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Research Article

Participatory ranking of fodders in the western hills of Nepal

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ABSTRACT

Fodder is an important source of feed of the ruminants in Nepal. In the mid hills of Nepal, farmers generally practice integrated farming system that combines crop cultivation with livestock husbandry and agroforestry. Tree fodders are good sources of protein during the forage and green grass scarcity periods especially in dry season. Local communities possess indigenous knowledge for the selection of grasses and tree fodders at different seasons in mid hills of western Nepal. A study was conducted on the perception of farmers with respect to selection of fodder species in eight clusters in Kaski and Lumjung districts that range 900-2000 meter above sea level and receive average precipitation of 2000- 4500mm per annum. During the fodder preference ranking, farmers prepared the inventory of fodders found around the villages and nearby forests and selected top ten most important fodders in terms of their availability, palatability, fodder yield, milk yield and milk fat yield. In total, 23 top ranking fodders species were selected from the eight clusters. These fodder species were also ranked using pairwise ranking and weighted scoring methods and ranking was done on the basis of merit numbers obtained from weighted scores. The analysis revealed *Artocarpus lakoocha* as best tree fodder followed by *Ficus semicordata*, *Thysanolena maxima* and *Ficus calvata.* Similarly, the calendar of fodders trees for lopping season and the best feeding time was prepared on the basis of farmers' local knowledge. This study suggests strategies for promotion of locally preferred tree fodder species and supplementing tree fodder with feed in different seasons depending on their availability and local preferences.

Keywords: Participatory ranking, Fodders, Western hills, Nepal.

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INTRODUCTION

Widely used in the form of cut-and-carry systems, fodder trees are indispensable resources for Nepal's coupled crop-livestock system. During the lean winter and early spring months (October-May) when there is limited availability of forage grass, trees fodder and shrubs constitute an important source of animal feed. While crop residues are also used as supplement to animal feed, they have low nutrient content and add to problems of poor digestion. A survey of 2,185 livestock keepers in four districts (Chitwan, Nawalparasi, Kaski, and Lamjung) across the Gandaki River Basin (GRB) of Nepal reveals that majority (84 percent) of the surveyed households has fodder trees on their private land. However, if the crop byproducts are supplemented with fodder tree foliage, the efficiency of nutrient utilization, a measure of nutrient intake, improves for livestock (Khanal et al., 2007).

Given the obvious contribution of fodder trees in Nepal's coupled crop-livestock systems, the need to identify and promote important fodder used by farmers is crucial. Introducing fodder tree, especially the ones with greater nutrients and extended period of lopping, will alleviate the problem of fodder scarcity experienced by farmers, while simultaneously increasing livestock productivity and resiliency of crop-livestock system. Following a series of consultative meetings with government officials, interactions with local farmers and livestock herders, and our own observation we conducted a series of participatory action research in the two Hill districts (Kaski and Lamjung) of western Nepal. One of the activities during the action research was ranking of fodder trees based on farmer's knowledge and attitude on four attributes: palatability, fodder yield, milk yield and content of milk fat.

MATERIALS AND METHODS

The study was carried out across the two Hill districts of the Gandaki River Basin (GRB) of Gandaki province. The GRB is also a major river system and a significant tributary of the Ganges in India. The 19 districts that lie in the GRB cut across all three ecological regions: Mountain, Hill, and Terai. The district of Kaski and Lamjung represent the Hills. The field study was conducted in four Village Development Committees (VDCs)[1] of each district. Since the types of fodder and their availability closely follow the altitude, the selection of VDCs was based on the altitudinal gradient (strata) - lower, middle, and high Hills (see Table 1). For the purpose of focus group discussion, we selected approximately equal number of people (25) from each VDC and priority was given to longtime resident. We followed an informal, semi-structured discussion lasting 6-7 hours.

The sites were selected from the ranges of 900 meters to 2000 meters above sea level from Kaski to Lamjung districts. Weather patterns across GRB vary greatly depending on the season: pre-monsoon (spring), monsoon (summer), post-monsoon (fall), and winter. The mountains act as both a southern barrier to cold air to the north in central Asia during the winter season, and a northern barrier to the moist summer monsoon flow from the south. Approximately 80-90% of the annual precipitation falls during the four summer months – June to September. There is a strong seasonality of the availability of tree fodder and forages.

