Chapter

Wild Fodder Yielding Plants in the Protected Areas of Bangladesh

Md Akhter Hossain, Rajib Mahmud, Nikhil Chakma and Mohammed Kamal Hossain

Abstract

Wildlife habitat is degrading worldwide due to myriads of biotic and abiotic reasons. The governments across the world countries are trying to halt the degradation through declaring protected areas (PAs) with potential wildlife habitats and strengthening conservation initiatives. These measures are expected to uphold the richness and diversity of the fodder yielding plants. But there is a dire necessity of information on composition and overall status of the fodder yielding plants for continuous monitoring of these habitats. Moreover, the potentiality of the protected areas can also be judged based on the composition and richness of fodder yielding plants. Having all these in mind, we assessed the composition and conservation status of the fodder yielding plants of all habit forms from three recognized protected areas named Chunati Wildlife Sanctuary, Dudhpukuria-Dhopachari Wildlife Sanctuary, and Madhupur National Park. The study indicated the presence of 306 fodder yielding plant species of all habit forms in the three studied protected areas. This chapter describes the composition, status, habit forms, and nature of occurrences of the wild fodder yielding plants which is expected to be highly helpful in wildlife habitat monitoring and undertaking specific measures for multiplication and conservation of fodder yielding plants.

Keywords: wildlife habitat, national park, forests, habitat monitoring, wildlife sanctuary

1. Introduction

Grasses, shrubs, and different palatable parts of trees, i.e., leaves, flowers, fruits, and seeds, that have nutritive values constitute fodder of wild herbivores [1]. The wildlife population greatly depends on the habitat richness with food, nesting, and breeding environment. The wild fruit and fodder-producing plants play a great role in maintaining ecosystem food supply. The plants are from different habit forms and taxonomic families. Plants from Poaceae, Cyperaceae, Fabaceae, Moraceae, Myrtaceae, and Zingiberaceae families particularly the leguminous plants dominate the fodder-producing plants [2]. There are significant seasonal variation of fodder availability and composition to which the wild animals’ nutrition needs are naturally adapted [3]. Insects, birds, chordates, and reptiles have different nesting and breeding natures which varies widely from each other. The habitat resources and overall conditions including food, water, shade, nesting, etc. are needed by a species for survival and reproductive success [4]. Moreover, habitat is organism-specific;
the appropriate combination of necessary abiotic and biotic components for successful reproduction and survival varies by species [5].

The global forests are drastically shrinking day by day due to a huge pressure on forests for conversion to other land use, human settlement, excessive resource extraction, etc. All these are affecting biodiversity negatively particularly the wildlife habitat which is degrading in an alarming way which leads to rapid shrinking of wildlife population and making them threatened. Declaring protected area (PA) is a worldwide strategy accepted for wildlife habitat conservation and ensuring undisturbed breeding ground by halting further fragmentation and degradation of habitat. This chapter presents the status of the protected areas from different corners of Bangladesh in terms of fodder yielding plant composition as well as the importance of fodder plant management for maintaining a healthy wildlife habitat. We identified three protected areas of characteristic features for studying the wild fodder yielding plants so that these represent all the PA of Bangladesh. This chapter also presents a brief account on the protected area management in Bangladesh as well as potentiality of those areas as wildlife habitats.

2. Rationale of the study

Quality of the wildlife habitat largely depends on the nature and composition of vegetation as it determines the nesting, breeding, and feeding potentiality of the habitats. The habitat degradation is causing loss of regeneration of many of the fodder plants. Moreover, overexploitation is also responsible for sharp reduction of the population size of the fodder plants [6]. It is important to detect the food habit of the herbivores and identify the fodder plants and their interactions with animals for sustainable management of the protected areas through wildlife conservation and undisturbed breeding ground [7]. But, in Bangladesh, there is a great dearth of information and research on the wild fodder-bearing trees. Information on the status and availability of plants will be helpful for better planning and management interventions of the PAs as wildlife habitats. The plants used as fodder by the animals are rich in necessary nutrition, i.e., protein, carbohydrate, fiber, etc. The ability of fodder plants to provide this range of nutrients is considered to evaluate potentiality of their nutritive values. Considering the mentioned situations, the study was undertaken to assess the overall composition of fodder plants as well as highlight their contributions for better maintaining a wildlife habitat. However, there is still a need for investigation of the nutritive values as many of the species were not explored yet [6]. We believe this study will fill up the knowledge gap on fodder yielding plant composition in the PA of Bangladesh as well as it will show the way for further research and interventions to habitat conservation and sustainable management.

3. Status of wildlife in Bangladesh

Bangladesh is the home of more than 3883 species of lower faunal groups along with 653 fish species, 49 amphibians, 154 reptiles, 706 birds, and 128 mammals. The fish communities including both freshwater and marine species are so diverse that they account an astonishing 3% of the world’s total fish species. In addition to the 383 resident birds, there are 323 migratory birds which visit our country especially during the winter. Both of these represent an amazing 7.2% of the world’s total bird species. Mammals constitute 2.28% of the world’s mammal species among which seven are marine in nature [8]. Though our wildlife diversity is very rich, but over
the last century unfortunately 13 species have become extinct from Bangladesh. Due to continuity of habitat degradation, many more are on the brink of extinction. Different reports indicated that 23% of vertebrates of Bangladesh are facing different levels of threats which are increasing exponentially with rapid habitat destruction. The situation is even more grim for the 57% of reptiles and 36% of mammals which are facing different levels of threats in our country [9]. Recently, the IUCN listed 40 species of mammals, 41 aves, 58 reptiles, and 8 amphibians that are struggling under various degrees of threat of extinction. It is obvious that the present wildlife population is confined and distributed irregularly in limited forest patches of Bangladesh (Table 1).

4. Wildlife habitats in Bangladesh

Among the 5 global ecological domains and 20 global ecological zones of the world, 33% of Bangladesh belongs to tropical rain forest GEZ and 67% to tropical moist deciduous forest GEZ of the tropical domains of global ecological domains [10]. The variation in climatic features, i.e., temperature, rainfall, soil, and hydrology, led to the development of 25 bioclimatic zones with distinct characteristics. Bangladesh has 1.45 million ha of forest land (9.8% of total area) of which 1.21 million ha (84% of forest) is natural forest and 0.24 million ha (16% of forest) is plantations [10].

Vegetation characteristics divided the natural forests of Bangladesh into evergreen/semievergreen, deciduous, and mangrove forest. Noncontinuous freshwater swamp is distributed in the northeast basin. Tropical evergreen and semievergreen forests constituting 44% of natural forest are extended over Chittagong, Chittagong Hill Tracts (CHT), Cox’s Bazar, and Sylhet covering an area of 6700 km² which is about 4.54% of total landmass of Bangladesh. Dominant native plant species include species of Dipterocarpus spp., Artocarpus spp., Ficus spp., Syzygium spp., Mangifera spp., Tectona grandis, etc. The moist deciduous Sal forest of Bangladesh is mainly consisted of Madhupur tract which is located in the central part covering an area of 340 km² [10]. Dominant trees of this forest are Shorea robusta, Lagerstroemia speciosa, Dillenia pentagyna, Adina cordifolia, Terminalia spp., Albizia spp., etc.

The Sundarbans, the largest single patch of mangrove forest, is located at the southern extremity of the Padma (Ganges) and Jamuna (Brahmaputra) delta which covers about 5770 km² area [11]. Fairly dense evergreen plant species of 10–15 m height is the main feature of this forest. These species are adapted for living under saline condition and regular inundation by the tides. Succulent leaves, stilt roots, pneumatophores, and viviparous germination are the key features of these plants. Heritiera fomes, Excoecaria agallocha, Nypa fruticans, Sonneratia apetala, Rhizophora spp., Ceriops decandra, Phoenix paludosa, and Acrostichum aureum are the common plants of the Sundarbans. Wetlands of Bangladesh also support a large number of

| Vertebrate groups | No. of species | References |
|-------------------|---------------|------------|
| Fish              | 653           | [9]        |
| Amphibians        | 64            | [8]        |
| Reptiles          | 174           | [8]        |
| Birds             | 711           | [8]        |
| Mammals           | 133           | [8]        |

Table 1. Number of recorded fauna of Bangladesh.
plants and wild animals of the country. Nearly 50% (8 million ha) of the total land surface of the country including river, natural lakes, tanks, reservoir, mangrove forests, estuarine, and seasonally inundated floodplains are considered as wetland.

5. Protected areas of Bangladesh

Bangladesh is situated in the northeastern part of the South Asia region, lying between 20°25’ and 26°38’ north latitude and 88°01’ and 92°40’ east longitude. The country is bordered by India to the north, northeast, and west, Myanmar to the southeast, and the Bay of Bengal covering the southern part with a coastline of 710 km. The climate of Bangladesh is tropical, with maximum summer temperature rising between 32 and 38°C. Annual rainfall ranges between 200 and 400 cm. Biogeographically the country lies at the junction of the Indian and Malayan subregions of the Indo-Malayan Realm and is located very near to the western side of Sino-Japanese region.

