Utilization patterns of *Diploknema butyracea* along the gradient of geography and culture in the Nepal Himalaya

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Research

Abstract

Background: Geographic, cultural, phylogenic, and socio-economic factors influence traditional knowledge. This study evaluates the collection and utilization pattern of the **chiuri**-Butter tree (*Diploknema butyracea* (Roxb.) H. J. Lam) across varying geographic and cultural gradients in Nepal.

Methods: We carried out a survey of 270 households from nine districts across lowland Tarai, Siwalik, mid-hills, and mountainous physiography covering all regions of western, central, and eastern Nepal. A generalized linear mixed model, ANOVA, and its corresponding post-hoc Tukey test were used to analyze the results.

Results: The maximum Use Reports of **chiuri** were observed for subsistence (1440) followed by primary health care medicine (240), and religious (213). The maximum values of **chiuri** (Use Reports 402, use value 0.47, and cultural importance index 13.4) were reported from Makawanpur followed by Chitwan, both districts well represent the Central Tarai-Siwalik region. These Use Reports value the **chiuri** go beyond mere ethnomedicinal. The *Chepang* ethnic group, inhabiting only the Central Tarai-Siwalik region of the country possesses a rich and diverse knowledge of **chiuri** collection, utilization, and conservation with a Use Reports of 10.85 per person.

Conclusions: *Chepang* and **chiuri** are interconnected, as they are associated with most extensive Use Reports. The people have meticulously conserved **chiuri** trees in their private lands, state forests, and community-based forests. Community-based conservation, local stewardship, and agroforestry policies can ensure sustainable use. Protecting chiuri forests may serve as a vital refuge for the semi-nomadic *Chepang*, preserving their traditions and livelihoods for future generations.

Keywords: Butter tree, *Chepang*, Ethnoecological knowledge, Socioeconomic attributes

Background

The selection of plants for traditional uses follows a non-random method, considering taxonomic affinities, ethnobotanical context, prior knowledge (Farnsworth & Bingel 1977, Cox 2007), geographical and socio-cultural factors (Kunwar *et al.* 2022), ecological characteristics (Kutal *et al.* 2021), and phytogeographical traits (Saslis-Lagoudakis *et al.* 2014). Socio-cultural factors such as ethnicity, age, sex, religion, education, and profession (Maffi 2005, Houehanou *et al.* 2011), as well as ecological attributes such as availability, abundance, frequency, and growth pattern of the plant, and geographical variables concerning the distance required to travel to obtain desirable resources, are duly considered while selecting and collecting plants (Low 1966, Blancas *et al.* 2013). Among these, prior knowledge, ethnicity, religion, occupation, slope, and distance primarily influence ethnobotany in Nepal (Kunwar *et al.* 2019, Kutal *et al.* 2021, Bhattarai *et al.* 2024). However, changes such as plant phenology, upslope movement of species, invasion by alien species, human outmigration, land abandonment, alterations in land use, and increasing human exploitation along with climate change are major drivers disrupting the tradition and knowledge of plant selection, collection, use, and conservation (Brosi *et al.* 2007, Vandebroek & Balick 2012, Zomer *et al.* 2013, Kunwar *et al.* 2018). Documentation of traditional knowledge developed by local communities through experiences of adapting to environmental crises is paramount in the era of climate change (Karki *et al.* 2022). Evaluating this knowledge and its patterns holds promise for formulating specific strategies for traditional knowledge preservation and building resilience while acknowledging the unique characteristics of each community, geography, culture, and biodiversity (Chaudhary *et al.* 2017, Singh *et al.* 2019).

Diploknema butyracea (Roxb.) H. J. Lam, also known as Butter tree in English, and **chiuri** in Nepali, is a multipurpose cultural keystone tree species of Nepal (Uprety & Asselin 2023, Bhattarai *et al.* 2024). It is a medium to large-sized tree up to 25 m high, slow-growing, native species to the Sub-Himalayan tract of Nepal, India, China, and Bhutan and has been reported between 200 m and 1500 m (Lee 1996, Press *et al.* 2000, Joshi 2010, Majumdar *et al.* 2012). Different ethnic groups of Nepal, India, Bhutan, and Tibet use **chiuri** for various purposes (Adhikari-Devkota *et al*. 2023). It is hailed for its multipurpose values as different parts/products such as bark, stem, leaf, nectar, fruit, butter, honey, oil cake, and gum are utilized (Bhattarai *et al.* 2024). Understanding the influence of socioeconomic variables on the traditional knowledge and utilization of **chiuri** is essential for informing policy interventions, sustainable development strategies, and cultural preservation efforts. However, loss of traditional knowledge and practices in many parts of the world due to acculturation, land use change, limited access to traditional resources, outmigration, industrialization, modernization, and climate change are evident including Nepal (Reyes-Garcia *et al*. 2013, Paniagua-Zambrana *et al*. 2014, Saslis-lagoudakis *et al*. 2014, Atreya *et al*. 2018). Such study is pressing, while land abandonment and sociocultural transformations are prevalent throughout Nepal (Kunwar *et al.* 2018). In this connection, we documented and compared the knowledge of different ethnic groups and sites, and assessed the influence of socioeconomic, demographic, and geographic variables on traditional knowledge of **chiuri** plant collection and use. We hypothesized that the ethnic groups (Tamang, Chepang) hold greater knowledge and are more closely connected to nature (forest, a case of **chiuri** tree in this study) than other peer groups.

