Chapter

Wild Fodder Yielding Plants in the Protected Areas of Bangladesh

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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

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.

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 bioecological 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 km^2 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 km^2 [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 km^2 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

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

Habit forms	Number of species reported from the selected protected areas					
	Chunati Wildlife Sanctuary		Dudhpukuria-Dhopachari Wildlife Sanctuary		Madhupur National Park	
	Total	Fodder yielding	Total	Fodder yielding	Total	Fodder yielding
Trees	240	81	182	61	139	70
Shrubs	102	17	125	21	48	10
Herbs	211	61	200	70	136	43
Climbers	106	25	71	8	46	22
Ferns	19	4	17	4	9	2
Epiphytes	7	—	7	—	7	—
Parasites	6	—	6	—	—	—
Total	691	188	608	164	385	147

Table 2.
Flora of the selected protected areas [28–30].

Groups	Number of species in the selected protected areas		
	Chunati Wildlife Sanctuary	Dudhpukuria-Dhopachari Wildlife Sanctuary	Madhupur National Park
Amphibians	26	25	17
Birds	252	231	120
Fish	10	23	—
Mammals	40	50	27
Reptiles	54	56	28

Table 3.
Fauna of the selected protected areas [28–30].

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* Willd.	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.	Tetoyakoroi	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 ghaesembilla* Gaertn.	Chokoi, Elena	Euphorbiaceae	LC	0.2		2.6
14	*Aphanamixis polystachya* (Wall.) R.N. Parker.	Ptiraj	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	Arecaceae	LC	0.2		0.4
18	*Artocarpus chama* Buch.-Ham. *ex* Wall.	Chapalish, Chambal	Moraceae	NE (rare)	3.9	17.6	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	Arecaceae	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)		
					CWS	DDWS	MNP
26	*Buchanania lancifolia* Roxb.		Anacardiaceae	NE (rare)	0.2		
27	*Callicarpa arborea* Roxb.	Bormala, Khoja	Verbenaceae	LC	7.4	6.8	0.4
28	*Calophyllum polyanthum* Wall. *ex* Choisy	Chandua, Kamdeb	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	0.2	
32	*Cleistocalyx nervosum* (DC.) Kosterm. var. paniala (Roxb.) J. Parn. & P. Chantaranothai		Myrtaceae	LC	0.2		2.2
33	*Cocos nucifera* L.	Narikel	Arecaceae	LC	0.2	0.6	0.4
34	*Cordia dichotoma* Forst. f.	Bolla gota, Bohal, Bhola	Boraginaceae	LC			0.4
35	*Cordia dichotoma* Forst. f.	Bohal	Boraginaceae	LC	0.3		0.4
36	*Crateva magna* (Lour.) DC.		Capparaceae	LC	0.3		
37	*Cryptocarya amygdalina* Nees.	Ojha	Lauraceae	NE (rare)	2.5	3.4	21.9
38	*Dalbergia 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 blancoi* 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	Arecaceae	NE	0.3		0.4
44	*Elaeocarpus floribundus* Blume	Titpai	Elaeocarpaceae	LC	0.2	1.8	1.3
45	*Elaeocarpus tectorius* (Lour.) Poir.	Jalpai	Elaeocarpaceae	LC	2.5	2.2	
46	*Ficus auriculata* Lour.	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)		
					CWS	DDWS	MNP
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 semicordata* 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		Moraceae	NE	0.4	5.2	
56	*Ficus virens* Ait.	Pakur, Pakar, Paikur	Moraceae	LC	0.1		0.9
57	*Firmiana colorata* (Roxb.) R. Br.	Udal	Sterculiaceae	LC	0.2		
58	*Flacourtia jangomas* (Lour.) Raeusch.	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 lanceaefolia* Roxb.		Clusiaceae	NE	0.2		
61	*Garcinia xanthochymus* Hook. f. *ex* T. Anders.	Tamal, Dephal	Clusiaceae	LC		1	
62	*Garuga pinnata* Roxb.	Bhadi, Silbhadi, Jeolbhadi	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* (Willd. *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.		Sapindaceae	LC	0.2	0.2	
71	*Lepisanthes senegalensis* (Poir.) Leenh.	Gotaharina	Sapindaceae	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 sylvatica* Roxb.	Uriam	Anacardiaceae	V	0.1	0.2	
77	*Manilkara zapota* (L.) P. van Royen	Sofeda	Sapotaceae	LC			0.4
78	*Miliusa velutina* (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 Krisnachura	Caesalpiniaceae	LC	0.4		0.4
81	*Phoebe lanceolata* (Ness) Ness	Chaongri, Dulia	Lauraceae	NE		0.2	
82	*Phoenix acaulis* Roxb.	Bon Khejur, Khudi khejur	Arecaceae	V			0.4
83	*Phoenix sylvestris* Roxb.	Khejur	Arecaceae	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	*Sapium 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 pinnata* (L.f.) Kurz	Bon-Amra, Piala	Anacardiaceae	LC		3.4	0.4
93	*Sterculia hamiltonii* (O. Kuntze) Adelb.		Sterculiaceae	LC		0.2	
94	*Streblus asper* Lour.	Sheora, Harba	Moraceae	LC	1.5	2	0.9
95	*Syzygium balsameum* (Wight) Walp.	Buti Jam	Myrtaceae	LC		1	

