Research Article

RANKING OF FODDER TREE SPECIES AND THEIR BIOMASS PRODUCTION IN THE HILLS AND MOUNTAIN OF NEPAL

S.Upreti[1] and N. R. Devkota[2]*

[1]Nepal Agricultural Research Council, Khumaltar, Lalitpur

[2]Agriculture and Forestry University, Rampur, Chitwan

ABSTRACT

Major fodder tree species of the selected hills and mountain districts of Nepal were ranked and biomass production was recorded during June to December 2012. The objective of the study was to rank the major fodder tree species against fodder yield, and to access the biomass production of the top ranked fodder tree species. The most commonly grown fodder tree species were ranked based on fodder yield. The experiment consisted of 9 treatments organized into a 3×3 factorial combination using a RCB design which included three categories of ages (3-6 years, 7-10 years and 11-14 years), and three fodder tree species- Badahar (*Artocarpus lakoocha*); Kutmiro (*Litsea polyantha*); and Kabro (*Ficus lacor*). Kabro had significantly ($p<0.05$) higher biomass yield (31.7 kg DM/tree), followed by Badahar (26.80 kg DM/tree) and Kutmiro (23.80 kg DM/tree). The biomass production of the selected fodder tree increased with age that was highest (34.2 kg DM/tree) for third age group (11-14 years) whereas the biomass production considering age and species was higher for Kabro (38.6 kg DM/tree) with third age group. The findings firmly suggest that fodder biomass production potential of the commonly found fodder tree species at hills and mountain region of Nepal could vary greatly that increases from 3rd year onward suggesting different looping plan to be followed as per species.

Key words: tree age, species, preference, animal.

INTRODUCTION

The most serious limiting factor in livestock production is acute shortage of feed supply especially during the winter in context of Nepal. The total ruminant livestock feed requirement is estimated at 9.3 million ton TDN, out of which annually only 5.9 million t is available i.e. 34 percent is deficits. This is equivalent to 37.0 million t of dry matter, or 111 million t of green grass (ANZDEC, 2000). This situation of demand and supply of nutrients suggests the need for more fodder tree plantation, use of scientific fodder lopping technique, and better feeding management to promote and support the ever increasing dairy industries in the country. The use of fodder tree is still traditional and most of the farmers lack knowledge regarding the proper technique of tree management.

In the context of existing feed balance, as stated the information above, more than 50 percent of the fodder for ruminant animals comes from forest resources (Kadariya, 1992). There are more than 500 fodder tree species out of which about 250 have been recognized as economical fodder tree available across the agro ecological zone in the country (Subba, 2000). Amatya (1990) reported that

* Corresponding author: nabadevkota.aafu@gmail.com

there are 44 different fodder species preferred by the farmers. Though this scenario indicates that there is great potentials on the production and use of fodder tree species to the livestock especially during winter feeding in Nepal still the quantity and quality of the available fodder trees depends upon the seasons, ages, species, elevations, aspects of the mountain degree of slopes and accessibility to agrosilvipastoral system (Kshatri, 2007) which needs to be further studied.

The preference on the available fodder tree species differs with both farmers and the ruminant animal. It may be determined by (a) fodder yield, (b) nutrient composition, (c) available duration, (d) palatability, and (e) safe to feed animal in terms of polyphenolic content (Kshatri, 2007 and FAO, 2012). Several studies revealed that the biomass production of trees greatly varies with species. In spite of the importance of fodder tree in the livestock raising system in the hills, limited work has been done to estimate and determine the production and productivity of the common fodder tree in Nepal. Therefore, this study was done focusing to collect information on the ranking and productivity estimation of commonly available and major fodder tree in the selected hills and mountain districts of Nepal.

MATERIALS AND METHODS

The study consists of socio-economic status of selected farmers based on commonly available fodder trees and their ranking and the biomass production of the selected species that were organized into treatments. The study was conducted at Tanahun, Dhading, Dolakha and Sindhupalchok districts from June 15th, 2012 to December 20th, 2012. A 3×3 factorial combination of RCBD was used considering age and species of the fodder tree as treatments and the four districts as replication. Accordingly, three categories of ages (3-6 years, 7-10 years and 11-14 years) were combined with three fodder species Badahar (*Artocarpus lakoocha*); Kutmiro (*Litsea polyanthus*); and Kabro (*Ficus lacor*). Fodder tree species were identified based on findings of socio-economic study and on the basis of identifying top ranked fodder tree species.

