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PATTERNS OF AGRO-DIVERSITY WITH ITS SOCIO-ECONOMIC USES AT GAGAS VALLEY, ALMORA, KUMAUN HIMALAYA

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Abstract

A large population (70%) of the Kumaun Himalayan region is largely depended on agriculture for its livelihood. In this community, various conventional crops and their associated cropping methods have prevailed for ages. The resulting agro-biodiversity systems are responsible for maintaining soil fertility, as well as a series of varied socio-cultural and religious rituals. But less emphasis, poor scientific understanding, and related socioeconomic issues, have gravely encumbered the recognition of solutions for a sustainable agricultural development in the Himalayan region. Currently, the policies have taken into consideration the importance of appropriate technologies, which can play a key role in coping with the uncertainties prevailing in the Himalaya and therefore have stressed the need for on-site training and capacity building of user groups in rural areas of the region. There is a vital need to fetch viable changes in the agricultural policy, research, land use and breeding approaches in reference to mountainous regions. The present paper describes patterns of agro-diversity with its socio-economic uses in the Gagas Valley, Kumaun Himalaya with some policy dimensions, and strategies for management of the agroecosystems.

Keywords: *Agro-diversity; Mixed cropping; Conservation; Indigenous knowledge*

Introduction

Agricultural biodiversity encompasses the variety and variability of animals, plants and micro-organisms that are necessary to sustain key functions of the agro-ecosystem, its structure and processes for, and in support of food production and food security [1]. In the Himalayan region, agriculture and allied activities not only provide livelihood to large sections of population but form a fundamental part of their way of living [2-4]. In this region, agro-ecosystems vary widely in the extent of biodiversity organization in terms of cultivars/ landraces within a species. Other components plays a significant role in maintaining the long-term stability of traditional agro-ecosystems in a variety of ways, such as it improves soil fertility by incorporating legumes in the crop mixture, helps to minimize crop loss due to insect pests, minimize losses from plant diseases and nematodes. Inaccessibility, environmental heterogeneity, ecological fragility and marginality have favored the evolution of subsistence production systems sustained with organic matter and nutrients derived from the forests, with the emphasis on optimizing productivity in the long term [2-6].

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In Uttarakhand, about 75–90% of the total population is engaged either with the main occupation of agriculture or its allied practices, dominated by traditional subsistence cereal farming [2-12]. There are about 40 crop species, and farmers spread throughout the different regions have selected landraces of about six types of cereals, five types of pseudo-cereals, six types of millets, 16 types of pulses, four types of oilseeds, five types of condiments and eight types of vegetable [13]. People living in Himalayan villages, utilizes plants for medicine, food, fodder, fuel, timber, agricultural implements and many more other purposes. Uttarakhand state a part of Indian Himalayan Region (IHR) is divided into two divisions, Kumaun and Garhwal Himalalya. The Kumaun Himalaya with an area of 38,000 sq km is rich in its agricultural flora having variation in crop diversity. With varied types of climate (subtropical to alpine), altitude, topography, soil types, valleys, rivers, watersheds and forest resources, Kumaun Himalaya region of Uttarakhand state is suitable for the growth of all kinds of plants.

The cropping pattern were built around two major cropping seasons locally called as Kharif (rainy season) and Rabi (winter season). Paddy (*Oryza sativa* L.), Maduwa (*Eleusine coracana* L., Gaertn.), Jhangora (*Echinochloa frumentacea* Link, Hort. Berol), Maize (*Zea mays* L.), Koni (*Setaria italica* L., P. Beauv.) Rajma (*Phaseolus vulagris* L.) and other pulses crops and vegetables were dominant rainy season crops. Wheat (*Triticum aestivum* L.), Jau (*Hordeum vulgare* L.), Sarson (*Brassica campestris* L.), and pulses like Masur (*Lens culinaris* Medik.), Chana (*Cicer arientinum* L.) were dominant crops of winter season.

