Chapter 7
Importance of Forest and Non-forest Environmental Resources to Sustainable Rural Livelihoods: Insights from a Case Study in Nepal

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1 Introduction

Forests and environmental resources provide a wide range of direct benefits to rural communities in many parts of the developing world. More than 2.4 billion people worldwide rely on forests for their livelihoods, particularly for energy, food and other subsistence needs (FAO 2018). Forest products such as timber, firewood, fodder, grasses, game, fruits and herbs are harvested in significant quantities by a large number of rural households, which constitutes more than 30% of the total income of rural households (Giri et al. 2018). Scholarly works emphasize the importance of forest resources for the rural poor and their dependence on forest products for maintaining rural livelihoods (Neumann and Hirsch 2000; Singh et al. 2010). Rijal et al., (2011) and emphasize the role of forest products as a cornerstone in the livelihood strategies of rural poor households. In Nepal, the majority of rural households depend on forests for their livelihoods (Rayamajhi et al. 2012; Larsen et al. 2014; Chhetri 2015; Bhandari et al. 2019).

The engagement of a rural household in forest-related activities is an economic choice in its pursuit to make a living, given its human characteristics, resource endowments and exogenous factors (Babulo et al. 2008). The community-based institutions play a crucial role in supporting sustainable livelihoods and support the socio-ecological resiliency (Ashley and Carney 1999; Melles et al. 2020). The importance of forest income is analysed in a meta-study by Vedeld et al. (2004), showing

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that forest serves as a safety net against crises, prevents from falling into deeper poverty and provides a pathway out of poverty. Moreover, the community engagement on management of resources contributes towards building the socio-ecological resiliency (see Ashley and Carney 1999; Melles et al. 2020), especially by generating income to meet their household needs. Perhaps, most forest products are economically marginal, which is why poor people are forest-dependent and forest-dependent people are poor (Angelsen and Wunder 2003).

For many rural people living in, or close to, forests in Nepal and elsewhere in developing countries, forest products are one of the major sources of cash income (Shackleton and Shackleton 2003; Chhetri et al. 2012; Rayamajhi et al. 2012). Apart from direct cash income, forests are sources of subsistence forest products, such as firewood for cooking, fodder for livestock and litter for manure, and an important livelihood means for the agrarian society of Nepal, where more than two-thirds of people depend on agriculture economy (CBS 2011). Furthermore, forests represent rich natural pharmacies by virtue of being enormous sources of plant and microbial material with known or potential medicinal or nutritional value. In addition, forests offer a safety net for the most economically vulnerable population groups in developing countries like Nepal.

Forests provide local-level employment opportunities to the rural people and support their livelihoods (Chhetri et al. 2012; Harbi et al. 2018; Baral et al. 2019). However, livelihood contribution varies by socio-economic group and is affected by several factors, such as location, species composition and nature of the forest (Baral et al. 2019). Gauli and Hauser (2011) found that, in the *Dolakha* district of Nepal, people with low household cash income, low self-food sufficiency and living close to the forest are involved in forest product collection, particularly NTFPs. Likewise, Rayamajhi et al. (2012) empirically showed that forests contributed 22% in the total income account of an average household in the lower Mustang district in terms of both cash and subsistence. In addition, various forest services such as climate regulation, soil and water conservation, aesthetic and religious value have positive impacts on people's livelihoods (Kanel and Niraula 2004).

People, mostly rural poor, are dependent on forests mainly because of a lack of other sufficient income sources. Such people depend on forests for essential forest products, including NTFPs, to sustain their livelihoods (Larsen and Olsen 2006 and Melles et al. 2020). Lack of productive assets, particularly land for agriculture, makes poor households depend on forests for cash income. People with good agriculture land and livestock also depend on forests for fodder and manure. Furthermore, households with low food self-sufficiency are most dependent on forest product collection to run their livelihoods, whereas wealthy households depend less on it (Pyhala et al. 2006).

Despite the large national dependence on forest products and services, the potential of forests to support livelihood improvement and socio-ecological resiliency is not clear. Knowledge of seemingly persistent inequitable benefit distribution generated from the forest and environmental resources by the rural forest-dependent households is needed to understand the role of forest-based livelihoods in rural Nepal in contributing towards the sustainable livelihoods, including socio-ecological

resiliency. However, there are only a few studies that are related to forest environmental contribution to household's income. Hence, this study tried to explore to what extent the forest and environmental products from different sources contribute to household income concerning the total household account and thereby on socio-ecological resiliency.

