Non-Timber forest products and their role in rural livelihoods: A case study from the Annapurna Conservation Area, Nepal

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Research

Abstract

Background: This study investigated the role of Non-Timber Forest Products (NTFPs) in supporting the livelihoods of communities in Parche area of Madi Rural Municipality, Kaski District, Nepal. Despite rich biodiversity and cultural diversity, communities face economic challenges from low agricultural productivity, reliance on remittances, and unstable tourism income. Sustainable NTFP use offers income potential, but limited awareness, value addition, and market access hinder its impact.

Methods: Data from 100 respondents were collected via surveys, interviews, and focus group discussion. Socioeconomic data were analyzed using descriptive statistics and Ordinary Least Square (OLS) regression to assess relationships between variables like age, education, landholding, livestock, family size, forest distance, and NTFP income. A t-test evaluated the significance of each coefficient.

Results: The study identified eight key NTFPs, with **Allo** (*Girardinia diversifolia*) and **Nigalo** (*Drepanostachyum falcatum*) significantly contributing to middle class household income. NTFPs also serve important medicinal, food, and household purposes. Analysis revealed that education ($p < 0.001$), landholding size ($p < 0.001$), family size ($p < 0.001$), and forest proximity ($p = 0.025$) significantly influence NTFP income, highlighting these factors as key determinants.

Conclusion: This study underscores the critical role of NTFPs in supporting rural livelihoods in the Parche area, with *Girardinia diversifolia* and *Drepanostachyum falcatum* identified as key income sources. Socioeconomic factors such as, education, family size, landholding, and forest proximity significantly influence NTFP income. Promoting sustainable use, value addition, and market access can enhance their economic and cultural benefits.

Keywords: Allo, Domestication, Income generation, Ordinary Least Square (OLS) Model

Background

Non-timber forest products (NTFPs) refer to all biological materials other than timber that are harvested for human use, including plants, fungi, and animal-derived materials from natural, managed, or degraded forests and adjacent landscapes (Belcher 2003, Islam & Quli 2017). In the past, NTFPs were given less attention than wood resources because they were seen exclusively as minor forest products of local significance (Arnold and Ruiz-Perez 1998). In recent decades, with growing

concerns about conservation, rural poverty, and sustainable development, researchers and organizations have made efforts to bring NTFPs to the center of discourse (Shrestha *et al.* 2020). The contribution of NTFPs to rural livelihoods and household income has received global recognition (Maharjan & Dangal 2020). In Nepal, NTFPs play a vital role in supporting rural livelihood (Lamichhane *et al.* 2021).The income generated from NTFPs has significantly boosted the local economy in Nepal. However, the management and commercialization of NTFPs remains a challenge, with concerns about overexploitation and unequal distribution of benefits (Banjade & Paudel 2008).

The varied topography of Nepal has helped to favor significant NTFP growth sites, and the Approximately 80% of the rural population in Nepal depends on NTFPs for their livelihoods, which include food, medicine, construction materials, and income generation (Shrestha *et al*. 2020, Miya 2021). According to FAO (2020), approximately 1.3 billion people depend on forests for their livelihoods, with many living in or near dense forests relying heavily on these resources for subsistence and income. Because they are viewed as a significant source of revenue, NTFPs have become increasingly vital for local people's livelihoods in developing nations. In addition to their complementary roles in timber, agriculture, and other land uses, NTFPs have benefits in the areas of economy, society, and ecology. The collection and use of NTFPs can play a protective role for forest environments when done sustainably. The collection and use of NTFPs can play a protective role for forest environments when done sustainably. According to ANSAB (2021) proper management of NTFPs can contribute to forest conservation and biodiversity while also providing alternative income sources for local communities. A study by Shrestha and Shah (2020) highlights that sustainable exploitation and commercialization of NTFPs are crucial for socio-economic development and poverty reduction in Nepal. The authors argue that the demand for NTFPs can lead to overexploitation if not managed properly, which underscores the importance of sustainable practices to protect forest ecosystems.

NTFPs serve both protective and productive roles in rural communities. They contribute to ecological balance, enhance soil quality, and support rural livelihoods while generating income, creating employment, promoting sustainable resource use, and fostering local and national economic development. In Nepal, indigenous populations have historically relied on NTFPs as a critical livelihood resource, using the income from their collection and trade to meet daily needs (Malla & Chhetri 2012). However, sustainable utilization of NTFPs faces several challenges. Overharvesting, habitat loss, unsustainable harvesting practices, and the impacts of climate change exert significant pressure on these valuable resources. Moreover, inadequate market systems, inequitable benefit-sharing mechanisms, and limited value addition restrict rural households from fully capitalizing on the benefits of NTFPs.

Despite these challenges, Nepal's NTFP market has grown, offering opportunities for poverty alleviation while demanding efficient and sustainable resource management. Although Nepal trades more than 100 species of NTFPs, 20 species account for 80% of the total trade in volume and value (Poudel 2015). This underscores the need for enhanced ecological databases, marketing systems, and human resource development to better harness their potential.

The country has made significant strides in addressing these issues through policies such as the Forestry Sector Strategy (2016-2025) and the National Biodiversity Strategy and Action Plan (2014-2020), which emphasize sustainable forest management, community empowerment, and equitable resource sharing (Government of Nepal 2016, MoFSC 2014). In the Annapurna Conservation Area (ACA), initiatives like the NTFP-based enterprise development program under the Annapurna Conservation Area Project (ACAP) have improved local livelihoods by fostering sustainable utilization and market integration (ACAP 2020). Similarly, donor-supported programs, such as the High-Value Agriculture Project in Hill and Mountain Areas (HVAP), have strengthened market linkages and enhanced the capacity of NTFP producers (ADB 2018). The Nagoya Protocol under the Convention on Biological Diversity (CBD) provides a framework for equitable benefit-sharing from biological resources, including NTFPs (CBD Secretariat 2011). Nepal, as a signatory, has taken steps to implement these principles to empower local communities, enhance market access, and ensure sustainable resource management (Government of Nepal 2014). Aligning with the Nagoya Protocol in the ACA region can formalize benefit-sharing mechanisms, promote equitable practices, and strengthen local stewardship. Despite these efforts, gaps remain in understanding the socio-economic contributions of NTFPs to rural livelihoods, particularly regarding their roles in household income, food security, and social well-being (Aryal *et al.* 2021). Addressing these gaps requires integrating sustainable NTFP management into broader conservation and development policies. Therefore, this study has assessed the contribution of NTFPs to rural livelihoods, and identifies the factors influencing the income from NTFPs.