[1] A VDC is one of the smallest administrative units in Nepal. Each district is divided into several VDCs. Similar to municipality. A VDC is further divided into nine wards. Each ward constitutes one to a few villages.

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Table 1. Characteristics of survey sites

Regions	Location	Altitude ranges	Ethnicity	Type of livestock
Mid hills	**Kaski** (Pumdibhumdi, Chapakot, Mijure, Namarjung VDCs) and **Lamjung** (Paushgaun, Bhujung, Ghanpokhara, Khudi VDCs)	900-2000 masl	Gurung and mixed community	Cattle, buffaloes, sheep and goats,

We follow two-step approach: a) participatory ranking, and b) nutrient analysis of the fodder.

a: Participatory ranking*:* A total of eight focus groups discussions were conducted, four in each district, whereby 192 (65 female) farmers participated. Began with the preparation of the inventory of locally available fodder trees, the focus groups discussions lasted anywhere from 6-7 hours. After listing all the locally used fodder trees, the group discussed and ranked top ten fodders using their local knowledge. The listing was done using the five attributes: palatability, net fodder yield, milk yield, and milk fat content. In order to quantitatively rank the fodder species in question, we asked them to follow Likert scales – 1 to 5, 1 being the worst and 5 being the best in specific attribute. During the focus group discussion farmers also prepared seasonal calendar of the fodder species in question which included growing season, lopping season, and the best time to feed. After the completion of focused group discussion and ranking exercise, we prepared a weighted score to finally identify top ten fodders in the study sites. The weighted score is derived as follows:

$$\text{Weighted Score}=\sum_{1}^{n}\left({}^{Pij}/_{Pt}\right)*n$$

Where,
n= Number of cluster
P*ij*= Weighted value of fodder *i* compared with fodder ij(n-1), j≠i,
P*t* = Total weight on pair-wise comparison, P*t*=∑ P*ij*

We used SPSS (version 20) for the analysis of results, Sympson Index of Diversity and Chi-Square test for testing significance values.

b: Nutrient analysis of the fodder*:* While subjective in nature, during the focus group discussion, farmers noted a considerable variation in attributes of commonly available fodder trees. These variations have important implications for livestock productivity. It is therefore important to incorporate best of science and with local knowledge systems so that overall contribution of fodder trees to crop-livestock systems can be enhanced.

The significant differences between genotypes were determined using least significant difference (LSD) test at probability level of 0.01 or 0.05 where the effects of the treatments were significant at 1% or 5% level of probability, respectively (Gomez and Gomez, 1984; Shrestha, 2019; Devkota et al., 2019; Pandey et al., 2019).

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RESULTS AND DISCUSSION

The result showed (Table 2) the top ten important fodders found in the hills in Gandaki River Basin of Nepal. The farmer's perception and preference on fodder species selection was varied as per available fodder species in hills. Among the top ten fodder species *Artocarpus lakoocha* (Badahar) was highly preferred by farmer and got top scored 9.49 in hills. Similarly *A.lakoocha* received the highest weighted values in top scoring followed by *Ficus semicordata* (Rai Khanyu), *Thysanolena maxima* (Amriso), so on.

Table 2. The best top ten fodder species in hilly region

Scientific Name	Nepali Name	Weighted Score	Overall Rank	Palatability Rank	Fodder Yield Rank	Milk Yield Rank	Milk fat Yield Rank
Artocarpus lakoocha	Badahar	9.49	I	I	I	I	I
Ficus semicordata	Rai Khanyu	6.22	II	II	III	II	II
Thysanolena maxima	Amriso	5.60	III	III	VI	VI	V
Ficus calvata	Bedulo	3.87	IV	IV	IV	IV	III
Ficus ariculata	Nimaro	3.73	V	V	II	III	IV
Ficus nemoralis	Dudhilo	3.22	VI	VII	VII	V	VI
Ficus globerrima	Pakhuri	2.40	VII	VIII	V	VIII	VIII
Bauhinia purpurea	Tanki	2.27	VIII	VI	VIII	VII	VII
Brassiopsis hainla	Chuletro	1.11	IX	IX	IX	IX	IX
Litsea monopotela	Kutmiro	0.87	X	X	X	X	X

Note: I = Most preferred, X = Least preferred, 9.49 = High score, 0.87 = Least score

Some similar type of fodder species found in hill that depends on the ecological belt and species of livestock in the locality, such as large animal prefers different varieties of fodders than small animals.

