

Review on Plant diversity Status and Conservation Practices in Nepal

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Abstract

Plant diversity plays the crucial role in maintaining the ecosystem and sustaining the life in the globe. Nepal lying in central Himalaya and at the crossroad of two phytogeographic regions is bestowed with rich biodiversity. Though the country occupies about 0.1% of global land area but comprises 3.2% of world's known flora. Biodiversity is eroding because of many factors such as habitat loss, deforestation, infrastructure development, over exploitation for human use, invasion by alien species, global climate change and natural calamities, thus threatening the existence in globe. Nepal has adopted both in-situ and ex-situ conservation practices to conserve the biodiversity and maintain the ecosystem in nature. A network of 20 protected areas is established and national forests under different categories are under protection to conserve the biodiversity in their natural habitats. Scientific forest management was initiated to enhance the forest productivity and conserve biodiversity. Botanical gardens in different localities are established for the conservation of rare, endangered, threatened and endemic plant species. Moreover, Government of Nepal has enlisted some plant species in Government protection list and CITES appendices to prevent them from degradation. Thirty three plant species with medicinal values are prioritized for research and economic development of the nation. Nepal's approach in conservation of plant diversity is commendable and is at the forefront in in-situ conservation practice. However, a considerable number of plants species that are rare, threatened, endemic are also found outside the protected areas and need to be conserved.

Key words: Plant diversity, *Ex-situ*; *In-situ*, Protected areas, Nepal.

1. Introduction

Biological diversity or biodiversity refers to the range of variations or differences among the living organisms of the world, and thus includes all the life forms from unicellular microscopic organisms to multicellular plants and animal with complex bodies. The term "Biological diversity" was first coined by Dasman in 1968, who also advocated the urgent need for conservation of biodiversity. The Convention on Biological Diversity (CBD, 1992), in its article 2 has defined the biological diversity "as the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part: this includes diversity within species, between species and of ecosystems" (CBD 1992).

Biodiversity plays the crucial role in supporting the life in earth and maintaining the global ecosystem. It is important in a number of ways: 1. Species are used as food, fodder, fuel, medicines etc. 2. Products from species are sold in national and international markets. 3. Biodiversity balances the ecosystem that provides a number of ecological services including the nutrient cycling and plant pollination. Species have social and cultural value, educational value, aesthetic value and economic value. The natural resources are the primary source of useful commodities and the biodiversity resources especially the forest resource is the main source of basic needs such as food, fodder, fiber, medicine etc. of human beings. The rural people still depend upon the forest products for their livelihood and primary health care. About 60% of population of the world and 80% of population of Nepal rely on traditional medicinal herbs present around them to cure different ailments (Shrestha and Dillion, 2003). Nepal is bestowed with rich biodiversity both in flora and fauna. The elevation gradients in Nepal range from 60 m above sea level in the Tarai to 8848 m of Mount Everest, the highest peak of the world (MoFSC, 2002). Different bioclimatic zones, rich edaphic factors combined with varied topographic conditions have created the area as the huge repository of both flora and fauna. Moreover, Nepal's position in the central region of Himalayan range and being at the crossroads of the Indo-Malayan and Palearctic phytogeographic regions made the country a mixing place of species originating in both the regions. It is reported that the most diverse elevation zone in Himalayan range in terms of species richness probably lies between 1,500 and 2,500 m (Barthlott *et al.*, 2005). The Global Strategy for Plant Conservation (GSPC) was adopted by CBD in 2002 for raising the awareness of the threats faced by plants worldwide and providing policy and action needed to halt the loss of plant diversity. The GSPC: 2011 -2010 has visioned the plant diversity as "Without plants, there is no life. The functioning of the planet and our survival depends on plants. "The strategy seeks to halt the continuing loss of plant diversity." (<http://www.cbd.int/gspc/>). However, because of many challenging factors such as habitat loss, deforestation, overexploitation, forest fire, pollution, climate change etc., many plant species are and threatened and in danger of extinction. Forest is the one of the most important natural resources of Nepal and habitat of plant diversity. In contest to Nepal, forest coverage and biodiversity did not decline for centuries as the people apply their wisdom to save or promote natural resources for their own survival (Basnet, 1992). However, currently the deforestation and biodiversity loss is the issue in every corner of the globe and biodiversity in globe is eroding in alarming rate. In developing countries, basically deforestation is due to population growth and agricultural expansion, aggravated over the long term by wood harvesting for fuel and export (Allens and Barnes, 1985). However, in Nepal besides the population pressure, subsistence agriculture expansion encroaching forestlands, illegal timber harvesting and forest fire, livestock grazing, daily fuelwood