This study provides a foundation for developing income generation strategies to uplift livelihoods. The findings will assist local, provincial, and central governments, as well as development agencies, in launching NTFP-based income generation activities (IGAs). Local communities can benefit by understanding the status and threats to NTFPs for sustainable use in

community forests and wastelands. The insights may guide policymakers in incorporating key issues into future policies, promoting sustainable management and preservation of traditional knowledge. By adopting a bottom-up approach, the study can help prioritize actions and support integrated programs that enhance livelihoods and contribute to the Sustainable Development Goals (SDGs).

Materials and Methods

Study area

The study was conducted in Parche area of Madi Rural Municipality, Kaski District, located within the Annapurna Conservation Area. This area was selected as the study site due to its rich biodiversity, extensive reliance on NTFPs by local communities, and the pressing need to address sustainable resource management in the region. Additionally, the area serves as a representative site for studying the contribution of NTFPs to rural livelihoods in mountainous landscapes. Parche is situated approximately 24 km northwest of Pokhara, the headquarters of Kaski District, Gandaki Province. It lies between the altitudes of 1,100 m and 3,331 m above sea level and has a minimum air temperature of about 5°C in winter (December-February) and a maximum air temperature of about 30°C in summer (April-August). Parche area has 589 households with a population of 2,418. The majority (72%) are Gurung, known for their cultural heritage and ties to the Gurkha regiments, while Dalits (25%) and Brahmin/Chhetri (3%) are engaged in traditional crafts, agriculture, and local businesses. Gurung (Tamu Kyi) is the primary language, with Nepali used for broader communication. Buddhism, blended with Bon traditions, is the dominant religion, alongside Hinduism practiced by Dalit and Brahmin/Chhetri communities. Agriculture and livestock rearing are the main livelihoods, supported by tourism in Siklesh and remittances from migrant workers. Education is improving, though higher studies often require travel to Pokhara, and healthcare services remain basic with limited facilities. Despite seasonal migration for work and education, the community maintains strong cultural ties through traditional festivals, rituals, and customs.

The high-elevation areas of the Parche region are covered by dense forests, whereas the middle and lower elevations are used to cultivate rice, maize, millet, wheat, and barley. Due to altitudinal and climatic changes that produce different vegetation from upper subtropical to lower alpine zones, the Parche, Madi region of Nepal's Annapurna Conservation Area is renowned for its high biodiversity (Khakurel *et al*. 2020.). The area is home to a variety of plant life, including *Alnus nepalensis* forests, mixed forests, broad-leaved forests, bushes, and high-altitude grasslands, along with varieties of NTFPs, including *Asparagus racemosus willd* (**Kurilo)**, *Swertia chirayita* (Roxb. ex Fleming) Karst (**Chiraito**), and (*Dactylorhiza hatagirea* (D. Don) Soó) (**Panchaule)**.

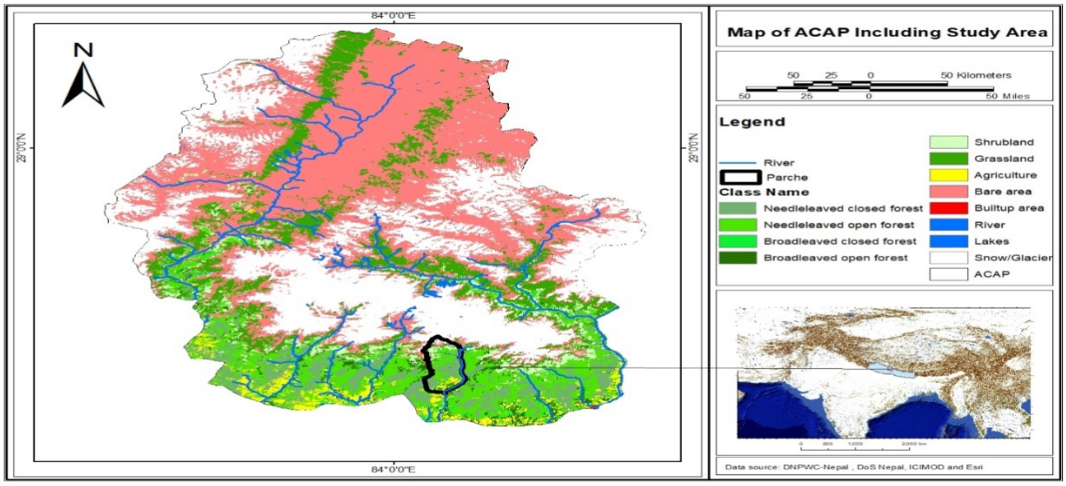

Figure 1. Map showing the study area

Sampling method and data collection

Primary data were collected through a household survey, key informant interviews, and focus group discussions.

Household survey

Prior to conducting the household survey, rapport was established with the community through informal meetings and discussions. Informed consent was obtained from the household head or an adult member, ensuring voluntary participation.

Interviews were conducted to collect detailed information on the socioeconomic and demographic features of the local population, including employment, income sources, and details of NTFP use (e.g., local names, parts used, purpose, access, distribution, harvesting time, and trade value).

