new address is House #16, Road #2/3, Banani, Dhaka 1213, Bangladesh

UNDP UN Offices 18th Floor, IDB Bhaban Agargaon Sher-e-Bangla Nagar **Dhaka** 1207 Bangladesh

FAO Representation in Bangladesh House No. 37. Road No. 8. Dhanmondi Residential Area, Dhaka, Bangladesh

Office of the Chief Conservator of Forests: Forest Department, Banabhaban, Agargaon, Dhaka-1207, Bangladesh, Phone: +88-02-8181737, Fax: +88-02-8181741

International Development Enterprises-Bangladesh: House #28 (3rd Floor), Road #130, Gulshan-1, Dhaka, Bangladesh, Phone- 880-2-9886515, 9886529 Web: www.ide-bangladesh.org

Government of the People's Republic of Bangladesh, 13, Shohid Captain Moonsur Ali Sharani, Department of Fisheries, Matshya Bhaban, Ramna, Dhaka-1000, Bangladesh

Bangladesh Agricultural Research Council (BARC): Krishi Khamar Sarak, Farmgate, Dhaka-1215, Bangladesh, Web : www.barc.gov.bd, Phone- 880-2-8114032, Fax- 880-2-8113032, E-mail- barc@bdmail.net

Department of Agricultural Extension (DAE): Khamarbari, Farmgate, Dhaka-1215, Bangladesh, Web : www.dae.gov.bd, Phone- 880-2-9140857, Fax- 880-2-9111502, E-mail- dgdae@dae.gov.bd

Department of Agricultural Marketing (DAM): Khamarbari, Farmgate, Dhaka-1215, Bangladesh, Web : www.dam.gov.bd, Phone- 880-2-9114310

Agriculture Information Service (AIS) : Khamarbari, Farmgate, Dhaka-1215, Bangladesh, Web : www.ais.gov.bd, Phone- 880-2-9112260, Fax- 880-2-9144644, E-mail- dirais@dekko.net.bd

Seed Certification Agency (SCA): Joydebpur, Gazipur, Bangladesh, Web : www.sca.gov.bd, Phone- 880-2-9252033, Fax- 880-2-9257134, E-mail- dir@sca.gov.bd

Cotton Development Board (CDB): Khamarbari, Farmgate, Dhaka-1215, Bangladesh, Web: www.cdb.gov.bd, Phone- 880-2-8117728, Fax- 880-2-8111417

Bangladesh Agricultural Development Corporation (BADC): Krishi Bhaban, Motijheel, Dhaka, Bangladesh, Web:www.badc.gov.bd, Phone- 9564328, Fax- 880-2-9564357

BARIND Multi Purpose Development Authority (BMDA): Rajshahi, Bangladesh, Web: www.bmda.gov.bd, Phone- 880-721-761368, Fax- 880-721-761897, E-mail- bmda@bttb.bd

Bangladesh Applied Nutrition and Human Resource Development Board (BANHRDB): Shech Bhaban, Manik Miah Avenue, Dhaka-1215, Bangladesh, Web: www.ban-hrdb.gov.bd, Phone- 880-2-9117862 , Fax- 880-2-8110798

Bangladesh Agricultural Research Institute (BARI): Joydebpur, Gazipur, Bangladesh, Web : www.bari.gov.bd, Phone- 880-2-9252715, Fax- 880-2-9262713, E-mail- dg.bari@bari.gov.bd

Bangladesh Rice Research Institute (BRRI): Joydebpur, Gazipur, Bangladesh, Web : www.brri.gov.bd, Phone- 880-2-9252736, Fax- 880-2-9261110

Soil Resources Development Institute (SRDI): Khamarbari, Farmgate, Dhaka-1215, Bangladesh, Web : www.srdi.gov.bd, Phone- 880-2-9113363, Fax- 880-2-9110844, E-mail- director@srdi.gov.bd

Bangladesh Jute Research Institute (BJRI): Manik Miah Avenue, Dhaka-1215, Bangladesh, Web : www.bjri.gov.bd, Phone- 880-2-9110868, Fax- 880-2-9118415, E-mail- info@bjri.gov.bd

Bangladesh Institute of Nuclear Agriculture (BINA): Mymensingh, Bangladesh, Web: www.bina.org.bd

Bangladesh Agricultural University Germplasm Centre (BAU-GPC): Fruit Tree Improvement Program (FTIP), Bangladesh Agricultural University, Mymensingh-2202, Bangladesh, E-mail: marahim1956@yahoo.com, Web: www.bau-gpc.org

Shushilon: An Organization for Development of Eco-sensitive and Vulnerable Community, Head Office: College Road, Kaligonj, Satkhira, Bangladesh, E-mail: headoffice@shushilan.org, Web: www.shushilan.org

DEAPTA: Development of Environment and Alleviation of Poverty Through Agriculture, College Road, Patkelghata-9421, Satkhira, Bangladesh, E-mail: deaptabd@gmail.com, Web: www.deaptabd.blogspot.com.