consumption, development activities and conflicting policies are the main causes of deforestation (Chaudhary *et al.*, 2015). Because of those different driving forces, the forest coverage and the biodiversity in the country had decreased drastically few decades ago. Hence to mitigate the forest coverage decline and conserve the biodiversity, Nepal has formulated a number of policies and legislatives and to ensure the basic needs of local communities and sustainable forest management. Nepal also signed in United Nations Convention on Biological Diversity (UNCBD) in 1992 and working with the spirit of the convention. A number of institutions have been engaged to conserve, manage and use the biological diversity in sustainable way. Ministry of Forests and Environment and its divisions and departments are fully engaged in biodiversity conservation. Department of National Parks and Wildlife Conservation are engaged in protected areas (PAs) management and biodiversity conservation. Department of Soil Conservation and Watershed Management look after the soil and water related issues which are the basis for biodiversity existence. Agrobiodiversity related issues are looked from Ministry of Land Reforms, Agriculture and Cooperative.

Establishment and management of Protected Areas is the best way to conserve and safeguard the biodiversity. However a number of taxonomically important, rare, endangered biodiversity also lie outside the PAs. Out of the total area of forest of Nepal, 82.68% lies outside the PAs and 17.32% inside the PAs (DFRS 2015). Thus a considerable number of biodiversity which are rare, threatened, endemic and vulnerable also exist outside the PAs. Human pressure on the resource utilization outside PAs creates the loss of such biodiversity. Biodiversity specially the forest diversity outside the PAs are threatened mainly by deforestation and forest degradation caused by various factors such as through land use conversion for agriculture, illegal settlements, infrastructures (including roads and electric transmission lines) and actions relating to the use of resources including overgrazing, unsustainable exploitation of forest products, habitat fragmentation and uncontrolled forest fires (MoFSC, 2014a).

In order to increase understanding and awareness of biodiversity issues, UN has proclaimed 22 May as “The International Day for Biological Diversity (IDB)”. CBD decides a theme for the day every year and different institutions in Nepal are also celebrating the day to generate the awareness on the needs of conservation of biodiversity.

In this paper, a review was done in the plant diversity status and conservation practices in Nepal to disseminate the latest data so far possible.

2. Data Source

This review paper was based on the information and data compiled from the published literatures and grey literatures.

3. Status of Plant Diversity In Nepal

Nepal ranked in 49th position in world biodiversity (Groombridge and Jenkins, 2000). Nepal covers about 0.1% of global land area, but harbours 3.2 % and 1.1% of world's flora and fauna respectively (Kharal and Dhungana, 2018). However in terms of floral diversity, it comprises 3.2% of world's known flora with 2.5% (1001 species) of algae, 5.1% (534 species) of pteridophytes, 5.1% (26 species) of gymnosperms and 3.2% (6973 species) of angiosperms (MoFSC, 2014b). Altogether 2,467 species of fungi, 792 species of lichens and 1,213 species of bryophytes are reported from Nepal (MoFE, 2018), Nepal ranks 10th in terms of richest flowering plant diversity in Asia and 31st in the world (Shrestha, 2016). The rich biodiversity plays the crucial role in livelihood of the people and economic development of nation.

With regard to agriculture biodiversity, 11,389 accessions of 52 crops from 62 districts are deposited in the National Gene Bank and of 790 plant species including 577 cultivated plants are useful for food (MoFE, 2018).

3.1. Threats to Plant Diversity

Presently, the biodiversity of world is facing the treats from many factors and threats on the ecosystems and species are no exceptions in Nepal as well. Nepal's Sixth National Report to the CBD has identified 30 threats prevailed on different ecosystems of the nation in different provinces (MoFE, 2018). Threat rankings were categorized into four categories viz. low, moderate, high and very high. Among the different ecosystems, forest ecosystem and mountain biodiversity were highly threatened.

The main threats posed by the plant diversity in the country are habitat loss, deforestation and degradation, infrastructure development, over exploitation for human use, invasion by alien species, global climate change, natural calamities, over exploitation of NTFPs and MAPs, forest fire etc. However, among those, human intervention in the natural ecosystem is one of the major threats for biodiversity loss in Nepal especially in the urban areas. Intervention in the ecosystem by human beings disturbs the biodiversity and becomes threatened for their existence. Mostly the species with narrow geographical range, with one or only a few populations, small sized population, with declining population size, and overexploited species become more vulnerable to extinction by such anthropogenic activities. It is reported that the current extinction rates are believed to be 1,000 times higher than natural background rates of extinction and future rates are likely to be 10,000 times higher (De Vos, 2014). If species has lost once, that is forever and irreplaceable. Within the assessed species, more than 32,000 species which are threatened with extinction (www.iucnredlist.org). Hence, conservation and sustainable use of biodiversity is of utmost need to maintain the life in earth for present and future generation. The threat assessments of biodiversity in different provinces are given in Table 1.

