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Pattern of Fodder Utilization in Relation to Sustainability under Indigenous Agroforestry Systems, North-Western Himalaya, India

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Abstract

Livestock is considered one of the integral part of livelihood, which rely mostly on fodder extracted from forests, grasslands, agriculture and agroforestry. The diversity, distribution, production and utilization pattern of the fodder species is important for prioritization of fodder species along an altitudinal gradient, and conservation and management practices. Indigenous agroforestry systems in the region play an important role in sustaining the goods and services of ever-growing needs of the farmers. Nearly 89.44% of fodder was meeting out from internal sources (agroforestry, kitchen garden, cultivated grassland, horticulture, grass from forest and forest trees) remaining 10.56% was procured from external sources (purchased grass, feed and oil). Over all, per household per year 4.15 tonne of fodder was needed excluding amount of fodder through open grazing. In general, maximum species were lopped annually, except *Olea ferruginea, Quercus floribunda, Q. leucotrichophora* and *Salix fragilis,* which were lopped in an interval of three years. The present study reveals the status of fodder and its sustainability under different agroforestry systems.

Keywords: Diversity; Agroforestry; Fodder; Utilization; Conservation and management; Cold desert; North-Western Himalaya

Introduction

Indian Himalayan Region (IHR) supports diverse habitats, species, populations, communities and ecosystems. Vegetation is ranges from tropical to alpine types. It supports about 18,440 species of plants, of which about 8,000 species are angiosperm (Singh and Hajra, 1997). The goods and services such as fodder, fuelwood, wild edibles, medicine, house building, agricultural implements, religious and various other purposes are being used by local communities (Samant and Dhar, 1997). The farmers of the IHR are relatively poor and they rely for their sustenance on the bio-resource in one way and

other (Samant *et al.,* 2007). About 279 species of fodder are known from the west Himalaya (Samant, 1998). In the rural areas to feed the livestock, they mainly depend up on the forest based fodder, though some demands of fodder are meeting out from the agriculture and agroforestry systems (Purohit and Samant, 1998, Singh *et al.,* 1998). The poor quality of fodder is inadequate to maintain the body weight of livestock.

In the north-western Himalaya, farmers maintain naturally regenerating tree species, particularly on edges of terraces without any significant input of manpower. This system is called as indigenous agroforestry system (Ram and Singh, 1996, Vishvakarma *et al.,* 1998). The indigenous agroforestry system plays an important role in reducing pressure from forest resources in terms of fodder and fuelwood along with the site improvement (Ram and Ramakrishnan, 1988, Pathak, 1991, Maikhuri and Semwal, 1997). Tree fodder is valuable for temperate climate (Singh and Kanstra, 1981, Roder, 1992), particularly during winter months when green fodder is becomes scarcely available in quantity (Khanal and Subba, 2001, Subba *et al.,* 1994) and quality (Vishvakarma *et al.,* 1998, Roder *et al.,* 2003). Fodder availability and fodder quality declines with the onset of dry season. Fodder resources used during the winter are largely influenced by the prevailing cropping system, the environment and the type of minerals (Roder, 1992). In the Himachal Pradesh, fodder requirements of the cattle is met mainly through by-products of agriculture crop, forests (tree fodder and grasses from forest), tree fodder from agroforestry system and grazing the open pasture. Looking the priority of fodder, therefore, the present study was conducted on the diversity, distribution, utilization, conservation and management of fodder species.

Materials and Methods

Approaches and data analysis

After a thorough reconnaissance of the entire Kullu and Lahaul valleys, five indigenous agroforestry systems were selected for the present study namely, Khokhan (1300 m), Bhosh (1700 m) and Bhanara (2020 m) in the Kullu valley, and Hinsa (2700 m) and Jahlma (3000 m) in cold desert of the Lahaul valley. The present study was based on the extensive and intensive surveys conducted in the representative parts (80% households surveyed) of the Kullu and Lahaul valleys for documentation of all the fodder species found in the Kullu and Lahaul valleys.

