



Research Article

Goat Feed Resources and Feeding Management in Mid-Hill of Nepal

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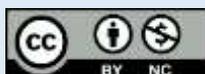
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Abstract

This study was commissioned to assess studies on feeding resources and feeding management of goat in mid hills of Nepal. During the study, 162 goat farms located in Ghiring and Baradi of Tanahun districts in Nepal were surveyed, and a semi-structured questionnaire was administered to each farm. Farmers in this region prefer integrating livestock raising with crop production. The majority of the farms surveyed kept indigenous Khari goats, either in pure flocks or through crossbreeding. The types of goat farming were commercial (8.02%), semi-commercial (29.01%) and subsistence (62.96%). The nature of management practices for goat farmers was intensive (70.99%), semi-intensive (14.81%) and free range (14.20%). Farmers grazed their livestock in different locations, including their own land (48.77%), forests (22.22%), and other places (29.01%). The selection of fodder species by farmers varied depending on the availability of different species in the mid hills, reflecting differences in their perception and preference. Among the top fodder species highly preferred by the farmer in summer season are *Ficus cunia* followed by *Bauhinia longifolia*, *Ficus hispida*, *Castanopsis indica* and *Ficus auriculata*. Fodder species highly preferred by the farmers in winter season are *Litsea polyantha* followed by *Drepanostachyum khasianum*, *Shorea robusta*, *Terminalia elliptica* and *Mangifera indica*. Goat production is an essential aspect of subsistence farming, providing both meat and cash income. Consequently, this study recommends promoting locally preferred tree fodder species and supplementing them with feed during different seasons, based on their availability and local preferences. Such strategies can help to improve goat production and support sustainable livelihoods for farmers in the region.

Keywords: Feed resources; goat, farming; Nepal

Introduction

Goat (*Capra hircus*) is the major small ruminants reared by most of the marginal farmer's in the country and also their major sources of cash income. Consequently, the government and many non-governmental organizations have included goat components as income generation activities in their programme. The goat population of Nepal is estimated to be 12.81 million producing 75023 mt meats per annum. The Gandaki province comprise 1533629

number of goat that produce 8981 Mt meat (SINA, 2019/20). These increases have led to a significant surge in demand for livestock feed, as reported by Singh (2019).

Livestock in the mid hills and mountain regions mainly rely on fodder trees and shrubs as a source of feed, and open or semi-open grazing practices are common. In the mid hill areas, farmers often collect fodder and graze their goats in government forests. In the mid hills and mountain regions there are a lot of species of fodder and shrubs found and

tried to fulfill the require amount of nutrients to the ruminants. Farmers in Nepal typically feed tree fodders and shrubs to their livestock during dry periods, particularly in the winter season. However, there are sufficient feeding materials available, such as forages, crop residues, and by-products, during other seasons to feed ruminants.

The study was to assess the locally available feed resources in relevance to goat feeding in mid hill of Nepal. Native fodders are traditionally being used in almost all of the domains of Nepal. Feeding of locally available fodder species is crucial in the hills of Nepal in terms of livestock production. Farmers use fodder trees and shrubs as a main source of protein to the ruminant may not be good time for feeding to their animals. They collect the fodders trees from the forest especially in the winter season but they don't care proper loping time and growing stage of fodders. According to Kadariya (1992), more than 50% of the fodder for ruminant animals in Nepal comes from forest resources. There are over 500 fodder tree species in the country, of which around 250 have been recognized as economically beneficial across various agro-ecological zones (Subba, 2000). Amatya (1990) reported that farmers prefer 44 different fodder species. It is crucial to feed goats during the appropriate feeding stage of fodder to obtain maximum nutrients from the feed. Therefore, this study recommends assessing the nutritive values of fodder trees and shrubs in the mid hills of Nepal to identify the optimal feeding seasons for these resources.