Table 3. Variation in farmer perception on fodder traits in the hills

Fodder species	Nepali name	Fodder yield $\bar{X} \pm \sigma$	Palatability $\bar{X} \pm \sigma$	Milk yield $\bar{X} \pm \sigma$	Milk fat yield $\bar{X} \pm \sigma$
Thysanolena maxima	Amriso	2.50±1.05	4.50±0.84	3.58±1.69	3.33±1.63
Artocarpus lakoocha	Badahar	4.71±0.49	5.00±0.00	4.57±0.53	4.57±0.79
Ficus calvata	Bedulo	3.83±0.75	4.17±0.75	4.00±0.63	4.17±0.75
Brassiopsis hainla	Chuletro	2.60±1.34	2.60±1.14	1.80±0.84	1.80±0.45
Ficus nemoralis	Dudhilo	2.80±1.30	4.60±0.55	4.00±1.00	3.60±0.89
Litsea monopotela	Kutmiro	2.50±0.71	2.50±0.71	1.50±0.71	1.50±0.71
Ficus ariculata	Nimaro	4.14±1.21	3.43±1.13	3.43±0.98	3.29±0.95
Ficus globerrima	Pakhuri	3.20±1.10	2.60±0.89	1.60±0.55	2.40±1.67
Ficus semicordata	RaiKhaniyo	4.14±1.07	4.43±0.53	3.86±0.90	3.86±0.90
Bauhinia purpurea	Tanki	2.00±1.10	3.83±1.17	3.17±1.17	3.00±1.67
χ^2-values		7.11	23.50	6.29	4.49
P –values		NS	**	NS	NS

Average rating for fodder traits (Low-1, Satisfactory-2, Average-3, Good-4, Best-5), N= 8 clusters, , mean $\bar{X}$, standard deviation (σ), **Significant at 1% (P<0.01), *Significant at 5% (P<0.05), ^{NS}Not-significantly different (P>0.05)

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Similarly the species of fodders and their availability also vary due to ecological region that grows up on climatic condition, aspect, altitude, soil condition etcetera. Most of the farmers' preferences depend on fodders trees and shrubs selection on the yield of fodder and palatability to their livestock.
There were huge variations on farmer perception the qualities (traits) of same species. The result shows the variation in scoring and ranking in the same fodder species in different traits which was clearly indicated in the Table 3.

Table 4. Calendar of fodder availability and scarcity periods in the hills

Fodder app.	Periods/ time	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
A. Lakoocha	Harvesting												
	Best feeding												
F. Semicordata	Harvesting												
	Best feeding												
T. Maxima	Harvesting				Fodders scarcity			Forages availability					
	Best feeding					Periods							
F.calvata	Harvesting												
	Best feeding												
F. Ariculata	Harvesting												
	Best feeding												
F. nemoralis	Harvesting												
	Best feeding												
F.globerrima	Harvesting												
	Best feeding												
B. purpurea	Harvesting												
	Best feeding												
B. Hainla	Harvesting												
	Best feeding												
L.Monopotela	Harvesting												
	Best feeding												

Farmer preferences on fodders selection were highly significant with palatability and mostly they were also given their preferences on cooling effect and nutrition of fodder significantly. Farmer perception did not focus on milk and fodder yield and all fodder species had the same tendency for milk yield and fodder yield.

Palatability is significant and high value showed on palatability and nutrition for the selection of the best fodder species on the basis of farmer preferences. In total 27 species of fodder

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trees in four clusters in Kaski and 30 species in four clusters in Lamjung areas were reported. The diversity richness (Simpson's index) of fodder species were also found 0.79 and 0.84 in Kaski and Lamjung districts respectively.

The results show that (Table 4) the fodder calendar with harvesting and the best feeding time yearly. On the basis of farmers perception the top ten fodders have their own harvesting time and the best feeding time to their livestock.

