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Phytodiversity in Beeshazar Lake and Surrounding Landscape System

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Abstract

This paper deals in general with diversity of vascular plants, status of invasive alien species (IAS) and nationally threatened plant species, human use potentials of phytodiversity, and some phytodiversity-based measures to restore and improve the Ramsar characteristics of Beeshazar Lake and surrounding landscape system, which isa part of the Barandabhar forest corridor (BFC) - an extension of buffer zone of the Chitwan National Park, Nepal.

Keywords: Phytodiversity, Beeshazar Lake

Introduction

A Ramsar site spreaded over in 3200 ha area, Beeshazar Lake and the surrounding landscape system (Lat N 27°24'-27°40', Long E 84°21'-84°24', average altitude 286 m, msl) is situated within the Barandabhar Forest Corridor (BFC) south to Mahendra Highway in Chitwan district of central Nepal. It is an extension of the buffer zone of Chitwan National Park (a World Heritage Site) supporting an appreciable assemblage of rare, vulnerable and endangered flora and fauna including white-rumped vulture (*Gyps bengalensis*), Royal Bengal tiger (*Panthera tigris*), one-horned rhinoceros (*Rhinoceros unicornis*), Asiatic elephant (*Elephas maximus*), barking deer, ghariyal (G*avialis gangeticus*), smooth-coated otter (*Lutra perpiscillata*), sloth beer (*Melaurus ursinus*), marsh crocodile (*Crocodylus palustris*), lesser adjutant stork (*Leptoptilos javanicus*), ferruginous duck (*Athyra nyroca*), band-tailed fish eagle (*Haliaetus leucoryphus*), and several species of migratory birds. Nevertheless, this unique Ramsar site is beset with numerous environmental problems, the major ones being its location adjacent to Mahendra Highway, ever increasing human population, high dependence of the majority of local people on the natural resources, and dearth of alternative livelihood options, eutrophication and excessive growth of weeds in the lake, low awareness for conservation benefits, and low incentive for conservation. Maintenance of the life-support functions of this Ramsar site requires two basic approaches: (a) scientific study of its varied biodiversity components to develop insights in their ecological functions and human use, and (b) to seek active and informed participation of the local people in landscape management. In this context, the major objective of the present study was to enumerate local as well as invasive, and nationally threatened plant species, along with the frequency of occurrence of each species found in Beeshazar Lake and the surrounding landscapes.

Materials and Methods

An intensive survey of the diversity of vascular plants found in Beeshazar Lake and surrounding areas was undertaken in the year 2007. Locations selected for this purpose were Machan area, Beeshazar Lake area, and the Guard Post area of BFC (Figure 1); as well as some homestead orchards occurring in Geetanagar VDC. All the selected locations of BFC possessed diverse habitats including water bodies, marshes/swamps, grasslands and forests even within a radius of 2 km.

The frequency of occurrence of the tree species was estimated using random quadrates of 400 m^2 size in adequate numbers. On the average if only one individual occurred per quadrate, the frequency of that tree species was considered occasional; if the number of individuals were between 2 and 4, the species was categorized as frequent; and those species having 5 or more individuals per 400 m^2 area were called abundant. Frequency of occurrence of woody climbers, shrubs, under shrubs, herbaceous climbers, terrestrial herbs, epiphytes, and aquatic herbs was classified into abundant,

The name list of the invasive alien species (IAS) was prepared as per the standard information (Hara *et al.*, 1978-1982; Jha and Jha, 2000); whereas the list of nationally threatened plant species was prepared as per the information given by Shrestha and Joshi (1996).

Information on human use potentials of the plant species were obtained from the local people and /or through standard literature (CSIR, 1989).

Results and Discussion

Phytodiversity

In total, 507 species of vascular plants (Pteridophytes 17 species; Angiosperms 490 species) were recorded from all the selected locations, among which 14.6% were trees, 17.6% shrubs and woody climbers (lianas), 46.6% terretrial herbs, and 11.4% aquatic herbs (Jha 2007).

