Research Article

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Medicinal herbs in community forests of Darchula District, Nepal: a boon of employment and income generation for rural users

Abstract

Collection and trade of medicinal plants are attractive and valuable source of employment and income generation in the community forests of high-altitude region especially for the mountainous country like Nepal. However, the research regarding employment and income generation through this business is very limited. Thus, this research was objectively conducted to assess the stock of major tradable medicinal species, employment and income generation through its collection and trade. Four community forests namely Chhangaru, Gokarna Godani, Tham and Tinkar community forests of Darchula district were selected for data collection. Total 60 samples were collected applying stratified sampling. The square plots having $5 \times 5\ m^2$ and $1 \times 1 m^2$ were laid down for the sapling and seedling staged medicinal plants respectively. The plant parts and their quantity were estimated weighing the harvested samples. Secondary data were collected from records of community forests; these were employment and income from 2015 to 2019, particularly. The data were analyzed using unitary and statistical method. The employment and income generation were calculated in participatory way from the record of income in the community forests. The results showed that in total 16 species of medicinal herbs were collected to sell from the community forests. Specifically, Paris polyphylla, Allium wallichii, Sapindus mukorossi, Valeriana jatamansi and Zanthoxylum armatum were the major medicinal herb species collected by the users to sell. The highest stock was recorded around 1018.470 kg/ha and consequently allowable collection was found highest around 40.739 ton from Tham community forest. One-way ANOVA showed that, there was significant difference in stock of medicinal herbs among the community forest at 95% confidence level. Total collection of medicinal herbs of all species was the highest around 54.285 ton annually from Chhangaru community forest which was the lowest only i.e. 18.15 ton from Gokarna Godani community forest. The estimated highest employment was generated from Chhangaru community forest with 2443 man-days from collection and selling of medicinal herbs which was about 1.5 times more than it created in 2015. The coefficient of variance was less around 0.11 of employment created in all the community forest in 2015 to 2019. The income generation was the highest US $ 10993 from Chhangaru community forest in 2019 and the trend was about triple increase than it in 2015. This study will be useful to understand the role of medicinal plants for rural livelihood.

Keywords: medicinal plants, subsistence living, sustainable harvesting, community forests, Darchula District, Nepal

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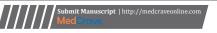School of Environmental Science and Management (SchEMS), Nepal

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Introduction

Livelihood and forest have been interconnected with each other from the human civilization.[1,2] In the beginning, only the forest was the home for human being where they live, get food, shelter, water, cloths and lesson.[3] The livelihood and dependency on the forest is not a new innovation but the way of interaction in the forest is indeed unique in the world.[4] One of the important ways is collection and trading of medicinal herbs for livelihood subsistence and income generation.[5] Global demand of medical products from plants has been increasing which is the foundation for livelihood.[5,6] There is over 45 million US dollar global trade of medicinal plants which employed over 4 million jobs in different countries mostly in Asia.[7] Alone India traded medicinal herbs of around 5.6 million US dollars[8] which is traded worth of approximately 3 billion US dollars of medicinal herbs from China. The worth of annual export medicinal herb from Nepal is over 3 million US dollars.[9] The export of these medicinal herbs is from high altitudinal region in general.[10] Most of the plant species in high Himalaya region have medicinal value. Nepal is very rich in biodiversity particularly of medicinal plants in high elevated forest and range land.[6] Therefore, high altitude areas are famous avenue for valuable medicinal plant and the poor rural dwellers on this for their subsistence living and promotion.[11] Though, there is no reliable record of employment generation and income creation from the medicinal herbs, over hundred thousand of rural poor people have been getting the benefit from this. The community forest users especially in Himalayan region are dependent up on this business. However, there is very limited record and research related to employment and income generation from the medicinal herbs in Nepal. Specifically, the research related to employment and income generation through medicinal herbs from community forests, especially in far-west Nepal, indeed a gap. Thus, this research was objectively conducted to assess the employment and income generation from medicinal herbs, exploring the key species.

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Materials and methods

Study area information

Darchula district is located in the far western province number seven of Nepal. It is located at 29°22″ to 30°15″ North latitude and 80°22″ to 81°9″ West longitude and altitudinal range is 518-7132 m above mean sea level. Average maximum temperature of the district is 18.6 0C and minimum is 5.7 0C. District comprises Tropical to Alpine type of climate with annual rainfall of 2.129mm (DFO, 2019). Four community forests of Darchula district were selected as the study site. These were Chhangaru, Gokarna Godani, Tham and Tinkar community forests having areas 125, 21.6, 105.7 and 91.7 ha respectively. Important medicinal herb species found in these community forests were Paris polyphylla, Allium wallichii, Sapindus mukorossi, Valeriana jatamansi and Zanthoxylum armatum (Table 1) (Figure 1).

