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Crop-biodiversity along altitude in Gangotri valley of Uttarkashi district of Garhwal Himalaya, India

Abstract

The study documents crop diversity by local inhabitants of Gangotri valley along varying altitude i.e. low (1000-1500m), middle (1500-2000m) and high (2000-2500m) altitude. A total of 55 crop species were recorded of which 41 species were di-cotyledons and 14 species were monocotyledons. Food grains comprised of 11 species, of which eight were monocotyledons and three were di-cotyledons. Pulses comprised 11 species. Vegetable crops consisted of 32 species (10 families). Spices crops constituted five species, oil-seed three species, and two species were placed in other category. From all the families, *fabaceae* was the largest with 15 species. Low altitude displayed the largest number of species (54) followed by middle (49) and high (16) altitudes. Six species were restricted to low altitude only. Some species occupied two or more altitudes. It was found that altitude exerted a significant effect on climate of the area due to which some species are adapted to particular environmental conditions under agroforestry systems.

Keywords: agroforestry, indigenous crops, cash crops, hybrids

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Introduction

Agriculture is as old as the human civilizations originated and flourished. Without agriculture human being cannot sustain themselves. Crop-farming and livestock are the two main components of agriculture. In the Himalayan region, agriculture is mostly done on the sustainable basis because the main hurdles are uneven topography and fluctuating climatic conditions. The global world population has risen by 37% and food consumption by 40% since year 1990.[1] In order to suffice the needs of the growing population an effort has to be made to increase the crop biodiversity and agriculture production.

There are less studies documenting in the plant diversity in Uttarkashi, agriculture status,[2,3] vegetation diversity[4] and tree distribution and regeneration,[5] however, the research listing the major cultivated crop plant species in Uttarkashi district is missing. Hence the main aim of this study was to list the different crop plant species growing along varying altitude.

Materials and methods

The study was conducted on agricultural farms having trees on bunds in the Gangotri valley of Uttarkashi district of Uttarakhand, India along varying altitude (low=1000-1500m, middle=1500-2000m and high=2000-2500m) in six villages namely, Siror (1394m) and Netala (1459m) falls in the low altitude, Silla (1765m) and Malla (1837m) in middle and Jhala (2213m) and Sukki (2500m) in high altitude. Random quadrats were laid according to the species area curve method and crop-biodiversity of the area was analyzed. Crop species were identified by using published book of flora,[6] taking help from agriculture science centre ('Krishi Vigyan Kendra', KVK) and consulting villagers. Informal inspection was also conducted among the villagers to evaluate the agriculture situation of the area.

Results and discussion

In this study, a total of 55 crop plant species were recorded of which 41 species (75%) were of di-cotyledons and monocotyledons constituted 14 species (25%) (Figure 1). Low altitude displayed largest crop diversity with all species found growing in this zone, closely followed by middle (49 species) and then high (16) altitudes (Figure 2). Six species were restricted to low altitude only, namely, *Arachis hypogaea*, *Cajanus cajan, Cicer arietinum, Pennisetum glaucum, Saccharum officinarum* and *Sorghum bicolor*. 33 species were found growing in both low and middle altitude and 15 species was found growing in all the three altitudes (Table 1).

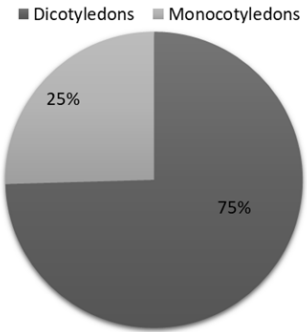

Figure 1 Crop plant species among di-cotyledons and monocotyledons (%).

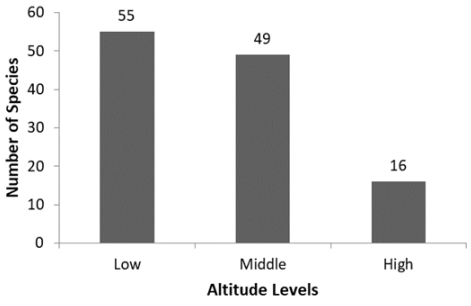

Figure 2 Distribution of crop plant species along altitude.

