



Original Research Article

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Indigenous Agroforestry as a Source of Fodder in the Western Himalaya, India

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Abstract

The study conducted in Indigenous Agroforestry systems for six study sites in Tehri Garhwal and Uttarkashi districts of Uttarakhand, India revealed that Indigenous Agroforestry systems are significantly supplemented the fodder requirement of livestock during lean period and also reduced the biotic pressure on the forest. In this study, *Grewia optiva* was recorded as dominant fodder tree species in lower to middle Himalayan region, however, *Celtis australis*, *Morus serrata*, *Bauhinia variegata* and *Toona serrata* were also used for fodder purpose in the lower and middle elevations of the study area under Indigenous Agroforestry. Tree species like *Quercus leucotrichophora*, *Quercus floribunda* were used in middle to higher elevation under Indigenous Agroforestry as main fodder tree species.

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Keywords

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Introduction

In Garhwal Himalaya, India the presence of trees on the proximity of agricultural farm boundaries and homesteads intends to increase the amount of production of fuel, fodder, fruits etc. However, the present existing practices of indigenous agroforestry techniques applied by the farmers appear to be poorly developed and exploitative. In majority of cases, the trees existing on traditional agroforestry practices are useful for the fodder production and therefore these trees are deliberately retained on the farm land. The foliage of tree present on farm land forms the alternative source of green fodder (Pandey and Singh, 1984) on one hand and supplements fuel and fruits on other. Similar facts supported by a study conducted in Western Himalaya stated that among fodder trees, *Grewia optiva*

contributed the maximum net primary productivity, followed by *Toona ciliata* and *Bauhinia variegata*. The *Grewia optiva* is an early successional species which gains better height and diameter by exploiting the high light regime (Khosla et al., 1995).

Materials and methods

The study was conducted in Indigenous Agroforestry systems along change in altitude and aspects in the hills of Garhwal Himalaya, India. The study comprised six study sites each in district Tehri Garhwal and Uttarkashi of Uttarakhand state in India varying altitudinal ranges of 1000 to 1500m, 1500 to 2000m and 2000 to 2500m asl covering northern and southern aspects (D₁E₁N₁, D₁E₁S₁, D₁E₂N₂, D₁E₂S₂, D₁E₃N₃, D₁E₃S₃). The area spread between sub-tropical to temperate zone (1000 to

2500m asl), with an average annual rainfall of 1200mm and the mean annual temperature ranging from 8°C to 35°C.

The main agricultural crops grown in these indigenous agroforestry systems of the selected areas are barnyard millet, finger millet, horse gram, soybean, etc during Kharif season and wheat, lentil, mustard, etc during Rabi season. Vegetable cultivation is restricted mostly to potato, pea, tomato, cucumber, radish, rye etc and that too, is restricted to homestead level only. Fruit tree comprising mainly of apple, apricot, citrus, peach, plum, walnut, guava, are grown sporadically near the habitation for meeting domestic requirements. The indigenous agroforestry systems are consisted of the fodder tree species like *Grewia optiva*, *Celtis australis*, *Ficus palmata*, *Toona ciliata*, *Bauhinia* spp. in the low to middle Himalayan region and *Quercus leucotrichophora* and *Quercus floribunda* in the higher Himalayan region. The fodder requirement was based on the daily consumption of fodder in the village, which was calculated on cow unit basis. The cow unit refers to: 1 cow/bullock = 1 cow unit, 1 buffalo = 2 cow unit, 1 goat/sheep = 0.5 cow unit (Khanna, 1982). The demand of fodder (tree fodder, grass, agricultural residue) was calculated separately for the summer and winter seasons.

The fodder consumption was based on the habit of the animal and season. The fodder collected from the adjoining forest area, fodder from the trees of the existing agroforestry system, residues of agricultural crops and grass in agricultural fields and forest area were calculated using feedback from the questionnaires. The daily fodder consumption pattern was calculated as:

Daily fodder consumption of the village =

$$\frac{\text{Quantity of fodder consumed daily per family}}{\text{No. of cattle per family}} \times \text{No. of cattle per village}$$

Results and discussion

The fodder used by the villagers to feed their livestock was mainly supplied from tree leaves, either from the adjoining forest or from the existing agroforestry systems. Generally, the demand of green fodder was met from the forest and agricultural fields, while the requirement of dry fodder was fulfilled by the preserved grasses (locally known as purelda) and straw of agriculture crops preserved in the form of hay and silage. The season also played an important role in the

availability of fodder. In summer season the fodder is easily available but in winter there is scarcity of fodder due to the leaf fall in trees (Samant et al., 2007) and grasses are also not available in sufficient quantity to supply the fodder requirement. At that time this fodder requirement was fulfilled by some of the tree leaves, present on the agroforestry systems. This utilization pattern of tree species for fuel and fodder purpose varies from place to place and from lower to higher elevation sites. This utilization pattern also depends upon the availability of the tree species and seasonal variation (Rawat and Vishwakarma, 2011).

