Estimating forest product values in Central Himalaya - methodological experiences

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Abstract

Forests are crucial to the livelihoods of millions of poor people in developing countries. Yet quantitative approaches to estimate the economic value of forest products and other environmental resources at household-level across different sites have only recently been developed and experiences on using such methods are only presently emerging. This paper presents methodological experiences from using a structured household survey approach to estimate household forest dependency in two high altitude areas in Central Nepal. Area and village level background and contextual information was collected using qualitative techniques; this was followed by a structured household (n = 180) survey conducted over a full year from December 2005 to December 2006. Households were randomly selected and inter alia subjected to quarterly income surveys. The emphasis in this paper is on investigating whether own-reported value data is valid and reliable. It is concluded that it is reasonable to use households own-reported values as these estimates produced aggregated unit values with acceptable properties.

Keywords: Economic valuation, valuing environmental resource use, Nepal

1. Introduction

Forests are crucial to the livelihoods of millions of poor people in developing countries. But just how important are they in preventing and reducing poverty? Which types of forests and products count most for the poor? Are forests mainly useful as gap-fillers and safety nets preventing extreme hardship or can they help lift people out of poverty? How do different forest management regimes and policies affect the benefits poor people derive from forests? Answers to such questions are essential to design effective forest policies and projects, and to incorporate forest issues in poverty reduction strategies. Yet we have surprisingly little empirically based knowledge to answer such questions adequately.

Research on the role and potential of forests in preventing and reducing poverty is limited and can be considered an emerging field of inquiry. Existing literature has been critically examined with the aim of understanding forest-poverty linkages and the potential of forests in poverty alleviation (Arnold and Bird, 1999; Arnold, 2001; Wunder, 2001; Angelsen and Wunder, 2003; Scherr et al., 2004; Sunderlin and Ba, 2005), and a recent World Bank paper used a meta-analysis to assess rural dependence on forest income (Vedeld et al., 2004). Available studies clearly show that comparisons of forest product valuation studies are generally not possible because of varying methods (e.g. Campbell et al., 2002; Cavendish, 2002; Godoy and Bawa, 1993; Gram, 2001; Narian et al., 2005; Vedeld et al., 2004; Wollenberg and Nawir, 1998). An important consequence of this is that forest income remains excluded from official data collection and thus is largely invisible to policy makers. There is therefore a need to develop best-practice methods for assessing the role of forests and other environmental resources in rural livelihoods, and then create a critical mass of good and comparable data. Methods should be developed for use at household level, cover all income sources comprehensively, be quantitative and be described in detail (Cavendish, 2002). Such methods have recently been developed by the Poverty and Environment Network (PEN introduction 2008, PEN prototype questionnaire 2007, PEN technical guidelines 2007) and empirical data collection is taking place across a variety of sites. This paper reports methodological findings, using the PEN prototype questionnaire and approach, on forest product valuation in a high altitude remote site in the Central Nepal Himalaya. The emphasis is on (i) investigating whether own-reported volume and value data is valid and reliable, and (ii) how to value products that are neither traded or bartered and where there are no useful substitutes on which to base valuation.

1.1 Case study area

Field work was undertaken in two Village Development Committees (VDCs – the lowest administrative unit) in the lower part of Mustang District (around 28°34'-28°41' N and 83°33'-83°44' E) in the Western Region of Nepal. Each VDC is made up of three villages. Altitudes are above 2000 masl with a temperate to sub-alpine climate; annual average precipitation is approx. 1500 mm.

Land use is characterised by upper and higher elevation subsistence production type systems (Metz, 1989, 1990; Olsen, 1996): large areas of rainfed fields whose fertility is mainly maintained through use of composted manure. Livestock dominated by cattle, sheep and goats.

Transhumance is common and there are large grassland and forest areas, including around 3000 ha of essentially closed canopy forests consisting of conifers (*Pinus*, *Cupressus*, *Abies*, *Tsuga*, *Taxus*) and mixed broadleaves (*Ilex, Rhododendron, Neolitsea, Acer, Betula, Populus*). Community-based grassland and forest management is common. The forest area per capita is about 1.7 ha as is the per capita area of grassland under community-based management. The most common sources of off-farm income are agricultural labour, portering, long distance trade, and from involvement in tourism (the study area is located in the Annapurna Conservation Area, a popular trekking destination).

The study area is characterized by a considerable level of forest dependency, e.g. through use of forest fodder to feed livestock and forest litter as input in compost production, and widespread poverty, e.g. the area has one of the lowest Human Development Indexes in the world (0.136 according to DDC 2002).

