Forestry's contribution to livestock feed in Uttarakhand, India: a quantitative assessment of volume and economic value

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Abstract

Livestock sector forms an important livelihood activity for farmers, through supporting agriculture and supplementing income in India. The lack of availability of sufficient feed is one of the major limiting factors for better productivity of livestock. The feed are of two types as roughages (high in crude fibrous material) available at public forest, farm lands, etc. and concentrates (high in nutrients and mixture of oil, coarse grain, and cereals).

The general degradation of forest reduces the fodder availability, severely. Therefore, improving forest condition may provide pathways for sustainability of both, livestock and forest. This may be addressed through sustainable forest management, which requires scientific inputs and may be shifting of some demand of locals to other resources. This requires huge amount from government. Presently, livestock sector is part of the Agriculture and Allied Activities sector in the accounting system of India, and therefore, all related shares and expenditure is part of the component. This results into under allocation for the actual shares of forestry contribution to livestock, in the Forestry and Logging sector. This occurs primarily, due to the lack of scientific information on the share and value of fodder from forest. This study has been undertaken to estimate the share and economic value of forests derived livestock feed.

Primary data has been collected as per pretested questionnaire from 316 randomly selected households engaged in livestock rearing from 66 villages distributed across the Uttarakhand, India. Information pertaining to the fodder to livestock from all sources and socio-economic attributes were collected from each household to understand the feed consumption behavior of livestock. The feed sources were classified in forests, other than forests and market. The shares and economic value of livestock feed derived from different sources has been estimated for all livestock. The prices of various feeds were either collected directly from market or estimated through non market valuation techniques based on two scenarios (contingent valuation and ratio of dry and green matter basis of 0.40).

The average proportion of feed quantity consumed by livestock was 58% from forests, 39% from other than forests and 3% from markets for hilly region. It was 97% from other than forests and 3% from markets for plain region. For hilly region, the proportion of economic value varies from 40–41% for forest; 40–41% for agriculture and 18–20% from market. The total value of forest fodder was Rs 4811 millions in scenario 1 and Rs 5209 millions in scenario 2 for the Uttarakhand.

The study concludes and recommends that these proportions may be utilized to allocate the appropriate share of livestock feed into Forestry and Logging sector, which may results into the realistic share of the sector.

Key words

fodder, economic value, weight, proportion of livestock feed, rural households, system of national accounts,

Introduction

In India, the livestock and agriculture production are intrinsically interlinked, and crucial for the overall food security. Livestock sector forms an important livelihood activity for most of the farmers, supporting agriculture in the form of critical inputs, contributing to the health and nutrition of the household, supplementing income, providing employment opportunities, and is a dependable assets for adverse period. Livestock contribution and thus significance has been increased many fold with present pace of animal origin food demand in developing countries due to growing human population, increasing per capita income, and urbanization (Delgado *et al.* 1999).

The sustained livestock production needs adequate feed provision, however feed scarcity is major limiting factor for better productivity in India. The production of livestock feed in India is about 503.00 million tones (Mt) for green fodder, 393.39 Mt for crop residue with 4.6% annual increase in area for cultivated fodder (Planning Commission 2006) against the requirements of 624.00, 322.00 and 30.00 Mt, for dry matter, total digestible nutrients and digestible crude protein, respectively with deficit of 30–35% (Bakshi and Wadhwa 2004; Reddy *et al.* 2006).

The primary feed resources include native grasslands, cultivated fodder and trees, crop residues, agro-industrial by-products, and non-conventional feed resources. Broadly, the feed and fodders for livestock are classified as roughages (high in crude fibrous material) and concentrates; dry and fresh. Roughages are available at public forest as tree fodder, farm lands as agricultural residue, pasture and grazing land as grasses, terrace risers as grasses and private fodder trees (Devendra *et al.* 2000). The common livestock feed resources are of twelve categories. These are crop reduces (straw, stoves, haulms etc.); grass land, alpine, sub-alpine, pasture land; community lands, common property resources, wasteland; cultivated fodder; forest lands; cut and carry grasses; novel unconventional feeds, top feeds, famine feeds; coarse grain; oil meals; cereal bran, hulls, husks; agro products and fish and bone meals (Planning Commission 2000).

Forest lands are major source of feed for livestock for forest dependent communities. In Kumaon Himalaya, half of the total fodder is extracted from cropland and another half from community pasture land, particularly in dry season (Singh and Naik 1987). About two-thirds to three-fourth of the fodder requirement are collected from forests and grasslands in the mid-hill (Bajracharya 1999; Singh 1999) and 26–43% in the lower hill of Himalayas (Singh 1999). Tulachan *et al.* (2002) reported that on average, 58% of total fodder biomass is extracted from common property resources (CPRs) and 42% is cultivated on private cropland in Himalayas.

The rapid changes in human population and biophysical processes lead to decrement of the forest ecosystem productivity. This general degradation of forests has reduced the amount of fodder and leaf litter, with implications for livestock productivity and in turn productivity of agricultural lands. Therefore, proper attention is needed for the sustainability of forests as well as livestock. This can be addressed by enhancing the forest productivity through proper conservation and management strategy. Inadequate financing in forestry sector as well as low performance in managing available forest resources characterizes the existing pricing policy and institutional failures in this sector (Neill and Spash 2000).

