

Preferences, use, and value of forest products in Bardia National Park, Nepal

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Manuscript received: 15 November 2025. Revision accepted: 28 February 2026.

Abstract. Acharya KR, Devkota BP, Silwal T. 2026. Preferences, use, and value of forest products in Bardia National Park, Nepal. *Asian J For* 10 (1): r100119. <https://doi.org/10.13057/asianjfor/r100119>. Agrarian communities living near protected areas, especially in developing countries worldwide, are highly dependent on park resources to meet their subsistence needs. Buffer zones, in and around protected areas, are established to achieve dual aims: fulfilling local communities' forest needs and conserving biodiversity. This study investigates the community preferences, uses, and values of park resources in the buffer zone of the Bardia National Park, Nepal. A household survey (n=531) of ten buffer-zone community forest user groups from November 2023 to February 2024, supplemented by direct observation of the *khar-khadai* (i.e., grass cutting) event in 2024. Logistic regression and chi-square test (χ^2) were used to identify possible socioeconomic and institutional factors that affected households' interest in extracting park resources. The results reveal that 63.7% of respondents showed an interest in collecting forest products, with significant differences by ethnicity ($\beta = 0.399$, $p < 0.001$) and community forest membership ($\beta = -0.152$, $p < 0.010$). Tharu and disadvantaged Dalit households showed greater interest in accessing park resources than other ethnic groups. Forest users from buffer-zone community forests with better forest conditions ($\chi^2 = 95.233$, $df = 9$, $p < 0.001$) showed lower interest in entering the national park. Fuelwood was identified as the most preferred forest product, followed by thatch grass, grass cane and *Sabai* grass. Timber was found to be the least preferred forest product collected from the national park. Despite increased availability of alternatives, forest product collection from national parks remained significant for Tharu and Dalit households, for whom buffer-zone community forests could not meet the demand. This study recommends that sustainable forest management practices be promoted in buffer-zone community forests to address the unmet needs of local users by maintaining equitable access to resources and promoting alternative resources.

Keywords: Buffer zone community forest, fuelwood, *Khar-Khadai* permit, protected area, subsistence use

INTRODUCTION

The dependency of agrarian communities on forest resources for their livelihoods is a key global issue. These communities exploit forest resources, including timber, fuelwood, fodder, and grazing, to meet subsistence needs. This presents a common conservation challenge for protected area managers (Hegde and Enters 2000; Karanth et al. 2006). Exploitation of park resources is particularly common in developing countries, where the livelihoods of surrounding populations depend heavily on forests (Kumar and Shahabuddin 2005). As in many developing countries, protected areas in Nepal are also typically established around densely populated areas, intensifying the interaction between conservation objectives and local livelihood needs (Heinen et al. 2019). Nepal initiated a buffer zone management program to balance conservation initiatives with residents' needs by amending the existing National Parks and Wildlife Conservation Act of 1973 (HMGN 1973). A buffer zone is the peripheral area that allows sustainable harvesting of forest products while reducing human pressure on the core area (HMGN 1996). Despite various innovative policies and management practices, the dynamics of resource dependence, user diversity, resource access policies, and the effectiveness of forest resource use

are inadequately understood, especially at the protected area level in Nepal.

The Buffer Zone Management Regulations in 1996 of Nepal ensure that local communities, inside or adjacent to protected areas, can share park revenues and access certain forest products (Lehmkuhl et al. 1988; Baral and Heinen 2007; Heinen et al. 2019). For instance, the annual "*khar-khadai*" event permits residents to harvest thatch grass and other products from inside the protected areas. The *khar-khadai* is a grass-cutting event in which buffer zone users are allowed to collect *khar* (thatch grasses) and *khadai* (tall grasses) from the national park for a specified period each year. The main aim of these policies is to balance conservation goals with the fulfilment of basic requirements for forest products to buffer zone users. Like other protected areas in the lowland, Bardia National Park also allows harvesting forest products, particularly thatch grass, grass cane, and fuelwood, once a year (Baral and Heinen 2007). Previous studies have assessed the impacts of such grass/fuelwood collection on local community livelihoods and on grassland management within the national park (Lehmkuhl et al. 1988; Thapa and Chapman 2010; ILRI 2021; Lamichhane et al. 2024). As the *khar-khadai* event is typically scheduled at the end of the growing season, when the grass has dried up, the impact on