5.1 Protected area management strategies

Protected areas are “areas especially dedicated to the protection and maintenance of biological diversity and associated cultural resources, which are managed through legal or other effective means, designated or regulated and managed to achieve specific conservation objectives” [12, 13]. PAs have long been considered as the cornerstone of all national and regional conservation strategies. While it is often argued that they are the most effective and widespread measure for conserving forests and biodiversity [13, 14], the importance of complementary off-reserve management has also been acknowledged [15–17]. Globally, the number of PAs has increased significantly over the last few decades in recognition of their importance for conservation. At present, there are more than 100,000 protected area sites worldwide, covering nearly 12% of the world’s land surface [18–20]. Currently there are 34 forest PAs in Bangladesh which represent about 17.5% of the total forest land of the country and 1.8% of country’s total land [21].

Bangladesh Forest Department shifts its paradigm of conventional forest management to community-led management for ensuring effective governance of natural resources. A total of 34 reserved forests have been declared as protected area where 23 PAs are managed through active participation of community people which is known as co-management. Community people come forward along with the forest department regarding conservation through ensuring sustainable natural resource management.

5.2 Legal frameworks of the protected areas of Bangladesh

The forestry sector of Bangladesh plays an important role in combating poverty for the people living in and around the forest. The history of forest management in Bangladesh is quite old and was shaped and influenced by colonial forest policy. The Forest Policy, 1979, was the first of its kind and was very much influenced by the colonial policy of forest management [22]. Over time this policy proved ineffective due to various socioeconomic factors such as population growth, poverty, overexploitation of resources, and top-down, centralized management approaches. It was felt by experts, communities, and policy makers that a new dimension to the existing forest policy was needed. The Forest Policy, 1994, specifically recognized the importance of peoples’ participation in forest management [23]. Another notable achievement of the 1994 policy was that it has succeeded in bringing tree plantation activities outside the forest area [24].
Most importantly, significant developments in Bangladesh forest legal and policy frameworks took place after the formulation of the 1994 policy [25]. Community participation in the forestry sector of Bangladesh has a long history that can be traced back as early as 1871, to teak plantations of Chittagong Hill Tracts managed by the tribal farmers. However, participation of community people in the forestry sector officially began in the 1980s. Donor-assisted community forestry project was the first attempt of its kind in the northwestern districts of Bangladesh. It gradually spread to other parts of the country through various projects and forms such as the Thana Afforestation and Nursery Development Project (TANDP), the Coastal Greenbelt Project (CGP), and the Forestry Sector Project (FSP). Despite the initial success in achieving physical targets, i.e., increase of plantation coverage, these projects failed to develop a mechanism to attract and engage local communities. They lacked institutional, personal, and community capacity building, legitimacy on usufruct rights, active community participation, and devolution of the decision-making power under the continued influence of “command and control” strategies. The introduction of co-management in the forest PAs is an effort to overcome these limitations to incorporate active community participation as a core aspect of PA governance [23]. The government of Bangladesh started introducing and implementing co-management in five forest PAs under a pilot project titled Nishorgo Support Project (hereafter referred to as NSP) for a period of 5 years (2004–2009) [26]. Many countries have already developed enabling legal and policy frameworks to support community rights and access and have thereby offered better incentives in the governance of the PAs and the resources sustained by them.

5.3 Protected areas as a potential wildlife habitat

As an effective tool, the protected areas are recognized internationally for the conservation of biodiversity. Currently the PAs of Bangladesh represent most of the ecosystems and thus include all habitats and species that are vital for conservation. The Bangladesh Forest Department under the Ministry of Environment, Forest and Climate Change manages a network of 17 national parks, 20 wildlife sanctuaries, 2 special biodiversity conservation areas, 1 marine protected area, 2 vulture safe zones, 2 botanical gardens, 2 safari parks, 10 eco-parks, and 1 aviary park. The total area under this protected area status covers 618253.49 ha of forest land and represents 4.19% area of the country [27]. The primary purpose of these sites is to conserve and protect habitat for wildlife, including migratory birds, species at risk, and other species of national interest.

5.4 Fodder plants in the protected areas of Bangladesh

As a sample of protected areas of Bangladesh, we reviewed the floristic studies [28–30] conducted in three protected areas of Bangladesh with characteristic features. They are “Chunati Wildlife Sanctuary,” Dudhpukuria-Dhopachari Wildlife Sanctuary, and “Madhupur National Park.” We used the plant data collected during the field survey as secondary data for assessing the fodder yielding plants with due permission from the respective authors. The identified plants were then explored with their use and conservation status following the encyclopedia of flora and fauna of Bangladesh [31].

Chunati Wildlife Sanctuary, established in 1986, is familiar as the habitat and breeding ground of the Asian elephant (Elephas maximus). It is one of the oldest PAs of Bangladesh rich with 691 plants from all habit forms [28]. In addition to the Asian elephant, Chunati harbors 26 species of amphibians, 54 reptiles, 252 birds, and 40 mammals [32]. Tables 2 and 3 provide a detailed account of the flora and fauna of the
selected protected areas. Dudhpukuria-Dhopachari Wildlife Sanctuary is a comparatively new protected area that is declared in 2010. It covers an area of 4716 ha rich in both floral and faunal diversity. The wildlife sanctuary harbors 608 plant species and 385 wildlife [29]. However, the Asian elephant is also the flagship animal of this PA. Madhupur National Park, also one of the oldest protected areas, was declared in 1982. It is situated in the central region of Bangladesh covered with mainly deciduous Shorea robusta. It harbors 385 plant species from all habit forms and 192 wildlife including amphibians, birds, mammals, and reptiles (Tables 2 and 3).

We identified the wild fodder yielding flora of different habit forms following the encyclopedia of flora and fauna of Bangladesh [31]. The review indicated that each of the protected areas harbors a substantial number of fodder yielding plants from different habit forms (Table 2).