In a study, it was observed that mainly *Grewia optiva*, *Celtis auatralis* and *Bauhinia variegata* were used for the fodder purpose in the lower elevation, while in middle elevation *Quercus leucotrichophora*, *Grewia optiva*, *Celtis auatralis*, *Bauhinia variegata* were used however, in higher elevation *Quercus floribunda* and *Quercus leucotrichophora* were used for the fodder purpose in the Garhwal Himalaya (Purohit and Samant, 1995). Similarly the stored dry grasses after mixing it with agriculture crops residue mainly of *Eleusine coracana* (finger millet) and *Echinochloa frumentacea* (barnyard millet) are also used to feed livestock during lean period.

The data recorded in Table 1 shows that the utilization of tree fodder in Tehri district varied from 510.00 kg/day/village to 790.00 kg/day/village in the summer and 620.00 kg/day/village to 1350.00 kg/day/village in the winter season. These calculations are made on the basis of livestock population. Supplementation of fodder from the existing agroforestry systems was 30-70 per cent in summer and 40-90 per cent in winter. Trees present on agriculture fields, supplement the fodder substantially, although fodder production depends upon the nature and number of the palatable species available in the agroforestry systems. In indigenous agroforestry systems fodder production was also an option for village women to reduce their labor, which traveled daily long distance, only for fodder collection even at some places twice in a day. These indigenous agroforestry systems supported villagers largely in lean period when there was scarcity of fodder. In study area *Grewia optiva* is considered as a best green fodder providing during winter season, when no other green fodder is available but this is restricted to the height of 1600m. In a study by Tewari (1995) *Celtis australis* is also a good fodder provider tree for summer season than in autumn in the middle Himalayan region.

Table 1. Seasonal fodder consumption pattern in the selected Agroforestry sites of Tehri District.

Site	Fodder wood consumption								Tree based fodder supplemented by existing AF trees (%)	
	Tree fodder				Other (grass, agriculture residue etc)					
	Kg/day/cattle head		Kg/day/village		Kg/day/cattle head		Kg/day/village		Summer	Winter
	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter		
D ₁ E ₁ N ₁	4.75 ± 0.31	6.85 ± 1.01	790.00	1050.00	4.10 ± 0.26	2.55 ± 0.11	870.00	590.00	30-40	50-60
D ₁ E ₁ S ₁	4.45 ± 0.09	7.30 ± 0.06	635.00	1350.00	4.50 ± 0.20	3.20 ± 0.18	770.00	523.00	30-50	40-70
D ₁ E ₂ N ₂	3.10 ± 0.27	8.10 ± 0.13	590.00	620.00	4.20 ± 0.22	3.20 ± 0.11	945.00	533.00	40-60	60-80
D ₁ E ₂ S ₂	4.90 ± 0.13	6.15 ± 0.33	785.00	970.00	5.60 ± 0.29	3.25 ± 0.46	825.00	624.00	50-70	60-80
D ₁ E ₃ N ₃	4.12 ± 0.39	7.25 ± 0.37	510.00	620.00	3.50 ± 0.22	2.60 ± 0.19	794.00	650.00	30-40	50-80
D ₁ E ₃ S ₃	5.90 ± 0.43	8.80 ± 0.38	610.00	780.87	4.90 ± 0.42	1.99 ± 0.19	675.00	490.00	40-60	70-90

Table 2. Seasonal fodder consumption pattern in the selected Agroforestry sites of Uttarkashi District.