wildlife forage availability is thought to be limited (Lehmkuhl et al. 1988; DNPWC 2022). However, regulating *khar-khadai* within protected areas provides thatch grass for local communities and benefits herbivores by maintaining short grasslands (ILRI 2021). According to Suleiman et al. (2017), resource dependence is a function of the economic, ecological and socio-cultural factors of the local community. Likewise, Ndo et al. (2024) reported that income, age, and ethnicity were the main determinants of forest product collection in Cameroon's National Park. Nonetheless, the recent trend of forest produce extraction under official permits in Nepal, particularly around the *khar-khari* phenomenon, does not yet appear to warrant a detailed, context-specific analysis.

The Government of Nepal initiated a community forestry program in the buffer zone of protected areas in 1999, and nearly half of buffer zone residents now have access to resources from buffer zone community forests (FRA 2015; Acharya et al. 2025). Buffer Zone Community Forests (BZCFs) are buffer zone forests handed over to buffer zone users to regulate harvesting practices, balancing the integrity of the ecosystem with community livelihoods. The handover process was completed after the tripartite arrangement involving the forest users, the Buffer-Zone User Committee, and the National Park Authority (DNPWC 1999; Thing and Poudel 2017; Acharya et al. 2025). Thapa and Chapman (2010) concluded that the disturbance levels are lower near settlements with greater access to these Buffer Zone Community Forests (BZCFs). However, there is still an urgent need to understand the gaps at different household levels within the buffer zone of Bardia National Park (BNP) and their dependency on various forest products available from BNP.

We hypothesize that interest in forest product extraction from national parks is significant and higher among lower socioeconomic groups and ethnic minorities, consistent with previous findings (Straede and Helles 2000; Thapa and Hubacek 2011; Mushi et al. 2020). We also assume that heterogeneity among user groups informs equitable and effective conservation and livelihood policies. The research considers the following questions. (i) Which forest products are preferred by local households from the national parks during the *khar-khadai* permit period, (ii) What factors determine household interest in collecting forest products from the national park, and (iii) How important are these products for households with different socioeconomic status? The main objective is to understand the community preferences, uses, and values of forest products collected from BNP and to inform improved conservation policies and strategies which balance conservation and human needs.

MATERIALS AND METHODS

Study area

The study confined on the buffer zone of Bardia National Park (BNP), which is the largest protected area in the lowlands and lies in the western Terai region of Nepal.

It was established in 1986, covering a total area of 968 km² (BNP 2022). The national park is internationally recognized for conserving flagship mega-fauna species such as the Royal Bengal tiger (*Panthera tigris tigris*), Asian wild elephant (*Elephas maximus*), and the reintroduced One-horned rhinoceros (*Rhinoceros unicornis*) (Baral and Heinen 2007; Thapa and Chapman 2010). The buffer zone of BNP (BNPBZ) was declared in 1997 and later expanded to its present size (507 km²), covering the northern parts of Bardia and Banke districts and the southern part of Surkhet district (BNP 2022).

Bardia National Park is located mainly within the tropical and subtropical monsoon climate zone and is home to a variety of forests, shrubs, grasslands, and riverine forests. It is mainly covered with Sal (*Shorea robusta*)-dominated forests, which is the dominant vegetation type (71% vegetation coverage), consistent with mixed hardwood forests, riverine forests along the Karnali and Babai river systems, and extensive grasslands (BNP 2022). These grasslands are dominated by species such as *Imperata cylindrica*, *Narenga porphyrocoma*, *Saccharum spontaneum*, and *Themeda* spp. and are a critical source of thatch grass and fodder for local communities, while also providing suitable habitat for ungulates and other wildlife (Lehmkuhl et al. 1988; Peet et al. 1999). Similarly, *Sabai* grass (*Eulaliopsis binate*) is confined to well-drained Churia hills. The BNP is not only important for the conservation of flora and fauna but is also home to 133,470 people residing in the eight municipalities of the three districts surrounding the buffer zone (BNP 2022). These residents are indigenous Tharu people and migrants from hillier areas of Nepal (Upadhyaya et al. 2020), with more than 50% families falling below the poverty line (BNP 2022). Tharu are the oldest and original inhabitants of the lowland Terai of Nepal (Cox 1990) and the largest ethnic community in Bardia District, which accounts 53% of the total population, followed by Chhetri (11%), Brahmin (8.7%), and Dalit (7.5%) (CBS 2021). Tharu are traditionally dependent on the forest for timber, thatch grass and fodder, and also collect leaves, canes and reeds, mushrooms, honey, vegetables, medicinal herbs and fruits for their livelihoods (Brown 1998). The principal occupation of households in the BNPBZ is subsistence farming. The main crops are rice, maize, and wheat, supplemented by the rearing of buffalo, cows, goats, and sheep for milk, meat, and draught power (Karki 2013).