1.1 Conceptual Framework

Understanding livelihoods begins with understanding how individuals and households manage their living. Forests provide a wide array of benefits to local communities (Rayamajhi et al. 2012; Chhetri et al. 2015; Larsen et al. 2014 and Baral et al. 2019). Community-level institutions and processes have been a most important approaches to natural resource management linking with social and ecological systems, which emphasized on the sustainable livelihood approaches (Ashley and Carney 1999; Melles et al. 2020). In a broader sense, household has managed the different income sources for their livelihoods (Ellis 2000). This research explored how socio-ecological system is being contributing to the livelihoods of rural communities of Nepal. For the analysis, sustainable livelihood approaches are taken into consideration.

Forest-dependent households are those households that rely on forest products to some degree for their livelihoods and whose condition would likely be worsened without access to forests. For poor households, forest-derived income can be particularly important in meeting their subsistence needs, bridging seasonal gaps, providing a more diversified livelihood base, and reducing and spreading the agricultural risk over space and time (Fisher and Shively 2005; Baumann 2006). Forest income considers all the resources which are available within the forests irrespective of the tenure rights on forests. Hence, the study considers all incomes that are collected from the forests as forest resources. Environmental resources are those resources that are available around the household, i.e. outside of the forest, which include firewood, timber and pole, bamboo, wild foods, medicine, grasses, forest litter, sand and stone, fish and aquatic, and others. Another source of income is the farm, which includes crops, livestock and wages. Non-farm income sources include remittances, services, gifts, pensions, business and others. Figure 1 presents a framework linking a different nature of household incomes and their contributions to people's livelihoods.

Guided by the above four sources of income of households, the study estimates the forest and environment resource dependence of the households by income quartile, especially to assess which categories of households are more dependent on forest and environmental resources. In this study, forest and environment dependence is defined in terms of income dependence, meaning that the households which derive a greater share of their income from forests and forest-related activities are more dependent on forests than others. A household income is a standard measure of welfare in rural household studies, i.e. the net value to a household of economic activity, inclusive of
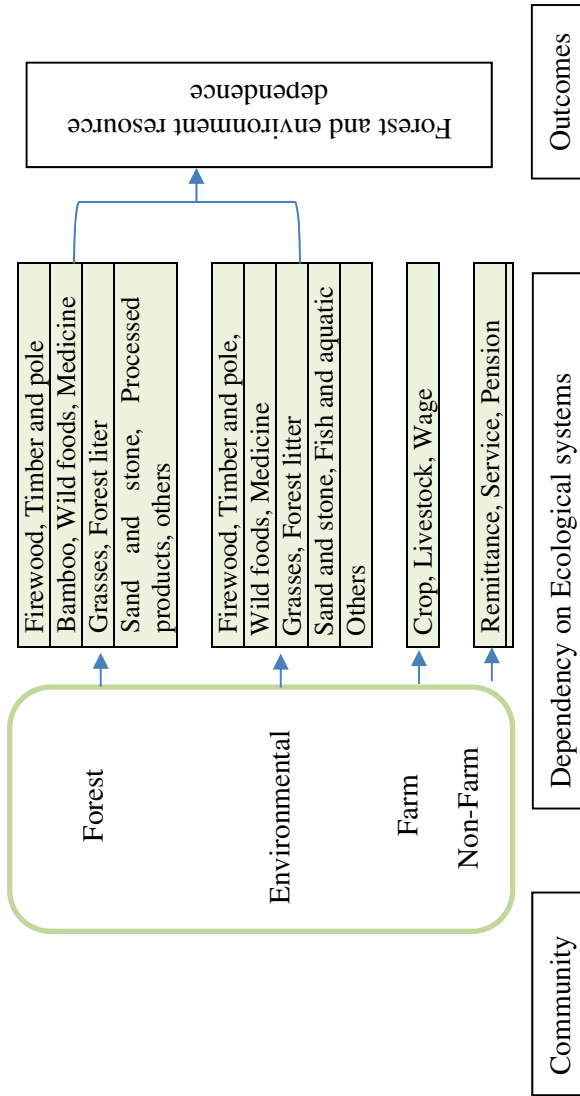
Fig. 1 Framework illustrating the linkages between different income sources to access the sustainable household's livelihoods

own use of labour income (Cavendish 2012) or gross income minus production costs. The study hypothesizes that poorer households have high forest and environment dependence compared to richer households and is conditioned by other household categories like the sex of the household head. In addition, diversity in forest activities with socio-ecological conservation and regrowth will play a more important role in supporting reducing poverty due to barriers on socio-ecological–socio-economic transformation (Ashley and Carney 1999; Melles et al. 2020).