Methodology and Study area

The present study area Gagas valley (Fig. 1), situated 30km away from Ranikhet town, a famous hill station, Almora District, lies approximately between 79°24'-79°29'E longitude, 29°36'- 29°42'N latitude with an altitude of 1300m in the state of Uttarakhand, which shares the international boundary with China in the north and with Nepal in the east. The average rainfall during (2015-2016) in the study area was about 750 millimeter. The temperature varies from 2°C during December and reaches up to 34°C in June.

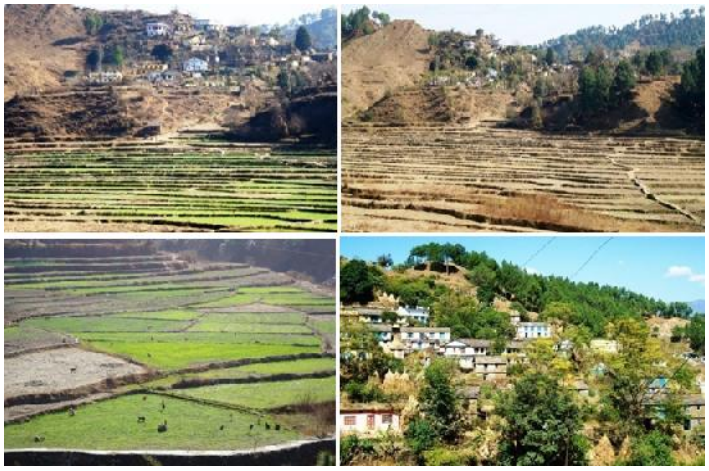

Fig. 1. Panoramic view of agricultural land of Gagas valley

An extensive cross sectional survey on patterns of agriculture diversity and its socio-economic uses was done following structured questionnaire survey during the year 2014-2016. People of different genders and age groups (Up to 30, 31- 60, above 60) were interviewed for information. To accomplish the conservation aspect, samples of seeds of cereals, millets, pulses, spices, vegetables and oil producing plants were collected from the study area and put forward

to Regional Ayurvedic Research Institute, (RARI) CCRAS, Thapla, Ranikhet, Almora according to institute's norms. Site characteristic, source of collection and local name of each taxa was noted at the time of collection and labeled on each specimen.

Results and Discussion

A survey of selected study area reveals the existence of various crops (Fig. 2 and Table 1) and their landraces of an assortment of crops (cereals, millets, pulses, vegetables, oil and fruits).

