Use of fodder trees and shrubs as protein supplements to ruminants and as a means of soil stabilization. The Nepalese case.

by N.P. Joshi

INTRODUCTION

Fodder trees and shrubs are used in Nepal as protein supplements in ruminant diets during the long dry period (October - May). It is estimated that 12% of the total digestible nutrients (TDN) come from fodder tree and shrub leaves (New Era, 1990). The major source of leaf fodder is from the forest. MPFS (1988) estimates the contribution from the forest is about 24% of the total TDN supply, mainly as fodder leaves. In some areas of the hills of Nepal up to 90% of the feed come from the forest (Metz, 1987).

The total TDN supply is estimated at 6.3 million tonnes (Joshi and Panday, 1991), of which 1.5 million T comes from forest resources. The share of tree leaves comes to about 0.75 million T. The ruminant population of Nepal is estimated at about 15.5 million (DFAMS, 1991), of which about 70% is concentrated in the hills and mountains. The TDN requirements has been estimated at about 8.8 million T TDN (Panday, 1982; Joshi, 1988). Hence the deficit is about 2.5 million T TDN (28% of the requirement).

Much of the forest below 2300m above sea level (a.s.l.) have been over-extracted, resulting in loss of ground cover, exposing soil to degradation and erosion (MPFS, 1988). Nepal is rich in biodiversity. There are more than 100 species of trees and shrubs that are being used as sources of animal fodder (Panday, 1982; Howland and Howland, 1984; Amatya, 1990; Neil, 1990).

LOCATION, PHYSIOGRAPHY AND LAND USE PATTERN

Nepal is a Himalayan kingdom located between India and China at 80°04' to 88°12'E and 26°22' to 30°27'N. It has an area of about 14.7 million ha, of which more than 80% of the land area is occupied by rugged hills and mountains. Although Nepal is a small country, because of its dramatic changes in altitude within short distances, climate ranging from tropical to tundra types occurs. Physiographic divisions are presented in Table 1. Land utilization patterns for the 5 physiological regions are given in Table 2.

TABLE 1. **Physiographic divisions**

Region	Elevation (m a.s.l.)	Area '000 ha	Area %
High Himal	>4200	3350	23
High Mountain	2000-4200	2960	20
Middle Mountain	1500-2000	4442	30
Siwalik	300-1500	1886	13
Terai	60-300	1110	14
Total		14748	100

Source: LRMP (1986)

TABLE 2. **Land use pattern (10^3 ha).**

Region	Cultivated land	Non cultivated land	Forest land	Shrub land	Grass land	Other	Total
High Himal	8	1	155	67	885	2234	3350
High Mountain	244	148	1639	176	508	245	3960
Middle Mountain	1223	667	1811	404	278	59	4442
Siwalik	269	59	1438	29	16	75	1886
Terai	1308	123	475	30	58	116	2110
Total	3052	998	5518	706	1745	2729	14748
(%)	21	7	37	5	12	18	100

Source: LRMP (1986)

RUMINANT POPULATION AND DISTRIBUTION

Ruminant population of Nepal is estimated at 15.5 million (DFAMS, 1991). It's ecological distribution is given in Table 3 where, for simplicity, physiological divisions are grouped into 3 ecological zones: mountains (high himal and high mountain), hills (middle mountain and Siwaliks) and the Terai.

The livestock sub-sector contributes about 25% of agricultural GDP or 15% of the national GDP (CBS, 1991). Ruminants supply milk, meat, wool and draught power for cultivation of land. Besides these, they provide manure to the extent of 49.3 million T/yr. Large ruminants supply 100% of farm power, 85 % of soil nutrients and 94 % of meat (DFAMS, 1991). They also act as the vital link between forests and crop production, by converting forest leaf litter to compost. Ruminants provide uncontrolled manure and urine to the forest, where they browse and graze. Bedding material (leaf litter) mixed with urine and manure make compost. Compost is the major source of fertilizer to replenish soil nutrients and sustain crop production.