The mixed deciduous forest of the study site was dominated by *Shorea robusta* (Sal) with *Terminalia alata* (Asana) as the co-dominant species. Other major associated tree species were *Adina cordifolia* (Karma), *Alstonia scholaris* (Chhatiwan), *Cleistocalyx operculatus* (Kyamun), *Dillenia pentagyna*, *Duabanga grandiflora* (Lampate), *Ficus semicordata* (Khanyu), *Holarrhena pubescens* (Madise-khirro), *Mallotus philippensis* (Sindure), *Schleichera oleosa* (Kusum), *Semecarpus anacardium* (Bhalayo), *Streblus asper*, *Syzygium cumini* (Jamun), and *Toona ciliata* (Tooni). Major riverine tree species of the BFC included *Acacia catechu* (Khair), *Bombax ceiba* (Simal)), *Duabanga grandiflora*, *Ficus semicordata*, *Hymenodictyon excelsum* (Bhurkul), *Terminalia alata*, and *Trewia nudiflora*. The average number of trees in BFC was 270/ha, and average regeneration of trees 890/ha.

Notable shrubs of the BFC were *Acacia pennata, Asparagus racemosus* (Kurilo), *Butea minor* (Palas), *Caesalpinia bonduc, C. decapetala, Combretum flagrocarpum, Derris cuneifolia, Flacourtia jangomas, Grewia optiva, Justicia adhatoda, Lantana camara, Leea aequata, Mimosa rubicaulis, Phoenix humilis, Woodfordia fruticosa, Xeromphis spinosa* and *Ziziphus mauritiana;* whereas, *Abrus precatorius, Ampelocissus latifolia, Bauhinia vahlii* (Bhorla), *Celastrus paniculatus, Ichnocarpus frutescens, Pothos cathcartii, Scindapsus officinalis, Smilax ovalifolia, Spatholobus parviflorus*, and

Tinospora sinensis were the notable woody climbers (lianas) of the study site.

Among the terrestrial herbs, *Chrysopogon aciculatus* dominated the heavily grazed grasslands, *Imperata cylindrica* the moderately grazed grasslands and *Saccharum spontaneum* was the dominant species in the partially grazed/ungraged grasslands.

Among the hydrophytes of the study site, common emergent species were *Acorus calamus, Aeschynomene asper, Brachiaria mutica, Butomopsis latifolia, Ceratopteris thalictroides, Cyperus pilosus, C. platystylis, Echinochloa colona, Hygrophila auriculata, H. polysperma, Ipomoea aquatica, I. carnea,* subsp. *fistulosa, Leersia hexandra, Limnophila heterophylla, Ludwigia adscendens, Marsilea crenata, Monochoria hastata, Oryza rufipogon, Persicaria barbata, P. lapathifolia, Sacciolepis indica, Schoenoplectus mucronatus, Sphenoclea zeylanica, Tamarix dioica* and *Typha angustifolia;* common submerged species were *Callitriche stagnalis, Ceratophyllum demersum, Hydrilla verticillata, Ottelia alismoides, Potamogeton crispus, Utricularia aurea* (an insectivorous plant), and *Vallisneria natans*; common floating-leafed species were *Nymphaea pubescens, Nymphoides hydrophyllum* and *Trapa quadrispinosa*, whereas, notable free-floating species were *Azolla imbricata, Eichhornia crassipes, Hygroryza aristata, Lemna perpusilla, Pistia stratiotes*, and S*pirodela polyrhiza.*

In general, there is a shortage of certain nutrients essential for development of life, e.g., minerals such as potassium, calcium, phosphorus and magnesium in the tropical zone; that is why the vegetation present in spite of its abundance, contains a comparatively small amount of these nutrients. Consequently it requires considerable effort from larger animals to collect enough salts to keep their bodies in condition. This explains why only a relatively small density of higher animals is found in the tropical forest. Another reason why these animals need a large area in order to find enough food is that, as a result of there being a larger number of different plant species, only a few individuals of any single species of tree are found, per hectare. Many animals depend on certain trees for their existence and so have to travel great distances. Thus, large tracts of the forest need to be maintained in order to cater for these species.

Grasslands and seasonal marshes of the BFC require management actions to arrest the progressive vegetation succession, and to increase the number and abundance of the palatable herbaceous species for the herbivorous wildlife. It can be achieved either through periodic manual defoliation or through prescribed burning (Riggin *et al*. 1988). Grazing by domestic livestock is inimical to the interest of wildlife, since wildlife can never compete successfully with domestic stock under ordinary circumstances, and domestic animals transmit contagious diseases to wildlife like foot and mouth disease, rinderpest, surra (sleeping sickness), haemorrhagic septicaemia, anthrax, etc. Keeping animals in stalls and cutting fodder by hand to bring them (zero grazing) can reduce the risk.