Demographic and Socioeconomic Attributes of Respondents

The respondents were diverse in sex, age, education, occupation, and socioeconomic characteristics. Altogether 100 respondents participated, with 66% male and 34% female. The majority (38%) were aged 50-59 years. Regarding education, most respondents (44%) were illiterate, while a smaller proportion had primary to higher secondary education.

The primary occupation for 69% of respondents was agriculture. Landholding sizes were predominantly medium (53%), and livestock possession varied, with 33% owning less than four animals. Family size also differed, with 62% having medium-sized families. Additionally, 29% of respondents were members of groups or institutions, while 51% belonged to the medium wealth class.

Table 1. Demographic and socioeconomic composition of the respondents

S.N	Characteristics		Frequency
1.	Gender	Female	34
		Male	66
2.	Age	30-39	11
		40-49	25
		50-59	38
		60-69	26
3.	Education of the respondents	Illiterate	44
		Literate	28
		Primary level	18
		Secondary level	7
		Higher secondary level	3
4.	Main occupation of the respondents	Agriculture	69
		Animal husbandry	10
		Hotel/homestay	7
		Business	3
		Job	3
		Wage earning	8
5.	Family size of the respondents	Small (up to 5 members)	29
		Medium (6 to 10 members)	62
		Large (greater than 10 members)	9
6.	Land holding size of the respondents	Landless	5
		Small (up to 5 ropani)	26
		Medium (5 to 10 ropani)	53
		Large (greater than 10 ropani)	21
7.	Livestock possession of the respondents	No livestock	24
		Less than 4 livestock	33
		4 to 19 livestock	25
		More than 19 livestock	18
8.	Social participation	No membership	71
		Membership	29
9.	Well-being status of the respondents	Rich	21
		Medium	51
		Poor	28

Key informant interview

Key informant interviews were conducted with elder individuals, ACAP staff members, CAMC (Conservation Area Management Committee) members, teachers, local leaders, local healers, and NEST (Nucleus for Empowerment through Skill Transfer) staff members. Informed consent was obtained from all key informants, following the ethical guidelines of the ISEB (2006), ensuring that their participation was voluntary, and that their cultural and personal rights were respected.

Determination of most preferred NTFPs

To determine the most preferred NTFPs using matrix preference ranking, a group meeting was held with 14 participants, including members of the Conservation Area Management Committee (CAMC), home stay committee, youth club, ACAP officials, local healers, and collectors. They were requested to order the most favored NTFPs according to the standards established by Gurung & Pyakurel (2006). Matrix preference ranking method involves ranking various NTFPs based on their perceived value and importance to the local community, using a set of criteria (Table 2).

Table 2. Matrix preference ranking criteria

S.N.	Criteria	Scale and value
1.	Market demand	High (3), Moderate (2), Low (1)
2.	Profit	High (3), Moderate (2), Low (1)
3.	Availability (in time)	Almost always (3), Occasionally (2), Seasonal rare (1)
4.	Geographical distribution	Widespread (3), Moderate (2), Low (1)
5.	Conservation status	High (3), Moderate (2), Low (1)
6.	Potential for cultivation	High (3), Moderate (2), Low (1)
7.	Regeneration potential	High (3), Moderate (2), Low (1)
8.	Contribution to income	High (3), Moderate (2), Low (1)
9.	Gender impact	Only women (3), Both men and women (2), Only man (1)
10.	Potential for value addition	High (3), Moderate (2), Low (1)
11.	Processing technology	High (3), Moderate (2), Low (1)
12.	Ethnobotanical value	High (3), Moderate (2), Low (1)

Source: (Gurung and pyakurel, 2006).

Secondary data were obtained from the ACAP office, including annual and periodic records on the quantity and types of NTFPs collected, as well as export data. Various published and unpublished books, reports, journals, articles, other relevant literature, and internet surfing. Two field visits were conducted to assess the presence and status of NTFPs in various forest types. The transect survey method was employed for this purpose, following protocols adapted from Samant (2007). Transects were strategically placed along forest trails commonly used by local communities, ensuring representative data collection. The surveyed areas included private and public forests spanning diverse ecological zones. These comprised Schima-Castanopsis-dominated subtropical forests, temperate broadleaf forests, and coniferous forests. This diversity allowed for a comprehensive assessment of NTFP distribution across different forest types and management systems.

Data analysis

The data were analyzed using R software and the Statistical Package for Social Sciences (SPSS) (IBM Corp 2022). Descriptive statistics, including mean, standard deviation, percentage, frequency, and range, were employed to summarize the data for variables such as respondent age, income, parts of NTFPs utilized, and patterns of local use. Percentages and charts were used to summarize the variables of the respondents, including the contribution of NTFPs to household income. The Ordinary Least Squares (OLS) regression model was used to analyze factors influencing household income from NTFPs, considering variables like age, landholding size, forest distance, education, and family size.

Well-being ranking

To determine the household well-being ranking, I followed the well-being ranking criteria developed by USAID funded Hariyo Ban Program (USAID 2009), which is also adopted by the ACAP (Annapurna Conservation Area Project). The variables used were land holding size, house ownership, crop production sufficiency period, and job involvement. The classification of households based on land ownership, agricultural production, and income sources is presented below:

Rich: Owns a house, has enough land (more than ten ropani, 1 ropani is equal to 508.72 square meters**)**, produces enough crops for the entire year with a surplus for sale, and at least one family member has job, receives a pension, or works abroad.

Middle class: Owns a house, owns land (five to ten ropani), produces enough crops for six to nine months, and at least one family member has job or receives a pension, or works abroad.

Poor: Owns a house, owns less than 5 ropani of land, cultivates others' land on a lease basis, produces enough crops for less than three months, and works as a laborer.