Table 1. List of species mentioned by the informants and their use categories

S.No.	Botanical Name	Vernacular Name	Family	Uses									Part Used
				F	Fo	M	Fi	Fu	S	O	Sp	Habit	
								Cereals					
1	*Oryza sativa* L.	Dhan	Poaceae	+	+	+			+			H	Sd
2	*Triticum aestivum* L.	Gehun	Poaceae	+	+				+			H	Sd
3	*Zea mays* L.	Makka	Poaceae	+	+	+				+		H	Sd
								Millets					
4	Echinochloa frumentacea Link	Jhungra	Poaceae	+	+							H	Sd
5	*Eleusine coracana* (L.) Gaertn.	Madua	Poaceae	+	+	+						H	Sd
6	*Hordeum vulgare* L.	Jau	Poaceae	+	+	+			+			H	Sd
7	*Setaria italica* (L.) P. Beauv.	Kauni	Poaceae	+	+	+						H	Sd
8	Sorghum vulgare (L.) Pers.	Jowar	Poaceae	+	+							H	Sd
								Pulses					
9	*Cajanus cajan* (L.) Mill.	Arhar	Fabaceae	+	+							H	Sd
10	*Cicer arientinum* L.	Chana	Fabaceae	+		+			+			H	Sd
11	Glycine max **(L.)** Merr**.**	Bhat	Fabaceae	+	+					+		H	Sd
12	*Lens culinaris* Medik.	Masur	Fabaceae	+								H	Sd
13	*Macrotyloma uniflorum*(Lam.) verdc.	Gehat	Fabaceae	+		+						H	Sd
14	*Phaseolus* spp.	Bean	Fabaceae	+								H	Sd
15	*Phaseolus vulagris* L.	Rajma	Fabaceae	+								H	Sd
16	*Pisum sativum* L.	Mattar	Fabaceae	+								H	Sd
17	*Vicia faba* L.	Bakla	Fabaceae	+								H	Sd
18	Vigna angularis **(**Willd.) Ohwi & Ohashi**.**	Rayans	Fabaceae	+								H	Sd
19	Vigna mungo **(L.)**	Mash	Fabaceae	+		+						H	Sd
20	Vigna unguiculata **(L.)** Walp.	Lobia	Fabaceae	+								H	Sd
								Vegetables					
21	*Abelmoschus esculentus* **(**L.) Moench**.**	Bhindi	Malvaceae	+								H	Fr
22	Amaranthus frumentacea Buch.-Ham**.**	Cholai	Amaranthaceae	+		+						H	L, Sd
23	*Benincasa hispida* (Thunb.) Cong.	Bhuza	Cucurbitaceae	+								H	Fr
24	*Brassica campestris* L.	Sarson	Brassicaceae	+		+				+	+	H	Sd
25	Brassica juncea **(L.)** Czern**.** & Coss**.**	Rye	Brassicaceae	+		+					+	H	Sd
26	*Brassica oleracea* L.	Phulgobhi	Brassicaceae	+								H	In
27	*Brassica oleracea* L.	Bandgobhi	Brassicaceae	+								H	L
28	*Brassica nigra* Koch.	Lahi	Brassicaceae	+								H	L
29	*Chenopodium album* L.	Bathua	Chenopodiaceae	+		+						H	L
30	Colocasia esculenta **(L.)** Schott**.**	Gaderi	Araceae	+								H	L, S, Rh
31	Cucumis melo L**.**	Kakree	Cucurbitaceae	+		+						H	Fr
32	Cucurbita maxima Duch**.**	Kaddu	Cucurbitaceae	+					+			H	Fr
33	*Cyclanthera pedata* Schrader.	Ramkarela	Cucurbitaceae	+								H	Fr
34	*Dioscorea bulbifera* L.	Gethi	Dioscoreaceae	+		+			+			H	Tu
35	*Fagopyrum esculentum* (L.)	Ugal	Polygonaceae	+					+			H	L, Sd
36	*Lagenaria siceraria* (Mol.) Standl.	Lauki	Cucurbitaceae	+								H	Fr
37	*Luffa cylindrica* (L.) M. Roem.	Torai	Cucurbitaceae	+			+					H	Fr