The direct measurements were done for fodder production from each source. The collected bundles of fodder species were observed, weighed and species were indentified with the help of local flora (Aswal and Mehrotra, 1994, Dhaliwal and Sharma, 1999, Singh and Rawat, 2000, Sood *et al.,* 2001). Fodder collection sites were also visited along with villagers during collection of fodder to identify the fodder species. Nativity of the species was identified following Anonymous (1883-1970) and Samant (1998), and endemism was indentified based on distribution of the species. Similarly, summation of total productivity and availability (current year) from various sources was treated as total annual fodder production at village level. Data of fodder production were grouped into; (i) internal sources such as agroforestry (includes trees along terraces, agriculture crops,

grass in between interspaces of two terraces and cultivated grasslands), willow plantation, kitchen garden, and grass from natural forest, and (ii) external sources such as grass purchased from other villages or villagers, and feed and oil. Fodder requirement at per household level was also calculated. The information on local names, altitudinal range, lopping and feeding season, mode of use, life form, fodder, fodder production and other uses were gathered with the help of local knowledgeable people (male and female).

Results and Discussion

Land composition

Agroforestry system is more suitable practice for *ex-situ* and *in-situ* conservation of natural resources (Prasad, 1987). Agroforestry practices in the Himalayan region have been known since times of immemorial and many indigenous and exotic species of trees are grown (Nair, 1993). In the present study, agriculture was a predominant form of land use type in the entire Lahaul valley (Kuniyal *et al.,* 2004, Oinam *et al.,* 2005, Vishvakarma *et al.,* 2005) and in the Khokhan village of the Kullu valley (Singh and Ram, 1997, Singh *et al.,* 1997) (Figure 1).

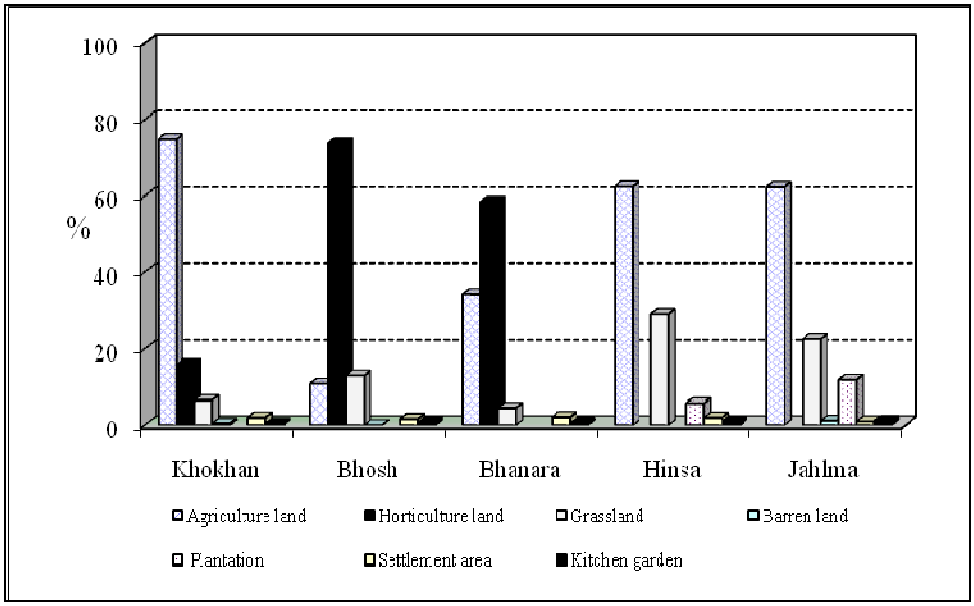

Figure 1 Land use composition in the Kullu and Lahaul valleys

In the both villages of the Lahaul valley, about 62% revenue area and about 75% in the Khokhan was under agriculture. At Bhosh and Bhanara villages, horticulture was a predominant land use type. In Bhosh, 47.59% and Bhanara 35.53% of horticulture crop was raised on agriculture field, and 26.11% and 22.13% horticulture, respectively of Bhosh and Bhanara were on grassland. Therefore, areas of both agriculture and grassland were declined and horticulture area was increased. In the Kullu valley, agriculture and grassland areas are being converted into horticulture area (Singh and Ram, 1997). At

Bhanara and Bhosh villages, even wet rice fields (*locally called rope*) are also drastically changing into horticulture land. In the Lahaul valley, willow and poplar plantations are raised for fodder and fuelwood under resource crunch and barren landscape conditions of the valley (Rawat *et al.,* 2006). There was not much difference between per capita landholding size among the villages of the Kullu and Lahaul valleys; per capita landholding size ranges from 0.09 to 0.13 ha/capita in the villages.