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From all the 55 species the largest family was found to be *fabaceae* with 15 species followed by *poaceae* (nine species), *cucurbitaceae* (eight), brassicaceae (five), *amaranthaceae*, *solanaceae* each having four species, *amaryllidaceae*, *apiaceae*, *zingiberaceae* each with two species and remaining families each containing one species.

In the economically useful category of species, 11 species were of food grains of which three are pseudo-cereal (*Amaranthus caudatus*, *A. cruentus* and *A. hypochondriacus*), four are millets (*Echinochloa frumentacea*, *Eleusine coracana, Pennisetum glaucum* and *Sorghum bicolor*) and rest are cereal crops. Among the food grains, *poaceae* was the largest family with eight species. Pulses (*fabaceae*) constituted 11 species, of which only two species were indigenous (*Macrotyloma uniflorum* and *Vigna umbellata*). Between vegetable species, there were 32 species distributed across 10 families of which *cucurbitaceae* was found to be largest having eight species, followed by *fabaceae* (seven sp.), brassicaceae (five), *amaranthaceae* and *solanaceae* (four species each), *apiaceae* (two) and rest of the family each having one species. Spices comprised five species (*Capsicum annuum, Coriandrum sativum, Curcuma longa, Trigonella foenum-graecum* and *Zingiber officinale*). Oil seed crops have only three species: *Arachis hypogaea, Brassica juncea* and *Glycinemax* and other crops contained two species (Table 1) (Figure 3).

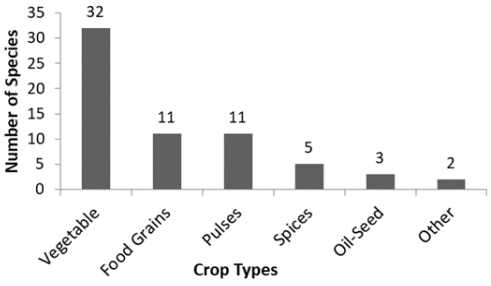

Figure 3 Distribution of agricultural crops in different category of crops.

Table 1 Crop-biodiversity along elevation in agroforestry systems on farm land

Family	Species	Vernacular name	English name	Other uses	Elevation
Food Grains					
Amaranthaceae	*Amaranthus caudatus* L.	Chawlai, Ramdana	Grain Amaranth, Foxtail amaranth	Seeds are used in halva and 'laddoos' (Indian sweet preparations)	L, M, H
	A. cruentus L.	Chawlai, Ramdana	Grain Amaranth, Red amaranth	Seeds are used in halva and 'laddoos' (Indian sweet preparations)	L, M, H
	A. hypochondriacus L.	Chawlai, Ramdana	Grain Amaranth	Seeds are used in halva and 'laddoos' (Indian sweet preparations)	L, M, H
Poaceae (Gramineae)	*Echinochloa frumentacea* Link	Jhangora, Sawan, Sanwa	Indian Barnyard millet	Seeds used in 'kheer' (pudding/ porridge)	L, M
	Eleusine coracana Gaertn.	Mandua, Koda, Ragi	Finger Millet	Flour used in halva (Indian sweet preparation)	L, M
	Hordeum vulgare L.	Jau (jaw)	Barley	Used as fodder and in religious rituals	L, M
	Oryza sativa L.	Dhaan	Rice, Paddy	Seeds used in 'kheer' (pudding/ porridge), crop residue used as fodder	L, M
	Pennisetum glaucum (L.) R. Br.	Bajra	Pearl Millet	Used as animal fodder	L
	Sorghum bicolor (L.) Moench	Jowar	Sorghum	Used as animal fodder	L
	Triticum aestivum L.	Gehun	Wheat	Flour used in halva (Indian sweet preparation)	L, M
	Zea mays L.	Makka, Makki	Maize	Chappatis, crop residue used as fodder	L, M

