

Plant genetic resources of Nepal: A guide for plant breeders of agricultural, horticultural and forestry crops

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Summary

Nepal is rich in indigenous wild and landrace plant genetic resources for agronomic, horticultural, forestry, or medicinal uses, but much of this germplasm remains uncollected and awaits economic development. We list 485 entries (species, or genera for ornamental plants) in 14 categories, and compare these to existing germplasm collections in Nepal and the United States to highlight collection and conservation needs. To help plan plant collecting, we outline the key botanical and logistical data and legal framework for planning field work in Nepal.

Introduction

Nepal is rich in plant genetic resources of value for agronomic, horticultural, forestry, or medicinal uses. This diversity is largely a result of many habitats. Nepal has semitropical environments at 60 m elevation in the southeast, increasing in elevation north to temperate and alpine environments, to barren snow fields in the highest elevations in the world in the Himalayas. Much germplasm remains to be collected, characterized, and used for crop improvement.

Nepal is a landlocked country, bordered by China on the north, and India on the east, south and west. The country is roughly rectangular in shape, with an east-west length of 885 km (80° 4' E – 88° 12' E), and an average north-south width of 193 km (26° 22' – 30° 27'). It occupies 147,181 m². Although popularly thought of as largely mountainous, it contains a variety of elevations from 60 m in the southeast, to the highest elevation in the world, Mount Everest (Sagarmatha) at 8848 m. There are more than 200 peaks of about 7000 m in altitude, and nine peaks of more than 8000 m in altitude (Sharma, 1984). Much of the north-

ern uplands of Nepal are cold desert, and not suitable for agriculture. Land use in Nepal is 37.6% forest, 18.0% agriculture, 15.3% permafrost, 13.4% pasture, 2.7% water, 0.7% settlements and roads, 12.3% other uses (Jha, 1992).

Nepal exhibits a remarkable range of elevations, and can be divided roughly into five eco-climatic regions governed by altitude: 1. the sub-tropical forested lowlands or terai, 2. the low deciduous-forested midlands, 3. the cool-temperate-coniferous forested midlands, 4. the alpine grassland highlands, and 5. the tundra (Sharma, 1984; Shrestha, 1989; HMG [His Majesty's Government], 1993; Jackson, 1994).

Population currently stands at about 20.6 million persons, with a growth rate of 2.08%, reduced from 2.66% in 1981. Population distribution is 46.7% in the terai, 45.5% in midlands, and 7.8% in the highlands. Agriculture contributes 46% of the gross domestic product. Nepal has some of the smallest land holdings in the world, the average being only 0.96 ha (with the average in the terai somewhat larger than in other regions). Nepal is one of the poorest countries in the world, with the average per-capita income of \$180. The

literacy rate is 36%. Tourism is one of the most important sources of revenue, accounting for gross receipts of \$U.S. 61.09 million (HMG, 1994).

The purposes of this paper are:

1. to assess the most promising indigenous angiosperm and gymnosperm plant genetic resources of Nepal useful for agronomic, horticultural, forestry, or medicinal uses, and to compare these to genebank holdings to highlight collecting and preservation needs, and
2. to outline the key botanical and logistic data and legal framework for planning field work in Nepal.

Materials and methods

This research was initiated by a Nepal national workshop entitled "Plant genetic resources conservation, use, and management, November 28-December 1, 1994", organized by the National Agricultural Research Council, Nepal, and the International Plant Genetic Resources Institute. It was continued by a literature review and a six week field trip by Jha and Spooner in Nepal to survey crops, cropping systems, agricultural research programs, and logistics in January and February, 1995. Literature sources to construct the list of plant genetic resources for Nepal (Table 1) follow.

All listed species are indigenous, or potentially cultivated for thousands of years with sufficient time to develop landraces (eliminating such crops as maize and potato). Nomenclature follows Hara et al. (1978, 1982) and Hara & Williams (1979) except the Fabaceae that follows Wiersema et al. (1990). Author abbreviations for taxonomic names follow Brummitt and Powell (1992). We used Usher (1974), Zeven & DeWet (1982), and Sauer (1993), and Smartt & Simmonds (1995) to infer long-established cultivation. The most comprehensive list of Nepali food plants is by Regmi (1982; abbreviated versions, 1984a, 1994), who lists English and Nepali common names, botanical characteristics, and uses of 482 Nepali crops. Crops in Nepal also are treated in Kihara (1956), Bhatt (1977), Suwal (1970), Manandhar (1986), Lohar et al. (1993), and Baral et al. (1994); medicinal plants by Manandhar (1980), Malla (1982, 1984), Malla & Shakya (1984), and Tiwari & Joshi (1990a,b,c); wild edible fruits by Bajracharya (1984); ornamentals by Stearn (1978), and Bajracharya et al. (1984); and fiber plants by Regmi (1984b). See Rajbhandari (1994) for ethnobotani-

cal studies of local areas or evaluations of individual species.

Some of these lists include plants of marginal, local, or unproven value. For example, the medicinal plant literature includes such plants as potato and rice, as well as plants of proven medicinal value. We conservatively chose those 26 medicinal plants with species names in Appendix VI of Malla et al. (1993) with export data, and 11 others of well-known medicinal value not appearing on this list, but our list surely lacks many important medicinal plants (see Tyler et al. [1988], Bruneton [1995] for overviews of medicinal plants worldwide). For forest species, we listed 107 of the 125 indigenous species from Nepal in Jackson (1994, vol. 2.). For ornamental plants, we began with the list in Stearn (1978) and Bajracharya et al. (1984), and added others based on our knowledge of their economic potential. Because there are so many plants of potential ornamental value, such as *Rhododendron*, with about 30 indigenous species (Hara, Chater, & Williams, 1982; Shrestha, 1984), we listed only genera, with a note of number of indigenous species per genus. Banerji & Pradhan (1984) list 88 genera and 247 species of Orchidaceae in Nepal, and we simply list these numbers. Wild species relatives are included only for the crop plants.

Data for germplasm holdings (Table 1) for Nepal are from Upadhyay (1995), and for the United States from the USDA Germplasm Resources Information Network (GRIN; data available by request from Database Manager, Germplasm Resources Information Network, USDA, ARS, Bldg. 003, BARC-West, 10300 Baltimore Ave., Beltsville, MD 20705-2350, USA, Tel: 301-504-5666; data also available through the Internet). Information or references on collection or characterization of these accessions or other accessions in Nepal but not yet in the Plant Genetic Resources System is presented by Dobremez et al. (1972), Iizuka (1985), Furman & Bharati (1989), Adhikari et al. (1994), Aryal (1994), Dongol et al. (1994), Joshi (1994), Kaini (1994), Koirala (1994), Maikhuri et al. (1994), Nupane (1994), Rajbhandari (1994), Shrestha (1994), Velayudhan & Upadhyay (1994), and Johnson (undated). For maps, we began with information in Parry & Perkins (1987), and supplemented data with surveys of government and local market sources.

Table 1. Indigenous wild and landrace species (genera for ornamental plants) of Nepal of value for development of aromatic plants, ARO; cash crops, CAS; cereals, CER; fibers, FIB; fodder, FOD; fruits, FRU; legume grains, LEG; medicines, MED; oils, OIL; ornamentals, ORN; spices, SPI; timber, TIM; vegetables, VEG; wild relatives of food plants, WILD. Elevations from Hara et al. (1978, 1982) and Hara & Williams (1979) unless otherwise noted. ¹Germplasm held in Nepal and in United States GRIN System (in parentheses)