2. Methods

This section briefly explains how forest income data was collected, checked, cleaned and valued. Essentially, data collection and handling followed the procedures specified in the PEN prototype questionnaire (2007) and the PEN technical guidelines (2007), i.e. first qualitative rural appraisal at village level subsequently used to adopt the prototype questionnaire to the local context, then testing of structured questionnaires, random selection of households, and application of questionnaires. Appraisal field work started in October 2005 and the last quarterly survey was conducted in December 2006.

The prototype questionnaire was translated into Nepali (PEN Nepali, 2008) by a team of faculties from the Institute of Forestry (IOF) at Tribhuvan University. All translated structured questionnaires were then tested in a village outside the sampling frame; based on this testing the final translations were worded.

Before field work commenced enumerators and supervisors were identified, selected and trained. Six high school graduate local enumerators (two female and four male) were thoroughly trained in a one-week programme and then used for the entire period of the survey. Trained IOF faculty supervised the local enumerators and checked the quality of the data and data collection; they participated in interviews and checked completed questionnaires. After coding in the field these were again checked and verified for consistency before entering into a unique yet simple MS Access

database. Errors and inconsistencies were resolved by returning to households for clarification.

2.1 Rapid appraisal

In each village in each VDC contextual information, e.g. on village history and resource use patterns, was solicited through semi-structured village meetings, focus group discussions and key informant interviews. This included participatory resource mapping, drawing up an annual calendar of key activities, and making detailed lists of forest products used for both subsistence and commercial purposes.

2.2 Household-level structured surveys

An overview of the population and sample size and distribution is provided in Table 1. To allow detailed intra- and inter village level analyses a large number of households (n = 194) were sampled – 56% and 59% in the two VDCs respectively. Sampled households were randomly selected using an up-dated census list from each VDC office and a computer generated random table. At survey end, 14 households were excluded from the data set due to incomplete information or because validity was estimated to be low – at end of field work enumerators estimated household-level truthfulness on a scale of 1 to 3, with 1 being not valid and 3 being very valid. The average score was 2.43 with a vast majority of households estimated to provide very valid or valid responses. This good result is primarily due to the skilful local enumerators, their hard work and good rapport with the respondents.

Table 1 Population and sample size and distribution, 2006

Description	Kunjo VDC	Lete VDC	Total
Total population	826	911	1737
Total households	163	174	337
Average household size	5.1	5.2	5.2
Sampled households	92	102	194

Two types of structured surveys were carried out: annual household surveys (at survey start and survey end) and four quarterly household surveys. The first annual household survey provided basic household information (demographics, land holding, assets, access to forest, relation to forest institutions, markets for forest products) while the second annual survey focus on changes (in assets, household level crises and unexpected expenditures, payments for forest services, welfare perceptions). The four quarterly surveys were basically designed for collecting high quality income data, including detailed questions on forest products. Off-farm and non-farm

wage income contributed by each household member was recorded. Data was collected to allow calculation of net income from product processing and businesses (gross income minus costs of production). Indeed, data was collected to allow for detailed calculation of net income for all types of activities, including costs of agricultural inputs such as seeds, fertilizer and hired labour and basic livestock data such as each species' mortality and natality. Non-farm income included a range of activities such as interest earned, remittances (both cash and in-kind payment from family, friends and the state) and inheritance.

All selected households were informed of the purpose of the research in advance through an official letter. Whenever possible two adult household members, always including the household head, were interviewed. On average a household-level interview lasted 45 minutes.

Local volume units were standardized to SI units through repeat weighing of all units for all major products. Valuation was, whenever possible, done by reporting farm-gate prices; if not available valuation was done using barter values, substitute prices, distant market prices or value of time (labour – see also PEN technical guidelines 2007). This time consuming work was possible as researchers were in the study area throughout the year.

3. Results

In the research project underlying the present paper, estimating the true sustainability of household-level income is important. Therefore, here, some attention is paid to converting local volume units to SI units though this information is not strictly required to just estimate household income using the above approach. This is then followed by investigating basic distributional statistics for unit values in order to check whether own-reported values are useful. For products where no own-reported values can be obtained, the assumptions and techniques used to estimated values are presented; particular attention is paid to the key products browse and graze.

3.1 Conversion of local volume units to SI units

A total of 115 forest, non-forest environmental, agricultural and livestock products, reported in many different local units, are used for both subsistence and commercial purposes. Some products are reported in many different units, e.g. fuelwood may be reported in large or small rope-tied backloads (bhari) or in large or small bamboo baskets (doko). The results of the weight and volume measurements of products of major importance to households are presented in Table 2. In general, the median and modal

values are close to the mean, and standard deviation is much less than the mean. The traditional local volume measures mana and pathi are related: eight mana to one pathi. This relationship is not found for all products; the least accurate figures are for garlic (5.6:1) and barley (6.3:1). Deviations are due to the variation created by (i) differences in moisture contents (products can be fresh, semi-dry or dry), (ii) use of available local volume vessels instead of two high quality standard vessels, and (iii) intra-species product variation, e.g. fine grain weighs more than coarse grain per unit. This indicates that, for some products, the number of observations should be increased.

