J. Himalayan Ecol. Sustain. Dev. Vol. 13 (2018) **ISSN 0973-7502**

Agrobiodiversity in Gewarh Valley: A Case Study from Almora District, Uttarakhand

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ABSTRACT

Kumaun Himalayas has been always known for its rich agro-biodiversity due to diverse agro-climatic conditions given a broad altitudinal regime in the region. While exploring agro-biodiversity in two villages of 'Gewarh valley' in Almora district of Uttarakhand, 78 species (both food crops and trees) were documented out of which 11 plants belonged to Fabaceae. The study villages have greater diversity of tree species as well. The number of food crops per unit area was generally higher in the kitchen garden. Plantation of trees on the bunds of the fields is common for bund stabilization and reducing soil erosion. It was also observed that the crops and the cropping pattern have changed over a period of time owing to diversion from mixed cropping to cash crops or monocropping, crop-raiding by wild animals, labour scarcity due to migration, water scarcity, *etc*. Crop-raiding has been emerged out as a major threat to the existing agro-biodiversity in the villages which needs to be dealt immediately. In order to continue harnessing the tangible and intangible benefits, plausible interventions are needed by involving local communities in order to enrich the agro-biodiversity in the hill farming systems thereof for the overall eco-development of the mountain region.

Key words: *Agro-biodiversity, Communities, Conservation, Himalaya*

INTRODUCTION

Himalayan region provides shelter to more than 10,000 plant species, out of which around 3160 species belonging to 71 genera are endemic (Sathyakumar and Bashir, 2010). Topography and soil conditions together with diverse climatic conditions manifest species richness in agro-biodiversity (Pande *et al.,* 2016). For the people of the region, agro-biodiversity has always been an integral part of the livelihood. In the Uttarakhand hills, around 40 crop species, 16 types of pulses, 6 types of millets, 8 types of vegetables, 5 types of condiments, 5 types of pseudocereals and 6 types of cereals landraces have been reported (Maikhuri *et al.,* 2001). The local communities also preserve the different

landraces of the crops which are suitable to those micro-climatic conditions (Bungla *et al.,* 2014). In a case study of Jardhar village of Garhwal Himalaya in Uttarakhand, the local people revealed that in earlier time period, their brides used to bring seeds with them from their parental home and when they used to go back home on visits, they took with them seeds from their marital home. In this way, seeds were exchanged without trading (Gupta, 2008). However, such cultural heritage is in transition (Maikhuri *et al.,* 2001), as a major portion of the Himalayan population has migrated from the hills towards the plains and metro-cities in search of better job opportunities and lifestyle, because of which many villages have turned into ghost villages. If we analyse the scenario of Uttarakhand, the total number of uninhabited villages have increased from 1034 (in the 2011 Census) to 1768 (in 2018), registering a rise of 734 villages in these seven years, which indicates the clear-cut threat to the existing agro-biodiversity of the region. Apart from this, ineffective tools and technologies, land tenure policies, over-exploitation of natural resources (Khumbongmayum *et al.,* 2004), inappropriate socio-economic and environmental conservation policies, increased weed infestation (Saxena and Ramakrishnan, 1984; Kohli *et al.,* 2004 and Murali and Setty, 2001), depleting carrying capacity of the rangelands (Negi, 1990; Rao, 1997), loss of genetic diversity (Maikhuri, 1993; Singh, 1997), hydrological change (Valdiya and Bartarya, 1991), soil erosion (Jain *et al.,* 2001), natural calamities and crop raiding by wild animals (Chauhan *et al.,* 2009) are also threatening the existing agro-ecosystems of the region.

Despite these, there are a few remote villages that still bear rich agro-biodiversity and play a significant role in the agro-biodiversity conservation in the region. Hence, the present study documents the richness of agro-biodiversity in two remote villages of hill district Almora in Uttarakhand.

MATERIAL AND METHODS

The present study was conducted in two adjacent villages namely, Dantola (29°51.266' N and 79°22.962' E) and Mahatgaon (29°51.608'N and 79°22.507'E) of the district Almora in the Gewarh valley of Uttarakhand, where the altitude varies from 1010 m asl to 1106 m asl (Fig.1 and 2).