Species	Use	Elevations in Nepal (m)	Germplasm ¹
ACANTHACEAE			
<i>Crossandra infundibuliformis</i> (L.) Nees	ORN	700–800	
<i>Hemigraphis hirta</i> (Vahl) T.Anders.	ORN	200–300	
<i>Hypoestes triflora</i> (Forssk.) Roem. & Schult.	ORN	1200–2600	
<i>Thunbergia</i> Retz. (4 species)	ORN	300–2300	
ACERACEAE			
<i>Acer</i> L. (13 species)	ORN	1200–4000	
<i>Acer caesium</i> Brandis	FOD, ORN, TIM	2200–3000	
<i>Acer campbellii</i> Hook.f. & Thoms.	FOD, ORN	2100–3600	
<i>Acer oblongum</i> DC.	TIM, ORN	1200–2400	
ACTINIDIACEAE			
<i>Actinidia</i> Lindl. (2 species)	ORN	1300–3000	
AMARANTHACEAE			
<i>Amaranthus lividus</i> L.	ORN, WILD	1500–2300	
<i>Amaranthus spinosus</i> L.	ORN, WILD	150–1200	
<i>Amaranthus tricolor</i> L.	ORN, VEG, WILD	200	
<i>Amaranthus viridus</i> L.	ORN, WILD	150–1200	
ANACARDIACEAE			
<i>Choerospondias axillaris</i> (Roxb.) Burt & Hill	FRU, TIM	1200–1500	
<i>Lannea coromandelica</i> (Houtt.) Merr.	FOD	100–1400	
<i>Mangifera indica</i> L.	FRU	300–700	
<i>Mangifera sylvatica</i> Roxb.	WILD	450–1000	
<i>Pistacia</i> L. (2 species)	ORN, WILD	750–2100	
<i>Rhus</i> L. (7 species)	ORN	300–2800	
APIACEAE (UMBELLIFERAE)			
<i>Coriandrum sativum</i> L.	SPI	2700	6 (2)
<i>Daucus carota</i> L.	VEG	1350 ^A	
<i>Foeniculum vulgare</i> Mill.	SPI	2300	(2)
APOCYNACEAE			
<i>Holarrhena pubescens</i> (Buch.-Ham.) G. Don	FOD, MED	100–1500	
<i>Nerium indicum</i> Mill.	MED, ORN	600–1000	
<i>Rauvolfia serpentina</i> (L.) Kurz	MED	100–900	
AQUIFOLIACEAE			
<i>Ilex</i> L. (8 species)	ORN	250–3700	
<i>Ilex excelsa</i> (Wall.) Hook.f.	FOD, ORN	600–2100	
ARACEAE			
<i>Acorus calamus</i> L.	MED	1700–2300	
<i>Alocasia navicularis</i> (Koch & Bouché) Koch & Bouché	VEG	450	
<i>Amorphophallus bulbifer</i> (Schott) Blume	ORN	300–900	
<i>Arisaema</i> Mart. (17 species)	ORN	300–4000	
<i>Colocasia affinis</i> Schott	WILD	2000	
<i>Colocasia esculenta</i> (L.) Schott	VEG	300–1200	
<i>Colocasia fallax</i> Schott	WILD	400–2000	
<i>Pothos cathcartii</i> Schott	ORN	250–1500	
<i>Scindapsus officinalis</i> (Roxb.) Schott	ORN	200–300	

Table 1A. Continued.

Species	Use	Elevations in Nepal (m)	Germplasm ¹
ARALIACEAE			
<i>Aralia cachemirica</i> Decne.	ORN	2400–4200	
<i>Brassaiopsis glomerulata</i> (Blume) Regel	FOD	300–1500	
<i>Brassaiopsis hainla</i> (D.Don) Seem.	FOD	1000–1800	
<i>Hedera nepalensis</i> K.Koch	ORN	2000–3200	
<i>Panax pseudo-ginseng</i> Wall.	ORN	2100–4200	
<i>Schefflera</i> J.R.Forst & G.Forst. (3 species)	ORN	300–3400	
ARECACEAE			
<i>Caryota urens</i> L.	ORN		
<i>Phoenix</i> L. (3 species)	ORN	150–1500	
ARISTOLOCHIACEAE			
<i>Asarum himalaicum</i> Klotzsch	ORN	3000–3300	
ASCLEPIADACEAE			
<i>Ceropegia</i> L. (6 species)	ORN	150–3300	
<i>Hoya</i> R.Br. (6 species)	ORN	1000–2500	
<i>Marsdenia tinctoria</i> R.Br.	DYE	500–1200	
ASTERACEAE (COMPOSITAE)			
<i>Achillea alpina</i> L.	ORN	1200–1900	
<i>Anaphalis</i> DC. (17 species)	ORN	800–5000	
<i>Aster</i> L. (17 species)	ORN	1400–4900	
<i>Dendranthema</i> Des Moul. (3 species)	ORN	2800–4700	
<i>Doronicum roylei</i> DC.	ORN	2900–4600	
<i>Echinops</i> L. (2 species)	ORN	1400–3300	
<i>Gerbera</i> L. (3 species)	ORN	1400–4500	
<i>Gynura</i> Cass. (3 species)	ORN	250–2600	
<i>Inula</i> L. (9 species)	ORN	150–3700	
<i>Ligularia</i> Cass. (4 species)	ORN	2200–4600	
<i>Senecio</i> L. (22 species)	ORN	1100–5000	
<i>Solidago virga-aurea</i> L.	ORN	2300–3400	
BALSAMINACEAE			
<i>Impatiens</i> L. (37 species)	ORN	600–4000	
BEGONIACEAE			
<i>Begonia</i> L. (18 species)	ORN	200–2900	
BERBERIDACEAE			
<i>Berberis</i> L. (30 species)	ORN	1200–4500	
<i>Mahonia</i> Nutt. (3 species)	ORN	1600–2900	
<i>Podophyllum hexandrum</i> Royle	MED, ORN	3000–4500	
BETULACEAE			
<i>Alnus nepalensis</i> D.Don	ORN, FOD, TIM	500–2600	
<i>Alnus nitida</i> (Spach) Endl.	ORN, TIM	2100–2200	
<i>Betula alnoides</i> D.Don	ORN, TIM	1200–2600	
<i>Betula utilis</i> D.Don	ORN, TIM	2700–4300	
BIGNONIACEAE			
<i>Campsis grandiflora</i> (Thunb.) K.Schum.	ORN	1400	
<i>Incarvillea</i> Juss. (4 species)	ORN	700–5900	

Table 1B. Continued.

Species	Use	Elevations in Nepal (m)	Germplasm ¹
BOMBACACEAE			
<i>Bombax ceiba</i> L.	ORN, TIM	200–900	
BORAGINACEAE			
<i>Anchusa ovata</i> Lehm.	ORN	3600–4000	
<i>Lithospermum</i> L. (2 species)	ORN	2500–3000	
<i>Myosotis</i> L. (3 species)	ORN	3200–4600	
BRASSICACEAE (CRUCIFERAE)			
<i>Arabis</i> L. (4 species)	ORN	2300–4400	
<i>Brassica juncea</i> (L.) Czern.	VEG	640–1340 ^B	
<i>Brassica rapa</i> L.	VEG	1340–3200 ^B	
<i>Cardamine</i> L. (9 species)	ORN	1000–4500	
<i>Draba</i> L. (15 species)	ORN	3000–6000	
<i>Erysimum</i> L. (3 species)	ORN	1600–4900	
<i>Lepidium sativum</i> L.	SPI, VEG	200–3000	4 (2)
<i>Raphanus sativus</i> L.	VEG	600–3500 ^C	17 (3)
BURSERACEAE			
<i>Garuga pinnata</i> Roxb.	TIM	300–1200	
BUXACEAE			
<i>Buxus</i> L. (2 species)	ORN	2000–3500	
CAMPANULACEAE (LOBELIACEAE)			
<i>Campanula</i> L. (9 species)	ORN	300–5100	
<i>Cyananthus</i> Benth. (10 species)	ORN	2100–5100	
<i>Lobelia</i> L. (7 species)	ORN	200–3200	
CANNACEAE			
<i>Canna</i> L. (2 species)	ORN	900–1400 ^D	
CAPRIFOLIACEAE			
<i>Abelia triflora</i> R.Br.	ORN	1500–4200	
<i>Lonicera</i> L. (21 species)	ORN	1400–4600	
<i>Sambucus hookeri</i> Rehder	ORN	1400–2400	
<i>Viburnum</i> L. (8 species)	ORN	300–4000	
CARYOPHYLLACEAE			
<i>Arenaria</i> L. (19 species)	ORN	900–5900	
<i>Gypsophyila cerastioides</i> D.Don	ORN	2100–4700	
<i>Silene</i> L. (24 species)	ORN	1300–5500	
CELASTRACEAE			
<i>Euonymus</i> L. (10 species)	ORN	700–3800	
COMBRETACEAE			
<i>Anogeissus latifolius</i> (DC.) Bedd.	TIM	450–1200	
<i>Terminalia alata</i> Roth	FOD, TIM	200–1400	
<i>Terminalia bellirica</i> (Gaertn.) Roxb.	MED, TIM	300–1100	
<i>Terminalia chebula</i> Retz.	MED, TIM	150–1100	
<i>Terminalia myriocarpa</i> Van Heurck & Müll.Arg.	TIM	1000	
CONVOLVULACEAE			
<i>Ipomoea</i> L. (5 species)	ORN	200–1200	
<i>Ipomoea eriocarpa</i> R.Br.	FOD, VEG	610–760	

Table 1C. Continued.