In the System of National Accounts (SNA) of India, the livestock sector is part of the Agriculture and Allied Activities sector and all related shares and expenditure is part of the component. Therefore, forestry contribution for livestock feed is not accounted under the Forestry and Logging sector and this leads to under allocation of budget. This is mainly due to the lack of information on the value of forest fodder as feed besides free and easy availability as well as lack of markets for it in rural areas. This has resulted low or no response for willingness to pay by users', lower revenue generation and lower investment for improvement of the resources. Therefore, economic valuation of forest fodder may act

as an instrument for possible incorporation of the share in SNA.

This study has been undertaken to facilitate the issue under consideration by assessing the economic value of livestock feed from forests. This may provide a tool to strengthen the share of forestry sector and facilitate for policy formulation to curtail the deficit of livestock feed and protecting the forest.

MATERIAL AND METHODS

Study area

The focus of study was the Uttarakhand state (28'44" N to 31'28" N latitude and 77'35" E to 81'01" E longitude) of India with altitude ranging from 300 m to more than 7,817 m asl. Apart from the Terai region in the Shivalik foothills, the entire state of Uttarakhand is part of the Himalayan ranges. The geographical area is 53,485 km² with 66% forest cover. The major forest type groups are tropical dry deciduous forests (Plain Region), tropical moist deciduous forests, sub-tropical pine forests, Himalayan moist temperate forests, Himalayan dry temperate forests, sub alpine and alpine forests (Hilly Region) (Champion and Seth 1968). The forest canopy spread is 4,762 km² under very dense forest (with more than 70% canopy cover), 14,165 km² under moderately dense forest (with 40–70% canopy cover), 5,568 km² under open forest (with 10–40% canopy cover) and 271 km² under scrub (with less than 10% canopy cover) (FSI 2009).

Based on the climate, the region may be classified into four zone. These are as follows:
1. Tropical- subtropical zone is dominated by sal species. The other prominent species of the region is khair, semal, kanju, sissoo etc. up to elevation of about 1300 m.
2. Sub Tropical Temperate zone includes pine forest (chir pine as dominant tree) and shrubs up to elevations varying between 900 and 2100 m.
3. Temperate sub Alpine zone extends generally between 1500 to 3300 m and contains mixed coniferous forest of deodar, fir, spruce and birch.
4. Alpine Zone extends up to 4200 m with gradual transition from larger flora to smaller bushes and alpine pastures. Above to this, there is no vegetation.

Traditionally, mixed cropping farming system is prevalent in the region due to social and economic considerations. Total population of the state is 8.48 million with rural population accounts 74.33% (Census 2001). The total number of adult cattle units (ACU) is 4278877.3 (Anonymous 2005). The composition includes cattle, buffaloes, sheep, goats and pig. ACU is defined as per Young (1971) except for buffalo, which is equivalent to 1.5 ACU based on discussions with villagers and reports of G.B. Pant University (1980).

Data collection

Primary data has been collected as per pretested questionnaire from 364 randomly selected households engaged in livestock rearing from 66 villages distributed across the state. Information pertaining to the fodder utilization and socio-economic attributes were collected from each household during 2008–2009. Structured and pretested questionnaires were used to collect primary data on livestock feed stuffs from selected livestock rearing households with the protocol that interviews would be conducted only with head of household. In the region, livestock fodder was derived from a variety of sources and for convenience, categorized into three sources such as forest, other than forests (includes agriculture and other own lands) and market. The feedstuffs for livestock include all types of grasses (dried and fresh), tree leaves, agricultural residue, minerals etc. The data pertaining to feedstuff with respective sources has been collected through posing direct questions in addition to livestock rearing mechanism. The major socio-economic attributes in the questionnaires were income, land, and livestock status of the households. Interviews were conducted in Hindi by researchers themselves with the support of one local fellow, wherever necessary, after obtaining the verbal consent of each head of household. Each interview lasted on average of 30 min. Discussions were held with peers and locals to gain sufficient knowledge about the prevailing livelihood and rearing mechanism in the region.

The feed status for all categories of livestock was collected to understand the consumption behavior of feed received from various sources. Quantity consumed with economic value in Rupee (Rs) has been estimated for various livestock including proportional share of various sources. The actual quantity of feed was noted from at least 10% households of each villages of different region in all seasons.

Rate of Various Products of Livestock Feed

The economic value of various feed products was needed to estimate the proportional share of various sources. The tree leaves and grasses were received from forests and agricultural land though in low volume, which also provide crop residue. Salt and minerals either in crude or in mixture were bought from market in general. The average economic value of products bought from market was estimated based on the prices of these products at various survey locations across the state. The value of farm products was collected based on the information received by villagers as imperfect market was functional in some places. These imprecise markets operate either directly in terms of money or indirectly through exchange of some products or services. It was also observed during the survey that grasses are being sold at some places particular during lean period. The price ranges from Rs 4 to 8 kg^{-1} (Rs 45 = 1 \$) including transportation cost. This forms the basis of cost of grass on per unit basis. The value of tree leaves was estimated based on the two approaches elaborated below, as it was not governed under market mechanism.

Scenario 1

In this, the per unit price of each commodity, which is tradable either in established markets or imprecise markets in any form were estimated based on the data collected from various locations and households. Based on these prices, average prices was estimated and used for value estimation of livestock feed. This was with the premises that villagers were supposed to provide precise information keeping in view of their role and understanding of livestock rearing mechanism and farm cultivation i.e. they can understand the functional tradeoff in more realistic way under the prevailing situations of their access to resources and household characteristics. This issue is more pertinent as they are rational user of these resources for their livestock, and on the other side they are producer of these products.