2 Methodology

2.1 Study Site

The study was carried out in purposefully chosen Ajirkot Rural Municipality (earlier Simjung and Ghyachchok village development committees, an administrative unit). Simjung falls in ward number 4 and Ghyachchok under ward number 1 (Fig. 2). The municipality is located in the middle hills of Gorkha district (27° 15″–18° 45″N and 84° 27″–84° 58″ E), about 120 km west of Kathmandu. The basic criteria used in selecting these case study areas include: (i) relatively high forest dependence, (ii) remoteness, (iii) diverse ethnic composition and (iv) presence of a relatively large
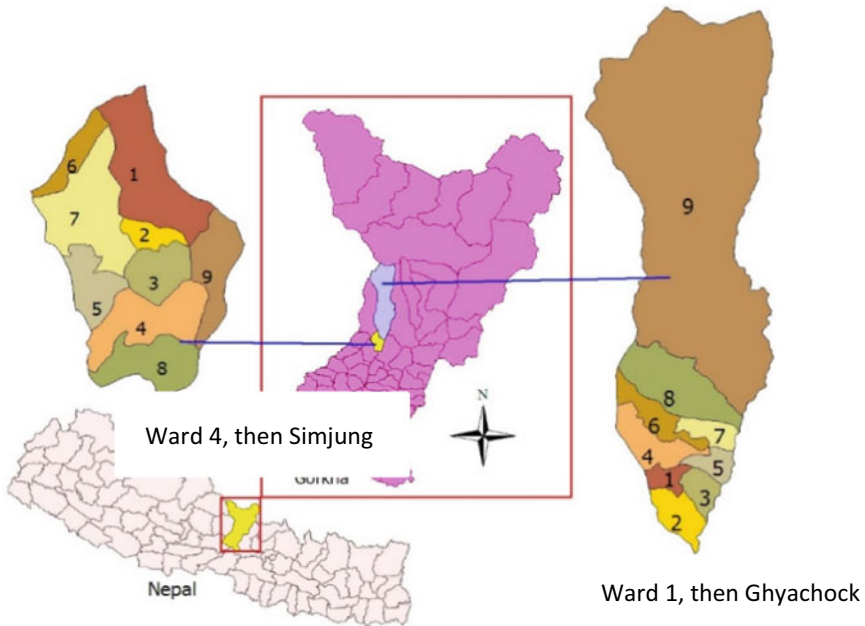

Fig. 2 Location of study site Ajirkot Rural Municipality, Gorkha district, Nepal

Table 1 General attributes of selected wards

Attributes	Ghyachchok (Ward no 1)	Simjung (Ward no 4)
Area	32.8 km^2	45.1 km^2
Ethnic compositions	Dominant by Gurung community and rest *Dalit* castes (kami, Damai and Sarki)	*Brahmin, Chhetri, Gurung, Tamangs, Newars, Magars,* etc., some other occupational castes; *Kami, Damai and Sarki*
Household compositions	Total HHs: 446, population: 2236 (1036 males and 1200 females) (CBS 2003)	Total HHs: 823; population: 3997 (1903 males and 2094 females) (CBS 2003)
Sample HHs	183	83
Economic activities	Farming, off-farm employment and business	Farming, off-farm employment and business
Source of forest products	Natural forests and farm trees	Community forests and national forests and trees in the farmland
Use of forests	Firewood, timber, wild vegetables, fodder, ground grass, etc.	Firewood, timber, wild vegetables, fodder, ground grass, etc.

Source Fieldwork 2012

number of households. The selected VDCs represent the socio-economic conditions that generally characterize rural mid-hill areas of Nepal (Table 1). An in-depth household survey was carried out to capture the socio-economic variations at the household level in terms of forest resource use and management. Out of a total of 404 community forest user groups (CFUGs) in Gorkha, 15 lie in Simjung and Ghyachchok, covering an area of 4.83 km^2 (482.8 ha) of national forest land (DFO 2008).