Accordingly, the following were the treatments combination:

T1=Badahar age group 3-6 years
T2= Badahar age group 7-10 years
T3= Badahar age group 11-14 years
T4=Kutmiro age group 3-6 years
T5= Kutmiro age group 7-10 years
T6= Kutmiro age group 11-14 years
T7=Kabro age group 3-6 years
T8=Kabro age group 7-10 years
T9=Kabro age group 11-14 years

Selection criteria: Total 11 different parameters were used, including the parameter suggested by the farmers to prepare the selection index for ranking the fodder trees. They were (1) biomass production of the fodder trees species, (2) nutrient content, (3) available duration , (4) availability of fodder tree species during scarce period, (5) palatability of the fodder tree species, (6) adverse effect on animal health with feeding fodder trees (i.e. toxicity), (7) safe to feed to animal in terms of polyphenolics contents, (8) preference, (9) insect pest infestation, (10) disease infestation, and

(11) availability in different ecological belts. The score was from 1 (best) to 4 (lowest). Total of 100 farmers were randomly selected covering all 4 districts. The study evaluated a total of 19 fodder tree species (Table 1) and ranked to top ten species (Table 2). Out of total 10 ranked, only top three fodder species were studied in detail for biomass production

Table 1. Selected top fodder species including all four districts preferences of 19 fodder tree species

Rank	Scientific Name	Common name	Score
1	*Artocarpus lakoocha Rox.*	Badahar	1.083
2	*Ficus infectoria Roxb.* *Ficus lacor Buch.*	Kabro (Kalo) Kabro (Seto)	1.273
3	*Quercus semecarpifolia Sm.*	Khasru	1.273
4	*Litsea polyantha Juss.*	Kutmiro	1.273
5	*Grewia tiliaefolia Vahl.*	Shyal phusro	1.364
6	*Ficus clavata Wall.*	Gedilo	1.455
7	*Ficus cunia Buch.*	Khanyu	1.455
8	*Quercus glauca Thunv.*	Phalat	1.455
9	*Premna bengalensis Clarke.* *Premna latifolia Roxb.*	Ginderi (Kalo) Ginderi (Seto)	1.545
10	*Ficus roxburghii Wall.*	Nimaro	1.545
11	*Michelia champaca L.*	Champ	1.636
12	*Leucaena leucocephala*	Ipil ipil	1.636
13	*Ficus hispida L.*	Khasreto	1.545
14	*Morus alba L.*	Mulberry	1.636
15	*Ficus religiosa L.*	Pipal	1.636
16	*Ficus glaberrima Bl.*	Pakhuri	1.636
17	*Melia azedarach L.*	Bakaino	1.833
18	*Garuga pinnata Roxb.*	Dabdabe	1.833
19	*Bauhinia purpurea*	Tanki	1.850

Source: Survey, 2012

Table 2. Selected top fodder species including all four districts preferences of 10 fodder tree species

Rank	Scientific Name	Common name	Score
1	*Artocarpus lakoocha Rox.*	Badahar	1.083
2	*Litsea polyanthus Juss.*	Kutmiro	1.273
3	*Ficus infectoria Roxb.* *Ficus lacor Buch.*	Kabro (Kalo) Kabro (Seto)	1.273
4	*Quercus semecarpifolia Sm.*	Khasru	1.273
5	*Leucoceptrum canum*	Ghurbis	1.364
6	*Grewia tiliaefolia Vahl.*	Shyal phusro	1.364
7	*Ficus clavata Wall.*	Gedilo	1.455
8	*Ficus cunia Buch.*	Khanyu	1.455
9	*Quercus glauca Thunv.*	Falant	1.455
10	*Premna bengalensis Clarke.* *Premna latifolia Roxb.*	Ginderi (Kalo) Ginderi (Seto)	1.545

Source: Survey, 2012

Fodder tree foliage biomass yield and age estimation: Annual edible biomass production (DM) (kg/tree) was estimated by lopping tree species of the same season. The edible portion was considered as of small twigs with leaves. Sample tree were lopped and fodder yield was recorded immediately after harvesting tree foliage (branches larger than pencil size) in fresh matter in Camry two digital weighing balance of capacity 600 g . Age of the fodder trees were estimated based on the owner's report and based on the response of those farmers older than 60 years of age as witnesses. As the deforestation was not allowed in the study sites so could not count the ring number to estimate the tree age; no records were available as to when the trees were planted.

Sample collection procedure: Leaf samples were collected from the mid canopy and all four sides of the given tree canopy. Fresh leaf samples weighing 300g were collected from each of the fodder tree species. The collected samples were weighed when fresh (green biomass), enclosed in ziploc plastic bags, and was brought to the laboratory for analysis (Energy, CP, EE, NDF, ADF, ADL, TA and Ca).

