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Agro-Biodiversity of Kumaun Himalaya, India: A Review

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ABSTRACT

Kumaun Himalaya is one of the unique systems, rich in indigenous traditional knowledge and culturally strong. In the present study, qualitative and quantitative data were collected on agro-biodiversity through field and literature survey. Altogether, 161 plant species belonging to 117 genera and 57 families were recorded. In addition, a large number of land races, varieties and wild relatives are also being used. Cultivation of these crops is mainly of subsistence in nature rather than for commercial purposes. Due to a number of reasons, the area under traditional crops is declining in Kumaun Himalayan region but many of the crop varieties are still conserved because of their socio-cultural and religious values. The human population has increased over time forcing farmers to change their cropping patterns, for example, replacement of mixed cropping to mono-cropping and switching over to cash crops. This has adverse implications on traditional agro-biodiversity of the region. There are both local and global advantages in supporting a dynamic traditional system of agro-biodiversity management. Therefore, promotion and conservation of agro-biodiversity should be done through sustainable use and on- farm and off- farm management.

Keywords: Agro-biodiversity, Crop cultivation, Traditional knowledge, Kumaun Himalaya.

INTRODUCTION

Agro-biodiversity refers to the human-managed or modified biological diversity for general agricultural purposes. It is the synergy and interaction between living things, land, technology and social systems. Agro- biodiversity is regarded as the sub-set of biodiversity that includes the diversity and variability of plants, animals, micro-organisms and *in situ* and *ex situ* conservation of genetic resources linked with agriculture[1]. In sustaining and strengthening food, nutrition, health and livelihood security all over the world, agriculture biodiversity play a pivotal role. Besides growing a few crops, people frequently collect wild edible and other plants from natural habitats to meet their subsistence needs[2]. It has been proven that agro-biodiversity can help to increase crop productivity while diseases can be controlled in the agroecosystems[3-7].

There are at least 3000 edible plant species known to man, with merely 30 crops contributing to nearly 95% of the world's calories intake and only 103 crops are economically important at national level[8]. There are many socioeconomic benefits of crop-diversity and their wild relatives such as "Genes from wild wheat in Turkey saved an epidemic of the wheat disease in USA in the 1960's[9]. There are several other instances where the wild relatives have contributed in the improvement of their cultivated

varieties of rice, maize, potato, sugarcane, wheat, tomato etc[9]. Thus, the wild relatives provide the necessary "genetic materials" to boost productivity and biological resistance to counter pests and disease.

With varied types of climate (subtropical to alpine), altitude, topography, soil types, valleys, rivers, watersheds and forest resources, Kumaun Himalayan region of Uttarakhand state is suitable for the growth of all kinds of plants. Floristically and ethno-botanically this area has been studied by number of workers[10-14]. However, the agriculture diversity including land races and its wild relatives are not properly documented. In recent years, documentation of traditional knowledge on cultivated crops, landraces and wild relative plants become a prerequisite to preserve traditional knowledge of a region. Therefore, the present study was carried out to collect valuable information on agro-diversity, traditional land races and its related indigenous knowledge of Kumaun Himalayan region. Further this study will also be helpful in: i. Taking appropriate steps for documenting the indigenous knowledge related to genetic resources; ii. Conservation and sustainable utilization of genetics resources; iii. Providing resources to the needy person or technologists; iv. Including them under IPRs; v. Promoting sustainable utilization of resources with fair and equitable sharing of the benefits accruing by their use and vi. Establishing farmer's rights over their collective knowledge and resources base.

Agricultural practices in Kumaun

Agriculture is one of the major occupation of the hill people because of the various agro-climate zone along the altitudinal gradient *viz.*, (i) lower altitude (up to 1200m) (ii) middle altitude (between 1200-2300 m) and (iii) higher altitudes (above 2300 m). The cultivated land of this region is mainly divided into three categories[15].

a. Land of forest edges (waste land near crop fields dominated with scrub vegetation)
b. Upraon- land of hill sites (having no irrigation facilities)
c. Talaon- land of valley bottom (having irrigation facilities)

Upraon and Talaon are the traditionally accepted categories of this region. Usually three or four crops are taken within twelve months (from November to October). These crops are:

a. Kharif crop (April to October)
b. Ravi crop (November to April)
c. Jayad crop (April to October)Kitchen garden, waste places, side of cultivated lands fields near houses are used for this purpose. The mixed crops are mainly vegetables.
d. Intermediate crop (May to August) - Irrigated fields are practiced for this purpose. The main crops are Ganiyar or Cheena (*Panicum miliaceum*), and Makka (*Zea mays*). After harvesting the crops, paddy plants are

Table 1: Differences between Traditional and Modern Agriculture[17,16]

Traditional agriculture	Modern agriculture
Many crops grown	Few crops grown on commercial scale
Mixed cropping of species with complementary requirements	Pure cropping (Mono-cropping)
Highly tolerant to environment stress	Less dependency on climate and soil condition
Crops mostly multipurpose plants	Crops mostly uni-purpose
Low inputs of fertilizer, water requirements	High inputs of fertilizer and irrigation
Harvested seeds- source for next sowing	Hybrid seeds and improved cultivars used
Resistant/tolerant to pests and disease.	Low resistance to disease and high inputs pests; pesticides, etc. needed as

transplanted in these fields. Demographic records show that majority of the population in Kumaun hills dwell in villages scattered over valleys and slopes. Valleys are surrounded by characteristic vegetational composition. The agricultural lands are often terraced on various degrees of slopes.

There is a striking difference between traditional and modern agriculture (Table 1). It is evident from the comparison that the traditional land races are well adapted to local conditions of moisture stress, disease/pests risk, etc., while the modern crops/cultivars have a narrow genetic base suited specialized conditions of high inputs and high environment risk[16]

Indigenous farming system of this region is quite scientific. Traditional practice involves the sowing of mixture of multiple crop seeds into a single terraced field which helps the farmers to supply different kinds of foods, maintaining crop biodiversity, restore soil fertility (by the use of leguminous plants), reduces the infection of pests and pathogen (traditional crop posses the inherent qualities to withstand the sudden outbreak of disease, pests and natural hazards, which protects the traditional farmers from absolute crop failure since millennial), locally well adopted, sometimes it is predicted that the multiple cropping helps in increasing production per unit area and per unit time which needs scientific validation. Crop rotation and crop composition (mixed cropping) prevailing in Kumaun Himalaya is given below:

Shifting cultivation

There are many evidence of shifting cultivation in Kumaun felling of trees and clearing of forests was usually practicised by Kumaunies to increase the crop farming. Crops like Potato, Kuuni, Chaulai, Muli, Gahat, Maduwa etc were cultivated by our ancestors during shifting cultivation. In recent year shifting cultivation is not seen anywhere in Kumaun Himalaya.

Crop Rotations

The traditional method of rotation of Kumaun Himalaya are as follows (Table 1a):

Mixed cropping

The farmers of Kumaun Himalaya still practicing of sowing a mixture of many traditional crops into a single plot of land. The following mixtures of seeds are commonly used by farmers into a single plot of land in Kumaun Himalaya (Table 1b).

Ugal- Cultivated extensively in Darma and Vyans valleys of Kumaun Himalaya and is widely cultivated in kitchen garden in low altitude in the study area.