Species	Use	Elevations in Nepal (m)	Germplasm ¹
CORDIACEAE			
<i>Cordia dichotoma</i> Forst.	FIB, FOD	200–1400	
CORYLACEAE			
<i>Carpinus</i> L. (2 species)	ORN	1200–2600	
<i>Corylus</i> L. (2 species)	ORN	2400–3200	
CRASSULACEAE			
<i>Bryophyllum pinnatum</i> (Lam.) Oken	ORN	850	
<i>Kalanchoe spathulata</i> DC.	ORN	1000–1500 ^D	
<i>Sedum</i> L. (16 species)	ORN	1500–5200	
CUCURBITACEAE			
<i>Cucumis callosus</i> (Rottb.) Cogn.	WILD		
<i>Cucumis melo</i> L.	VEG	200–800	1
<i>Cucumis sativus</i> L. (includes var. <i>hardwickii</i> (Royle) Kitam., and var. <i>sikkimensis</i> Hook.f.)	VEG	1300–1800	22 (8)
<i>Cucurbita pepo</i> L.	VEG	100–1500 ^E	27 (1)
<i>Lagenaria siceraria</i> (Molina) Standl.	VEG	200–2300	9
<i>Luffa cylindrica</i> (L.) Roem.	VEG	1200–1700	21
<i>Momordica balsamina</i> L.	WILD	600–2100	
<i>Momordica charantia</i> L.	VEG	300–2100	21 (1)
<i>Momordica dioica</i> Willd.	WILD	1100	
<i>Trichosanthes cordata</i> Roxb.	WILD	500	
<i>Trichosanthes cucumerina</i> L.	WILD	400–1200	
<i>Trichosanthes dioica</i> Roxb.	VEG	600	
<i>Trichosanthes ovigera</i> Blume	WILD	200–1700	
<i>Trichosanthes tricuspidata</i> Lour.	WILD	1200–2300	
<i>Trichosanthes wallichiana</i> (Ser.) Wight	WILD	600–2700	
CUPRESSACEAE			
<i>Cupressus</i> L. (2 species)	ORN	1400–3300	
<i>Cupressus torulosa</i> D.Don	ORN, TIM	1800–3300	
<i>Juniperus communis</i> L.	ARO, ORN, TIM	2700–3200	
<i>Juniperus indica</i> Bertol.	ARO, ORN, TIM	3700–4100	
<i>Juniperus recurva</i> D.Don	ARO, ORN, TIM	3300–4600	
<i>Juniperus squamata</i> D.Don	ARO, ORN, TIM	3300–4400	
CYCADACEAE			
<i>Cycas pectinata</i> Griff.	ORN	300–450	
DAPHNIPHYLLACEAE			
<i>Daphniphyllum himalense</i> (Benth.) Müll.Arg.	TIM	2500–2800	
DIOSCOREACEAE			
<i>Dioscorea alata</i> L.	ORN, VEG	600–1200	
<i>Dioscorea belophylla</i> (Prain) Haines	ORN, WILD	200	
<i>Dioscorea bulbifera</i> L.	ORN, WILD	150–2100	
<i>Dioscorea deltoidea</i> Griseb.	MED, ORN, WILD	450–3100	
<i>Dioscorea esculenta</i> (Lour.) Burkill	ORN, WILD	100–1500 ^E	
<i>Dioscorea glabra</i> Roxb.	ORN, WILD	900–2200	
<i>Dioscorea hamiltonii</i> Hook.f.	ORN, WILD	1200–1700	
<i>Dioscorea hispida</i> Dennst.	ORN, WILD	600	

Table 1D. Continued.

Species	Use	Elevations in Nepal (m)	Germplasm ¹
<i>Dioscorea kamoensis</i> Kunth	ORN, WILD	1800–2200	
<i>Dioscorea melanophyma</i> Prain & Burkill	ORN, WILD	2000–2500	
<i>Dioscorea pentaphylla</i> L.	ORN, WILD	600–1500	
<i>Dioscorea prazeri</i> Prain & Burkill	ORN, WILD	910	
<i>Dioscorea pubera</i> Blume	ORN, WILD		
DIPTEROCARPACEAE			
<i>Shorea robusta</i> C.F.Gaertn.	TIM	150–1500	
EBENACEAE			
<i>Diospyros</i> L. (5 species)	ORN	500–1500	
ELAEAGNACEAE			
<i>Elaeagnus</i> L. (5 species)	ORN	1300–3500	
ERICACEAE			
<i>Pieris formosa</i> (Wall.) D.Don	ORN	2000–3300	
<i>Rhododendron</i> L. (30 species)	ORN	1500–5600	
EUPHORBIACEAE			
<i>Bridelia retusa</i> (L.) Spreng.	FOD, TIM	150–1200	
<i>Euphorbia</i> L. (19 species)	ORN	300–5000	
<i>Phyllanthus emblica</i> L.	FRU, MED	150–1400	
<i>Ricinus communis</i> L.	OIL	150–2400	(1)
FABACEAE (LEGUMINOSAE)			
<i>Acacia</i> Mill. (6 species)	ORN	150–1400	
<i>Acacia catechu</i> (L.f.) Willd.	TIM	200–1400	
<i>Acacia nilotica</i> (L.) Del.	TIM	150	
<i>Acacia rugata</i> (Lam.) Voigt	MED	400–800	
<i>Acrocarpus</i> Arn.	TIM	300	
<i>Albizia chinensis</i> (Osbeck) Merr.	FOD, TIM	200–1500	
<i>Albizia julibrissin</i> Durazz.	ORN, TIM	1300–3000	
<i>Albizia lebbeck</i> (L.) Benth.	FOD, TIM	250–2300	
<i>Albizia lucidior</i> (Steud.) H.Hara	TIM	200–1000	
<i>Albizia odoratissima</i> (L.f.) Benth.	TIM	100–500	
<i>Albizia procera</i> (Roxb.) Benth.	FOD, TIM	300–1100	
<i>Bauhinia purpurea</i> L.	FOD	300–1600	
<i>Bauhinia variegata</i> L.	FOD, ORN, VEG	150–2000	
<i>Cajanus cajan</i> (L.) Millsp.	LEG	200–2000	228
<i>Caragana</i> Fabr. (11 species)	ORN	2400–4600	
<i>Cassia</i> L. (4 species)	ORN	75–2500	
<i>Cicer arietinum</i> L.	LEG	150–1300	358 (6)
<i>Cicer microphyllum</i> Benth.	WILD	4100–4800	
<i>Dalbergia latifolia</i> Roxb.	TIM	200–1000	
<i>Dalbergia sissoo</i> DC.	FOD, TIM	110–1400	
<i>Erythrina arborescens</i> Roxb.	FOD, ORN, TIM	1300–3000	
<i>Erythrina stricta</i> Roxb.	FOD	1000–1600	
<i>Erythrina suberosa</i> Roxb.	TIM	900–1200	
<i>Glycine max</i> (L.) Merr.	LEG, OIL	200–1700	540 (75)
<i>Lablab purpureus</i> (L.) Sweet	LEG	1000–2500	37

Table 1E. Continued.