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Table Continued

Family	Species	Vernacular name	English name	Other uses	Elevation
Pulses					
Fabaceae (Leguminosae)	*Cajanus cajan* (L.) Millsp.	Arhar, Tor	Pigeon pea	Leaves used as fodder	L, M
	Cicer arietinum L.	Chana	Chickpea	Leaves used as fodder	L
	Glycine max (L.) Merr.	Bhat	Soybean	Seeds roasted then eaten, crop residue used as fodder	L, M
	Lablab purpureus (L.) Sweet	Seimi	Bean		L, M
	Lens culinaris Medikus	Masoor	Lentil		L, M
	Macrotyloma uniflorum (Lam.) Verdc.	Gahat	Horse Gram	Seeds used as stuffing for 'pranthas' (unleavened bread); boiled seeds given to remove kidney and urinary stones	L, M
	Phaseolus vulgaris L.	Rajma	Kidney Bean		L, M, H
	Pisum sativum L. [*Pisum sativum* subsp. *arvense* (L.) Asch. & Graebn]	Matar	Pea		L, M, H
	Vigna mungo (L.) Hepper	Urad	Black Gram		L, M
	V. umbellata (Thunb.) Ohwi & H. Ohashi	Naurangi	Rice Bean		L, M
	V. unguiculata (L.) Walp.	Lobia	Cowpea		L, M
Vegetables					
Amaranthaceae	*Amaranthus* species	Chaulai	Amaranth	Leaves used as stuffing for 'pranthas' (unleavened bread) and in 'pakoras'	L, M, H
	Spinacia oleracea L.	Palak	Spinach	Leaves used as stuffing for 'pranthas' (unleavened bread) and in 'pakoras'	L, M
Amaryllidaceae (earlier placed in Alliaceae)	*Allium cepa* L.	Pyaz	Onion	Used as condiment and salad	L, M
Apiaceae (Umbelliferae)	*Coriandrum sativum* L.	Dhania	Coriander	Leaves used as condiment and fruits used as spice	L, M
	Daucus carota L.	Gaajar	Carrot	Used as salad	L, M
Araceae	*Colocasia esculenta* (L.) Schott	Arbi, Paapad	Taro	Leaves used as 'pakoras' (fried snack) and 'patrodu' (a pancake type)	L, M

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Table Continued

Family	Species	Vernacular name	English name	Other uses	Elevation
Brassicaceae (Cruciferae)	*Brassica juncea*	Rai	Brown Mustard		L, M, H
	B. oleracea L. var. *botrytis* L.	Phulgobhi	Cauliflower	Used to make 'pakoras'	L, M, H
	B. oleracea L. var. *capitata* L.	Bandhgobi, PattaGobhi	Cabbage	Used as salad	L, M, H
	B. rapavar. rapa	Shalgam	Turnip	Used as salad	L, M, H
	Raphanus sativus L. var. (cultivar) '*Longipinnatus*' L.H. Bailey	Mooli	Radish, Daikon	Used as salad	L, M, H
Chenopodiaceae	*Beta vulgaris* L.	Chookandar	Beetroot	Used as salad	L, M
Cucurbitaceae	*Benincasa hispida*(Thunb.) Cogn.	Tarbooz, Petha	White Gourd, Ash Gourd		L, M
	Cucumis sativus L.	Kheera	Cucumber	Used as salad	L, M
	Cucurbita argyrosperma K. Koch	Kaddu, Sitaphal	Japanese pie pumpkin	Flowers are used to make 'pakoras'	L, M, H
	C. maxima Duchesne	Kaddu, Sitaphal	Cultivated Squash	Flowers are used to make 'pakoras'	L, M, H
	C. moschata Duchesne ex Poir.	Kaddu, Sitaphal	Pumpkin	Flowers are used to make 'pakoras'	L, M, H
	C. pepo L.var. *pepo* L. Bailey	Kaddu, Sitaphal	Field Pumpkin	Flowers are used to make 'pakoras'	L, M, H
	Lagenaria siceraria (Molina) Standl.	Launki	Bottle gourd, Calabash		L, M
	Luffa cylindrical M. Roem.	Tori	Sponge gourd		L, M
Fabaceae (Leguminosae)	*Cyamopsis tetragonoloba* (L.) Taub.	Gawar phalli	Guar, Cluster Bean		L, M
	Lablab purpureus (L.) Sweet	Seimi	Hyacinth bean, Indian Bean		L, M
	Phaseolus vulgaris L.	Pharas Bean	Common Bean, Green Bean, French Bean	Seed flour used to make 'pakoras'	L, M, H
	Pisum sativum L. [*Pisum sativum* subsp. arvense (L.) Asch. & Graebn]	Matar	Pea		L, M, H
	Trigonella foenum-graecum L.	Methi	Fenugreek	Seeds used as spice and condiment	L, M
	Vicia faba L.	Semi	Broad Bean, Fava Bean		L, M
	Vigna unguiculata (L.) Walp.	Lobia	Cowpea		L, M