Table . 1. Threat assessment of biodiversity in different Provinces

Ecosys tems	Threats	Provinces						
		1	2	3 (Bag.)	4(Gand.)	5	6 (Kar.)	7(Spa.)
Forests	Habitat loss and deforestation	Moderate	High	High	Moderate	Moderate	Moderate	High
	Illegal hunting and trade	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate
	Human wildlife conflict	Moderate	Moderate	High	High	High	Moderate	High
	Invasion by IAPs	Moderate	Moderate	High	Moderate	Moderate	High	Moderate
	Forest Fire	Moderate	High	High	High	High	High	High
Protect ed Areas	Poaching	Moderate	Moderate	Moderate	Moderate	Moderate	High	Moderate
	Grazing	High	High	Moderate	Moderate	High	Very High	Very High
	Illegal Timber harvesting	Low	Moderate	Moderate	Moderate	Moderate	High	Moderate
	Uncontrolled tourism	Low	Low	Moderate	Moderate	Moderate	High	Low
Rangel ands	Overgrazing	Moderate	High	Moderate	Moderate	Very High	High	High
	Invasion by IAPs	Moderate	Moderate	High	Moderate	High	High	High
Wetlan ds	Human encroachment	Moderate	High	Moderate	High	Moderate	High	High
	Over-fishing	High	High	High	Moderate	Moderate	High	High
	Wide spread mining of gravels	High	High	High	High	Moderate	High	High
	Illegal hunting and trapping of birds & other wild animals	Moderate	Moderate	Moderate	Moderate	Moderate	Moderate	High
	Invasion by IAPs	Moderate	Moderate	High	Moderate	Moderate	Moderate	Moderate
Agricul ture	Loss of agrobiodiversi	High	High	High	High	High	High	High

	ty							
	Improper use of pesticides	High	High	Very High	High	High	High	Moderate
	Urbanization	High	High	High	High	Moderate	High	High
	Lack of incentives to conserve local landraces	Moderate	High	Moderate	High	High	High	High
Mountain	Poaching	Moderate	High	High	Moderate	Moderate	Moderate	High
	Overharvesting of plant species	Moderate	High	High	High	NA	Very High	Moderate
	Climate change	High	Moderate	High	High	Moderate	High	High
	Unplanned and unregulated roads	Very High	Very High	Very High	High	High	Very High	Very High
Species loss	Over exploitation of timbers and NTFPs	High	High	Moderate	High	Low	High	High
	Alien invasive plant species	Moderate	Moderate	Moderate	Moderate	High	High	High
Genetic resources loss	Loss of local land races	Moderate	Moderate	High	High	Very High	Moderate	High
	Loss of wild relatives	Moderate	High	High	Moderate	Very High	Moderate	High
	Increased vulnerability to pest and diseases	Moderate	High	High	High	High	High	Moderate

Source: MoFE 2018

Note: IAPs = Invasive alien plants; Bag = Bagmati; Gan = Gandaki; Kar = Karnali; Spa = Sudurpaschim

4. Conservation Practices in Nepal

As Nepal being a signatory to the Convention on Biological Diversity (CBD), Nepal is continuously working with the spirit of the convention and obliged to fulfill the objectives

of the CBD including the conservation of biological diversity, its sustainable use and fair and equitable sharing of benefits from the utilization of genetic resources. To achieve these objectives of CBD, the contracting parties are needed to develop national strategies for the conservation of biodiversity. Both *in-situ* as well as *ex-situ* conservation methods are practiced in Nepal for the conservation and management of biodiversity.

4.1. *In-situ* Conservation

In-situ conservation is the on-site conservation or conservation of biodiversity in their natural habitat. According to Glowka *et al.* (1994), it also includes the conservation of domesticated or cultivated plant species in the surroundings where they have developed their distinctiveness. Article 8 of CBD (1992) promoted the contracting parties to establish a system of protected areas or areas where special measures need to be taken to conserve biological diversity.

Protected Areas (PAs)

With the goal of conservation of biodiversity and ecosystem, networks of 20 protected areas (PAs) are established in Nepal. Those PAs include 12 National parks, six conservation areas, one wildlife reserve, one hunting reserve and 13 buffer zones (DNPWC, 2075 BS). CBD held at Nagoya city of Aichi Prefecture in 2010 has envisioned in expanding the protected area coverage by 17% on the terrestrial environment (Aichi Biodiversity target 11) by 2020 (CBD, 2010). However, Nepal is at the forefront in establishing the PAs with 23.39 % or 34,419.75 sq. km of the land area under protection (DNPWC, 2075 BS). The PAs established at different geographic regions is the major approach in biodiversity conservation in Nepal (Table. 2. Fig. 1).

Table 2. Protected areas of Nepal.