Materials and Methods

A survey was conducted using a semi-structured questionnaire to assess the goat feeding practices at Giring and Baradi of Tanahun. A total of 162 goat keeping farmers in Tanahun were interview one-on-one. Interaction with leading farmers and livestock extension worker was carried out to know the feeding status of the goat. As part of the survey, baseline data was collected on the economics of goat production in areas where goats are kept. Additionally, purposive sampling was conducted in major goat-producing areas to gather baseline information on production traits and feeding resources of goats. The sample collections of different feed resources (fodder and forage) were collected from Baradi and Ghiring of Tanahun. The identification of fodder tree species was based on the findings of a socio-economic study and the identification of top-ranked species. In this study, leaf samples were collected from the mid-canopy and all four sides of the canopy of each tree to analyze the nutrient composition of different feed resources. The fresh leaf samples weighing 300g were collected from each of the identified fodder tree species and weighed when fresh (green biomass). Then, they were enclosed in zip lock plastic bags and transported to the laboratory for analysis. Proximate analysis was conducted to measure crude protein

(CP), crude fiber (CF), total ash (TA), ether extract (EE), acid detergent fiber (ADF), acid detergent lignin (ADL), neutral detergent fiber (NDF), calcium and phosphorus. The collected data were entered into Microsoft Excel for editing and validation before being analyzed using Statistical Packages for Social Science (SPSS) Version 20.0 software.

Results

Characteristics of the Surveyed Households

In total, 162 respondents were interviewed and 88.89% were rural, 11.11% were urban area. The ethnicity of the concern household were Janajati 61.73% whereas Brihmin/Chhetri were 38.27%. At this area 96.30% male and were 3.70% were female household heads. The household size of the study area was male (3.04±1.31) and female (2.90±0.61). The majority of household were either read and write (24.07%); can count only (20.07%), secondary school (19.14%) while adult education (15.43%). The results suggest that the majority of goat farming activities were being carried out by farmers with low levels of literacy. This has significant implications for their ability to effectively manage and implement production methods. Therefore, adult literacy training may need to be arranged for the studied community to enhance their literacy skills and improve their capacity to manage their goat farming activities effectively. The majority of the farmer's occupation were agriculture (96.91%) and office work (3.09%) (Table 1).

Feeding Systems

The survey results indicated that 85.19% of the farmers provided local feed ingredients, roughages 70.99%, while 7.41% provided market ingredients to the goat in this area. The majority of roughages used by the farmers were available fodder (90.12%), green grass (81.48%) and millet (38.89%). The preferred feeds for the goats, as identified in the study, were Napier grasses and various crop residues provided in combinations depending on availability. Many farmers used roughages and rarely purchased concentrate, indicating that small ruminants were being kept in low-input systems. The survey suggests that farmers are making efforts to ensure adequate nutrition for their livestock despite limited means, although the quality and quantity of many tropical grasses may be insufficient (Table 2).

The results showed (Table 3) that the feeding practices of goat farmers in Ghiring and Baradi of Tanahun of Nepal. The sources of feed for goat feed were majority of farmers preferred homemade feed (70.99%), commercial feed (19.75%) and both commercial and homemade feed were 9.26%. The majority of farmers started goat farming in Intensive (70.99%), Semi-intensive (14.81%) and free range (14.20%). High price of feed (53.70%) is the major problems of the survey area.

Table 1: Socioeconomic demographic information's of goat farmers (n=162)

Parameter	Options	Respondents (N)	Percent (%)
Area	Rural	144	88.89
	Urban	18	11.11
Ethnicity	Janajati	100	61.73
	Brihmin/Chhetri	62	38.27
Head of family	Male	156	96.30
	Female	6	3.70
Education level	Can count only	33	20.37
	Read and Write	39	24.07
	Adult Education	25	15.43
	Primary	6	3.70
	Secondary	31	19.14
	10 plus 2	22	13.58
Occupation of farmers	Graduate & above	6	3.70
	Agriculture	157	96.91
Own house	Office work	5	3.09
	Yes	162	100.00
Own land	Yes	162	100.00

Table 2: Feeding materials used by goat farmers (n=162)

Parameter	Options	Respondent (N)	Percent (%)
Feed & ingredients used	Local ingredient	138	85.19
	Market ingredient	12	7.41
	Roughages	115	70.99
	Others	12	7.41
Roughages	Millet straw	63	38.89
	Green grass	132	81.48
	Fodder	146	90.12

* Multiple Response

Table 3: Feeding practices of goat farmers field conditions (n=162)