Species	Use	Elevations in Nepal (m)	Germplasm ¹
<i>Lathyrus aphaca</i> L.	ORN, WILD	200–1200	
<i>Lathyrus laevigatus</i> (Waldst. & Kit.) Gren.	ORN, WILD	2100–3100	
<i>Lathyrus pratensis</i> L.	ORN, WILD	2300–3000	
<i>Lathyrus sphaericus</i> Retz.	ORN, WILD	1300–1600	
<i>Lens culinaris</i> Medik.	LEG	150–1000	346 (13)
<i>Lespedeza</i> Michx. (3 species)	ORN	1500–3000	
<i>Lotus corniculatus</i> L.	FOD, ORN	1500–3900	
<i>Macrotyloma uniflorum</i> (Lam.) Verdc.	LEG	450–2800	40 (3)
<i>Piptanthus nepalensis</i> (Hook.) D.Don	ORN	2000–3800	
<i>Pisum sativum</i> L.	LEG	1200–4000	91 (12)
<i>Trigonella foenum-graceum</i> L.	SPI, VEG	1400 ^A	(4)
<i>Vicia faba</i> L.	LEG	1400 ^A	38 (5)
<i>Vigna angularis</i> (Willd.) Ohwi & H. Ohashi	LEG	300–700 ^E	3 (8)
<i>Vigna mungo</i> (L.) Hepper	LEG	450–2100	128 (16)
<i>Vigna radiata</i> (L.) R. Wilczek	LEG	100–300 ^E	71 (4)
<i>Vigna umbellata</i> (Thunb.) Ohwi & H. Ohashi	LEG	450–2100	157 (4)
<i>Vigna unguiculata</i> (L.) Walp.	LEG	800–1300	181 (2)
FAGACEAE			
<i>Castanopsis hystrix</i> Miq.	FOD, TIM	1000–2500	
<i>Castanopsis indica</i> (Roxb.) Miq.	FOD, FRU, TIM	1200–2900	
<i>Castanopsis tribuloides</i> (Sm.) A. DC.	FOD, TIM	450–2300	
<i>Lithocarpus elegans</i> (Blume) Hatus.	FOD, ORN, TIM	1400–2000	
<i>Lithocarpus pachyphylla</i> (Kurz) Rehder	ORN, TIM	2100–2800	
<i>Quercus</i> L. (9 species)	ORN	450–3800	
<i>Quercus floribunda</i> A. Camus	FOD, ORN, TIM	2100–2700	
<i>Quercus glauca</i> Thunb.	FOD, ORN, TIM	450–3100	
<i>Quercus lamellosa</i> Sm.	FOD, ORN, TIM	1600–2800	
<i>Quercus lanata</i> Sm.	ORN, TIM	460–2600	
<i>Quercus leucotrichophora</i> A. Camus	ORN, TIM	1500–2400	
<i>Quercus semecarpifolia</i> Sm.	ORN, FOD, TIM	1700–3800	
GENTIANACEAE			
<i>Exacum</i> L. (2 species)	ORN	900–2000	
<i>Gentiana</i> L. (43 species)	ORN	750–5800	
<i>Swertia chirayita</i> (Fleming) H. Karst.	MED	1500–2500	
GERANIACEAE			
<i>Geranium</i> L. (13 species)	ORN	900–4800	
GESNERIACEAE			
<i>Aeschynanthus</i> Jack (5 species)	ARO, ORN	300–2700	
<i>Didymocarpus albicalyx</i> C. B. Clarke	ARO, MED	1200–1800	
GROSSULARIACEAE			
<i>Ribes</i> L. (9 species)	ORN	2500–4400	
HIPPOCASTANACEAE			
<i>Aesculus indica</i> (Cambess.) Hook.	ORN, TIM	1900–2400	
HYDRANGEACEAE			
<i>Deutzia</i> Thunb. (3 species)	ORN	1700–3400	
<i>Hydrangea</i> L. (5 species)	ORN	200–3300	

Table 1F. Continued.

Species	Use	Elevations in Nepal (m)	Germplasm ¹
<i>Philadelphus tomentosus</i> D.Don	ORN	2000–3300	
HYPERICACEAE			
<i>Hypericum</i> L. (14 species)	ORN	150–4400	
IRIDACEAE			
<i>Belamcanda chinensis</i> (L.) Redouté	ORN	1300–2300	
<i>Crocus sativus</i> L.	SPI	1400	
<i>Iris</i> L. (5 species)	ORN 2	1800–4400	
JUGLANDACEAE			
<i>Juglans regia</i> L.	FRU, ORN, TIM	1200–2100	(4)
LAMIACEAE (LABIATAE)			
<i>Ajuga</i> L. (7 species)	ORN	600–5100	
<i>Coleus barbatus</i> (Andrews) Benth.	ORN	1000–2500	
<i>Mentha arvensis</i> L.	ARO	1200–2000	
<i>Mentha piperita</i> L.	ARO		
<i>Mentha spicata</i> L.	SPI	1300–2700	
<i>Nepeta</i> L. (10 species)	ORN	1200–5300	
<i>Ocimum</i> L. (4 species)	ORN	300–1500	
<i>Ocimum basilicum</i> L.	ARO	300–1500	
<i>Plectranthus mollis</i> (Aiton) Spreng.	ORN	900–1500	
<i>Salvia</i> L. (11 species)	ORN	170–5000	
<i>Stachys</i> L. (2 species)	ORN	2100–4000	
<i>Teucrium</i> L. (4 species)	ORN	300–2800	
LAURACEAE			
<i>Cinnamomum glaucescens</i> (Nees) Hand.-Mazz.	ARO, MED	2000–2500	
<i>Cinnamomum tamala</i> (Buch.-Ham.) Nees & Eberm.	MED, SPI	450–2000	
<i>Litsea cubeba</i> (Lour.) Pers.	SPI	1000–2700	
<i>Litsea monopetala</i> (Roxb.) Pers.	FOD	500–1000	
LILIACEAE (AMARYLLIDACEAE/ALLIACEAE)			
<i>Allium carolinianum</i> DC.	ORN, WILD	4800–5100	
<i>Allium cepa</i> L.	ORN, VEG	1350 ^A	67 (1)
<i>Allium fasciculatum</i> Rendle	ORN, WILD	2800–4500	
<i>Allium hysistum</i> Stearn	ORN, WILD	5500	
<i>Allium prattii</i> C.H.Wright	ORN, WILD	2400–4500	
<i>Allium przewalskianum</i> Regel	ORN, WILD	3900–4200	
<i>Allium sativum</i> L.	ORN, VEG	1350 ^A	(1)
<i>Allium sikkimense</i> Baker	ORN, WILD	3000–4800	
<i>Allium tuberosum</i> Spreng.	ORN, WILD	2300–2600	
<i>Allium wallichii</i> Kunth	MED, ORN, WILD	2400–4650	
<i>Asparagus</i> L. (4 species)	ORN	600–2900	
<i>Asparagus racemosus</i> Willd.	MED, ORN, VEG	600–2100	
<i>Chlorophytum</i> Ker Gawl. (3 species)	ORN	500–3200	
<i>Clintonia udensis</i> Trautv. & C.A.Mey.	ORN	3200–4000	
<i>Fritillaria cirrhosa</i> D.Don	ORN	3000–4600	
<i>Gloriosa superba</i> L.	ORN	400–2200	
<i>Lilium</i> L. (6 species)	ORN	1100–4600	

Table 1G. Continued.

Species	Use	Elevations in Nepal (m)	Germplasm ¹
<i>Paris polyphylla</i> Sm.	MED	1800–3300	
<i>Polygonatum</i> Mill. (8 species)	ORN	1700–5000	
<i>Smilacina</i> Desf. (3 species)	ORN	2400–4200	
<i>Smilax</i> L. (15 species)	ORN	150–3500	
<i>Tricyrtis maculata</i> (D.Don) J.F.Macbr.	ORN	1300–2500	
LINACEAE			
<i>Linum usitatissimum</i> L.	FIB, OIL	150–3800	22
LYTHRACEAE			
<i>Lagerstroemia</i> L. (3 species)	ORN	200–1500	
<i>Lagerstroemia parviflora</i> Roxb.	ORN, TIM	200–800	
MAGNOLIACEAE			
<i>Magnolia</i> L.	ORN	2250–3400	
MALVACEAE			
<i>Abelmoschus manihot</i> (L.) Medik.	FIB	1200	
<i>Abutilon</i> Mill. (2 species)	ORN	200–1100	
<i>Alcea rosea</i> L.	ORN	1400 ^D	
<i>Hibiscus</i> L. (4 species)	ORN	200–3800	
<i>Hibiscus cannabinus</i> L.	FIB	200	
<i>Hibiscus esculentus</i> L.	VEG	1400 ^A	(5)
<i>Lavatera kashmiriana</i> Cambess.	ORN	500–3600	
<i>Malva</i> L. (2 species)	ORN	2100–3000	
<i>Michelia champaca</i> L.	ORN, TIM	600–1300	
MELIACEAE			
<i>Azadirachta indica</i> A.Juss.	FOD, MED, TIM	300–900	
<i>Toona ciliata</i> Roem.	TIM	200–1700	
MORACEAE			
<i>Artocarpus heterophyllus</i> Lam.	FRU	800	
<i>Artocarpus lakoocha</i> Roxb.	FOD, FRU	400–1600	
<i>Ficus</i> L. (32 species)	ORN	150–2500	
<i>Ficus auriculata</i> Lour.	FOD, ORN	250–1700	
<i>Ficus benghalensis</i> L.	FOD, ORN	500–1200	
<i>Ficus glaberrima</i> Blume	FOD, ORN	600–1500	
<i>Ficus hispida</i> L.f.	FOD, ORN	450–1100	
<i>Ficus lacor</i> Buch.-Ham.	FOD, ORN	500	
<i>Ficus nemoralis</i> Miq.	FOD, ORN	1400–2200	
<i>Ficus religiosa</i> L.	FOD, ORN	150–1500	
<i>Ficus semicordata</i> Sm.	FOD, ORN	200–1700	
<i>Ficus subincisa</i> Sm.	FOD, ORN	300–1800	
<i>Morus australis</i> Poir.	FOD, FRU, ORN	900–2400	
<i>Morus macroura</i> Miq.	ORN	1200–1700	
<i>Morus serrata</i> Roxb.	FOD, FRU, ORN	1600–2400	
MYRICACEAE			
<i>Myrica esculenta</i> D.Don	FRU, ORN	1200–2300	

Table 1H. Continued.