SN	Name of Protected Area	Estd. (AD)	Area Covered (Km ²)	Buffer Zone (Km ²)	Geographic region
1.	Chitwan NP	1973	952.63	729.37	Tarai
2.	Bardia NP	1976	968.00	507.00	Tarai
3.	Sagarmatha NP	1976	1,148.00	275.00	Mountain
4.	Langtang NP	1976	1710.00	420.00	Mountain
5.	Rara NP	1976	106.00	198.00	Mountain
6.	SheyPhoksundo NP	1984	3555.00	1349.00	Mountain
7.	Khaptad NP	1984	225.00	216.00	Mountain
8.	Makalu Barun NP	1991	1500.00	830.00	Mountain
9.	ShivapuriNagarjunNP	1989 (2002*)	159.00	118.61	Midhills
10.	Banke NP	2010	550.00	343.00	Tarai
11.	Sukhlaphanta NP	1976 (2017*)	305.00	243.50	Tarai

12.	Parsa NP	1984 (2017*)	627.39	285.30	Tarai
Wildlife Reserve					
13.	KoshiTappu WR	1976	175.00	173.00	Tarai
Hunting Reserve					
14.	Dhorpatan HR	1987	1325.00	-	Mountain
Conservation Areas					
15.	Annapurna CA	1992	7629.00	-	Mountain
16.	Manaslu CA	1998	1,663.00	-	Mountain
17.	Kanchanjunga CA	1997	2,035.00	-	Mountain
18.	Api Nampa CA	2010	1,903.00	-	Mountain
19.	Gaurishankar CA	2010	2,179.00	-	Mountain
20.	Krishnashar CA	2009	16.95	-	Tarai

Note: NP = National parks; WR = Wildlife reserve; HR = Hunting reserve; CA = Conservation Area;* Upgraded to National park.

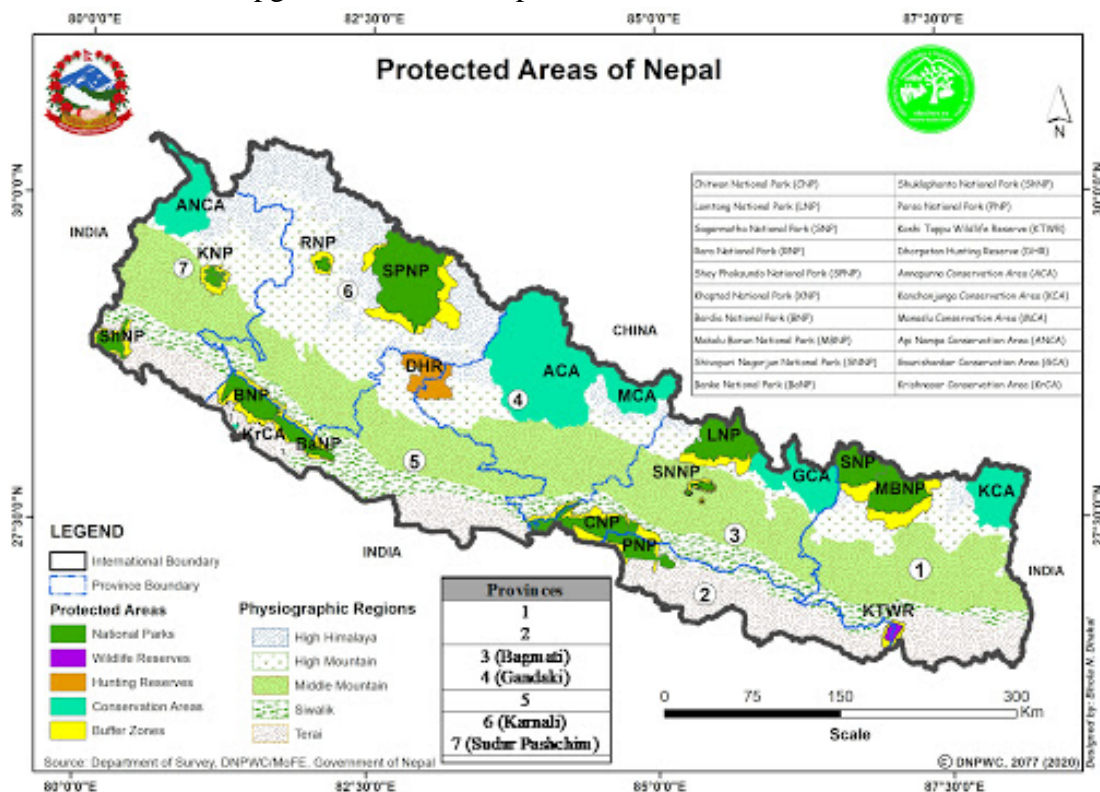


Fig.1. Protected Areas of Nepal (Source: <https://www.dnpwc.gov.np>)

Forest management

Besides the PAs, different types of forests such as Government managed forest, Community forest, Leasehold forest, Collaborative forest, Protection forest, Religious forest and private forest are also the means of *in-situ* conservation (MoFE, 2018).