The fodder calendar showed the availability and scarcity periods of fodders in the GRB region. Farmer perception on fodder species selection was found little variation in mid hills and most of them were similar type of fodder species in other clusters. Farmers rank fodder trees and shrubs species according to their local traits like accessibility, palatability and nutritious during the lean period. Green fodder trees and shrubs are important sources of protein, vitamin A, carotene for lactation period, cooling effect on animal body during the growing stage. Fodder trees are most essential resources of animal feed in Nepal mainly in the dry seasons (Rana et al., 1999). Farmers ranked *Artocarpus lakoocha* (Badahar) in top in the hills because it is indicated that the intake of *A. lakoocha* increases milk yield in buffaloes (Rana & Amatya, 2000). This is due to low level of concentration of essential oil (piperitone) that makes these fodders more palatable. This essential oil content in fodder is responsible for peculiar smell and test of the fodder and forage (Rahman, 1995). Besides its high dry matter content, it has good palatability, and it is nutritious to their livestock and consumed by all animals like cattle, buffaloes, goat, and sheep.

According to farmers local knowledge *A. Lakoocha* is recognized for its high milk yield, milk fat yield and high palatability to ruminants because it has less amount of essential oil that increases the palatability in livestock. Even though farmers do not grow more *A lakoocha* in their locality due to short period of seed viability, slow growth rate and poor availability of fruit from tree. Because farmers use the tree as a fodders for their livestock so it does not produce fruits for seeds. In the mid hills *A. lakoocha* was followed by *Ficus semicordata* (Rai Khanyu), and *Thysanolena maxima* (Amriso) on the basis of farmers' knowledge.

In the integrating livestock rearing system farmers highly depend on fodders and forages feeding to their livestock. There is no enough fodders production for feeding to the livestock. Fodder trees provide nearly 40% of the total annual fodder requirement of the ruminants in the hills (Malla, 2004). However, there were huge variations in fodder species selection preferred by farmers in the hills. Mainly farmer focused on fodders qualities/traits especially focused on palatability and fodder yield. Majority of scoring preferred *A. Lakoocha* (Badahar) in the mid hill and *terai* on the basis of its palatability to animals. Similarly farmers screened *Thysanolena maxima* (Amriso) in both region hill and terai areas because of its availability and easily preferred by livestock during the feeding.

Some fodders such as *Thysanolena maxima* (Amriso), *F. ariculata* (Nimaro*), F. subinisa* (Bedulo) were grown nearby homestead, on farmland, bonds and forest land. Other species of fodder like *Bauhinia purpurea* (Tanki), *Brssiopsis hainla* (Chuletro), and *Litsea monopotela* (Kutmiro) were not preferred for their shading effect, low yield and cooling effects. There were high variation in fodder traits among the species and most of the farmers preferred with

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palatability and nutrition because farmers always expect that the animal would be healthy with good feeding.

The result of study showed that the species vs milk yield and ghee yield were found non - significant because farmer not give their attention on these traits during the fodders selection. But in the case of *terai* farmers focused on Ghee yield because of milk collection cooperative i.e. market access to dairy products and measure amount of fat with good price in the local market. According to fodder calendar trees fodder and fodders were available from November to March. The green forages were found abundant in the monsooon season especially from July to October and most scarcity period of fodder for livestock feeding in mid-March to June in the mid hills of Nepal.

In overall the study showed the palatably and nutrition were highly significant in the Gandaki River basin because most of the farmer selects fodders trees and shrubs for their livestock on the basis of palatability and nutrition.

CONCLUSION

The study revealed that farmers themselves screened fodders trees and shrubs on the basis of their qualities and traits that are mainly preferred by their livestock. Farmers mainly concentrate on selection of fodders and forages on the basis of production, accessibility and high palatability to their animals. In the hill farmers have followed the agro-forestry farming system with few fodders trees which are not enough for their animals and mostly depend on forest for fodders and forages. Therefore, farmers can benefits from livestock husbandry with promotion of the best preferred fodders trees in their farm through agro-forestry system. Researchers should also perform scientific study of selected fodders for bridging the gap between scientists and indigenous knowledge of farmers. Consequently, in the mid hill the study plays the vital role to develop livestock husbandry for smallholder's farmers including transhumance system in the Gandaki River Basin.

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Authors' Contributions

Tamang, B.B., Shah, M.K., Chaudhary, P. and Chhetri, N. designed and performed experiments and wrote paper; Dhakal, B. developed analytical tools and analyzed data.

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Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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