Invasive Alien Species (IAS)

Thirteen invasive alien species (exotic weed species) were recorded from the study area (Table 1) among which the highly obnoxious species were *Chromolaena odorata, Eichhornia crassipes, Eupatorium adenophorum, Ipomoea carnea* subsp. *fistulosa, Lantana camara, Mikania micrantha*, and *Parthenium hysterophorus*.

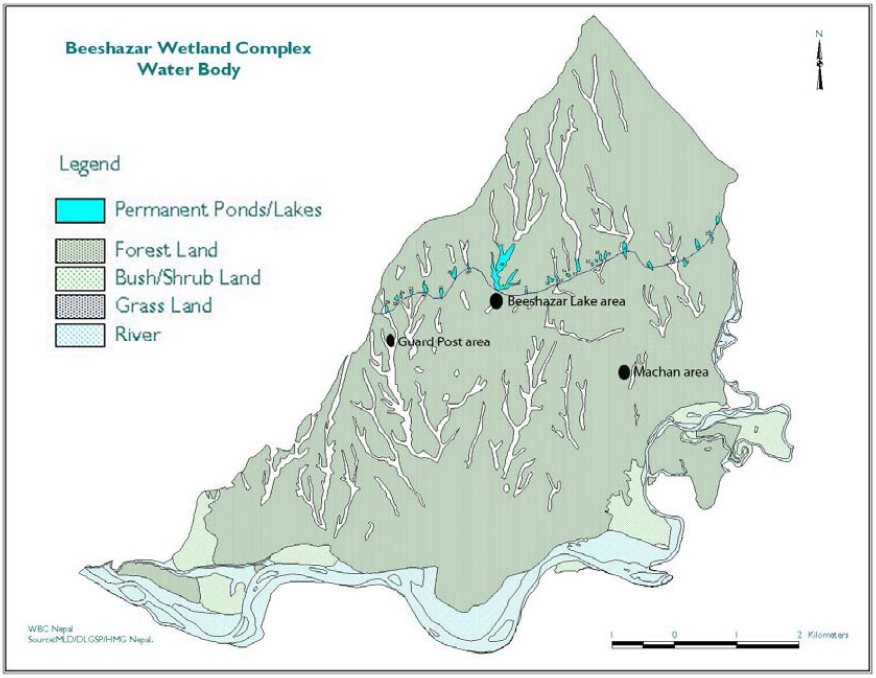

Figure 1. Map of the study site

Table 1. Invasive Alien Species (IAS) of plants (Exotic weed species)

S.N.	Species	Distribution
1.	*Chromolaena odorata*	A native of New World Tropics; naturalized
2.	*Eichhornia crassipes*	South America; naturalized widely in Asiatic Tropics
3.	*Eupatorium adenophorum*	A native of Mexico; introduced into the Himalayas about 100 years ago
4.	*Gomphrena celosioides*	Introduced from tropical America; naturalized
5.	*Hyptis suaveolens*	Introduced from tropical America; naturalized
6.	*Ipomoea carnea* subsp. *fistulosa*	A native of New World Tropics; naturalized
7.	*Latana camara*	Introduced from tropical America; naturalized
8.	*Mecardonia procumbens*	A native of subtropical America; naturalized
9.	*Mikania micrantha*	A native of South America; naturalized
10.	*Parthenium hysterophorus*	A native of tropical America; naturalized
11.	*Peperomia pellucida*	A native of tropical America; naturalized
12.	*Solanum aculeatissimum*	A native of tropical America; naturalized
13.	*Tridax procumbens*	A native of South America; naturalized

These species compete with native flora for the resources very successfully, and possess strong allelopatic potentials. Evidences indicate that secretions of pollen grains of the IAS on the stigma can affect the development of pollen or ovule maturation of the native floras (Kanchan and Jayachandra 1980) .Thus the IAS are potent threats to native species propagating through seeds. Nevertheless, the allelopathic potential of one IAS can be used in bio-control of another IAS. For example, Saxena (1992) has reported that aqueous extract of flowers of *Lantana camara* inhibits the growth of *Eichhornia crassipes* even at a very low concentration. This bio-control potential of *Lantana camara* against *Eichhornia crassipes* needs intensive investigation in context to the weed problems of Beeshazar Lake.

Nationally threatened plant species

Among the nationally threatened plant species (Table 2) recorded from the BSF, only *Shorea robusta* had fairly frequent presence; other species were occasional to scarce in distribution in the study area.