2.2 Data Collection and Compilation

The study focuses on primary data, with households as the unit of analysis. To collect the cash and subsistence income structure, a Poverty Environment Network (PEN) prototype questionnaire was employed. Data collection was carried out in 2012. By treating the list of households of both wards as one population, sample households were selected for an interview, using a random sampling technique employing a computer-generated random number table. In total, 276 households were randomly selected from 1,269 households. Surveys were administered by local enumerators supervised by the first author. Information on household incomes from agriculture, livestock, forest products, non-forest environmental products, business, wages, remittances, pensions and others was collected. Collected data were entered in Excel. After cleaning the data, data analysis was carried out through the STARTA software.

2.2.1   Household Survey

Total household income accounts were generated using an adapted Nepalese version PEN prototype questionnaire (PEN 2007) and the PEN standard data collection and handling procedures. Data were collected throughout 2012, using four quarterly recall household surveys, and involved 276 randomly selected households. Surveys were administered by local enumerators supervised by a research assistant and the first author. During survey rounds, follow-up was conducted daily to check the filled-in questionnaires and to clarify doubts by returning to the respondent households. The contextual knowledge of the local enumerators enabled relevant probing and facilitated trustful communication with the respondents. To establish good relations with respondent households, the researcher provided photographs taken during the initial interview and other small gifts were presented for extended periods and general interest in the respondents' well-being was shown. The household surveys focused on socio-economic household-level characteristics: assets and the data on households' incomes from agriculture, livestock, forest products, non-forest environmental products, business, wages, remittances, pensions and others. Data from previous quarterly survey rounds were brought for subsequent interviews to increase accuracy.

2.2.2   Recording and Valuing of the Available Products

Households used a large number of products, for both commercial and subsistence purposes, harvested across land use types in both wards. Marketable forest products such as timber and firewood, some animal products such as *ghee* (clarified butter) and milk, and most of the agricultural products were valued based on the village market prices. The barter system was used to value the forest products such as leaf litter, fodder and ground grasses, whereas some other products were valued based upon the exchange (substitution) pricing method, where the value of the marketed goods was used to value the value of non-marketed goods. The willingness-to-pay method also worked well in some cases. All products were measured in local units and were later converted into standard units. In addition, a price survey questionnaire was developed, where a list of all forests, livestock and agricultural products was first prepared and the price of each of those products—mostly non-marketed goods measured in local units, was filed out by organizing group meetings in various *toles* (settlements). Such price survey meetings were organized in each ward. The data of the price survey were used in triangulating the reported price (by the household) of various goods.

2.2.3   Data Categorization and Analysis

Total household income, including all cash and subsistence net incomes, is calculated by summing up all gross incomes minus the costs (intermediate inputs and capital costs) (Sjaastad et al. 2005) and is presented in per adult equivalent unit

(aeu). To avoid double-counting, the total household income was categorized into different income categories as prescribed in the PEN guideline (PEN 2007) and further grouped into three major income sources: environmental, farm and non-farm incomes. Environmental income is the sum of forest and non-forest environmental incomes. Forest income includes the net earnings from raw and processed products plus the wages from forest product activities and forest services. Non-forest environmental income includes the net value of non-cultivated wild products collected outside the forest, including fish and mineral products. The aggregate of the crop, livestock and farm wage constitutes the farm income. All other cash incomes generated from own business, national and international remittances, government and private sector employment and pensions, gift and rents, etc., comprise the non-farm income.

It was recorded from the household survey that communities were using 83 environmental and agricultural products for subsistence and commercial purposes. The costs of the products that were commonly traded in their door and local market were taken for determining the market price value of those products. The costs of products generally not traded such as grass, leaf litter and fodder were determined through the valuation techniques, e.g. willingness-to-pay method (Rayamajhi and Olsen 2008; Boxall and Beckley 2002 cited in Chhetri et al. 2015), and were analysed. The average household income per adult equivalent unit (aeu) is presented across quartiles by source and type (cash and subsistence). Second, the forest and non-forest environmental incomes are further decomposed by product categories. Last, data on income by the sex of the household head are presented and discussed.

3   Results and Discussion

First, average household income per aeu (NRs) is presented across quintiles by a source of income: environmental, farm and non-farm. Secondly, total annual mean household income from cash and subsistence, and environmental and non-environmental sources by income source across quartile are decomposed and presented. Unprocessed environmental (forest and non-forest environmental) income (NRs) per aeu by forest product type and sex of household head was examined.