Materials and Methods

Study area

Nepal, renowned for its rich cultural heritage and diverse traditional knowledge, presents a compelling case for examining the interactions between socioeconomic and demographic factors and traditional knowledge. Administratively, the country is divided into seven provinces, 77 districts, and 753 local bodies. The diverse west, central, and east longitudes (80°33'-88°12' E) and north-south latitudes (26°8'-30°27') (Banerji 1963), offer distinct geological landscapes, each shaped by unique historical, cultural, and socio-economic attributes (Chaudhary 2023). It has three distinct vertical physiographic regions: the lowland flat plains or Tarai in the southern part of the country, the hills in the middle, and the mountains in the north (Chhetri & Easterling 2010). The Siwalik range lies between the Tarai and the hills (PCTMCDB 2015). We carried out the ethnobotanical study in three physiographic regions (Tarai-Siwalik, Hill, and Mountain) of Western, Central, and Eastern Nepal (Figure 1). The map of the study sites was prepared using ArcMap 10.8 version. The study sites have a diverse array of ethnicities. Western Nepal is predominantly inhabited by Kshetri, Brahman-Hill, Dalit, and others. In Central Nepal, Kshetri, Brahman-Hill, Tamang, Chepang, and others are the major ethnic groups, while in Eastern Nepal, the major ethnic groups include Limbu, Sherpa, Kshetri, Brahman-Hill, Rai, Tamang, and Dalit (CBS 2021) (Table 1). Kshetri and Brahman-Hill are dominant and privileged caste groups, respectively, with the first (16%) and second largest (12%) populations mostly residing in mid-hills. Dalits, a disadvantaged caste group, constitute around 13% of the population and mostly inhabit western Nepal. *Tamang* and *Chepang* are Tibeto-Nepalese ethnic groups (Saslis-Lagoudakis *et al.* 2014), with populations of 5% and 0.2%, respectively, heavily populated in central Nepal (CBS 2021).

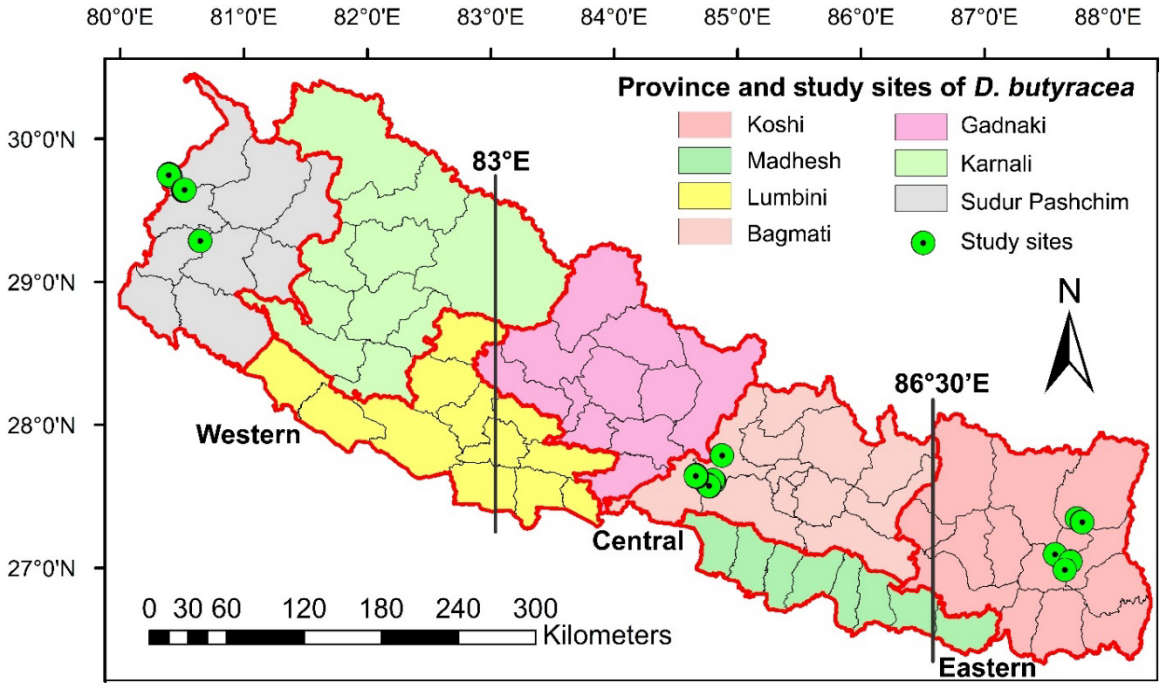

Figure 1. Map of study areas showing data collection points

Table 1. Ethnic diversity and population status in the study sites (CBS 2021)

District	Study site	Physiography	Total Population	Outmigration (%)	Major ethnic group (%)
Dadeldhura	Ganyapdhura Rural Municipality	Mid-hills	13722	16.07	*Kshetri (39.79), Brahman-Hill (18.44), Kami (13.74), Mijar (12.18), Thakuri (7.35)*
Baitadi	Dasarathchand Municipality	Mid-hills	31567	9.75	*Brahman-Hill (32.98), Kshetri (30.1), Kami (21.75), Thakuri (5.74), Dashnami (3.62)*
Darchula	Malikarjun Rural Municipality	Mountains	15635	5.96	*Kshetri (63.47), Kami (16.78), Brahman-Hill (11.44), Thakuri (6.56), Damai (0.88)*
Chitwan	Rapti Municipality	Tarai-Siwalik	66617	8.02	*Brahman-Hill (20.08), Tamang (19), Chepang (17.88), Kshetri (9.26), Tharu (6.35)*
Makawanpur	Raksirang Rural Municipality	Siwalik	25996	1.87	*Tamang (46.25), Chepang (43.96), Kshetri (2.75), Thakuri (2.37), Kami (1.55)*
Dhading	Benighat-Rorang Rural Municipality	Mid-hills	33854	2.70	*Chepang (34.9), Brahman-Hill (10), Kshetri (9.38), Tamang (8.89), Magar (8.2)*
Panchthar	Kummayak Rural Municipality	Mid-hills	12746	7.16	*Limbu (50.5), Kshetri (22.29), Brahman-Hill (6.14), Kami (4.77), Damai (4.57)*
Terhathum	Laligurans Municipality	Mid-hills	15329	6.05	*Limbu (31.46), Kshetri (29.97), Gurung (8.27), Magar (6.93), Brahman-Hill (5.11)*
Taplejung	Phungling Municipality	Mountains	28449	5.66	*Limbu (33.41), Kshetri (11.47), Brahman-Hill (10.88), Gurung (9.69), Sherpa (8.41)*

