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Farmers' preference of fodder trees in mid hills of Uttarakhand: a comprehensive ranking using analytical hierarchy process

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Abstract
Fodder trees are playing a crucial role to meet the deficiency of animal feeds in hilly areas during the winter season and lean period. To know the preference of hill farmers about the hill fodder trees, a study was conducted in mid hills of Almora district during 2015-16. Based on five parameters *viz.,* i) palatability ii) ease of propagation iii) growth rates iv) frost resistance and v) forage yield, the 14 most popular fodder tree species were ranked based on multi criteria decision making technique analytical hierarchy process (AHP). The study revealed that majority of the farmers view was with *Grewia optiva* and *Quercus leucotrichophora* as superior than other species for the parameter palatability, faster growth, ease of propagation and forage yield. The overall scores of analysis indicated about *Quercus leucotrichophora*, *Ehretia Laevis*, *Prunus cerasoides* and *Grewia optiva* as most preferred fodder trees. In this study for all the parameters, the consistency ratio was less than 0.1. The results could be used for fodder tree distribution and promotion programme and policy for mid hills of Himalaya.

Keywords: Forage, Himalaya, Multi criteria decision making, Preference ranking

Introduction

India has large livestock population of about 530 million and is expected to grow at the rate of 0.55% in coming years. But the average yield of milk and meat is 20-60% lower than the world average (Ghosh *et al*., 2014). Livestock has remained as a crucial part of the traditional agricultural systems in hilly regions of Indian Himalaya. It has played a most important role in generating hill farmers' income through the production of milk, meat, butter, hides or skin, wool, compost manure, and others. However, the scenario in hills of Indian Himalaya is far inferior due to low productivity of hill native animals. Apart from quality, the potential of breeds are not fully realized because of constraint related to feeding and health management (Satyapriya *et al*., 2013). Availability of insufficient and low quality feeds and fodders especially during the winter season (Pandey *et al.,* 1998) are most critical hindering factor for feeding management. Hence, fodder trees from forests, terries riser and agricultural lands play major role to meet the deficiency of animal feeds in hilly areas (Dhungana *et al*., 2012; Yadav and Bisht, 2013).

Fodder tree is valuable in the hills especially during winter and summer months when very less availability of green forage in both quantity and quality. In general, fodder tree leaves contain higher calcium and protein compared to grasses and straws (Rana *et al*., 1999; Azim *et al*., 2011) and a wide range of fodder trees have been utilized by the ruminants as a major source of feeding materials. Fodder trees provide about 40% of the total annual fodder demand of the ruminants in the hills (Malla, 2004). This emphasizes the needs of promoting and developing ranges of fodder trees as important source of feeding materials especially for ruminants in mid hills of Himalaya.

There are more than thirty major fodder trees are cultivated in mid hills of Uttarakhand. Farmers during dry season are travelling miles for collection of fodder. There are several studies on knowledge levels of farmers about feeds and fodder crops and variable responsible for that (Sonone *et al*., 2008; Lioutas *et al*., 2010; Singh *et al*., 2010, Satyapriya *et al*., 2010, 2013). Preferential studies have also been done on several aspects of forest and environmental issues (Paul *et al.,* 2017; Mooventhan *et al.,* 2016). Although very less study was found about the preference of farmers about fodder trees particularly in hills of Himalaya. But it is important to know the preference of hill farmers about the hill fodder trees so that, it can help in providing information for larger fodder plantation programmes and policies. Hence, the study was conducted to analyse farmers' preference of hill fodder trees. On the basis of survey most commonly used 14

multipurpose trees were identified in the entire study area of mid hills of northern western Himalaya.