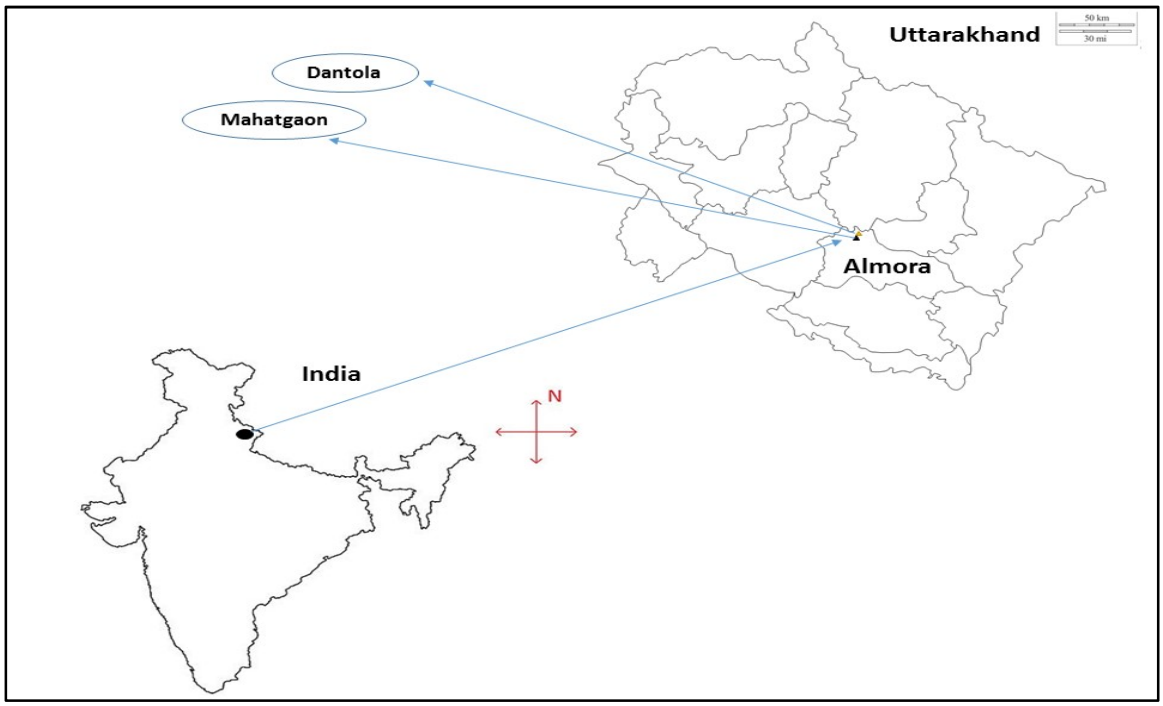

Fig. 1. Location map of the study area

The district Almora covers an area of 3144 km^2 and shares its boundary with Pithoragarh district in the East, Pauri Garhwal district in the west, Bageshwar and Chamoli district in the north and Nainital and Champawat district in the south. The district receives an actual annual rainfall of 862.8 mm (Uttarakhand District Factbook, Almora District, 2017). Agriculture is the source of livelihood for more than fifty percent people of the district. The main agricultural crops grown in the district are rice, wheat, millet, tea, apples, peaches, apricots, plums, etc. Total forest cover of the district is 1583 km^2 (around 50% of the total area) that signify its crucial role in livelihood of the people of the hill district (Uttarakhand District Factbook, Almora District, 2017).

The study villages are situated in 'Gewarh valley' which is well known for its scenic beauty, biodiversity and rich cultural heritages, because of which many tourists visit the region every year. The total area of the village Dantola is 100.228 ha, out of which 56.993 ha comes under village forest, 35.283 ha area is under agriculture (both irrigated and non-irrigated), and 0.711 ha culturable wasteland. Likewise, the total area of the village Mahatgaon is 79.426 ha, out of which 41.6 ha is village forest, 31.54 ha is agriculture area (both irrigated and

non-irrigated), 1.136 ha is culturable wasteland and 3.656 ha is unculturable wasteland (Uttarakhand Revenue Department). The total number of households in Dantola and Mahatgaon are 44 and 72, respectively. More than 70% of the households were of traditional type, made of slate (locally called pathar/pathal), mud, cow dung, big stones and wood. The villagers use both traditional 'chullah' (stove, made of mud) and LPG gas for cooking, although the 'chullah' is preferred during winter.

The residents are mainly involved in agriculture for their livelihood. In the summers (May to June), the villagers experience water scarcity. Nonetheless, the area gets a good sunshine along with sufficient amount of rainfall all through the year. Major portion (74%) of the rainfall is received from south-west monsoon (Bhunya *et al.,* 2010). The agricultural crops are eventually grown without keeping the land fallow for a long time. Nevertheless, the land remains barren for 15-20 days after every cropping season. Most of the agricultural activities are done by the women making them the backbone of the agro-ecosystem conservation. A door-to-door survey was conducted in the village with the help of a structured and pre-tested questionnaire during the year 2017 and the information regarding the agro-biodiversity was gathered by covering 68% households from Dantola and 53% households from Mahatgaon village along with the regular field visits. During the survey, one person from each of these household was chosen who gave his/her family views to answer the questions.