Table 1 Information of study site

Community forests	Address	Area ha	Household	Population
Chhangaru	Byas Municipality, Ralpha	125	96	433
Gokarna Godani	Khar	21.6	92	414
Tham	Khar	105.7	126	567
Tinkar	Byas Municipality, Ralpha	91.7	66	342

Figure 1 Medicinal herbs collected for trade purpose.

Sample design

Primary and secondary data were collected from the community forests. Primary data were collected through field survey and inventory applying stratified sampling based on species dominance. Total 60 sample plots were established for the field data collection, 15 samples each for Chhangaru, Gokarna Godani, Tham and Tinkar community forests. The participatory map was prepared to locate abundance area of the medicinal plant species and survey of these areas was done to prepare the map. Next, the rectangular plots having 5×5 m^2 and 1×1m^2 were laid down for the sapling and seedling sized medicinal plants respectively.[12,13] The plants parts and their quantity were estimated weighing the harvested samples. Secondary data were collected from records of community forests; these were employment and income from 2015 to 2019 in particular. Moreover, the secondary information was collected from the records available from community forests, division forest office and professional institutions. The data were analyzed using unitary and statistical method. The employment and income generation were calculated in participatory way from the record of income in the community forests.

Data analysis

This was done using unitary method and descriptive and inferential statistical tools.

Calculation procedure of employment and income: Total Mandays calculation=30×Total Employed Number of Month×Total Employed Population

Total Income Generation Calculation: Total Mandays×Per day wages rate[14]

Notes Wages rate for 2015, 2016, 2017, 2018 and 2019 were NPRs. 550, NPRs. 575, NPRs. 575, NPRs. 600 and NPRs. 600 respectively. This was converted into US dollar.

Statistical analysis

The stock and annual collection was compared among the community forests using one-way ANOVA and Tukey's b test. Mann Kendall correlation was performed to assess the trend analysis of employment creation and income generation.

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Results

Annual harvestable quantity of medicinal herbs from community forests

Status of medicinal herbs in community forests: The allowable collection of medicinal herbs was varying in the community forests. Total sixteen species of medicinal herbs were collected to sell from the community forests. Specifically, Paris polyphylla, Allium wallichii, Sapindus mukorossi, Valeriana jatamansi and Zanthoxylum armatum were the major medicinal herb species collected by the users to sell. The highest stock was recorded around 1018.470 kg/ha and its allowable collection was the highest around 40.739 ton from Tham community forest. However, it was the lowest around 724.310 kg/ha stock in Tinkar community thus the lowest allowable collection approximately 28.972 ton (Table 2).

Note: AC is allowable collection

One-way ANOVA showed that, there was significant difference in stock of medicinal herbs among the community forest at 95% level of confidence. However, the Tukey's B test showed that the stock of medicinal per ha was significantly difference of Gokarna Godani and Tham with the sock of other community forests at 5% level of significance.

Similarly, one-way ANOVA showed that there was significance difference in allowable collection per ha of medicinal herbs among the community forests at 95% confidence level. On the other hand, Tukey's b test showed that, the allowable collection quantity per ha of medicinal herbs of Gokarna Godani and Tham was significantly differed with the allowable collection of other community forests at 5% level of significance.

Harvestable quantity of medicinal herbs from community forests: The harvestable quantity of medicinal herbs in the community forest was differed according the available area of the species. Total collection of medicinal herbs of all species was the highest around 54.285 ton annually from Chhangaru community forest which was the lowest only 18.15 ton from Gokarna Godani community forest (Table 3).

Table 2 Allowable collection of medicinal herbs from community forests

Local name	Scientific name	Chhangaru CF Weight kg/ha	AC ton	Gokarna Godani CF Weight kg/ha	AC ton	Tham CF Weight kg/ha	AC ton	Tinkar CF Weight kg/ha	AC ton
Satuwa	Paris polyphylla	71.93	2.877	64.6	2.584	59.4	2.376	57.34	2.294
Ban Lasun	Allium wallichii	67.27	2.691	64.4	2.576	65.07	2.603	65.07	2.603
Pashanved	Berginia ciliata	62.2	2.488	55.2	2.208	55.2	2.208	45.32	1.813
Ritha	Sapindus mukorossi	64.6	2.584	55.87	2.235	50.6	2.024	47.43	1.897
Sugandhwal	Valeriana jatamansi	68.33	2.733	55	2.2	53	2.12	49.43	1.977
Amala	Phyllanthus emblica	60.13	2.405	58.13	2.325	56.13	2.245	0	0
Chiraito	Swertia chirayita	65.53	2.621	23.87	0.955	54.93	2.197	48.44	1.938
Timur	Zanthoxylum armatum	59.33	2.373	88	3.52	58	2.32	60.23	2.409
Dal chini bark	Cinnamomum tamala	59.27	2.371	109.93	4.397	113	4.52	0	0
Chutro bark	Berberis aristata	51.6	2.064	49.6	1.984	54.67	2.187	55.43	2.217
Kurilo	Asparagus racemosus	53.87	2.155	112.2	4.488	56.4	2.256	49.44	1.978
Atis	Aconitum heterophyllum	53.53	2.141	51.8	2.072	53.47	2.139	52.66	2.106
Sadharan Chyau	Agaricus bisporus	0		0		63.6	2.544	0	0
Setak chini	Polygonatum verticillatum	0		0		55.47	2.219	57.77	2.311
Kaulo Bokra	Persea odoratissima	0		0		110.6	4.424	89.77	3.591
Bhiringiraj	Eclipta prostrata	0		0		58.93	2.357	45.98	1.839
	Total	737.59	29.504	788.6	31.544	1018.47	40.739	724.31	28.972