Economic analysis: Total household income is calculated by adding up income from the following sources:

1. Farm income

Crop income: Total income from crop production - Total costs for crop production

Livestock income: Value of livestock products (milk, meat, eggs) + Livestock sales + Livestock services

2. Non-farm income: income from wages, remittances, shops, rentals, salaries, pensions, etc.
3. Income from NTFPs: Income from NTFP products collected for subsistence + Income from NTFP products sold commercially. Prices of NTFP products were obtained through household surveys and market research.
4.

Thus, the total household income was estimated as;

Household total income= $\sum_{i-1}^{n}(\text{Crop income} + \text{Livestock income} + \text{Nonfarm income+NTFP income})$ (Adongo *et al.* 2019).

Result and Discussion

Diversity of NTFPs and their priority order

The study identified a total of 34 NTFP species in the Parche area of Madi Rural Municipality. Among them, eight species of NTFPs were prioritized, with *Girardinia diversifloia* emerging as the most favored, closely followed by *Drepanostachyum falcatum* (Table 3).

Table 3. List of prioritized NTFPs

S.N.	Local name	Scientific name	Family
1	Allo	*Girardinia diversifloia*	Urticaceae
2	Nigalo	*Drepanostachyum falcatum*	Poaceae
3	Niuro	*Diplazium sps.*	Athyriaceae
4	Timur	*Zanthozylum armatum*	Rutaceae
5	Dhaka saag	*Arisaema griffithii*	Araceae
6	Kurilo	*Asparagus racemosus*	Liliaceae
7	Chiraito	*Swertia chirayita*	Gentianaceae
8	Makai saag	*Arisaema consanguineum*	Araceae

Girardinia diversifloia and *Drepanostachyum falcatum* are more readily available in the local environment, making them easier for households to collect and utilize (ANSAB 2010). These species also provide significant economic benefits compared to others, substantially contributing to household income and driving their prioritization. The community's traditional knowledge regarding the uses and benefits of *Girardinia diversifloia* and *Drepanostachyum falcatum* further reinforced their preference, as these species were deeply rooted in and well-documented within local practices. Additionally, *Diplazium sps.*, *Arisaema griffithii*, and *Arisaema consanguineum*are widely consumed as vegetables in daily meals, emphasizing their role in the local diet. *Swertia chirayita*, *Asparagus racemosus*, and *Zanthozylum armatum* were also notable for their medicinal properties and accessibility. Although other high-value medicinal plants existed, their limited availability reduced their usage, highlighting the community's preference for more readily available species.

Economic use of NTFPs and their contributions

The contribution of NTFPs to the annual household income across different wealth classes in the Parche area is illustrated in Figure 2. Among poor households, NTFPs contributed an average of 51.18 USD, while for middle class households, the contribution was 139.11 USD. For wealthy households, the average contribution was 87.73 USD. The relative contribution of NTFPs was highest among medium class households (16.48%), followed by poor households (10.69%) and wealthy households (5.2%).

This pattern reflects broader trends reported in various studies across different regions. Middle class households derived the highest absolute income from NTFPs, consistent with findings from a study in Nepal, where NTFPs contributed up to 90% of rural household income in some areas (Yadav *et al*. 2019). However, other studies have shown that poorer households often depend more on NTFPs as a proportion of their total income (Babulo *et al*. 2009). In both the Parche area and similar contexts, NTFPs serve as a critical safety net for poorer households, particularly in remote communities with limited agricultural opportunities (CIFOR PEN 2013). Similar findings were observed in the Horn of Africa, where NTFPs provided essential financial support during economic hardships (Shackleton & Shackleton 2004).

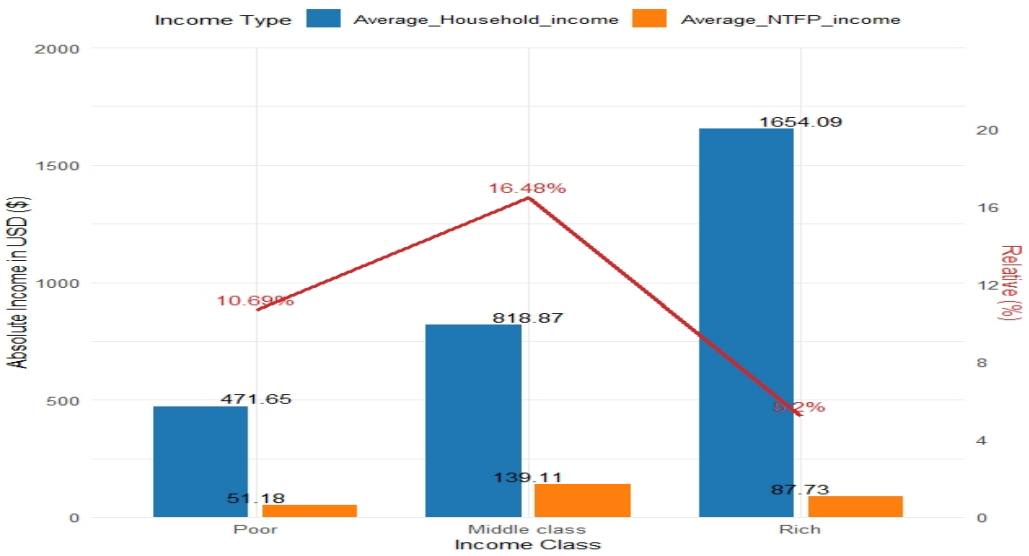

Figure 2. Absolute and relative contribution of NTFP income

Middle class households were predominantly engaged in agriculture, poor households relied on wage labor, and wealthy households primarily depended on remittances. As reported by Angelsen *et al*. (2014), poorer households tend to be more reliant on NTFPs than wealthier ones. Similarly, Kar & Jacobson (2012) observed that poor households depend on NTFPs for both subsistence and cash income. However, this study highlights that middle class households benefited more from NTFPs than expected (Figure 3).