Parameter	Options	Respondent (N)	Percent (%)
Sources of feed	Commercial feed	32	19.75
	Homemade feed	115	70.99
	All the Above	15	9.26
Management practice	Intensive	115	70.99
	Semi-intensive	23	14.81
	Free range	24	14.20
Types of farming	Commercial	13	8.02
	Semi-commercial	47	29.01
	Subsistence	102	62.96
Problems of feeding	Market problem	6	3.70
	High price of feed	87	53.70
	Technical supports	69	42.59
Feed storage time	Less than 1 months	33	20.37
	One to two months	10	6.17
	More than 2 months	16	9.88
	No storage of feed	103	63.58

The majority of the farmers started goat farming subsistence (62.96%), and semi-commercial (29.01%) whereas commercial type of goat farmers are only 8%. The commercial as well as homemade feed storage time in the survey area are less than 1 month, one to two months, more than two month and not storage of feed were 20.37%, 6.175%, 9.88%, and 63.585 respectively. The feed resources offered to goat in survey area of Tanahun is

presented in Table 4. Duration of grazing (hours), green ground grass(kg/goat), fodder and forage (kg/goat), commercial feed (kg/goat) and homemade feed (kg/goat) were 1.19 ± 1.89 , 2.65 ± 1.21 , 2.41 ± 1.13 , 0.11 ± 0.38 and 0.08 ± 0.04 respectively. The farmers are not supplying minerals and vitamins for their goats.

Data shown in the Table 5 shows that the majority of respondent reported that feeder's types for feeding goats are hanging grass on rope (96.30%) whereas wooden grass rake (3.70%). However, cultivation of forages grasses (56.79%). The farmers not get improved forages grasses seedlings are 48.77%. The grazing of goat reported by respondent are own land (48.77%), forest area (22.22%). The surveyed respondent reported that feed ingredient cost higher than summer season (9.88%) than winter season (90.12%). The respondent reported that fodder tree availability mostly on

winter season (90.12%) whereas ground forage availability on summer season were 94.44%.

Nutrient Content of Fodder

Nutrient content of fodder available for summer and winter season in survey area presented in Table 6 and Table 7. There are different types of fodder trees, forage crops and feed are found in Tanahun area. The chemical composition of feed stuff varies according to soil composition, application of fertilizer, variety, irrigation, cultivation practices, stages of growth, frequency of harvesting.

Table 4: Feeds resources offered to goat in farmers field conditions (n=162)

Parameter	Respondent (N)	Mean	Std. Deviation
Duration on grazing, hours	162	1.19	1.89
Green ground grasses, goat/kg	162	2.65	1.21
Fodder and forage, goat/kg	162	2.41	1.13
Commercial feed, goat/kg	162	0.11	0.38
Homemade feed, goat/kg	162	0.08	0.04
Minerals and vitamins, goat/kg	162	0.00	0.00

Table 5: Feeding practices and condition in farmers field conditions (n=162)

Parameter	Options	Respondent (N)	Percent (%)
Feeder type for feeding	Hanging grass	156	96.30
	Wooden grass rake	6	3.70
Cultivation forage grasses	Yes	92	56.79
	No	70	43.21
Support for fodder nursery	Yes	7	4.32
	No	155	95.68
Improved forage grasses seeding	Yes	79	48.77
	No	83	51.23
Practices chopped grasses	Yes	0	0.00
	No	162	100.00
Area for grazing	Own land	79	48.77
	Forest	36	22.22
	Others places	47	29.01
Feed ingredients cost high	Summer season	16	9.88
	Winter season	146	90.12
Fodder tree availability	Summer season	16	9.88
	Winter season	146	90.12
Ground forage availability	Summer season	153	94.44
	Winter season	9	5.56