Fig. 2. A panoramic view of the study area

RESULTS AND DISCUSSION

Earlier, the cropping pattern in the villages was fully traditional as the farmers were using their own seeds along with farmyard manure and wood ash as the source of fertilizers. But, during the recent years, the farmers have also started buying seeds from agriculture department and chemical fertilizers like urea and NPK. Earlier, the crop cultivation involved manual operations and usage of oxen. Now-a-days, with the advent of road access, the farmers have started using tractors and threshers for ploughing and harvesting respectively. The traditional mixed cropping system has also been replaced by monocropping system due to labour scarcity.

The vegetation in the study villages includes forest, agriculture and wasteland/fallowland (both culturable and non-culturable). The same arable land is cultivated twice a year, both in *rabi* (October/ November-April/May) and *kharif* (May/June-September/October) season (Table 1). The land is kept fallow for around 15-20 days at the end of every cropping season. All crops are irrigated in the *rabi* season, as the rainfall is not sufficient for the crops. In *kharif* season, only paddy (transplanted) is irrigated. Due to the increased scarcity of water, the area under paddy is decreasing year by year. The major *rabi* crops are wheat, barley, lentil, gram, brown mustard, mustard and flax seed. Likewise, major *kharif* season crops are paddy, sorghum, black soybean or *bhat,* soybean, finger millet, urdbean or mash and horsegram.

Different agro-forestry trees like *Pyrus pashia* (Mehal), *Bombax ceiba* (Semal), *Grewia optiva* (Bhimal), *Ficus racemosa* (Timil), *etc.* are found scattered on the bunds of agricultural fields. Out of these trees, *Pyrus pashia* (Mehal) is very much preferred by the villagers for planting on the bunds as it is a thorny tree because of which they are not approached by monkeys and apes. It is also a source of fuelwood and used to make agricultural tools. Apart from crops, fruit trees are also grown scattered in the village and in kitchen gardens. The villagers fulfill their requirement of vegetables and spices from the kitchen garden as every household has a kitchen garden. Overall, 78 major species were documented in both the villages including cereals, pulses, millets, vegetables, fruits, agro-forestry trees and shrubs (Table 2).

Table 1. Major crops grown in *rabi* and *kharif* season

***Rabi* crops**	***Kharif* crops**
Triticum aestivum (L.)*, Hordeum vulgare* (L.), *Lens culinaris* Medik., *Linum usitatissimum* (L.), *Brassica juncea* **(L.)** Czern and Cross**.,** *Brassica campestris* L., *Trifolium alexandrinum* L.	*Oryza sativa* (L), *Eleusine coracana* (L.), *Sorghum vulgare* (L.) Pers., *Glycine max* (L.) Merr., *Glycine max, Vigna mungo* (L.), *Macrotyloma uniflorum* (Lam.) verdc.
Monocropping and Intercropping of major agricultural crops	
Monocropping 1. *Glycine max* (Soybean) 2. *Glycine max* (L.) Merr. (Bhat, also known as Black Soybean) 3. *Oryza sativa* (transplanted paddy) 4. *Triticum aestivum* (Wheat) 5. *Hordeum vulgare* L. (Barley) 6. *Cicer arientinum* L (Gram (few farmers)) 7. *Eleusine coracana* (L.) (Madua) 8. *Macrotyloma uniflorum* (Lam.) verdc. (Gahat, grown only in Dantola) 9. *Vigna mungo* (L.) (black gram/urd)	
Intercropping 1. *Oryza sativa* (rained) + *Sorghum vulgare* (Paddy+Jowar) 2. *Triticum aestivum* + *Brassica campestris* (Wheat+Mustard) 3. *Glycine max* + *Sorghum vulgare*+ *Zea mays* (Bhat/soyabean+jowar+ maize) 4. *Lens culinaris* + *Brassica juncea* (Masoor+Rye) *5. Triticum aestivum/Lens culinaris* + *Linum usitatissimum* (Alsi is grown on side of the field) 6. *Macrotyloma uniflorum* (Lam.) Verdc. + *Sorghum vulgare* (L.) Pers. (Gahat +Jowar)	