TABLE 3. **Ruminant population and ecological distribution (10^3).**

Region	Cattle	Buffalo	Sheep	Goat	%	Total
Mountain	806	303	366	808	14.8	2296
Hills	3242	1772	404	3089	54.9	8503
Terai	2243	928	125	1395	30.3	4690
Total	6255	3044	906	5295	100.0	15489

Source: DFAMS (1991)

FEED RESOURCES

The total TDN supply from different sources are given in Table 4. The major sources of nutrients provided to the ruminants are mainly from straws (51 %), green grasses (30%), fodder tree leaves (12%) and concentrates (7%) (New Era, 1990). However, earlier estimates for tree and shrubs as fodder were as high as 35% of the total available TDN (Panday, 1982; Brewbaker, 1984; LRMP, 1986; MPFS, 1988). Forest

resources are by far the most important source of fodder tree and shrub leaves. Projection of fodder supply from various sources are estimated at 6.7, 7.4 and 8.3 million T TDN for the years 1990/91, 2000/01 2010/11 respectively (MPFS, 1988). The feed and fodder balance sheet is presented in Table 5.

TABLE 4. **TDN supply from different sources (10^3 Tonnes)**

Source	Amount	%
Grassland	670	10.6
Forest	1010	16.0
Shrubs/burnt forest	530	8.4
Fallow grazing	240	3.8
On-farm fodder	120	1.9
Raisers/bunds	330	5.2
Crop by-products and residues	3424	54.1
Total	6324	100.0

Source: ANZDEC/APROSC (1986), MPFS (1988) adjusted for change in crop production figures 1988/89.

TABLE 5. **Feed balance sheet (10^3 T TDN)**

	Mountains	Hills	Terai	Total
Feed required	930	4985	2949	8864
Feed available	1056	2228	3040	6324
Feed balance	126(+)	2757(-)	91(+)	2540(-)
% deficit/surplus	113(+)	55(-)	103(+)	29(-)

Source: Joshi and Panday (1991)

There are big variations in the estimates of feed requirements. MPFS (1988) estimates the feed TDN requirements at 6.35 million T, which is much lower than estimates reported by several authors (Panday, 1982; Joshi, 1988). The variations may have been due to the differences in the assumed body weights used to calculate the livestock standard unit (LSU).

FOREST RESOURCES

The forest area of Nepal is estimated to be about 5.5 million ha or 37.4% of the total area of the country, of which about 100,000 ha is deforested each year (Brewbaker, 1984). In the quest for fuel and fodder, man has over-exploited forest resources, making them incapable of supporting the growing need for fuelwood and fodder.

Most of the remaining forests in the hills and mountains of Nepal are temperate, subalpine and alpine forests dominated by *Quercus*, *Pinus*, *Tsuga*, *Abies*, *Rhododendron*, *Lyonia*, *Symplocos*, *Acer*, *Juniper* and *Lauraceae* (Metz, 1987). The natural vegetation is grouped under the following categories according to altitude (MPFS, 1988):

a) Tropical forest (< 1000m), predominantly *Shorea robusta*, *Acacia catechu* and *Dalbergia sissoo*.
b) Subtropical forest (1000-2000m), predominantly *Pinus roxburghii*, *Schima wallichiana*, *Castanopsis* spp., *Alnus nepalensis*, *Albizia* spp. and *Toona* spp.
c) Lower temperate forest (2000-2700m) predominantly *Pinus wallichiana*, *Quercus* spp.
d) Upper temperate forest (up to 3100m) predominantly *Pinus wallichiana*, *Quercus* spp. and *Acer* spp.
e) Subalpine forest (3000-4200m), predominantly *Abies spectablis*, *Betula utilis* and *Rhododendron*.
f) Alpine zone (up to 4500m), predominantly shrubs specially *Rhododendron* and junipers.

Hardwoods are the most extensive forest component, comprising about 60% of the total. The distribution of different forest types are presented in Table 6.

In last 10 yrs, about 120,000 ha has been brought under afforestation (CBS, 1991). Thus far, most plantation species have been pines, which are of little value for livestock feeding. The reason for this is their ability to stabilize soils in exposed, landslide-prone areas. There is growing awareness among Nepalese hill farmers that deforestation and soil erosion have negative effects on their livelihood.