Field visits and data collection

We conducted three field visits: the first in western, the second in central, and the third in eastern Nepal from January to April 2023. On average, each field visit lasted for 15 days. Voucher specimens (SC01-SC165) collected from the field were deposited at the National Herbarium and Plant Laboratories, Kathmandu (KATH), and the Faculty of Forestry, Agriculture and Forestry University, Hetauda. During the field visits, a total of 270 household heads (30 in each study site which household has **chiuri** in his/her land, older than 20 years) were interviewed. We used purposive sampling techniques for household selection and snowball sampling for key informants such as traditional healers, collectors, traders, and community forest user groups. We adhered to the International Society of Ethnobiology's code of conduct (http://ethnobiology.net/ code-of-

ethics/), and each respondent's verbal consent was obtained before the survey following a free prior informed consent process. Each respondent was informed about the research objectives, the voluntary nature of their participation, their anonymity, and their right to withdraw at any time. We classified socioeconomic variables into three levels as individual, family, and locality (Table 2).

Table 2. Description of socioeconomic variables

Independent variable name	Level	Variable type	Variable classification
Age	Individual	Continuous	15 to 98 years
Education level	Individual	Ordinal	(1) Illiterate; (2) Literate; (3) Primary; (4) Higher
Occupation	Individual	Nominal	(1) Agriculture; (2) Service; (3) Business
Gender	Individual	Nominal	(1) Male; (2) Female
Ethnicity	Individual	Nominal	(1) Brahman-Hill /Kshetri; (2) Ethnic; (3) Dalit
Living history	Individual	Continuous	1 to 100 years
Household size	Family	Continuous	1 to 22
Livestock owned	Family	Continuous	1 to 25
Land owned	Family	Continuous	0.03 to 5.14 ha
Proximity to resource	Locality	Ordinal	(1) 0.5 Km; (2) 1 Km; (3) 1.5 Km; (4) > 2 Km
Sourcing	Locality	Nominal	(1) Forest only; (2) Forest and private land
Physiography	Locality	Nominal	(1) Tarai-Siwalik; (2) Hill; (3) Mountain
Development	Locality	Nominal	(1) Rural Municipality; (2) Municipality

Free listing was done to generate a comprehensive list of emic uses of **chiuri** in every part/product utilized by different cultural groups along the geography of Nepal. A total of 21 emic uses (anthelmintic, asthma, beverage, cooking oil, dowry, edible, enlighten lamp, fertilizer, fodder, food, fuel wood, honey, jaggery, latex, pesticide, piscicidal, religious, skin crack, soap base, timber, and worship), of all useful parts/products were classified into six etic categories such as medicinal, religious, cultural, subsistence, industrial, and culinary (modified from Cook 1995, Kutal *et al.* 2021). The diversity of plant parts/products and their usefulness reported by each respondent were used as a score to evaluate and compare the level of traditional knowledge along the geography and culture. We employed a binary system, using '1' to indicate the presence and '0' for the absence of **chiuri** utilization in the field.

Data Analysis

Ethnobotanical indices

The following ethnobotanical indices were calculated to analyze the quantitative ethnobotany using R studio (version 2024.04.0).

Use Reports (URs)

It is the total uses for the part/product by all participants within each use category for that part/product. It is an account of the number of participants who mention each use-category NC for the part/product and the sum of all uses in each use-category (Phillips *et al.* 1994).

$$URs = \sum_{u=u1}^{uNC} \sum_{i=i1}^{iN} URui$$

The Use Value (UV)

The use value or importance of **chiuri** was assessed using the methodology described by (Phillips & Gentry 1993, Phillips *et al.* 1994) as -

$$UV = \frac{\sum UVi}{N}$$

Where UVi represents the use value of the species for a single informant obtained as the sum of the number of different uses mentioned by informant i and where N is the total number of informants.

Frequency of Citation (FC)

It is the sum of participants that cite a use for the part/product (Tardio & Pardo-de-Santayana 2008).

$$FC = \sum_{i=i1}^{iN} URi$$

Cultural Importance Index (CII)

To find out the cultural significance of each plant part/product in every locality, the cultural importance index (CII) was calculated as the summation of the Use Reports (URs) in every use category mentioned for a species in the locality divided by the number of participants (N) in that locality (Hoffman & Gallaher 2007).

$$CII = \sum_{u=u1}^{uNC} \sum_{i=i1}^{iN} URui\ /N$$

Statistical analysis

To analyze the influence of socio-economic attributes on plant Use Reports in study sites we first used analysis of variance analysis (ANOVA) and its corresponding post-hoc Tukey test. To analyze the influence of socioeconomic variables on **chiuri** Use Reports at individual, family, and locality levels, we carried out a generalized linear mixed model. The level of significance was applied at $p \leq 0.05$. All the analyses were performed in R studio in R 4.3.1 (The R Foundation for Statistical Computing Platform 2023) using ethnobotanyR package.

Results

Usefulness of chiuri and its parts

A total of 2023 Use Reports across 21 emic uses of ten useful parts/products of **chiuri** were recorded and later classified into six etic categories for easier presentation (Table 3). Among the useful parts/products, fruit, leaf, and stem were cited with a 100% frequency of citation, followed by butter (57.03%) and honey (50.54%). Bark was prioritized for its medicinal properties, while stems and branches provided fuelwood and timber. Leaves were used as fodder during famine and for religious applications, while flowers were primarily used for honey production. Fruits served as both delicious food and occasional wine ingredients, and seeds were crucial mainly for butter production. Seeds were used to produce butter and oil cake; the latter was quite valuable as a fertilizer and pesticide. Besides plant parts, entire trees were also used for specific cultural purposes, although the frequency of citations was low (7.71%).