Table 2. Species richness in the agro-ecosystems of the study villages

S. No.	**Botanical Name**	**Vernacular name**	**Family**	**Habit**	**Part used**	**Uses**
Cereals						
1	*Oryza sativa* L.	Dhan	Poaceae	Herb	Seed, whole plant	Food, fodder, sacred
2	*Triticum aestivum* L.	Gehun	Poaceae	Herb	Seed, whole plant	Food, fodder, sacred
3	*Zea mays* L.[#]	Makka	Poaceae	Herb	Seed, whole plant	Food, fodder, sacred
Millets						
4	*Eleusine coracana* (L.)	Madua	Poaceae	Herb	Seed, whole plant	Food, fodder, sacred
5	*Hordeum vulgare* L.	Jau	Poaceae	Herb	Seed, whole plant	Fodder, sacred
6	*Sorghum vulgare* (L.) Pers.	Jowar	Poaceae	Herb	Seed, whole plant	Fodder, broom, sacred
Pulses						
7	*Glycine max* (L.) Merr.	Bhat	Fabaceae	Herb	Seed, whole plant	Food, fodder

8	*Glycine max* (L.) Merr.	Soyabean	Fabaceae	Herb	Seed, whole plant	Food, fodder
9	*Lens culinaris* Medik.	Masoor	Fabaceae	Herb	Seed, whole plant	Food, fodder
10	*Cicer arientinum* L.*	Channa	Fabaceae	Herb	Seed, whole plant	Food, fodder
11	*Vigna mungo* (L.)	Urd/mash	Fabaceae	Herb	Seed, whole plant	Food, fodder
12	*Macrotyloma Uniflorum* (Lam.) verdc.	Gahat	Fabaceae	Herb	Seed, whole plant	Food, medicinal, fodder
13	*Pisum sativum* L.[#]	Matar	Fabaceae	Herb	Seeds	Food
14	*Phaseolus vulgaris* L. [#]	Beans	Fabaceae	Herb	Seeds, Pods	Food
Oilseeds						
15	*Linum usitatissimum* L.*	Alsi	Linaceae	Herb	Seed	Food, Oil, medicinal
16	*Brassica juncea* **(**L**.)** Czern**.** and Coss**.**	Rye	Brassicaceae	Herb	Seed, whole plant	Food, Oil, spices, fodder, sacred
17	*Brassica campestris* L.	Sarson	Brassicaceae	Herb	Seed, whole plant	Food, Oil, fodder, oil is applied on pulses before storage, medicinal, sacred
Fodder crop						
18	*Trifolium alexandrinum* L.[+]	Barseem	Fabaceae	Herb	Whole plant	Fodder
Vegetable crops						
19	*Solanum tuberosum* L. [#]	Aalu	Solanaceae	Herb	Tuber, whole plant	Food, fodder
20	*Colocasia esculenta* (L.) Schott. [#]	Gaderi	Araceae	Herb	Leaves, tuber	Food
21	*Raphanus sativus* L. [#]	Muli	Brassicaceae	Herb	Roots, leaves	Food, fodder, medicinal
22	*Lagenaria siceraria* (Mol.) Standl. [#]	Lauki	Cucurbitaceae	Climber	Fruit	Food
23	*Luffa cylindrical* (L.) M. Roem. [#]	Torai	Cucurbitaceae	Climber	Fruit	Food
24	*Trichosanthes cucumerina var. anguina* (L.) [#]	Chichan Snake gourd	Cucurbitaceae	Climber	Fruit	Food
25	*Benincasa hispida* (Thunb.) Cong. [#]	Bhuj	Cucurbitaceae	Climber	Fruit	Food
26	*Cucurbita maxima* Duch.[#]	Kaddu	Cucurbitaceae	Climber	Fruit	Food
27	*Solanum melongena*L. [#]	Baigan	Solanaceae	Herb	Fruit	Food
28	*Spinacea oleracea*L. [#]	Palak	Chenopodiaceae	Herb	Leaves	Food