Table 1a: Crop rotation in Kumaun Himalaya

Alsi	Paddy	Wheat
Alu	Wheat	Alu (in rainy season)
		wheat
Alu	Mirch	Tamatar
Cheena	Paddy	Wheat
Cheena	Paddy	Alu (in winter season)
		Paddy
Lahsun	Desi Kaddu	Makka
Makka	Dhan (Paddy)	Gahoo (Wheat)
Masoor	Paddy	Wheat
Maduwa	Hawsir- Masoor	Paddy- Wheat
Muli	Dun/Dhun	Lal mirch
Ugal	Haldi	Methi

Table 1b: Mixed cropping in Kumaun Himalaya

1. Paddy + Kauni + Madir + Bajur + Til + Urd + Kakari + Muli + Ugal.
2. Paddy + Til + Kauni + Kumil
3. Paddy + Til + Kauni + Makka + Raiyas + Bhindi + Muli
4. Paddy + Soyabean + Urd + Kakari + Kauni + Muli + Oogal
5. Wheat + Matar + Sarsoo + Chana + Jau
6. Jau + Matar + Sarsoo + Chana + Masoor
7. Makka + Bhindi + Muli + Lobia
8. Maduwa + Bajur + Bhatt + Urd + Lobia + Chua
9. Madir + Maduwa + Bhatt + Bajur, etc.

Table 2: Agro-diversity* of the Kamaun Himalaya

Latin name of plant	Common/ vernacular name of plant** Agricultural crops	Altitude ranges (m asl)	Family
Cereals			
Avena sativa	Oat, Jai	Up to 1200 m	Poaceae
Hordeum himalayanse	Nacked barley, Owa jau	Up to 1000 m	Poaceae
Hordeum vulgare	Barley, Jau, Va, Chama	Up to 1000 m	Poaceae
Oryza sativa	Dhan, Paddy, Sathi	Up to 2300 m	Poaceae
Triticum aestivum	Wheat, Gegun, Dapati, Gehoo, Nephal	Up to 3400 m	Poaceae
Zea mays	Maiz, Makka, Mungari, Bhutta, Tantoo, Junala, Indian corn, Ghwag, Kakuni	Up to 2000 m	Poaceae
Millets			
Echinochloa frumentacea	Baryyard millets, Jhangora, Maidira	Up to 2000 m	Poaceae
Eleusine coracana	Finger millet, Koda	Up to 2000 m	Poaceae
Fagopyrum esculentum	Buckwheat, Ugal, Oggal, Kottu, Palthi,	Cultivated	Polygonaceae
Fagopyrum tataricum	Buckwheat, Phapar***, Kotu, Tarter, Bhe	2000-2400 m	Polygonaceae
Panicum miliaceum	Hog millet, Bhangna, China	Up to 1000 m	Poaceae
Pennisetum typhoides	Bajra, Pearl Millet	Up to 2000 m	Poaceae
Setaria italica	Foxtail millet, Kauni, Koni	Up to 2000 m	Poaceae
Pulses			
Cajanus cajan	Arhar, Thohar, Tor, Pigeon-pea, Cajan pea, Red pea	Up to 1200 m	Fabaceae
Canavalia gladiata	Sema, Makhan sem, Sword Sem	Up to 1500 m	Fabaceae
Cicer arietinum	Chana, Chick pea, Gram	Up to 1500 m	Fabaceae
Glycine max	Soyabean	500-1500 m	Fabaceae
Glycine soja	Kalabhatt	500-1500 m	Fabaceae
Lens culinaris	Masur	Up to 1500	Fabaceae
Phaseolus lunatus	Vilaiti Sem, Lima bean	Up to 1600 m	Fabaceae
*Phaseolus vulgaris*****	Cheemi, Kidney bean, French bean, Faraz bean, Razma	Up to 3000 m	Fabaceae
Vigna faba	Bakla, Broad bean, Kalamatar, Windsor bean	Up to 1500 m	Fabaceae
Vigna aconitifolium	Mat bean, Bhringa, Moth bean	Up to 2000 m	Fabaceae
Vigna angularis	Adjuki beans, Rains, Guruns	Up to 2000 m	Fabaceae
Vigna mungo	Black gram, Urd	Up to 3000 m	Fabaceae
Vigna radiata	Green gram, Mung, Pessana	Up to 1200 m	
Vigna umbellata	Guruns, Rayans, Bhitia dal,		
Vigna unguiculata	Cow pea, Sonta, Lobia	Up to 2500 m	Fabaceae
Vitis vinifera (Climber fruit)	Angoor, Grape	Up to 2000 m	Vitaceae
Spices			
Amomum subulatum	Bari elachi, Greater cardamomum,	Up to 1000 m	Zingiberaceae

	Nepal cardamomum		
Benincasa hispida	Bhunya, Chet- Kumbra, Petha, White gourd, Wax gourd	Up to 600 m	Cucurbitaceae
Brassica nigra	Kali rai	Up to 2200 m	Brassicaceae
Cleome viscose	Jakhia, Hurhur	Between 1000-2500 m	Capparaceae
Corandrum sativum	Dhaniya, Coriander	Up to 2200 m	Apiaceae
Curcuma domestica	Haldi, Turmeric	Up to 2000 m	Zingiberaceae
Vegetables			
Abelmoschus esculentus	Ladies finger, Okra, Bhindi	Up to 2000 m	Malvaceae
Allium carolinianum	Dhun, Ladam	Up to 2500 m	Amaryllidaceae
Allium cepa	Onion, Pyaz	Up to 2000 m	Amaryllidaceae
Allium sativum	Lahsun, Lasun, Garlic	Up to 2500 m	Amaryllidaceae
Amaranthus frumentaceus	Chuewa, Chua, Anaardana, Princes feather, Marcha, Ramdana, Amaranth	Up to 2800 m	Amaranthaceae
Amaranthus oleracea	Amaranth, Chaulai	Up to 2000 m	Amaranthaceae
Amorphophallus campanulatus	Zimikand, Elephant foot, Yam, Telgu Potato	Up to 1000 m	Araceae
Beta vulgaris	Chukunder	Up to 1000 m	Amaranthaceae
Brassica oleracea var*. botrytis*	Cauliflower, Phoolgobhi	Up to 1500 m	Brassicaceae
Brassica oleracea var. *capitata*	Bandgobhi, Pattagobi, Cabbage	Up to 2500 m	Brassicaceae
Brassica oleracea var*. gongylodes*	Knol- knoll, Ganthgobhi	Up to 1000 m	Brassicaceae
Brassica rapa	Shaljam, Turnip	Up to 1000 m	Brassicaceae
Capsicum annuum	Khursani, Mirch, Chilly	Up to 2200 m	Solanaceae
Chenopodium album	Pig weed, Bethuwa, Jau Sag, Chaurai, Gossefoot	Up to 1500-3500 m	Amaranthaceae
Colocasia esculenta	Ghuiya, Elephant ear, Pinalu, Gaderi	Up to 1500 m	Araceae
Colocasia himalensis	Taro, Pinalu, Kurchain	Between 500-2000 m	Araceae
Cucurbita maxima	Gaddu, Kaddoo, Sitaphal, Squash gourd,	Up to 1500 m	Cucurbitaceae
Cucumis sativus	Kheera	Up to 2200 m	Cucurbitaceae
Cyclanthera pedata	Kundroo, Meeta-karela, Konkra	Up to 1500 m	Cucurbitaceae
Cyphomandra betacea	Tree tomato	Cultivated	Solanaceae
Daucus carota var*. sativa*	Gajar, Carrot	Up to 600 m	Apiaceae
Ipomoea batata	Shakarkand, Meetha Alu, Sweet Potato	Up to 1000 m	Convolvulaceae
Lagenaria siceraria	Lauki, Tumari, Tumara, Bottle ground, White flowered gourd, Calabash Cucumber	Up to 2200 m	Cucurbitaceae
Luffa acutangula	Torai, Riged gourd, V egetable sponge	Up to 2000 m	Cucurbitaceae
Luffa aegyptiaca	Ghiya Torai, sponge,	Up to 2000 m	Cucurbitaceae