All the collected data were subjected to statistical analysis. ANOVA was used to test collected data. The data were analyzed by comparing mean of the treatments using LSD ($P<0.05$). Statistical software Genstat discovery (4) edition was used to analyze the data.

RESULTS AND DISCUSSION

Socio economic characteristics of farmers

This section describes the socio economic characteristics of randomly selected household in Tanahun, Dhading, Dolakha and Sindhupalchok districts. The major sub heads under this section includes family structure, land holding, animal population and herd composition.

Family structure

The findings revealed similar situation of sharing for family population (23 to 25 percent) in all four districts of the study sites. Further, the ratio of male and female (16 to 17 percent) was also similar indicating that the both sex were equally involved for fodder management (Table 3). This result has indicated that availability of adult man power is good enough to manage and harvest the fodder trees species in the study districts. A similar result was reported by the FAO (2012) study in these districts. However, Upreti (2010) reported a higher male ratio (25 percent) in the study districts.

Table 3. Family structure of the respondents households in the study sites (n=100)

Districts	Adult male	Adult female	Boy	Girls	Total	% share
Tanahun	29	29	19	17	94	23.90
Dhading	32	34	15	18	99	25.20
Dolakha	36	36	13	16	101	25.70
Sindhupalchok	34	30	18	17	99	25.20
Total	131	129	65	68	393	100.00
Percent share	33.30	32.80	16.50	17.30	100.00	

Source: Survey, 2012.

Land holding

The findings showed that among the total available land, majority was occupied by Bari and Khar Bari (71%) indicating the potential of fodder tree plantation, in such land type particularly, in Khar bari, in the study sites (Table 4). With this reality, the Leasehold Forestry and Livestock Program have promoted fodder tree even in the private land in the major mid hills of the country (FAO, 2012). This finding also highlighted the scope of fodder trees in the hills.

Table 4. The mean land holding (ha/household) size of a household in the study sites (n=100)

Districts	Khet	Bari	Kharbari	Total	% share
Tanahun	0.21	0.67	0.41	1.30	50.70
Dhading	0.15	0.05	0.15	0.35	13.60
Dolakha	0.17	0.16	0.13	0.47	18.30
Sindhupalchok	0.17	0.15	0.12	0.45	17.40
Total	0.72	1.04	0.81	2.58	100.00
Percent share	27.90	40.40	31.60	100.00	

Source: Survey, 2012T

T**able 5. Animal population and herd composition of the study sites (n=100)**

Districts	Cattle		Buffalo		Goats		Total	% share	Animal Unit (AU)	TDN (kg)
	Adult	Young	Adult	Young	Adult	Young				
Tanahun	2.94	2.18	1.61	1.63	5.84	4.38	18.58	37.40	6.04	6704.22
Dhading	1.33	1.00	1.25	1.00	1.33	1.00	6.91	13.90	3.93	4368.07
Dolakha	1.85	1.00	1.50	1.00	3.91	2.00	11.26	22.60	4.61	5126.36
Sindhupalchok	2.00	1.50	2.00	1.50	3.50	2.50	13.00	26.10	5.31	5901.50
Total	8.12	5.68	6.36	5.13	14.58	9.88	49.76	100.00		22100.10
Percent share	16.30	11.40	12.80	10.30	29.30	19.90	100.0			

Note: (1) Animal Unit (AU) = 300 kg live weight – 1, (2) Average TDN required = 5525.03 per year per AU.

Source: Survey, 2012

Animal population and herd composition

The finding from this study showed that the percent share of animal population ranged from 22 to 37 percent in the study districts (Table 5). The fare distribution of livestock species in all study districts (Figure 1) was revealed with the higher population of all categories of ruminant in the Tanahun. Adult populations in all districts are also higher than young. This situation indicated the need of more fodder plantation to support the livestock and their requirements. The average AU per house hold was 4.97, and the annual TDN requirement for AU per house hold was 5,525.03 kg. This shows the inadequate amount of TDN to satisfy the requirements.

Selected and ranked fodder trees

At first top ten fodder tree species were ranked considering the farmers preference. The selected fodder tree species were scored from 1.08 (*Artocarpus lakoocha*) to 1.54 (*Premna spp*).The other fodder species were: *Litsea polyantha*, *Ficus infectoria*, *Quercus semecarpifolia*, *Leucoceptrum*

canum, Grewia tiliaefolia, *Ficus clavata*, *Ficus cunia*, *Quercus glauca,* and *Premna bengalensis* (Table 2).