Materials and Methods

Sampling sites and data collection: This study was carried out in Dal, Shitlakhet, Chan, Nau gaon villages of Almora district, mid hill area of Uttarakhnad (29°38'N, 79°37'E) during November 2015 to January 2016. The data were collected with a pre-tested interview schedule through personal interview and focused group approach. Out of 400 households of the study villages, a sample of 50 respondents was randomly selected for the study. The list of fodder trees grown in the study area was obtained through field observation, participatory discussion with lead farmers, tree owners and other key informants. For ranking of the fodder trees, criteria for preferring fodder species were developed by asking farmers to suggest important qualities of fodder of their choice. A total five important fodder tree parameters were selected for studying preference of particular species over other. The four parameters *viz.* i) palatability, ii) ease of propagation iii) growth rates and iv) frost sensitiveness were based on Dhungana *et al.* (2012) and in addition fifth parameter 'forage yield' was also selected based on its importance.

Statistical method: The weights for the parameters were calculated by utilizing analytical hierarchy process (AHP) technique. This method is based on pair-wise comparison and provides scenario checking ability to the researchers and thus helping to classify goals and ways in one complicated environment. In this study, fourteen trees were prioritized based on five parameters through AHP. A group of five farmers in ten batch were selected and administered with the AHP interview schedule. The AHP algorithm mainly consists of two parts: 1) construction of the pair-wise comparison and 2) prioritization of decision alternatives. The steps of AHP methodology followed in this research are:

Step 1: *Structuring of the decision problem into a hierarchical model*

In this step decomposition of the decision problem into elements according to their common characteristics and the formation of hierarchical model were done.

Step 2: *Constructing the pair-wise comparison matrix*

Two types of pair wise comparisons were made in the AHP. The first one was between the factor pairs within the same hierarchical level which involves analyst inputs of relative importance ratings based on the pair wise comparative ratings in a scale of 1 to 9. The factors weights were computed and used in the final hierarchical merit aggregation process.

The matrices of pair-wise comparisons are obtained.

In this matrix, the element $a_{ji} = \frac{1}{a_{ij}}$ and thus, when i=j a_{ij} =1. Every element in an upper level is used to compare with respect to the elements in the level below. This was done by pair-wise comparison two by two and through dedicating numeral scores which shows priority and majority between two decision elements.

$$A = (a_{ij}) = \begin{pmatrix} 1 & \frac{w_1}{w_2} & \cdots & \frac{w_1}{w_n} \\ \frac{w_2}{w_1} & 1 & \cdots & \frac{w_2}{w_n} \\ \vdots & \vdots & \ddots & \vdots \\ \frac{w_n}{w_1} & \frac{w_n}{w_2} & .... & 1 \end{pmatrix}$$

Step 3: *Calculating the consistency*

The traditional Eigen vector method is the weight vector that was our goal. It helps in measuring the consistency of the referees preference arranged in comparison matrix. The consistency index (CI) measures the degree of logical consistency among pair-wise comparisons. Saaty (1994) defined the consistency index (CI) as follows:

$$CI = \frac{\lambda_{\max} - 1}{n - 1}$$

Where, *n* is the number of existing items in the judgment matrix problem.

Consistency ratio (CR) indicates that the amount of allowed inconsistency *i.e.* (0.1 or 10%). It is calculated using the following formula:

$$CR = \frac{CI}{RI}$$

The value of the random index (RI) for matrices (Saaty, 2008) of order (n) was used in CR calculation.

Results and Discussion

Diversity, availability status and uses of fodder tree species in mid-hills of Himalaya: In the present study 14 tree species belonging to different families were recorded in the different area of the mid hill Himalaya (Table 1). Among the tree species four are evergreen and rest are deciduous in nature. The availability status, prevalence, nature and indigenous uses of the tree species were recorded. Most of the trees taken for this study are known in this area for their multipurpose uses such as medicinal value, timber, fuel and fodder purpose (Bhatt *et al.*, 2010; Ballabha *et al.*, 2013). The plants were divided into categories of abundant, common and rare based on their availability status; among these 5 species (*Celtis australis*, *Quercus leucotrichophora, Bauhinia retusa, Grewia optiva, Melia azedarach*) are abundant, 6 species (*Bauhinia variegate, Morus alba, Quercus glauca, Prunus cerasoide, Alnus nepalensi, Quercus serrata)* are common and 3 species (*Ehretia Laevis, Robinia pseudoacasia, Debregeasia longifolia*) are rare in this area. Prevalence of all the fourteen fodder trees found suitable for mid hills to high hills and there distribution ranged from 1200 to 2400 meter above mean sea level except tree species Khoda (*Ehretia Laevis)* which were distributed at near about below 1200 meter from sea level (Yadav and bisht, 2013; Ballabha *et al.*, 2013; Bhatt *et al.*, 2010)