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Table Continued

Family	Species	Vernacular name	English name	Other uses	Elevation
Malvaceae	*Abelmoschus esculentus* (L.) Moench	Bhindi	Lady Finger, Okra		L, M
Solanaceae	*Capsicum annuum* L.	Shimla Mirch	Bell Pepper		L, M
	Solanum lycopersicum L. [Syn. *Lycopersicon esculentum* Mill.]	Tamaatar	Tomato	Used to make 'chutney' (Sauce)	L, M, H
	S. melongena L.	Baigan	Brinjal, Eggplant, Aubergine	Used to make 'pakoras'	L, M
	S. tuberosum L.	Aaloo	Potato	Used to make 'pakoras'	L, M, H
Oil-seed					
Brassicaceae (Cruciferae)	*Brassica juncea* (L.) Czern.	Rai	Brown Mustard		L, M, H
Fabaceae (Leguminosae)	*Arachis hypogaea* L.	Moong phalli	Groundnut	Seeds roasted then eaten	L
	Glycine max(L.) Merr.	Bhat	Soybean		L, M
Pedaliaceae	*Sesamum indicum* L.	Til	Sesame	Seeds eaten raw and used to make 'laddoos' (Indian sweet preparations)	L
Spices					
Solanaceae	*Capsicum annuum* L.	Mirch	Chili Pepper	Used to make pickle	L, M
Zingiberaceae	*Curcuma longa* L.	Haldi	Turmeric	Used for medicinal and religious purpose	L, M
	Zingiber officinale Roscoe	Adrak	Ginger	Used for medicinal purpose	L, M
Other					
Amaryllidaceae (earlier placed in Alliaceae)	*Allium sativum* L.	Lahsun, Lassun	Garlic	Used as condiment and medicine	L, M
Poaceae	*Saccharum officinarum* L.	Ganna	Sugarcane	Used for juice	L

L, low altitude (1000-1500m); M, middle altitude (1500-2000m); H, high altitude (2000-2500m)

Some species have one major purpose e.g. spice (*Capsicum annum*, chili; *Curucuma longa* and *Zingiber officinale*) and minor usage is in pickles and in medicine. Further, some crop plants have two major uses e.g. leaves of all the pseudo-cereals are also used as vegetable, unripe fruit of some pulses are used as vegetable (*Lablab purpureus, Phaseolus vulgaris* and *Pisum sativum*) and ripe fruit as oil-seed crop (*Glycine max*), fruits and seeds of some vegetables are used as spice (*Coriandrum sativum* and *Trigonella foenum-graecum*), vegetables as salad [*Beta vulgaris*, *Brassica oleracea* var. *capitata*, *Daucus carota*, *Raphanus sativus* L. var. (cultivar) 'Longipinnatus', *Solanum lycopersicum*], seeds of vegetable as oil-seed crop (*Brassica juncea*). Further, some crop plants have miscellaneous uses also such as fodder, medicine, religious rituals and in preparation of traditional recipes (Table 1).

Most of the crops were found growing in low and middle altitude because people have domesticated these crops over many years and thus, they have developed their own varieties of different crop plants which have adapted to existing climatic conditions of the area. In the high altitude very less crops were observed and the reason could be

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the harsh climatic conditions offered by the high altitude.

