Sustainable Forest Management and Poverty Alleviation:

Roles of Traditional Forest-related Knowledge

Extended Abstracts
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1. Tapping of resin by local people in Cambodia - Ly Chou Beang & Lao Sethaphal
2. Woman tapping wild rubber tree in Indonesia - Zuraida
3. Collecting vines by indigenous tribal woman in the Philippines - A.B. Ella

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TRADITIONAL KNOWLEDGE ON FIREWOOD AND FODDER VALUES CORRESPONDS TO SCIENTIFIC ASSESSMENT

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Introduction

Conversion of natural habitats through different land utilisation practices is the largest single cause of loss of biological diversity in Sikkim (Chettri & Sharma 2006). In the Sikkim Himalaya, 76% of the total resources needs are derived from natural as well as agro-forestry system due to free and easy access and simplicity in their use (Sundriyal & Sharma 1996, Chettri *et al.* 2002). The ever-increasing human and livestock populations in rural areas exerts immense pressure on forests and aggravate directly on livelihood by causing shortage of resources such as firewood and fodder. Utilisation of resources by selection of species with preference is widely practised in the Sikkim Himalaya (Rai *et al.* 2002, Chettri & Sharma 2006, Chettri & Sharma 2007). These practices have created immense pressure on the preferred species leading to change in species composition and distribution of these preferred species in natural forests (Chettri *et al.* 2002). However, farmers have made very little efforts in understanding the basis of such preferences of plant species. This paper is an attempt to compare the firewood and fodder quality of different plant species, with reference to people's ranking and their chemical properties.

Methodology

Study on firewood and fodder preferences by the local communities and their chemical properties were made in the Yuksam and Tshoka villages of west Sikkim. Matrix ranking tool of Participatory Rural Appraisal (PRA) was used for people's preference ranking on firewood and fodder species; and the chemical properties for firewood were tested by various methods used by Purohit & Nautiyal (1986), Rai *et al.* (2002), and Chettri & Sharma (2007). In addition, 25 fodder species were considered for another set of chemical analysis where crude protein (CP) and ether extraction (EE) of fodder species were estimated in dry matter basis following Anderson and Ingram (1993). Fodder value index was developed to assess the quality of fodder species with consideration of calorific value, dry matter (DM), crude protein (CP), ash content, and moisture content (MS), following suggested relationship by Saha *et al.* (1997). These attributes were then compared with the people's scores among the 17 widely used firewood species of the study area. Initially, Pearson's Correlation analysis was performed among the people's score, Fuelwood Value Index (FVI) and Fodder Value Index (FoVI), along with other wood attributes. A stepwise backward regression was also used for these two variables keeping the people's score as dependent variable and the wood attributes as independent variables to see the relationship between people's preference and wood and fodder characteristics.

Results

Baseline information gathered using Participatory Rural Appraisal (PRA) tools showed that the communities living at Yuksam-Dzongri trekking corridor use a wide variety of species for firewood and fodder. Due to the ability to recognise and the knowledge on quality of species, the communities living in these areas practised selective resource collection, and compensate with other species if the preferred species are not available. The research also revealed that the local people's preferences for firewood ($Y=3.30+0.48x$, $R= 0.48$, $P<0.05$) and fodder ($Y=0.74 +0.39x$, $R= 0.62$, $P<0.05$) were significantly related to the FVI and FoVI.

Firewood and fodder: preference ranking

Sixteen firewood and 23 fodder species were recorded as preferred species during the PRA session at Yuksam. *Quercus lieata and Q. lamellose* were ranked the highest firewood species followed by *Schima wallichii*, *Betula alnoides* and *Eurya acuminate* (Table 1). Among the 23 fodder species, 59%

were tree fodder, 14% shrubs, 18% herbs and 9% climbers. *Thysanolaena maxima* was the highest ranked fodder species followed by *Ficus nemoralis* and *Q. lamellosa*. However, *Prunus cerasoides* and *Artemisia vulgaris* were among the least preferred species.