Diversity, distribution, nativity and uses

The adequate information on fodder supply and demand is not available in the Kullu and Lahaul valleys. Therefore, the present study provides comprehensive information on demand and supply, diversity, distribution and utilization pattern of fodder species. An inventory of plant species of five indigenous agroforestry systems was prepared (Table 1). The distribution of fodder species along an altitudinal gradient ranged between 900-3800 m. The trees included deciduous and evergreen species, and most of the fodder species are native to the Himalayan region and neighbouring countries. Total 67 plant species were recorded. Out of these, 43.28% trees, 26.87% small trees and 29.85% were shrubs. It was observed that the diversity of fodder species decreased with increasing altitude (Samant, 1998). Among all the five agroforestry systems contribution of trees was highest of 45.00% at Khokhan and lowest 31.82% at Hinsa. Indigenous agroforestry system of Khokhan was dominated by *G. oppositifolia.* However, *Q. floribunda* was dominant species at Bhosh and Bhanara villages. The important species in the Lahaul valley were *S. fragilis*, *Hippophae rhamnoides*, *Juglans regia*, *Populus nigra, Prunus armeniaca, P. cornuta* and *Prunus communis*. *S. fragilis* was a major contributor of fuelwood and fodder under the cold desert agroforestry system of the Lahaul valley. *Morus serrata*, *R. pseudoacasia* and *S. wallichiana* were common species found in all the three villages of the Kullu valley, whereas, *S. fragilis*, *F. xanthoxyloides* and *P. cornuta* were common species at both villages of the Lahaul valley (Rawat *et al.,* 2006). The high diversity of the species between 1801-2600 m may be due to mild climatic conditions and diverse habitats supporting a wide range of plant species used by human population as fodder to feed their livestock, whereas, low diversity in the higher altitudes may be due to severe climatic conditions not conducive for the germination and growth of the sensitive species (Samant, 1998, Samant *et al.,* 2007).

Fooder production

Indigenous agroforestry systems in the Kullu and Lahaul valleys play a pivotal role in fulfilling the subsistence requirement of people. Major proportion of fodder was come out from agroforestry system in the both valleys. In general, major fodder resources of the Kullu and Lahaul valleys were grasses, tree fodder, cultivated grassland, edible weeds from cropped lands, by-product of traditional crops like maize, rice, wheat, pulses, chenopods, buckwheat and cash crops like pea, potato and hops. During winter, coppice of willow trees were pollard and bark of coppices was peeled out. This bark and thinner parts of coppices around one centimeter diameter is given as green fodder to livestock, sheep and goat (Rawat *et al.,* 2006). Hay is prepared after harvesting the cultivated grasses in the months of September-October.

Table 1 Important plant species found under indigenous agroforestry systems of the Kullu and Lahaul valleys (Continuous)