The contingent valuation approach was used to estimate the value of tree leaves/fodder. Their willingness to pay (WTP) in terms of rupee value or labor work time or in both ways were noted against the derived forest fodder. The values of these products were adjudged based on bidding processes (Carson 2000) and as per discussions among the peers. The value was ranged between Rs. 2 to 6 kg^{-1}. The direct questions were asked

to the head of households as they are the best judge on their welfare under the prevailing household characteristics. The labor time was converted to rupee value based on standard rate of government of India for area B, which is prevalent in Uttarakhand. This is Rs. 169 per man days of eight hours as per Labor Commissioner, Uttarakhand vide letter No. 4807-08/4-01/07 dated 03.09.2009. Conversion of labor time with value was deemed fit keeping in view of traditional skill and expertise of tree lopping.

Scenario 2

In this, all the prices except non tradable products i.e. tree fodder were remains same. This was in the view that once these products have entered into trading, then the operating price will be true representative of the value of the products. However, for the tree fodder, we have considered the nutrient and palatability criteria. Generally, the green tree fodder is better than agriculture crop residue due to more protein and fibrous nature with better digestibility in green condition. However, with dried scenario, the tannin is more in the tree fodder, which restrict their use as feed due to low digestibility. This forms the criterion for estimating the cost of tree fodder by considering the conversion factor of the green fodder into dry condition. The proportional average of 40% for dry and green biomass weight of fodder species and 33% for grasses was used to estimate the value of tree fodder and grasses, respectively (Rajesh Kumar 2009). The value was obtained by multiplying the straw value with this proportion. Though this may depreciate the tree fodder value, however keeping in view of production of straw at the agriculture farm with application of manure and muscle power, this value seems reasonable. However, tree grows naturally without any external facilitation and freely available to the households. Thus, with this view, the value of tree fodder was estimated.

RESULTS

The composition of livestock population in the state was cows, buffaloes, goats and oxen. The average number of cows per household was 1.58, 0.97 buffalo; 1.36 goat. The average milk production was only 1.92 liter milk for cow while 2.32 liter milk for buffalo which testi-

Tab. 1. Quantity (in kg) of Livestock Feed Derived from Various Sources for Rearing in Uttarakhand State

Items	OX			Cow			Young Cow			Cow Not Calved			Male Buffaloes		
	Hill	Plain	State	Hill	Plain	State	Hill	Plain	State	Hill	Plain	State	Hill	Plain	State
From Market															
Grain	0.03	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.10	0.04	0.00	0.00	0.00
Crushed pulses	0.11	0.16	0.12	0.79	1.05	0.84	0.00	0.00	0.00	0.05	0.00	0.04	0.00	0.69	0.14
Husk	0.09	0.00	0.07	0.12	0.00	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gram	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gur	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oilseed & cake	0.08	0.32	0.13	0.01	0.37	0.08	0.00	0.00	0.00	0.10	0.02	0.08	0.00	0.46	0.09
Bran	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Salt & Others	0.07	0.01	0.06	0.06	0.06	0.06	0.00	0.00	0.00	0.03	0.01	0.03	0.00	0.05	0.01
Sub Total Market	**0.38**	**0.48**	**0.40**	**0.98**	**1.48**	**1.08**	**0.00**	**0.00**	**0.00**	**0.21**	**0.13**	**0.19**	**0.00**	**1.19**	**0.24**
From Other than Forest Lands															
Dry fodder	5.32	18.86	8.03	4.51	14.42	6.49	0.79	2.00	1.04	4.29	21.25	7.68	0.00	28.70	5.74
Green fodder	5.38	13.56	7.02	5.74	13.46	7.28	1.41	3.57	1.85	4.63	4.60	4.62	0.00	15.84	3.17
Sub Total Other than Forest Lands	**10.70**	**32.42**	**15.05**	**10.25**	**27.88**	**13.78**	**2.21**	**5.57**	**2.88**	**8.92**	**25.85**	**12.30**	**0.00**	**44.54**	**8.91**
From Forest															
Tree Fodder	7.95	0.00	6.36	9.58	0.00	7.66	1.86	0.00	1.49	9.27	0.00	7.41	0.00	0.00	0.00
Grasses	8.00	0.00	6.40	6.37	0.00	5.10	1.13	0.50	1.00	5.87	0.00	4.70	0.00	0.00	0.00
Dry Fodder	1.36	0.00	1.09	0.09	0.00	0.07	0.19	0.00	0.15	0.13	0.00	0.10	0.00	0.00	0.00
Sub Total Forest	**17.32**	**0.00**	**13.85**	**16.04**	**0.00**	**12.83**	**3.18**	**0.50**	**2.65**	**15.26**	**0.00**	**12.21**	**0.00**	**0.00**	**0.00**
Total	**28.40**	**32.90**	**29.30**	**27.28**	**29.37**	**27.69**	**5.39**	**6.07**	**5.53**	**24.39**	**25.98**	**24.71**	**0.00**	**45.73**	**9.15**
Proportion Forest	0.61	0.00	0.47	0.59	0.00	0.46	0.59	0.08	0.48	0.63	0.00	0.49	-	0.00	0.00
Proportion Other than Forest Lands	0.38	0.99	0.51	0.38	0.95	0.50	0.41	0.92	0.52	0.37	0.99	0.50	-	0.97	0.97
Proportion Market	0.01	0.01	0.01	0.04	0.05	0.04	0.00	0.00	0.00	0.01	0.01	0.01	-	0.03	0.03