Table 2. Nationally threatened plant species found in Beeshazar lake system and adjoining terrains.

S.N.	Species	Frequency of occurrence
1.	*Acacia catechu*	Occasional
2.	*Alstonia scholaris*	Occasional
3.	*Asparagus racemosus*	Occasional
4.	*Bombax ceiba*	Scarce
5.	*Oberonia falconeri*	Occasional
6.	*Rauvolfia serpentina*	Scarce
7.	*Piper longum*	Scarce
8.	*Shorea robusta*	Frequent
9.	*Terminalia bellirica*	Occasional
10.	*T. chebula*	Scarce
11.	*Vanda cristata*	Occasional

Bird habitat

Birds are the keystone species of the Ramsar site, hence restoration of Beeshazar Lake and adjoining areas must be aimed for the enhancement of protected habitats and improvement of populations of at least huntable water- fowls (ducks, geese and swans) and vanishing wading birds (webless long- legged water birds such as cranes, herons, egrets, etc.). These species depend on the wetlands for food from fish and aquatic insects to plants and their nectar or fruits. Cover and nesting opportunities are also abundant in wetlands due to their natural phytodiversity and general inhospitality to humans; and open water areas provide a barrier to many mammalian predators. Besides these, wetlands reduce temperature extremes through all seasons; their vegetation density provides protective shelter from severe winter winds and summer heat; and tall trees (living or dead) present within or in the immediate vicinity of the wetlands are the excellent perching and nesting options for several bird species.

In general, for the restoration and enhancement of its Ramsar characteristics Beeshazar lake urgently requires: (i) removal of *Eichhornia crassipes* and other weeds to maintain clean open water, (ii) introduction of some suitable hydrophytes such as *Nelumbo nucifera* (Kamal), *Nymphaea stellata* (red Kumudini), and *Nymphoides indica* into its shallow-water regions as feed for birds and for their aesthetic aspects; and (iii) plantation of the native pant species such as *Acorus calamus* (Bojho), *Calamus tenuis* (Baint), *Duabanga grandiflora* (Lampate), *Erianthus ravennae*, *Ficus semicordata* (Khanyu), *Hymenodictyon excelsum* (Bhurkul), *Narenga porphyrocoma* (Kharahi), *Pandanus nepalensis* (Kebra), *Salix tetrasperma*, *Trewia nudiflora* (Guler); and

Typha angustifolia (Pater) on its land-water interface to check the eutrophication of the lake.

Human use potentials of plant diversity

People living in the surrounding areas of BSF are primarily agriculture based and horizontal expansion of agriculture has already encroached substantial part of BSF in the past. Solution to this problem is the development and growth of other sectors so that population is weaned away from the land. In this context, plant diversity of BSF has tremendous potentials to be utilized for he establishment of small scale cottage industries such as collection and processing of medicinal plants, 'katha" (catechu), honey, silk, lac, etc; and handicrafts based on traditional skills such as wood-works, weaving of cordage, mats, baskets, etc, (Table 3). It will generate adequate income and employment opportunity for the havenots besides improving the biological environment. It will also encourage social fencing of the BSF. A brief description of the potential uses of the plant diversity of BSF is given in following paragraphs.

Edible plants: The plants with edible parts are fruits of Bel, Anta, Sarifa, Kathar, Mewa, Aamp, Amba, Aru, Anar, Jamun, Singhara, and Ber. Leaves of Mitho-Neem are used for flavouring curry, whereas fruits of Pate-amla, Amala, Amari, Karona, Imali are used in chutneys and/or in pickles. Young shoots of Podo-sag, Karkalo, Karmi, Purbeli-sag, Sisnu, Nigro, Jibre-sag, Pani- and Rukh-neuro are used as pot- herbs.