Table 3. Ethnobotanical indices of **Chiuri** parts/products utilization

Part/Product	Frequency of Citation (FC) (%)	Use Report (URs)	Emic use	Etic category
Bark	34.07	100	Anthelmintic	Medicinal
			Latex	Subsistence
Butter	57.03	233	Cooking oil	Culinary
			Soap base	Industrial
			Skin crack	Medicinal
			Enlighten lamp	Religious
Flower	45.56	131	Syrup	Subsistence
Fruit	100	273	Edible, beverage	Subsistence
Honey	50.54	300	Food	Industrial
			Asthma	Medicinal
			Worship	Religious
			Food	Subsistence
Leaf	100	348	Leaf plate	Religious
			Fodder	Subsistence
Oil cake	87	174	Fertilizer, pesticide, piscicidal	Subsistence
Stem	100	451	Fuel wood, timber	Subsistence
Nectar	2.96	8	Jaggery	Subsistence
Entire plant (Tree)	7.71	13	Dowry	Cultural

Utilization of all parts/products for medicinal, religious, cultural, subsistence, industrial, and culinary use categories revealed the multipurpose nature of trees. The highest Use Reports were observed for the subsistence (1440) followed by medicinal (240) and religious (213) use categories (Figure 2). The subsistence use category with 12 emic uses played a crucial role in supporting the livelihoods of the locals. Delicious food from fruit, nutritive fodder from leaves, and fuelwood from stem branches were common emic uses throughout the country with the highest frequency citation (100%). Similarly, latex from bark, syrup, honey, jaggery from flowers, a beverage from fruit, fertilizer, and pesticidal uses of oil cake were also cited to be used for subsistence uses.

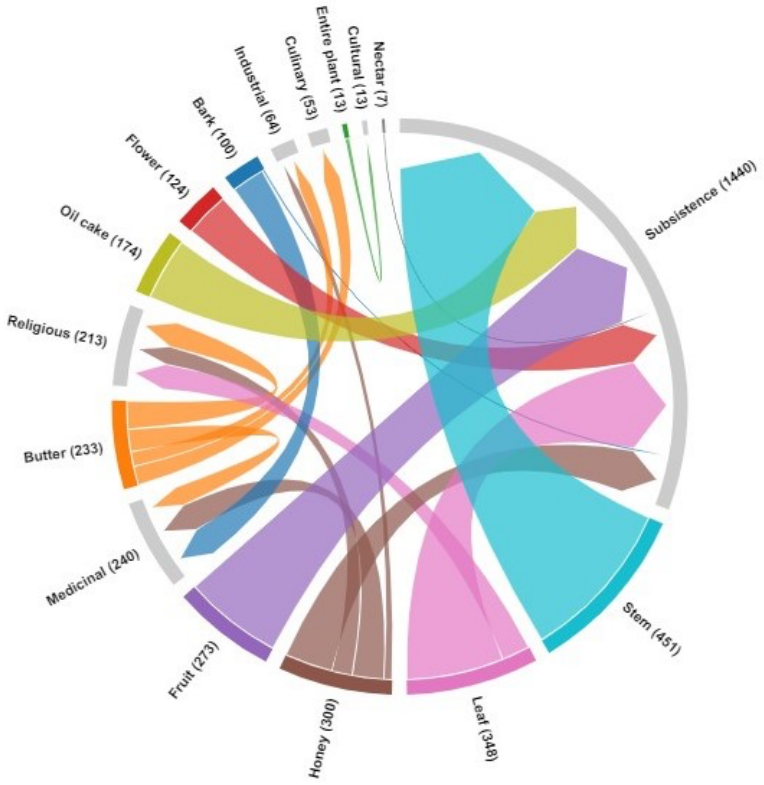

Figure 2. Use categories of different parts/products of *D. butyracea*

The selection and use of **chiuri** plant parts varied greatly depending on geography and culture. All **chiuri** plant parts/products (10) were reported to be used in Makawanpur followed by nine in Chitwan district, both from Central Nepal. Similarly, the *Chepang* ethnic group valued all plant parts/products (fruit, leaf, stem, butter, honey, oil cake, bark, latex, nectar, and entire plant) for all six use categories. On the contrary, the least, three plant parts/products (fruit, leaf, and stem) were reported to be used for ethnobotanical applications in the Panchthar district, eastern Nepal, and by the *Limbu* ethnic group.

Chiuri use values along geography and culture

We found a statistically significant association (p=0.000) among the Use Reports (URs), Use Value (UV), and Cultural Importance Index (CII) along the geography, and culture (Table 4). Longitudinally, the maximum Use Reports (983) (10.92 person^{-1}) was reported from central Nepal followed by western (663) (7.37 person^{-1}), and eastern (377) (4.19 person^{-1}). Similarly, among physiographic regions, the Tarai-Siwalik holds the highest Use Reports (13.25 person^{-1}) followed by mountain (7.03 person^{-1}) and hills (5.37 person^{-1}). At the site level, the highest scores of URs (402), UV (0.47), and CI (13.4) were reported from Makawanpur followed by Chitwan (URs 393, UV 0.44, and CI 13.1) whereas the lowest scores (URs 122, UV 0.14, and CI 4.07) were reported from Panchthar, eastern Nepal. Similarly, a significant variation (p=0.000) in **chiuri** utilization was observed among the ethnic groups. The *Chepang* ethnic group had diverse knowledge and practices of **chiuri** with a Use Reports of 10.85 person^{-1} followed by *Tamang* (8.17 person^{-1}), *Dalit* (8 person^{-1}), and *Kshetri* (6.98 person^{-1}) and the least for group *Dashnami* (2.75 person^{-1}). These findings underscore the complex interplay between geographical location and cultural perceptions in shaping resource utilization patterns.

Socioeconomic attributes and chiuri utilization

The knowledge of **chiuri** utilization was statistically and significantly varied at an individual level, education (p=0.000), occupation (p=0.002), and ethnicity (p=0.000). However, there was no significant variation in the Use Reports among

respondent's age groups (p=0.449), gender (p=0.465), and living history (p=0.932) (Figure 3). At the family level, we observed a significant positive association between Use Reports and household size (p=0.003), and livestock owned (p=0.002) but a significant negative interaction was observed at land owned (p=0.002) (Figure 4) suggesting that those with smaller land holdings reported higher **chiuri** use. Similarly, at the locality level, both proximity to the trees and sourcing from forest and both forest and private land had a significant difference in **chiuri** Use Reports in many sites indicating that the easier accessibility to the resource, the higher the Use Reports (Figure 5).