29	*Abelmoschus esculentus* (L.) Moench. #	Bhindi	Malvaceae	Herb	Fruit	Food
30	*Brassica nigra* Koch.#	Lai	Brassicaceae	Herb	Leaves	Food
31	*Dioscorea bulbifera* L. #	Gethi	Dioscoreaceae	Climber	Tuber	Food, medicinal
32	*Momardica charantia* L.#	Karela	Cucurbitaceae	Climber	Fruit	Food
33	*Cucumis sativus* L. #	Kakdi/ Kheera	Cucurbitaceae	Climber	Fruit	Food
34	*Brassica oleracea* L.#	Phoolgobhi	Brassicaceae	Herb	Inflorescence	Food
Spices						
35	*Zingiber officinale* Roscoe. #	Adrak	Zingiberaceae	Herb	Rhizome	Spices, medicinal, food
36	*Allium sativum* L. #	Lehsun	Liliaceae	Herb	Bulb	Food, Spices, medicinal
37	*Allium cepa* L. #	Pyaj	Liliaceae	Herb	Bulb	Spices, food
38	*Capsicum frutescens* L. #	Mirch	Solanaceae	Herb	Fruit	Spices, food
39	*Capsicum annum* L. #	Shimla mirch	Solanaceae	Herb	Fruit	Food, spices
40	*Mentha arvensis* L. #	Pudina	Lamiaceae	Herb	Leaves	Food, Spices, medicinal
41	*Curcuma domestica* Valet#	Haldi	Zingiberaceae	Herb	Rhizome	Food, spices, sacred, medicinal
42	*Coriandrum sativum* L. #	Dhaniya	Apiaceae	Herb	Leaves, seeds	Spices, Food
43	*Trigonella foenum-graecum* L. #	Methi	Fabaceae	Herb	Seed, leaves	Food, spices, medicinal
Dominant Trees (both fruiting and agro-forestry trees, scattered in kitchen garden, fields and fallow land)						
44	*Mangifera indica* L.	Aam	Anacardiaceae	Tree	Fruit, wood	Food, pickle, sacred, fuelwood
45	*Psidium guajava* L.	Amrud	Myrtaceae	Tree	Fruit, leaves	Food, medicinal
46	*Prunus domestica* L.	Pulum	Rosaceae	Tree	Fruit	Food
47	*Prunus persica* (L.) Batsch.	Aadu	Rosaceae	Tree	Fruit	Food
48	*Juglans regia* L.	Akhrot	Juglandaceae	Tree	Fruit	Food, leaves insect repellent in grainages, medicinal
49	*Punica granatum* L.	Dadhim	Punicaceae	Tree	Fruit	Food
50	*Morus alba* L.	Toot	Moraceae	Tree	Fruit	Food, fodder

51	*Pyrus communis* L.*	Nashpati	Rosaceae	Tree	Fruit	Food, fodder
52	*Musa paradisiacal* L.	Kela	Musaceae	Herb	Fruit	Food, sacred
53	*Litchi chinensis* Sonn.*	Litchi	Sapindaceae	Tree	Fruit	Food
54	*Syzigium cuminii* (L.)	Jamun	Myrtaceae	Tree	Fruit	Food
55	*Emblica officinalis* Gaertn.	Amla	Phyllanthaceae	Tree	Fruit	Food, sacred
56	*Melia azadirach* L.	Bakain	Meliaceae	Tree	Leaves	Fodder
57	*Bombax ceiba* L.	Semal	Bombacaceae	Tree	flower	Food
58	*Ficus relegiosa* L.	Peepal	Moraceae	Tree	Whole tree	Sacred
59	*Grevia optiva* Dumm. Ex Burret.	Bhimal	Tiliaceae	Tree	Leaves, branches	Fibre, fodder, fuel
60	*Ficus auriculata* Lour	Timil	Moraceae	Tree	Leaves, wood, fruit	Food, sacred, fodder
61	*Ficus palmata* Forsk.	Bedu	Moraceae	Tree	Leaves, fruit	Food, medicinal, fodder
62	*Pyrus pashia* Buch.-Ham. Ex.D. Don	Mehal	Rosaceae	Tree	Whole tree	Sacred, storing dried grass and paddy straw, food, agricultural implements
63	*Toona serrata* (Royle) M. Roemer	Tun	Meliaceae	Tree	Wood	Construction
64	*Celtis australis* Linn.	Kharig	Ulmaceae	Tree	Leaves	Fodder
65	*Ficus subincisa* Buch. – Ham.	Chachari	Moraceae	Tree	Leaves	Fodder
66	*Populous deltoides* W.Bartram ex Marshall *	Poplar	Salicaceae	Tree	Wood	Plantation
67	*Dalbergia sissoo* Roxb. Ex DC.*	Shisham	Fabaceae	Tree	Wood	Plantation
68	*Pinus roxbhurghii* Sarg.	Chir	Pinaceae	Tree	Wood, seed	Food, Construction, fuelwood
69	*Prunus cerasoides* Don.	Painya	Rosaceae	Tree	Wood, leaves	Agriculture implement, fodder, sacred
70	*Citrus pseudolimon* Tan.[#]	Hill lemon	Rutaceae	Tree	Fruit	Food, medicinal
71	*Phoenix dactylifera* L.	Khajur	Arecaceae	Tree	Fruit	Soil binder
Major shrubs						
72	*Barberis aristata* DC.	Kilmora	Berberidaceae	Shrub	Fruit, roots, bark	Food, medicinal
73	*Rubus ellipticus* Smith in Rees	Hisalu	Rosaceae	Shrub	Fruit,	Food, medicinal