Table 2 Conversion of local units to SI units for forest, non-forest environmental and agricultural products in Lower Mustang District, 2006 (only includes products where $n > 5$)

Products	Local unit	SI unit	N	Min	Max	Median	Mean	s.d.
Maize	pathi	gram	12	3350	4500	3775	3775	313.0
	mana	gram	12	390	450	423	420	18.6
Barley	pathi	gram	10	2450	2775	2513	2563	97.4
	mana	gram	10	350	455	418	405	36.6
Naked barley	pathi	gram	12	3000	3600	3295	3274	184.9
	mana	gram	7	400	500	470	451	34.9
Green chilly	mana	gram	6	310	450	410	383	50.5
Beans	pathi	gram	8	3200	3800	3375	3450	218.8
	mana	gram	10	350	450	395	406	33.1
Buckwheat	pathi	gram	12	2300	2900	2780	2707	192.7
	mana	gram	10	350	450	388	387	29.2
Potato	pathi	gram	10	2700	3100	3000	2955	132.2
	mana	gram	11	350	525	400	405	48.4
Garlic dry	pathi	gram	10	1800	2400	2175	2130	184.4
	mana	gram	9	350	410	380	378	23.7
Mushroom (dry tawe)	pathi	gram	8	250	350	295	290	30.8
	mana	gram	10	35	50	43	42	5.8
***Zanthoxylum armatum* fruits**	mana	gram	10	120	210	175	166	32.3
Fuelwood	L-bhari	kg	10	40	49	43	44	3.4
	S-bhari	kg	7	30	39	38	36	3.1
	L-doko	kg	8	44	55	48	48	4.0
	S-doko	kg	16	28	42	32	33	3.9
Charcoal	doko	kg	9	21	28	26	25	2.2
	bora[1]	kg	8	11	15	14	14	1.3
Fodder grass	mutha[1]	kg	17	0.8	1.1	1.0	0.9	0.1

Products	Local unit	SI unit	N	Min	Max	Median	Mean	s.d.
(high quality - sanchi dry)								
Fodder grass (sanchi fresh)	mutha	kg	7	3.9	5.2	4.3	4.5	0.5
Bamboo (nigalo)	bhari	kg	15	20	31	24	24	3.3
Compost manure	doko	kg	15	16	36	28	26	7.0
Bamboo shoot (tusa)	mutha	kg	7	2.5	4	2.9	3.2	0.6
Fodder grass (ordinary)	bhari	kg	22	22	47	28	30	7.5
	doko	kg	21	18	40	33	30	6.9
Pole (large, bolo)	piece	m^3	47	0.007	0.227	0.105	0.104	0.035
Pole (small, khamba)	piece	m^3	60	0.022	0.088	0.039	0.044	0.013
Stick (sata, taiyu)	piece	m^3	28	0.003	0.009	0.007	0.006	0.003
Beam (dalin)	piece	m^3	62	0.071	0.189	0.142	0.131	0.027
Beam (satari)	piece	m^3	58	0.042	0.142	0.071	0.072	0.018
Planks (falek)	piece	m^3	61	0.005	0.021	0.012	0.013	0.003

[1] Bora is a large sack and mutha is a small bundle

3.2 Checking own-reported values

In his ground-breaking study of environmental resource use in Zimbabwe, Cavendish (2002) concluded that own-reported values are generally a good measure of the value of environmental resources. Whether this also holds true in the present high altitude Central Himalayan study area is investigated in this section – basic distributional statistics for unit values of the main forest, non-forest environmental, agricultural and livestock products are presented in Table 3. The column "Valuation method" specifies the dominant method used to value each product: local market means that the basis is farm-gate price; barter means that value is derived from trade with a market commodity; substitute that valuation is through a close substitute with a local market price; distant market that valuation uses the price at a distant market deducted for transport costs; and time means that valuation is done based on labour time multiplied by the relevant local daily wage rate (varies with season and gender). The valuation methods are listed in order of preference.

In general, all agricultural products could be valued using farm-gate prices (77%) or barter values (23%); for livestock products farm-gate prices (90%) were generally available – the main exception being manure (see section 3.3). This pattern is different for the large group of forest and

non-forest environmental products: for 31% farm-gate prices are available, while barter is used for 10%, substitute pricing for 23%, distant market prices for 13% (nearly all medicinal plant products), and labour time for 23%. Product-level choice of valuation technique, when farm-gate and barter pricing were not possible, was generally determined by use, harvesting and trading patterns: using close substitute whenever possible, otherwise using distant (road head) market prices for traded goods and estimating the opportunity cost of labour for products collected during discrete harvesting trips. See also section 3.3 for how valuation of difficult products were undertaken.