Site	Fodder wood consumption								Tree based fodder supplemented by existing AF trees (%)	
	Tree fodder				Other (grass, agriculture residue etc)					
	Kg/day/cattle head		Kg/day/village		Kg/day/cattle head		Kg/day/village		Summer	Winter
	Summer	Winter	Summer	Winter	Summer	Winter	Summer	Winter		
D ₂ E ₁ N ₁	4.03 ± 0.23	5.62 ± 0.03	610.00	848.00	3.98 ± 0.02	3.02 ± 0.03	758.00	434.00	50-60	70-90
D ₂ E ₁ S ₁	4.98 ± 0.02	6.01 ± 0.02	875.33	1568.21	5.40 ± 0.03	4.30 ± 0.08	1120.00	535.66	30-40	60-80
D ₂ E ₂ N ₂	2.98 ± 0.18	3.98 ± 0.34	597.00	889.00	4.02 ± 0.16	3.20 ± 0.11	856.34	625.30	40-80	60-90
D ₂ E ₂ S ₂	3.10 ± 0.03	4.02 ± 0.03	425.00	720.00	3.28 ± 0.04	5.05 ± 0.06	440.00	390.05	30-50	70-80
D ₂ E ₃ N ₃	4.91 ± 0.89	5.03 ± 1.04	748.00	1172.00	2.20 ± 0.62	4.10 ± 1.03	811.12	540.13	50-60	60-90
D ₂ E ₃ S ₃	5.10 ± 0.30	6.92 ± 0.08	680.00	1210.55	2.10 ± 0.03	1.06 ± 0.14	977.24	568.31	30-40	60-70

The average tree fodder requirement varied from 3.10 kg/day/cattle head to 5.90 kg/day/cattle head in summer and 6.15 kg/day/cattle head to 8.80 kg/day/cattle head in winter season in Tehri (Table 1). In a study by Khanduri et al. (2002) similar findings (5.74 kg/day/cattle head to 6.76 kg/day/cattle head) were also reported in the Kedarnath forest division of Rudraprayag district of Uttarakhand, India. Consumption of tree fodder and agriculture crop residue was almost same in the non grazing period. Generally livestock are allowed for open grazing for 6 to 7 hours in a day. At higher elevation this is very common where cultivated fields are low. According to Bhatt and Badoni, 1995, the unrestricted movement of livestock (open grazing) has been a long accepted practice in the Garhwal Himalaya, India.

Table 2 shows that the utilization of tree fodder in Uttarkashi district varied from 425.00 kg/day/village to 875.33 kg/day/village in the summer while in the winter season the fodder consumption varied from 720.00 kg/day/village to 1568.21 kg/day/village in the selected agroforestry sites. The average tree fodder requirement in Uttarkashi varied from 2.98 kg/day/cattle head to 5.10 kg/day/cattle head in summer and 3.98 kg/day/cattle head to 6.92 kg/day/cattle head in winter season. Indigenous agroforestry systems play an essential role in supplementation of fodder wood requirement (Rawat and Vishwakarma, 2011). In the study area general fodder resources were grasses, tree leaves, edible weeds from agriculture fields and other by product of agriculture crops like amaranths, rice, wheat, maize, pulses etc. In central Himalaya 36% fodder is obtained from byproducts of agriculture crops, 13% from private grasslands, 39% from community grazing site and 12% from forest area and by purchasing (Rawat and Vishwakarma, 2011). Mostly tree leaves were used for green fodder either from agroforestry systems or from adjacent forest area. In winter season when there was a scarcity of green fodder due to the fallen of the tree leaves, at that time fodder requirement was fulfilled by the tree leaves, present on the agroforestry systems.

Like in study area of Tehri, in Uttarkashi also *Grewia optiva* was dominant fodder tree species in lower and middle Himalayan region. Besides it, *Celtis australis*, *Morus serrata*, *Bauhinia variegata*, *Toona serrata*, *Quercus leucotrichophora* were also commonly used for fodder purpose in the lower and middle elevations of the study area. Tree species like *Ficus palmata*, *Morus serrata* were used as both fresh and dry fodder. In a similar trend it was cited that in Kullu valley leaves of

Aesculus indica, *Ficus palmata*, *Quercus leucotrichophora*, *Quercus floribunda*, *Grewia oppositifolia* were used for fodder purpose (Rawat, 2006; Rawat et al., 2006). In the elevation between 2000-2500m the species like *Quercus floribunda*, *Quercus semicarpifolia* are commonly used for the fodder purposes. Farmers of district Uttarkashi stored the dry grasses, mixed it with agriculture crops residue mainly of *Amaranthus caudatus* (Chaulai), *Eleusine coracana* (finger millet) and *Echinochloa frumentacea* (barnyard millet) to feed livestock during the lean period.

Conflict of interest statement

Author declares that there is no conflict of interest.

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