This finding aligns with various studies in Nepal, where the dependence on NTFPs varies significantly across wealth classes. For instance, in Jajarkot district, NTFPs contribute 15-50% of household income, including among middle class families (Lamichhane *et al.* 2021). Similarly, in the Karnali zone, NTFPs provide 35-50% of total household income, serving both subsistence and cash needs across different wealth groups (Shrestha *et al*. 2020). In Jumla district, wild medicinal plants account for an average of 58% of total annual household income and 78% of cash income, demonstrating substantial reliance on NTFPs even among households not classified as poor (Timmermann & Smith-Hall, 2019).

Middle class households benefit more from NTFPs due to their better access to markets, cultural practices, and traditional knowledge. Their relatively higher economic status enables investments in transportation, networks, and technology, facilitating effective market access compared to poorer households. Additionally, these households often have historical ties to forest resource management, providing them with the skills and knowledge necessary to exploit NTFPs more efficiently. These advantages allow medium-income households to derive greater income contributions from NTFPs.

NTFP species have contribution in overall household income in which the *Girardinia diversifolia* (**Allo)** has the highest contribution (84.56%), followed *Drepanostachyum falcatum* (**Nigalo)** 11.63%. *Arisaema consanguineu* Wall. (**Makaisaag)** has the lowest contribution (0.29 %) (Figure 3). Allo and Nigalo were easily accessible in Parche area andwere used by local people to make different products for domestic purpose and for sale. Kurilo, Niuro (*Diplazium esculentum* (Retz.) Sw.), *Arisaema griffithii* Schott H. Hara (**Dhaka saag)**, **Makai saag** were used for vegetable and *Zanthoxylum armatum* DC. (**Timur)** and **Chiraito** were used for medicinal purpose.

Most of the people have traditionally been involved in the collection and processing of **Allo**, as well as crafting **Bhangra** (a traditional wear made from Allo by the Gurung and Magar communities). This activity has increasingly become an important income source for both poor and middle-class households. Despite its historical significance in rural economies, it was gaining more recognition as a livelihood strategy in these communities having market value around 29.24-43.87 USD/piece for Bhangra and they used to make other handicrafts and sale to tourists/visitors. However, households in the wealthy class were also involved in Allo collection and making Bhangra but most of them collect only for their household use, and not for trade. People used Nigalo for making baskets, mats, thatching material, Bhakari, Mandro, Nanglo etc. Many people were engaged in the collection, processing, and production of Nigalo-based items. While some producers used to bring their products to the Pokhara market for sale, where they fetch prices of 3.66-4.39 USD per piece for Doko (A traditional bamboo basket used for carrying firewood and other materials), 2.92-3.66 USD per piece for Nanglo, and 5.95-6.58 USD for Mandro,

others sold their products locally due to limited access to the Pokhara market. Local sales often occurred within nearby communities, where these products served both functional and economic purposes.

In case of Nigalo shoot, 4990 kg were exported (in the year 2072-73) from Lwang ghalel area of Machhapuchre Rural municipality, Kaski and total of 1637.63 USD revenue were collected but in Parche area (From the record of ACA, Unit Conservation Office, Lwangghalel). Nigalo shoot was not exported for sale, people used it only for domestic purpose. Two types of Nigalo, Tite and Ghude were found is this area where as Ghude is edible, but its distribution was very low and need to go long distance for its collection thus, people do not prefer it for selling purpose.

The findings of this study align with broader trends observed in similar studies across Nepal, where NTFPs play a crucial role in rural livelihoods. For instance, research indicates that NTFPs can contribute significantly to household income, often comprising 30% to 90% depending on the region and specific products involved (Bista & Webb 2006, Pant *et al.* 2012). The high contribution of Allo in Parche was particularly noteworthy, as it reflected the species' cultural significance and economic potential, especially through the production of traditional garments like Bhangra. This product not only served as a source of income but also preserved cultural heritage among the Gurung and Magar communities. The reported market value of Bhangra, ranging from 29.24 to 43.87 USD per piece, illustrates the economic viability of NTFP-based activities. Similar studies highlighted that NTFPs contribute significantly to national GDP; for example, it was reported that the NTFP sector contributes approximately 5% to Nepal's national GDP (Miya 2021). The accessibility of Allo and Nigalo for crafting products that can be sold both locally and in larger markets demonstrates the potential for income generation through sustainable practices.

As the Allo and Nigalo have great contribution to the household's cash income, extra awareness and training relating to processing, making different products, value addition, certification and marketing of these products is needed in this area. (Deokota & Chhetri 2009) reported that Allo is used for making Sacks, Bags, Coarse clothes, Fishnets and Namlo (head straps to carry load) which is sold in the local market, and it has become an established income generating commodity in Sunsari district. The findings of my study was also similar to this result.