Preference ranking of fodder trees: Farmers' preference status of fourteen fodder trees based on different criteria was recorded (Table 2). The study revealed that majority of the farmers agreed with Bhimal (*Grewia optiva*) as a highly preferred species followed by Banj (*Quercus leucotrichophora*) and Kachnar (*Bauhinia*

Table 1. Diversity, availability status and indigenous uses of the tree species in the mid-hills of Himalaya

Scientific Name	Local Name	Family	Prevalence (above msl)	Availability status
Bauhinia variegata L.	Kwiriyal	Caesalpiniaceae	800-2000 m	++
Celtis australis L.	Kharik	Caesalpiniaceae	Upto-2400 m	+++
Ehretia Laevis Roxb.	Chamror/Khoda	Ulmaceae	Upto-1200 m	+
Morus alba L.	Shahtoot	Betulaceae	Upto-1000 m	++
Robinia pseudoacasia L.	Robinia	Boraginaceae	1100-2400 m	+
Quercus glauca Thunb.	Phalyant	Urticaceae	800-2000 m	++
Prunus cerasoides D. Don	Padam	Tiliaceae	Upto-2400 m	++
Quercus leucotrichophora A. Camus	Banj	Meliaceae	1100-2000 m	+++
Alnus nepalensis Don	Uteesh	Moraceae	1000-2000 m	++
Debregeasia longifolia (Burm. f.) Wedd.	Tushar	Rosaceae	800-1500 m	+
Bauhinia retusa L.	Kachnar	Fagaceae	1000-1500 m	+++
Grewia optiva J. R. Drumtnond ex Burret	Bhimal	Fagaceae	800-1600 m	+++
Melia azedarach L.	Batain	Fagaceae	Upto-1400 m	+++
Quercus serrata Murray	Manipuri Oak	Papilionaceae	1000-1800 m	++

Scientific Name	Feeding Season	Nature	Indigenous use
Bauhinia variegata L.	Summer, rainy, autumn	Deciduous	Fd, Fu, Ti, Md
Celtis australis L.	Summer	Deciduous	Fd, Fu, F, Ti, Md
Ehretia Laevis Roxb.	Winter	Deciduous	Fd, Fu, Ti
Morus alba L.	Winter, summer	Deciduous	Fd, Fu, F, Ti, Md
Robinia pseudoacasia L.	Summer	Deciduous	Fd, Fu, Ti, Md
Quercus glauca Thunb.	Winter,summer	Evergreen	Fd, Fu, Ti, Md
Prunus cerasoides D. Don	Summer	Deciduous	Fd, Fu, Ti, Md
Quercus leucotrichophora A. Camus	Winter, summer	Evergreen	Fd, Fu, Ti, Md
Alnus nepalensis Don	Winter	Deciduous	Fd, Fu, Ti
Debregeasia longifolia (Burm. f.) Wedd.	Winter	Evergreen	Fd, Fu
Bauhinia retusa L.	Summer	Deciduous	Fd, Fu, Ti, Md
Grewia optiva J. R. Drumtnond ex Burret	Winter	Evergreen	Fd, Fu, Ti, Md
Melia azedarach L.	Summer	Deciduous	Fd, Fu, Ti, Md
Quercus serrata Murray	Summer	Deciduous	Fd, Fu, Ti

*+++ = Abundant, ++ = Common, + = Rare. Fd= Fodder; Fu= Fuel; F= Fruit; Md= Medicinal and Ti= Timber