3.1   Household Income

The results show there is some variation in household per aeu absolute and relative income shares by sources (Table 2). The mean annual income per aeu is NRs 53,208 and ranges from NRs 14,132 to NRs 122,669 from the lowest income quartile to the highest income quartile, respectively (Table 2). Share of household's environmental income is as much as the farm income if the farm wage income is deducted from the latter or environmental product collection is accounted for in the former. Non-farm income is the largest income, contributing an average of 51.4%, whereas the forest

Table 2 Total annual mean household (n = 276) absolute and relative income (NRs)[1] per aeu by income source and quartile

Income source	Income quartiles				Sample mean
	Lowest 25%	Second	Third	Highest 25%	
Environmental					
Forest	2411 (17.1)	5021 (17.0)	4877 (10.5)	6453 (5.3)	4691 (8.8)
Non-forest	2915 (20.6)	4851 (16.4)	7626 (16.4)	13,631 (11.1)	7256 (13.6)
Subtotal	**5326 (37.7)**	**9873 (33.4)**	**12,503 (26.9)**	**20,084 (16.4)**	**11,946 (22.5)**
Farm					
Crop	1477 (10.5)	2379 (8.1)	3244 (7.0)	4190 (3.4)	2823 (5.3)
Livestock	3613 (25.6)	6608 (22.4)	8607 (18.5)	16,491 (13.4)	8830 (16.6)
Wage	2148 (15.2)	3420 (11.6)	2580 (5.5)	794 (0.6)	2235 (4.2)
Subtotal	**7237 (51.2)**	**12,407 (42.0)**	**14,430 (31.0)**	**21,475 (17.5)**	**13,887 (26.1)**
Non-farm					
Remittance	2226 (15.8)	5442 (18.4)	7231 (15.5)	27,550 (22.5)	10,612 (19.9)
Service	73 (0.5)	40 (0.1)	12 (0.0)	121 (0.1)	62 (0.1)
Gifts	115 (0.8)	85 (0.3)	252 (0.5)	754 (0.6)	301 (0.6)
Pension	850 (6.0)	1346 (4.6)	4962 (10.7)	13,557 (11.1)	5179 (9.7)
Business	-2380 (-16.8)	-823 (-2.8)	979 (2.1)	32,418 (26.4)	7549 (14.2)
Other	685 (4.8)	1158 (3.9)	6132 (13.2)	6710 (5.5)	3671 (6.9)
Subtotal	**1570 (11.1)**	**7251 (24.6)**	**19,572 (42.1)**	**81,114 (66.1)**	**27,374 (51.4)**
Total	**14,132 (100.0)**	**29,528 (100.0)**	**46,502 (100.0)**	**122,669 (100.0)**	**53,208 (100.0)**

and environmental incomes together contribute an average of 22.5% of total household income. The contributions of the forest and environmental incomes decrease as the income of the household increases, indicating that poorer households are more dependent than richer households. Relative means of environmental and farm income sources decrease with increasing income, while the non-farm share increases with increasing income (Table 2). While in absolute terms richer household monotonically captures substantial share of income in all three categories, the wage income makes a significant contribution to the lower-income quartiles as farm income and in the real sense, the environmental income in real sense is realized by the household's net labour contribution. This echoes with the findings of other studies, which conclude that forest and environmental products are major sources of income in particular for the poorer and largely depend on forests and environmental resources for their livelihoods (Rayamajhi et al. 2012; Chhetri et al. 2015; Baral et al. 2019). Moreover, the environmental income played a major role in building the socio-ecological resiliency of the rural households especially by promoting sustainable management of the resources, reducing the vulnerability from the climatic shocks and increasing

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[1] One US$ equivalent to approximately 80 NRs in 2012.

the income and employment opportunities. The increase in contribution of forestry income of the poor households often contributes towards the resiliency (see Gautam 2009; Melles et al. 2020).