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		Myrtaceae	NE	0.2		
103	*Syzygium tetragonum* Wall. *ex* Kurz.	Pholda jam, Lal Pholda	Myrtaceae	NE		3	
104	*Tamarindus indica* L.	Tentul	Caesalpiniaceae	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.	Katbadam	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

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].

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.		Caesalpiniaceae	LC	✓		
4	*Bridelia stipularis* (L.) Blume	Sitki (climbing)	Euphorbiaceae	LC	✓	✓	✓
5	*Caesalpinia hymenocarpa* (Prain) Hattink.		Caesalpiniaceae	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	✓		
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	✓		

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

Table 5.
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].

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 coerulescens*, and *Polygala furcata*.

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 macrorrhizos* (L.) G. Don	Mankatchu	Araceae	LC			✓
6	*Alternanthera philoxeroides* (Mart.) Griseb.	Helencha, Malancha shak	Amaranthaceae	LC			✓
7	*Amaranthus spinosus* L.	Kantashakh, 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		
					CWS	DDWS	MNP
22	*Brassica oleracea* L. var. botrytis L.	Phulkopi	Brassicaceae	LC	✓		
23	*Bryophyllum pinnatum* (Lamk.) Oken	Pathorkutchi, Pathorchura	Crassulaceae	LC	✓		✓
24	*Capillipedium assimile* (Steud.) 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 oresbia* 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 arcuatus* 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 cyperoides* (L.) O. Ktze.	Kucha, Kusha	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 Shama-ghas	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.	Koni Ghas	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	*Hydrolea 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	*Saccharum officinarum* L.	Akh	Poaceae	CD	✓		
102	*Saccharum ravennae* L.	Ekor	Poaceae	DD	✓		
103	*Saccharum spontaneum* L.	Kash, Kaichcha, Kagara	Poaceae	LC	✓	✓	
104	*Sacciolepis indica* (L.) A. Chase		Poaceae	LC		✓	
105	*Sagittaria sagittifolia* L.	Muyamuya, Chhotokut	Alismataceae	LC		✓	
106	*Senna hirsuta* (L.) Irwin & Barneby		Caesalpiniaceae	NE		✓	
107	*Sesbania bispinosa* (Jacq.) Wight.		Fabaceae	LC	✓		
108	*Setaria sphacelata* (Schum.) Stapf. & C.E. Hubb. *ex* M. B. Moss		Poaceae	CD		✓	
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	*Typhonium 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			✓

SN	Botanical name	Local name	Family	Conservation status	Occurrence in selected PAs		
					CWS	DDWS	MNP
118	*Xanthosoma violaceum* Scott.	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].

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		
					CWS	DDWS	MNP
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.	Chalkumra	Cucurbitaceae	LC	✓		
6	*Caesalpinia digyna* Rottler	Kotchoi Kanta, Umulkuchi	Caesalpiniaceae	LC	✓	✓	
7	*Calamus latifolius* Roxb.	Budum bet, Korak bet	Arecaceae	V	✓	✓	

SN	Botanical name	Local name	Family	Conservation status	Occurrence in the PAs		
					CWS	DDWS	MNP
8	*Calamus tenuis* Roxb.	Chiringbet, Sanchi Bet, Bandari Bet, Jali bet	Arecaceae	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	Lalong-chhali, Keti	Fabaceae	LC		✓	
17	*Dioscorea belophylla* (Prain) Voigt *ex* Haines	Dudh alu	Dioscoreaceae	LC			✓
18	*Dioscorea bulbifera* L.	Pagla Alu	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* Forssk.	Kalmi Shakh	Convolvulaceae	LC	✓		
23	*Ipomoea batatas* (L.) Lamk.	Mistialu	Convolvulaceae	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	✓		✓

SN	Botanical name	Local name	Family	Conservation status	Occurrence in the PAs		
					CWS	DDWS	MNP
30	*Momordica cochinchinensis* (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	*Tetrastigma bracteolatum* (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	Dhekia Shak	Angiopteridaceae	LC		✓	
41	*Blechnum orientale* L.		Blechnaceae	LC	✓	✓	
42	*Christella arida* (D. Don) Holtt.	Bish Dhekia	Thelypteridaceae	LC			✓
43	*Diplazium esculentum* (Retz.) Sw.	Dhekia, Dhekia Shak	Athyriaceae	LC	✓	✓	
44	*Helminthostachys zeylanica* (L.) Hook.	Shada Dhekia	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].

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

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 habit 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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