For most products the mean, median and modal units are very close in value showing little skewness, and in general the standard deviation is lower than the mean and in many cases lower than half the mean. This indicates that own value estimates reflect resource values (rather than being just arbitrary answers provided by respondents who feel obliged to participate in the research). Products deviating from this pattern (notably wooden furniture, poles, cattle) are arguably quite heterogenous (e.g. size, quality) and we would expect high variation in unit values. For some products, the number of observations are too low to ensure good estimates, e.g. the unit value of a doko of fuelwood (n = 8) would vary according to the species composition and the wood moisture content. Such intra-product quality variation was not recorded and is a cause of dispersion in the unit values. Thus, to arrive at estimates with acceptable properties, it is important to disaggregate products as much as possible. Product differences are reflected in the large differences in minimum and maximum values of many products – a span also influenced by spatial and temporal variability in values. The latter is seen in the seasonal value variation for selected products, with a high number of observations, in Table 4.

In the last column in Table 3, the product unit value (typically Nr/kg) is provided; this should be similar regardless of local unit and valuation technique used. This is generally the case though there are exceptions, e.g. for garlic, ghee and wild vegetables. It should be noted that value/local unit is more accurate than the value/SI unit as the latter is calculated using a weight conversion factor; as seen in Table 2 this may require many (more) observations to establish estimates with good properties. We would also expect the unit price of processed products to be higher than for raw materials; this is consequently the case in Table 3, e.g. when comparing raw and processed bamboo (chitro, doko, kaap), fuelwood and charcoal, timber and wooden furniture, poles and ploughs, milk and butter/cheese/ghee.

Table 3 Own-reported unit values (Nr) of forest, non-forest environmental, agricultural and livestock goods in Lower Mustang District, 2006 (100 products where $n \geq 5$)

Products	Local unit	n	Min	Max	Median	Mean	s.d.	Valuation method	Nr/kg[1]
I. Forest and non-forest env. products									
Bamboo product (chitro)	piece	48	100	350	200	199.4	55.1	local market	33
Bamboo product (doko)	piece	111	50	150	100	93.6	15.5	local market	31
Bamboo product (kaap)	piece	13	10	30	10	12.7	6.0	local market	28
Charcoal	doko	21	100	300	170	164.3	63.5	local market	7
	bora	148	50	200	100	115.4	28.4	local market	9
Fodder grass (dry sanchi)	mutha	235	5	40	8	12.0	8.1	local market	3
Juice (seabuckthorn)	litre	22	100	400	100	123.2	65.2	local market	123(/l)
MAP (yarsagumba)	piece	11	30	50	30	35.5	6.9	local market	142000
Mushroom (guchi)	kg	16	500	4000	4000	2687	1750	local market	2687
Mushroom (tawe dry)	pathi	59	200	350	300	298.3	20.7	local market	1029
	mana	11	10	130	40	46.8	31.6	local market	1170
Lumber	m^3	159	3531	17657	6357	6519	1244	local market	6519(/m^3)
Wooden furniture	piece	27	20	4500	1000	1258	1325	local market	11438(/m^3)
	set	20	500	5000	1625	1940	1145	local market	9700(/m^3)
Wooden tool (agri.)	piece	97	10	170	15	23.9	29.4	local market	7980(/m^3)
Wooden tool (plough)	piece	44	200	1000	500	511.4	229.2	local market	10227(/m^3)
Walnut	kg	21	20	40	20	27.1	9.6	local market	27
***Z. armatum* fruit**	mana	20	40	70	60	59.0	8.5	local market	358
Bamboo shoot	kg	205	10	60	40	36.9	15.0	barter value	37
	mutha	130	10	60	30	34.5	13.2	barter value	35
Incense	bhari	103	90	350	300	259.4	69.3	barter	12