Table 4. Scores of use report, use value, and cultural importance index of **Chiuri** along geography

Location	Physiographic region	Major ethnic groups	Use Report	Use Value	Cultural Importance Index
Western Nepal	Mountains (Darchula)	*Kshetri, Brahman-Hill, Dalit, Thakuri*	291	0.32	9.7
	Mid-hills (Baitadi)	*Kshetri, Brahman-Hill, Dashnami, Dalit*	158	0.18	5.27
	Mid-hills (Dadeldhura)	*Brahman-Hill, Kshetri, Dalit*	214	0.24	7.13
Central Nepal	Mid-hills (Dhading)	*Chepang, Tamang, Gurung, Kshetri, Magar, Mijar*	188	0.18	5.27
	Siwalik (Makawanpur)	*Chepang, Tamang*	402	0.47	13.4
	Tarai-Siwalik (Chitwan)	*Chepang, Tamang, Tharu*	393	0.44	13.1
Eastern Nepal	Mountains (Taplejung)	*Limbu, Magar, Sherpa, Sunuwar*	131	0.15	4.37
	Mid-hills (Terhathum)	*Limbu, Brahman-Hill, Kshetri, Dalit, Dashnami*	124	0.14	4.13
	Mid-hills (Panchthar)	*Magar, Limbu, Brahman-Hill, Dalit*	122	0.14	4.07
Total			**2023**	**2.26**	**4.07**

The generalized linear mixed model showed that various socioeconomic and demographic factors differently impacted the Use Reports of **chiuri**, with seven out of 11 factors showing significant influence (Table 5). Specifically, age was a significant factor only in Dadeldhura while education had a notable negative impact in Makawanpur and Panchthar, suggesting that individuals with higher education are less likely to use **chiuri** products and parts, possibly due to access to alternative resources or practices. At the locality level, both proximity to the resource and sources had a significant association in many study sites indicating that the easier availability of the resource, the higher the Use Reports. Remarkably, proximity plays a critical role, as evidenced by the strong negative coefficient for proximity to resources, indicating that individuals residing closer to **chiuri** resources are more likely to report its use.

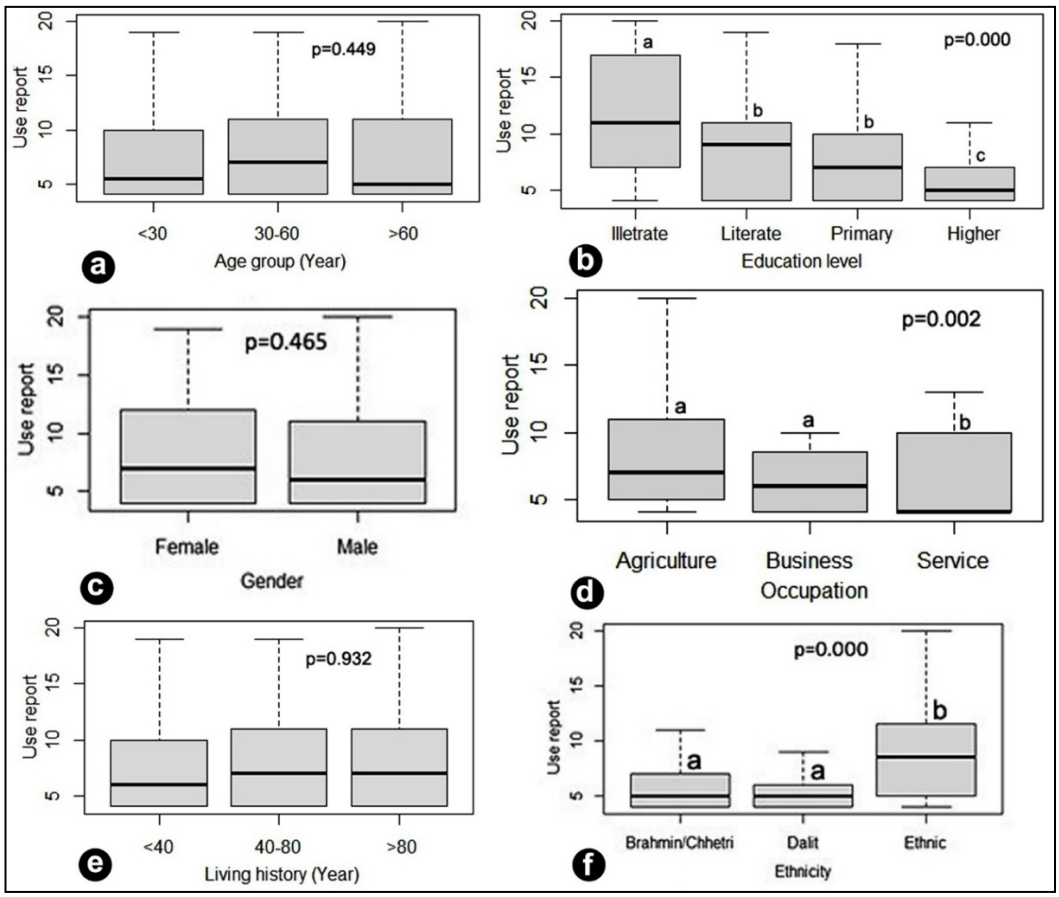

Figure 3. Association between use report and socioeconomic variables at individual level a) age; b) education level; c) gender; d) occupation; e) living history; f) ethnicity