74	*Ziziphus spp.*	Ber	Rhamna-ceae	Shrub	Fruit	Food
75	*Ricinus communis* L.	Arand	Euphorb-iaceae	Under shrub	Leaves, fruit	Medicinal
76	*Urtica dioica* Linn.	Bichu-ghas	Urticaceae	Herb	leaves	Food, medicinal
77	*Pyracantha crenulata* Roxb.	Ghingaru	Rosaceae	Shrub /tree	Wood	Small tools
78	*Citrus aurantifolia* (Christm.) Swing.#	Kagjinim boo	Rutaceae	Shrub	Fruit	Food, medicinal

* Crops, only grown in village Dantola
#Crops grown in kitchen garden
+Crop grown in village Mahatgaon

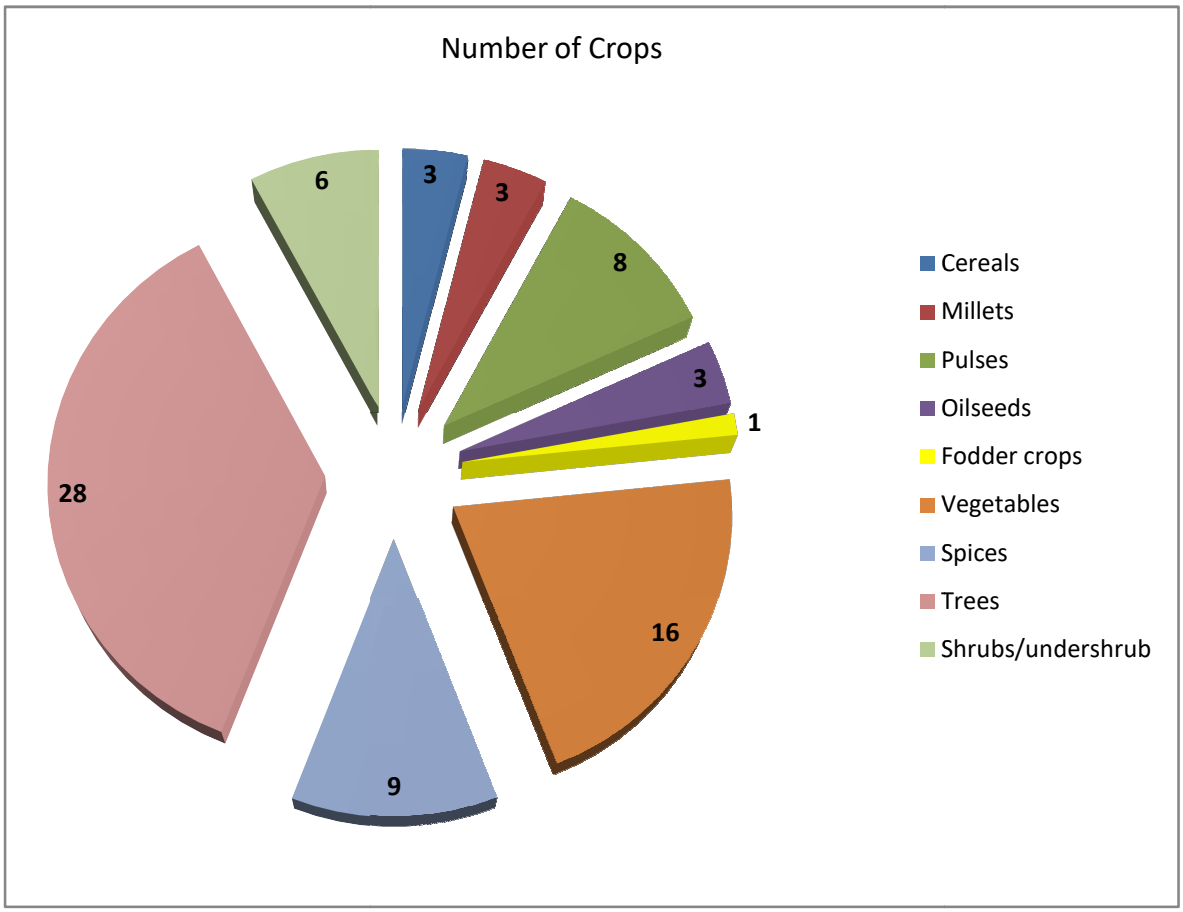

Fig. 3. Distribution of agro-biodiversity in the study villages