S. No.	Name of species	Local name	Altitude (m)	Uses	Nativity
A. Trees					
1	*Abies pindrow* Royle	Rai	2100-3500	Fl., Ti.	Re. Himal.
2	*Aesculus indica* (Wall. ex Camb.) Hook.	Khanor	1700-2500	Fl., Fd., Med., Ed.	Reg. Himal.
3	*Alnus nitida* Endl.	Kosh	1000-3000	Fl, Ti., Agr. Imp., NF.	Reg. Himal.
4	*Bombax ceiba* L.	Semal	1200-2600	Fl., Fd., Med., Ed.	Am. Austr.
5	*Cedrus deodara* G. Don	Devdar	1800-3000	Fl., Ti.	Reg. Himal.
6	*Celtis australis* L.	Kharak	800-2000	Fl., Fd., Ed.	Eu. As. Temp. Ind. Or.
7	*Dalbergia sisoo* Roxb.	Shisham	900-1800	Fl., Ti, NF	Ind. Or. Afghan.
8	*Grewia oppositifolia* Roxb.	Beul	800-2000	Fl., Fd., Fib., Ed.	Reg. Himal.
9	*Juglans regia* L.	Akhrot	1000-3000	Fr., Ti.	As Occ. Reg. Himal.
10	*Juniperus macropoda* Boiss.	Shur	2600-4000	Inc., Aes.	Persia, Reg. Himal.
11	*Malus baccata* (L.) Borkh.	Lijo	2400-3000	Fl., Fd., Ed.	Reg. Himal. As Bor.
12	*Melia azedarach* L.	Baij/Drack	1200-2600	Fl, Fd., Med.	Reg. Himal. (alibicult)
13	*Morus serrata* Roxb.	Toot/Sahtoot	1000-2200	Fl., Fd., Med., Ed.	Reg. Himal.
14	*Olea ferruginea* Royle	Kahoo	1200-2500	Fl., Fd., Med.	Reg. Oriens
15	*Pinus wallichiana* A.B. Jackson	Kail	1700-3000	Fl., Ti.	Reg. Himal.
16	*Pistacia integerrima* (Stewart.)Rech.	Kakar Singi	1200-2500	Fl., Fd., Med.	China
17	*Populus ciliata* Royle	Poplar	1800-3000	Fl., Ti.	Reg. Himal. Illus
18	*Populus nigra* L.	Poplar	1500-3500	Fl., Ti.	Reg. Himal.
19	*Prunus cornuta* (Wall. ex Royle) Stued	Kurun/Jamun	2500-3500	Fl., Fd., Ed.	Europe As. Bor.
20	*Quercus floribunda* (Lindl.)	Mor	1200-3000	Fl., Fd., Ti., Agr. Imp.	Reg. Himal.
21	*Quercus leucotrichophora* A. Camus	Bon	1200-2500	Fl., Fd., Ti., Agr. Imp.	Reg. Himal.
22	*Robinia pseudoacacia* L.	Kikar	1000-3000	Fl., Fd., Rec.	Am. Bor.
23	*Salix wallichiana* Anderss.	Buins	1200-2000	Fl, Fd. Rec.	Reg. Himal.

Continued..

Table 1 continued

S. No.	Name of species	Local name	Altitude (m)	Uses	Nativity
24	*Salix fragilis* L.	Beli	2400-3600	Fl., Fd., Tim., Agr. Impl., Rec.	Europe As Bor.
25	*Sapindus mukorossi* Gaertn.	Doda	Upto 1500	Fl., Fd., Wa., Cl.	As. Trop.
26	*Toona serrata* (Royle) M. Roem.	Daral	2000-2800	Fl., Fd., Ti.	Malaya Australia
27	*Ulmus villosa* Brandis	Kashau/Hamber	1200-2500	Fl., Fd., Ti.	Europe As Bor.
28	*Ulmus wallichiana* Planch.	Mahun	1000-2000	Fl, Fd.	Ind. or.
29	*Rhus punjabensis* Stewart ex Brandis	Karvi Copi	1500-2200	Fl., Med.	Reg. Himal.
B. Small trees					
1	*Citrus limonum* (RISSO)	Nimbu	1000-2000	Fr.	As Trop.
2	*Crataegus songarica* C.Koch.	Pingyat	2400-3500	Fl, Fd., Ed., Ti.	Europe as Temp.
3	*Ficus palmata* Forsk.	Phagra	800-2000	Fl, Fd., Med., Ed.	Afr. Trop. Arab.; Ind. or.
4	*Fraxinus xanthoxyloides* (D.Don) DC.	Chhum/Sanjal	2400-3000	Fl., Fd., Med. Agr. Imp.	Reg. Himal.
5	*Prunus amygdalus* Batsch	Badam	1500-2200	Fr.	Middle East
6	*Prunus armeniaca* L.[1]	Khumani	1500-3000	Fr.	Reg. Caucas
7	*Prunus armeniaca* L.[2]	Khumani karvi	1500-3000	Fr.	
8	*Prunus avium* L.	Chery	2000-3000	Fr.	Reg. Himal.
9	*Prunus domestica* L.	Plum	1500-3000	Fr.	Europe.; Reg. Cauc.
10	*Prunus persica* (L.) Batsch	Aru	1500-3000	Fr.	Reg. Himal.
11	*Prunus prostrata* Labill.	Ralyo	2400-3300	Fl., Fd., Ed.	Reg. Mediterri; Oriens
12	*Punica granatum* L.	Anar	1000-2000	Fr.	Europe austr. Maurit
13	*Pyrus communis* L.	Nashpati	1000-2000	Fr.	Europe, As. Bor.; Reg. Himal.
14	*Pyrus malus* L.	Seb	1300-3000	Fr.	Europe, As. Bor.; Reg. Himal.
15	*Pyrus pashia* L.	Segal	1000-2000	Fl., Fd., Med., Ed.	Reg. Himal.
16	*Salix acmophylla* Boiss.	Jangli Beli	2400-3500	Fl., Fd.	Oriens; Ind. or
17	*Diospyros kaki* L.	Japani	1500-2500	Fr.	An. Bor.