Species	Use	Elevations in Nepal (m)	Germplasm ¹
MYRSINACEAE			
<i>Ardisia</i> Sw. (3 species)	ORN	200–2400	
<i>Myrsine</i> L. (3 species)	ORN	900–2700	
MYRSINACEAE			
<i>Maesa chisia</i> D.Don	MED	1200–2600	
MYRTACEAE			
<i>Eugenia</i> L. (3 species)	ORN	300–1100	
<i>Syzygium aromaticum</i> Merr & Perry	SPI		
<i>Syzygium cumini</i> (L.) Skeels	TIM	300–1200	
NYCTAGINACEAE			
<i>Mirabilis himalaica</i> (Edgew.) Heim.	ORN	2300–4000	
OLEACEAE			
<i>Chionanthus ramiflorus</i> Roxb.	ORN	500	
<i>Fraxinus floribunda</i> Wall.	FOD, ORN, TIM	1200–2000	
<i>Fraxinus micrantha</i> Lingelsh.	ORN	2100–3000	
<i>Jasminum</i> L. (11 species)	ORN	200–3400	
<i>Ligustrum</i> L. (3 species)	ORN	800–2900	
<i>Nyctanthes arbor-tristis</i> L.	ORN	200–1200	
<i>Osmanthus</i> Lour. (2 species)	ORN	2400–3800	
<i>Syringa emodi</i> Royle	ORN	2500–3600	
ONAGRACEAE			
<i>Circaea</i> L. (3 species)	ORN	2000–4100	
<i>Epilobium</i> L. (16 species)	ORN	900–4900	
<i>Ludwigia</i> L. (5 species)	ORN	200–1400	
ORCHIDACEAE			
88 genera, 247 species (Banerji & Pradhan, 1984)	ORN		
<i>Brachycorythis obcordata</i> (Lindl.) Summerh.	MED, ORN	1000–2000	
<i>Dactylorhiza hatagirea</i> (D.Don) Soo	MED, ORN	2800–4000	
<i>Ephemerantha macraei</i> (Lindl.) P.F.Hunt & Summerh.	MED, ORN	500–2400	
OXALIDACEAE			
<i>Oxalis</i> L. (4 species)	ORN	300–3100	
PAEONIACEAE			
<i>Paeonia emodi</i> Wall.	ORN	2100–2200	
PANDANACEAE			
<i>Pandanus nepalensis</i> St.John	ORN	700–1000	
PAPAVERACEAE			
<i>Corydalis</i> Vent. (32 species)	ORN	1900–6000	
<i>Dicentra</i> Bernh. (3 species)	ORN	1300–3000	
<i>Meconopsis</i> Vig. (14 species)	ORN	2400–5800	
<i>Fumaria</i> L. (2 species)	ORN	150–2400	
<i>Papaver</i> L. (2 species)	ORN	1800–3000	
PEDALIACEAE			
<i>Sesamum orientale</i> L.	OIL	600–2400	44 (21)
PINACEAE			
<i>Abies densa</i> Parker	ORN, TIM	3000–4000	
<i>Abies pindrow</i> Royle	ORN, TIM	2100–2500	

Table 11. Continued.

Species	Use	Elevations in Nepal (m)	Germplasm ¹
<i>Abies spectabilis</i> (D.Don) Mirb.	ORN, MED, TIM	2400–4400	
<i>Cedrus deodara</i> (D.Don) G.Don	ORN, TIM	2000–2500	
<i>Larix</i> Mill. (2 species)	ORN	1400–3900	
<i>Larix griffithiana</i> Carrière	ORN, TIM	1400–3900	
<i>Picea smithiana</i> (Wall.) Boiss.	ORN	2300–3600	
<i>Pinus roxburghii</i> Sarg.	ORN, TIM	1100–2100	
<i>Pinus wallichiana</i> A.B.Jacks.	ORN, TIM	1800–3300	
<i>Tsuga dumosa</i> (D.Don) Eichler	ORN, TIM	2100–3600	
PIPERACEAE			
<i>Piper</i> L. (7 species)	ORN	200–2800	
<i>Piper betle</i> L.	ORN, SPI		
<i>Piper longum</i> L.	ORN, MED, SP	1200–800	
<i>Piper nigrum</i> L.	ORN, SPI		
PITTOSPORACEAE			
<i>Pittosporum napaulense</i> (DC.) Rehder & Wilson	ORN	1300–1500	
POACEAE (GRAMINEAE)			
<i>Agrostis</i> L. (12 species)	ORN	900–5000	
<i>Arundinaria maling</i> Gamble	TIM	2500–3000	
<i>Arundo donax</i> L.	ORN	2100–2440	
<i>Avena barbata</i> Link	ORN, WILD	2000–3000 ^C	
<i>Avena fatua</i> L.	ORN, WILD	2300–2700	
<i>Bambusa nutans</i> Wall.	FOD, TIM	700–1700	
<i>Calamagrostis</i> Adans. (4 species)	ORN	1500–3500	
<i>Coix lachryma-jobi</i> L.	CER	900–2100	
<i>Dendrocalamus hamiltonii</i> Nees & Arn.	TIM, VEG	1000–2000	
<i>Eleusine coracana</i> (L.) Gaertn.	CER	1100–2000	869 (4)
<i>Eleusine indica</i> (L.) Gaertn.	WILD	600–2600	
<i>Erianthus</i> Michx. (5 species)	ORN	200–3200	
<i>Festuca</i> L. (nine species)	ORN	1800–5600	
<i>Hordeum turkestanicum</i> Nevski	CER	2700–3600	
<i>Hordeum vulgare</i> L.	CER	200–3830 ^F	468 (607)
<i>Imperata cylindrica</i> (L.) Beauvais	ORN	700–2400	
<i>Miscanthus</i> Andersson (2 species)	ORN	1100–3200	
<i>Oryza minuta</i> C.Presl	WILD	200	
<i>Oryza rufipogon</i> Griff.	WILD	600	
<i>Oryza sativa</i> L.	CER	200–2600 ^E	2387 (146)
<i>Panicum</i> L. (10 species)	WILD	100–2400	
<i>Panicum miliaceum</i> L.	CER	2400	(7)
<i>Phragmites</i> Adans. (2 species)	ORN	1000–3600 ^E	
PODOCARPACEAE			
<i>Podocarpus neriifolius</i> D.Don.	ORN	1000–1100	
POLYGONACEAE			
<i>Fagopyrum dibotrys</i> (D.Don) H.Hara	WILD	1500–3400	
<i>Fagopyrum esculentum</i> Moench	CER	1800–4100	236
<i>Fagopyrum tataricum</i> (L.) Gaertn.	CER	1400–3900	
<i>Polygonum</i> L. (4 species)	ORN	300–4800	

Table 1J. Continued.