Feed for livestock: Foliage of 76 plant species were recorded as fodder for livestock out of which notable tree and shrub species were Khair, Chieuri, Kadam, Kathar, Koiralo, Gayo, Palas, Lampate, Phaledo, Nebharo, Khasreto, Khanyu, Phalsa, Madishe-Khirro, Ziznmar, Ipil-ipil, Kutmero, Bakaino, Tatelo, Tooni, etc. The foliage of plant species with potentials to increase flow of milk when fed to cattle are Palas, Apang-ghans, Lajjabati, Karmi and *Nymphoides hydrophyllum.*

Medicinal: Among the enlisted plants with medicinal properties (51 species, Table 3): seeds of *Abutilon indicum* are rich in mucilage and are laxative and demulcent; the powdered rhizomes of Bojho produce beneficial results in cases of dyspesia and chronic diarrhoea; the unripe or half- ripe Belt fruit is regarded as astringent, digestive and stomachic, beneficial in cases of diarrhoea and dysentery; whereas ripe Bel fruit is sweet, aromatic and cooling; the leaves of Gandhe are used for cuts and sores; Gurjo is used as a substitute for Chirayita (*Swertia chirayita*); *Biophytum sensitivum* has insulin like principles; fruits of Gaj-pipal and root-barks of Kurilo have aphrodisiac properties; whereas barks of Chhatiwan have abortifacient properties; the fresh tender leaves of Gayo are used for the treatment of jaundice; a concentrated infusion of the roots of Bhimsen-pati finds use as a treatment for malaria; the leaves and seeds of Gainde-kanda are used in external applications for dispersing inflammatory swellings; the fresh juice of Ankuri- phul is prescribed in insaniy, epilepsy and nervous debility; Ghod-tapde is used as diuretic, alterative and tonic, and sometines used in the treatment of leprosy; the seeds of *Chrozophora rottleri* are used as cathartic; like Ghod- tapde, *Commelina benghalensis* is also useful in leprosy; the fruits of Aule-bohari is astringent, anthelmintic, diuretic, demulcent and

Table 3. Human use of plant species found in Beeshazar Lake system and adjoining areas (Nepali name of the plant species is given in bracket)

A. *Edible fruits/ Vegetables/ Pot-herbs*

(i) Angiosperms

Aegle marmelos (Bel)
*A. squamata (*Sarifa)
Antidesma acidum (Amari)
Artocarpus heterophyllus (Kathar)
*Basella alba (P*odo-Sag)
Carica papaya (Mewa)
*Carissa carand*as (Karona)
Colocasia esculenta (Karkalo)
Ipomoea aquatica (Karmi)
*Lasia spinosa (*Purbeli-Sag)
Mangifera indica (Aamp)
Morus australis (Kimu)
Murraya koenigii (Mitho-Nim)
Phyllanthus acidus (Pate-Amala)
P. emblica (Amala)
Psidium guajava (Amba)
Prunus persica (Aru)
Punica granatum (Anar)
Syzygium cumini (Jamun)
Tamarindus indica (Imali)
Urtica dioica (Sisnu)
Trapa quadrispinosa (Singhara)
Ziziphus maurtiana (Ber)

(ii) Peteridophytes

Ampelopteris prolifera (Nigro)
Diplazium esculentum (Pani-neuro)
Ophioglossum petiolatum
Stenochlaena palustre

B. *Feed for Livestock*

Acacia catechu (Khair)
Aesandra butyracea (Chieuri)
Amischophacelus axillaris
Anthocephalus chinensis (Kadam)
Artocarpus heterophyllus (Kathar)
Arundinella benghalensis
Atylosia scarabaeoides
Axonopus compressus
Bauhinia purpurea (Koiralo)
Brachiaria distachya
B. mutica
B. ramosa
Bridelia retusa (Gayo)
Butea minor (Palas)
Carex nubigena
Setaria glauca
Smithia ciliata
Sporobolus diander
Sterculia villosa (Odalo)
Terminalia bellirica (barro)
T. chebula (Harro)
T. bellirica (Barro)
Toona ciliata (Tooni)
Vetiveria zizanioides (Siki/ Khus)
Ziziphus mauritiana (Baer)

C. *Medicinal*

Abutilon indicum
Acorus calamus (Bojho)
Aegle marmelos (Bel)
Ageratum conyzoides (Gandhe)
Alstonia scholaris (Chhatiwan)
Asparagus racemosus (Kurilo)
Azadirachta indica (Neem)
Biophytum sensitivum
Boerhavia diffusa (Punarnava)
Lippia nodiflora (Kurkure-jhar)
Ludwigia adscendes
Mimosa pudica (Lajjabati)
*Monochoria hastat*a (Neel-kamal)
Mucuna pruriens (Kauchho)
Nymphoides hydrophyllum
Ottelia alismoides
Oxystelma esculentum (Arnasinge-laharo)
Birdelia retusa (Gayo)
Buddleja asiatica (Bhimsen-pati)
Caesalpinia bonduc
Canscora diffusa (Ankuri-phul)
Centella asiatica (Ghor-tapde)
Chrozophora rottleri
Commelina benghalensis
Cordia dichotoma (Aule- bohari)
Costus speciosus (Betlauri)
Datura metel (Dhaturo)
Deeringia amaranthoides
Eclipta alba (Bhringaraj)
Equisetum debile (Ankhali)
Euphorbia hirta (Dudhe-jhar)
Glochidion lanceolarium
Hydrolea zeylanica
Hygrophila auriculata
Peperomia pellucida
Phyllanthus emblica (Amala)
P. reticulatus (Sikat)