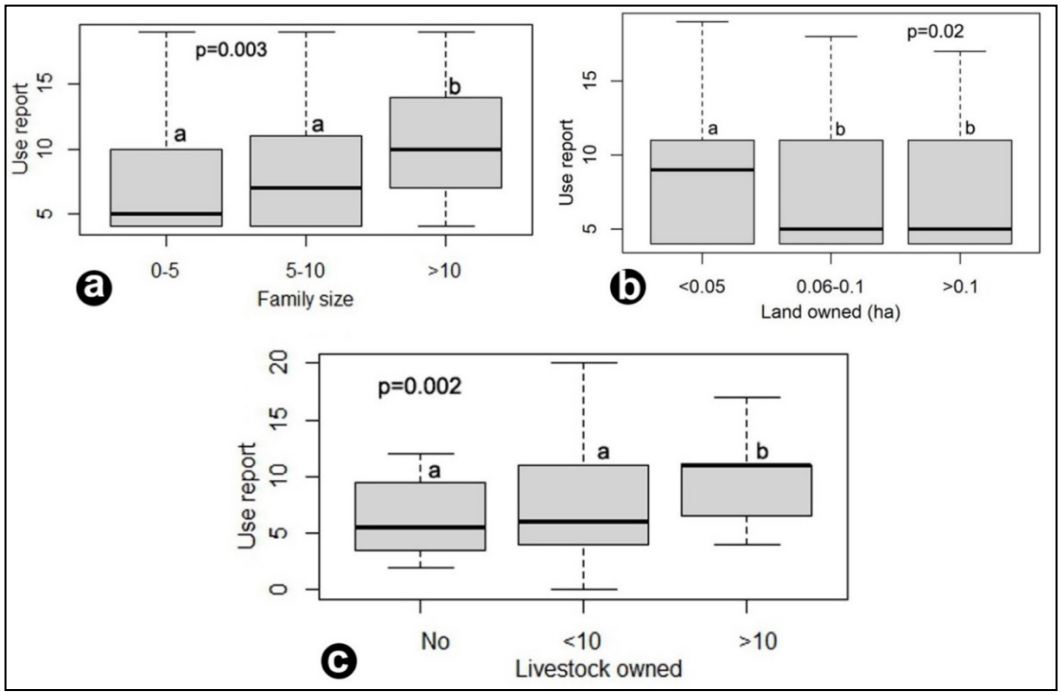

Figure 4. Association between use report and socioeconomic variables at the family level a) household size; b) land owned; c) livestock owned

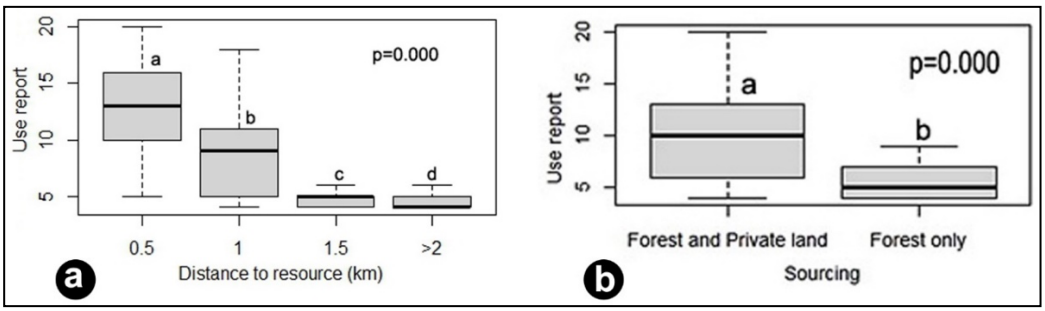

Figure 5. Association between use report and socioeconomic variables at locality level a) distance to resource b) sourcing

Table 5. Generalized linear mixed model of socioeconomic variables influencing *D. butyracea* use report (significance level (p): *=0.05, **=0.01, ***=0.000)

Variables	**Western Nepal**			**Central Nepal**			**Eastern Nepal**		
	Dadeldhura	Baitadi	Darchula	Chitwan	Makawanpur	Dhading	Panchthar	Terhathum	Taplejung
Intercept	1.893	1.492	2.236	9.146	8.706	4.959*	8.317***	3.511***	1.891
Age	0.086*	0.041	0.035	0.094	-0.011	0.001	-0.011	0.001	0.012
Education level	0.087	-0.229	0.397	-3.085	-2.081*	-0.210	-1.091**	-0.001	0.088
Occupation	2.207***	1.849	-0.160	6.183*	3.858	-0.828	-0.140	-0.105	0.727*
Gender	-0.110	0.738	-0.056	-2.941	-2.333	-0.266	-0.002	-0.022	0.468
Ethnicity	0.570	0.126	0.647	1.819	5.257*	0.100	0.228	0.002	0.203
Living history	0.003	0.015	0.025	-0.029	0.018	-0.004	-0.001	-0.001	-0.002
Household size	-0.074	-0.001	0.164	-0.069	-0.118	0.067	0.115*	0.043*	0.035
Livestock owned	0.105	0.042	-0.006	0.035	-0.110	-0.077	-0.051	-0.008	-0.008
Land owned	-0.001	-0.018	0.022	0.039	-0.032	0.025	0.001	0.001	-0.002
Proximity to resource	-3.308**	-1.854	-5.463**	-2.409	-9.816	-0.815	-0.001	-0.147	-0.748*
Sourcing	-0.448	0.849*	1.979	-0.261	0.165	2.312***	-0.071	0.330*	0.318

Similarity and dissimilarity of the uses

Besides the regular subsistence uses of fruit, leaf, and stem branches, some parts, and products of the **chiuri** trees were applied for those not reported earlier (Table 6). A total of 17 uses were found unique and the most were again recorded from Central Nepal districts (Chitwan, Makawanpur) and by the *Chepang*. In the *Chepang* community, Makawanpur, the tree was used as a dowry, and its nectar was made into jaggery, which was then offered to special guests. The bark of the **chiuri** tree in Chitwan and Makawanpur is utilized for its juice for fish poisoning and anthelmintic treatment and latex for birds trapped mainly by the *Chepang* and *Tamang* groups. Oil cake was used as a leech repellent and a biofertilizer and pesticide in agricultural fields. The fruit was processed into wine besides delicious food by the *Limbu* people in Terhathum.