TABLE 6. **Nepal's natural forest (10^3 ha).**

Region	Conifers	Hardwoods	Mixed	Total	%
Hill Himal	54	18	83	155	3
High Mountain	492	560	577	1729	30
Middle Mountain	344	990	421	1762	33
Siwalik	37	1187	209	1433	26
Terai	0	445	0	445	8
Total	927	3200	1290	5524	100

Source: MPFS (1988)

There are useful native species which can establish themselves on difficult exposed sites and can begin the process of natural succession to establish forest covers. For example, *Alnus nepalensis* is a multipurpose, nitrogen-fixing tree which establishes on landslide-prone, exposed soils (Thapa and Budathoki, 1987). This species should be exploited to check soil erosion and for the rehabilitation of degraded forests.

IMPORTANT FODDER TREES AND SHRUBS

Extensive lists of trees and shrubs used as animal fodder in Nepal are reported elsewhere (Panday, 1982; Howland and Howland, 1984; Neil, 1990). Jackson (1987) describes in more detail the tree species found in natural vegetation, together with their silvicultural practices and chemical compositions.

Chemical composition of fodder trees and shrubs

The chemical composition of some important fodder trees are given in Table 7. More extensive lists are reported elsewhere (PAC, 1982; Panday, 1982; Bajracharya *et al.*, 1985; Joshi and Singh, 1989; Panday, 1990). Variations are found in chemical composition reported by several authors for the same species (e.g., *Ficus roxborghii*: CP 13.1-18.3%).

TABLE 7. **Chemical composition of some important fodder trees in the hills of Nepal**

Species	DM%	N%	Ash%
Albizia mollis	50	2.8	6.9
Artocarpus lakoocha	41	2.2	14.7
Bauhinia purpurea	57	2.8	11.2
Budleja asiatica	31	3.4	9.9
Castanopsis hystrix	44	2.0	3.8
Celtis australis	69	1.8	28.8
Dendrocalamus strictus	48	2.4	14.2
Dalbergia sissoo	40	2.6	8.6
Eurya acuminata	40	1.3	6.9
Erythrina arborescens	37	2.7	19.6
Ficus nemoralis	30	2.4	12.2
F. roxburghii	34	2.1	12.0
Grewia tiliafolia	35	3.1	11.9
G. oppositifolia	71	2.3	10.8
Litsea polyantha	40	2.1	8.9
Michalia champaca	49	2.2	4.5
Machilus odoratissima	43	1.8	4.4
Prunus cerasoides	41	2.6	6.3
Quercus lamellosa	66	1.9	4.1
Q. semicarpifolia	69	1.4	3.1
Salix spp.	52	3.0	10.2
Saurauia napaulensis	40	0.9	8.6
Schima wallichii	59	1.2	4.6

Source: PAC (1982); Bajracharya *et al.* (1985); Panday (1990).

Species preferred by farmers

There is a great variation in farmers' preference for different multipurpose tree species for fodder, fuel and timber. The preferred species in one region may not be the same in another region. Generally, in the hills of Nepal, *Artocarpus lakoocha*, *Ficus spp.*, *Saurauia napaulensis* are the most preferred species. In the mountains, the most preferred species are *Salix* spp. and *Quercus* spp. (Brewbaker, 1984). Promising indigenous fodder tree species need to be characterized in terms of their nutritional value and proper canopy management for optimum fodder yield. Among them *Budleja asiatica*, *Grewia tiliafolia*, *Ficus* spp. and *Salix* spp. are the

most promising ones. *Alnus nepalensis* needs special mention as it establishes very fast in the exposed, degraded soil. Since it is a nitrogen-fixing tree, it should be explored in combination with other broad-leaved trees. Some other tree species used by the farmers are given below:

Hills (1000-1500m):

Bassia butyraceae
Bauhinia spp.
Erythrina arborescens
Celtis australis
Litsea polyantha
Machillus gamblei
Prunus serasoides
Alnus nepaleneis

Mountain (3000m):

Castanopsis tribuloides
Machillus odoratissima

SOIL EROSION AND ENVIRONMENTAL DEGRADATION

Nepalese mountains are geologically young and natural mass wastage and soil erosion rates are therefore high. Forest degradation, deforestation, uncontrolled grazing, cultivation of marginal lands and other improper land use practices are responsible for accelerating the rate of soil erosion. It is estimated that 20-2000 t/ha annual soil losses occur from poorly managed sloping terraces and degraded rangeland (MPFS, 1988).