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Table 3 Total collection quantity of medicinal herbs from community forests

| Scientific name | Chhangaru CF | | Gokarna Godani CF | | Tham CF | | Tinkar CF | |
	AA ha	TC ton/yr	AA ha	TC ton/yr	AA ha	TC ton/yr	AA ha	TC ton/yr
Paris polyphylla	4.5	12.947	0.32	0.827	3.45	8.197	2.7	6.192
Allium wallichii	2.3	6.188	0.2	0.515	2.4	6.246	1.98	5.153
Berginia ciliate	0.78	1.94	0.1	0.221	0.5	1.104	0.5	0.906
Sapindus mukorossi	1.3	3.359	0.2	0.447	0.23	0.465	0.6	1.138
Valeriana jatamansi	1.2	3.279	0.43	0.946	0.76	1.611	0.78	1.542
Phyllanthus emblica	2.3	5.532	0.4	0.93	0	0	0	0
Swertia chiraita	0.6	1.572	0.11	0.105	1.5	3.295	1.4	2.712
Zanthoxylum armatum	0.7	1.661	0.9	3.168	0.78	1.809	0.4	0.963
Cinnamomum tamala	3.2	7.586	2.01	8.838	2.6	11.752	0	0
Berberis aristata	0.8	1.651	0.2	0.397	0.6	1.312	0.5	1.108
Asparagus recemosus	3.2	6.895	0.3	1.346	2.3	5.188	2.5	4.944
Aconitum heterophyllum	0.78	1.67	0.2	0.414	0.6	1.283	0.5	1.053
Agaricus bisporus	0	0	0	0	0.6	1.526	0	0
Polygonatum verticillatum	0	0	0	0	0.9	1.997	2.3	5.315
Persea odoratissima	0	0	0	0	0.5	2.212	0.98	3.519
Eclipta prostrata	0	0	0	0	0.45	1.061	1.78	3.274
Total		54.285		18.15		49.062		37.823

Note: AA, available area, TC, total collection

Descriptive analysis of allowable collection and collected medicinal herbs: The annual allowable collection (AC) and annual harvestable quantity (AH) of medicinal herbs was varied according to community forests. The estimated annual collection mean±SE was the highest 40.68±0.357 ton and the annually harvested quantity was 37.823±0.114 in Tham community forest (Table 4).

Employment opportunity and income generation from medicinal herbs

The medicinal herbs are the good source of employment and annual income in the community forests.

Employment opportunity from medicinal herbs in community forests: The estimated highest employment was generated from Chhangaru community forest with 2443 mandays from collection and selling of medicinal herbs which was about 1.5 times than it created in 2015. The coefficient of variance was less around 0.11 of employment created in all the community forest in 2015 to 2019. This showed, the opportunity of employment was very high (Table 5). The Man Kendall correlation and showed that there was increasing trend of employment through collection and trading of medicinal herbs since correlation coefficient was around 0.8 but the correlation was insignificant since p-value (two tailed) was just 0.05, bias was 0.013 in all community forests.

Income generation from medicinal herbs in community forests: The income generation was the highest US $ 10993 from Chhangaru community forest in 2019 and the trend was about triple than it in

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2015. Similarly, the co-efficient of variance was approximately 0.43 (CV<0.5) which more or less consistency in their income generation from collection and trade of medicinal herbs in the community forests in the period of 2015 to 2019 (Table 6). The bivariate analysis using year as independent (X) and income generation as independent (Y) using Man Kendall correlation showed that there was increasing trend of income generation with r-value 0.89 but the correlation was insignificant since p-value (two tailed) was just 0.05, bias was 0.023 in all community forests.