As revealed by the finding of this study Badahar ranked the top species out of the selected and best possible species identified among the available fodder tree. Similarly, Kutmiro ranked second and Kabro ranked third. The criteria involved in this selection are described above. A similar criterion was also used by (Ghimire *et al*., 2011) to rank the fodder trees and had relatively good understanding in ranking the species.

The adaptation of selection index helps, to understand all the nutritional parameters of particular fodder tree and to evaluate their potential to the ruminant feeding.

Biomass production

The biomass production of fodder trees (kg DM/tree) differed significantly (P<0.05) among the fodder species studied by not considering age. Accordingly, Kabro had the higher biomass yield (31.70 kg DM), followed by Badahar (26.80 kg DM/tree) and Kutmiro (23.80 kg DM/tree) (Table 6). The biomass yield (kg DM/tree) recorded in this study is lower than it was reported by (FAO, 2012). Upreti and Shrestha (2006) reported that, the yield differs with the species such as Badahar (31.25 kg DM/tree), Kutmiro (26.69 kg DM/tree) and Kabro (40.98 kg DM/tree). Pande (1994) and Panday (1982) also had reported wider variation in the yield of Badahar as recorded in the same districts of this study. Even with the same site and district the yield could be varied because of the variation in the tree size and with the age of the tree species of the study. This finding supported such variation.

Table 6. Biomass production of selected fodder tree species regardless of age

Treatments (Fodder species)	Yield/Tree (kg DM/tree)
Badahar	26.80[a]
Kutmiro	23.80[a]
Kabro	31.70[b]
SEM ±	1.78
P value	0.009
LSD(0.05 level)	4.99
CV %	38.90

LSD=Least significant difference, CV=Coefficient of variation, and SEM=Standard error of mean

Table 7. Biomass production (kg DM per tree) of selected fodder tree species by age without considering species

Treatments (Age)	Yield/tree(kg DM/tree)
1(3-6 years)	20.80[a]
2(7-10 years)	27.30[b]
3(11-14 years)	34.20[c]
SEM ±	1.78
P value	<.001
LSD(0.05 level)	4.99
CV %	38.90

LSD=Least significant difference, CV=Coefficient of variation, and SEM=Standard error of mean

Table 8. Biomass production (kg DM/tree) of selected fodder tree species by considering species and age

Treatments	Yield/tree (kg DM/tree)
Badahar ×Age1 (3-6years)	20.30
Badahar ×Age2 (7-10years)	25.90
Badahar × Age3 (11-14years)	34.30
Kutmiro × Age1 (3-6years)	14.60
Kutmiro ×Age2 (7-10years)	27.10
Kutmiro ×Age3 (11-14years)	29.70
Kabro ×Age1 (3-6years)	27.60
Kabro × Age2 (7-10years)	28.80
Kabro × Age3 (11-14years)	38.60
SEM ±	3.08
P value	NS
LSD(0.05 level)	8.65
CV%	38.90

LSD=Least significant difference, CV=Coefficient of variation, SEM=Standard error of mean, and NS=Non significant

The biomass production of ranked fodder tree varied significantly ($P< 0.05$) in terms of age, but not by considering fodder tree species. The trend of biomass production was such that it increased as the age advanced and vice versa (Table 7). The first age group (3 to 6 years) had produced 20.8 kg DM per tree followed by group 2 (7-10 years) 27.3 kg DM and group 3 (11-14 years) of 34.2 kg DM per tree per lopping. With the increasing age the biomass production was in increasing order and it was possibly due to the increased number of branches and with other morphological traits (tree size and tree height).

Biomass production of fodder trees remained statistically similar ($P>0.05$) when treatment combination was considered in terms of different age group and popular tree species. The biomass yield ranged from14kg DM/tree Kutmiro of age1 (3-6years) to 38kg DM/tree Kabro of age 3(11-14years). The trend of biomass production was such that it increased as the age of species advanced as vice versa for all the fodder trees considered in the study (Table 8).

CONCLUSIONS

There is a great variation in fresh herbage mass yield of popular fodder trees in mid hills districts of Nepal. The Badahar, Kutmiro and the Kabro were the most popular and promising fodder species. Variation among the top ranked fodder tree in biomass indicates scope to explore the best species. Likewise biomass production was positively related with the age of the fodder tree species even in the traditional management system indicating the higher biomass potential of certain fodder tree that could be varied as per species. This also suggest the need to develop appropriate lopping practice.

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