Any reduction in biodiversity and/or a reduction in the ability of the land to meet the needs of the current and future population on a sustainable basis can be considered as environmental degradation. The environmental crisis is closely associated with the exploitation of forest resources by a rapidly increasing population. Much of the land has been cleared to meet the growing demand for food and livestock (ANZDEC/ APROSC, 1991). These higher forests are extremely important both for controlling erosion and associated environmental problems, and for providing essential products to the people living below.

CURRENT STRATEGIES FOR AFFORESTATION AND WATERSHED MANAGEMENT

Strategies are needed to arrest degradation and allow rehabilitation of degraded forests with community participation. HMGN, through the Ministry of Forest and Environment and the Ministry of Agriculture and their constituent Departments, are undertaking several projects in this area, with the support from various bilateral and multilateral agencies.

In this context special mention of the Community Forestry Development Project (CFDP) is appropriate. Started in 1976/77, the approach encompasses the interests of the community in meeting their long-term needs for forest products on a sustainable basis, using participatory forest management practices. This approach helps in linking forest resource utilization with farming practices. Community forestry is considered as the most effective strategy for restoring and managing the forests, especially in the hills of Nepal.

One success story in community forestry is worth mentioning: that of Nala, a hamlet 30 km east of Kathmandu. The community of Nala faced severe shortage of fodder and fuelwood in the '40s. Realizing the importance of forests for their livelihood, they formed a community group in 1952 and later received help from the Department of Forest and the Nepal-Australia Community Forestry Program. Now the community is enjoying a surplus of fodder, fuelwood and other forest products from what is now called Nalako Thulo Ban. It is considered to be a good model for broad-leaved plantations in other parts of the country.

In 1988, a long term forest resource management program was developed in what is now known as the Master Plan for Forest Sector (MPFS).

Along with the forest management programs, various watershed management programs have been undertaken to check soil erosion (including Bagmati, Tinau and Phewa watershed projects). These are basically integrated projects for afforestation and control of soil erosion.

There are also several integrated projects that have agricultural crops and livestock as major components. Integration of forest, livestock and crop agriculture in any development project in Nepal, especially in the

hills, is essential for the success of the project.

There are 42 different agencies involved in research related to afforestation. However, there is a lack of coordination. Effort has been initiated by the Forest Research Division (FRD) of the Deptartment of Forestry by creating a Forest Research and Information Centre (FRIC). Research thus far has been focussed on the silvicultural practices of indigenous and exotic species and chemical composition of fodder trees and shrubs. Most of the research is being conducted in the lower hills of Nepal (< 1000 m) but it is argued that the research conducted here may not be appropriate for the middle hills.

CONCLUSIONS AND RECOMMENDATIONS

The constraints to livestock production is mainly due to feed and fodder scarcity. The scarcity is seasonal, from October to May, and during this long dry period fodder trees and shrubs are the major source of green fodder. Forestry is the major source of leaf fodder and bedding material for livestock in the hills.

Forestry plantations have been thus far limited to pines, because of easiness in establishment. Private plantations are limited to the richer farmers who have extra land but the community approach to forest management is becoming more popular.

Research thus far has been on silvicultural practices of indigenous and exotic species but there is still a dearth of information on the nutritive value of fodder tree species. Little information is available on the antinutritional substances present in the fodder tree leaves.

Planting of broad-leaved species should be encouraged in place of conifers in plantation forestry, to meet the demand for fodder, fuelwood and timber. Grasses/legumes can be incorporated along with plantation species to maintain ground cover and avoid soil erosion while the trees are growing. Indigenous as well as exotic tree species, like *Leucaena, Gliricidia, Sesbania*, etc., should be used to stabilize the exposed and degraded soils and help regenerate natural succession. Species should be selected which require less root depth and are frost tolerant, shed tolerant and less susceptible to browsing by livestock.

Farmers should be educated on the benefits of agroforestry to encourage private plantating of multipurpose tree species. A participatory approach can be used to identify the farmers' preferred species for forest or private plantation.