Items	Buffaloes			Young Buffaloes			Goat			Sheep			ACU		
	Hill	Plain	State	Hill	Plain	State	Hill	Plain	State	Hill	Plain	State	Hill	Plain	State
From Market															
Grain	0.29	0.00	0.23	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.01	0.06
Crushed pulses	0.42	1.67	0.67	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.24	0.71	0.33
Husk	0.54	0.00	0.43	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.00	0.12
Gram	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gur	0.01	0.00	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Oilseed & cake	0.27	0.55	0.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	0.34	0.14
Bran	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Salt & Others	0.09	0.07	0.08	0.00	0.00	0.00	0.02	0.00	0.01	0.00	0.00	0.00	0.05	0.04	0.04
Sub Total Market	**1.62**	**2.29**	**1.75**	**0.00**	**0.00**	**0.00**	**0.02**	**0.00**	**0.02**	**0.00**	**0.00**	**0.00**	**0.60**	**1.10**	**0.70**
From Other than Forest Lands															
Dry fodder	6.95	23.10	10.18	0.25	3.00	0.80	0.13	3.00	0.70	0.00	0.00	0.00	3.78	20.19	7.06
Green fodder	11.19	21.10	13.18	1.47	3.57	1.89	0.91	3.57	1.44	0.00	0.00	0.00	5.02	13.43	6.71
Sub Total Other than Forest Lands	**18.14**	**44.20**	**23.35**	**1.72**	**6.57**	**2.69**	**1.04**	**6.57**	**2.14**	**0.00**	**0.00**	**0.00**	**8.80**	**33.62**	**13.77**
From Forest															
Tree Fodder	7.36	0.00	5.88	2.16	0.00	1.73	2.82	0.00	2.25	3.55	0.00	2.84	6.01	0.00	4.81
Grasses	14.02	0.00	11.21	2.26	0.00	1.81	2.72	0.50	2.27	4.19	0.00	3.35	6.52	0.02	5.22
Dry Fodder	0.84	0.00	0.68	0.34	0.00	0.27	0.22	0.00	0.17	0.70	0.00	0.56	0.48	0.00	0.39
Sub Total Forest	**22.22**	**0.00**	**17.77**	**4.76**	**0.00**	**3.81**	**5.75**	**0.50**	**4.70**	**8.44**	**0.00**	**6.75**	**13.02**	**0.02**	**10.42**
Total	**41.98**	**46.49**	**42.88**	**6.48**	**6.57**	**6.50**	**6.81**	**7.07**	**6.86**	**8.44**	**0.00**	**6.75**	**22.42**	**34.74**	**24.89**
Proportion Forest	0.53	0.00	0.41	0.74	0.00	0.59	0.84	0.07	0.69	1.00	-	1.00	0.58	0.00	0.42
Proportion Other than Forest Lands	0.43	0.95	0.54	0.26	1.00	0.41	0.15	0.93	0.31	0.00	-	0.00	0.39	0.97	0.55
Proportion Market	0.04	0.05	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-	0.00	0.03	0.03	0.03

State average is based on weights of number of units.

fy the fact that the productivity of milk cattle is poor. Goats were reared mainly for sacrifice purposes during festivals (male) or to supplement their income during adverse financial constraints. These livestock are unproductive keeping in view of production economics; however their role is very pertinent for agriculture cultivation particularly for manure. The cause of low productivity was seasonal fluctuation in fodder availability and financial constraints besides poor breed, as revealed.

The proportion of household without cow was 24.4% and 64.0% households owned up to two cows while only 11.6% owned more than 2 cows. Buffalo was not reared by 46.2% of the households due to stall feeding nature and 44.7% households owned up to two buffaloes while only 9.1% of the households owned more than two buffaloes. Goat was not reared by 68% of the households, keeping in view of the social status. About 60% of the households owned a pair of oxen while 38.6% had none and 1.9% of the households owned more than two oxen. Oxen are being used as drought power. The larger proportion of livestock was indigenous as they are suited for the hilly condition due to their adaptability and resistance against diseases besides low maintenance cost in comparison to hybrid livestock as revealed by the respondent during the survey. Moreover hybrid cattle is costly and beyond the scope of majority of the villagers.

The fodder collection is a daily routine activity by 98% households who collects either from forests or agricultural land or from both depending on situation except during rainy season. Sometimes during severe cold days, collection takes place on alternate day especially in high altitude zone. The fodder comprises mostly of grasses and tree fodder. The womenfolk were mostly involved in the collection of fodder and sometimes accompanied with children. They travelled 1 km to more than 5 km distance and devoted one to more than five hours for fodder collection.

Nearly 67% households collect fodder from their private lands with frequent visit to grassland too by 62.7%. Forest fodder was collected by 83.4% with 15.1% buy fodder i.e. grasses and straws from the other sources during severe scarcity of correcting fodder. The fodder sources change from season to season as the respondents prefer to collect fodder from the easily accessible area. As during rainy season, lots of grasses are available in the private lands and grasslands while during winter season forest are the only source of green fodder in the form of tree leaves.