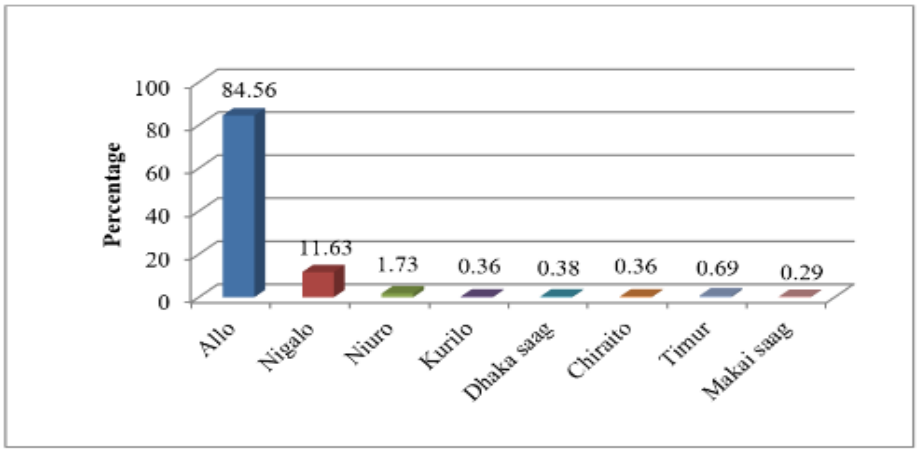

Figure 3. Contribution of different NTFPs in overall income of NTFPs

Local use patterns of NTFPs

NTFPs are deeply intertwined with the socio-economic and cultural fabric of forest-dependent communities in the study area, providing a crucial livelihood safety net during times of hardship (Shackleton *et al.* 2011). A total of 34 NTFP species were documented, along with their local use patterns. Among these, herb species were the most commonly used (50%), followed by shrubs (25%), trees (19%), and climbers (6%). In terms of plant parts consumed, 23% were whole plants, 16% roots, 14% bark, 7% stems, 7% young shoots, 9% fruits, 5% rhizomes, and 14% leaves (Figures 4 and 5).

A study conducted in the Panchadeval Binayak Municipality of Achham District, Nepal, identified 89 NTFP species, with medicinal uses accounting for 53.92% and edible uses for 30.33% (Shahi *et al.* 2022). These findings align with those of the present study, emphasizing the significant role of NTFPs in supporting local livelihoods, particularly for food and medicinal purposes. The consistent focus on herbs as a key category in both studies highlights the essential role these plants play in

fulfilling subsistence needs. Research conducted in community forests of Palpa, Nepal, revealed that local communities utilize a diverse range of NTFPs, with a strong focus on medicinal plants and wild foods. The study noted that 60% of the documented NTFPs were herbs, which correlates well with the current findings where herbs constitute 50% of the total species documented (Ghimire *et al.* 2024). This similarity highlights a broader trend in Nepal where herbs are predominant due to their accessibility and utility.

NTFPs were highly used for medicinal purpose (67.64%) followed by vegetable 11.67% (Figure 6). *Arisaema griffithii, Arisaema consanguineum, Drepanostachyum falcatum* (shoot) ,*Asparagus racemosus,* and *Diplazium sps.* were highly used for vegetable in the study area. Among different NTFPs found in study area, only 5.88 % were used for commercial purpose, especially *Girardinia diversifloia* and *Drepanostachyum falcatum* largely used for commercial purpose and these two species have great contribution to household income. Some NTFPs are used as fruit (8.82%) and insecticides (5.88%) in the study area.

In the study area, NTFPs were primarily utilized for medicinal purposes, accounting for 67.64% of their use, followed by vegetables at 11.67%. This finding aligns with broader research indicating that medicinal and aromatic plants are among the most significant NTFPs utilized in Nepal. For instance, Pant et *al.* (2012) highlighted the critical role of medicinal plants in the livelihoods of rural communities, often serving as the primary source of healthcare for many households. Among the vegetables identified in this study, species such as *Arisaema griffithii, Arisaema consanguineum, Drepanostachyum falcatum* (shoot)*, Asparagus racemosus, and Diplazium spp*. were frequently harvested. These species are recognized for their nutritional and medicinal value, corroborating findings from Ghimire and Awasthi (2016), who noted their significance in local diets and traditional medicine practices. Interestingly, only 5.88% of NTFPs were reported to be used for commercial purposes. This is consistent with Subedi (2003), who noted that while there is potential for commercial exploitation of NTFPs, most are primarily utilized for subsistence rather than market sales.

The results show that the local use pattern of NTPFs by the local people of Parche area are mostly similar to those used by other communities of Nepal. Similar result was found on the utilization of NTFP species for medicinal and food purposes was found to be reasonably high in Kangchenjunga Landscape, Eastern Himalaya (Uprety et *al*. 2016). This utilization of NTFP's for medicinal value agrees with research done by the World Health Organization which found that many local people use varieties of wild plants in traditional ways for their daily requirements as well as primary health care (WHO 2008).