5.4.1 Trees

A total of 112 tree species belonging to 71 genera and 32 families were found to yield part of it (i.e., leaves, branch, fruit, seed, flower, etc.) as fodder. A comparison number of species in the selected PAs indicated that CWS has 87 species, whereas DDWS and MNP showed 69 and 67 species, respectively (Table 4).
| SN | Botanical name | Local name | Family | Conservation status | Density in PAs (stem/ha) |
|----|----------------|------------|--------|---------------------|-------------------------|
|    |                |            |        | CWS | DDWS | MNP |
| 1  | *Acacia mangium* | Mangium | Mimosaceae | LC | 24.3 | 0.4 | 0.4 |
| 2  | *Acronychia pedunculata* (L.) Miq. | Bonjamir, Jairgola | Rutaceae | NE | 0.2 | 10.6 |
| 3  | *Aegle marmelos* (L.) Corr. | Bel | Rutaceae | LC | 0.1 | 0.4 | 0.4 |
| 4  | *Alangium chinense* (Lour.) Harms | Marleza Gachh | Alangiaceae | NE (rare) | 3.6 |
| 5  | *Albizia chinensis* (Osb.) Merr. | Chakua Koroi | Mimosaceae | LC | 4 | 4.8 | 0.9 |
| 6  | *Albizia lebbeck* (L.) Benth. & Hook | Kala Koroi | Mimosaceae | LC | 1.3 |
| 7  | *Albizia odoratissima* (L. f.) Benth. | Tetojakoroi | Mimosaceae | LC | 0.4 | 4.4 |
| 8  | *Anacardium occidentale* L. | Kajubadam | Anacardiaceae | LC | 0.8 |
| 9  | *Annona squamosa* L. | Ata | Annonaceae | LC | 0.4 | 0.4 |
| 10 | *Antidesma acidum* Retz. | Elena | Euphorbiaceae | LC | 0.8 | 0.4 |
| 11 | *Antidesma acuminatum* Wall. in Wight. | Chokoi | Euphorbiaceae | LC | 0.4 |
| 12 | *Antidesma bunius* (L.) Spreng. | Wishwar choa, Banshial Boka | Euphorbiaceae | LC | 1.3 | 0.4 |
| 13 | *Antidesma ghasembilla* Gaertn. | Chokoi, Elena | Euphorbiaceae | LC | 0.2 | 2.6 |
| 14 | *Aphanamixis polystachya* (Wall.) R.N. Parker. | Ptitraj | Mimosaceae | LC | 0.8 | 3.8 | 0.4 |
| 15 | *Aporosa dioica* (Roxb.) Mull.Arg. | Castoma | Euphorbiaceae | NE | 3.8 |
| 16 | *Aporosa sp.* | Kharjon | Euphorbiaceae | NE | 23.3 |
| 17 | *Areca catechu* L. | Supari | Areceae | LC | 0.2 | 0.4 |
| 18 | *Artocarpus chamae* Buch.-Ham. ex Wall. | Chapalish, Chambal | Moraceae | NE (rare) | 3.9 | 176 | 0.4 |
| 19 | *Artocarpus heterophyllus* Lamk. | Kanthal | Moraceae | NE (rare) | 4.3 | 0.2 | 0.4 |
| 20 | *Artocarpus lacucha* Buch.-Ham. | Borta | Moraceae | LC | 2.4 | 4.4 | 1.3 |
| 21 | *Averrhoa bilimbi* L. | Belombo | Oxalidaceae | LC | 0.2 |
| 22 | *Averrhoa carambola* L. | Kamranga | Oxalidaceae | LC | 0.2 |
| 23 | *Baccaurea ramiflora* Lour. | Lotkon | Euphorbiaceae | LC | 0.1 | 0.2 |
| 24 | *Borassus flabellifer* L. | Tal | Areceae | LC | 0.2 | 0.4 |
| 25 | *Bridelia retusa* (L.) A. Juss. | Kata Kushui, Kata Koi | Euphorbiaceae | LC | 0.6 |
| SN | Botanical name | Local name | Family | Conservation status | Density in PAs (stem/ha) |
|----|----------------|------------|--------|------------------|------------------------|
| 26 | *Buchanania* lancifolia Roxb. | Bormala, Khoja | Anacardiaceae | NE (rare) | 0.2 |
| 27 | *Calliandra arborea* Roxb. | Chauda, Kamde | Verbenaceae | LC | 7.4 | 6.8 | 0.4 |
| 28 | *Calophyllum polyanthum* Wall. ex Choisy | Chauda, Kamde | Clusiaceae | NE (rare) | 0.6 |
| 29 | *Cassia fistula* L. | Sonalu | Caesalpiniaceae | LC | 0.5 | 1 | 1.7 |
| 30 | *Citrus reticulata* Blanco | Komla | Rutaceae | LC | 0.1 | 0.4 |
| 31 | *Clausena heptaphylla* (Roxb.) Wight & Arn. ex Steud. | Karan phal, Panbahar, sada Moricha | Rutaceae | LC | 1.12 | 2 |
| 32 | *Cleistocalyx nervosum* (DC.) Kosterm. var. paniala (Roxb.) J. Parn. & P. Chantaranothai | | Myrtaceae | LC | 0.2 | 2.2 |
| 33 | *Cocos nucifera* L. | Narikel | Areaceae | LC | 0.2 | 0.6 | 0.4 |
| 34 | *Cordia dichotoma* Forst. f. | Bolla gota, Bohal, Bhol | Boraginaceae | LC | |
| 35 | *Cordia dichotoma* Forst. f. | Bohal | Boraginaceae | LC | 0.3 | 0.4 |
| 36 | *Crateria magna* (Lour.) DC. | | Capparaceae | LC | 0.3 |
| 37 | *Cryptocarya amygdalina* Nees. | Ojha | Lauraceae | NE (rare) | 2.5 | 3.4 | 21.9 |
| 38 | *Dallbergia sissoo* Roxb. | Sissoo | Fabaceae | LC | 0.1 |
| 39 | *Dillenia indica* L. | Chalta | Dilleniaceae | LC | 0.2 | 0.2 |
| 40 | *Dillenia scabrella* Roxb. ex Wall. | Ajuli, Ajugi | Dilleniaceae | LC | 4.1 | 5.8 | 0.4 |
| 41 | *Diospyros blanconi* A. DC. | Bilati gab | Ebenaceae | LC | 0.2 | 0.4 |
| 42 | *Diospyros malabarica* (Desr.) Kostel. | Deshi gab | Ebenaceae | LC | 0.2 | 1.4 |
| 43 | *Elaeis guineensis* Jacq. | Palm oil | Areaceae | NE | 0.3 | 0.4 |
| 44 | *Elaeocarpus floribundus* Blume | Titpai | Elaeocarpaceae | LC | 0.2 | 1.8 | 1.3 |
| 45 | *Elaeocarpus tectarius* (Lour.) Poir. | Jalpai | Elaeocarpaceae | LC | 2.5 | 2.2 |
| 46 | *Ficus auriculata* Loureiro | Lal Dumur | Moraceae | LC | 1.6 | 0.8 |
| 47 | *Ficus benghalensis* L. | Bot | Moraceae | LC | 0.6 | 1.2 | 1.7 |
| 48 | *Ficus hispida* L. f. | Dumur | Moraceae | LC | 26.9 | 4.6 | 0.9 |
| 49 | *Ficus lanceolata* Buch.-Ham. ex Roxb. | | Moraceae | V | 0.3 |
| SN  | Botanical name                  | Local name          | Family       | Conservation status | Density in PAs (stem/ha) |   |
|-----|---------------------------------|---------------------|--------------|---------------------|--------------------------|---|
| 50  | *Ficus racemosa* L.             | Dumur, Jagyadumur   | Moraceae     | LC                  | 0.3 2.4 0.9              |   |
| 51  | *Ficus religiosa* L.            | Bot                 | Moraceae     | LC                  | 0.4                        |   |
| 52  | *Ficus rumphii* Bl.             | Bot                 | Moraceae     | LC                  | 0.4                        |   |
| 53  | *Ficus pseudoracemosa* Buch.-Ham. ex Smith | Chokorgola      | Moraceae     | NE                  | 0.9 0.8                    |   |
| 54  | *Ficus tinctoria* G. Forst. subsp. gibbosa (Blume) Corner | Moraceae     | NE (rare)                  | 0.1                        |   |
| 55  | *Ficus variegata* Blume         | Pakur, Pakar, Paikur | Moraceae     | LC                  | 0.4 5.2                    |   |
| 56  | *Ficus viridescens* Ait.        | Pakur               | Moraceae     | LC                  | 0.1 0.9                    |   |
| 57  | *Firmiana colorata* (Roxb.) R. Br. | Udal               | Sterculiaceae | LC                  | 0.2                        |   |
| 58  | *Flacourtia jangomas* (Lour.) Raesusch. | Painnagola | Flacourtiaceae | LC                  | 1.2 0.2 0.9                |   |
| 59  | *Garcinia cowa* Roxb. ex DC.    | Cao                 | Clusiaceae   | NE (rare)            | 9.3 5.2 2.2                |   |
| 60  | *Garcinia lanceaefoliae* Roxb.  | Tamal, Dehal        | Clusiaceae   | LC                  | 0.2                        |   |
| 61  | *Garcinia xanthochymus* Hook. f. ex T. Anders. | Burseraceae       | LC            | 1                    |                           |   |
| 62  | *Garuga pinnata* Roxb.          | Bhadi, Silbhadi, Jeelbhadi | Burseraceae | LC                  | 0.2 7 3.9                  |   |
| 63  | *Grewia nervosa* (Lour.) Panigr. | Datoi               | Tiliaceae    | LC                  | 8.5 19.2 22.4              |   |
| 64  | *Grewia sapida* Roxb. ex DC.    | Naricha             | Tiliaceae    | LC                  | 0.2                        |   |
| 65  | *Grewia tiliifolia* Vahl.       | Pholsa, Dhomoni     | Tiliaceae    | LC                  | 0.6                        |   |
| 66  | *Grewia serrulata* DC.          | Naricha             | Tiliaceae    | LC                  | 0.4                        |   |
| 67  | *Hevea brasiliensis* (Wild. ex A. Juss.) Mull.Arg. | Rubber           | Euphorbiaceae | LC                  | 0.4                        |   |
| 68  | *Hydnocarpus laurifolius* (Dennst.) Sleum. | Hiddigach | Flacourtiaceae | NE (rare)            | 1.4 5.2                    |   |
| 69  | *Lannea coromandelica* (Houtt.) Merr. | Jialbhadi          | Anacardiaceae | LC                  | 4 0.2 3.9                  |   |
| 70  | *Lepisanthes rubiginosa* (Roxb.) Leenh. | Sapiaceae       | LC            | 0.2 0.2              |                           |   |
| 71  | *Lepisanthes senegalensis* (Poir.) Leenh. | Gotaharina         | Sapiaceae    | LC                  | 0.2 0.2                    |   |
| SN | Botanical name | Local name | Family | Conservation status | Density in PAs (stem/ha) |
|----|----------------|------------|--------|---------------------|-------------------------|
|    |                |            |        | CWS | DDWS | MNP |
| 72 | Litchi chinensis Sonn. | Litchu, Lychee | Sapindaceae | LC | 1.0 | 0.4 |
| 73 | Maesa indica (Roxb.) A. DC. | Maesa, Moricha, Romjani | Myrsinaceae | CD | 0.1 | 2.2 |
| 74 | Mallotus philippensis (Lamk.) Mull.Arg. | Sinduri | Euphorbiaceae | CD | 0.6 | 0.2 | 60.8 |
| 75 | Mangifera indica L. | Am | Anacardiaceae | LC | 2.9 | 0.4 | 0.9 |
| 76 | Mangifera sylvetica Roxb. | Uriam | Anacardiaceae | V | 0.1 | 0.2 |
| 77 | Manilkara zapota (L.) P. van Royen | Sofeda | Sapotaceae | LC | 0.4 |
| 78 | Miliusa velatina (Dunal) Hook. f. | Gandhi gajari | Annonaceae | LC | 3.0 |
| 79 | Moringa oleifera Lamk. | Sajna | Moringaceae | NE | 0.9 |
| 80 | Peltophorum pterocarpum (DC.) K. Heyne | Radhachura, Halud Krishnachura | Caesalpiniaceae | LC | 0.4 | 0.4 |
| 81 | Phoebe lanceolata (Ness) Ness | Chaongri, Dulia | Lauraceae | NE | 0.2 |
| 82 | Phoenix acaculis Roxb. | Bon Khejur, Khudi khejur | Arecales | V | 0.4 |
| 83 | Phoenix sylvestris Roxb. | Khejur | Arecales | LC | 0.2 | 0.4 | 0.4 |
| 84 | Phyllanthus emblica L. | Amloki | Euphorbiaceae | LC | 2.4 | 2 | 0.9 |
| 85 | Protium serratum (Wall. ex Colebr.) Engl. | Gotgutia | Burseraceae | LC | 2.1 | 12.2 | 32.8 |
| 86 | Psidium guajava L. | Payara | Myrtaceae | LC | 4.2 | 0.2 | 0.4 |
| 87 | Samanea saman (Jacq.) Merr. | Raintree | Mimosaceae | LC | 0.4 | 0.9 |
| 88 | Sapindus baccatum Roxb. | Cham phata | Euphorbiaceae | LC | 0.4 | 3 |
| 89 | Schleichera oleosa (Lour.) Oken. | Joyna, Kusum | Sapindaceae | NE | 14.2 |
| 90 | Semecarpus anacardium L.f. | Bheula, Bhela | Anacardiaceae | NE | 11.2 |
| 91 | Senna siamea (Lamk.) Irwin & Barneby | Minjiri | Caesalpiniaceae | LC | 3.6 | 1.8 | 0.4 |
| 92 | Spondias pinata (L.f.) Kurz | Bon-Amra, Piala | Anacardiaceae | LC | 3.4 | 0.4 |
| 93 | Sterculia hamiltonii (O. Kuntze) Adelb. | Sterculiaceae | LC | 0.2 |
| 94 | Syzygium balsameum (Wight) Walp. | Buti Jam | Myrtaceae | LC | 1.5 | 2 | 0.9 |
Table 4.
List of fodder yielding trees in three selected protected areas [here, LC, least concern; NE, not evaluated; NE (rare), not evaluated but seems to be rare].