3.2 Total Household Income by Income Quartile and Source

There are large variations in household per aeu absolute cash and subsistence incomes across quintiles and income sources (Table 3). The mean total annual household per aeu income in the study area is NRs 34,836 (ranging from NRs 5,588 in the lowest

Table 3 Total annual mean household (n = 276) absolute cash and subsistence income (NRs.) per aeu by income source and quartile

Income source	Income type	Income quartiles				Sample mean
		Lowest 25%	Second	Third	Highest 25%	
Environmental						
Forest	Subsistence	2344	4908	4832	6008	4523
	Cash	68	112	44	448	167
Non-forest	Subsistence	2880	4804	7516	13,116	7078
	Cash	36	48	108	516	177
Subtotal	**Subsistence**	**5224**	**9716**	**12,348**	**19,120**	**11,602**
	Cash	**104**	**160**	**152**	**964**	**345**
Farm		0	0	0	0	
Crop	Subsistence	1384	2024	2972	3764	2536
	Cash	96	352	272	424	287
Livestock	Subsistence	1940	3436	4268	7292	4235
	Cash	1672	3172	4336	9200	4595
Wage	Subsistence	–	–	–	–	–
	Cash	2148	3420	2580	792	2235
Subtotal	**Subsistence**	**3324**	**5464**	**7240**	**11,056**	**6771**
	Cash	**3916**	**6944**	**7192**	**10,416**	**7117**
Non-farm						
	Subsistence	–	–	–	–	–
	Cash	**1568**	**7248**	**19,568**	**81,112**	**27,374**
Total	**Subsistence**	**8544 (60.5%)**	**15,176 (51.4%)**	**19,588 (42.1%)**	**30,180 (24.6%)**	**18,372 (34.5%)**
	Cash	**5588 (39.5%)**	**14,352 (48.6%)**	**26,912 (57.9%)**	**92,492 (75.4%)**	**34,836 (65.5%)**

income quintile to NRs 92,492 in the highest). On average, subsistence income source contributes (60.5%) to the lowest income quartiles, followed by the second income quartile (51.4%), third income quartile (42.1%) and the highest income quartile (24.6%), whereas cash income increases from 39.5% in the lowest income quartile to 75% in the highest income quartile. It clearly shows that relative means of subsistence income sources decrease with increasing income while cash income increases with increasing income (Table 3). Thus, the reliance of poorer households on environmental products is primarily for subsistence, indicating their high dependency in this sector, implying very limited remunerative off-farm income opportunity for the poor in the village which seems to be the key factor for out-migration of the youths in search of employment in Nepal. The finding resembles the works of other scholars (Larsen et al. 2014; Chhetri et al. 2015; Bhandari et al. 2019), where poor households have less cash income compared to rich households. The present study found that environment income increases by income quartile. For example, cash income increases from NRs 104 to NRs 964 per annum and NRs 5,224 in the lowest quartile to NRs 19,120 in the highest income quartile. Both cash and subsistence incomes increase with the increasing income quartile, which coincides with the works of other scholars (Babulo et al. 2009; Kamanga et al. 2009; Rayamajhi et al. 2012 and Chhetri et al. 2015). However, an opposite pattern of higher environmental income dependency among highest income households has also been reported in this study (see Adhikari 2005; Chhetri et al. 2015). A possible explanation to the scenario depicted here is that abundance of the forest in the vicinity is a key factor that seems to lead to higher dependence on the forest be it for the poor or the well off alike. It may be explained that if forest depletes time for collection increases because thereby gradually dependency and income both decrease. Overall, the income survey noted that remittances and pensions are important or dominant sources of income except for the poorest income quintile. There may be significant barriers that hinder poorer households from pursuing these livelihood options, including costs (transport, visa, rent-seeking), lack of human capital (languages, illiteracy, skills) and negative modification of access due to social relations (difficulty in navigating official procedures and low caste). Rigg (2006) and Chhetri et al. (2015) have a similar finding that increasing human capital may constitute the most promising way to increase access of poorer households to higher return activities.