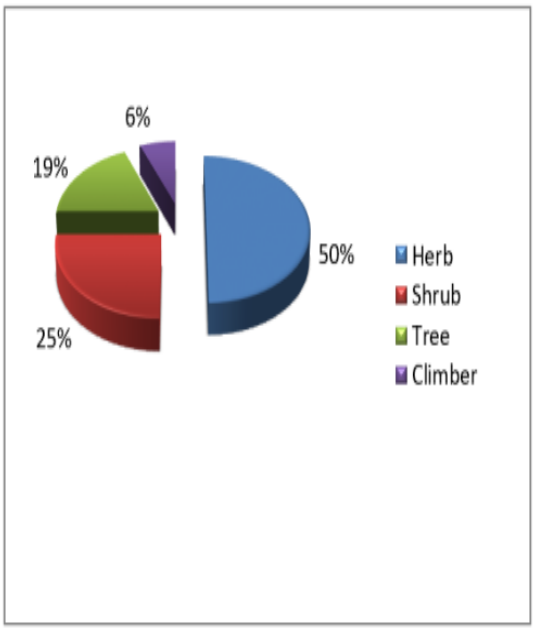

Figure 4. Proportion of NTFPs by life forms

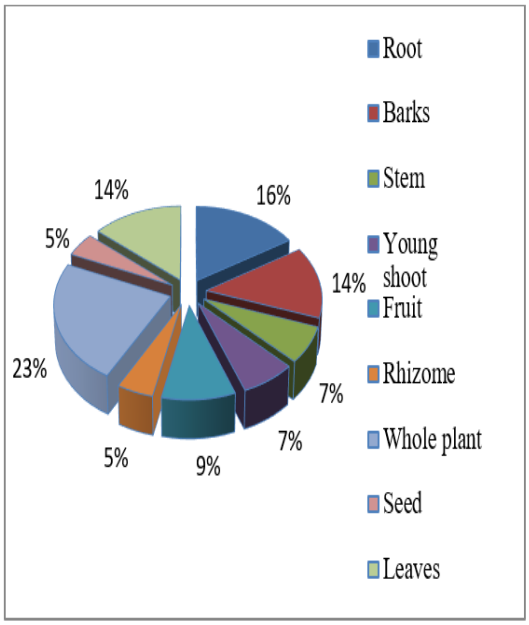

Figure 5. Proportion of NTFPs by part used

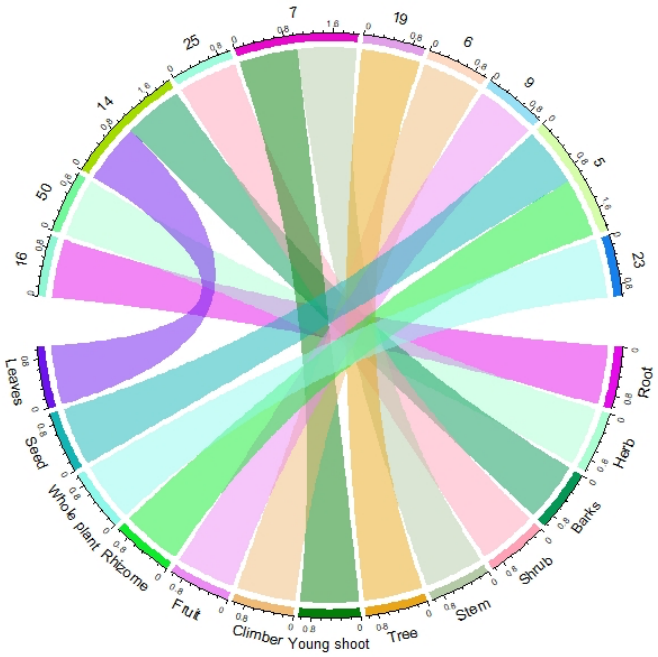

Figure 6. Chord diagram showing proportion of NTFPs by life forms and part used.

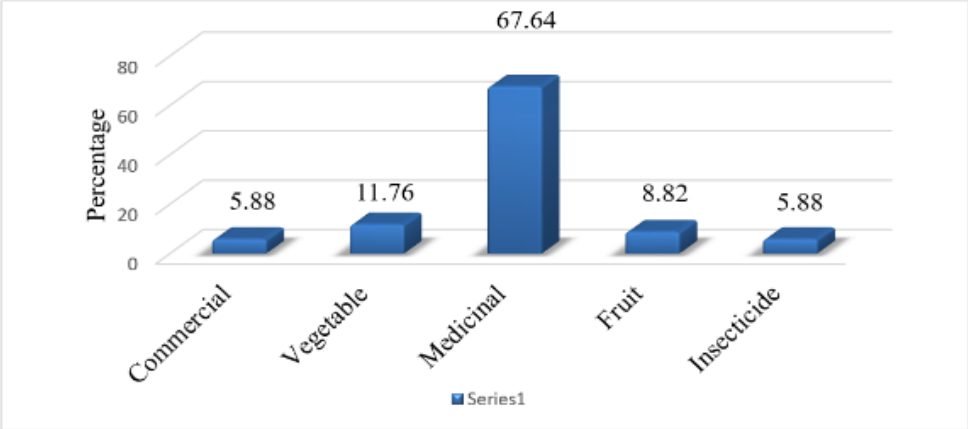

Figure 7. Local use pattern of NTFPs

Factors associated to use of NTFPs and conservation

In this study, education and family size showed significant positive correlation with NTFPs income whereas land holding size and distance showed significant negative correlation (Table 4). The positive correlation between education and NTFP income may seem counterintuitive at first, as previous studies (Godoy & Contreras 2001, Shylajan & Mythili 2007) typically report a negative relationship, with more educated individuals opting for non-forest income opportunities. However, in this study it was found that the educated people generate significantly larger amount from NTFPs especially *Girardinia diversifloia,* in compare to people with low education, it is because the educated people have enough knowledge about market of *Girardinia diversifloia* and they can also export their product in foreign country. Educated individuals tend to have better knowledge of potential markets for NTFPs compared to those with less education. For instance, *Bhangra,* made from *Allo*, can fetch a higher price in external markets, but its value diminishes when sold locally within the village. This disparity highlights that less educated individuals may lack the awareness or resources to explore broader market opportunities beyond their immediate locality, thereby limiting their income from NTFP sales. In contrast, more educated individuals are better equipped to identify and access profitable markets outside their villages as they possess the knowledge and skills necessary to navigate broader market opportunities (Belcher *et al.* 2005).

Households with larger family sizes tend to generate significantly higher incomes from NTFPs. This is because larger families rely more on NTFP income, with more members available to contribute to resource collection, thereby boosting household earnings. This aligns with findings from a study in Swat, Pakistan, where Khan *et al.* (2022) observed that larger households often have more individuals engaged in collecting and processing NTFPs. The increased labor availability enhances collection efficiency and facilitates better market engagement.