Species	Use	Elevations in Nepal (m)	Germplasm ¹
<i>Rheum</i> L. (7 species)	ORN	2400–4800	
<i>Rheum australe</i> D.Don	MED, ORN	3200–4200	
<i>Rumex</i> L. (6 species)	ORN	200–4200	
PRIMULACEAE			
<i>Androsace</i> L. (17 species)	ORN	300–5600	
<i>Lysimachia</i> L. (11 species)	ORN	1200–3800	
<i>Primula</i> L. (60 species)	ORN	1100–5600	
RANUNCULACEAE			
<i>Aconitum</i> L. (31 species)	ORN	2100–4900	
<i>Aconitum bisma</i> (Buch.-Ham.) Rapaics	MED, ORN		
<i>Aconitum spicatum</i> (Brühl) Stapf	MED, ORN	1800–4200	
<i>Actea spicata</i> L.	ORN	2500–3700	
<i>Anemone</i> L. (13 species)	ORN	1300–5600	
<i>Aquilegia</i> L. (2 species)	ORN	2400–4200	
<i>Caltha</i> L. (3 species)	ORN	2700–5500	
<i>Cimicifuga foetida</i> L.	ORN	3000–4000	
<i>Clematis</i> L. (23 species)	ORN	300–4000	
<i>Delphinium</i> L. (20 species)	ORN	1200–6500	
<i>Ranunculus</i> L. (17 species)	ORN	800–5900	
<i>Thalictrum</i> L. (20 species)	ORN	1200–5600	
<i>Trollius</i> L. (2 species)	ORN	3500–5800	
RHAMNACEAE			
<i>Rhamnus</i> L. (7 species)	ORN	600–3000	
<i>Zizyphus incurva</i> Roxb.	TIM	900–1600	
<i>Zizyphus rugosa</i> Lam.	FOD	150–800	
ROSACEAE			
<i>Aruncus dioicus</i> (Walter) Fernald	ORN	3000–4000	
<i>Cotoneaster</i> Medik. (31 species)	ORN	1100–4500	
<i>Fragaria daltoniana</i> J.Gay	ORN, WILD	2000–2800	
<i>Fragaria nilgerrensis</i> J.Gay	ORN, WILD	2800–4200	
<i>Fragaria nubicola</i> Lacaita	ORN, FRU	1600–4000	
<i>Fragaria rubiginosa</i> Lacaita	ORN, WILD	2800–3600	
<i>Geum</i> L. (3 species)	ORN	2500–4400	
<i>Malus</i> L. (2 species)	ORN	1800–3600	
<i>Photinia integrifolia</i> Lindl.	ORN	1300–2800	
<i>Potentilla</i> L. (22 species)	ORN	1000–6000	
<i>Potentilla fulgens</i> Hook.	MED, ORN	1600–4800	
<i>Prinsepia utilis</i> Royle	OIL	1500–2900	
<i>Prunus</i> L. (10 species)	ORN	1000–4000	
<i>Prunus cerasoides</i> D.Don	FOD, FRU, ORN	1300–2400	
<i>Prunus napaulensis</i> (Ser.) Steud.	ORN, TIM, WILD	1600–2600	
<i>Pyracantha crenulata</i> (D.Don) M.Roem.	ORN	1200–2500	
<i>Pyrus pashia</i> D.Don	FRU, ORN	750–2600	(5)
<i>Rosa</i> L. (5 species)	ORN	1500–4600	
<i>Rubus</i> L. (32 species)	ORN, WILD	300–4100	

Table 1K. Continued.

Species	Use	Elevations in Nepal (m)	Germplasm ¹
<i>Rubus ellipticus</i> Sm.	ORN, FRU	1300–2300	(1)
<i>Sanguisorba diandra</i> Wall.	ORN	3000–4400	
<i>Sorbus</i> L. (12 species)	ORN	2300–4300	
<i>Spiraea</i> L. (8 species)	ORN	1200–4900	
RUBIACEAE			
<i>Adina cordifolia</i> (Roxb) Brandis	TIM	150–800	
<i>Anthocephalus chinensis</i> (Lam.) Walp.	TIM	300–1400	
<i>Coffea benghalensis</i> Roem. & Schult.	ORN, WILD	300–900	
<i>Galium</i> L. (9 species)	ORN	1200–4600	
<i>Lasianthus wallichii</i> Wight	ORN	1500	
<i>Luculia gratissima</i> (Wall.) Sweet	ORN	1000–2100	
<i>Rubia manjith</i> Fleming	MED	1200–2100	
RUTACEAE			
<i>Aegle marmelos</i> (L.) Corr�ea	MED	600–1100	
<i>Citrus aurantium</i> L.	FRU, ORN	1000	
<i>Citrus limon</i> (L.) Burm.f.	FRU, ORN	1600	
<i>Citrus medica</i> L.	FRU, ORN	700–1200	
<i>Citrus sinensis</i> Osbeck	FRU, ORN		
<i>Ruta cordata</i> D.Don	ORN		
<i>Skimmia</i> Thunb. (3 species)	ORN	1600–3300	
<i>Zanthoxylum armatum</i> DC.	MED, SPI	1100–2500	
SALICACEAE			
<i>Populus</i> L. (3 species)	ORN	1400–3200	
<i>Populus ciliata</i> Royle	ORN, TIM	2000–3200	
<i>Salix</i> L. (30 species)	ORN	200–5500	
<i>Salix disperma</i> D.Don	ORN, FOD	1500–3500	
<i>Salix tetrasperma</i> Roxb.	ORN, FOD	200–2700	
SAPINDACEAE			
<i>Litchi chinensis</i> Sonn.	FRU	500	
<i>Sapindus mukorossi</i> Gaertn.	MED	1000–1200	
SAPOTACEAE			
<i>Aesandra butyracea</i> (Roxb.) Baehni	FOD, FRU, OIL	200–1500	
SARAUIACEAE			
<i>Saurauia napaulensis</i> DC.	FOD	750–2100	
SAXIFRAGACEAE			
<i>Astilbe rivularis</i> D.Don	ORN	2000–3600	
<i>Bergenia ciliata</i> (Haw.) Stermb.	MED, ORN	900–1700	
<i>Bergenia purpurascens</i> (Hook.f. & Thoms.) Engl.	ORN	3800–4700	
<i>Saxifraga</i> L. (74 species)	ORN	1900–5800	
<i>Tiarella polyphylla</i> D.Don	ORN	2000–4000	
SCROPHULARIACEAE			
<i>Pedicularis</i> L. (63 species)	ORN	1300–2700	
<i>Picrorhiza scrophulariiflora</i> Pennell	MED	3500–4800	
<i>Torenia</i> L. (5 species)	ORN	400–1800	
<i>Veronica</i> L. (15 species)	ORN	300–5600	
SOLANACEAE			
<i>Solanum melongena</i> L.	VEG	1200–1500	1 (1)

Table 11. Continued.

Species	Use	Elevations in Nepal (m)	Germplasm ¹
SYMPLOCACEAE			
<i>Symplocos</i> Jacq. (9 species)	FOD, ORN	150–3000	
TAXACEAE			
<i>Taxus baccata</i> L.	MED, ORN, TIM	2300–3400	
THEACEAE			
<i>Camellia</i> L. (3 species)	ORN	450–1200	
<i>Camellia kissi</i> Wall.	CAS, ORN	900–2200	
<i>Eurya acuminata</i> DC.	FOD	1300–2500	
<i>Eurya cerasifolia</i> (D.Don) Kobuski	FOD	900–2300	
<i>Schima wallichii</i> (DC.) Korth.	TIM	600–2100	
THYMELEACEAE			
<i>Daphne bholua</i> D.Don	FIB, ORN	2000–2900	
<i>Daphne papyracea</i> Steud.	FIB, ORN	1500–2300	
<i>Daphne retusa</i> Hemsl.	ORN	1200–2400	
TILIACEAE			
<i>Corchorus capsularis</i> L.	FIB	300–1200	2
<i>Corchorus olitorius</i> L.	FIB	700–1200	
<i>Grewia optiva</i> Burret	FOD	150–1800	
<i>Grewia subinaequalis</i> DC.	FOD	400–1500	
ULMACEAE			
<i>Celtis</i> L. (3 species)	ORN	300–2800	
<i>Celtis australis</i> L.	FOD, ORN, TIM	1300–2200	
<i>Ulmus</i> L. (3 species)	ORN	100–3000	
URTICACEAE			
<i>Boehmeria rugulosa</i> Wedd.	FOD, TIM	300–1700	
<i>Pilea</i> Lindl. (14 species)	ORN	300–3300	
VALERIANACEAE			
<i>Nardostachys grandiflora</i> DC.	MED	3200–5000	
<i>Valeriana jatamansii</i> Jones	MED	1500–3300	
VERBENACEAE			
<i>Clerodendron</i> L. (10 species)	ORN	200–1600	
<i>Gmelina arborea</i> Roxb.	FIB, FOD, TIM	200–1100	
<i>Lantana</i> L. (2 species)	ORN	200–1500	
<i>Verbena officinalis</i> L.	ORN	900–2400	
<i>Vitex</i> L. (3 species)	ORN	100–3000	
VIOLACEAE			
<i>Viola</i> L. (14 species)	ORN	1200–4500	
VITACEAE			
<i>Ampelopsis glandulosa</i> (Wall.) Momiy.	ORN	1300–1600	
<i>Cissus</i> L. (4 species)	ORN	300–1200	
<i>Parthenocissus</i> Planch. (2 species)	ORN	1800–3200	
<i>Vitis</i> L. (4 species)	ORN	900–2400	
ZINGIBERACEAE			
<i>Amomum aromaticum</i> Roxb.	SPI	tropics	
<i>Amomum subulatum</i> Roxb.	SPI	1000–2000	

Table 1M. Continued.