Table 6. Unique use reports of **chiuri** (*Diploknema butyracea*)

Study site	**Parts/products**	**Emic use**	**Ethnic group/caste**
Makawanpur	Tree	Dowry	*Chepang*
	Nectar	Jaggery	
Chitwan, Makawanpur	Bark	Latex, Fish poisoning, Anthelmintic	*Chepang, Tamang*
	Oil cake	Fertilizer, pesticide, leech repellent	
Terhathum	Fruit	Juice, Wine	*Limbu*
Baitadi, Chitwan, Dadeldhura, Darchula, Makawanpur	Butter	Cooking oil, enlightening religious lamp, boil, pimples, soap base	*Brahman-Hill, Chepang, Kami, Kshetri, Magar, Tamang, Tharu*
Chitwan, Darchula, Makawanpur	Honey	Food, Asthma	*Chepang, Tamang, Tharu, Magar, Brahman-Hill, Tharu, Kami,*

Discussion

Chiuri parts/products and their values

The fruit, leaves, and stem/branches of this multipurpose tree were reported with a 100% citation frequency, showing that everyone was familiar with the tree and had used at least one of its parts or products. The bark is employed in traditional medicine in treating various ailments such as rheumatism, ulcers, inflammation, and diabetes and for fishing purposes due to its stupefying properties. Its bioactive compounds, including flavonoids, tannins, glycosides, terpenoids, and carbohydrates together with a considerable amount of phenolic compounds content exhibit antioxidant, anti-inflammatory, and analgesic potential, supporting its traditional medicinal uses (Baruwal Chhetri *et al*. 2020, Dahal *et al.* 2021, Devkota *et al.* 2019, Joshi 2010, Watanabe *et al.* 2013). The ripe fruit yields a delicious syrupy sugar and a juicy pulp rich in sugars, carbohydrates, proteins, fats, ash, and essential minerals, making it a good source of nutrients after food (Adhikari *et al.* 2007, Sundriyal & Sundriyal 2004).

Besides the general uses of fruit for consumption and leaves and stems for leaf plates, fodder, and fuelwood, the plant is also valued for its butter and honey. These products were cited with frequencies of 57.03% and 50.54%, respectively, and had 233 and 300 Use Reports. This highlights their significance and widespread use across various geographical regions and ethnic groups. **Chiuri** butter is particularly valued in subsistence, religious, medicinal, culinary, and even industrial utilization especially in cosmetics, pharmaceuticals, and even confectionery when blended with Kokum (*Garcinia indica*) or Sal (*Shorea robusta*) holding a large economic potential (GIZ 2013, Reddy & Prabhakar 1994). Despite changes in subsistence use due to socio-acculturation, outmigration, and the easy availability of alternatives, the **chiuri** tree remains socioculturally significant among indigenous and ethnic groups like the Chepang and Tamang. This enduring importance is particularly intriguing, as the use of **chiuri** is deeply intertwined with Chepang culture, making them inseparable (Chikanbanjar *et al*., 2021).

The high number of Use Reports for **chiuri** in subsistence and medicinal applications demonstrates that its value extends beyond cultural significance. **Chiuri** plays a vital role in rural livelihoods, offering essential products for subsistence, household economies, and primary health care. The application of **chiuri** plant parts and products ranged from dowry to food to agricultural and medicinal uses, demonstrating its versatility and potential for the maintenance of culture and biodiversity. In ancient literature, the *D. butyracea* tree was said to be a *Kalpabriskha* (wish-fulfilling sacred tree) (Joshi *et al.* 2018), and still today every part/product such as bark, butter, flower, fruit, honey, leaf, oil cake, stem, entire plant (tree) are used for a variety of purposes (Bhattarai *et al.* 2024) including economic uses (Acharya 2014). As **chiuri** tree species have been significant to the forest-dependent ethnic groups for maintaining traditions, culture, livelihood, health care, and spiritual practices, it could be conserved as a socio-cultural asset of the ethnic groups inhabiting the rural areas.

Knowledge of chiuri utilization and socioeconomic variables

Significant variation in **chiuri** use was observed among different education levels, occupations, and ethnicities, underscoring the importance of these variables in determining the extent of reliance on traditional resources. The respondents with higher education and non-agricultural occupations had relatively less knowledge of **chiuri** utilization, aligning with global ethnobotanical trends (Bruyere *et al*. 2016). This trend was observed as individuals with higher education levels often seek office jobs, moving away from traditional knowledge (Ouachinou *et al.* 2019). In contrast, those with less formal education remained dependent on forest resources and agriculture-based livelihoods, reporting more varied uses of **chiuri** (Atreya *et al.* 2018). Generally, ethnic groups possessed higher knowledge, skills, and dependency on this multipurpose tree, utilizing it for medicinal, religious, cultural, and culinary purposes beyond mere subsistence. Notably, the *Chepang* ethnic group considers **chiuri** trees a symbol of pride and tradition, often offering them as dowries to their daughters and valuing their presence in their territory (Shakya 2000, Dhakal 2014, Chikanbanjar *et al.* 2021) highlighting its socio-cultural significance alongside other diverse uses (Uprety & Asselin 2023). *Chepang* people lament the declining interest of youngsters to collect and use **chiuri** parts/products. The decreasing utilization of **chiuri** products is manifested in Chitwan (Poudel *et al.* 2024).

The nonexistence of significant associations with age, gender, and living history suggests that **chiuri** use is broadly distributed across these demographics, reflecting a general cultural familiarity with the tree. Although many studies such as (Karki *et al.* 2023, Albuquerque *et al.* 2011, Cox 2000) revealed the significant influence of age group and gender on the utilization pattern of multipurpose tree species, all respondents reported knowledge of using at least a few parts such as leaf, fruit, and stem branches of **chiuri** for subsistence purposes.

The positive correlation between **chiuri** use and household size, as well as livestock ownership, suggests that larger families and those with more livestock rely more on **chiuri**, likely due to increased economic demands and the need for diverse resources to support their household economy (Chinsembu *et al.* 2014). Conversely, the negative correlation with land

ownership implies that those with smaller land holdings may rely more heavily on **chiuri**, likely because they have fewer agricultural resources and thus turn to forest resources to meet their needs. Larger landowners often have diversified income sources, such as as commercial farming or employment, decreasing the necessity of relying on **chiuri** for subsistence. In contrast, households with limited land rely more on communal forest resources, including **chiuri**, for food, medicine, and economic activities. The findings further reinforce the significance of accessibility, with proximity to resources and sourcing from both forest and private lands being crucial for higher **chiuri** Use Reports (Reddy & Chakravarty 1999).