Table 6: Nutrient content of fodder available for summer season in Tanahun

Fodder	%TA	%CP	%CF	%EE	%NDF	%ADF	%ADL	%Hecel	%Cel	%Ca	%P
Summer fodder											
Khanayo (<i>Ficus cunia</i>)	10.92	12.94	27.22	3.34	51.80	36.44	16.94	12.25	18.65	1.38	0.30
Tanki (<i>Bauhinia longifolia</i>)	7.94	15.91	-	1.97	57.21	45.05	17.19	12.15	27.87	1.83	0.30
Katus (<i>Castanopsis indica</i>)	3.61	11.49	-	3.55	68.36	59.88	28.65	8.48	31.23	3.55	68.36
Pakhuri (<i>Ficus hispida</i>)	9.87	13.18	-	2.90	50.16	33.47	17.13	7.38	17.64	1.39	0.40
Nimaro (<i>Ficus auriculata</i>)	14.20	10.64	-	4.56	55.09	45.87	22.57	9.22	23.30	3.08	0.25
Bakaino (<i>Melia azedarach</i>)	11.01	19.64	-	2.10	48.89	37.49	14.67	11.40	22.82	3.21	0.52
Dabdabe (<i>Garuga pinnata</i>)	12.58	14.12	-	2.43	42.10	34.46	14.86	7.63	19.61	2.15	0.35
Napier (<i>Pennisetum purpureum</i>)	10.11	8.58	-	-	73.78	45.48	24.55	28.30	20.93	-	-
Kavro (<i>Ficus lacor</i>)	11.56	12.10	7.17	2.20	53.97	45.34	21.29	8.13	24.04	2.62	0.35
Dumri (<i>Ficus racemose</i>)	13.95	13.62	-	3.85	46.08	38.78	22.78	7.30	16.00	-	-
Badahar (<i>Artocarpus lakoocha</i>)	14.99	16.14	-	1.78	52.11	40.62	15.12	11.57	25.50	1.45	0.36

Note: TA: Total ash, CP: Crude protein, CF: Crude Fiber, EE: Ether Extract, NDF: Neutral detergent fiber, ADF: Acid detergent fiber, Acid detergent lignin (ADL); HeCel: Hemicellulose, Cel: Cellulose, Ca: Calcium, P: Phosphorus

Table 7: Nutrient content of fodder available for winter season in Tanahun

Fodder	%TA	%CP	%CF	%EE	%NDF	%ADF	%ADL	%Hecel	%Cel	%Ca	%P
Winter fodder											
Saal (<i>Shorea robusta</i>)	6.36	8.88	-	1.63	64.49	49.81	21.54	14.68	28.27	1.12	0.54
Saajh (<i>Terminalia elliptica</i>)	7.92	10.03	-	-	55.88	47.88	28.93	8.00	18.95	-	-
Mango (<i>Mangifera indica</i>)	11.56	9.00	-	2.00	63.14	50.30	22.43	12.84	27.87	-	-
Nigalo (<i>Drepanostachyum khasianum</i>)	9.63	11.95	-	1.83	70.67	51.19	16.91	19.48	34.28	0.56	0.17
Kutmiro (<i>Litsea polyantha</i>)	7.34	14.70	25.32	1.90	62.76	52.04	25.94	10.71	26.10	1.14	0.34
Ipil Ipil (<i>Leucaena leucacephala</i>)	10.02	19.46	-	2.10	57.20	40.82	22.36	16.37	18.46	2.04	0.32
Chuletro (<i>Brassaiopsis hainla</i>)	11.26	12.31	-	1.50	50.64	44.49	23.56	6.15	20.93	5.72	0.45
Amriso (<i>Thysanolaena maxima</i>)	10.93	9.91	-	1.30	69.69	46.30	14.02	23.39	32.28	0.40	0.33
Bedulo (<i>Ficus clavata</i>)	13.69	12.60	-	-	53.56	41.08	14.19	12.49	26.91	0.60	0.38
Kimbu (<i>Morus alba</i>)	9.67	15.76	13.01	5.67	48.00	30.77	16.24	9.76	15.06	1.27	0.43

Note: TA: Total ash, CP: Crude protein, CF: Crude Fiber, EE: Ether Extract, NDF: Neutral detergent fiber, ADF: Acid detergent fiber, Acid detergent lignin (ADL); HeCel: Hemicellulose, Cel: Cellulose, Ca: Calcium, P: Phosphorus

Fodder Preferences

Based on the findings presented in Table 8, it was observed that the top ten important fodders in the mid hills of Tanahun district of Nepal varied according to the farmers' perception and preference of available fodder species. During the summer season, *Ficus cunia* (Khanayo) was the most preferred fodder species by farmers, scoring the highest percentage of 61.11% among the top ten. Similarly, *Bauhinia longifolia* (Tanki), *Ficus hispida* (Pakhuri), *Castanopsis indica* (Katus) and *Ficus auriculata* (Nimaro) so on.