Table 1 contains the quantity of livestock feed obtained for individual livestock for all types of fodder derived from various sources. These are grain, crushed pulses, husk, gram gur, oilseeds and cake, bran and salt from market; dry fodder (agriculture residue) and green fodder from other than forests land and tree fodder (tree foliage and shrubs), grasses and dry fodder (dried grasses) from forests. This table also contains the quantity consumed by hilly and plain region livestock of Uttarakhand. The proportion of feed quantity for different sources is also estimated and it was noted that the proportion of forest feed was high in hilly region, however the other than forests was more prevalent source of livestock feed in plain region. The marketed commodity "contribution" ranges from 1–3%, was non significant.

The price of livestock feed commodities were collected from different locations, where these resources enter into market mechanism. The average was estimated based on obtained prices (Tab. 2). However, the dry weight basis concept was also tried keeping in view of fibrous nature of the forest feed particularly herbs and foliages. The price of dry grasses was estimated by multiplying the weight with the proportion of green grass and straw price. The WTP for forest fodder which include grasses and tree fodder was estimated through contingent valuation (Tab. 2).

The daily and annual quantity consumed by total livestock (ACU) was estimated for hilly and plain region for Uttarakhand (Tab. 3). The average per day quantity consumed by the one ACU was 22.41 kg with 13.01 kg from forests, 8.8 kg from other than forest lands and 0.6 kg from market for the hilly region. In plain, average per day quantity consumed by the one ACU was 34.74 kg with 0.02 kg from forests, 33.62 kg from other than forest lands and 1.1 kg from market. The high value of fodder for plain region was due to low population of goat and sheep, which consume less than big sized livestock. The proportion of feed quantity consumed from various sources was 58% from forests, 39% from agriculture and 3% from markets for hilly region. However, for plain region, the contribution of fodder for livestock feed from forests was 0 and 97% from agriculture with 3% from markets (Tab. 3).

Tab. 2. Price of Various Feed Resources (in Rs.)

Items	Descriptive Statistics			
	Mean	SE	Min.	Max.
Mineral mixture	38.00	2.89	30.00	50.00
Green fodder	4.80	0.70	2.00	7.00
Choker (Husk and Bran)	9.77	0.53	8.00	13.00
Salt	9.60	0.42	8.00	11.00
Oilseeds and cake	48.00	6.27	30.00	70.00
Straw dry fodder	4.40	2.61	3.00	6.00
Forest fodder				
WTP (Day^{-1} Kg^{-1}) for grasses and tree fodder	1.22	0.06	0	13.41
Dry fodder (Ratio of dry and green Herb = 0.33)	4.80 * 0.33 ≈ 1.60			
Tree Leaves equivalent to Dry Straw (ratio of dry and green biomass = 0.40; Miscellaneous species)	4.40 * 0.44 = 1.76			

Value Analysis for Livestock Feed Derived from various Sources

The proportion of feed of different sources in weight and value terms was estimated for hilly, plain and whole state. For hilly region the proportion of forest was 40%, agriculture 41% and 18% from market for the scenario 1. The proportion of forest is zero for plain region and agriculture contributes 78% with 22% from market for the same scenario. The whole state, the contribution of forests was 26% and from agriculture, it was 54% (Tab. 4). In scenario 2, the ratio was 42% for forest and 40% for agriculture in hilly region, however it becomes 27% and 53% for states (Tab. 5). The value of quantity derived from forest for the state was Rs 4811 millions in scenario 1 and Rs 5209 millions for scenario 2.

DISCUSSIONS

The livestock feed in this region is characterized mainly in terms of grasses (green and dry); tree fodder (levees and small twigs of bushes) and minerals including oil. These feeds are generally derived from locally natural resources or from agriculture farms with very low inputs from the market, as most of minerals, grain and oil are also derived from farm produce. These feedstuff are grain, crushed pulses, husk, gram gur, oilseeds and cake, bran and salt from market as well as from farm produce; dry fodder (agriculture residue) and green fodder from other than forests land and tree fodder (tree foliage and shrubs), grasses and dry fodder (dried grasses) from forests. The low proportion for the marketed products is probably due to the poor status of the households of the region besides easy accessibility to the nearby forests. Moreover, the livestock are generally unproductive, however reared mainly for manure purposes (Pandey 2010). Largely, livestock production is mainly for subsistence in the region rather than commercial purposes. This is mainly due to the prevailing mechanism of subsistence and low input production with low demand for animal origin food products as also concluded by Steinfeld *et al.* (2006) for similar region.

Middle Himalayas have long traditions of mixed farming. The mixed farming strategy allows small holders to use resources integrally and to diversify products and services to improve their livelihood. Major biomass demands from forests include grazing and collection of fodder and fuelwood (Måren and Vetaas 2007). Even though this system contributes to sustaining the family economy, there is evidence that the tendency of overgrazing forest and fallow areas causes high pressure on fodder resources and hinders land restoration. Fallow areas play a significant role in feeding animals, especially during the dry season where land and fodder are scarce. Therefore, the present study may be utilized to address the status of natural resources for future sustainability. This is also essential keeping in view of the increased number of human population, which leads to gradual encroachment of grazing area and forestland for cultivation and other purposes. This will result in the limited grazing and forest areas for the livestock, which may cause over grazing of the grazing area and consequently leads to land degradation due to soil erosion. Therefore, grazing areas have to be properly managed through evolving mechanism in collaboration with the users group. At the same time, the number of unproductive cattle has to be reduced by replacing with improved animal. High quality fodder and forage specially the legume production system has to be enhanced vigorously such that livestock can obtain green fodder round the year.