Firewood and fodder: Chemical properties

Among the 16 widely used woody tree species, rhododendrons were found with high calorific value and the FVI. Among them, *Rhododendron arboreum* showed the highest value followed *by Q. lamellose* and the least was recorded from *Alnus nepalensis* and *Litsea elongate*. Among the fodder species, *Thysanolaena maxima* showed the highest calorific values as well as the FoVI (Table 2). The other attributes also varied among the species corresponding to the FVI and FoVI. Interestingly stepwise regression supported the rationale behind people's score, as the firewood and fodder attributes are strongly correlated to the basis of preferences. This analysis clarified that energy value; density, moisture and ash contents were the key attributes for people's preference for firewood. However, it revealed that moisture content is of least importance to the people's choice. Similarly, the calorific value, dry matter and nitrogen content were the most important distinguishing factor for people's preference.

Discussion

Chemical properties of plants provide important information about their values (Purohit & Nautiyal 1986). It is therefore, important to assess the quality as per preference. For ideal firewood, high heat of combustion, high density, low ash content, and other combustion properties are the most desirable (Purohit & Nautiyal 1986). Among firewood species *Rhododendron* spp. and *Quercus* spp. were found to have high FVI which corresponded with the preference ranking scores. Similar report has been reported from Central Himalaya (Purohit & Nautiyal 1986). Nitrogen contents in almost all the lower ranking species were high. Higher nitrogen content produces more nitrogen oxides from the wood during combustion thus reducing the acceptability as good firewood (Purohit & Nautiyal 1986). Due to low ash content, high density and low moisture, *R. arboreum* was found to be the most desirable firewood with the highest FVI value as discussed by Chettri & Sharma (2006).

Among the enlisted species for fodder, all the three high ranked species were tree fodders. Shrubs, herbs and climbers showed comparatively low ranking for preference as also reported by Bajracharya *et al.* (1985). This may attribute to the seasonal availability of these species. *Thysanolaena maxima*, *Ficus nemoralis, Quercus lamellose, Imperata cylindrica* and *Saurauia napaulensis* were found to be the highest ranking fodders with comparatively high calorific value and other characteristic supporting the earlier studies of Saha et al. (1997) and Ranjhan (1977). In spite of high calorific value, many shrubs and herbs species have low feed value. This may be due to low DM. The estimated data revealed that the quality of fodder does not depend solely on one variable like calorific value nor the protein content but the combination of such properties results in deciding the high feed value of fodder, which corresponded with the report by Bajracharya *et al.* (1985). The attribute to ecological factors including soil and climate, also influences the chemical composition of fodder plant (Wolf 1972). Most of the tree species ranked high as fodder by the local community have more than 30% dry matter and less than 10% ash as suggested by Pandey (1975) and Ranjhan (1977), suggesting that the local knowledge of preference are applicable for the selection of better fodder. Overall, the chemical properties and preference rank agreement seems to be applicable for many of the tree fodders but vary with herbs, shrubs and climber.

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Table 1. Firewood Value Index (FVI) and other wood attributes of the firewood species enlisted from Yuksam-Dzongri trekking corridor, west Sikkim.

Sl No	Latin and local names in parenthesis	People's scores	Energy value (kJ/g)	Moisture content (%)	Density (g/cm^2)	Ash content (%)	Biomass/ ash ratio	FVI
1	*Rhododendron arboreum* (Lali guras)	6	19.72	25	0.69	0.24	417	22678
2	*Quercus lamellose* (Bajrant)	10	20.47	39	0.72	0.23	435	16431
3	*Rhododendron falconeri* (Korling)	4	19.30	49	0.65	0.25	400	10241
4	*Schima wallichii* (Chilaune)	9	19.41	59	0.76	0.22	455	11365
5	*Quercus lineata* (Phalant)	11	20.21	47	0.69	0.28	357	10596
6	*Prunus cerasoides* (Panyun)	5	17.15	44	0.73	0.27	370	10538
7	*Rhododendron barbatum* (Lal chimal)	6	17.91	47	0.75	0.29	345	9855
8	*Castanopsis hystrix* (Jat katus)	4	18.78	43	0.79	0.38	263	9080
9	*Prunus nepualensis* (Arupate)	2	18.46	47	0.76	0.33	303	9046
10	*Beilschmiedia sikkimensis* (Tarsing)	5	15.79	41	0.58	0.25	400	8935
11	*Acer oblongum* (Phirphire)	4	17.78	35	0.67	0.63	159	5403
12	*Betula alnoides* (Saur)	8	18.91	56	0.67	0.47	213	4814
13	*Eurya acuminata* (Jhiguni)	8	16.75	50	0.72	0.67	149	3600
14	*Symplocos ramosissima* (Kharane)	1	15.24	76	0.67	1.3	77	1033
15	*Alnus nepalensis* (Uttis)	2	16.25	66	0.45	1.6	63	692
16	*Litsaea elongata* (Kali pahenli)	2	13.59	58	0.35	1.83	55	448