Table 8. Selected top fodder species farmers preferences of 10 fodder species in summer season at mid hills

Fodder	Respondent (N)	Percent (%)	Rank
Khanayo (<i>Ficus cunia</i>)	99	61.11	I
Tanki (<i>Bauhinia longifolia</i>)	96	59.26	II
Katus (<i>Castanopsis indica</i>)	80	49.38	IV
Pakhuri (<i>Ficus hispida</i>)	94	58.02	III
Nimaro (<i>Ficus auriculata</i>)	77	47.53	V
Bakaino (<i>Melia azedarach</i>)	45	27.78	X
Dabdabe (<i>Garuga pinnata</i>)	77	47.53	VI
Napier (<i>Pennisetum purpureum</i>)	68	41.98	VII
Kavro (<i>Ficus lacor</i>)	46	28.40	IX
Dumri (<i>Ficus racemose</i>)	23	14.20	XI
Badahar (<i>Artocarpus lakoocha</i>)	60	37.04	VIII
others	28	17.28	XII

* Multiple Response

The results showed (Table 9) the top ten fodder species available in winter season *Litsea polyantha* (Kutmiro) was highly preferred by the farmers got top scored 93.66%. Similarly, *Drepanostachyum khasianum* (Nigalo), *Shorea robusta* (Saal), *Terminalia elliptica* (Saajh) and *Mangifera indica* (Mango) so on.

Table 9: Selected top fodder species farmers preferences of 10 fodder species in winter season at mid hills

Fodders	Respondents (N)	Percent (%)	Rank
Saal (<i>Shorea robusta</i>)	103	65.61	III
Saajh (<i>Terminalia elliptica</i>)	75	47.77	IV
Mango (<i>Mangifera indica</i>)	66	42.04	V
Nigalo (<i>Drepanostachyum khasianum</i>)	110	70.06	II
Kutmiro (<i>Litsea polyantha</i>)	147	93.63	I
Ipil Ipil (<i>Leucaena leucecephala</i>)	96	61.15	IV
Chuletro (<i>Brassaiopsis hainla</i>)	33	21.02	IX
Amriso (<i>Thysanolaena maxima</i>)	6	3.82	XI
Bedulo (<i>Ficus clavata</i>)	26	16.56	X
Kimbu (<i>Morus alba</i>)	45	28.66	VII
others	35	22.29	VIII

* Multiple Response

Table 10. Availability of different services in farmers field conditions (n=162)

Parameter	Options	Respondent (N)	Percent (%)
Quality of feed ingredients available	Adequate	6	3.70
	Inadequate	156	96.30
Feed ingredients suppliers	Inadequate	162	100.00
	Inadequate	162	100.00
Feed manufacturing company	Inadequate	162	100.00
	Inadequate	162	100.00
Feed testing laboratory	Inadequate	162	100.00
	Inadequate	162	100.00
Availability of feeds premix	Adequate	6	3.70
	Inadequate	156	96.30
Availability of labour for feed manufacture	Inadequate	162	100.00
	Inadequate	162	100.00
Training for stakeholder for feed manufacture	Inadequate	162	100.00
	Inadequate	162	100.00
Specific transport facility	Adequate	12	7.41
	Partially Adequate	18	11.11
	Inadequate	132	81.48
Local government priority for quality feed production	Partially adequate	6	3.70
	Inadequate	156	96.30
State government priority for quality feed Production	Partially adequate	6	3.70
	Inadequate	156	96.30
Central government priority for quality feed production	Partially adequate	36	22.22
	Inadequate	126	77.78
NARC support to local area	Adequate	6	3.70
	Partially adequate	54	33.33
	Inadequate	102	62.96