G. *Bee- keeping /Sericulture / Lac-insects*

Bombx ceiba (Simal)
Clematis acuminata
Litsea monopetala (Kutmero)
Mangifera indica (Aamp)
Morus australis (Kimu)
Phyllanthus emblica (Amala)
Pithecellobium dulce (Jilebi)
Pogostemon benghalensis (Rudilo)
Ricinus communis (Andi)
Syzygium cumini (Jamun)
Tamarindus indica (Imali)
Terminalia alata (Asana / Saj)
T. bellirica (Barro)
T. chebula (Harro)
Ziziphus muritiana (Baer)

H. *Green manure / Compost*

Artemisia dubia (Titepati)
Azolla imbricata
Ceratopteris thalictroides
Eichhornia crassipes (Kechali)
Monochoria hastata (Neel kamal)
Pistia stratiotes (Kumbhi)
*Sesbania sesban (*Dhaincha)

I. *Insect repellents*

Achyranthes aspera (Apmarg)
Acorus calamus (Bojho)
Azadirachta indica (Neem)
Cascabela thevetia (Kaner)
Mucuna pruriens (Kauchho)
Solanum surattense (Barberi)
S. torvum (Bihi)
Sphaeranthus indicus
Tridax procumbens (Husure-jhar)

J. *Miscellaneous*

(i) Silk cotton

Bombax ceiba (Simal)
Calotropis procera (Aak)

(ii) Katha (catechu)

Acacia catechu (Khair)

(iii) Paper pulp

Dendrocalamus strictus (Bans)
Eucalyptus citriodora (Masala)
Imperata cylindrica (Siru)

Contd…

Chrozophora rottleri
Codariocalyx gyroides
Coix lachryma - jobi (Bhirkaule)
Commelina benghalensis
C. paludosa
Cynodon dactylon (Dubo)
Dactyloctenium aegypticum
Desmodium heterocarpon
D. triflorum (Jungli-Methi)
Desmostachya bipinnata (Kush)
Dichanthium annulatum
Digitaria ciliaris (Chitre-banso)
Duabanga grandiflora (Lam-pate)
Echinochloa colona (Sama)
Eleusine indica (Kode-jhar)
Eragrostis tenella
E. unioloides
Erythrina suberosa (Phaledo)
Ficus auriculata (Nebharo)
F. hispida (Khasreto)
F. semicordata (Khanyu)
Grewia optiva (Phalsa)
Heteropogon contortus
Holarrhena pubescens
Imperata cylindrica (Siru)
Indigofera linifolia
Ipomoea aquatica (Karmi)
Lannea coromandelica (Ñnmar)
Leersia hexandra
Leucaena leucocephala (Ipil-ipil)
Litsea monopetala (Kutmero)
L. salicifolia
Medicago lupulina
Melia azedirach (Bakaino)
Mimosa pudica (Lajjabati)
Morus australis (Kimu)
Mucuna pruriens (Kauchho)
Nymphoides hydrophyllum
Oroxylum indicum (Tatelo)
Oryza rufipogon (Jungli-dhan)
Panicum paludosum
Paspalidium flavidum
Paspalum conjugatum
P. distichum
P. scrobiculatum
Phragmites australis (Narkat)
P. karka (Narkat)
Phyllodium pulchellum
Pogonatherum crinitum
Reinwardtia indica (Pyauli)
Saccharum spontaneum (Kans)
Sacciolepis indica
Piper longum (Pipla)
Rauvolfia serpentina (Sarpgandha)
Rorippa nasturtium-aquaticum
Sambucus hookeri (Galeni)
Scindapsus officinalis (Gaj-pipal)
Solanum aculeatissimum (Kataiya)
Sphaeranthus indicus
Syzygium cumini (Jamum)
Terminalia bellirica (Barro)
T. chebula (Harro)
Tinospora sinensis (Gurjo)
Tridax procumbens (Hussure-jhar)
Vallisneria natans
Vetiveria zizanioides (Siki / Khus)