In hills, fodder trees, shrubs and grazing in the forests are the main sources for the livestock feed including use of agricultural residue (Singh and Sundriyal,

Tab. 3. Quantity Consumed by Total Livestock on ACU basis of Uttarakhand

Items	Per Day Quantity Consumed on per ACU		Per Day Quantity Consumed in Uttarakhand by all ACU (in kg)		Annual Quantity Consumed in Uttarakhand by All ACU (in kg)		Annual Total Quantity Consumed in UK (in kg)
	Hill	Plain	Hill	Plain	Hill	Plain	Whole State
From Market							
Grain	0.07	0.01	234221.176	9328.605	85490729.24	3404940.825	88895670.07
Crushed pulses	0.24	0.71	803044.032	662330.955	293111071.7	241750798.6	534861870.3
Husk	0.15	0	501902.52	0	183194419.8	0	183194419.8
Gram	0	0	0	0	0	0	0
Gur	0	0	0	0	0	0	0
Oilseed & cake	0.09	0.34	301141.512	317172.57	109916651.9	115767988.1	225684639.9
Bran	0	0	0	0	0	0	0
Salt & Others	0.05	0.04	167300.84	37314.42	61064806.6	13619763.3	74684569.9
Sub Total Market	**0.6**	**1.1**	**2007610.08**	**1026146.55**	**732777679.2**	**374543490.8**	**1107321170**
From Other than Forest Lands							
Dry fodder	3.78	20.19	12647943.5	18834453.5	4616499379	6874575526	11491074905
Green fodder	5.02	13.43	16797004.34	12528316.52	6130906583	4572835528	10703742111
Sub Total Other than Forest Lands	**8.8**	**33.62**	**29444947.84**	**31362770.01**	**10747405962**	**11447411054**	**22194817015**
From Forest							
Tree Fodder	6.01	0	20109560.97	0	7339989753	0	7339989753
Grasses	6.52	0.02	21816029.54	18657.21	7962850781	6809881.65	7969660662
Dry Fodder	0.48	0	1606088.064	0	586222143.4	0	586222143.4
Sub Total Forest	**13.01**	**0.02**	**43531678.57**	**18657.21**	**15889062677**	**6809881.65**	**15895872559**
Total	**22.41**	**34.74**	**74984236.49**	**32407573.77**	**27369246318**	**11828764426**	**39198010744**
Proportion Forest	0.58	0.00	0.58	0.00	0.58	0.00	0.41
Proportion Other than Forest Lands	0.39	0.97	0.39	0.97	0.39	0.97	0.57
Proportion Market	0.03	0.03	0.03	0.03	0.03	0.03	0.03

Tab. 4. Value in Rupee for Annual Quantity Consumed by Total Livestock of Uttarakhand based on Scenario 1

Items	Price per Unit (in Rs.)	Value of Quantity (in Rs. Day⁻¹ ACU⁻¹)		Per Day Value of Quantity for all ACU of Uttarakhand (in Rs.)		Annual Value of Quantity for all ACU of Uttarakhand (in Rs.)		Annual Total Value for UK (in Rs.)
		Hill	Plain	Hill	Plain	Hill	Plain	Whole State
From Market								
Grain	38	2.8	0.56	9368847.04	522401.88	3419629169.60	190676686.20	3610305855.80
Crushed pulses	38	9.03	26.85	30214531.70	25047304.43	11028304071.96	9142266115.13	20170570187.09
Husk	9.77	1.49	0	4985565.03	0.00	1819731236.68	0.00	1819731236.68
Gram	38	0	0	0.00	0.00	0.00	0.00	0.00
Gur	38	0.06	0	200761.01	0.00	73277767.92	0.00	73277767.92
Oilseed & cake	48	4.33	16.24	14488252.74	15149654.52	5288212251.56	5529623899.80	10817836151.36
Bran	38	0	0	0.00	0.00	0.00	0.00	0.00
Salt & Others	9.6	0.44	0.35	1472247.39	326501.18	537370298.08	119172928.88	656543226.96
Sub Total Market		**18.15**	**44**	**60730204.92**	**41045862.00**	**22166524795.80**	**14981739630.00**	**37148264425.80**
From Other than Forest Lands								
Dry fodder	4.4	16.63	88.82	55644259.38	82856669.61	20310154675.16	30242684407.65	50552839082.81
Green fodder	4.8	24.12	64.48	80705925.22	60150845.04	29457662703.84	21955058439.60	51412721143.44
Sub Total Other than Forest Lands		**40.75**	**153.29**	**136350184.60**	**143007514.65**	**49767817379.00**	**52197742847.25**	**101965560226.25**
From Forest								
Tree Fodder	1.22	7.33	0	24526303.14	0.00	8952100647.56	0.00	8952100647.56
Grasses	4.8	31.3	0.11	104730325.84	102614.66	38226568931.60	37454349.08	38264023280.68
Dry Fodder	1.6	0.77	0	2576432.94	0.00	940398021.64	0.00	940398021.64
Sub Total Forest		**39.40**	**0.11**	**131833061.92**	**102614.66**	**48119067600.80**	**37454349.08**	**48156521949.88**
Total		**98.30**	**197.40**	**328913451.44**	**184155991.31**	**120053409775.60**	**67216936826.33**	**187270346601.93**
Proportion Forest		0.40	0.00	0.40	0.00	0.40	0.00	0.26
Proportion Other than Forest Lands		0.41	0.78	0.41	0.78	0.41	0.78	0.54
Proportion Market		0.18	0.22	0.18	0.22	0.18	0.22	0.20