Table 11: Calendar of fodder availability and scarcity periods

Fodder app.	Periods/time	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
Summer													
Khanayo (<i>F. cunia</i>)	Harvesting	Green	Green	Green	Green	Green					Green	Green	Green
	Best feeding		Blue	Blue	Blue	Blue							
Tanki (<i>B. longifolia</i>)	Harvesting	Green									Green	Green	Green
	Best feeding	Blue										Blue	Blue
Pakhuri (<i>F. hispida</i>)	Harvesting	Red	Red									Red	Red
	Best feeding	Blue	Blue	Blue	Blue		Forage availability						
Katus (<i>C. indica</i>)	Harvesting	Red	Red	Red	Red								
	Best feeding		Blue	Blue	Blue								
Nimaro (<i>F. auriculata</i>)	Harvesting	Red										Red	Red
	Best feeding	Blue										Blue	Blue
Winter													
Kutmiro (<i>L. polyantha</i>)	Harvesting	Red	Red									Red	Red
	Best feeding	Blue	Blue									Blue	Blue
Nigalo (<i>D. khasianum</i>)	Harvesting	Red									Red	Red	Red
	Best feeding	Blue									Blue	Blue	Blue
Saal (<i>S. robusta</i>)	Harvesting		Red	Red	Red	Red							
	Best feeding		Blue	Blue	Blue	Blue							
Saajh (<i>T. elliptica</i>)	Harvesting	Red	Red	Red								Red	Red
	Best feeding	Blue	Blue									Blue	Blue
Mango (<i>M. indica</i>)	Harvesting	Red	Red						Red	Red	Red	Red	Red
	Best feeding	Blue									Blue	Blue	Blue

The findings demonstrate a fodder calendar (as shown in Table 11) that outlines the optimal time for harvesting and feeding of the top ten preferred fodder species according to the perceptions of farmers in the mid hills of Nepal. This calendar also indicates the periods of availability and scarcity of different fodders.

Discussions

In the hilly region of Nepal, fodder trees and shrubs play a vital role in providing nutritious feeds to livestock during the dry season when the amount and quality of available forages are limited. This lean period often leads to a shortage of diet in ruminants, resulting in reduced livestock productivity in tropical countries due to the unavailability of forages, crop residues, or byproducts. Even small farmers or landless farmers who keep small herds of goats, sheep,

buffalos, and cattle mostly rely on feed resources from nearby forest tree fodders. To ensure a steady supply of nutritious feeds, farmers in the hills of Nepal also grow various species of fodder trees, such as *Artocarpus lakoocha* (Badahar), *Ficus roxburghii* (Nivaro), *Thysanolaena maxima* (Amriso), *Ficus semicordata* (Rai Khanyu), and *Bauhinia purpurea* (Tanki), as part of a silvipastoral agro-forestry system. These fodders provide excellent feeds during the dry season when the livestock population is susceptible to protein and nutrient deficiencies, as reported by Bhatt and Verma (2002), Singh (1982), and Singh (2004)

During the winter season, tree fodders serve as vital sources of high-quality feed for grazing ruminants and supplements to crop residues or low-quality byproducts. However, increased human population is causing land fragmentation,

which is making it more challenging for livestock to access these fodders and manage the associated risks (Thornton, 2010). Trees and shrubs growing in arid and semi-arid ecosystems have strong root systems and can sprout vigorously from the stump and roots, making them durable to extreme droughts in the winter season, and thus, they play a crucial role in providing fodder for animals when grass-pasture is absent (Papachristou and Papanastasis, 1994). Additionally, tree fodders form an integral part of the complex interactions between plants, animals, and crops. These interactions contribute positively to balancing plant-animal-soil ecosystems and offer a sustainable source of feeds (Aganga and Tshwenyane, 2003; Devendra, 1994).

The nutrient content in the soil is an essential determinant of the quality of fodders and forages, and fertile lands with healthy and vigorous plants can lead to good nutrient uptake from the soil (Adams and Rieske, 2003). The ecological distribution of tree fodders and shrubs can vary due to their adaptability, with some species capable of growing in a broad range of ecological zones, spanning from 200m to 1700m above sea level. The chemical composition, nutritive value, and biomass production of these species are subject to a variety of factors such as topography (Oberhuber and Kofler, 2000) and climate (Burke *et al.*, 1997), which may differ from region to region.

According to farmer's perceptions and preferences in the hills of the Gandaki River Basin in Nepal, the top ten important fodder species are *Artocarpus lakoocha* (Badahar), *Ficus semicordata* (Rai Khanyu), *Thysanolenia maxima* (Amriso), *Ficus calvata* (Bedulu), *Ficus ariculata* (Nimaro), *Ficus nemoralis* (Dudhilo), *Ficus globerrima* (Pakhuri), *Bauhinia purpurea* (Tanki), *Brassiopsis hainla* (Chuletro), and *Litsea monopotela* (Kutmiro). Among these, *Artocarpus lakoocha* is the most preferred, while *Litsea monopotela* is the least preferred (Tamang *et al.*, 2020). According to Shah *et al.* (2019), the nutrient contents of tree fodders and shrubs show seasonal fluctuations, with some increasing and others decreasing in nutrient content over time. However, there was no significant variation observed in nutrient content due to differences in altitude. As a result, it is crucial to harvest these fodders and forages during the appropriate season for livestock management purposes.