Continued..

Table 1 continued

S. No.	Name of species	Local name	Altitude (m)	Uses	Nativity
18	*Cydonia oblonga* Mill.	Bee Dana	1500-2500	Fr.	Reg. Mediterr. Et Cauc
C. Shrubs					
1	*Berberis chitria* Lindl.	Kingor	1000-2500	Fl., Med., Ed.	Ind. or.
2	*Berberis jaeschkeana* Schneid.	Kyamali	2400-3800	Fl., Med., Ed.	Reg. Himal.
3	*Berberis pseudumbellata* Parker	Kyamali	2400-3800	Fl., Med., Ed.	Himal. bor. Occ
4	*Cotoneaster bacillaris* Wall. ex Lindl.	Ruins	2400-3800	Fl., Fd., Ti.	Reg. Himal.
5	*Cotoneaster pruinosus* Klotz.	Roktali	2400-3800	Fl., Fd.	Reg. Himal.
6	*Hippophae rhamnoides* L.	Sarla, Chharma	2400-3800	Fl., Fd., Ti., Med., Rec., Fen	U.S.S.R, Afghanistan, India, W. Pakistan, Tibet, Mongolia
7	*Indigofera heterantha* Wall. ex Brandis	Kali Kathi	2400-3800	Fl., Fd.	Reg. Himal.
8	*Juniperus communis* L.var. saxatilis Pallas	Path/Bithar	2500-3800	Fl., Med.	Reg. Bor. Temp. et arit
9	*Lonicera hypoleuca* Decne.	Kharmu	2400-3500	Fl., Fd.	Reg. Himal.
10	*Prinsepia utilis* Royle	Bhenkul	900-2000	Fl., Fd.	Reg. Himal.
11	*Rhamnus triqueter* (Wall. ex Roxb.) Lawon	Kuja/Chamso	1500-3500	Fl., Fd., Ti.	Reg. Himal.
12	*Ribes alpestre* Decne.	Pilikcha	2400-3500	Fl., Fd.	Reg. Himal., Euop.; Afr. Bor.;
13	*Ribes orientale* Desf.	-	2400-3500	Fl., Fd.	Oriens; Reg. Himal.
14	*Rosa webbiana* Wall. ex Royle	Shyabala	2200-3500	Aes., Fl., Fd.	Reg. Himal.
15	*Rosa macrophylla* Lindl.	Kuja	900-2200	Fl, Fd., Fen.	Reg. Himal., China
16	*Rubus ellipticus* Smith	Aachha	1200-2200	Fl., Ed.	Ind. or.
17	*Salix daphnoides* Vill.	Jangli Beli	2400-3600	Fl., Fd., Ba.	Europe; As bor.
18	*Syringa emodi* Wall. ex Royle	Pashu	2400-3300	Fl., Fd.	Reg, Himal.
19	*Zanthoxylum armatum* DC.	Timber	1500-2500	Fl., Med.	Reg. Himal. China
20	*Ziziphus oxyphylla* Edgew.	Ber	900-2000	Fl., Ed.	Reg. Himal.