Table 4 Statistics of allowable collection and annual harvestable quantity

Statistics	Chhangaru CF	AH ton/yr	Gokarna Godani CF	AH	Tham CF	AH	Tinkar CF	AH
	AC ton		AC ton		AC		AC	
Mean±SE	29.468±.317	18.113±.097	31.523±.264	49.062±.159	40.68±.357	37.823±.114	28.98±.209	54.285±.451
SD	1.38	18.115	1.151	49.2	1.556438	37.9	0.910997	2.018118
Minimum	27	17.35	29.11	47.17	37.9	36.853	27.3	51
Maximum	32	19.2	34	50.21	44	39.2	30.1	58

Note: AC stands for annual allowable collection, AH is annual harvest

Table 5 Employment generation in community forest

Mandays	2015	2016	2017	2018	2019
Chhangaru CF	1890	1948	2435	2174	2443
Gokarna GodaniCF	632	651	814	727	817
Tham CF	1708	1761	2201	1965	2208
Tinkar CF	1317	1357	1697	1515	1702
Grand Total	5546	5717	7147	6381	7170

Table 6 Income trend from medicinal herbs in community forests

Income (US$)	2015	2016	2017	2018	2019
Chhangaru	3515	4870	7305	9784	10993
Gokarna Godani	1175	1629	2443	3272	3676
Tham CF	3176	4401	6602	8842	9935
Tinkar	2449	3393	5090	6817	7659
Grand Total	10315	14293	21440	28714	32263

Discussion

Community forests are very rich source of medicinal herbs[2,15] which is also applicable in Community Forests of Darchula distrct, far west Nepal. Total sixteen species were identified for potential trade in Chhangaru, Tinkar, Gokarna Godani and Tham community forests. The important tradable species were Paris polyphylla, Allium wallichii, Sapindus mukorossi, Valeriana jatamansi and Zanthoxylum armatum in the community forests. Though there are more than 700 plant species in Nepal used for various medicinal purposes,[11,16,17] but the number of tradable species are limited in less number as exemplified in Darchula district. The entire Himalayan regions in Nepal and India are rich source of medicinal plants such as Swertia chirayita, Astilbe rivularis, Bergenia ciliata, Acorus calamus, Nardostachys grandiflora, Valeriana jatamansii.[18–20] These species are dominantly found in the community forests as well. The reason of similarity in the species may be similarity in geographical distribution and climatic condition.

The stock of medicinal herbs was differed in the community forest for instance it is found to be 1018.470 kg/ha and the allowable collection was up to 40.739 ton from Tham community forest. Kunwar et al.[21] stated that local people have been collecting about

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50% quantity of total stock of medicinal herbs to trade. The stock of medicinal herbs was varying according to site and hence the annual harvestable amount is also varied accordingly. Importantly, the microclimate affects the stock of medicinal herbs in different sites.[22,23] The annual harvestable quantity of these herbs was up to 54.285 ton annually from Chhangaru community forest. Most of the area of this community forest was rich for medicinal herbs. Total available area of medicinal herb in this community forest was 21.67 ha. The study of Vrabcová et al.[24] also confirms that the quantity of annual harvest of medicinal herbs depends up on the total stock available in the forest.

The collection of medicinal herbs in the community forest directly support to the rural employment in the community forests.[25,26] Total 2443 man-days employment was generated in 2019 from collection and selling of medicinal herbs in Chhangaru community forest. The community forest has been offering enormous employment opportunity and one of the rich sources is business of medicinal herbs in rural areas of Nepal.[27,28]

The community forest users were being involved to collect and sell the medicinal herbs in hilly region[29] of Nepal consequently getting attractive earning from this. The rural community forest users earned US$ 10993 from Chhangaru community forest in 2019. So, this is source of livelihood subsistence and promotion of rural economy as well. The local people as users collect the medicinal herbs from community forest and trade to India and other countries and hence it is an attractive business particularly in high Himalaya.[30] The total monetary value of exported medicinal and aromatic plants in Nepal was US$ $ 8.74 million, 7.26 million and 7.67 million in 2015, 2016 and 2017 respectively.[31] Hence, it is evident that medicinal herbs from the community forests in the mountain regions of Nepal are great assets for subsistence living of rural community of Nepal to a large extent.[32]

Conclusion and recommendation

In total, sixteen plant species in the four-community forest were found highly important for trade and export. The users of community forest generally collect and sell Paris polyphylla, Fritillaria cirrhosa, Sapindus mukorossi, Valeriana jatamansi and Zanthoxylum armatum. The stock and allowable collection of medicinal and aromatic plants were found different in the community forests. Hence, the annual harvestable quantity, employment generation and rural people's earning also were differed in the community forests suggesting that the availability of these medicinal herbs also differs due to varied habitat condition. It is also suggesting that the high-altitude community forests are valuable source of employment generation and income generation. However, intensive study is essential to assess the sustainable quantity and contribution of medicinal and aromatic plants in the rural livelihood. This research will provide useful information to understand the role of medicinal herbs for the employment generation and earing for community forest users of rural community.

Conflicts of interest

Authors declare that there is no conflict of interest.

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