Lycopersicum esculentum	Tamater, Tomato	Up to 3500 m	Solanaceae
Momordica charantia	Karela, Bitter gourd	Up to 2500 m	Cucurbitaceae
Pisum arvense	Kong, Goli	Up to 1800 m	Fabaceae
Pisum sativum	Matar, Pea, Vegetables	Up to 2000 m	Fabaceae
Raphanus sativum	Muli, Radish	Up to 3000 m	Brassicaceae
Solanum melongena	Baigan, Bhaddu, Brinjal, Egg plant	Up to 2200 m	Solanaceae
Solanum tuberosum	Alu, Potato, Aol	1500-3500	Solanaceae
Spinacea oleracea	Palak, Palinga, Spinach	Up to 1500 m	Amaranthaceae
Trichosanthes anguina	Chichinda, Serpent gourd, Snake gourd	Up to 2000 m	Cucurbitaceae
Tricosanthes dioica	Parval, Patol, Pointed gourd	Up to 500 m	Cucurbitaceae
Trigonella foenum-graecum	Methi, Fenugreek	Up to 2000 m	Fabaceae
Zingiber officinale	Adu, Adrekha, Ginger	Up to 1500 m	Zingiberaceae
Multipurpose plants			
Arundinaria falcate	Tham, Naktur	Up to 2000 m	Poaceae
Brassica compestris var. *toria*	Yellow sarsoon, Rare, Indian colza, Pili sarsoon	Up to 2200 m	Brassicaceae
Brassica juncea subsp. *Juncea*	Indian mustard, Rai	Up to 2200 m	Brassicaceae
Brassica napus	Mustard, Sarsoon, Toria, Indian rape, Brown sarson	Up to 2200 m	Brassicaceae
Camellia sinensis	Cha, Chay, Tea	Up to 2000 m	Theaceae
Papavar somniferum	Popy, Post, Opium	Cultivated	Papaveraceae
Cannabis sativa	Hemp, Bhang	Up to 2200 m	Cannabaceae
Citrullus lanatus	Watermelon, Tarbuj	Up to 600 m	Cucurbitaceae
Cucumis melo var. *melo*	Kharbooj, Musk melon	Up to 2000 m	Cucurbitaceae
Dioscorea glabra	Tarur, Tair	500-2000 m	Dioscoreaceae
Hibiscus cannabinus	Patson, Mesta, Ambari	Up to 1500 m	Malvaceae
Lactuca sativa	Salad, Kahu, Lettuce	Up to 1500 m	Asteraceae
Lepidium sativum	Garden Cress, Haling, Halim	Up to 1500 m	Brassicaceae
Mentha arvensis	Jangli Pudina	Up to 1200 m	Lamiaceae
Mentha piperita	Vilayati pudina, Pipermint	Up to 1500 m	Lamiaceae
Mentha viridis	Pahari pudina	Up to 1500 m	Lamiaceae
Nicotiana rustica	Pahari Tamakhu, East Indian Tamaku, Tabacco	Up to 1000 m	Solanaceae
Perilla frutescens	Perilla, Bhangeera, Bhangjeera	Between 500-1800 m	Lamiaceae
Saccharum officinarum	Ganna, Ikh, Riklu, Sugar cane, Noble cane	Up to 1500 m	Poaceae
Sesamum indicum	Sesame, Til	Up to 1500 m	Pedaliaceae
Tinospora cordifolia	Giloe, Gurcha	Up to 1500 m	Menispermaceae
Tree crop			
Fruit trees			
Aegle marmelos	Bel, Bilva	Up to 2000 m	Rutaceae
Achras sapota	Chiku	500 m	Sapotaceae
Artocarpus heterophyllus	Kathal, Jackfruit	Up to 800 m	Annonaceae
Annona reticulate	Sitaphal	250-500m	Moraceae
Carica papaya	Papita, Papit	Up to 1000 m	Caricaceae
Castanea sativa	European Chestnut, Khan Pangar	Up to1200 m	Fagaceae

Citrus aurantifolia	Kaghzi-nimbu, Lime	Up to 2000 m	Rutaceae
Citrus decumana	Maha Nimbu, Sadaphal	Up to 2000 m	Rutaceae
Citrus aurantium	Narangi	Up to 1500 m	Rutaceae
Citrus hystrix	Zamir	Up to 1500 m	Rutaceae
Citrus limon	Nimbu, Pahari Nimbu	Up to 1500 m	Rutaceae
Citrus reticulate	Santara	Up to 2200 m	Rutaceae
Citrus sinensis	Musambi, Malta	Up to 2000 m	Rutaceae
Citrus grandis	Chakotara	Up to 1500 m	Rutaceae
Cinnamomum tamala	Tejpat	250-500 m	Lauraceae
Diospyros kaki	Kaku	Up to 1500 m	Ebenaceae
Emblica officinalis	Amla, Aonla, Indian gooseberry, Myrobalan emblic	Up to 12000 m	Phyllanthaceae
Eriobotrya japonica	Lokat, Lukat	Cultivated	Rosaceae
Juglans regia	Akhoo, Akhrot, Kagzi Akhrot, Walnut	Up to 2500 m	Juglandaceae
Litchi chinesis	Litchi	Up to 1500 m	Sapindaceae
Mangifera indica	Am, Aam, Mango	Up to 1000 m	Anacardiaceae
Morus serrata	Kimu, Shahtoot	Between 1800-2000 m	Moraceae
Murraya koenigii	Kaddipatta	500-1000 m	Rutaceae
Musa paradisiaca	Kela, Kewa, Banana	Up to 1500 m	Musaceae
Prunus domestica	Plum	Up to 1500 m	Rosaceae
Prunus armeniaca	Khubni, Zardalu, Apricot	Up to 2000 m	Rosaceae
Prunus persica	Aru, Peach	Up to 2000 m	Rosaceae
Psidium guajava	Amrood,Guava	Up to 1500 m	Myrtaceae
Punica granatum	Anar, Darim, Pomegranate	Up to 2000 m	Punicaceae
*Pyrus malus*****	Seb, Seao, Apple	Between 1500-2500 m	Rosaceae
Syzygium cumini	Jamun, Phalenda, Jambolan	Up to 1000 m	Myrtaceae
Multipurpose trees			
Acacia catechu	Khair	Up to 1300 m	Mimosaceae
Adina cordifolia	Haldu	Up to 1000 m	Rubiaceae
Azadirachta indica	Neem	Up to 1000 m	Meliaceae
Bauhinia variegata	Kachnar	Between 300-1900 m	Caesalpiniaceae
Bombax ceiba	Semal	200-1400 m	Urticaceae
Biota orientalis	Morpankhi	250- 500 m	Cupressaceae
Bohermaria olerosa	Gethi	Up to 1500 m	Urticaceae
Celtis australis	Khirak	Up to 500 m	Ulmaceae
Cordia myxa	-	1200 m	Boraginaceae
Dalbergia sissoo	Shisham	Up to 1500 m	Fabaceae
Dendrocalamus strictus	Bans	Up to 1500 m	Poaceae
Dioscorea glabra	Genthi	500-2000 m	Dioscoreaceae
Diploknema butyracea	Cheura, Indian butter tree	Up to 1000 m	Sapotaceae
Elaeocarpus sphaericus	Rudraksh	250-300 m	Elaeocarpaceae
Ficus bengalensis	Bergad	Up to 1500 m	Moraceae
Ficus glomerata	Timala	800 m	Moraceae
Ficus palmata	Timul, Anjiri	Between 800-200 m	Moraceae
Ficus clavata	Khasuri	Up to 1500 m	Moraceae
Ficus religiosa	Pipal	Up to 1600 m	Moraceae
Grewia optiva	Bhimal, Bhiku, Binl	Up to 1500 m	Tiliaceae
Litsea polyantha	Katmara	Up to 500 m	Lauraceae
Mallotus philippensis	Roli	1000 m	Euphorbiaceae
Melia azadarach	Dekan	250-500 m	Meliaceae