Products	Local unit	n	Min	Max	Median	Mean	s.d.	Valuation method	Nr/kg[1]
(diyalo)								value	
	doko	165	50	400	100	159.6	89.6	barter value	8
Ornamental plants	mutha	8	5	30	10	10.6	8.2	barter value	11
	piece	91	2	30	5	7.6	4.8	barter value	23
Tree bark (incense)	kg	7	5	30	20	19.3	9.3	barter value	19
	mutha	11	5	20	10	14.1	5.8	barter value	14
Tree leaves	mutha	50	5	50	20	24.1	10.8	barter value	24
	piece	8	2	10	5	5.9	3.2	barter value	18
Bamboo (broom grass)	mutha	55	10	100	40	46.2	24.4	substitutes	5
Fish	kg	6	100	300	220	215.0	66.3	substitutes	215
Amphibia (medicinal)	kg	5	60	200	100	112.0	52.2	substitutes	112
	piece	24	5	70	50	46.5	18.5	substitutes	122
Snails (medicinal)	piece	7	5	10	5	7.1	2.7	substitutes	143
Mushroom (tawe fresh)	kg	315	20	300	100	102.6	55.3	substitutes	103
Wild fruit (guyalo)	kg	62	20	50	20	23.0	7.1	substitutes	23
Wild fruit (kopen)	kg	48	10	50	20	23.5	7.3	substitutes	24
Wild fruit (ainselu)	kg	5	30	50	30	36.0	8.9	substitutes	36
Wild veg. (dude-lasune)	kg	424	5	60	20	23.3	7.9	substitutes	23
	mutha	142	5	80	30	26.0	12.1	substitutes	26
	doko	15	100	400	200	183.3	69.9	substitutes	9
Wild veg. (dhogayo)	kg	32	10	50	20	21.4	8.2	substitutes	21
	bhari	15	200	500	300	313.3	83.4	substitutes	16
Wild veg. (green)	kg	25	10	40	20	23.2	7.8	substitutes	23
	mutha	60	5	50	20	21	11.8	substitutes	21
MAP (chiraito)	mutha	8	5	50	10	14.4	14.5	distant market	37

Products	Local unit	n	Min	Max	Median	Mean	s.d.	Valuation method	Nr/kg[1]
MAP (kutki)	piece	11	2	40	10	14.7	10.3	distant market	173
MAP (nirmasi)	piece	6	10	35	20	20.0	9.5	distant market	235
MAP (satuwa)	piece	8	5	30	10	11.3	8.3	distant market	132
MAP (panchaunle)	piece	7	10	20	10	12.1	3.9	distant market	143
Wooden stick	piece	195	5	40	10	9.1	5.3	distant market	3020
Bamboo	bhari	283	100	430	300	273.8	82.4	value of time	11
	piece	247	1	20	5	4.6	2.8	value of time	10
Clay (sagarmato)	doko	55	25	200	50	83.1	58.3	value of time	3
Fodder grass (ordinary)	bhari	112	20	130	50	55.7	33.9	value of time	2
Fuelwood (trunk)	bhari	357	20	250	80	84.1	34.7	value of time	2
	doko	8	20	200	45	63.8	57.3	value of time	2
Fuelwood (branch-twig)	bhari	227	20	300	60	68.3	39.2	value of time	2
	mutha	18	10	30	20	22.2	6.5	value of time	3
Decayed litter	bhari	28	20	80	30	34.5	14.4	value of time	1
	doko	5	25	50	50	40.0	13.7	value of time	1
Poles	piece	121	10	800	50	110.2	132.6	value of time	2204(/m^3)
Thatch grass	bhari	11	100	200	150	153.6	36.7	value of time	5
Tree bark	bhari	8	30	70	35	38.1	13.1	value of time	1
	doko	5	20	50	30	34.0	15.2	value of time	1
Dry pine leaf litter (sanpat)	bhari	100	50	200	100	98.3	19.13	value of time	2
Mixed leaf litter	bhari	137	40	300	60	66.75	28.17	value of time	2
II. Agricultural products									
Apple	kg	10	15	30	20	19.0	4.6	local market	19

Products	Local unit	n	Min	Max	Median	Mean	s.d.	Valuation method	Nr/kg[1]
Plum	kg	5	10	20	20	16.0	5.5	local market	16
Peach	kg	21	10	30	20	17.1	5.8	local market	17
Barley	muri	108	800	2400	1200	1151.9	254.9	local market	22
	pathi	30	40	80	70	66.0	7.7	local market	25
Bean	muri	71	1600	4000	3000	3085.9	260.4	local market	45
	pathi	129	70	200	160	161.3	18.2	local market	47
Buckwheat	muri	151	1000	3200	1400	1425.8	298.1	local market	26
	pathi	47	50	100	70	74.1	12.2	local market	27
Cabbage	kg	436	10	35	20	19.7	4.4	local market	20
Carrot	kg	107	10	60	25	25.5	9.7	local market	25
Cauliflower	kg	188	10	60	30	28.2	8.6	local market	28
Chilli	kg	23	20	80	43	44.7	17.9	local market	45
Garlic	kg	81	10	100	20	35.1	25.2	local market	35
	pathi	80	50	300	150	147.3	40.8	local market	49
Green leafy veg	kg	322	10	80	15	19.9	13.4	local market	20
	mutha	298	5	60	15	16.2	5.3	local market	16
Maize	muri	304	1000	1800	1200	1227	112.0	local market	16
	pathi	17	40	70	60	60.6	8.1	local market	16
Onion	kg	31	10	80	40	34.7	17.4	local market	35
Potato	pathi	196	40	120	60	57.5	11.8	local market	19
	muri	241	600	1600	1000	998.6	241.3	local market	17
Soyabean	muri	10	2000	4000	2750	2840	751.6	local market	41
	pathi	48	100	300	155	162.6	49.9	local market	46