D. *Agriculture/ household implements*
Acacia catechu (Khair)
Adina cordifolia (Karma)
Artocarpus heterophyllus (Kathar)
Bombax ceiba (Simal)
Cassia fistula (Amaltas)
Cassine glauca (Pitojhia)
Cordia dichotoma (Aule-bohari)
Dalbergia sissoo (Sisau)
Dendrocalamus strictus (Bans)
Duabanga grandiflora (Lampate)
Holarrhena pubescens
Mitragyna parviflora (Kaim)
Schleichera oleosa (Kusum)
Semecarpus anacardium (Bhalayo)
Shorea robusta (Sakhua/ sal)
Syzygium cumini (Jamun)
T. bellirica (Barro)
Terminalia alata (Asana / Saj)
T. chebula (Harro)

E. *Thatch/codage*
Desmostachya bipinnata (Kush)
Erianthus ravennae
Imperata cylindrica (Siru)
Narenga porphyrocoma (Kharahi)
Phragmites karka (Narkat)
Saccharum spontaneum (Kans)
Typha angustifolia (Pater)

F. *Mats / Brooms /Basketry*
Chrysopogon aciculatus (Kuro)
Dendrocalamus strictus (Bans)
Typha angustifolia (Pater)
Thysanolaena maxima (Amliso)
Vetiveria zizanioides (Khus/ Siki)
Saccharum spontaneum (Kans)

(iv) Biodiesel /lubricant / edible oil
Aesandra butyracea (Chieuri)
Jatropha curcas (Baghandi)
Ricinus communis (castor)

(v) Breeding stocks
Curcuma zedoaria
Hygroryza aristata
Leersia hexandra (Nabo-dhan)
Oryza rufipogon (Jungali-dhan)
Saccharum spontaneum (Kans)
Shuteria involucrata (Bhatmas)
Solanum surattense (Barberi)
S. torvum (Bihi)

(vi)Intoxicant / alcoholic drink
Aegle marmelos (Bel)
Artocarpus heterophyllus (Kathar)
Cannabis sativa (Bhang)
Ziziphus mauritiana (Baer)

(vii) Hedge plants
Bauhinia purpurea (Koiralo)
Caesalpinia pulcherrima
Delonix regia (Gulmohar)
Erythrina suberosa (Phaledo)
Euphorbia pulcherrima (Lalu-pate)
Ficus auriculata (Nebharo)
Leucaena leucocephala (Ipil-ipil)
Morus australis (Kimu)
Murraya koenigii (Mitho-Nim)
M. paniculata (Kamini)
Saraca asoka (Asok)
Sesbania grandiflora (Agasti)
Streblus asper (Sahaur)
Terminalia catappa (Badam)

(viii) Religious plants
Aegle marmelos (Bel)
Cynodon dactylon (Dubo)
Desmostachya bipinnata (Kush)
Ficus benghalensis (Bar)
F. religiosa (Peepal)
Oroxylum indicum (Totalo)
Phyllanthus emblica (Amala)

(ix) Food plates
Bauhinia vahlii (Bhorla)
Shorea robusta (Sal)

rhizome of Betlauri is credited with purgative and tonic properties; dried leaves of Dhaturo have narcotic and antispasmodic properties; leaves of *Deeringia amaranthoides* are applied to sores, and roots of this plant are useful as sternutatory; Bhrigraj is used as tonic and deobstruent in hepatic and spleen enlargements and skin diseases, and leaf-juice of Bhringaraj boiled with coconut oil is used in anointing the head to render the hair black and luxuriant; latex of Dudhe- jhar is used as application for warts; Ankhali contains silica in therapeutically active form; leaves of *Hydrolea zeylanica* are considered to possess cleansing and antiseptic properties; roots, leaves and seeds of Gokhur-kanda are used as diuretics, and also employed for jaundice, dropsy, rheumatism, anasaraca, diseases of the urinogenital tract; leaves of Sikat are considered diuretic and cooling; the crushed leaves of *Peperomia pellucida* are used in the applications for headache and fever, and plant juice is given in abdominal pain; fruits of Amala are acrid, cooling, refrigerant, diuretic and laxative; roots of Sarpagandha has sedative properties; *Rorippa nasturtium-aquaticum* possesses antiscorbutic and stimulant properties and is eaten fresh to improve appetite; a powder of the leaves of Galeni is used as snuff to stop bleeding of the nose; pounded roots of Kataiya are applied to the gums to relieve toothache; juice of Bhuin-kadam is styptic and said to be useful in liver and gastric disorders; extracts of bark and seeds, and also leaves of Jamun are used in the treatment of diabetes; the fruit of Barro is well-known commercial myrobalan **called bellric myrobalan**; in combination with Amala and Barro, fruits of Harro are extensively used as adjuncts to other medicines in almost all diseases under the name 'Triphala;' leaves of Husure-jhar are reported to be employed for restoring hair; the vetiver oil obtained from the roots of Siki / Khus is applided locally in rheumatism, lumbago and sprain; and *Vallisneria natans* is used as a stomachic, and for leucrrhoea.