[1]Wild variety
[2]Sweet variety grafted on wild variety

Abbreviations used: Reg. Himal.=Himalayan Region, Ind Or=Indian Oriental, Bor=Borealis, Temp=Temperate, Arct=Arctic, et=And, As=Asia, Centr=Central, Afr=Africa, Geront=Gerontia,

Trop=Tropical, Amphig=Amphigaea, Austr=Australia, Am=America, N. Zel.= New Zealand, Orient=Oriental, Cosmop=Cosmopolitan, Occ=Occidentalis, Afghan=Afghanistan, Turkist=Turkistan, Arab=Arabia, Subtrop=Subtropical, Hisp=Hispan, Min=Minor, Polynes=Polynesia, Madag=Madagascar, Alger=Algeria,

Aes=Aesthetic, Agr. Imp. = Agricultural Implements, Ba. = Basket, Fen. =Fencing, Cl.=Cleaning, Ed.=Edible, Fd.=Fodder, Fl.=Fuel, Fib. =Fiber, Fr.=Fruit, Inc.= Incense, Med.=Medicinal, NF. =Nitrogen Fixing, Rec.= Reclamation, Ti=Timber, Was. =Washing

On the basis of present study, total (1108.13 tonne) fodder was needed as annual fodder requirement for total 267 households of the five study villages. Out of 1108.13 tonne fodder, nearly 89.44% came from agroforestry, kitchen garden, cultivated grassland, horticulture, grass from forest and forest trees. The remaining 10.56% was procured from external sources (Table 2).

Table 2 Fodder production (%) from various sources under agroforestry systems of the Kullu and Lahaul valleys

Sources of fodder	**Kullu**			**Lahaul**		**Per HH#/tonne/Yr**
A. Fodder from internal sources	**Khokhan**	**Bhosh**	**Bhanara**	**Hinsa**	**Jahlma**	
Agroforestry	74.12	74.06	55.95	78.01	77.41	3.03
Willow (*Salix*) forestry	–	–	–	16.05	16.91	0.24
Kitchen garden	0.35	0.55	0.91	0.31	0.32	0.02
Grass land (Separate)	3.37	6.96	3.55	–	–	0.11
Fodder from horticulture	1.14	2.99	17.79	–	–	0.13
Grass from forest	4.65	–	–	–	–	0.08
Tree fodder from forest	3.89	2.08	6.46	–	–	0.11
B. Fodder from external sources	12.47	13.36	15.34	5.63	5.36	0.44
Purchased grass	5.12	4.23	3.95	1.32	0.41	0.14
Feed	7.36	9.13	11.26	4.26	4.94	0.30
Oil	0.002	–	0.14	0.05	0.01	0.001
Total fodder (tonne)	(100.0) 444.73	(100.0) 140.32	(100.0) 143.71	(100.0) 145.59	(100.0) 233.78	4.15
Actual need of fodder (tonne)	444.73	140.32	143.71	145.59	233.78	4.15

Animal feed (1bag=50kg)

Where: HH# household

In the Lahaul valley, about 16% of total fodder requirement came from willow forestry. Overall per household per year 4.15 tonne of fodder was needed excluding amount fodder through open grazing. As per an estimate a fodder requirements of 14.65 tonne dry weight ha^{-1} yr^{-1}, in central Himalaya is met through different sources *i.e.* 36% crop by-products, 13% fodder harvested from private grasslands, 39% grazing (26% community grazing and 13% from private grasslands and crop-fields) (Negi and Bhatt, 1993) and remaining 12% by harvesting from forest and purchased feed, *etc*. Out of remaining 12%, 6% demand was met from the ground vegetation of forest. In the Kullu valley, 2.95 tonne/household/year fodder was produced from agroforestry system, whereas, 3.17 tonne/household/year was produced in the Lahaul valley under