Livestock production in Nepal has been facing a major challenge in terms of shortage of forage materials for a long time. The lack of quality feed and fodders, especially during the lean period from October to March, is a significant concern. This is because ruminant animals largely rely on natural pastures and crop residues for the majority of the year in Nepal. Natural pastures are the main source of fodders and forages available to farmers in Nepal (GRS, 2018). According to Singh & Singh (2019), the national feed balance deficit (TDN) decreased from 30.9% in the 1980s to 20.05% in 2016/17. The mid hills had the highest

feed deficit (-24.09%), followed by the terai (-18.91%). Koshi and Bagamati Province had the most severe feed deficits at -30.48% and -38.44%, respectively. Feed deficits in the remaining provinces ranged from -9.19% to -15.85%, but Karnali Province had a positive feed balance (+6.35%).

Goats are an very valuable genetic resource that are well adapted to low-input agricultural production systems. They are low-maintenance and easy to handle, which makes them ideal for rural households with limited resources. Due to their resilience, they are able to provide a consistent source of milk and meat even during times of drought, when cattle may not be able to survive. (Rege, 1994).

According to Singh (2020) study, the total amount of crude protein (CP) available from improved forage and pasture was approximately 118.7 thousand tons, with the Terai region having the highest portion of CP at 56.8%, followed by the mid hills. In contrast, the high hills had a much lower share of only 6.4%, indicating a lack of attention given to introducing improved forage and pastures in this region compared to the Terai and Mid-hills.

According to Singh (2019), the major sources of feed supply for livestock in Nepal are crop residues and milling by-products, which account for 44.0% of the total feed supply, followed by forests at 20.5%. Despite the Forage mission program achieving moderately satisfactory improvements in the production of improved forages, the contribution of improved forages and pastures to the total feed supply is only 6.9%. Other sources of feed supply include farm weeds (15.1%), barren area (3.6%), commercial silage (0.9%), kitchen wastes (0.043%), and grain supplementation (4.8%). This suggests that there is still great potential for the production and use of fodder tree species, especially during winter feeding in Nepal. However, the quantity and quality of available fodder trees depend on various factors such as season, age, species, elevation, aspect of the mountain, degree of slopes, and accessibility to agro-silvipastoral systems (Kshatri, 2007), which require further study. According to Singh (2019), there has been a reduction of 26.8% in grassland area and a 7% reduction in forest area in Nepal. Conversely, agricultural land has increased by 7.6% and shrub land by 4.5%. This has resulted in an increase in feed supply for livestock as compared to the situation in 1990. Singh (2019) further notes that there has been an increase of at least 2.15 times in cereal crop production, and a 1.49 times increase in average crop yields, contributing to a significant increase in the supply of livestock feeds.

Conclusion

The results of the study showed that farmers selected fodder trees and shrubs based on specific qualities and characteristics that were preferred by their goats. There is a great variation in availability and nutrient content of popular fodder trees in mid hills of Nepal. The *Ficus cumia*,

Bauhinia longifolia, *Ficus hispida*, *Castanopsis indica* and *Ficus auriculata* were the most popular and promising fodder species for summer season where as *Litsea polyantha*, *Drepanostachyum khasianum*, *Shorea robusta*, *Terminalia elliptica* and *Mangifera indica* for winter season among the available fodder. It also depends on geographical region affect the production of fodders and forages as feeding materials to the goats. Farmers have good knowledge on visible part of fodders such as yield, palatability, but they are less aware about the invisible parameters like nutrition, mineral availability etc. Farmers mainly concentrated on selection of fodders and forages on production, easy availability and high palatability to the animal. In the survey area goat farming system depend on with fodders, forages and available local feed resources

Authors' Contribution

All authors contributed equally at all stages of research work and preparation of the manuscript. Final form of manuscript was approved by all authors.

Conflict of Interest

The author states that there are no conflicts of interest related to the publication of this paper.

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