Lyonia ovalifolia	Ayar	Between 700-3500m	Ericaceae
Populus deltoids	Poplar	250-500 m	Salicaceae
Prunus ceresoides	Padam	Between 600-2500 m	Rosaceae
Phytolacca acinosa	Jagroo, Jarg, Indian Pokeweed	Up to 2000 m	Phytolaccaceae
Polyalthia longifolia	Ashoka	250-500 m	Annonaceae
Quercus leucotrichophora	Banj	1800 m	Fagaceae
Ougeinia oojeinensis	Sanar	Up to 1200 m	Fabaceae
Sapindus mukorossi	Ritha, Reetta, Soaonut tree	Up to 1500 m	Sapindaceae
Shorea robusta	Sal	Up to 800 m	Dipterocarpaceae
Tectona grandis	Sagwan	Up to 800 m	Lamiaceae
Trachycarpus takil	Thakal	800-2000 m	Arecaceae
Viburnum cotinifolium	Bhatnai,	Up to 1800 m	Adoxaceae

*The above list of agro-diversity is based on personal observation coupled with[15,18-22]

** These crops are grouped into different categories such cereals, pseudo cereals, major millets, minor millets, oil seeds, vegetables, spices and condiments, pulses, aromatic and medicinal plants, economic and useful plants, cash crops, horticultural crops, miscellaneous uses etc.

*** Phapar extensively in Munsyari and Johar valley of Kumaun Himalaya

****Seb It is said that the Bauna seb of Munsyari are highly delicious

*****Rajma Extensively cultivar at interior area of Munsyari

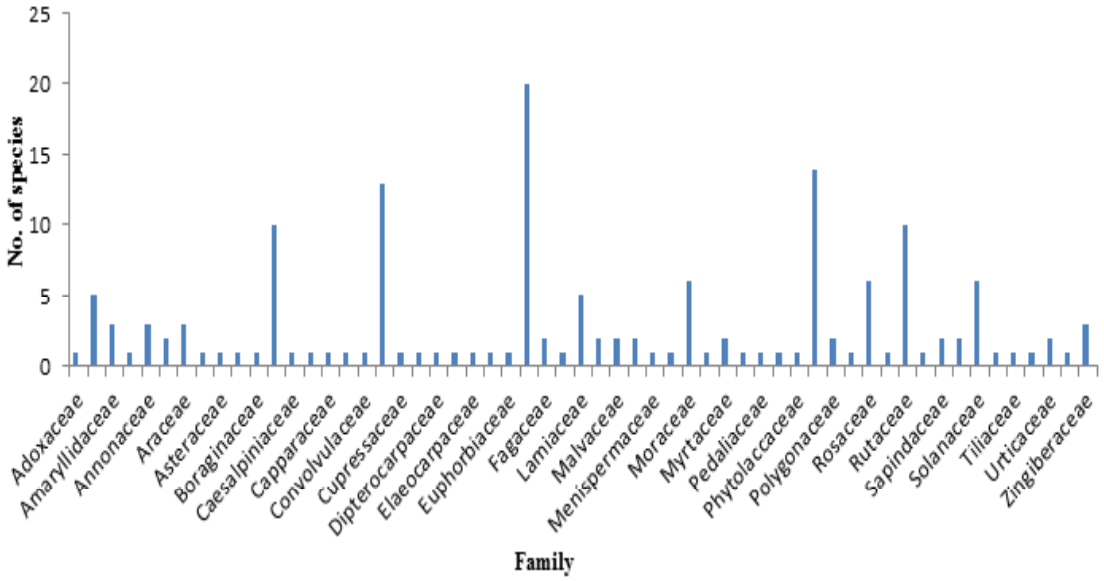

Fig. 1: Number of plant species belonging to different families

Agro-diversity

In the present study, 161 plants belonging to 117 genera and 57 families were listed (Table 2). Based on the species diversity, Fabaceae (20 species) formed the most diverse family followed by Poaceae (14 species), however 32 were mono-specific (Fig. 1). Based on their uses vegetables (23.12%) formed the most frequent mode of uses followed by multipurpose trees (21.87), fruit trees (20%), multipurpose crops (13.12%), pulses (10%), millets (4.37 %), cereals (3.75%) and spices (3.75%) (Fig. 2). The plant species were categorized into their form of habit *i.e.* herbs, shrubs, trees and climbers (Fig. 3). The diversity on the basis of the plant revealed that herb formed the most dominant habit (50 %) followed by tree (37.50%).

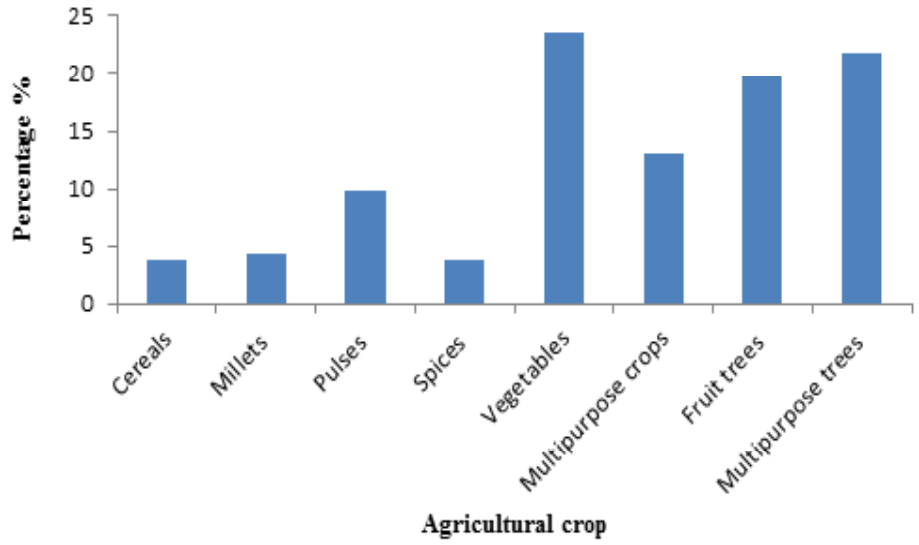

Fig. 2: Utilization of plant species

Fig. 3: The diversity on the basis of the plant habit

Table 3: Land races/ varieties of different crops as described by various authors