3.3 Total Household Forest Income by Income Quartile and Source

Table 4 shows different types of forest sources by different income quartiles. A large number of forest products are derived from all the income groups. The result shows that the households in the highest income quartile benefit more from firewood, wild foods, forest litter, processed products, and sand and stone. Grasses in the study villages and most other rural areas are by far the most important forest products next

Table 4 Total annual mean household (n = 276) forest income (NRs) per aeu by income source and quartile

Income source	Quartiles				Sample mean
	Lowest 25%	Second	Third	Highest 25%	
Firewood	1148	1798	1655	2326	1732
Timber and pole	177	253	218	196	211
Bamboo	5	4	15	0	6
Wild foods	103	218	137	237	174
Medicine	0	11	41	36	22
Grasses	1081	1907	1901	1608	1624
Forest litre	6	80	99	177	90
Sand and stone	89	150	194	294	182
Processed products	−285	440	374	1060	397
Others	87	160	244	519	253
Total	**2411**	**5021**	**4877**	**6453**	**4691**

to firewood; actually, the collection and consumption of it are more frequent than that of firewood and if carefully accounted its value may be higher (Rayamajhi and Olsen 2008; Chhetri et al. 2015). The grasses have multiple uses in the rural villages from cut and feed of livestock, grazing, cut and carry for bedding material on livestock sheds as well as thatching roof and making ropes which generate different earning possibilities for the poor also by selling grass to the well-off households with a larger number of livestock (Rayamajhi et al. 2012). The previous studies carried out by Chhetri et al. (2015), a study carried out in Gorkha, concluded that richer people benefit more compared to other classes. The study by Rayamajhi et al. 2012, from Mustang showed that the poor are relatively more dependent on firewood and bamboo, and the less poor on browse and graze. Likewise, Baral et al. (2019) and Bhandari et al. (2019) studies carried out in central Terai and mid-hills concluded that rich households get major benefits from public and direct goods. The households in the third income quartile benefit from bamboo and medicine. The majority of scholars (Oli and Treue (2015); Baral et al. (2019); Bhandari et al. (2019) and Baral et al. (2019)) conclude that forest and environmental services contribute to diversifying livelihood opportunities.

In a similar study from Mustang district in Nepal, poorer households are relatively most dependent on forest income (31%) while richer households' forest income is higher in absolute terms and consists of more valuable forest products. More explicitly, households derive as much as 22% of their total income from the forest and 4% from non-forest environmental common property goods combined higher than that from either crop or livestock income (Rayamajhi et al. 2012).

3.4 Total Household Non-forest Environmental Income by Income Quartile and Source

Table 5 shows non-forest environmental income from different sources. Poor households are less dependent on non-forest environmental sources for firewood and timber. A possible explanation is that if common property forest in the vicinity is abundant why bother to plant and protect trees in private farmlands (Rayamajhi et al. 2012); in particular, the poor in general cannot afford to allocate a separate parcel of land for it other than crop production; they travel larger distances to collect bamboo, wild food, medicine and grasses for self-consumption and cash income by selling in the local market. The households in the highest income quartile benefit more from all the sources except medicine. A lower-income household member indicated: '*Most of the time we go around the forests and even the surroundings to collect medicinal plants as they can be easily sold in the market to supplement our cash need. It is small in size and not attractive for the richer people*'. In the case of medicinal plants, households in the lowest income quartile benefit more. For example, Gauli and Hauser (2011) found that people with low household cash income, low food self-sufficiency and living close to the forest are involved in forest product collection, particularly medicinal plants. Among the income sources, grasses are the highest revenue-generating source, followed by firewood and sand and stone. The lower-income household member said: '*We don't have cattle; so, we are not interested to collect grasses. Some low-income households have few cattle; they collect in the surroundings of the house.* Most rich households have cattle; so, they collect grasses and sometimes we also support them in collecting grasses'. As expected, households in the highest quartile benefit from the high-income-yielding sector. This coincides with the finding of Larsen et al. (2014) and Chhetri et al. (2015), who studied in

Table 5 Total annual mean household (n = 276) non-forest environmental income (NRs) per aeu by income source and quartile

Income source	Quartiles				Sample mean
	Lowest 25%	Second	Third	Highest 25%	
Firewood	345	459	728	1531	766
Timber and pole	94	58	88	120	90
Bamboo	14	35	47	98	48
Wild foods	111	175	184	304	194
Medicine	11	1	3	0	4
Grasses	2122	3435	5514	9496	5142
Forest litre	8	29	42	208	72
Sand and stone	41	229	172	541	246
Fish and aquatic	113	165	269	328	219
Others	55	265	580	1006	476
Total	**2915**	**4851**	**7626**	**13,631**	**7256**

the same district. Households in the lowest quartile also benefit the least from all the sources except timber, pole and bamboo. This contradicts with the findings of Adhikari et al. (2004), Baral et al. (2009) and Baral et al. (2019), who conclude that the poorest section of people only has a stake in the leaf litter and grasses and subsistence goods like firewood rather than timber and poles. A lower-income household member said: '*We are less dependent on the forest and environmental goods. We mostly work for wages or migrate to work in cities rather than relying on the forest*'.