| SN | Botanical name | Local name | Family | Conservation status | Density in PAs (stem/ha) |
|----|----------------|------------|--------|---------------------|------------------------|
|    |                |            |        |                     | CWS | DDWS | MNP |
| 96 | Syzygium claviflorum (Roxb.) A. M. Cowan & J. M. Cowan | Myrtaceae | LC    |                     | 3.8 | 0.4  |     |
| 97 | Syzygium cumini (L.) Skeels | Kalojam | Myrtaceae | LC    | 1.3 | 0.8  | 0.9 |
| 98 | Syzygium cymosum DC. | Khudi Jam | Myrtaceae | NE    | 0.2 |     |     |
| 99 | Syzygium firmum Thw. | Dhaki jam | Myrtaceae | LC    | 7.5 | 1.8  | 0.4 |
| 100| Syzygium fruticosum (Wall.) Masamune | Putijam | Myrtaceae | LC    | 13.0 | 1    | 6.5 |
| 101| Syzygium jambos (L.) Alston | Gulapjam | Myrtaceae | LC    | 0.2 |     |     |
| 102| Syzygium praecox (Roxb.) Rathakr. & N. C. Nair | Pholda jam, Lal Pholda | Myrtaceae | NE    | 0.2 |     |     |
| 103| Syzygium tetragonum Wall. ex Kurz. | Pholda jam, Lal Pholda | Myrtaceae | NE    | 3   |     |     |
| 104| Tamarindus indica L. | Tentul | Caesalpinaceae | LC | 0.1 | 0.6 | 0.9 |
| 105| Terminalia bellirica (Gaertn.) Roxb. | Bohera | Combretaceae | LC | 7.5 | 10.6 | 29.3 |
| 106| Terminalia catappa L. | Kathbadam | Combretaceae | LC | 0.2 |     |     |
| 107| Terminalia chebula Retz. | Haritaki | Combretaceae | V | 0.8 | 0.6 | 4.7 |
| 108| Tetrameles nudiflora R. Br. | Chandul, Maina Kat | Datiscaceae | NE | 0.1 | 1.8 |     |
| 109| Trema orientalis (L.) Blume | Jiban, Naricha | Ulmaceae | LC | 5.1 | 0.2 | 0.4 |
| 110| Vitex glabrata R. Br. | Goda arsol, Hakuni gach | Verbenaceae | LC | 1.0 | 1.4 | 0.9 |
| 111| Vitex peduncularis Wall. ex Schauer | Goda | Verbenaceae | NE (rare) | 3.3 | 11  | 0.9 |
| 112| Ziziphus mauritiana Lamk. | Boroi | Rhamnaceae | LC | 0.2 |     | 0.4 |

Density of the fodder yielding tree species varied greatly with PAs. *Ficus hispida* was having the highest stem density in CWS, whereas in DDWS *Grewia nervosa* and *Artocarpus chama* were having the highest density. On the other hand, *Mallotus philippensis* and *Protium serratum* were the two mostly dense tree species in MNP. There were 15 fodder yielding exotic tree species in the three protected areas. The studies indicated that density of very few species was good (10 stems/ha); however most of them are having very poor density which apparently seems not indicative of a rich wildlife habitat.
5.4.2 Shrubs

There were 27 fodder yielding shrubby species recorded from the selected three protected areas. These species taxonomically belong to 23 genera and 15 families (Table 5). Both CWS and DDWS were represented by 17 shrubby fodder yielding species, whereas MNP showed 14 species indicating its comparative inferiority of supporting wildlife. However, *Cajanus cajan* and *Manihot esculenta* were the two exotic fodder species recorded from the cultivation sites of MNP and CWS.

| SN | Botanical name | Local name | Family | Conservation status | Occurrence in selected PAs |
|----|----------------|------------|--------|----------------------|----------------------------|
|    |                |            |        |                      | CWS | DDWS | MNP |
| 1  | *Bambusa tulda* Roxb. | Mitinga, Mitinga, Mirtinga, Taralla, Tolla bansh | Poaceae | LC | ✓ | ✓ | ✓ |
| 2  | *Bambusa vulgaris* Schrad. ex Wendl. | Baijja, Baria, Jowa Bansh, Bangla Bans, Ora Bansh | Poaceae | LC | ✓ | ✓ | ✓ |
| 3  | *Bauhinia acuminata* L. | Caesalpiniaeae | LC | ✓ |
| 4  | *Bridelia stipularis* (L.) Blume (climbing) | Sitki | Euphorbiaceae | LC | ✓ | ✓ | ✓ |
| 5  | *Caesalpinia hymenocarpa* (Prain) Hattink. | Caesalpiniaeae | NE (rare) | ✓ |
| 6  | *Cajanus cajan* (L.) Millsp. | Arhor, Sarata alu, Sortai alu | Fabaceae | LC | ✓ | ✓ |
| 7  | *Capparis zeylanica* L. | Capparaceae | LC | ✓ | ✓ |
| 8  | *Citrus aurantifolia* (Christm. & Panzer) Swingle | Lebu | Rutaceae | LC | ✓ | ✓ | ✓ |
| 9  | *Clausena suffruticosa* (Roxb.) Wight & Arn. | Sadamoricha | Rutaceae | LC | ✓ |
| 10 | *Clerodendrum serratum* (L.) Moon | Verbenaceae | NE (rare) | ✓ |
| 11 | *Crotalaria spectabilis* Roth | Pipli-jhunjan | Fabaceae | LC | ✓ |
| 12 | *Dendrocalamus longispathus* (Kurz) Kurz | Ora | Poaceae | NE | ✓ |
| 13 | *Grewia asiatica* L. | Pholsa | Tiliaceae | NE (rare) | ✓ | ✓ |
| 14 | *Grewia serrulata* DC. | Panisara, Pichandi, Khulla damor | Tiliaceae | LC | ✓ | ✓ |
| 15 | *Helicia erratica* Hook. f. | Proteaceae | NT | ✓ |
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5.4.3 Herbs

The review revealed a total of a higher number of fodder yielding herbs occurring in the protected areas. One hundred twenty-one herbaceous species belonging to 82 genera and 29 families were recorded from the protected areas (Table 6). DDWS was represented with the highest number of herb species (70 species) which was followed by CWS and MNP with 60 and 39 herb species, respectively. A substantial number of (15 species) herbs that are reported growing in and around the protected areas were introduced in Bangladesh at different times, and most of these were found to be cultivated in the adjacent forest areas of the protected areas. Wildlife takes advantages of cultivation by raiding them for food especially during the cultivation season. The conservation status of three fodder yielding herbs was vulnerable, i.e., *Colocasia oresbia*, *Homalomena coerulea*, and *Polygala furcata*.