Table 2. Criteria wise preference ranking of different fodder trees

Fodder tree	Mean score based ranking				
	Palatability	Ease of propagation	Growth rate	Frost sensitiveness	Forage yield (kg /tree / year)
Kwiriyal	IV (4.19)	IX (3.15)	VII (3.85)	XII (4.26)	VI (72.20)$
Kharik	IX (3.22)	XI (2.78)	XII (3.00)	V (3.16)	XIV (18.30)
Chamror/Khoda	XII (2.51)	X (3.00)	IX (3.59)	IV(3.00)	XIII (28.72)
Shahtoot	X (3.22)	VII (3.56)	X (3.40)	VIII (3.588)	III (102.96)
Robinia	X (3.22)	VIII (3.22)	XI (3.04)	IX (3.625)	XII (30.36)
Phalyant	V (3.80)	III (4.64)	IV (4.42)	X (4.000)	X (41.04)
Padam	VIII (3.38)	VI (4.34)	VI (4.02)	III (2.765)	VIII (54.70)
Banj	II (4.660	I (4.88)	II (4.88)	II (2.176)	I (118.70)
Uteesh	XIII (2.32)	XI (2.78)	VIII (3.78)	VI (3.167)	V (81.30)
Tushar	XI (2.78)	XI (2.78)	XIII (2.60)	I (1.882)	XI (35.60)
Kachnar	III (4.20)	II (4.78)	V (4.38)	XIV (4.900)	IV (85.90)
Bhimal	I (5.00)	II (4.78)	I (4.98)	XI (4.118)	II (115.40)
Batain	VII(3.54)	V(4.38)	IX (3.59)	XIII (4.840)	VII (72.00)
Manipuri oak	VI (3.66)	IV (4.40)	III (4.59)	VII (3.239)	IX (48.182)

*The figures in parentheses in column No. 3 to 6 represents the average ordinal scores values; $ indicate the fresh forage yield

retusa) whereas, Tushar (*Debregeasia longifolia*), Khoda (*Ehretia Laevis*) and Uteesh (*Alnus nepalensis*) were lowest preferred species for palatability criteria. Based on the different studies done by different research groups on nutritional analysis of different fodder tress available in the mid hill Himalaya, it was found that the crude protein content of Bhimal, Kachnar, Uteesh, Banj ranged from 10-20%, 15-18%, 15-21%, 10-15% and crude fibre content varied from 25-32%, 16-24%, 17-24%, 20-27%, respectively (Jarial *et al.*, 2013; Mondal *et al.*, 2016; NDDB, 2012). However, Banj (*Quercus leucotrichophora*), Kachnar (*Bauhinia retusa*) and Bhimal (*Grewia optiva*) were found to be highly preferred species for its propagation easiness, fast growth and highest forage yield. The mid hill area is affected by frost during December to mid-February. In this period due to frost injury a huge forage loss in the form of fodder leaves scorching occur in mid and high hills (> 2000 meters) of Himalaya. Accordingly a parameter on frost injury as pointed out by farmers was included in that study. As per farmers response Kachnar (*Bauhinia retusa* L.), Batain (*Melia azedarach* L.), Kwiriyal (*Bauhinia variegata* L.) etc. were preferred more due to their frost resistance. As per as forage yield was concerned, farmers harvested highest forages from Banj (118.70 kg) followed by Bhimal (115.40 kg), Sahtoot (102.96 kg), and Kachnar (85.90 kg) fresh leaves from a tree in a year.

The table 3 indicated the weights, consistency index and ratio values of selected fodder tree parameters. It was found that the yield parameter was weighted most (55%), followed by palatability (16.8%), frost sensitiveness (12.8 %) whereas, propagation was weighted least (4.1%). The result indicated about the importance of parameters as yield was most important parameters of any crop same as fodder followed by the palatability parameter as livestock's preference reflected through this parameter. Frost was an important criterion for hills and considered next.