Tab. 5. Value in Rupee for Annual Quantity Consumed by Total Livestock of Uttarakhand for Scenario 2

Items	Price per Unit (in Rs.)	Value of Quantity (in Rs. Day⁻¹ ACU⁻¹)		Per Day Value of Quantity for all ACU of Uttarakhand (in Rs.)		Annual Value of Quantity for all ACU of Uttarakhand (in Rs.)		Annual Total Value for UK (in Rs.)
		Hill	Plain	Hill	Plain	Hill	Plain	Whole State
From Market								
Grain	38	2.8	0.56	9368847.04	522401.88	3419629169.60	190676686.20	3610305855.80
Crushed pulses	38	9.03	26.85	30214531.70	25047304.43	11028304071.96	9142266115.13	20170570187.09
Husk	9.77	1.49	0	4985565.03	0.00	1819731236.68	0.00	1819731236.68
Gram	38	0	0	0.00	0.00	0.00	0.00	0.00
Gur	38	0.06	0	200761.01	0.00	73277767.92	0.00	73277767.92
Oilseed & cake	48	4.33	16.24	14448252.74	15149654.52	5288212251.56	5529623899.80	10817836151.36
Bran	38	0	0	0.00	0.00	0.00	0.00	0.00
Salt & Others	9.6	0.44	0.35	1472247.39	326501.18	537370298.08	119172928.88	656543226.96
Sub Total Market		**18.15**	**44**	**60730204.92**	**41045862.00**	**22166524795.80**	**14981739630.00**	**37148264425.80**
From Other than Forest Lands								
Dry fodder	4.4	16.63	88.82	55644259.38	82856669.61	20310154675.16	30242684407.65	50552839082.81
Green fodder	4.8	24.12	64.48	80705925.22	60150845.04	29457662703.84	21955058439.60	51412721143.44
Sub Total Other than Forest Lands		**40.75**	**153.29**	**136350184.60**	**143007514.65**	**49767817379.00**	**52197742847.25**	**101965560226.25**
From Forest								
Tree Fodder	1.76	10.58	0	35400857.74	0.00	12921313076.56	0.00	12921313076.56
Grasses	4.8	31.3	0.11	104730325.84	102614.66	38226568931.60	37454349.08	38264023280.68
Dry Fodder	1.6	0.77	0	2576432.94	0.00	940398021.64	0.00	940398021.64
Sub Total Forest		**42.65**	**0.11**	**142707616.52**	**102614.66**	**52088280029.80**	**37454349.08**	**52125734378.88**
Total		**101.55**	**197.40**	**339788006.04**	**184155991.31**	**124022622204.60**	**67216936826.33**	**191239559030.93**
Proportion Forest		0.42	0.00	0.42	0.00	0.42	0.00	0.27
Proportion Other than Forest Lands		0.40	0.78	0.40	0.78	0.40	0.78	0.53
Proportion Market		0.18	0.22	0.18	0.22	0.18	0.22	0.19

2009). Similar pattern of livestock feeding process as in present case has been reported in several other studies (Bajracharya 1999; Tripathi 1999; Tulachan *et al.* 2002). This situation in future will remain same until and unless livestock productivity coupled with the appropriate measures for marketability of livestock derived products will not be achieved. The measure should also address the subsistence nature of household economy through providing better opportunity for income earning to these peasant households.

Conclusions and Policy Implications

Himalayan mid-elevation anthropogenic landscapes function as complex agro-ecosystems where management and conservation need to balance the knowledge, practices, and needs of a diversity of users, with global aims biodiversity conservation and sustainability for future users (Måren and Vetaas 2007). These contributions of Himalayas are tremendous for human welfare, currently, and may be continued, if human activities in the forest do not affect negatively the ability of the forest to continue in the way it was original (Franklin 2001). That is, if human impacts on the form of chronic disturbance by overgrazing, lopping, or cutting, forest-forming species, which are not allowed to progress to mature tree size (Singh 1998) may be counter balanced by appropriate measures. Therefore, proper and effective policies, which lead to the conservation of forest at one side and fulfilling of the essential needs of these people is required by implementing suitable programs. These programs ranges from the introduction of technology such as biogas, LPG etc., conservation and development of pasturelands, plantation of trees on the unstable land to stop the erosion and restore the vegetation etc. Community forestland should be taken for the use of fuel and fodder need and the natural forestland should be kept as protected and reserved forest so that the stability of the terrain could be maintained and fragility could be reduced. Infrastructure should be strengthened without the unnecessary cutting of trees and controlling the soil erosion (Satti 2006).

These programs and policies are needed huge amount of fund and may obtain by adjusting the actual share of accounts for the forestry sector into the system of national accounts. In this context, these estimated proportion may be helpful to allocate the livestock feed value based on ratios, under the component of Forestry Sector instead of Agriculture Sector of System of national accounts. This may ultimately increase the outlay of the sector. This enhanced budget may be used to strengthen on economy-environment relationships and provide pathways for sustainable development by addressing community needs from other sources instead of forests. This also facilitates the feed scarcity by improving the conditions of forests and grazing lands through conservation and management to these resources (Pandey and Mishra 2008). The information may also suffice for extrapolation and comparison purposes to other similar regions.