### Table 6.

| SN | Botanical name                  | Local name             | Family       | Conservation status | Occurrence in selected PAs |
|----|---------------------------------|------------------------|--------------|---------------------|-----------------------------|
|    | *Maclura cochinchinensis* (Lour.) Corner |                        | Moraceae     | LC                  | ✓                           |
| 16 | *Manihot esculenta* Crantz      | Cassava, Gach alu      | Euphorbiaceae| LC                  | ✓                           |
| 17 | *Melocanna baccifera* (Roxb.) Kurz |                        | Poaceae      | LC                  | ✓ ✓                         |
| 18 | *Murraya koenigii* (L.) Spreng. |                        | Rutaceae     | LC                  | ✓                           |
| 19 | *Phlogacanthus thyrsiformis* Roxb. ex D. J. Mabberley | | Acanthaceae | NE                  | ✓                           |
| 20 | *Premna esculenta* Roxb.       | Lalana                 | Verbenaceae  | LC                  | ✓ ✓ ✓                       |
| 21 | *Punica granatum* L.           | Dalim                  | Punicaceae   | LC                  | ✓                           |
| 22 | *Sarcochlamys pulcherrima* Gaudich. | Jangallya shak, Maricha | Urticaceae   | NE                  | ✓ ✓                         |
| 23 | *Solanum melongena* L.         | Begun                  | Solanaceae   | LC                  | ✓ ✓ ✓                       |
| 24 | *Solanum torvum* Sw.           | Tit begun, Gota begun  | Solanaceae   | LC                  | ✓ ✓                         |
| 25 | *Ziziphus oenoplia* (L.) Mill. | Bonboroi, Tolotoki kanta, Tokni boroi | Rhamnaceae   | LC                  | ✓ ✓ ✓                       |
| 26 | *Ziziphus rugosa* Lamk.        | Jangli Boroi, Anoi, Anoi gota, Anari gota | Rhamnaceae   | NE                  | ✓ ✓                         |