Products	Local unit	n	Min	Max	Median	Mean	s.d.	Valuation method	Nr/kg[1]
Tomato	kg	29	20	70	50	47.9	15.1	local market	48
Amaranthus	kg	15	20	60	20	25.0	11.2	barter value	25
	pathi	16	100	200	150	151.9	42.3	barter value	34
Gourd	kg	58	10	50	20	22.7	8.8	barter value	23
Pumpkin	kg	28	10	50	20	27.5	13.0	barter value	27
	piece	33	15	70	40	38.3	11.8	barter value	19
Radish/turnip	kg	217	10	30	15	16.9	4.8	barter value	17
Tree tomato	kg	13	20	65	60	52.7	13.3	barter value	52
III. Livestock products									
Butter	kg	8	200	300	275	266.3	38.9	local market	266
Cheese	kg	12	200	350	275	270.8	62.0	local market	270
Egg	piece	608	10	15	10	10.0	0.2	local market	200
Ghee	kg	17	300	600	350	370.6	101.6	local market	370
	mana	61	150	400	300	286.4	42.3	local market	573
Hide/skin	piece	117	10	1500	50	75.1	150.6	local market	-
Honey	mana	66	200	350	300	304.2	22.3	local market	608
Meat chicken	kg	309	120	800	300	316.7	96.6	local market	316
Meat mutton	kg	220	100	500	200	204.7	67.7	local market	205
Meat pig	kg	6	100	200	160	161.7	37.1	local market	162
Meat yak	kg	12	100	500	200	220.8	119.6	local market	221
Milk	litre	78	40	90	55	55.6	12.0	local market	55(/l)
	mana	145	10	40	25	26.7	5.7	local market	53(/l)
Wool	kg	22	10	70	27.5	29.5	17.2	local market	30

Products	Local unit	n	Min	Max	Median	Mean	s.d.	Valuation method	Nr/kg[1]
Beehive	piece	128	300	6500	1000	1384	1140	local market	-
Buffalo	piece	84	3000	25000	16000	15464	5687	local market	77
Chicken	piece	828	200	1200	600	623.9	160.5	local market	312
Cow	piece	476	300	35000	1200	1888.9	3658.6	local market	9
Dog	piece	221	100	2000	400	429.6	186.8	local market	43
Duck	piece	8	200	800	500	518.8	239.0	local market	259
Goat	piece	237	800	5000	2000	2209.9	813.3	local market	110
Horse	piece	120	15000	100000	35000	39220	17389	local market	196
Mule	piece	77	15000	45000	30000	30701.3	4199.2	local market	154
Ox	piece	529	1500	8000	5500	5174.9	1086.2	local market	26
Pigeon	piece	16	100	350	150	161.3	57.5	local market	269
Pig	piece	30	1500	15000	5000	6683.3	3902.9	local market	134
Sheep	piece	129	1100	7000	3000	2948.3	783.8	local market	147
Yak	piece	20	4000	40000	18000	20150	8362.0	local market	101
Mule carrier	days	6	150	600	300	316.7	150.6	local market	-
Horse riding	days	48	100	1500	500	517.7	268.5	distant market	-
Draught power	days	350	100	600	300	257.9	73.7	value of time	-
Manure[2]	bhari	29	25	60	30	37.4	13.9	value of time	1
	doko	548	15	150	50	43.3	17.8	value of time	2

[1] These figures should be treated with caution: the most reliable are those where local units have been weighed in SI units (see Table 2 for products with $n > 5$). Other rely on respondent guesstimates or, more rarely, figures from the literature.

[2] The value of composted manure can be calculated as the sum of dry pine needle litter and manure.

Table 4 Seasonal variation in own-reported values (Nr) for selected forest products (with high number of observations), Lower Mustang District, 2006