Agricultural and household implements: Woods of 19 plant species (Table 3) are suitable for the construction of agricultural and household implements including ploughs, yokes, tool handles, carts, cartwheels, spokes, cots, pegs, pestles, pastry board, pastry roller, churner, door frames, furniture, etc.

Thatch and cordage: Plants used for thatching the huts and cattle shedes are Kush, *Erianthus ravennae*, Siru, Kharahi, Narkat, Kans, and Pater; whereas Kans and barks of Odalo are used in making cordage.

Mats/ brooms/ basketry: Culms of Pater and rachis of Khus are woven into mats; Bans are used for wicker-work, baskets and other types of containers and furniture; and roots of Khus are used in making screens (Khus-chicks) which are hung like curtains in the houses, and when sprinkled with water impart a fragrant coolness to the air. The culms of Amliso and Kuro are used as brooms.

Bee-keeping/ sericulture/ lac-insects: The blossoms of Simal, *Clematis acuminata*, Aamp, Amala, Jilebi, Rudilo, Jamun, Imali, Harro and Barro are important sources of nectar for the honey-bees; the tasar silkworms (*Antheraea mylitta*) feed on the foliage of Jamun, Asana, Kimu, Andi and Barro and Muga silkworms feed on the

foliage of Kumtero; whereas Imali and Baer are the hosts of lac-insects.

Green manure/ compost: The plant species utilized as green manure and compost are *Azolla imbricata* which harbours *Anabaena azollae*, a nitrogen fixing blue-green alga (BGA) in its foliar intercellular spaces; whereas Titepati, Pani-dhaniya, Kechali, Neel-kamal, Kumbhi, and Dhaincha can be utilized in compost preparation.

Insect repellents: The powdered rhizome of Bojho possesses insecticidal properties and is useful against bed-bugs, moths, lice, etc.; fruits of Barberi and Bihi contain active principles against mosquito larvae; the petroleum ether axtract of Husure-jhar has insecticidal and parasiticidal properties; dried shoots of Neem and Bhuin-kadam are mixed with paddy and wheat grains to prevent their damage in storage; and, the seeds of Apmarg ground into a paste are used as external application for poisonous insect-bites.

Miscellaneous: (i) Silk cotton: Floss of Simal and Aak is suitable for stuffing mattresses, cushions and pillows; (ii) Katha (catechu); Khair: yields catechu for use in Pan (betel) preparation; (iii) Paper pulp: Plants suitable for paper-plup are Bans, Masala, Siru and Kans; (iv) Biodiesel/ lubricant/ edible oil: Flowers of Chieuri yield edible butter ; seeds of Baghandi yield bio-diesel; and seeds of Andi (castor) yield lubricant used in bullock carts; (v) Breeding stocks: *Hygroryza aristata*, Nabo-dhan and Jungali- dhan may be used as breeding stocks for paddy; Kans for sugarcane; Barberi for brinjal; Bihi for tomato; *Shuteria involucrata* for soybean; and *Curcuma zedoaria* for turmeric; (vi) Country liquor: Fruits of Bel, Kathar and Baer have potentials to be used in preparation of country liquor, whereas leaves of Bhang is used as a traditional intoxicant; (vii) Food plates: Leaves of Sal and Bhorla are used as food plates; (viii) Hedge plants: Fourteen plant species enlisted in Table 3 are suitable for hedge/ fencing; (ix) Religious plants: Notable religious plants of the study site were Bel, Dubo, Kush, Bar, Peepal, Tatelo and Amala.

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