38	*Lycopersicon esculentum* Mill.	Tamatar	Solanaceae	+							H	Fr
39	*Momardica charantia* L.	Karela	Cucurbitaceae	+		+					H	Fr
40	*Raphanus sativus* L.	Muli	Brassicaceae	+		+					H	L, Rt
41	*Solanum melongena* L.	Baigun	Solanaceae	+							H	Fr
42	*Solanum tuberosum* L.	Alu	Solanaceae	+		+					H	Tu
43	*Spinacea oleracea* L.	Palak	Chenopodiaceae	+							H	L
44	*Trichosanthes anguina* L.	Chichan	Cucurbitaceae	+							H	Fr
							Spices					
45	*Allium cepa* L.	Pyanj	Liliaceae	+		+				+	H	Bl, L
46	*Allium satvum* L.	Lahsun	Liliaceae	+		+				+	H	Bl
47	*Cannabis sativa* L.	Bhang	Cannabinaceae	+			+	+	+		H	Sd
48	*Capsicum frutescens* L.	Mirch	Solanaceae	+						+	H	Fr
49	*Capsicum* spp.	Shimla Mirch	Solanaceae	+		+				+	H	Fr
50	Cleome viscosa L**.**	Jakhya	Cleomaceae	+		+				+	H	Sd
51	*Coriandrum sativum* L.	Dhania	Apiaceae	+		+				+	H	L, Sd
52	Curcuma domestica Valet	Haldi	Zingiberaceae	+		+		+		+	H	Rh
53	Mentha arvensis L.	Pudina	Lamiaceae	+					+	+	H	L
54	*Perilla frutescens* (L.) Britt.	Bhangjira	Lamiaceae	+		+			+	+	H	L, Sd
55	*Trigonella foenum-graecum* L.	Methi	Fabaceae	+		+				+	H	L, Sd
56	Zingiber officinale Roscoe.	Adrak	Zingiberaceae	+		+				+	H	Rh
							Oil					
57	*Brassica campestris* L.	Sarson	Brassicaceae	+		+			+		H	Sd
58	*Linum usitatissimum* L.	Alsi	Linaceae	+			+		+	+	H	Sd
59	*Sesamum indicum* L.	Til	Pedaliaceae	+				+	+	+	H	Sd
							Fr					
60	*Carica papaya* L.	Papita	Caricaceae	+		+					T	Fr
61	Citrus aurantifolia **(**Christm**.)** Swing**.**	Kagji Nimbo	Rutaceae	+		+			+	+	S	Fr
62	Citrus limon **(**L.) Burm. f**.**	Nimboo	Rutaceae	+		+					T	Fr
63	*Citrus sinensis* (L.) Osbeck.	Malta	Rutaceae	+		+			+		T	Fr
64	*Citrus jambhiri* Lushington.	Jamir	Rutaceae	+		+					T	Fr
65	Emblica officinalis *Gaertn***.**	Amla	Euphorbiaceae	+		+		+			T	Fr
66	*Ficus auriculata* Lour.	Timil	Moraceae	+	+	+	+	+			T	Fr
67	*Ficus palmata* Forsk.	Bedu	Moraceae	+	+	+		+			T	Fr
68	*Juglans regia* L.	Akhrot	Juglandaceae	+		+	+		+		T	Fr
69	*Mangifera indica* L.	Aam	Anacardiaceae	+			+	+		+	T	Fr
70	*Morus alba* L.	Kimu	Moraceae	+	+			+			T	Fr
71	*Musa paradisiaca* L.	Kela	Musaceae	+				+			H	Fr
72	*Prunus armeniaca* L.	Khubani	Rosaceae	+							T	Fr
73	*Prunus domestica* L.	Pulam	Rosaceae	+		+					T	Fr
74	*Prunus persica* (L.) Batsch.	Aru	Rosaceae	+		+					T	Fr
75	*Psidium guajava* L.	Amrud	Myrtaceae	+		+					T	Fr
76	*Punica granatum* L.	Darim	Punicaceae	+				+		+	T	Fr
77	*Pyrus communis* L.	Nashpati	Rosaceae	+	+	+					T	Fr
78	*Vitis vinifera* L.	Angur	Vitaceae	+		+					Cl	Fr

Abbreviations: F: Food, Fo: Fodder, M: Medicinal, Fi: Fiber, Fu: Fuel, S: Sacred, O: Oil, S: Spices, H: Herb, T: Tree, Cl: Climber, Sd: Seed, Fr: Fruit, L: Leaves, Rt: Root, Rh: Rhizome, Tu: Tubers, Bl: Bulbs, In: Inflorescence

In the study area, maximum diversity is exhibited by vegetables crops (31%) followed by fruits (24%), pulses (15%), spices (15%) and millets (7%) cereals (4%), and oil (4%) (Fig. 3). Among the crops of cereals, *Oryza sativa* L. with 5 landraces showed maximum diversity followed by *Triticum aestivum* L. 3 and *Zea mays* L. 2. Among millets, *Eleusine coracana* (L.) Gaertn. represented maximum 4 land races followed by *Hordeum vulgare* L., Echinochloa frumentacea Link. each with 2 land races. *Setaria italica* (L.) P. Beauv., Cucurbita maxima Duch., *Luffa cylindrica* (L.) M. Roem. and *Raphanus sativus* L. 2 landraces, *Sesamum indicum* L. (Til) 1 landrace.