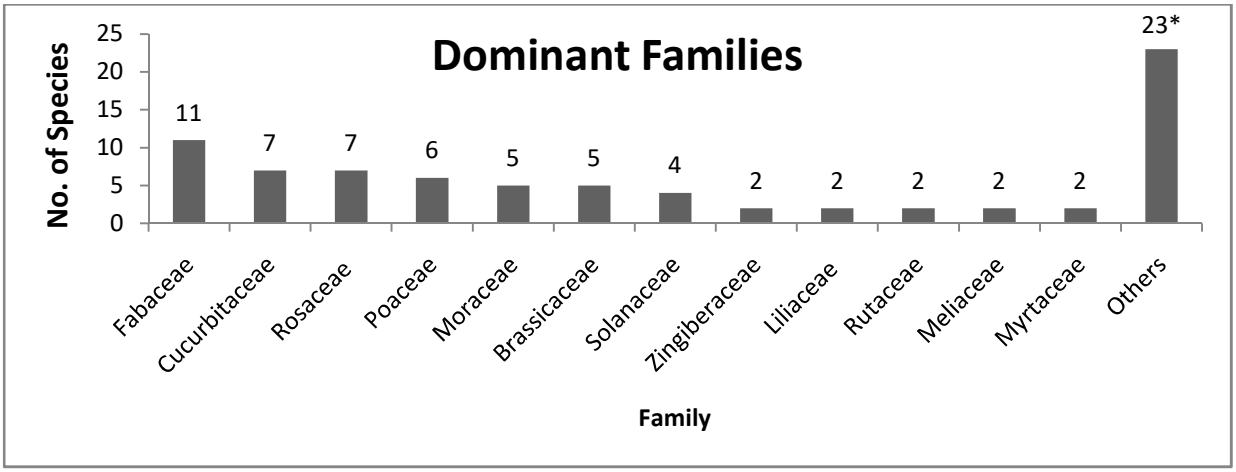

Fig. 4. Taxonomic distribution of food crops in the study villages, (* 1 species, each representing 23 different families)

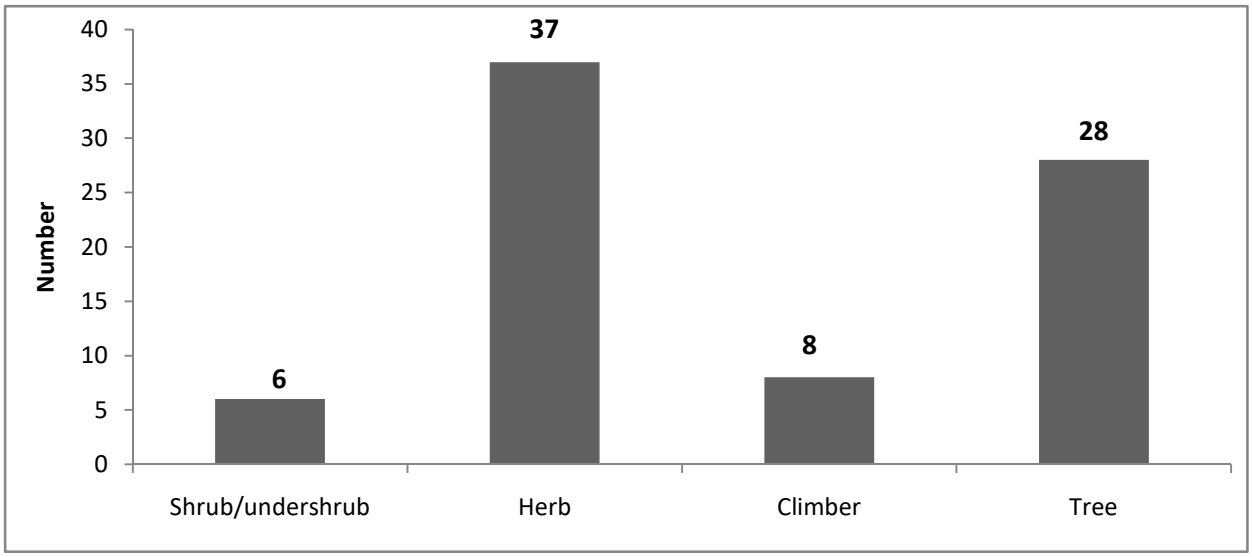

Fig. 5. Distribution of agro-biodiversity based on plant habit

Overall, 78 major species were documented in both the villages including cereals, pulses, millets, vegetables, fruits, agro-forestry trees and shrubs (Fig. 3). Among crops, almost all of the farmers use their local land races for all the crops, only a few by seeds of paddy