Crop	Land races/ varieties	References
Rice *(Oryza sativa)*	Adrat, Akari, Amarasi, Badatiya, Bakuwa, Basmati, Banpasa, Batasuva, Chinabhuri, Chunkuli, Dhan, Dhani, Dhaniya, Dhesuva, Duda, Gajaliya, Gajlo, Geruwa, Halduwa, Haltuniya, Hansraj, Jamol, Jauliya, Joggana, Katyuri, Kirmuli, Maisuwa, Makani, Makarat, Mandkuri, Motiya, Muthamuth, Nauliya, Paliya, Parayai, Ratuwa, Rajbhati, Rakasuwa, Rasiya, Sathiya, Rupsawa, Sal, Salam, Sathiya, Sishala, Tmiliya, Uya	Atkinson[23]
Rice *(Oryza sativa)*	Anchan, Anjana, Baiganee, Bagari Pinglee, Baguadhan, Bakulee, Banpasa, Bareekbagariya, Barhatiya, Basantee, Basmatee, Bawakua, Beganee, Bhadaree, Bhatya, Champa, Champha, Chawaniya, Chhoti, Chhoti Dhan, Chhotia, Chinbhuree, Chwar, Congraisee, Dafautee, Dalbadal, Danbasmatee, Dandinaula, Dangya, Dhulloo, Dndhia, Dudh, Dumaree, Dusee, Gadailu, Gadyaoo , Garoo, Garurhiya, Geeja, Ghanyasoo, Gorakhpuree, Gunji, Gyapulee, Gyarasu, Hansraj, Jaintuwa, Jaitoli, Jamalee, Jangali Dhan, Japanee, Jarhkhya, Jautee, Jhapulee, Jhakha, Jhandwa, Jimmee, Jirulee, Jaulee, , Joliya, Jukhan, Kaladhan, Kalainun, Kaleejeeree, Kaleematalee, Kaltoonia, Kanjuree, Karpar, Katyuria, Kharia, Khaijjya, Khar, Kiramaree, Kumaldee, Kumaon, Lalbasmatee, Lalsathee, Lathmar, Lukaree, Madguri, Madhuree, Maheen Dhan, Maisuree Dhan, Dhan, Motabagarhiya, Motiya, Naj, Nakka, Nandanee, Nandhani, Nauliya, Pakistani Dhan, Parvat, Patyuli, Pinglee, Pingloondtjaja, Prasad Dhan, Punjabee, Rajamee, Ramjawan, Ratanya, Rijula, Rotiya, Sabari Dhan, Sadhwee, Safedsyal, Sal, Sawa, Shakhool, Shakuntala, Sheree, Simanjaree, Sonasyuria, Sondhoo, Sukhanaraja, Sukhila, Swanpatee, Thapacheenee, Timlee, Thula, Tilakbasmatee, Ukharh, Ukheree	Pant and Negi[24]
Rice *(Oryza sativa)*	Ashotiya, Bageshwaree, Baraun, Bamnee, Baraun, Barhkatyuree, Barhpaso, Barmee, Bauna Dhan, Bauranee, Bhatiya-Syaw, Bheemtali, Bindulee, Bumaka, Basantee, Chamariya, Chamyarh, ,Cheenachar (Chianafor), Chyuradhan, Daultiya, Dharidhan, Dhurbasmatee, Diranni, Dotiyalidhan, Gajaee, Gajayya, Govind, Jaithannee, Jhusyan, Jirulee, Kala Chhotuwa, Kaljarhiya, Kalounthee, Kantoliya, Kapkoti, Kashmeera, (Kashmeeree), Kebaes, Laldhan, Lalnaul, Lambeesa, Lamed, Makran, Matiyaee, Maldhan, Moteewala, Nalwadhan, Nanmaisawa, Neelbarhi, Ooant, Parhdudh, Pelya, Raiman, Raimuni, Shela, Shyamgiri, Sunkharchi, Sunkhoja, Sunkharchi, Thapalee, Suntola.	Bhatt and
Rice *(Oryza sativa)*	Bhallon, Bangoi, Baunda, Champa, Dhari Dhan, Darnsaalu, Dev Lal, Govind, Gajaiya, Ghesuwa, Jhumkia, Jhusia, Kathliya, Kumaldi, Kavnauli, Lal Santhi, Lal Basmati, Lathmar, Makaranl, Nageen, Parvati, Shamgiri, Sukhnandi, Sunder, Saukiyan, Oont etc.	Chauhan[25] Prasoon[28]
Rice *(Oryza sativa)*	Ara-22, Arkotiya, Bak/Bakuwa/Bawakuwa, Bakul Dhan, Bamnee Dhan , Barh-Katyuri Dhan, Barhpak, Basantee, Basmatee, Bauna Dhan, Bauranee, Bilash Dhan, Binduli, Chamarhi Dhan, Chamyarh, Chibhurhi Dhan, Chinafor (Cheenafor), Chotidhan (Chhotia Dhan), Dafauti Dhan, Dalbadal, Dan Basmatee, Daulti, Dhaniyan, Dhurbasmati, Duddhan, Gajae Dhan, Gauridyaree Dhan, Govind Gopal, Haldoo (Masirh Haldoo), Hansraj, Jamae Djhan (Jamal Dhan), Lal Jamae, Kae/Kalo, Jamee, Safed Jamae, Jau Dhan, Jauliya Dhan,	