Species	Use	Elevations in Nepal (m)	Germplasm ¹
<i>Cautleya</i> Hook.f. (2 species)	ORN	1200–3100	
<i>Curcuma angustifolia</i> Roxb.	CON	1500	
<i>Curcuma aromatica</i> Salisb.	SPI	700–1100	
<i>Elettaria cardamomum</i> Maton	SPI		
<hr/>			
<i>Hedychium</i> Koenig (12 species)	ORN	200–3100	

^ABhatt, 1977^BMatsumura, 1956^CHujieda & Watahara, 1956; Hara & Williams, 1979^DBajracharya et al., 1984^CNakao & Mori, 1956^EPers. observ.^FNakao, 1956

Results and discussion

Table 1 lists 485 specific and generic entries. Of these, 239 genera have species potentially useful for direct economic development or breeding as ornamentals (in addition to 88 genera of orchids), 103 species for timber or fodder, 60 for foods (fruits, vegetables, cereals, or legumes), 54 as wild species relatives of food plants, 37 for medicines, 17 for spices, nine for fibers, ten for aromatics, six for oils, one as a cash crop, one for dye. Modifications will be made to Table 1 with additional discoveries of Nepal's genetic resources and understanding of the breeding potential of the wild species. This list represents the first attempt to place priorities on conservation of the wide range of germplasm for all classes of uses, and we welcome comments on modifications.

It will not be economically feasible to collect, increase, identify, maintain, characterize, and distribute all of these species in genebanks. For example, many woody species have recalcitrant seeds and are best collected as needed from the wild, and habitat preservation is needed for protection.

Floristic and Monographic Literature. Historical summaries of collecting and floristic work in Nepal are presented by Dobremez et al. (1972), Rajbhandari (1976), Hara et al. (1978), Stearn (1978), and Sutton (1978). Formal botanical exploration of Nepal began when Francis Buchanan (later Hamilton) from the East India Company collected herbarium specimens from Nepal in 1802. Don (1925) used these collections and those of others to record 650 species for Nepal. A major

early floristic work of Nepal is Hooker (1872–1897), and still is consulted widely.

For political reasons, later access to Nepal was restricted largely to outside collectors until 1949. Major collectors assembling plants from Nepal since that time have been O. Polunin, J.D.A. Stainton, W.R. Sykes, L.J.H. Williams from Great Britain, and H. Hara and collaborators from Japan. Extensive collections also have been made by personnel from Nepal's Department of Medicinal Plants, including S.B. Malla, T.B. Shrestha, P. Pradhan, and P.R. Shakya. M.L. Banerji (India) also collected many plants from Nepal (Banerji, 1965; Hara et al., 1978).

The British and Japanese teams collaborated in the latest enumerations of gymnosperms and angiosperms for Nepal (Hara et al., 1978, 1982; Hara & Williams, 1979). These list monographic and floristic references; those published after 1982 can be obtained by Rajbhandari (1994). These enumerations were preceded by Malla (1976a), and by treatments periodically summarizing results of the Japanese expeditions (Kihara, 1955; Hara, 1966, 1971; Ohashi, 1975). These contain useful information on synonymy, distribution, vegetation, phytogeography, cytology; place names, selected systematic treatments of various groups, and photographs. Except for the individual systematic treatments, most plant groups lack keys, but these are provided by Pande (1967a), Suwal (1968), and Malla (1981).

The most important surveys and classification of Nepal's forests are Stainton (1972) and Jackson (1994). Other treatments of Nepal's forests are Banerji (1973), Ohsawa et al. (1973), Byers (1979), and Martens

(1983). Ferns are treated by Iwatsuki (1988), lichens by Awasthi (1965, 1991) and Sharma (1984), mosses by Kattel & Adhikari (1992), orchids by Banerji & Pradhan (1984). The most complete (and highly illustrated) overall floristic treatment to the Himalayan region of Nepal is Polunin & Stainton (1984), superseded by condensed and updated versions by Polunin & Stainton (1987) and Stainton (1988). Floras of adjacent regions in India are listed in Polunin & Stainton (1984). Floristic treatments of small regions of Nepal are Pande (1967b), Suwal (1969), Malla (1973, 1976b, 1986), and Miehe (1987). Heavily illustrated and/or popular treatments of Nepal's flora are Nakao (1964), Hara (1968), Mierow & Shrestha (1978), Metha & Bole (1991), and Storrs & Storrs (1990). Shrestha (1984) and Jackson (1994) provide common names in English and Nepali for common plants and trees, respectively.

Vegetation, Climate. The two most comprehensive treatments of vegetation for Nepal are Dobremez (1976) and Stainton (1972), but also see Hara (1966), Rau (1974), Hara et al. (1978), Shrestha (1982), Polunin & Stainton (1984), and Jha (1992). Stainton (1972) recognizes 35 forest types for Nepal, ranging from tropical to temperate to alpine types. Dobremez (1976) recognizes 71 total vegetation types for Nepal (some as subgroups of vegetation types), ranging from tropical to subtropical, to temperate, to subalpine, to alpine, to steppe, and published them in seven maps (Dobremez & Jest, 1971; Dobremez, 1972, 1973, 1978; Dobremez & Shakya, 1975; Dobremez & Shrestha, 1978; Dobremez, et al., 1985). Grasslands occur in all elevation zones (Tsuchida, 1983).

Nepal is located in the monsoon system of the Indian subcontinent. Eighty percent of the rain falls during the summer monsoon period from June to September, and most of the rest falls in winter from December to March. Average rainfall is about 1600 mm, but this varies in different eco-climatic zones. Some areas north of the frontal Himalayan chain experience a rain shadow effect. The highest average rainfall is 4988 mm at Lumle (Central Nepal, 1642 m, on the frontal chain), and the lowest at 238 mm at Jomsom (Central Nepal, 2743 m, behind this chain). The western part of Nepal at all elevation zones is drier than eastern Nepal (Jha, 1992). Best times to collect germplasm varies from May to November, depending on the species.

Biodiversity. Nepal's great range in elevations and climates allows for many habitats and tremendous biodiversity. For example, even though covering only 0.09% of the earth's land surface, Nepal has 9.49% of

the species of birds, 5.0% of mammals, and 2.82% of the higher plants (Jha, 1992). Hara & Williams (1979) and Hara et al. (1978, 1982) list 5,400 species of gymnosperms and angiosperms for Nepal, but estimate a total 6,500 species. Joshi & Joshi (1991) report 307 endemic species of Nepal. This diversity is protected partly by eight national parks, five wildlife reserves, and two conservation areas occupying 12% of Nepal's surface covering all of these altitude areas. Forty-one plant species are known to be endangered or threatened (HMG, 1991).

Nepal faces many problems relating to population growth, poverty, and environmental degradation. Forest degradation (mostly for domestic fuel wood use) and deforestation (for commercial use and land clearing for agriculture), are causing much of this degradation. Fuel wood accounts for 77.3% of the domestic energy consumption (HMG, 1994), and tree fodder is greatly used as animal feed. Exploitation of forests was about 70,000 hectares per year during the period between 1965 to 1979. After 1979, this rate decreased to 12,000 hectares per year (HMG, 1990). Much of Nepal is deforested, especially in the lowlands, and only about 15% of the existing forest land has a crown cover of more than 70% (HMG, 1993).

Agriculture in Nepal. More than 80% of the economically active workers in Nepal are involved in agriculture. Sixty percent of the agricultural land is in the terai (HMG, 1994). The total land area in 1991/1992 devoted to cereal grains was 80.0%, legumes 8.4%, oil seeds 6.4%, tubers 1.9%, cash crops 1.5%, vegetables 1.0%, and spices 0.7%. The percentage production (based on metric tons) for cereal grains during this period was: rice 59.0%, maize 22.0%, wheat 14.3%, millet 4.2%, and barley 0.5%. The percentage production (based on metric tons) for legumes during this period was: lentil (*Lens culinaris* Medic.) 47.2%, grass pea (*Lathyrus sativus* L.) 13.4%, chick pea (*Cicer arietinum* L.) 10.7%, soybean (*Glycine max* (L.) Merr.) 7.4%, pigeon pea (*Cajanus cajan* (L.) Millsp.) 7.3%, black gram (*Vigna mungo* (L.) Hepper) 6.6%, horse gram (*Macrotyloma uniflorum* (Lam.) Verdc.) 2.4%, and others (broad bean (*Vicia faba* L.), cow pea (*Vigna unguiculata* (L.) Walp.), field pea (*Pisum sativum* L.), rice bean (*Vigna umbellata* (Thunb.) Ohwi & H. Ohashi), and mung bean (*Vigna radiata* (L.) R. Wilczek), (*Phaseolus* spp.) 5.0% (HMG, 1994)).

There is much potential in Nepal for greater yields with improved technology and varieties. Total arable land was 1,591,900 ha. in 1961, and 2,323,400 ha. in 1991, for an increase of 46% (HMG, 1994). Although

more land has been placed under cultivation, yields in the midlands and highlands have decreased due to soil erosion, sedimentation, poor irrigation facilities, lack of fertilizers, and reduced soil fertility, but yields have increased in the terai (HMG, 1993).