Table 3. Weights, consistency index and ratio values of selected fodder tree parameters

Criteria	Weights (Eigen vectors)	CI	CR
Propagation	0.041	0.034	0.022
Growth rate	0.110	0.013	0.009
Palatability	0.168	0.002	0.001
Frost sensitiveness	0.128	0.007	0.004
Yield	0.550	0.016	0.010

For all these parameters consistency index and consistency ratio were calculated. Consistency ratio (CR) indicated that the amount of allowed inconsistency *i.e.* (0.1 or 10%). In this study for all of the parameters the CR was calculated less than 0.1 which means the comparisons were more consistent. The table 4 indicated the overall ranking of fodder tree based on AHP composite score. Based on the analysis it was found Banj ranked first with composite score 0.127 followed by Padam (0.125), Khoda (0.113) and Bhimal (0.108). Tushar, Robinia and Manipuri oak were found least preferred as per the analysis.

Table 4. Ranking of fodder tree based on AHP composite score

Fodder tree	Weights (Eigen vectors)					
	Palatability	Ease of propagation	Growth rate	Frost sensitiveness	Forage yield	Composite score
Tushar	0.025	0.013	0.016	0.019	0.034	0.028 (XIV)
Uteesh	0.022	0.018	0.061	0.046	0.062	0.051 (XII)
Khoda	0.025	0.016	0.056	0.037	0.177	0.113 (III)
Kharik	0.048	0.018	0.032	0.043	0.097	0.071 (V)
Robinia	0.041	0.021	0.032	0.064	0.026	0.034 (XIII)
Shehtoot	0.041	0.044	0.034	0.059	0.082	0.065 (VII)
Padam	0.051	0.059	0.070	0.028	0.186	0.125 (II)
Kwiriyal	0.111	0.034	0.049	0.108	0.041	0.062 (VIII)
Manipuri oak	0.056	0.093	0.100	0.045	0.030	0.047 (XII)
Batain	0.056	0.072	0.039	0.168	0.024	0.053 (X)
Oak/ Banj	0.154	0.195	0.145	0.020	0.134	0.127 (I)
Phalyant	0.074	0.115	0.098	0.084	0.023	0.052 (IX)
Kachnar	0.101	0.150	0.086	0.181	0.019	0.067 (VI)
Bhimal	0.193	0.154	0.182	0.098	0.065	0.108 (IV)

*Figures in parentheses indicates the ranks

Conclusion

The study revealed that majority of the farmers agreed with Bhimal (*Grewia optiva)* and Banj (*Quercus leucotrichophora)* were superior to other species for the parameter palatability, faster growth, ease of propagation and forage yield. The overall scores of analysis indicated about Banj *(Quercus leucotrichophora)*, Khoda *(Ehretia Laevis)*, Padam *(Prunus cerasoides)* and Bhimal *(Grewia optiva)* as most preferred fodder trees. For any fodder tree distribution and promotion programme these tree saplings could be used for wide acceptability and success in mid hills of Himalaya.

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References

Azim, A., S. Ghazanfar, A. Latif and M. A. Nadeem. 2011. Nutritional evaluation of some top fodder tree leaves and shrubs of district Chakwal, Pakistan in relation to ruminants requirements. *Pakistan Journal of Nutrition* 10: 54-59.

Ballabha, R., J. K. Tiwari and P. Tiwari. 2013. Diversity and indigenous uses of tree species in the vicinity of Srinagar hydroelectric power project in Alaknanda valley of Garhwal Himalaya, India. *Research Journal of Agriculture and Forestry Sciences* 1: 6-10.

Bhatt, V., V.K. Purohit and V. Negi. 2010. Multipurpose tree species of western Himalaya with an agroforestry prospective for rural needs. *Journal of American Science* 6: 73-80.

Dhungana, S., H. P. Tripathee, L. Puri, Y.P. Timilsina and K. P. Devkota. 2012. Nutritional analysis of locally preferred fodder trees of middle hills of Nepal: A case study from Hemja VDC, Kaski District. *Nepal Journal of Science and Technology* 13: 39-44.

Ghosh, P. K., H. V. Singh, S. K. Mahanta, R. V. Kumar, P. Sharma, M. M. Das and A. Singh. 2014. Fodder trees in India: A potential feed resources during drought and lean period. ICAR-IGFRI, Jhansi, India. pp. 170.