Forest covered 43.5% of areas in Nepal in 1960 but drastically decrease to reach 38.1% in 1978 and 29% in 1994 (DFRS, 2015). However, forest increased and recovered until reaching 39.1% in 2010 (Uddin *et al.*, 2015), 40.36% in 2015 (DFRS, 2015) and 44.47% in 2018 (MoFE, 2019). Satellite based study has also showed increased forest in Nepal during last three decades (Baniya *et al.*, 2018). Most of the accessible forests are handed over and managed under different categories (community forest, collaborative forests, leased forest) for multiple uses under forest users (Poudel, 2018). By the community mobilization in the forest for over three decades, the forests in middle mountains and high mountains have increased in terms of area and quality (DFRS, 2015). But within the same periods, the forests in Churia foot hills, Siwaliks and Tarai continued to degrade due to serious challenges such as land encroachment, forest fire, over grazing, over exploitation (Poudel, 2018). Many rural communities still depend upon the forest products for their livelihood and primary health care wholly and partly. Moreover, the selling of different forest products and services, including timber, non-timber forest products (NTFPs) and ecotourism, has become a significant source of revenue generation for GoN (Subedi *et al.*, 2014). However, lack of scientific forest management in the past, some forests, mostly in the accessible areas, are over matured while the others are exploited leading to forest degradation (Poudel, 2018). Though the forestry sector in Nepal has economic, environmental and socio-cultural potential but conservation centered management has been losing its benefits (Jayasawal and Bishwokarma, 2016). Realizing the urgent need for sustainable management of Nepal's forest and recognizing the huge potential for prosperity through forestry, a new vision on forestry "Forestry for Prosperity" was announced by Government of Nepal (GoN) in 2012 (Poudel, 2018). The vision contained four major pillars of prosperity viz. sustainable and scientific management, sustainable use of forest products and services, commercialization and marketing of forest resources and creating enabling environment (Poudel, 2018). The vision thus laid the foundation for scientific forest management (SciFM) and for sustainable management in Production forests. Later on, government also developed and enacted the Scientific Management Guidelines in 2014. The government has defined the SciFM as "an application of appropriate silviculture system and forest management principles through design of systematic compartment of fixed rotation age" (Poudyal *et al.*, 2019). The Sustainable forest management was aimed to maintain and enhance the economic, social and environmental values of all types of forests, for the benefit of present and future generations (FAO, 2020). The terms "Scientific forest management" and "sustainable forest management" have been used and understood interchangeably in the global forestry

scenario in recent decades linking management activities to principles of sustainable development (Jayasawal and Bishwokarma 2016). The vision encouraged the promotion of sustainable forest management initiatives especially in the high value timber species and in 2012 and later with support from Multi Stakeholder Forestry Programme (MSFP) in 2013, the Department of Forests (DoF) repiloted SciFM in the high value Sal (*Shorea robusta*) forest in Tilauakot collaborative forest in Kapilvastu, employing advanced silvicultural systems (Jayasawal and Bishwokarma 2016). Later on SciFM has been also been started in at least one forest in eight district including Morang, Makawanpur, Chitwan, Nawalparasi, Kapilbastu, Rupendehi, Palpa and Kailali using intensive silvicultural operations in 26,000 ha of forests (Jayasawal and Bishwokarma 2016). As of March 2018, 81,500 ha of the production forest are under SciFM programme (MoFE, 2018).

4.2. Ex-situ Conservation Though conserving the biodiversity in natural habitat is the ideal method, but biodiversity should also be conserved as *ex-situ*. Conservation of the components of biodiversity outside their natural habitats is referred as *ex-situ* or off-site conservation. Habitat loss, extinction of species, human population growth, intervention on the natural habitat etc. recalls the need for *ex-situ* conservation of biodiversity. Rare, endangered, threatened and endemic species are especially needed to be conserved in *ex-situ*. Article 9 of CBD promotes each contracting parties to adopt measures for *ex-situ* conservation of components of biological diversity, preferably in the country of origin of such components, for the purpose of complementing *in-situ* conservation. In 2010, CBD adopted the updated Global Strategy for Plant Conservation (GSPC) 2011-2020 with 16 targets for plant conservation to be achieved by 2020 (<https://www.cbd.int/gspc/targets.shtml>). According to target 8 of GSPC, at least 75% of threatened plant species in *ex-situ*, preferably in the country of origin, and at least 20% available for recovery and restoration programs is urgently and effectively conserved (<https://www.cbd.int/gspc/targets.shtml>). *Ex-situ* conservation strategies play the important role in conservation of plants species vulnerable to the climate change. The different methods of *ex-situ* conservation are the botanical gardens, seed gene bank, *in vitro* storage, cryopreservation etc.