Cultural and geographical influence on chiuri use

The statistical analysis (ANOVA) showed that **Chiuri** utilization varied significantly (p=0.000) across geographic and cultural groups. Central Nepal had the highest Use Reports (983, 10.92 person^{-1}), followed by western (663, 7.37 person^{-1}) and eastern (377) (4.19 person^{-1}). Similarly, the Tarai-Siwalik holds the highest Use Reports (795, 13.25 person^{-1}) followed by mountain (422, 7.03 person^{-1}) and hills (806, 5.37 person^{-1}). The result deduced that the Central Tarai-Siwalik possessed the highest values of **chiuri** for local livelihood. Maximum plant utilization records in central and western Nepal were attributed to the richness of different ethnic groups such as *Chepang*, *Tamang Magar*, *Tharu*, etc., and their prevailed close association with forest and water. *Chepang, Magar and Tamang* ethnic groups are indigenous and knowledgeable in better utilization of forests (Lama, 2023) and so are *Tharu* for water (Chaudhary *et al.* 2021). Among the groups, the *Chepang* had the most diverse knowledge and practices (10.85 URs person^{-1}), followed by *Tamang* (8.17 URs person^{-1}) and both are native to and densely populated in central mid-hills. Historically, the *Chepang* group, inhabiting close to central Tarai-Siwalik has maintained a mutual relationship with nature, relying on forests, water, and wildlife for their livelihoods (Aacharya *et al.* 2023). Higher Use Reports in Central hills and Tarai-Siwalik could be a reason that the **chiuri** plant abundantly grows at the range of 700-1200 m (Bhattarai *et al.* 2024, Brosi *et al.* 2007), and sometimes scales up to 200-1500 m (Press *et al.* 2000). Siwalik is a continuum of southern lowland Tarai to populous and diverse mid-hills (Chaudhary & Subedi 2019).

The *Chepang* and *Tamang* ethnic group in Makawanpur, with the highest Use Reports (402) and a cultural importance index of 13.4, followed by *Chepang*, *Tamang* and *Tharu* ethnic groups with the Use Reports (393) and the cultural importance index (13.1) in Chitwan showcases a strong connection between their traditional knowledge, practices, and ethnobotany. *Chepang* ethnic group is semi-nomadic and mostly dependent on forest for their livelihood. There is the lowest outmigration rate (1.87-2.7%) in Makawanpur and Dhading districts, home to *Chepang*, also nuanced that the *Chepangs* are rich in traditional knowledge, cultural beliefs, *and* **chiuri** trees. This was supported by the negative correlation (R=-0.24) between the absentee population and knowledge of **chiuri** plant use. Rising outmigration, socio-acculturation, and the easy availability of alternatives have promoted people to seek other options, posing a threat to the cultural heritage of **chiuri** and *Chepang*. The *Chepang* people not only rely on and worship the **chiuri** tree but also meticulously manage and conserve trees across different land tenure systems, including state forest lands, unregistered private lands (locally known as *Khoriya*), and registered private lands (Bhattarai *et al.* 2024; Sharma, 2011). In private lands, there were ~15 **chiuri** trees in each *Chepang* household in Raksirang, Makawanpur (Golay *et al.* 2021). *Chepang* people avoid cutting down **chiuri** trees (Bhattarai *et al.* 2021). This stewardship reflects their commitment to preserving the integrity of the **chiuri** tree (Haq *et al*., 2022) while also demonstrating the long-term strength of community-based conservation initiatives, which have been widely promoted across the developing world as a strategy for protecting natural resources and ensuring their sustainable use (Baral & Stern, 2011). This close connection between ecology and ethnobotany was evident, as districts with rich populations and abundant resources demonstrated extensive ethnobotanical knowledge and vice-versa.

Conclusions

The diverse **chiuri** utilization pattern in geographical and socioeconomic contexts reveals distinct patterns, with certain parts such as the fruit, leaf, and stem/branches holding particular significance. Subsistence use emerged as the most prevalent category with the highest Use Reports (1,440), followed by medicinal uses (240). The maximum Use Reports of **chiuri** for subsistence use and medicinal applications granted the usefulness of **chiuri** goes beyond mere cultural. As the tree has multipurpose values and ten parts/products of the tree are being used, there is a growing concern about the conservation of species. The highest Use Reports (402), use value (0.47), and cultural importance index (13.4) were reported from Makawanpur district followed by Chitwan, both districts represent the Tarai-Siwalik region of central Nepal and are home to the *Chepang* ethnic group. Culturally, the *Chepang* had diverse knowledge and practices of **chiuri** utilization with a Use Reports of 10.85 person^{-1} followed by *Tamang* (8.17 person^{-1}) and both are native to and densely populated in central Mid-hills and Siwalik. *Chepang* people are the primary conserver of **chiuri** and they have meticulously conserved trees across different land tenure systems, including state forestlands, community-based forests, and private lands in central Nepal. The **chiuri** Use Reports showed significant variation in education, occupation, ethnicity, household size, and proximity to the

chiuri tree. These findings underscore the importance of considering geography and cultural covariates in understanding the ethnobotany of **chiuri**. Thus, nationwide documentation and conservation of **chiuri** through community-based conservation strategies, including participatory forest management and local stewardship initiatives, as well as encouraging **chiuri** orchard establishment via national agroforestry policies, can play a crucial role in ensuring sustainable utilization and enhancing economic resilience for local communities.

Declarations

Ethics approval and consent to participate: We adhered to the International Society of Ethnobiology's code of conduct (http://ethnobiology.net/ code-of-ethics/) and each respondent's consent was obtained before the survey following the free prior informed consent process.

Consent for publication: Not applicable

Availability of data and materials: Necessary data are included inside the manuscript. Other data will be made available upon request.

Competing interests: The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Author contributions: SB, BB, AKS, and RMK designed the work. SB collected the field data, analyzed and prepared the draft. All authors read, corrected, and approved the manuscript.

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