3.5 Unprocessed Environmental (Forest and Non-forest) Income by Product Type and Sex of Household Head

Table 6 shows the income earned by male-headed and female-headed households from different sources. The result shows that female-headed households are earning more from firewood, timber and pole, and is significant at 1% compared to the male-headed households. Likewise, female-headed households are also earning from wild food and grass is significant at 5%. Although male-headed households are earning more from medicinal plants, sand and stones, their earning is statistically not significant. This is because, in the study site, female-headed households tend to heavily rely on remittance generating direct cash income, which in general increase their purchasing capacity for pole and timber for constructing new buildings. However, the study findings contradict the findings of other scholarly works, which conclude that female-headed households of low income and social stratum are less likely to participate in the collection of forest products (Adhikari et al. 2004; Thoms 2008). The study found that female-headed households receive more benefits than male-headed households. This echoes with the findings of Asfaw et al. (2013) and Giri et al. (2018), who also observed that female-headed households benefit more than their male counterparts.

On the other hand, all the four income groups pursued a diversity of livelihood strategies; therefore, study dividing the households into comparing household income groups and livelihood strategy groups comparing the results may give better insights for targeting policy interventions in the area. While the share of the environment income is the highest among low-income quartile households, the value of income received is the highest among the high-income quartile households. This is mainly because the high-income quartile households have high landholding sizes and they cultivate trees on the farmland and leave land fallow for firewood and grass collection. An abundance of the forest in the vicinity is a key factor that seems to lead to higher dependence on the forest be it rich or poor household alike simply because when forest products deplete time for collection increases thereby community restrictions get more stringent; hence, dependency and income both decrease, following Gilmour's hypothesis—scarcity is the mother of invention.

Table 6 Unprocessed environmental (forest and non-forest environmental) income (NRs.) per aeu by forest product type and sex of household head

	Firewood	Timber and pole	Bamboo	Wild food	Medicinal plants	Grass	Forest litre	Sand and stone	Other
Male headed	2302	247	51	327	29	6301	146	470	611
Female headed	3401	548	72	554	9	8919	236	228	845
Total	**2497**	**301**	**55**	**367**	**26**	**6766**	**162**	**427**	**729**
ANOVA	***	***	NS	**	NS	**	NS	NS	NS

*** ANOVA statistic significant at 1%, ** at 5% and *** at 10%

4 Conclusion

This study assessed the role of the forest and non-forest environment income in supporting the rural livelihoods, focusing on their contribution to the household income sources by income quartile and sex of the household head and its contribution on building the socio-ecological resiliency. Our findings amplified that households adopt a diverse set of income sources and their dependency varies across the quartile. Forest and non-forest environment income remains one of the dominant sources of income among lower-income households. Moreover, low-income quartile households were more dependent on subsistence income (60.5%), followed by the second income quartile (51.4%), third income quartile (42.1%) and the highest income quartile households with low dependence (24.6%), whereas in the case of cash income, high-income quartile people are generating 75.4% of their total income as cash income and the share of it is only 39.5% for the lowest income quartile group. Remittances and pensions are important or dominant sources of income except for the poorest income quintile. It shows that the households in the highest income quartile benefit more from firewood, wild food, forest litter, process products, and sand and stones, whereas the lower-income quartile benefits more from bamboo, timber and poles. The study concludes that forest and non-forest environment income remains one of the dominant sources of income for poor and marginalized households and their customary rights need to be protected.

Though role of the forest income for the poorer households has increased, the study argued that there is a need of the resilience thinking approach achieving sustainable livelihood outcomes for communities. For this, institutional changes are needed. While the community forestry institutions are involved in managing the forests, there is need for collaboration with the different actors, especially private sector and government agencies in promoting the use of the forest resources, such that local communities are capacitated to manage the resources sustainably along with cope or recover from the shocks and stresses including maintaining of the forest assets. Currently, the forest resource condition of the country has not only degraded but a single agency (forest user group) is given responsibility for the management, which might pose a risk towards attaining the socio-ecological resiliency. There is a need to reform the policy and practices at the national level such that polycentric approach is promoted in management of the forest resources, such that socio-ecological resilience could be ensured.

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