*List of fodder yielding shrubs reported from the selected protected areas [here, LC, least concern; NE, not evaluated; NE (rare), not evaluated but seems to be rare].*
| SN | Botanical name                                      | Local name                     | Family   | Conservation status | Occurrence in selected PAs |
|----|----------------------------------------------------|--------------------------------|----------|---------------------|-----------------------------|
|    |                                                    |                                |          |                     | CWS | DDWS | MNP |
| 1  | *Acroceras tonkinense* (Balansa) C.E. Hubb. ex Bor |                                | Poaceae  | LC                  | ✓   |       |     |
| 2  | *Actinoscirpus grossus* (L.f.) Goetgh & D. A. Simpson | Kasuru, Kasari, Kesar          | Cyperaceae | LC                  | ✓   |       |     |
| 3  | *Allium cepa* L.                                  | Piyaj                          | Liliaceae | LC                  | ✓   |       |     |
| 4  | *Allium sativum* L.                               | Rashun                         | Liliaceae | LC                  | ✓   |       |     |
| 5  | *Alocasia macrorrhiza* (L.) G. Don                | Mankatchu                      | Araceae  | LC                  | ✓   |       |     |
| 6  | *Alternanthera philoxeroides* (Mart.) Griseb.      | Helencha, Malancha shak        | Amaranthaceae | LC | ✓   |       |     |
| 7  | *Amaranthus spinosus* L.                           | Kantashkh, Kata Notay, Khoira kanta | Amaranthaceae | LC | ✓   | ✓     |     |
| 8  | *Amaranthus tricolor* L.                           | Lalshakh, Danga, Data shak     | Amaranthaceae | LC | ✓   | ✓     | ✓     |
| 9  | *Amischophacelus axillaris* (L.) Rolla Rao & Kamm. | Baghanulla                     | Commelinaceae | LC | ✓   |       |     |
| 10 | *Amorphophallus bulbifer* (Roxb.) Blume           | Amla-bela, Jongle Ol.          | Araceae  | LC                  | ✓   | ✓     | ✓     |
| 11 | *Amorphophallus paeoniifolius* (Dennst.) Nicolson | Bag katchu, Batema katchu      | Araceae  | LC                  | ✓   |       |     |
| 12 | *Ananas comosus* (L.) Merr.                       | Anarosh                        | Bromeliaceae | LC | ✓   | ✓     | ✓     |
| 13 | *Aponogeton echinatus* Roxb.                      | Ghechu                         | Aponogetonaceae | CD |       | ✓     |
| 14 | *Aponogeton natans* (L.) Engl. & Krause           |                                | Aponogetonaceae | NT |       | ✓     |
| 15 | *Arundo donax* L.                                 | Poaceae                        | LC       | ✓                   |     |       |     |
| 16 | *Axonopus compressus* (Sw.) P. Beauv.             | Ghora dubo, Har, Farak pata    | Poaceae  | LC                  | ✓   | ✓     | ✓     |
| 17 | *Bothriochloa bladhii* (Retz.) S. T. Blake        | Gandha Gourana                 | Poaceae  | LC                  | ✓   |       |     |
| 18 | *Brachiaria decumbens* Stapf                      | Poaceae                        | LC       | ✓                   |     |       |     |
| 19 | *Brachiaria distachya* (L.) Stapf                 | Corighas                       | Poaceae  | LC                  | ✓   | ✓     | ✓     |
| 20 | *Brachiaria kurzii* (Hook. f.) A. Camus           | Poaceae                        | LC       | ✓                   |     |       |     |
| 21 | *Brachiaria reptans* (L.) Gard. & Hubb.           | Poaceae                        | LC       | ✓                   |     |       |     |
| SN | Botanical name | Local name | Family | Conservation status | Occurrence in selected PAs |
|---|---|---|---|---|---|
| 22 | *Brassica oleracea* L. var. *botrytis* L. | Phulkopi | Brassicaceae | LC | ✓ |
| 23 | *Bryophyllum pinnatum* (Lamk.) Oken | Pathorkutchi, Pathorchura | Crassulaceae | LC | ✓ ✓ ✓ |
| 24 | *Capillipedium assimile* (Steu.) A Camus | | Poaceae | DD | ✓ |
| 25 | *Capsicum annuum* L. | Morich | Solanaceae | LC | ✓ |
| 26 | *Capsicum frutescens* L. | Morich | Solanaceae | LC | ✓ |
| 27 | *Carica papaya* L. | Papaya, Pape | Caricaceae | LC | ✓ ✓ |
| 28 | *Centella asiatica* (L.) Urban | Thankuni | Apiaceae | LC | ✓ ✓ ✓ |
| 29 | *Chenopodium album* L. | Batua Shakh | Chenopodiaceae | LC | ✓ |
| 30 | *Chrysopogon aciculatus* (Retz.) Trin | Lengra, Premkanta | Poaceae | LC | ✓ ✓ ✓ |
| 31 | *Colocasia esculenta* (L.) Schott | Katchu | Araceae | LC | ✓ ✓ ✓ |
| 32 | *Colocasia fallax* Schott | | Araceae | LC | ✓ |
| 33 | *Colocasia oreshia* A. Hay | Sadakachu | Araceae | V | ✓ |
| 34 | *Commelina benghalensis* L. | Dholpata, Kanchira | Commelinaceae | LC | ✓ ✓ |
| 35 | *Commelina sikkimensis* C.B. Clarke | Batbaithia, Shag | Commelinaceae | CD | ✓ |
| 36 | *Corchorus capsularis* L. | Pat shakh | Tiliaceae | LC | ✓ |
| 37 | *Curcuma longa* L. | Halud | Zingiberaceae | LC | ✓ ✓ |
| 38 | *Cyanotis cristata* (L.) D. Don | | Commelinaceae | LC | ✓ |
| 39 | *Cymbopogon citratus* (DC) Stapf | Dhan Sabarang, Lemon Ghas | Poaceae | CD | ✓ |
| 40 | *Cynodon arcuratus* J. S. Presl ex C. B. Presl | | Poaceae | LC | ✓ |
| 41 | *Cynodon dactylon* (L.) Pers. | Durba grass | Poaceae | LC | ✓ ✓ ✓ |
| 42 | *Cyperus corymbosus* Rottb. | Gola Methi | Cyperaceae | NE | ✓ |
| 43 | *Cyperus cypervoides* (L.) O. Ktze. | Kucha, Kushi | Cyperaceae | LC | ✓ |
| 44 | *Cyperus difformis* L. | Behua | Cyperaceae | LC | ✓ ✓ |
| 45 | *Cyperus digitatus* Roxb. | Behua | Cyperaceae | LC | ✓ |
| 46 | *Cyperus distans* L. f. | Pani Malanga | Cyperaceae | LC | ✓ |
| 47 | *Cyperus laxus* Lamk var. laxus | | Cyperaceae | LC | ✓ ✓ |
| SN | Botanical name                          | Local name | Family     | Conservation status | Occurrence in selected PAs |
|----|----------------------------------------|------------|------------|---------------------|---------------------------|
|    |                                        |            |            |                     | CWS DDWS MNP              |
| 48 | *Cyperus rotundus* L.                   | Mutha      | Cyperaceae | LC                  | ✓                         |
| 49 | *Cyperus tuberosus* Rottb.              |            | Cyperaceae | LC                  | ✓ ✓                       |
| 50 | *Cyrtococcum oxyphyllum* (Steud.) Stapf |            | Poaceae    | LC                  | ✓                         |
| 51 | *Cyrtococcum patens* (L.) A. Camus      |            | Poaceae    | LC                  | ✓ ✓                       |
| 52 | *Dactyloctenium aegyptium* (L.) P. Beauv| Makra      | Poaceae    | LC                  | ✓                         |
| 53 | *Desmostachya bipinnata* (L.) Stapf     |            | Poaceae    | LC                  | ✓                         |
| 54 | *Dichanthium caricosum* (L.) A. Camus   | Detara     | Poaceae    | LC                  | ✓                         |
| 55 | *Digitaria bicornis* (Lamk.) Roem. & Schult. ex Loud | Poaceae | NE        | ✓                   |
| 56 | *Digitaria sanguinalis* (L.) Scop.      |            | Poaceae    | LC                  | ✓                         |
| 57 | *Echinochloa crus-galli* (L.) P. Beauv  | Bara       | Poaceae    | LC                  | ✓ ✓                       |
| 58 | *Eichhornia crassipes* (Mart.) Solms    |            | Pontederiaceae | LC | ✓                         |
| 59 | *Eleusine indica* (L.) Gaertn.          | Malankuri  | Poaceae    | LC                  | ✓ ✓                       |
| 60 | *Eragrostis ciliaris* (L.) R. Br.       |            | Poaceae    | LC                  | ✓ ✓                       |
| 61 | *Eragrostis lehmanniana* Nees           |            | Poaceae    | NE                  | ✓                         |
| 62 | *Eragrostis tenella* (L.) P. Beauv. ex Roem. & Schult. | Poaceae | LC        | ✓ ✓                       |
| 63 | *Eragrostis unioloides* (Retz.) Nees ex Steud. | Poaceae | LC        | ✓                         |
| 64 | *Eriochloa procera* (Retz.) C. E. Hubb. |            | Poaceae    | LC                  | ✓ ✓                       |
| 65 | *Euphorbia heterophylla* L.             |            | Euphorbiaceae | NE (rare) | ✓                         |
| 66 | *Fuirena umbellata* Rottb.              |            | Cyperaceae | LC                  | ✓                         |
| 67 | *Homalomena coerulescens* Jungh.       |            | Araceae    | V                   | ✓                         |
| 68 | *Hydroclea zeylanica* (L.) Vahl         |            | Hydrophyllaceae | LC | ✓                         |
| 69 | *Hymenachne pseudointerrupta* C. Muell. |            | Poaceae    | LC                  | ✓                         |
| SN | Botanical name | Local name | Family | Conservation status | Occurrence in selected PAs |
|----|----------------|------------|--------|---------------------|---------------------------|
|    |                |            |        |                     | CWS | DDWS | MNP  |
| 70 | *Imperata cylindrica* (L.) P. Beauv. | Chhan, Chau, Kash | Poaceae | LC | ✓ | ✓ |
| 71 | *Juncus prismatocarpus* R.Br. | | Juncaceae | LC | ✓ | ✓ |
| 72 | *Kyllinga brevifolia* Rottb. | | Cyperaceae | LC | ✓ |
| 73 | *Kyllinga bulbosa* Beauv. | | Cyperaceae | LC | ✓ |
| 74 | *Kyllinga nemoralis* (J. R. Forst. & G. Forst.) Dandy ex Hutchins. & Dalziel | | Cyperaceae | LC | ✓ | ✓ |
| 75 | *Lasia spinosa* (L.) Thw. | | Araceae | LC | ✓ |
| 76 | *Lemna perpusilla* Torrey | | Lemnaceae | LC | ✓ |
| 77 | *Leucas indica* (L.) R.Br. ex Vatke | Dandakolas, Haldusha, Sweetadrone | Lamiaceae | LC | ✓ |
| 78 | *Lophatherum gracile* Brongn. | | Poaceae | LC | ✓ |
| 79 | *Lycopersicon esculentum* Mill. | Tomato | Solanaceae | LC | ✓ | ✓ |
| 80 | *Mollugo pentaphylla* L. | | Molluginaceae | LC | ✓ |
| 81 | *Monochoria hastata* (L.) Solms | Baranukha | Pontederiaceae | LC | ✓ | ✓ |
| 82 | *Monochoria vaginalis* (Burm. f.) Presl | Nukha, Sarkachu | Pontederiaceae | LC | ✓ | ✓ |
| 83 | *Musa ornata* Roxb. | Ramkola | Musaceae | CD | ✓ | ✓ |
| 84 | *Musa paradisiaca* L. | Champa kola | Musaceae | LC | ✓ | ✓ |
| 85 | *Oplismenus burmannii* (Retz.) P. Beauv. | | Poaceae | LC | ✓ |
| 86 | *Oryza sativa* L. | Dhan | Poaceae | CD | ✓ | ✓ |
| 87 | *Panicum maximum* Jacq. | | Poaceae | LC | ✓ |
| 88 | *Panicum paludosum* Roxb. | Barti, Borali, Kalash Nar | Poaceae | LC | ✓ |
| 89 | *Panicum repens* L. | | Poaceae | LC | ✓ |
| 90 | *Paspalidium flavidum* (Retz.) A. Camus | Bolai Mandi, Karin Ghas | Poaceae | LC | ✓ |
| 91 | *Paspalum conjugatum* Bergius | | Poaceae | LC | ✓ |
| 92 | *Paspalum longifolium* Roxb. | | Poaceae | NE | ✓ |
| 93 | *Paspalum orbiculare* G. Forst. | | Poaceae | LC | ✓ |
| 94 | *Paspalum scrobiculatum* L. | | Poaceae | LC | ✓ |
| SN | Botanical name | Local name | Family | Conservation status | Occurrence in selected PAs |
|----|----------------|------------|--------|----------------------|---------------------------|
|    |                |            |        |                      | CWS | DDWS | MNP |
| 95 | *Phragmites karka* (Retz.) Trin. ex Steud. | Dharma, Nalkhagra | Poaceae | LC                   | ✓   | ✓    |
| 96 | *Physalis angulata* L. | Fotka | Solanaceae | LC | ✓ |
| 97 | *Polygala furcata* Royle | | Polygalaceae | V | ✓ |
| 98 | *Pueraria peduncularis* (Grah. ex Benth.) Benth. | | Fabaceae | LC | ✓ |
| 99 | *Raphanus sativus* L. | Mula | Brassicaceae | LC | ✓ |
| 100 | *Rhynchospora corymbosa* (L.) Britton | | Cyperaceae | LC | ✓ | ✓ |
| 101 | *Sacciolepis indica* (L.) A. Chase | Akh | Poaceae | CD | ✓ |
| 102 | *Saccharum ravennae* L. | Elkor | Poaceae | DD | ✓ |
| 103 | *Saccharum spontaneum* L. | Kash, Kaichcha, Kagara | Poaceae | LC | ✓ | ✓ |
| 104 | *Sesbania bispinosa* (Jacq.) Wight. | | Fabaceae | LC | ✓ |
| 105 | *Sennia hiruta* (L.) Irwin & Barneby | Muyamuya, Chhotokut | Alismataceae | LC | ✓ |
| 106 | *Senna hiruta* (L.) Irwin & Barneby | | Caesalpiniaceae | NE | ✓ |
| 107 | *Sesbania bispinosa* (Jacq.) Wight. | | Fabaceae | LC | ✓ |
| 108 | *Sesbania bispinosa* (Jacq.) Wight. | | Fabaceae | LC | ✓ |
| 109 | *Setaria verticillata* (L.) P. Beauv. | | Poaceae | LC | ✓ |
| 110 | *Solanum americanum* Mill. | Tit-begun | Solanaceae | LC | ✓ | ✓ | ✓ |
| 111 | *Solanum tuberosum* L. | Golalu | Solanaceae | LC | ✓ |
| 112 | *Sorghum bicolor* (L.) Moench | Jowar | Poaceae | CD | ✓ |
| 113 | *Thysanolaena maxima* (Roxb.) Kuntze | Jahruful | Poaceae | LC | ✓ | ✓ |
| 114 | *Typhonomium trilobatum* (L.) Schott | Ghetkul | Araceae | LC | ✓ | ✓ |
| 115 | *Vernonia cinerea* (L.) Less. | Shial lata, Dankuni, Kuksim | Asteraceae | LC | ✓ | ✓ | ✓ |
| 116 | *Xanthium indicum* Koen. ex Roxb. | Khagra, Ban-okra | Asteraceae | LC | ✓ |
| 117 | *Xanthosoma sagittifolium* (L.) Schott | Panchamukhi katchu | Araceae | LC | ✓ |
5.4.4 Climbers and other fodder plants