Generally, the agriculture in the Gangotri valley is practiced by people such as: less educated who cannot do other jobs, women whose spouse are employed in city/town and those who have a large amount of ancestral land. It has been found that very few farmers plant indigenous crops (e.g. millets and pseudo-cereal) or even if it is planted the land acreage under cultivation is reduced because in the recent period people's acceptability towards indigenous crops has declined and therefore, these crops do not offer good return to farmer. These indigenous crops are grown from an ancient time and their land races have been selected and domesticated carefully by the farmers in relation to environmental conditions prevalent in the mountain ecosystem and thus, are better adapted to these conditions. Among the pulses, the indigenous crops grown are: horse gram and rice bean. Further, some indigenous crops were found to be completely neglected or grown by very few farmers such as, *Fagopyrum esculentum* (common buckwheat, 'Oggal'/'Ougal'), *F. tataricum* (tartary buckwheat, 'Phaphar'), *Panicum miliaceum* (proso millet, 'Cheena') and *Setaria italica* (foxtail millet, 'Kauni'). These indigenous crops if planted along with cash crops will provide additional benefit to farmers because they are more nutritious than other food grains, climate adaptable, require less maintenance and soil nutrients and also their genetic heritage will be preserved. It has been found that farmers themselves are buying these crops from the market at excessive price for self-consumption purpose and city people are also developing a taste for these crops due to their beneficial effects in some disorders such as diabetes, obesity, arthritis etc.

Most of the farmers have switched to cultivating cash crops (e.g. cabbage, capsicum, cauliflower, potato, pea, soybean and tomato) because these crops have good demand in market and thus, make the farmer financially more secure after crop harvest. Further, the crop loan and insurance for these crops are easily available as compared to indigenous crops. However, these cash crops have some drawbacks also, such as farmers use hybrid seeds, which are costly and during each sowing the seeds have to be bought again and again by the farmer. Further, these cash crops require more fertilizers and are labour intensive. Increase in usage of chemical fertilizer will acidify the crop fields and consequently, after some years of good yield the productivity will decline. It was reported by high altitude village farmers (Sukki and Jhala) that their main income source are cash crops (apple, potato, kidney bean and amaranth) and if they stop cultivating these crops then their financial system will crash.

The agriculture done by the people in the valley is generally traditional (i.e. not utilizing much scientific methodology) and mostly done for sustenance purpose. Presently, the agriculture crops are grown as monoculture on agriculture field in the Gangotri valley and thus, there is increase in incidence of disease attack on crop plants, decline in crop specific nutrients of soil, decrease in bio-diversity and heavy use of fertilizers and crop protection chemicals thus, causing environmental deterioration. One solution could be to employ the method of inter-cropping (mixed/multiple cropping), wherein two or more than two crops are grown simultaneously on the same piece of land.

If these indigenous crops are grown in a mix with other crops using appropriate technical guidance, then crop yield will improve and also there will be less attack of insect/pathogen. Further, cash crops cannot be ignored completely and therefore, these crops should be grown in combination with indigenous crops, which are nutritious and cheap and thus, are in reach of monetary poor people. To improve the agriculture condition, some agroforestry tree species should also be promoted among the farmers so as to reduce the burden of farmers for relying solely on the agriculture crops for their daily domestic needs.

Conclusion

The study concludes that with increase in altitude there is decrease in crop-biodiversity. The study finds that there is decrease in cultivated area of indigenous crops and also farmers are abandoning agriculture due to financial uncertainty in agriculture and preferring jobs, which offer a secure capital. Thus, in order to uplift the status of farmer modern agriculture techniques with traditional knowledge should be combined in order to create a more feasible, and financially secure agro-ecosystem.

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Conflict of interest

Author declares there is no conflict of interest in publishing the article.

References

1. FAO. State of the World's Forests 2016. Forests and agriculture: land-use challenges and opportunities. Food and Agriculture Organization of the United Nations, Rome; 2016. 107. p.
2. Rawat VS. Land utilization farming with reference to Uttarkashi, the hilly district of Uttarakhand. *Researcher*. 2009;1(6):41–47.
3. Bisht C, Badoni A. Distribution and indigenous uses of some medicinal plants in district Uttarkashi, Uttarakhand, India. *Researcher*. 2009;1(6):38–40.
4. Bijalwan A, Singh S. Vegetational diversity along altitudinal gradients in the upper Yamuna forest division of Uttarakhand, India. *Asian Journal of Science and Technology*. 2013;4(3):28–32.
5. Bijalwan A, Dobriyal MJR. Geometry, distribution and regeneration pattern of trees in agroforestry systems along altitude and aspects in the upper Yamuna region of Uttarakhand Himalaya, India. *Applied Ecology and Environmental Sciences*. 2016;4(1):15–25.
6. Gaur RD. *Flora of the District Garhwal: North West Himalaya (with ethnobotanical Notes)*. Transmedia, Srinagar, Garhwal; 1999.