Products	Local unit	N	Winter			Spring			Summer			Autumn		
			n	Mean	s.d.	n	Mean	s.d.	n	Mean	s.d.	n	Mean	s.d.
Bamboo	bhari	283	69	193	67	59	282	80	94	319	51	61	288	75
Charcoal	bora	148	73	111	27	24	105	21	22	110	18	29	139	32
Bamboo basket (doko)	piece	111	2	103	25	41	95	17	45	90	15	23	97	11
Fodder grass (ordinary)	bhari	42	21	74	23	3	50	0	10	75	27	8	74	33
	mutha	201	14	17	10	59	20	7	84	10	6	44	10	7
Fuelwood (trunk)	bhari	562	230	81	26	96	70	8	66	81	38	170	82	16
Fuelwood (twig/branch)	bhari	283	113	71	38	40	55	16	24	135	93	106	60	16
Compost manure	doko	444	108	35	12	102	45	14	119	49	9	115	53	24
Mushroom (tawe)	pathi	59	NA	NA	NA	4	300	0	52	297	21	2	325	35
Poles	piece	108	37	102	103	37	84	110	26	55	68	8	135	127
Leaf litter (sanpat)	bhari	234	137	66	20	9	94	81	NA	NA	NA	88	101	17
Wooden stick (tayu)	piece	195	61	10	5	55	7	3	61	7	6	18	16	4

Thus the results in Table 3 indicate that valid and reliable own-reported values, also for forest and non-forest environmental products that are not traded or bartered, can be established using the described valuation methods and that these values can be interpreted in an economic sense as prices. Such values can thus be used in forest income calculations for households where own-reported estimates are not available.

When estimating the opportunity cost of labour, it should be noted that labour wage rates vary across seasons and gender. An overview of these variations is presented in Table 5. There is a tendency for wage rates to be higher during the summer (main harvest season) and lower during the winter but this is not statistically significant. There is also a tendency for male wage rates to be higher than female wage rates but again the differences are not significant.

Table 5 Farm and non-farm labour wage rate (Nr/day±s.d. / *n*) variation across seasons and gender, Lower Mustang District, 2006

	Sex	Winter	Spring	Summer	Autumn	Mean
Farm	Female	185±41 / 6	208±34 / 30	205±44 / 22	220±49 / 25	209±43 / 83
	Male	188±48 / 14	209±48 / 29	251±76 / 18	238±64 /12	220±62 / 73
Non-farm		189±45 / 19	221±92 / 11	272±91 / 11	236±70 / 11	223±77 / 52
	Female					
	Male	290±125 / 31	364±148 / 27	335±64 / 35	292±70 / 31	319±108 /124
Mean		233±102 / 70	253±112 / 97	276±84 / 86	253±70 / 79	255±95 / 332

3.3 Techniques used to estimate values for difficult products

The majority of products making up household income can be valued using interviewees own-reported values. In most cases, valuation is straight forward, e.g. (i) lumber of *Pinus wallichiana* are purchased from the local saw mill for Nr 180/cuft and this is used as the farm-gate price for this product, or (ii) some wild mushrooms and wild vegetables have close substitutes, such as cultivated vegetables, with a local market price. However, there are products for which valuation is difficult. In the following, an overview is provided of how valuation was done for products that are neither traded or bartered and where there are no useful substitutes on which to base valuation**.**

Fuelwood is usually collected on discrete harvesting trips (i.e. harvesting trips organised with this single purpose) during late autumn and winter and were hence valued using the opportunity cost of labour, taking into account gender and seasonal variations in daily wage rates (the average daily adult wage rate was Nr 255±95; Table 5). There is some variation in the resultant estimated values as there are variations in species harvested, distance to collection sites, and individual carrying capacity.

In the production systems in the study area, stall feeding is common. Manure is gathered from the stalls and mixed with dry pine needle litter and mixed leaf litter (the latter usually in smaller amounts) in composting pits. The composted manure is transported in dokos to agricultural fields and applied. The ***dry pine needle litter*** and ***mixed leaf litter*** is usually gathered in bharis during discrete collection trips, only allowed after the first flush of snow in late autumn or early winter, and valued using the opportunity cost of labour.

Likewise, ***manure*** is valued based on the time required to collect, transport and apply the composted manure using the opportunity cost of labour. The unit value of ***composted manure*** can thus be calculated as the sum of the unit value of litter and manure. There is some variation around the mean

value for both litter and manure as collection distance and individual carrying capacity vary.

Clay is excavated along river banks and used for roofing of houses. Again, as the excavation and transport are discrete activities, the opportunity cost of labour was used for valuation. Value variation is due to differences in physical performance of excavators/porters.

A few ***medicinal plant products*** are traded locally, and some are traded through long-established marketing chains and can be valued using prices at road heads (distant market prices). We had only very few observations of medicinal plants used for self-medication and it appears likely that this product group is significantly under-reported.