	Jhamuri Dhan, Jhapuli Dhan, Jharu Dhan, Jiruli Dhan, Jogyan Dhan, Joli Dhan, Jumae Dhan, Jyoli Dhan, Kaljarhiya, Kalyaw (Katyari), Kapkotee, Kastureedhan, Katyuree, Kawthuni, Khaji Dhan, Kirmue (Kirmaedhan), Lal Jarhi, Lamb Haldoo, Machhalee, Madguri, Maldhani, Masirh Vikas, Mot Vikas, Mota Haldoo, Motia (Moti), Murgee Dhan, Nachani Dhan, Nan-Dhani, Nauli, Neelvaree, Paktoli, Pashdudh, Raat, Rajmati (Rajmatee), Ramautiya (Ramaut), Ryoorhiya, Sambesaree Dhan, Sathi (Sathiya), Saunpi, Sawadhan, Shakuntala, Simajir Dhan, Sunkhae Dhan, Syauliya, Thapa Chini, Ti-Bakhul, Tilak Dhan, Timuli Dhan	Pande and
Wheat *(Triticum aestivum)*	Gehun safed or white wheat, Dawa (a white awnless variety), Daulat Khani, Lal gehun, Tanga or jusher (The bearded varieties)	Pande[29] Atkinson[23]
Wheat *(Triticum aestivum)*	Thang Gehun, Lal Gehun, Safed Gehun, Jhushi Gehun, Uda, Pissoo Gegun, Kathu Gehun, Dhani Gehun, Daulat Khani	Bhatt and Chauhan[25]
Wheat *(Triticum aestivum)*	Awned ana awnless	Negi and Pant[15]
Wheat *(Triticum[25] aestivum)*	Kalyan, Malasia, Roksona, Mongaria, Dabti, Jhusi, Geruwa, Sonhara	Samant[26]
Wheat *(Triticum aestivum)*	1. Vikasak Gehun- (a) Chhota Gehun, (b) Mota Gehun 2. Santhniya Gehun or Grahak Gehun- (a) Mungaria or Munariya Gehun, (b) Dudhi Gehun	From Kumaon
Barley *(Hordeum vulgare)*	Rena (a short awned variety), Gojai, Bijra	Atkinson[23]
Barley *(Hordeum vulgare)*	Thang Jau (awnless varieties), Jhusi Jau (awned varieties)	Bhatt and Chauhan[25]
Makka *(Zea mays* L.)	Timasa, Chaumasa, Chhaimasa Ghwag	Bhatt and Chauhan[25]
Makka *(Zea mays* L.)	Mungari (Cob more than 12" long), Murli (Cob long and think), Nani Kakuni (grains small, maturing in July), Thuli Kakuni (grains big, maturation time September), Asaujia kakuni: (a) Asaujia lal (grains red, big and small both type), (b) Asaujia safed (grains small, white and densely arranged)	Present investigation
Maduwa (*Elusine coracana* (L.) Gaertn.)	Nangchuniya, Tokaria, Putkya, Garhwalo, Jhankaria, Bhuwakhetia (round head inflorescence variety), Lumariyaw, Dhuniyaw, Lal madu (red grains), Safed Madu (whitish grain)	Bhatt and Chauhan[25]
Madu (*Elusine coracana* (L.) Gaertn.)	Garau, Putki, Dwit, Ganoli	Tewari and Das[27]
Madu (*Elusine coracana* (L.) Gaertn.)	Gol Madu (fingers closed): (a) Timasi (matured in three months), (b) Chhaimari (matured in six months), (c) Chaumasi (fingers smaller as matured during rainy season), Chhitalu (fingers open and drooping), Nangchuni (The ears can be removed with the help of nail after maturation), Katuriya Mandua (big. Or long fingers and closed).	Present investigation
Madira *(Echinochloa frumeutacea* (Roxb.) Link.)	Thul Madira (The ears long, thick and red), Nan Madira (The ears small, ash coloured, and taste), Jharu Madira (Wild relatives of Madira), Bhatkkahnti	

	Madira (Grains easily removed from the ears after maturation)	From Kumaon
Ganiyar (*Panicum miliaceum* L.)	The grains yellow, The grains light yellow	Present investigation
Joar or Bajur (*Sorghum vulgare* L.)	Chhitali Bajur or Lal Bajur or Gol Bajur, Syuti Bajur or Safed Bajur (Inflorescence drooping), Kuchia Bajur (*Sorghum vulgare* var. technicum)	Present investigation
Kauni (*Setaria italic* (L.) P. Beauv.)	Peeli Kauni (grains yellow colour), Kali Kauni (grains blackish colour)	Present investigation
Ganna (*Saccharum officinarum* (L.) Cutt.):	Paunthi rich (Stem thick, reddish colour), Pataw rich (Stem thin, long, red colour), Rikhu- (i) Paunthi rikhu: Sugercane with thick culm, (ii) Patwa rikhu: Sugarcane with thin culm, (iii) Dhauli rikhu : Culm of sugarcane with pinkish flower.	Present investigation
Pulses		
Gahat *(Dolichos uniflorus* Lam.)	Rat Gahat, Garua Gahat, Kaw Gahat, Bhangrail Gahat (based on seed colour)	Present investigation
Guruns (*Vigna umbellate*	White, Green, Black, Pale yellow (Thunb.) Ohwi and Ohashi	Present investigation (based on seed colour)
Chana (*Cicer arietinum* L.)	Chhota chana, Bara chana (Based on seed size)	Present investigation
Bhatt (*Glycine max* (L.) Merr.)	Soyabean, Bhatt (Stem creeping, seeds red, white and mottled), Safed Bhatt (Seeds with black streak), Soriya Bhatt (Creeper (trailer), seed largest), Bhangrail Bhatt (Seeds slightly reddish colour), Kaw/Black Bhatt (Seed black, compressed (*Glycine soja*), Thangri Bhatt(Plant erect)	Present investigation
Matar *(Pisum sativum* L.)	Thuli matar (seeds larger), Kanyu matar (seeds round small: *Pisum sativum var. arvense*)	Present investigation
Masur (*Lens culinaries* Medik)	Kali Masur (Hawsiw masur) seeds small, Rati Masur (Khyasuri Masur)	Present investigation
Urd (*Vigna mung* (L.) Hepper)	Kukuriyans (cultivated up to 2000 m), Mans (cultivated above 2500 m .	Present investigation
Razama (*Phaseolus vulgaris* L.)	Thumari Razama (dwarf plant), Lagili Razama (climber plant)	Present investigation
Sonth (*Vigna uniguiculata* (L.) Walp.)	Thul Sunth (larger seeds), Nani Sunth (Smaller seeds)	Present investigation
Pseudocereals		
Chaulai (*Amaranthus* spp.)	Lal Chaulai (Inflorescence red), Hari chaulai (Inflorescence green), Kaw Chu (Seeds black), Safed Chu (Seeds white)	Present investigation
	Lundra (drooping inflorescence), Mondim (compact inflorescence), Lapra (scattered inflorescence)	Negi and Pant[15]
Ogal (*Fagopyrum esculentum* Moench)	Ogal with red flowers, Ogal with whitish pink flower.	Present investigation
Vegetable/spices/condiments, oil yielding seeds		
Alu (*Solanum tuberosum* L.)	Safed Alu, Lal Alu, Kufri Alu	Present investigation
Karela	Til karela (*Monordica charantia* L.),	