Botanical Gardens

Botanical gardens are the main important *ex-situ* conservation sites and help in conservation and management of plant diversity. Botanical gardens play the crucial role in the conservation of plant diversity especially the rare, endangered, threatened and endemic plant species. Department of Plant Resources (DPR), Government of Nepal (GoN), has established 12 Botanical gardens covering an area of 745.92 ha in nine districts (Lamichhane, 2018) (Table 3.). Moreover, GoN has envisioned establishing botanical garden in each of 7 states of Nepal (MoFE, 2018)

Table 3. Botanical Gardens of Nepal.

SN	Botanical Garden (BG)	Locality/District	Area (ha.)	Altitude (m)	Vegetation Zone
1.	National BG	Godavari, Lalitpur	82	1515	Sub-tropical
2.	Mai Pokhari BG	Mai pokhari/Ilam	9	2200	Temperate
3.	Dhanusadham BG	Dhanushadham/Dhanusa	20.27	100	Tropical
4.	Vrindaban BG	Padampokhari/Makawanpur	96	500	Tropical
5.	Mountain BG	Daman/Makawanpur	65	2320	Temperate
6.	Tistung BG	Tistung/Makawanpur	45	1700	Sub-tropical
7.	World Peace Biodiversity Garden	Raniban, Pokhara/ Kaski	164	775	Sub-tropical
8.	Dhakeri BG	Banke	5	130	Tropical
9.	Mulpani BG	Kapurkot/Salyan	5.65	2000	Temperate
10.	Dhitachaur BG	Dhitachaur/Jumla	4.5	2500	Temperate
11.	Deoria BG	Deoria/Kailali	149.5	170	Tropical
12.	Godavari BG	Godavari, Kailali	100	185	Tropical

3.4.3. Protected plant species in Nepal

GoN under the Forest Act 1993 has protected some plant species under different categories to avoid the decline in their population in natural habitats (Table 4.).

Table 4. List of plant species legally protected in Nepal.

Scientific Name	Common/English Name	Local name
A. Plant species banned for collection, use, sale, distribution, transportation and export		
Angiosperms		
<i>Juglans regia</i>	Walnut	Okhar
<i>Dactylorhiza hatagirea</i>	-	Panchaunle
<i>Neopycrorhiza scopulariiflora</i>	Gentian	Kutki

B. Plant species banned for export except for processed with permission of Department of Forests		
Angiosperms		
<i>Cinnamomum glaucescens</i>	-	Sugandhakokila
<i>Cordyceps sinensis</i>	-	Yarsagumba
<i>Rauwolfia serpentina</i>	Serpentine	Sarpagandha
<i>Valeriana jatamansi</i>	Spikenard	Jatamansi
<i>Valeriana wallichii</i>	Valerian	Sugandhawal
Gymnosperms		
<i>Abies spectabilis</i>	Fir	Talispatra
<i>Taxus baccata</i>	Himalayan yew	Loth salla
<i>Taxus wallichiana</i>	East Himalayan Yew	
<i>Taxus contorta</i>	West Himalayan Yew	
Lichens		
<i>Parmelia</i> spp.	Lichen	Jhayu
C. Plant species banned for harvest, transportation and export for commercial purposes		
Angiosperms		
<i>Acacia catechu</i>	Cutch Tree	Khayar
<i>Bombax malabaricum</i>	Silk cotton tree	Simal
<i>Dalbergia latifolia</i>	Rose wood	Satisal
<i>Michelia champaca</i>	Magnolia	Champ
<i>Pterocarpus marsupium</i>	Indian Kino tree	Bijaya Sal
<i>Shorea robusta</i>	Common sal	Sal

Source: GoN/MoFSC (2014b)

3.4.4. CITES listed Plant species of Nepal

Convention on International Trade in Endangered species of Wild Fauna and Flora (CITES) is a multilateral treaty for the protection of endangered animal and plant species. The increasing demand of the wild life in the world has created the illegal collection and trade of the wild life leading to the erosion of many species, making them vulnerable to extinction. To control the threatened wild species, the agreement was made between the governments of world to ensure that international trade in specimens of wild animals and plants does not threaten their survival. CITES was drafted as a result of resolution in 1963 at a meeting of members of IUCN (The World Conservation Union). Nepal being a signatory party in CITES since 1975, has enlisted a number of plant species from Nepal under various CITES appendices (Table 5.).

Table 5. List of Plant species under CITES appendices.