agroforestry system. It was also observed that in the area, where, horticulture were well developed, pressure on forest trees were more for fodder as in case of Bhosh and Bhanara. In the Kullu valley, fodder procurement from external sources was more than Lahaul valley. There was no any dedicated forestry system for fodder production in the Kullu valley (Vishvakarma *et al.,* 1998). In the Kullu valley, relatively higher proportion of area was under horticulture; under horticulture fodder production was quite less as compared to willow forestry (Rawat *et al.,* 2006). In general, contribution of agroforestry in the Kullu valley was slightly lower than contribution of same in the Lahaul valley.

Utilization pattern

Lopping period

The arrangement of different tree species under indigenous agroforestry systems, meets seasonal needs for food, fodder, fuelwood and other subsistence requirements. The lopping period varied from species to species. *M. serrata*, *R. pseudoacacia* and *S. wallichiana* were lopped during the months of June to November. *P. cornuta, Ulmus villosa, F. xanthoxyloides* and *P. prostrata* were lopped from July to October (Table 3). Some tree species lopped during the months of September-October, and dried the fodder in shade to maintain the fodder quality of fodder traditionally for prolonged winter. Fodder dried in shade is considered to maintain the quality, palatability and nutrition status of fodder. *G. oppositifolia, O. ferruginea, Q. floribunda* and *Q. leucotrichophora* in the Kullu valley and *S. fragilis* and *S. acmophylla* in the Lahaul valley were lopped from November to March. All the horticulture trees were pruned in the months of December and January. Fine portion of pruned material was given to cattle and thick branches were used as fuelwood. The lopping period of shrubs varies from place to place.

Seasonal utilization pattern

The utilization pattern of fodder species varied season to season, lower to higher elevations. The variation in utilization pattern is due to the availability of species in respective seasons (Samant *et al.,* 2007). Similarly, the use pattern varies from season to season. The most of the fodder species used in summer due to availability of deciduous species, however, the availability of fodder was scarce during winter, because of leaf fall (Samant *et al.,* 2007). Majority of the fodder species are used as multipurpose contributed to the high socio-economic values. Nutritious tree fodder is important for oxen at the time of ploughing. The nutritive values of *C. australis* 14.0%, crude protein, 50.8% nitrogen free extract and 11.9% crude fibre, *G. oppositifolia* crude protein 10.1% nitrogen free extract 54.8%, calcium 4.2% and phosphorous 10.3%, *Q. leucotrichophora* crude protein 9.5%, crude fiber 31.3% and nitrogen free extract 48.4% (Anonymous, 1970-1997, Purohit and Samant 1995). The nutritive fodder is required to the animals for growth, maintenance, production and reproduction. It is depend on to intake, chemical composition and digestibility factors (Gutteridge, 1995). Therefore, these species are required priority attention for mass multiplication and conservation (Bisht *et al.,* 1999). Utilization of appropriate fodder species at exact time makes livestock healthy (Rawat, 2006).

Table 3 Seasonal utilization pattern of important fodder species under agroforestry systems of the Kullu and Lahaul valleys (Continuous)