	Mith Karela (*Cyclanthera pedata* L.) Schrad	Present investigation
Kaddo (*Cucurbita*	Jatari kaddoo, Lamb kaddoo, Deshi kaddoo	Present investigation
maxima duch ex Lamk.)		
Gaderi and Pinalu	Lal Gaderi (Corm red coloured), Safed Gaderi	Present investigation
(*Colocasia*	(Corm white coloured with reddish streaks),	
esculenta	Lal Pindalu (Also known as “Kuraise”), Safed Pindalu	
(L.) Schoot.)	(Also known as “Ranu”), Kochiya (Corm much longer than its width)	
Toria (*Momordia*	Tittoria (bitter taste), Mith Toria (edible) with ridges and furrows	
charantia L.)	(*Luffa acutangula* (L.) Roxb.), Mith Toria edible) without	
	ridges and furrows (*Luffa aegyptica* Mill)	Present investigation
Saroon (*Brassica* spp.)	Brown Sarson, Pilli Sarson, Kali Sarson	Present investigation
Lahi (*Brassica* spp.)	Kali Lahi, Hari Lahiz	Present investigation
Rai or Piri Rai	Kali rai, Brown rai	Present investigation
Tamatar (*Lycopersicum*	Kanthi tamatar (small fruit), Thul tamatar	
esculentum L.)	(fruit larger and round), Lamb tamatar	
	(fruit longer with less seeds)	Present investigation
Tarur (*Dioscorea*	Chakae tarur (Root flat), Lamb Tarur	Present investigation
belophylla voigt ex Haines):	(Root deep rooted and long)	
Onion (*Allium cepa* L.)	Ranikhet Pyaz (outer skin reddish),	
	Safed Pyaz (outer skin white or pink)	Present investigation
Palak (*Spinacea*	Chapar panoo (leaves spreading on the ground),	
oleracea L.)	Thar panoo (leaves not spreading in ground)	Present investigation
Bhindi (*Abelmoschus*	Jhusiyaw bhindi, Chhoti bhindi	Present investigation
esculentus (L.) Moench)		
Muli (*Raphanus sativus* L.):	Dudhi muli or Thar muli, Gol muli or	
	Chapti muli	Present investigation
Lal mirch	Shimla mirch, Achari mirch,	Present investigation
(*Capsicum annuum* L.)	Patli mirch, Muni mirch	
Lauki (*Lagenaria*	Tumari (fruit round its fruits also show	
siceraria (Mol) Standley)	variability), Lauki (variable in fruit shape and size)	Present investigation
Til (*Sesamum indicum* L.)	Saf til (seeds white), Rat til (seeds brown), Kaw til (seeds black)	Present investigation
Haldi (*Curcuma longa* L.)	Haldi (corn matured in one year), Haldi (corn matured in three years)	
Horicultural/fruit yielding plants		
Anar/Darium	Kalmi Darim (fruit matured in the month of August),	
(*Punica granatum* Linn.):	Jhungari Darium (fruit matured in the month of September), Kalmi Anar	
	(seeds larger, than Darim seeds), Murbbi Anar	
	(seeds larger then Kalmi Anar)	Present investigation
Akhrot (*Juglans regia* L.)	Kanthi akhrot (cotyledons not easily removed), Danthi akhrot	
	(cotyledons can be removed easily), Kalmi akhrot (cotyledons	
	thin, easily cracked and cotyledons easily removed)	Present investigation
Aru (*Prunus*	Kusami aru (fruit matured between 14 april to 15 May),	
persica (L.) Batsch.):	Bhadoe aru (fruit matured between 15 may to 15 june),	
	Ashari aru (fruit matured between 15 june to 15 july),	
	Vilayati aru (fruit matured between 15 may to 15 june)	Present investigation
Amrud (*Psidium guajava* L.)	Lal Amrud (fruit pulp red), Safed Amrud (fruit pulp white),	
	Kanthi Amrod (Different to eat), Timul Amrud (Pulp white)	Present investigation
Aonla	Nan Aonla (fruit small,wild), Thul Aonla (fruit large, cultivated)	Present investigation
(*Emblica officinals*		
gaertn.)		
Am (*Mangifera*	Danti Am, Kanthi Am, Jangli Am, Chussu Am,	
indica L.)	Chukul Am, Gautari Am, Bombai Am	Present investigation

Kimu (*Morus serrata* Roxob.)	Jangali Kimu (ripe fruit green), Gharalu Kimu (ripe fruit red or scarlet red)	Present investigation
Kela (*Musa paradisiacal* L.):	Hanjari kela (fruit small cup to 3", ripe fruit scented), Dudhi kela (fruit 4" to 6 long, ripe fruit creamy or badami, very sweet), Mungari kela (fruit up to 8" long, also known as "Kachuw kela" not too taste.)	Present investigation
Khubani (*Prunus armeniaca* L.)	Kusami Khubani (cotyledons bitter in taste), Kalmi, Khubani (Cotyledons bitter in taste but fruit large in size), Badami Khubani (Cotyledons edible, fruit large)	Present investigation
Jamun (*Syzygium cumini* (L.) Skeels.)	Jamun (fruit small, dark violet, tree small), Fawanu or Thul Jamun (Tree larger, fruit larger, ripe fruit black)	Present investigation
Timul (*Ficus roxburghii*) Wall	Pankar Timul (Syconus edible, not infected with insects), Achkar Timul (Syconus not edible because of insects infection)	Present investigation
Citrus spp.	Nimbu (*Citrus limon* (L.) Burm.f.), Mahanimbu (*Citrus decumana*), Amrit Phal (*Citrus medica* L.), Kagji Nimbu (*Citrus aurntifolia* L.), Matkakri (*Citrus* sp.), Jamir (*Citrus hystric*), Mausmi/Malta (*Citrus sinensis* (L.) osbeck.), Narangi(*Citrus reticulata*)- (a)Hara Narangi (fruit sweet, small fruit), (b) Kathu Narangi (fruit small, rind orange, taste sour), (c) Kalmi Narangi (fruit big, vind orange, tasty)	Present investigation
Naspati (*Pyrus pyrifolia* (Burn.f.) Nakai)	Naunia Naspati (fruit large, tasty, fruit with red streaks), Gol Naspati (fruit ball shaped, sour-sweet), Tumari Naspari (fruit bell shaped, sweet), Ghyu naspati (fruit pulp: laslasa)	Present investigation
Pulm (*Prunus* spp.)	Nan Pulam (ripe fruit sweet, yellow in colour), Noan Pulam (ripe fruit sweet, black in colour), Thul Pulam (fruit larger, tasty, ripe fruit black), Kalmi Pulam (fruit larger, tasty, also known as "Jatwa Pulam)	Present investigation
Flowers		
Kailunchi (*Cannas* pp.)	Plant with light yellow flowers, pseudostem green, Plant with scarlet, small; pseudostem brown, Plant stem (pseudostem) green with larger yellow flowers, Pseudostem brown colour with large scarlet flower.	Present investigation
Hanjari (*Tagetus* spp.)	Variablity in flower colour, shape and arrangements of ray and disc florets. Plant height is also variable.	Present investigation

Cultivated crops

The crop diversity in Kumaun Himalaya is very high, which is maintained through mixed cropping or crop rotations and planting multipurpose trees or traditional agroforestry species along the border and waste lands of cultivated fields. Horticultural crops are also cultivated by farmers, which further enhance the biodiversity. The following inventory of the different cultivars, their characteristics wild relatives, diversity, cultural practices, uses pattern was collected from the farmers, through direct interventions as well as the work of Atkinson[23], Duthie[10], Negi and Pant[15], etc. Recently introduced species/germ plasms of crop plants are also recorded.