Climbers growing on bushes, trees, and forest floor are important fodder. The leaves and young shoots of the climbers and lianas are mainly eaten by wildlife as food. There were 39 climber plants belonging to 28 genera and 14 families reported as fodder species from the three protected areas. However, review of other reports indicates that the fodder yielding climber composition is almost similar to other forests of southeastern and central regions of Bangladesh. Besides the climber, there were seven fodder yielding pteridophytic species which belong to different genera of seven families. A total of five exotic climbers were recorded to be cultivated by the local people inside the boundary of the protected areas which sometimes raided by wildlife, i.e., monkey, squirrel, etc. The conservation status indicated the presence of one vulnerable plant named Calamus latifolius, the fruit of which is eaten by different birds and wildlife as food (Table 7).

| SN  | Botanical name            | Local name          | Family         | Conservation status | Occurrence in the PAs |
|-----|---------------------------|---------------------|----------------|---------------------|------------------------|
| 118 | Xanthosoma violacenum     | Dudh katchu, Dastur| Araceae        | LC                  | ✓                      |
| 119 | Zea mays L.               | Vuttra              | Poaceae        | CD                  | ✓                      |
| 120 | Zingiber capitatum Roxb.  | Jongli Ada          | Zingiberaceae  | NE (rare)           | ✓                      |
| 121 | Zingiber officinale Rosc. | Ada                 | Zingiberaceae  | LC                  | ✓ ✓                    |

Table 6. List of fodder yielding herbs recorded from the selected protected areas [here, DD, data deficient; LC, least concern; NE, not evaluated; NE (rare), not evaluated but seems to be rare; V, vulnerable].

| SN  | Botanical name            | Local name          | Family         | Conservation status | Occurrence in the PAs |
|-----|---------------------------|---------------------|----------------|---------------------|------------------------|
| 1   | Acacia pennata (L.) Willd.| Teorakanta          | Mimosaceae     | NE (rare)           | ✓                      |
| 2   | Ampelocissus barbata (Wallich) Planch. |   | Vitaceae      | CD                  | ✓                      |
| 3   | Ampelocissus latifolia (Roxb.) Planch. |   | Vitaceae      | NE                  | ✓                      |
| 4   | Basella rubra L.          | Poi shak            | Basellaceae    | LC                  | ✓                      |
| 5   | Benincasa hispida (Thunb.) Cogn. | Chalumra            | Cucurbitaceae  | LC                  | ✓                      |
| 6   | Caesalpinia digyna Rottler | Kotchoi Kanta, Umulkuchi | Caesalpiniae | LC                  | ✓ ✓                    |
| 7   | Calamus latifolius Roxb.  | Budum bet, Korak bet| Areaceae       | V                   | ✓ ✓                    |
| SN | Botanical name          | Local name            | Family           | Conservation status | CWS | DDWS | MNP |
|----|------------------------|-----------------------|------------------|---------------------|-----|------|-----|
| 8  | Calamus tenuis Roxb.   | Chiringbet, Sanchi Bet, Bandari Bet, Jali bet | Areceaceae       | LC                  | ✓   | ✓    | ✓   |
| 9  | Cissus elongata Roxb.  |                       | Vitaceae         | LC                  | ✓   |      |     |
| 10 | Citrullus lanatus (Thunb.) Matsumura & Nakai | Tormuj | Cucurbitaceae | LC | ✓ | |
| 11 | Coccinia grandis (L.) Voigt | Kawa jangi, Telakucha | Cucurbitaceae | LC | ✓ | |
| 12 | Coccinia grandis (L.) Voigt | Telakucha | Cucurbitaceae | LC | ✓ | ✓ |
| 13 | Cucumis melo L.         | Khira                 | Cucurbitaceae    | LC                  | ✓   |      |     |
| 14 | Cucumis sativus L.      | Khira, Futi           | Cucurbitaceae    | LC                  | ✓   |      |     |
| 15 | Cucurbita maxima Duch. ex Lamk. | Mistikumra | Cucurbitaceae | LC | ✓ | ✓ |
| 16 | Dalbergia pinnata (Lour.) Prain | Lalangchhali, Keti  | Fabaceae         | LC                  | ✓   |      |     |
| 17 | Dioscorea belophylla (Prain) Voigt ex Haines | Pagla Alu | Dioscoreaceae | LC | ✓ | ✓ | ✓|
| 18 | Dioscorea bulbifera L.  | Pagla                  | Dioscoreaceae    | LC                  | ✓   | ✓    | ✓   |
| 19 | Dioscorea esculenta (Lour.) Burkill | Maitta Alu | Dioscoreaceae | NE | ✓ | |
| 20 | Dioscorea hamiltonii Hook. f. | Thakan Budo | Dioscoreaceae | NT | ✓ | |
| 21 | Dioscorea pentaphylla L. | Alu lata              | Dioscoreaceae    | LC                  | ✓   | ✓    | ✓   |
| 22 | Ipomoea aquatica Forsk. | Kalmi                  | Convolvulacea    | LC                  | ✓   |      |     |
| 23 | Ipomoea batatas (L.) Lamk. | Mistialu              | Convolvulacea    | LC                  | ✓   |      |     |
| 24 | Lablab purpureus (L.) Sweet | Shim                  | Fabaceae         | LC                  | ✓   |      | ✓   |
| 25 | Lagenaria siceraria (Molina) Standl. | Lau | Cucurbitaceae | LC | ✓ | ✓ |
| 26 | Luffa acutangula (L.) Roxb. | Jhinga              | Cucurbitaceae    | LC                  | ✓   | ✓    | ✓   |
| 27 | Luffa cylindrica (L.) M. Roem. | Purul | Cucurbitaceae | LC | ✓ | |
| 28 | Mikania cordata (Burm. f.) Robinson | Assamlata | Asteraceae | LC | ✓ | |
| 29 | Momordica charantia L. var. charantia C. B. Clarke | Karolla | Cucurbitaceae | LC | ✓ | ✓ |
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6. Threats to the fodder species

Threats to the fodder yielding plant species are similar to that of the protected areas and forests across the different regions of Bangladesh. According to the fifth report on CBD submitted by the Bangladesh government in 2015, direct threats to the PAs are (1) encroachment in protected areas, (2) degradation of forests and

| SN | Botanical name | Local name | Family | Conservation status | Occurrence in the PAs |
|----|----------------|------------|--------|----------------------|------------------------|
| 30 | Momordica cochinensis (Lour.) Sprengel | Kakrol | Cucurbitaceae | LC | ✓ | ✓ |
| 31 | Piper betle L. | Pan | Piperaceae | LC | ✓ |
| 32 | Smilax perfoliata Lour. | Kumari lata | Smilacaceae | LC | ✓ |
| 33 | Solena amplexicaulis (Lamk.) Gandhi | | Cucurbitaceae | LC | ✓ |
| 34 | Tapiria hirsuta Hook. f. | | Anacardiaceae | CD | ✓ |
| 35 | Tetragastrichia bracteolata (Wall.) Planch. | Golgoli lata | Vitaceae | CD | ✓ |
| 36 | Trichosanthes anguina L. | Chichinga | Cucurbitaceae | LC | ✓ |
| 37 | Trichosanthes dioica Roxb. | Patal | Cucurbitaceae | LC | ✓ |
| 38 | Uvaria hirsuta Jack | Banor kola | Annonaceae | NE | ✓ |
| 39 | Vigna unguiculata (L.) Walp. | Borboti | Fabaceae | LC | ✓ |
| 40 | Angiopteris evecta (Forst.) Hoffm | Dhekiak, Shak | Angiopteridaceae | LC | ✓ |
| 41 | Blechnum orientale L. | | Blechnaceae | LC | ✓ | ✓ |
| 42 | Christella arida (D. Don) Holtt. | Bish Dhekiak | Thelypteridaceae | LC | ✓ |
| 43 | Diplazium esculentum (Retz.) Sw. | Dhekiak, Dhekiak Shak | Athyriaceae | LC | ✓ | ✓ |
| 44 | Helminthostachys zeylanica (L.) Hook. | Shada, Dhekiak | Helminthostachyaceae | LC | ✓ | ✓ |
| 45 | Lygodium microphyllum (Cav.) R. Br. | | Lygodiaceae | LC | ✓ |
| 46 | Marsilea quadrifolia L. | | Marsileaceae | LC | ✓ |