Summer	**Mode of use**	**Rainy**	**Mode of use**	**Winter**	**Mode of use**
A. Trees					
Bombax ceiba	F#	*Bombax ceiba*	F	*Aesculus indica*	D#
Celtis australis	F	*Celtis australis*	F	*Grewia oppositifolia*	F
Grewia oppositifolia	F	*Grewia oppositifolia*	F	*Morus serrata*	D
Malus baccata	F	*Malus baccata*	F	*Olea ferruginea*	F
Melia azedarach	F	*Melia azedarach*	F	*Pistacia integerrima*	D
Morus serrata	F	*Morus serrata*	F	*Quercus floribunda*	F
Robinia pseudoacacia	F	*Prunus cornuta*	F	*Quercus leucotrichophora*	F
Salix wallichiana	F	*Robinia pseudoacacia*	F	*Salix fragilis*	F
Toona serrata	F	*Salix wallichiana*	F	*Ulmus villosa*	D
		Toona serrata	F	*Ulmus wallichiana*	D
		Ulmus villosa	F		
		Ulmus wallichiana	F		
B. Small trees					
Crataegus songarica	F	*Crataegus songarica*	F	*Ficus palmata*	D
Fraxinus xanthoxyloides	F	*Fraxinus xanthoxyloides*	F	*Fraxinus xanthoxyloides*	D
		Prunus prostrata	F	*Prunus armeniaca*[1]	F
		Pyrus pashia	F	*Prunus armeniaca*[2]	F
				Prunus avium	F
				Prunus domestica	F
				Prunus persica	F
				Punica granatum	F
				Pyrus communis	F
				Pyrus malus	F
				Salix acmophylla	F
C. Shrubs[a]					
Hippophae rhamnoides	F	*Cotoneaster bacillaris*	F	*Salix daphnoides*	F
Indigofera heterantha	F	*Cotoneaster pruinosus*	F	*Hippophae rhamnoides*	F
Lonicera hypoleuca	F	*Hippophae rhamnoides*	F		
Prinsepia utilis	F	*Indigofera heterantha*	F		
Rhamnus triqueter	F	*Lonicera hypoleuca*	F		
Ribes alpestre	F	*Prinsepia utilis*	F		
Ribes orientale	F	*Rhamnus triqueter*	F		
Rosa macrophylla	F	*Ribes alpestre*	F		
Syringa emodi	F	*Ribes orientale*	F		
		Rosa macrophylla	F		
		Syringa emodi	F		

[1] Wild variety

[2] Sweet variety grafted on wild variety

a= Most of shrubs are fodder of sheep and goat

F# Fresh, D# Dry

Tree species such as *F. palmata*, *M. serrata, U. villosa* and *U. wallichiana,* were used both as fresh and dry in the Kullu valley; similarly *F. xanthoxyloides* is used both fresh and dry in the Lahaul valley (Table 3). Dry leaves of *Aesculus indica* and *Ficus palmata,* and fresh leaves of *G. oppositifolia*, *O. ferruginea, Pistacia integerrima*, *Q. floribunda* and *Q. leucotrichophora* in the Kullu, and *S. fragilis* and *S. acmophylla* in the Lahaul valley were used during winter months (Rawat *et al.,* 2006; Rawat, 2006). Besides these, fine twigs of horticultural crops are served as fodder during winter. Shrubs were used as a fodder during summer season. The leaves of *A. indica, Crataegus songarica, F. palmata, F. xanthoxyloides, Malus baccata, P. integerrima, P. prostrata* and *Toona serrata* were fed to the sheep and goats, while, fodder obtained from the remaining species were given to all types of livestock.

There was not any special trend for feeding of grasses to the cattle. Fresh maize, barley, wheat, grass, weeds and tree fodder were used as fresh. Straw and husk of these were used as dry fodder. Fresh oat and hay, fresh barley and hay, fresh oat and paddy straw, fresh barley and paddy straw, fresh wheat and hay were prevalent mixture of fresh and dry fodder given to the animals. Grains of maize, barley, wheat, gram and soybean were also given to the cattle. It was given during winter to save them from prolong severe cold.

Conclusion

1. Need to promotion of protected plantation of preferred multipurpose fodder species in the programmes like afforestation, reforestation and forest rehabilitation with participatory approaches.
2. Studies on population, biomass and identification of biotechnological measures to improve germination, propagation and dissemination of know-how to the farmers are also necessary. There is a need to analyze the nutritive values of fodder species for the identification of quality fodder, prioritization and mass multiplication of these species as quality fodder can be done.
3. Capacity building and skill development of farmers are also required on mass multiplication, pollarding, coppicing, lopping and utilization pattern of fodder species. Studies on species wise quantum collection, species preference, probability of use and resource use index of the fodder species are needed.
4. More plants of *M. serrata, Q. leucotrichophora* and *Q. floribunda* are recommended to plant in the area like Bhosh and Bhanara (temperate), where, pressure on forest resources were more due to conversion of grassland and agricultural land in to horticulture land.

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