Fig. 2. Various crops grown in Gagas Valley

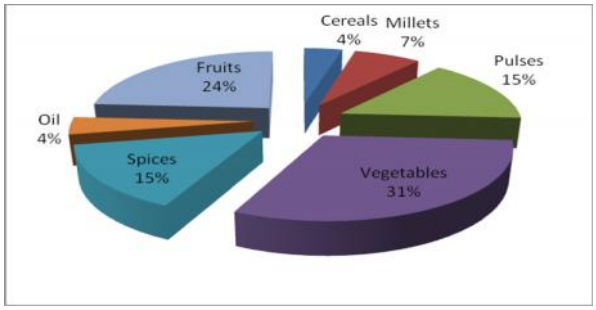

Fig. 3. Proportional diversity of various crops

During the study, it was observed that Fabaceae (13 species) is the dominant family of crops, trailed by Cucurbitaceae and Poaceae (8 species each), Brassicaceae (7 species), Rosaceae, Rutaceae and Solanaceae (4 species each) and Moraceae (3 species) (Fig. 4). Apart from the nutritional value of these crops species, they are also having some other utilization patterns (fuel, fodder, food, medicinal, fiber, sacred oil, spices). There are 78 species all having

food and nutritional value, 49 species representing medicinal, 23 species fodder, 18 species spices, 17 species sacred, 12 species oil, 11 species fuel and 2 species fiber (Fig. 5).

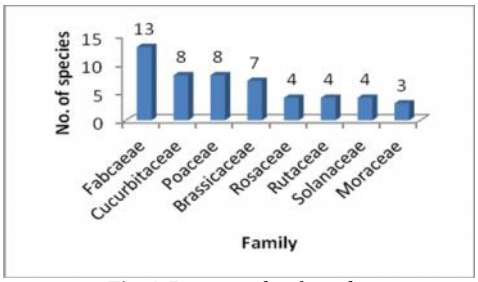

Fig. 4. Dominant families of crops

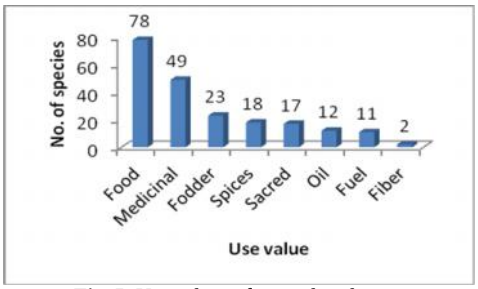

Fig. 5. Use values of agricultural crops

In the study region, inter or mixed cropping and rotating of cereals/millets and grain legumes in a specific sequence is preferred by farmers as the total grain yields per ha as compared to that obtained through sole cropping. It was also found that the traditional knowledge about agriculture was equally distributed between migrant and local inhabitants. Most of the agricultural crops thrived in the region are also used for other purposes i.e. medicinal, economic (Timber, oil, spices etc.), fodder, sacred, other than their nutritional values. It is a fact that a large number of populations in the study region is dependent on agriculture and apart from growing cereals, millets etc., region is a crux for vegetables. Huge quantities of vegetables are sold to nearby towns from here. But still a drastic beg off in diversity and production of traditional crops during last decades occurred due to changing socio-economic conditions, promotion of cash crops and change in climatic conditions in agriculture system of Himalaya [2-15].

Conclusion

The decline in interest of local farming communities towards traditional crop cultivation, all across the region, is well known, and its reasons are attributed to climatic, cultural, and socio-economic transformations [2-17]. Thus it could be emphasized that for the conservation of traditional crop diversity and their landraces for genetic heritage, socio cultural activities of the inhabitants with other institutional and policy support and sustainable land use development could be the safest and effective conservation initiatives [18].

Indigenous knowledge on agro-diversity could play a better role in the development of mountainous regions. Mixed cropping of 12 crops (Baranaja), combination of cereals with millets, millets with legumes, and legumes with legumes [2-20], is a common practice in the region, due to the fact that these crops are adapted to the local environmental conditions and possess the inherent qualities to withstand the environmental risks and other natural hazards [21]. This kind of mixed cropping ensures increase yield stability, thus providing improved returns [22-27] and least soil erosion by providing continuous cover. To conserve the, conventional crops and cropping systems, it will be helpful to develop faith on these systems for not only good source of food and nutrition.

Agro-biodiversity based livelihood options can be added through the inclusion of various bio–resources-based technologies, which need an explicit strategy to support the implementation of appropriate technologies that consider the needs of the people in different agro-climatic zones [28].

On the basis of above studies we stress that some long-term seed conservation techniques for the local farmers are needed, and proper irrigation methodology should be developed. Traditional crops should be conserved in the research centers and gene banks.

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