Appendix	Scientific name	Family	Nepali name/Local Name
Appendix I (Restricted for trade worldwide)	<i>Paphiopedilum insigne</i> (Wall. ex Lindl.) Pfitzer	Orchidaceae	
	<i>Paphiopedilum venustum</i> (Wall. ex Sims.) Pfitz.	Orchidaceae	
Appendix II (Regulated trade; export permit required)	<i>Rauvolfia serpentina</i> (L.) Benth. ex Kurz	Apocynaceae	Sarpangandha/ chandmaruwa
	<i>Podophyllum hexandrum</i> Royle	Berberidaceae	Laghupatra/Papra/ Ban Bhata
	<i>Dalbergia</i> spp. <i>Dalbergia latifolia</i> Roxb. <i>Dalbergia pinnata</i> (Lour.) Prain <i>Dalbergia sericea</i> G. Don <i>Dalbergiasisoo</i> Roxb. ex DC. <i>Dalbergia stipulacea</i> Roxb. <i>Dalbergia volubilis</i> Roxb.	Leguminosae	Satisal Daamar Sisau
	<i>Cyathea</i> spp. <i>Cyathea brunoniana</i> (C.B. Clarke) C.B. Clarke & Baker <i>Cyathea gigantea</i> (Wall. ex Hook.) Holtum <i>Cyathea khasyana</i> (Moore ex Kuhn) Domin <i>Cyathea spinulosa</i> Wall. ex Hook..	Cyatheaceae	Rukhuneu
	<i>Cycas pectinata</i> Buch.-Ham.	Cycadaceae	Kalbal/Thakal
	<i>Dioscorea diltoidea</i> Wall. ex Griseb.	Dioscoreaceae	Kukur tarul
	<i>Euphorbia</i> spp.	Euphorbiaceae	

	<i>Euphorbia fusiformis</i> Buch.-Ham. ex D.Don		KanikeGhans
	<i>Euphorbia prostrata</i> Aiton		
	<i>Euphorbia royleana</i> Boiss		Siundee
	Orchidaceae spp.	Orchids	
	<i>Taxuswallichiana</i> Zucc.	Himalayan yew	Lauthsalla, talispatra
	<i>Taxuscontorta</i>		
Appendix III (Regulated trade from Nepal)	<i>Meconopsisregia</i>	Himalayan yellow poppy	Kyashar
	<i>Gnetummontanum</i>	Gnetum	Bhotelahara
	<i>Podocarpusneriifolius</i>	Podocarpus	Gunsi
	<i>Tetracentronsinensis</i>	Tetracentron	Jharikot

Source: Joshi *et al.*, 2017

3.4.5. Prioritized plant species in Nepal

Natural resources of Nepal are the prized procession of the country, the proper utilization of which can enhance the economy of nation. Biodiversity is closely linked to livelihood of Nepalese people. Being the plant diversity rich country, one of the sectors in which the country has relative advantage is the medicinal and aromatic plants. Hence the GoN has prioritized 33 medicinal plants (MPs) for research and economic development of nation (DPR, 2006; 2016) (Table 6.).

Table 5. List of MPs prioritized by GoN.

SN	Scientific Name	Family	Nepali Name
1.	<i>Aconitum heterophyllum</i> Wall. ex Royle	Ranunculaceae	Atish
2.	<i>Aconitum lethale</i> Griff. Synonym: <i>Aconitum spicatum</i> (Bruhl) Stapf <i>Aconitum ferox</i> var. <i>spicatum</i> Bruhl	Ranunculaceae	Bikha
3.	<i>Acoruscalamus</i> Linn.	Acoraceae	Bojho
4.	<i>Asparagus racemosus</i> Willd.	Asparagaceae	Satawari
5.	<i>Azadirachtaindica</i> A.Juss.	Meliaceae	Neem
6.	<i>Bergeniaciliata</i> (Haw.) Sternb.	Saxifragraceae	Pakhanbhet
7.	<i>Cinnamomumglaucescens</i> (Nees) Hand.-Mazz.	Lauraceae	Sugandhakokila
8.	<i>Cinnamomumtamala</i> (Buch.-Ham.) T.Nees&Eberm	Lauraceae	Tejpat
9.	<i>Curculigoorchioides</i> Gaertn.	Hypoxidaceae	KaloMusali
10.	<i>Dactylorhizahatagirea</i> (D. Don.) Soo	Orchidaceae	Panchaauale