and wheat provided by the State Agriculture Department. In the study villages, kitchen garden constituted a major farm activity that had around 30 crops, mostly the vegetables. A greater diversity was also exhibited by woody perennials in the agro-forestry system that included fruit trees, fodder trees, fuelwood trees, etc. (Table 2). Fig. 4 indicates that Fabaceae (11 species) is the dominant family, followed by Cucurbitaceae (8 species), Rosaceae (7 species), Poaceae (6 species), Moraceae and Brassicaceae (5 species) and Solanaceae (4 species). Around 47% of plants recorded in the village agro-ecosystem were herbs that included cereals, vegetables, millets, oilseeds and pulses (Fig. 5). There were 19 plants which are used for medicinal purposes. The thorny shrubs of *Berberis aristata* and *Rubus ellipticus*, besides acting as fence, provide edible fruits to the workers in the field. Among woody perennials, the fruiting trees are generally planted within the residential area, while other agro-forestry trees are found in the fields and fallow land. Our study recorded 14 plants having sacred values in the region which justifies the protection of these species because of their use in rituals and festivals of local people. As a proposition towards conservation of agro-biodiversity, the people of the study area celebrates several festivals like 'Harela', 'Phooldehi', *etc.* (Rautela and Karki, 2015). Thus, agro-biodiversity is an irreplaceable form of ecosystem service to these Himalayan communities.

Despite being contiguous, the villages had differences in the distribution and/or cultivation of crops including multipurpose trees. For example, village Dantola has the system of plantation of Shisham (*Dalbergia sissoo*) and Poplar (*Populous deltoides*) and also cultivation of flax (*Linum usitatissimum*) and fruit crops such as litchi (*Litchi chinensis*) and plum (*Prunus domestica* L.), which were not observed in the other study village. Further, the traditional crops such as Foxtail millets, pearl millets that were earlier grown have been given-up due to labour scarcity due to migration and crop raiding by wild animals like wild pig, fox, monkeys and apes. Wild pig (locally known as *'Barha')* is a major crop raider in the villages, because of which there is a substantial loss in crop production every year, thus diverting the interest of villagers from agriculture. Such phenomena have led to a gradual loss of biodiversity that were abundant as local landraces before. Notwithstanding, many crop varieties and landraces are still conserved because of their religious and socio-cultural values, despite several ecological and socio-economic challenges.

In the state of Uttarakhand, the communities have always been passionate about nature. One of the great examples of traditional communities protecting their ecosystem is

'Chipko Andolan' or 'Hug the Trees Movement' (1973) of Chamoli region of Uttarakhand in which the local people hugged the trees of their forest to protect them from cutting (Bhatt, 1990). Another great example is 'Beej Bachao Andolan' (BBA) or 'Save-the-Seeds Movement' (late 1980s) of Tehri Garhwal (Gupta, 2008) in view of saving traditional seeds of the hills along with promoting traditional farming practices. The indigenous people have had mutual relationship with their ecosystem as they utilize the natural resource like food, fodder, timber, fuel wood, fiber, flosses, edible wild products, ivory, etc., in a sustainable manner and in return, they protect their ecosystem by following certain rules and regulation or associating the ecosystem to their deities, taboos, rituals, festivals and customs (Negi, 2010). Thus, their involvement becomes important while formulating the conservation policies (Pant and Ramisch, 2010). Agrawal and Gibson (1999) have also emphasized on community-based conservation on which the failure or success of any conservation efforts depend *viz*., (i) the multiple actors with multiple interests that make up communities, (ii) the processes through which these actors interrelate, and, (iii) the institutional arrangements that structure their inter-actions.

CONCLUSION

The study leads to the conclusion that the selected villages are rich in agro-biodiversity, because of its immense contribution to their livelihood. Kitchen garden is the most diverse system where the number of crops per unit area is maximum. The study found that the threats to the existing agro-biodiversity (*i.e.* crop raiding, migration, *etc.*) are increasing which require immediate attention of the policy makers in order to prevent its further degradation and maintain sustainability in the region. Given the present day requirements of the local people and international commitments, it is important to balance our conservation efforts between conservation of traditional crops/ cultivars and food security and achieve socio-economic development to retain the hill farmers in village and sustain Himalayan agriculture linking ecology with economics and ethics.

ACKNOWLEDGEMENTS

The authors acknowledge the Department of Science and Technology (DST), Government of India, for financial support to the Task Force on Himalayan Agriculture under the National Mission for Sustaining the Himalayan Ecosystem (NMSHE) program. We thank the farmers of the study villages for having shared valuable information on farm practices.

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