Jarial, S., A. Kumar and V. Padmakumar. 2013. Assessment of feeding practices, nutritional status and gap for dairy buffaloes in hilly districts Tehri Garhwal and Pithoragarh of Uttarakhand, India. *Indian Journal of Animal Sciences* 83: 960–963.

Lioutas, E. D. I., T. Kalogianni and C. Charatsari. 2010. Training needs and factors discouraging participation in agricultural education/training programs. *Livestock Research for Rural Development* 2: 51-55.

Malla, M. B. 2004. Chemical composition and feed value of fodder trees from Palpa District, Nepal. *Banko Jankari* 14: 27-30.

Mondal, T., R. P. Yadav, J. K. Bisht, V. S. Meena and S. Kumar. 2016. Nutritional analysis of locally preferred fodder trees leaf in mid hills of Himalaya. In: Proc. *International conference on Natural Resource Management Perspectives* (R. Peshin, A.K. Dhawan, F. Bano and K.S. Risam, eds.). *Indian Ecological Society*. February 18-20, pp. 436.

Mooventhan, P. K.S. Kadian, R. Senthilkumar, A. Manimaran, B.S. Meena and C. Karpagam. 2016. Assessment of tribal dairy farmers' perceived importance, level of awareness and constraints in the adoption of good feeding practices using exploratory factor analysis. *Range Management and Agroforestry* 37: 98-103.

NDDB. 2012. Nutritive value of commonly available feeds and fodders in India. National Dairy Development Board Annual Report. pp.34-69.

Pandey, S.B., R.C. Khanal and S.K. Khanal. 1998. Effect of feeding urea- molasses-mineral block (UMMB) on the performance of lactating cross Dairy cows. Technical Report. Nepal Agricultural Research Council, Animal Nutrition Division, Khumaltar, Lalitpur Nepal. pp. 3-10.

Paul, S., A.K.Tripathi., Burman R. Roy, M. Panggam, S.K. Ray, N. Kalita, R. Vanlalduati and A.K. Singh. 2017. Jhum cultivation and its consequences on forest and environment in eastern Himalayan tract of India: a participatory assessment. *Range Management and Agroforestry* 38: 121-126.

Rana, R.S. F., Yano, S.K. Khanal and S.B. Pandey. 1999. Crude protein and mineral content of some major fodder trees of Nepal. Lumle Agriculture Research Center, Nepal. pp. 99-113.

Saaty, T.L. 1994. How to make decision: the analytic hierarchy process. *Interfaces* 24: 19-43.

Saaty, T.L. 2008. Decision making with the analytic hierarchy process. *International Journal Services Sciences* 1: 83-98.

Satyapriya, R.K., Agrawal, P. Sharma, M. Singh and S. Kumar. 2013. Knowledge level of fodder cultivating farmers about berseem production technology. *Range Management and Agroforestry* 34: 73-76.

Satyapriya, R.K. Agrawal, P. Sharma, S. Pandey, N. Biradar and S. Radotra. 2010. Fodder and animal production technological gap analysis of resource poor farmers in Araria district of Bihar. *Range Management and Agroforestry Symposium Issue* (B): 188-189.

Singh, M., Satyapriya, P. Sharma, S. Pandey and J.P. Upadhyay. 2010. Extent of knowledge, skill and adoption of forage crops by the farmers in the disadvantaged region of Bundelkhand. *Range Management and Agroforestry Symposium Issue* (B): 161-162.

Sonone, S.R., S.B. Shinde, M.G. Mote and K.D. Chavan. 2008. Feeding practices of crossbred cattle in Indapur tahsil in Maharashtra. *Journal of Maharashtra Agricultural Universities* 33: 128-129.

Yadav, R.P and J.K. Bisht. 2013. Agroforestry: A way to conserve MPTs in north western Himalaya. *Research Journal of Agriculture and Forestry Sciences* 1: 8-13.