Table 2. Calorific value and nutrient composition of 23 widely used fodder species of Yuksam-Dzongri trekking corridor.

Sl No	Species (local name)	People's scores	Calorific value (kJ/g)	Ash free Calorific value (kJ/g)	Dry matter (%)	Ash (%)	N (%)	CP (%)	FoVI
1	*Thysanolaena maxima* (Amliso)	22	22.04	21.99	38	8.9	2.54	15.8	18.18
2	*Ficus nemoralis* (Dudhilo)	20	20.92	22.42	30	11.2	2.24	14	16.81
3	*Quercus lamellosa* (Bajrant)	19	20.23	17.06	65	6.4	1.24	7.7	15.38
4	*Imperata cylindrica* (Seeru)	18	18.92	20.45	46.6	7.5	1.36	8.5	13.02
5	*Saurauia napaulensis* (Gagoon)	17	18.23	20.14	18.9	9.5	2.09	13.1	12.19
6	*Rhaphidophora sp.* (Kanchirna)	16	18.17	22.21	24	12.6	1.69	10.6	11.8
7	*Litsaea elongata* (Pahenli)	17	19.35	20.69	42.2	6.5	2.25	14.1	11.49
8	*Ficus roxburghii* (Nebaro)	20	18.6	19.53	33.3	4.8	2.35	14.7	10.66
9	*Arundanaria hookeriana* (Parang)	11	19.85	22.15	48	5.9	1.38	8.6	10.55
10	*Eragrostis tenella* (Banso)	11	17.67	21.42	15.8	17.5	1.46	9.12	9.65
11	*Cauteleya spicata* (Pani saro)	8	18.04	20.31	21.2	11.2	1.78	11.1	7.81
12	*Bambusa nutans* (Malla bans)	9	19.23	21.06	33.8	8.7	1.42	8.87	6.75
13	*Crysopogon gryllus* (Salimo)	9	17.66	24.68	40	8.2	1.41	8.8	6.09
14	*Ichnocarpus frutecens* (Dudhe lahara)	8	18.86	19.6	35.5	3.8	1.88	11.7	6.04
15	*Arundanaria racemosa* (Mallingo)	9	18.86	22.05	56.7	14.5	1.37	8.6	5.47
16	*Brassaiopsis mitis* (Phutta)	8	16.23	21.32	27.9	5.1	1.38	8.6	4.96
17	*Pantapanax leschenaultii* (Chinde)	5	19.11	20.64	36.1	7.4	1.36	8.5	4.65
18	*Solanum aculeatissum* (Bhede ghans)	6	18.61	20.63	38.3	9.8	1.26	7.9	3.49
19	*Aconogonum molle* (Thotne)	9	19.98	22.6	32.5	11.6	1.78	11.1	3.46
20	*Prunus cerasoides* (Panyun)	3	20.04	22.59	32.3	11.3	1.69	10.6	3.36
21	*Artemisia vulgaris* (Tetey pattey)	2	17.17	19.33	24.1	11.2	1.7	10.6	1.94
22	*Leucanthus pedicularis* (Sanu gagleto)	4	14.73	18.69	14.5	21.2	1.94	12.13	1.54
23	*Elastostemma sessile* (Thulo gagleto)	5	15.73	17.11	12.7	8.1	1.56	9.7	1.03