Stall feeding practices for livestock should be encouraged. Help can be given to the farmer to prepare a fodder calendar, depending upon the size of the herd. On-farm research is required to determine the optimum level of fodder leave supplementation. Further research is also needed on the nutritive value of fodder tree and shrub leaves and to standardize the chemical analysis.

We need to identify a few, promising fodder tree species and establish their sivilcultural practices, propagation techniques, lopping techniques and measure their chemical composition (including anti-nutritional factors) and feeding value.

Bibliography

Amatya, S.M. 1990. *Fodder Trees and their lopping cycle in Nepal.* Janmabhumi Press, Tahachal, Kathmandu, pp. 85.

ANZDEC/APROSC. 1991. *Discussion Document.* Livestock Sector review. Vol 2.

Bajracharya, D., Bhattarai, T.B. , Dhakal, M.R., Mandal, T.N., Sharma, M.R., Sitaula and Vimal, B.K. 1985. Some feed values for fodder plants from Nepal. *Agnew Botanika* 59: 357-365.

Brewbaker, J.L. 1984. *Fodder and fuelwood N2-fixing trees for Nepal. Integrated Cereal Project.* His Majesty's Government of Nepal pp. 18.

CBS. 1991. *Statistical Year Book of Nepal.* Central Bureau of Statistics. His Majesty's Government of Nepal.

DFAMS. 1991. *Livestock Statistics of Nepal: Preliminary Estimates.* Department of Food and Agricultural Marketing Services, Kathmandu, Nepal.

Howland, A.K. and Howland, P. 1984. *A dictionary of common forest and farm plants of Nepal.* Forest Research and Information Centre, Dept. of Forest, Kathmandu pp. 145.

Jackson, J.K. 1987. *Manual of afforestation in Nepal.* Nepal-United Kingdom forestry Research Project. Dept. of Forestry, Kathmandu pp. 247.

Joshi, N.P. 1988. Feed availability, requirement for animals and current patterns of utilization in Nepal. In: *Non-conventional feed resources and fibrous agricultural residues: Strategies for expanded utilization*, C. Devendra (ed.), International Development Centre, Ottawa, Canada pp. 147-157.

Joshi, N.P. and Singh, S.B. 1989. Availability and use of shrubs and tree fodder in Nepal. In: *Shrubs and Tree Fodder for Farm Animals*. C. Devendra (ed.), International Development and Information Centre, Ottawa, Canada pp. 211-219.

Joshi, N.P. and Panday, S.B. 1991. Available Feed Resources and their

contribution in the performance of livestock and poultry in Nepal. Paper presented at the *First International Animal Nutrition Workers Conference for Asia and Pacific*, Animal Nutrition Society of India, Sept. 23-28, 1991, Banglore, India pp. 26.

LRMP. 1986. *Land Resource Mapping Project*. Agricultural Project Services Centre, Kathmandu.

Metz, J.J. 1987. An outline of the Forest Use Practices of an upper elevation village of West Nepal. *Banko Jankari* 3: 21-28.

MPFS. 1988. *Master Plan for the forestry sector*. Main report. Ministry of Forests and Soil Conservation HMG/N/ADB/ FINNIDA, Kathmandu pp. 291.

Neil, P.E. 1990. *Research trends and forestry research data base for Nepal*. Forestry Research and Information Centre Occasional Paper no. 1/90 pp. 35.

New Era. 1990. *A study on dairy farmers in Nepal: Breeds and their potentials*. New Era, Maharajganj, Nepal.

PAC. 1982. *Chemical analysis of fodder tree leaves* (unpublished). Pakhribas Agriculture Centre, Dhankuta.

Panday, K.K. 1982. *Fodder trees and tree fodder in Nepal*. Swiss Development Cooperation and Swiss Federal Institute of Forestry pp. 107.

Panday, S.B. 1990. Fodder trees as ruminants feed in the hills of Nepal. *Annual Technical Report (1989/90)*. Central Animal Nutrition Division, Khumaltar, Lalitpur pp. 51-60.

Thapa, H.B. and Budathoki, P. 1987. Tree planting and natural succession at Pipal chaur, Sankhu. *Banko Jankari* 3: 15-16.