11.	<i>Dioscoreadeltoidea</i> Wall. exGriseb.	Dioscoreaceae	Bhyakur
12.	<i>Fritillariacirrhosa</i> D. Don.	Liliaceae	Kakoli
13.	<i>Gaultheria fragrantissima</i> Wall.	Ericaceae	Dhasingare
14.	<i>Juglansregia</i> Linn.	Juglandaceae	Ookhar
15.	Lichens spp	-	Jhyau
16.	<i>Morchellaspp.</i>	Pezizaceae	KhoyaChyau/ GuchchiChyau
17.	<i>Nardostachysjatamansi</i> (D.Don.) DC. Synonym: <i>Nardostachysgrandiflora</i> DC.	Caprifoliaceae	Jatamansi
18.	<i>Neopicrorhizascrophulariiflora</i> (Pennell) D.Y.Hong Synonym: <i>Picrorhizascrophulariiflora</i> Pennell	Plantaginaceae	Kukti
19.	<i>Ophiocordyceps sinensis</i> (Berk.) G.H. Sung &J.M.Sung, Hywel-Jones &Spatafora Synonym: <i>Cordyceps sinensis</i> (Berk.) Sacc., Fungi,)	Clavicipitaceae	Yarsagumba
20.	<i>Paris polyphylla</i> Sm.	Melanthiaceae	Satuwa
21.	<i>Phyllanthusemblica</i> Linn.	Phyllanthaceae	Amala
22.	<i>Piper longum</i> Linn.	Piperaceae	Pipala
23.	<i>Rauwolfiaserpentina</i> (L.) Benth. ex Kurz	Apocynaceae	Sarpagandha
24.	<i>Rheum australe</i> D.Don. Synonym: <i>Rheum emodii</i> Wall. exMeisn.	Polygonaceae	Padamchal
25.	<i>Rubiamanjith</i> Roxb. ex Fleming	Rubiaceae	Majitho
26.	<i>Sapindusmukorossi</i> Gaertn.	Sapindaceae	Riththa
27.	<i>Sinopodophyllumhexandrum</i> (Royle) T.S. Ying Synonyms: <i>Podophyllumhexandrum</i> Royle <i>Podophyllumemodi</i> Wall. ex Hoof. f. & Thomos	Berberidaceae	Laghupatra
28.	<i>Swertiachirayita</i> (Roxb.ex Fleming) Karsten Synonym: <i>Swertiachirata</i> (Wall.) C.B.Clarke <i>Gentianachirayita</i> Roxb. ex Fleming	Gentianaceae	Chiraito
29.	<i>Tagetesminuta</i> Linn.	Asteraceae	JangaliSayapat ri
30.	<i>Taxuswallichiana</i> Zucc.	Taxaceae	LauthaSalla

	Synonym: <i>Taxusbaccatasubsp. wallichiana</i> (Zucc.) Pilg.		
31.	<i>Tinosporasinensis</i> (Lour.) Merr.	Menispermaceae	Gurjo
32.	<i>Valerianajatamansii</i> Jones	Caprifoliaceae	Sugandhawal
33.	<i>Zanthoxylumarmatum</i> DC.	Rutaceae	Timur

Source: DPR 2006, 2016.

Among 33 prioritized MPs, 13 plant species viz. *Curculigoorchioide*, *Dactylorhizahatagirea*, *Fritillariacirrhosa*, *Morchellaspp.*, *Nardostachysjatamansi*, *Neopicrorhizascrophulariiflora*, *Ophiocordyceps sinensis*, *Paris polyphylla*, *Piper longum*, *Rauwolfia serpentine*, *Swertiachirayita*, *Taxuswallichiana*, *Tinosporasinensis*, are prioritized for the agro-technology development (DPR, 2006; 2016).

4. Conclusion

Plant diversity in Nepal is closely linked to livelihood and economic well beings of Nepalese people. People in rural areas still depend upon the plant diversity around them for their livelihood. Biodiversity should be conserved and used in a sustainable way to safeguard the aspirations of present and future generations. Every plant species in the earth matters whether it is small or large and needs to be protected. *In-situ* and *ex-situ* conservation practices in fact play the major role in conservation of plant diversity and are practiced in Nepal. The PAs besides conservation of nature and natural resources are also the attraction spots for the tourists and thus help to enhance the economy of nation. The habitats with rare, endangered, endemic, taxonomically important and with high number of species need to be established as PAs. The PAs must be actively managed and monitored regularly to prevent the deterioration. The well designed management plan is crucial to prevent the biodiversity loss in PAs. Though establishing the PAs is essential for biodiversity conservation but it is short-sighted to depend totally on PAs for biodiversity conservation and protection of species need be done outside the PAs as well. Forests are the main habitat where the rich plant diversity is found. The indigenous people use to apply their wisdom and management practices to save and promote the biodiversity for their survival for the long time. Hence the local knowledge and practices needs to be considered for the conservation outside the PAs. Besides the *in-situ* conservation, *ex-situ* conservation of threatened and endangered plant species help in recovery, rehabilitation and their introduction in natural habitat. *Ex-situ* conservation needs to be carried out in different bioclimatic zones of the country and botanical gardens needs to establish in each zone.

In-situ and *ex-situ* conservation practices besides the conservation of biodiversity and ecosystem, also help in ecotourism development and hence enhance the economy of nation. Moreover, biodiversity can be well conserved if the people become aware about the

consequences of the loss of biodiversity which can be achieved by various methods such as education, communication, outreach programs.

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