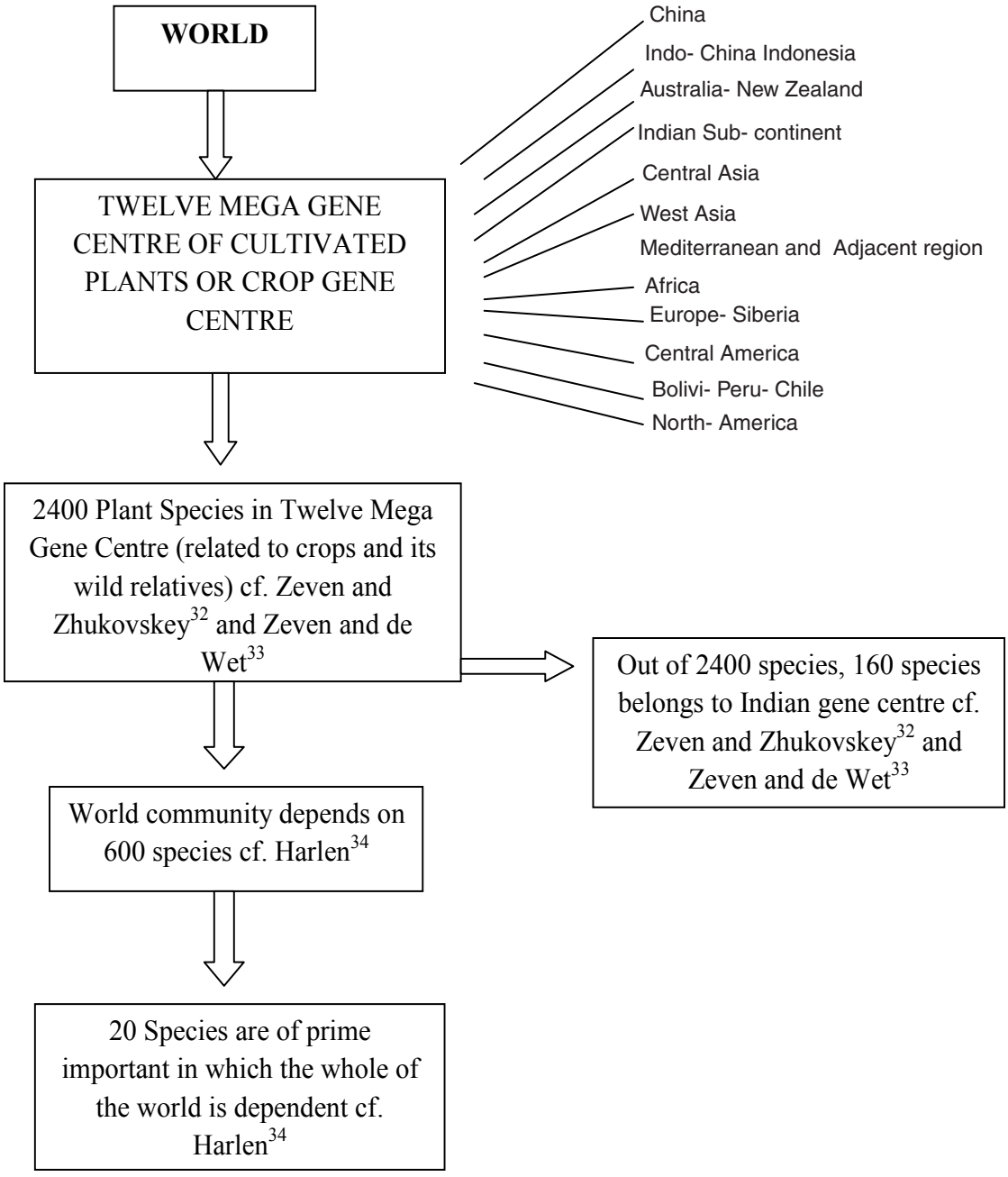

Fig. 4: Mega Gene Centre of Cultivated plants and some other related details. (Box No. 1 and 2 and 3 based on Zeaven and Zhukovskey32 and Zevaen and de Wet33. Box. No. 4 and 5 based on Harlen34. Vide35).

Table 4: List of wild relatives of cultivated crops

Common name	Botanical name
Am	*Spondias pinnata*
Amarantha	*Amaranthus spinosus*, *A. viridis, A. cruentus*
Aru	*Prunus cerasoides (Payan), P. Cornuta, P. jacquemontii (Kursang)*
Bhindi	*Abelmoschus radiates*, *A. pungens*, *A. crinitus*, *A. ficulneus*
Chana	*Cicer microphyllum* (found in Niti valley, Chamoli Garhwal)
Dhuwar	*Allium stracheyi, Allium humile*, *A. victorialis*, *A. wallichii*
Haling	*Lepidium apetalum, L.capitatum* (found in Chamoli district)
Kauni	*Setaria viridis* (found in Mana, Chamoli Garhwal)
Madira	*Echinochloa crus-galli*
Maduwa	*Eleusine indica*
Maize	*Coix lacryma-jobi*
Moth	*Vinga vexillata* and *V. trilobatas*
Pinalu/ Gaderi	*Gonatanthus pumilus* (Ban-pindalu), *Remusatia vivipara* (Bagh-pindalu)
Seb	*Pyracantha crenulata*
Tarur/Genthi	*Dioscorea alata*, *D. penthaphylla*, *D. kumaonensis*, *D. hispida* etc.
Wheat	*Triticum secalinus*

Traditional land races

Landraces are essential to preserve the agricultural genetic pool. These races are usually based on the morphological variation of plants, their parts and other characteristics qualities of plants such as: colour of roots, stem, flowers, fruits and seed, taste of fruits, ridges and furrows of fruits; erect, compact and drooping habit of inflorescence; branching pattern and habit of plants; period of crop maturation; spike arrangement, husk colour, awnless husk, finger length, etc of cereals. Landraces differed in their popularity and in some cases traditional races of cereals are named after place and person (who brought that land race).

Rice (*Oryza sativa* Linn): It is a widely cultivated crop plant of Kumaun Himalaya. There are number of land races or varieties of this plant (Table 3). The land races (germplasm) of this crop grown in this region have been discussed by Atkinson[23], Pant and Negi[24], Bhatt and Chauhan[25]. Beside these, Samant[26] and Tewari and Das[27] also reported 17 and 04 varieties of this plant (Paddy) from Askot and Dhaula Devi area of Kumaun Himalaya (Table 3).

Wild Relatives of cultivated land races

There are large numbers of wild relatives of crop plants growing in Kumaun Himalaya. Some of the wild relatives of cultivated crops[15] are given in Table 4 which could be conserved through the Mega Gene Centre of Cultivated plants as shown in the Fig.4.

Causes of Agrodiversity Erosion in Kumaun Himalaya

Traditional agriculture systems are cost effective; rely on local resources ecofriendly to the

environment and are more sustainable than modern farming system[36,37]. These systems are gradually abandoned to meet the demand for agricultural products with the population growth[38,39,40]. Because of changes in landuse systems, deforestation, population pressure, urbanization, degradation of land races, and over-harvesting of non-timber forest products, agrobiodiversity is now declining very quickly from the ecosystems at species, variety and management system levels. So instead of diversified crop fields, farmers are now concentrated on few commercially demanded crops. If serious view of existing situation is not taken into account, the region will lose traditional knowledge of cultivation and uses of these crops forever and would also lose the possibility of being a diverse and nutritive food producing region.

In recent past, the crop diversity has declined to an alarming rate except few isolated pockets of remote areas. Some of the important reasons are:(a) Monoculture cropping system (b) Unplanned change in cropping systems (c) Change in food habits of local people (d) Accidental or deliberate introduction of exotic species (e) Construction of multipurpose dams and road (f) Replacement of traditional crops by high yielding varieties or cultivation of cash crops.

Suggested strategies for agrodiversity conservation in Kumaun Himalaya

Traditional crops and land races should be conserved in the research centers and gene banks. Farmers should be motivated for *in- situ* conservation of their traditional crops and land races. *In-situ* conservation of traditional crops and land races could succeed when these crops are strongly linked with the economic development of farmers.

Awareness and capacity building programmes should be conducted to enable the local people to use highly diversified crop plants, to increase agricultural productivity, to conserve the diversified crops as *in-situ* germplasm for future use and to understand their services to mankind not only as a source of food, fuel, fodder, fibre etc. but also for ecological services.

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