The other issues may revolve around the quality output from the livestock sector. Based on the study, it can be deduced that the productivity enhancement for livestock sector may be achieved, provided the provision of adequate quality feed stuffs such as minerals, concentrate may be strengthened for livestock feed besides other issues such as quality breed (as also reported by Pratap 2002; Bakshi and Wadhwa 2004). These may be achieved through providing subsidy on such feed stuffs to these peasant households in addition to the better infrastructure for creating opportunity to easy access to market for the livestock derived products.

References

Anonymous. 2005. 17th Indian Livestock Census All India Summary Report. Min. of Agri., Depa. of Ani. Hus. & Dairying. New Delhi.

Bajracharya B. 1999. Sustainable soil management with reference to livestock production systems. ICI-MOD, Katmandu.

Bakshi M.P.S., Wadhwa M. 2004. Evaluation of forest tree leaves of semi-hilly arid region as livestock feed. Asian *Australian Journal of Animal Science,* 17, 777–783.

Carson R. 2000. Contingent Valuation – A user's guide". *Environmental Science and Technology,* 34(8), 1413–1418.

Champion H.G., Seth S.K. 1968. A revised survey of forest types of India. Manager of Publications, Government of India, Delhi.

Delgado C., Rosegrant M., Steinfeld H., Ehui S., Courbois C. 1999. Livestock to 2020: The next food revolution. Discussion paper 28. IFPRI, Washington.

Devendra C., Thomas D., Jabbar M.A., Zerbini E. 2000. Improvement of Livestock Production in Crop–Animal Systems in Agro-ecological Zones of South Asia. ILRI (International Livestock Research Institute), Nairobi, Kenya, pp. 117.

Franklin S.E. 2001. Remote sensing for sustainable forests management. Pub. Lewis Publishers Washington, D.C., pp. 75.

G.B. Pant University. 1980. Integrated natural and human resource planning and management in the hills of U.P.'Pantnagar: Progress report of subproject: Study of Grassland and Livestock Resources Management in the Kumaun Hills. Pant Nagar, India.

Måren I.E., Vetaas O.R. 2007. Does Regulated Land Use Allow Regeneration of Keystone Forest Species in the Annapurna Conservation Area, Central Himalaya? *Mountain Research and Development*, 27(4), 345–351.

Neill O' J., Spash L.C. 2000. Environmental valuation in Europe. Conceptions of value in environmental decision making. *Policy research brief*, 4, 3–18.

Pandey R. 2010. Quantitative estimation of livestock feed from forest in Uttaranchal Himalayas. Final report (Unpublished), CSO, New Delhi.

Planning Commission. 2000. Draft report of the working group on animal husbandry and dairying for five-year plan 2002–2007. Planning Commission, Govt. of India, New Delhi.

Planning Commission. 2006. Report of the working group on animal husbandry and dairying: 11th Five Year Plan (2007–2012). Planning Commission, Govt. of India, New Delhi.

Pratap S.B. 2002. Technological echotecnological change in India's livestock subsector: Evidence and issues. In: Birthal, P. and Parthasarathy Rao (ed.): Technology options for sustainable livestock production in India (eds.: P. Birthal,R. Parthasarathy). Proceedings of the Workshop on Documentation, Adoption, and Impact of Livestock Technologies in India, 18–19 Jan 2001, ICRISAT-Patancheru, India, pp. 220.

Rajesh K. 2009. Ratio of dry and green biomass of some plants of Uttarakhand. Personal Communication, FSI, Dehradun.

Reddy Y.V.R.; Reddy M.J.; Hemlata B., Ramakrishna Y.S. 2006. Economic Evaluation of Dairy Farming in Rural India. Agrotech Publishing Academy, Udaipur, pp. 191.

Sati V.P. 2006. Forest Resource Management in Mountain Regions: A Case for the Pindar Basin of Uttaranchal Himalaya. *Lyonia*, 11(1), 75–84.

Singh SP. 1998. Chronic disturbance, a principal cause of environmental degradation in developing countries. *Environmental Conservation*, 25(1), 1–2.

Singh N., Sundriyal R.C. 2009. Fuelwood, fodder consumption and deficit pattern in central Himalayan village. *Nature and Science*, 7(4), 85–88.

Singh R.1999. Smallholder Dairy Farming Initiatives: Success and Failure of Milk Cooperatives in the HKH. Paper presented at the International Symposium on Livestock in Mountain/Highland Production Systems: Research and Development Challenges into the Next Millennium, 7–10 December 1999, Pokhara, Nepal.

Singh V., Naik D.G. 1987. Fodder resources of central Himalaya. In. Pangtey, Y.P.S. and Joshi, S.C. (Ed.) Western Himalaya (eds.: Y.P.S. Pangtey, S.C. Joshi), Vol. I (Environment). Shri. Almora Publication, Almora, pp. 223.

Steinfeld H.; Gerber P.; Wassenaar T.; Castel V.; Rosales M., Haan C. 2006. Livestock's long shadow: Environmental issues and options. FAO, Rome, Italy.

Tripathi R.S. 1999. Economics of buffalo milk production in Indian Central Himalaya. Inter. *Journal of Animal Science*, 14, 101–108.

Tulachan P.M., Jabbar M.A., Saleem M.A.M. 2002 Smallholder Dairy in Mixed Farming Systems of the Hindu Kush – Himalayas. ICIMOD, Kathmandu, Nepal.

UFD. 2006. Uttaranchal Forest Statistics 2005–2006. Uttarakhand Forest Department, Dehradun.

Yang W.Y. 1971. Methods of Farm Management Investigation. Agricultural Development Paper No. 8. Rome: FAO.