Nepal's need for agricultural improvement has led to the development of a Plant Genetic Resources Program and many field stations of the National Agricultural Research Council and Department of Agriculture Development. These are positioned in representative environments throughout the country. Plant sciences at these stations place a priority on evaluations of indigenous landraces and advanced cultivars, production of foundation seeds, plant protection, improvement of cultural practices, and outreach. Nepal has plant breeding programs for maize, rice, some legumes, and wheat, but most advanced varieties of these and other crops are obtained from international centers or other national programs, especially India.

Logistics, Maps. The transportation system in Nepal is poor. Nepal has 3,083 km of blacktop roads, 2,181 km of gravel roads, and 3,064 km of earth roads (HMG, 1994). The majority of these are in the lowlands. Forty-three cities in Nepal can be reached by commercial airlines (Shrestha, 1989, maps them), but travel in upland areas is unsure during December-March because of wind or snow. Helicopter service is available for other areas. Travel throughout the rest of the country is by foot on a well-used system of foot paths. Many of the paths traverse some of the most spectacularly scenic areas of the world, and account for much of the popularity of Nepal for tourism.

Topographic Maps. HMG, Survey Department, 1989. Nepal in three sheets, 1:500,000-scale, includes national park boundaries.

HMG, Survey Department, 1984–1990. Zone Maps. One map for each of the 14 Zones (Bagmati, Bheri, Dhawalagiri, Gandaki, Janakpur, Karnali, Koshi, Lumbini, Mahakali, Mechi, Narayani, Rapati, Sagarmatha, Seti (except Karnali Zone, in two parts), 1:250,000-scale (except Dhaulagiri Zone, at 1:125,000-scale).

HMG, Survey Department, 1986–1994. District (subdivision of zone) maps, 1:125,000-scale, one map for each of the 75 districts.

Survey of India, 1950s–1962. 266 maps (all available except 10 maps of some border areas), 1:50,000-scale, all low-quality blue copies. The Nepal National Survey Department currently is producing new color topographic maps based on recent aerial surveys, with the plan to produce 1:25,000-scale maps in the terai

and midlands, and 1:50,000-scale maps in the uplands. Currently, only some areas radiating from the capital, Kathmandu, are completed.

Nelles Verlag, for Arbeitsgemeinschaft für vergleichende Hochgebirgsforschung, Munich, 1993. Twelve maps published for east Nepal: Everest, 1:25,000-scale; Kathmandu City, 1:10,000-scale; Kathmandu Valley, 1:50,000-scale; Khumbu Himal, 1:50,000-scale; Lapchi Kang, 1:50,000-scale; Rolwaling Himal, 1:50,000-scale; Shorong/Hinku, 1:50,000-scale; Tamba Kosi, 1:50,000-scale; Dudh Kosi, 1:50,000-scale; Helambu-Lantang, 1:100,000-scale; Annapurna, 1:100,000-scale; Patan City, 1:7,500-scale.

National Geographic Society, Washington, D.C., 1988. Mount Everest, 1:50,000-scale. Shows mountain and glacier names for the Mount Everest area in Nepal and Tibet, land features and vegetation.

Satellite Maps. National Remote Sensing Center, P.O. Box 3103, Babar Mahal, Kathmandu, 1986. Planimetric maps of satellite images, 1:250,000-scale. Nineteen maps cover Nepal.

Road, Trail, Service Maps. TT Maps and Publications Ltd., 328, G.S.T. Road, Chromepet, Madras 600 004, India, 1994. Road guide to Nepal, 1:850,000-scale. Includes a 29-page booklet providing information on selected cities, trekking routes, and hotel information, and a map with roads, zone boundaries, some trekking routes, cities, and a separate physical map.

HMG, Department of Roads, 1989. Main trail maps, 1:250,000-scale. Six maps cover all of Nepal for the following development regions: far western, mid western (Rapti/Bheri Zones), mid western (Karnali Zone), western, central and eastern. Includes details on roads, trails, place names, political subdivisions, and waterways.

Publisher and date not listed, Nepal maps for extreme and soft trekking. Maps available for the popular hiking routes of Annapurna (1:250,000-scale), Dolpa (1:30,000-scale), Kathmandu Valley (1:50,000-scale), Langtang (1:120,000-scale), and Mustang (1:250,000-scale). Roads, trekking routes, land features, place names.

Mandala Book Co., Kathmandu. 1984–1988. Coarse blue-line maps of most of the midland and upland regions, 13 maps at 1:50,000-scale, 1:125,000-scale, or 1:250,000-scale.

HMG, Department of Roads, 1989. Central Service Maps of Nepal, 1:250,000-scale. Forty-eight sheets are identified by a single district, but cover much of peripheral districts. Consequently, most of the 75 districts of

Nepal are covered. Includes details on roads, trails, place names, political subdivisions, and waterways, and availability of 34 services, grouped in 12 classes: agriculture, banks, communications, education, electricity, health, industry, police, religious sanctuary, tourism, trade, and transport.

Gazetteers. United States Department of Interior, 1952. India Official Standard Names Approved by the United States Board on Geographic Names. Division of Geography, Department of Interior, U.S. Government, Washington, D.C. Two volumes, Nepal in Vol. 1, pp. 59–82.

Sharma, C.K., 1977. River systems of Nepal. Published by Mrs. Sangeeta Sharma, Kathmandu, Printed by Shri K.K. Ray, Calcutta.

HMG, National Council for Science and Technology, Kathmandu, 1988. Index of Geographical Names of Nepal. Vol. 1, Eastern Development Region; Vol. 2, Central Development Region; Vol. 3, Western Development Region; Vol. 4, Mid Western Development Region; Vol. 5, Far Western Development Region. Includes latitude and longitude and height, length, or area for place names, waterways, lakes, and mountains.

Hiroo, H., 1988. Index gazetteer of the Himalaya. Japan Nepal Society, Tokyo, Japan. Includes latitude and longitude for place names, rivers, mountain ranges, and roads.

Shrestha, S.H., 1989. Nepal in Maps. Educational Enterprise Pvt. Ltd., Kathmandu, Nepal. Provides statistics in text and 55 maps of topography, drainage, climate, natural resources, industry, agriculture, tourism, ethnic data, roads, and trekking routes.

Travel Guides. There are many travel guides for Nepal, easily available in many bookstores and travel agencies. The following two are very informative:

Raj, P.K., 1994. Around the Annapurnas: one of the famous walks of the world. Nabeen Publications, P.O. Box 5345, Kathmandu, Nepal. Information on logistics, money exchange, visas, trekking permits, clothing for trekking, climate, ethnic information for Nepal, and descriptions of villages in the Annapurna area.

Bezruchka, S. 1991. Trekking in Nepal: a traveller's guide. Sixth Ed. Mountaineers Books, Seattle, Washington. Includes detailed information on trekking, natural history, cultural information, glossary of Nepali and Tibetan terms, bibliographies on various topics, and index.

In Nepal, most maps are obtainable from the Survey Department, HMG, Dilli Bazar, Kathmandu, and S.M. Trading Centre, New Baneshwor, P.O. Box 4782, Kathmandu, Nepal.

Collecting Regulations. A visa is required for entry into Nepal, obtainable at Nepal embassies or consulates or at the Nepal airport. At the time of this printing, a visa costs \$40/first month, then \$2/day for second month, \$3/day third month, and thereafter. Trekking permits are required for hiking in remote areas in the north. Costs vary according to the area, but average about \$5/week for first four weeks, and \$10/week in next month. A park entry fee of \$13 is required for entry into most National Parks.

Exploration for herbarium specimens or germplasm in National Parks and Conservation Areas is prohibited under the National Park and Conservation Act, 1972. Exploration in forests requires approval of HMG, under provisions of the Forest Protection Act, 1977. Nepal is a member of the FAO Commission on Plant Genetic Resources, and abides by the international code of conduct for germplasm collecting and transfer. Nepal has signed the Convention on Biological Diversity, 1992, and access to genetic resources has been granted based on mutually agreed terms. The country is in the process of developing a National PGR System and policy to safeguard the plant genetic diversity in a sustainable manner, and plant collectors from abroad must receive permission to collect germplasm from HMG. For agricultural germplasm, interested parties should contact Ministry of Agriculture, Singh Durbar, Kathmandu, for forest and medicinal resources contact the Ministry of Forestry, Babarmahal, Kathmandu, Nepal.

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Note: "HMG" refers to "His Majesty's Government, Nepal".

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