Whereas households having large land holding size generate significantly lower income from NTFPs, it is because the large land holding households are highly dependent on agricultural crop production and comparatively the households having small land holding size are highly involve in NTFPs collection. The negative correlation between landholding size and NTFP income is consistent with findings from Pant *et al.* (2012), in Dolakha, Nepal, which suggests that agricultural landholding size negatively impacted NTFP income. Households with larger landholdings were less dependent on NTFPs, as they primarily relied on agricultural activities for income generation. This aligns with the findings of Fisher *et al.* (2010), which suggest that households with more land are less dependent on forests for their livelihood. Smaller landholders, on the other hand, are more reliant on NTFPs due to fewer alternatives for subsistence or income generation. Cavendish (2000) also observed a similar trend in Zimbabwe, where land-poor households depended more on common-pool resources like NTFPs, while wealthier households with larger landholdings had more agricultural-based income. McSweeney (2004) noted that in Honduras, families with larger landholdings were less reliant on forest products, as they had more diversified income streams. While the studies mentioned above show a consistent trend regarding the negative correlation between landholding size and NTFP income, some research has indicated varying results based on local contexts. For example, in certain regions of Nepal, educated individuals with larger landholdings may still engage in NTFP collection due to market opportunities or cultural practices (Ghimire & Awasthi 2016). This suggests that factors such as education and market access can mediate the relationship between landholding size and reliance on NTFPs.

Similarly, the negative impact of distance on NTFP income aligns with the concept that proximity to the forest reduces the time and effort required for collection, making forest resources more accessible and increasing their use. Fisher et *al.* (2010) also found that households closer to the forest have higher levels of dependency on NTFPs, as the lower time investment encourage more frequent and efficient use of forest resources. Similarly, Acharya (2006) found that in Nepal's mid-hill regions, households residing within 1-2 kilometers of forested areas were more actively involved in NTFP collection and derived a greater share of their income from these resources compared to those living farther away. The reduced time and effort required for collection make forest resources more accessible, encouraging frequent use and higher income generation from NTFPs.

The conservation of Non-Timber Forest Products (NTFPs) faces several significant challenges. Overharvesting is a primary concern, as unsustainable collection practices threaten the long-term availability of high-priority species, putting them at risk of depletion. Habitat loss due to agricultural expansion and deforestation further exacerbates this issue, diminishing the forest areas rich in NTFPs that are essential for both ecological balance and community livelihoods. Climate change is another looming challenge, as altered precipitation and temperature patterns disrupt the distribution and productivity of many NTFP species, making them less reliable for local populations. Additionally, market limitations hinder the full economic potential of NTFPs, as inadequate access to markets and a lack of value addition prevent these resources from generating greater income for local communities.

To address these challenges, several recommendations for conservation can be implemented. Promoting sustainable harvesting techniques is crucial to ensure that NTFPs are collected in a way that allows for their regeneration and long-term availability. Providing training in value addition and product certification can help communities increase the economic value of NTFP products, enhancing their marketability. Strengthening market access and creating equitable benefit-sharing mechanisms will ensure that the economic rewards from NTFP use are fairly distributed among local communities. Finally, encouraging local stewardship through community-based resource management programs can empower communities to take an active role in the conservation and sustainable use of NTFPs, ensuring that these resources continue to support both people and the environment for generations to come.

Conclusion

This study highlights the critical role of NTFPs in rural livelihoods and their prioritization in the Parche area. *Girardinia diversifolia* and *Drepanostachyum falcatum* were identified as the most preferred species due to their accessibility, significant economic value, and deep integration into local traditions. The findings emphasize that middle class households

derived the highest income contribution from NTFPs, benefitting from better market access and resource management skills, while poorer households relied more heavily on NTFPs as a safety net.

Table 4. Determinants of households income from NTFPs (n=100)

Explanatory variables	Coefficient	S.E.	t value	p value
Age of respondents	275.962	236.500	1.167	0.246
Education	4194.796	357.027	11.749	0.000
Livestock unit	-63.621	212.671	-0.299	0.765
Land holding size	-2776.638	495.209	-5.607	0.000
Family size	3629.746	645.622	5.622	0.000
Distance from home to forest	-1000.990	437.910	-2.286	0.025
Constant	6597.021	2461.769	2.680	0.009
F (6,93) = 281.898 **Adj. R^2= 0.945**				

Girardinia diversifolia emerged as the most economically significant NTFP, contributing up to 84.56% of the household income among prioritized species. Its use in producing traditional garments like Bhangra illustrates the cultural and economic value of sustainable NTFP practices. *Drepanostachyum falcatum*also played a vital role in household economies, particularly for crafting functional and marketable items.

Factors such as education, family size, landholding, and proximity to forests significantly influenced income from NTFPs, with educated households leveraging market opportunities more effectively. Local use patterns predominantly focused on medicinal and subsistence needs, with 67.64% of NTFPs utilized for medicinal purposes, underlining their importance in traditional healthcare.

These findings align with broader trends across Nepal, where NTFPs are a cornerstone of rural economies, supporting livelihoods, preserving cultural heritage, and contributing to household income. Promoting sustainable practices, enhancing market access, and providing training in value addition and certification can further optimize the economic potential of NTFPs in rural communities.

Declarations

List of abbreviations: NTFP-Non Timber Forest Product; OLS- Ordinary Least Square; MAP-Medicinal and Aromatic Plant; IGA- Income Generating Activities; SDG- Sustainable Development Goal; ACAP- Annapurna Conservation Area Project; CAMC-Conservation Area Management Committee; NEST- Nucleus for Empowerment through Skill Transfer; SPSS- Statistical Package for the Social Science; WHO- World Health Organization; IUCN- International Union for Conservation of Nature and Natural Resource; CIFOR- Center for International Forestry Research; HICAST- Himalayan College of Agricultural Sciences and Technology; WWF- World Wildlife Fund, USAID- United States Agency for International Development; USD-United States Dollar.

Ethics approval and consent to participate: Data were collected with full respect for confidentiality and informed consent. All participants were briefed on the objectives of the study prior to their involvement.

Consent for publication: Not applicable.

Availability of data and materials: All relevant data are included in the article.

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Author contributions: Chungla Sherpa: Designed the study, conducted fieldwork, collected and analyzed data, and interpreted the results. Prepared the initial manuscript draft, including writing, reviewing, and editing. Managed the literature review, data visualization, and final proofreading.

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