Livestock are critical to most households in the study area and most livestock products can be valued using farm-gate or barter pricing. The important exception is browse and graze. Most livestock feed freely in de facto community managed forest and grassland areas and the value of browse and graze is significant as these constitute the major source of fodder for cattle, buffaloes, horses, mules, goats, sheep and yak. Browse and graze are, however, difficult to value as there is no market for grazing rights and no close substitutes. Cavendish (2002) discusses the possibilities of valuing livestock feed at the output end but this requires a string of assumptions, e.g. that livestock do not add value to food inputs, that makes these approaches very questionable. Instead, we here present an alternative approach that focus on directly valuing browse and graze at the input end. First, using Nepal specific data, we estimate annual fodder consumption per livestock unit; then, using data from our structured survey, we determine the relative importance of main land use types as sources of fodder; finally we combine this with the valuation of ordinary quality fodder grass, that can be estimated using the opportunity cost of labour, to arrive at the total value of fodder per household (approach can also be used to calculate the total value of fodder per land use type).

The daily per livestock unit (LU, equivalent to adult cow weighing 200 kg) feed requirement is 4.8 kg dry weight: 17 kg fresh weight/day, with browsing and grazing animals consuming 70% of this (enough to meet minimal maintenance requirement, ensure limited milk production and provision of draught power), and dry/wet weight ratio of 0.4 (Metz 1994). This figure is close to the minimal subsistence annual fodder demand of 1.7 t (oven-dry weight) per LU per year estimated by Mahat et al. (1987).

A seasonal overview of the relative importance of sources of fodder in the study area is provided in Table 6. There is some stall feeding of livestock, especially during the winter, but the majority of fodder (82%) is

obtained through browsing and grazing. In Chimkhola, neighbouring the present study area, Metz (1994) similarly estimated that browse and grazing provided around 70% of livestock fodder. In our study area, forests are the single most important source of fodder (55% of total), followed by grass land (21%) and agricultural land (15%), Table 6. It is also noteworthy that forests are important throughout the year while grass lands are mainly important in the summer and autumn and agricultural land in the winter (livestock graze directly on fields when there are no crops) which is also when stall feeding is most important. Livestock is consequently moved between alpine pastures (grass lands) and valley bottoms (agricultural land). Most fodder used in stall feeding is derived from agricultural land (67%), i.e. agricultural residues (trees are not found on agricultural land in the study area), and forests (23%).

Table 6 Relative importance (%) of sources of livestock fodder across seasons and the relative importance of browse/graze and stall feeding across seasons and sources of fodder, Lower Mustang District, 2006. Based on quarterly interviews with 164 livestock owning households

	Agriculture	Forest	Grass land	Other land	Browse and graze	Stall feeding
Winter	34	50	5	11	67	33
Spring	12	55	13	20	87	13
Summer	12	63	24	2	91	9
Autumn	1	53	44	2	85	15
Full year	**15**	**55**	**21**	**9**	**82**	**18**
Browse and graze	4	62	24	10		
Stall feeding	67	23	8	3		
Avg value of browse and graze (Nr/hh)	1833	6721	2566	1100	10020	2200

Fodder grass (sanchi) is harvested and stored in small semi-dry twisted bundles (mutha). High quality grass has a local market price as it is purchased by mule owners (transporting goods through the area using so-called mule trains). Ordinary quality grass is usually collected on discrete harvesting trips for use in stall feeding and can thus be valued using the opportunity cost of labour. Thus the value of ***browse and graze*** can be calculated, using the figures for weight and values in Tables 2 and 3, to Nr 0.74 per dry weight kg (mean price of Nr 55.7 per bhari ordinary quality grass weighing 30.3 kg of green weight converted to dry weight using the dry/wet weight ratio of 0.4). This can then be used to estimate the total value of livestock browse and graze per household (as well as per source of fodder, such as forests). When calculating per household income, the value

of browse, graze and stall feed should be deducted from livestock income and booked under the sources of fodder.

4. Discussion and conclusion

Households in the Central Himalaya use a large number of products, for both commercial and subsistence purposes, harvested across land use types in the landscape. The majority of products can be valuated using farm-gate or barter prices or through valuation of a close substitute with a local market price. Analysis of basic distributional statistics for such prices, generated through own-reported values by interviewed households, show that prices are valid and reliable across very different product types. It was also attempted to standardise local units for the major forest and agricultural products; this work is very time consuming and for some products it seems that the number of observations need to be increased as there may be substantial variation in weight, e.g. due to differences in moisture content or species composition.

Products that are neither traded nor bartered and where there are no useful substitutes on which to base valuation are more difficult to value. Fortunately, in this study area, most of the major products were collected during discrete harvest trips and it was straight forward to estimate the opportunity cost of labour. One particularly challenging product to value was browse and graze; livestock income is important to most households in the study area and, to get an accurate picture of the relative importance of different sources of subsistence and cash income, it is important to estimate the value of fodder inputs. By combining already available data on livestock unit feed requirements with data collected on sources of fodder and valuation of fodder grass, using the opportunity cost of labour, it was possible to estimate the value of browse and graze as well as stall feeding.

In conclusion, we found it reasonable to use households own-reported values as these estimates produced aggregated unit values with acceptable properties.

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