Table 7.
List of fodder yielding climbers and ferns recorded from the protected areas [here, CD, conservation dependent; LC, least concern; NE, not evaluated; NE (rare), not evaluated but seems to be rare; NT, near threatened; V, vulnerable].
wetlands, (3) infrastructure development, (4) unsustainable and/or illegal exploitation of terrestrial resources, (5) unsustainable and/or illegal fishing practices, (6) change in hydrological regime, (7) pollution, and (8) invasive species [33]. On the other hand, the indirect threats are the institutional and environmental conditions that are behind the direct threats visible on the ground [34]. The main indirect threats are (1) poor institutional capacity, (2) lack of coordination among different agencies, (3) policy and information gaps, (4) lack of enforcement, (5) inadequate and poorly managed system of protected areas, (6) corruption, (7) lack of political commitment, (8) lack of awareness, (9) climate and biophysical changes, and (10) lack of alternative livelihoods in sensitive habitats.

An unprecedented threat to the fodder plant diversity of Bangladesh is exerted by the conversion of wildlife habitat into human settlements along with rampant urban development throughout the country’s forested areas [35].

The ecosystem integrity of the PAs of Bangladesh are in very vulnerable situation because they are part of reserved forests which have, in most cases, only been declared after being degraded heavily by various means. It has been assumed that 10% of it is already extinct due to overexploitation. The Bangladesh National Herbarium (BNH) has reported 106 vascular plant species at varying degrees of risk of extinction [33].

The main threats to flora and fauna of protected area conservation emanate from the degradation of forests and wetlands. It is assumed that the anthropogenic pressures on natural resources caused ecosystem depletion. Biotic pressures are exacerbated by dramatic change in climate pattern coupled with sea level rise, increase soil salinity, and increase incidence and severity of cyclones and change in rainfall patterns and temperatures, disturbing the regular seasonality of fruit and flower blooms. This impacts the regeneration of important flora and fauna species and disrupts food chain.

A study revealed that protected areas in the tropical moist evergreen and semi-evergreen forests of hilly regions were highly subject to illegal wood cutting, while those in tropical moist deciduous forests of plain land area were prone to encroachment for settlement and agriculture, and those in mangrove forests of littoral zones were extremely vulnerable to wildlife poaching [36].

7. Effect of fodder plants on wildlife population

Plants and animals are two of the main interacting components of an ecosystem. A very close symbiotic relationship exists between flora and fauna including microbes, i.e., fungi, algae, bacteria, etc. Pollination, decomposition of degradable wastage, nutrient cycling, forming food web, and maintaining the food chain are the main fields where contribution of fauna is very significant. On the other hand, supplying nutrients through food production, providing shade and shelter, and maintaining fertility and productivity of an ecosystem are the key contributions of the floral communities to the associated ecosystem. The smaller animals use the cover of plants and dead leaves to hide from the predators. These animals, i.e., moth, katydids, frogs, and grasshoppers, can blend into the surrounding environment at will and become invisible to the predators searching for food. The tropical rain forests like the protected areas of Bangladesh are very much responsive to animal and plant interaction. In adaptive surroundings of tropical forests, a huge diversity of animals, birds, and insects subsist together. An area of 6 square kilometer of typical tropical rain forest can harbor as much as 1500 flowering plants, 400 species of birds, 100 reptiles, and 60 amphibians along with thousands of butterfly species. However, in a complex ecosystem, the biotic interactions can be toward
any directions, i.e., plant-plant, plant-animal, plant-microbe, animal-microbe, and animal-animal. All of these interactions employ different biotic services [37].

The richness of a wildlife habitat with fodder very sharply determines the fluctuation of wildlife population. Unavailability of food inside the forests make many of the wildlife to come out toward adjacent localities in search of food. For example, a higher number of human–elephant conflicts (HEC) were reported from the southeastern Bangladesh due to degradation and fragmentation of elephant habitat which caused reduction of Asian elephant’s population from 500 in the middle of the last century to 228–327 [38]. It is worth and interesting to mention that in some protected areas like Nijhum Dweep National Park, the deer population is shrinking gradually due to higher competition with the thousands of buffalos and cows for fodder. Similar to that of the Asian elephant and deer, the population of monkey along with other herbivores is also reducing at alarming rate due to degradation of overall habitat quality in Bangladesh [39, 40].

8. Protection and enrichment strategies for fodder plants

The process of conserving rare plant species can be divided into three phases: (i) Identification-determining which species are in danger of extinction. (ii) Protection-determining and implementing the short-term measures necessary to halt a species’ slide to extinction. (iii) Recovery-determining and implementing the longer-term measures necessary to rebuild the population of the species to the point at which it is no longer in danger of extinction [41].

People living in and around a forest depend on forest resources for a substantial proportion of their subsistence, including food, fiber, medicines, and other uses [42]. Many others perceive forest exploitation as a means of escaping poverty [43, 44]. Forest conservation is likely to be low on these peoples’ priorities if it limits their possibilities for livelihood support [45]. So, the development of living condition of the surrounding local people of the important wildlife habitats through improving their livelihood security and diversifying income, so as to meet all their basic needs, should be of first priority; otherwise the conservation effort will go in vain. It is important to extend and strengthen the protective measures by local administrative bodies of Bangladesh Forest Department (FD) against the threats like settlement, agricultural expansion, severe grazing, hunting, shooting, illegal cutting, etc. Local administrative units (beat offices) of the Forest Department must be strengthened with necessary manpower, staff quarters, equipment, logistics, and training, so that they become more capable to conduct the protection and conservation measures because they are the only authority to look after forest and wildlife.

Steps should be taken to halt further expansion of any agricultural/horticultural practices toward the forests. Awareness raising and consciousness of local people regarding the importance of habitat integrity, wildlife, environmental conservation, biodiversity, and endangered ecosystems are mandatory. The government may provide some incentives through money, small loan, training, etc. to help local people in managing sustainable alternative income-generating programs. Relocation and permanent allocation of some barren lands to the forest-dwelling people may reduce their dependency and threats induced by them on the existing forest. Cultivation of crops, i.e., pineapple, banana, paddy, taro, and lemon, should be restricted to some marginal areas of the forests or protected areas. Cattle grazing and browsing pressure in many protected areas is significant, and hence control of grazing animals for reducing the direct effects of disturbance is essential. Special conservation measures both ex situ and in situ methods may be initiated to conserve the threatened and rare native plant species. Enrichment plantation with native wildlife (i.e. rhesus macaque, capped
langur, etc.) fruit-bearing plant species should be conducted in the gap spaces of the forests. Activities that were identified by the IUCN and different conservation organizations which contribute to forest and species conservation, i.e., area-based protection, area-based management, species-centered management, education and awareness, improved law and policy, livelihoods and incentives, and capacity building, may be considered for conservation of forest resources in all protected areas. Permanent sample plots of adequate size (0.5–1.0 ha) may be established in representative vegetation types of each wildlife habitat to facilitate long-term ecological and biodiversity assessment which may help monitor the success of restoration and conservation of the fodder yielding plants. Community patrolling should be strengthened to reduce illicit felling as well as raise awareness among local people regarding nature conservation. Digging furrow in suitable locations across the forest may be helpful for controlling fire infestation and litter extraction by local people using small vehicles.

9. Conclusion

Fragmentation and degradation of wildlife habitat quality resulted in reduction of the diversity and population of fodder yielding plants. It is a worldwide trend in which the policy makers and scientists are concerned about. However, Bangladesh having a substantial area declared as protected areas is trying to conserve and restore the wildlife habitat quality. Still now, the protected areas of the country are still harboring a good number of fodder yielding plants from all habitat forms. However, many of the fodder species are having very poor density which may reduce further and get extinct if appropriate species-specific multiplication and conservation measures are not taken immediately.

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Author details

Md Akhter Hossain*, Rajib Mahmud, Nikhil Chakma and Mohammed Kamal Hossain

1 Institute of Forestry and Environmental Sciences Chittagong University, Chittagong, Bangladesh

2 Food and Agriculture Organization of the United Nations, Dhaka, Bangladesh

*Address all correspondence to: akhter.hossain@cu.ac.bd

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