The buffer zone was established with the aim of meeting the subsistence needs of the people within the park-affected area for forest products and to improve and expand wildlife habitat (HMGN 1973). Thus, the long-term goals of implementing the BZ program are to promote the self-sufficiency of buffer zone residents in timber, fuelwood, thatch grass and fodder, consequently reducing pressure on major park resources, and to sustainably conserve biodiversity (HMGN 1996; Acharya et al. 2025). To achieve this objective, the forest area within the BZ is managed under various forest management regimes, including Buffer Zone Community Forest (BZCF), Buffer Zone Leasehold Forest, Buffer Zone religious forests, Buffer Zone Private Forest, and Buffer Zone Forest

(DNPWC 1999). More than 50% of the total buffer zone forests in BNP have been handed over to the local community as BZCF (FRA 2015). The BNP has already transferred 146 BZCFs to local community forest users, covering 119,724.71 ha of forest area and involving 26,257 households (MoFE 2020).

We selected ten BZCFs using a two-stage sampling approach. In the initial stage, the BZCF established before 2010 was listed. A long operating period ensures institutional maturity and the availability of longitudinal management records. A valid, approved operational plan is a prerequisite for harvesting resources from the handed-over BZCFs (DNPWC 1999). From the list, BZCFs with valid operational plans were selected for the study area. These two criteria were applied to ensure that selected BZCFs were well-established, had sufficient institutional maturity, and maintained sufficient management records, and could harvest forest products in accordance with the approved operational plan. Based on these criteria, 50 BZCFs were shortlisted. Ten BZCFs were randomly selected from the list using a lottery method without

replacement. Information on the selected BZCFs was obtained from the BNP. The location of the selected BZCFs in the buffer zone of Bardia National Park is presented in Figure 1.

Major attributes of the selected buffer-zone community forests include forest area, establishment year, growing stock, number of member households, forest area per household and number of selected households for the survey (Table 1). Growing stock and forest area availability per household reflect resource availability, and the established year indicates the maturity of the BZCFs. The table shows that Dalla, Kailashi, Brindapuri and Shukhad-Sutaiya BZCFs have higher forest area availability than the remaining BZCFs, whereas Thakurdwara and Neulapur BZCFs have better forest growing stock. Similarly, Karmala and Bahadurpur have both poor availability of growing stock and forest area per household. All the selected BZCFs were established 15 years ago, ensuring that their operational plans were revised at least three times during the operational period.

Table 1. Attributes of the selected Buffer Zone Community Forests in Bardia National Park, Nepal

Name of BZCF	Area (ha)	Established year	Growing stock m ³ /ha	Member households	Forest area availability (ha/hh)	Sampled households
Bahadurpur	41.93	2004	129.69	178	0.23	40
Bhudkaiya	92.96	2005	146.25	200	0.46	47
Brindapuri	111.92	2004	152.67	127	0.88	29
Chitkaiya	121.43	2003	162.38	295	0.41	66
Dalla	80.21	2004	185.73	47	1.74	11
Kailashi	293.79	2007	112.57	307	0.95	65
Karmala	47.5	2008	90.19	269	0.17	60
Neulapur	133.75	2004	189.10	349	0.38	81
Shukhad -Sutaiya	228.73	2006	161.00	308	0.74	69
Thakurdwara	95.94	2003	197.46	281	0.34	63
Total	1248.2			2361	0.53	531

Source: BNP (2024) and Field Survey (2024)

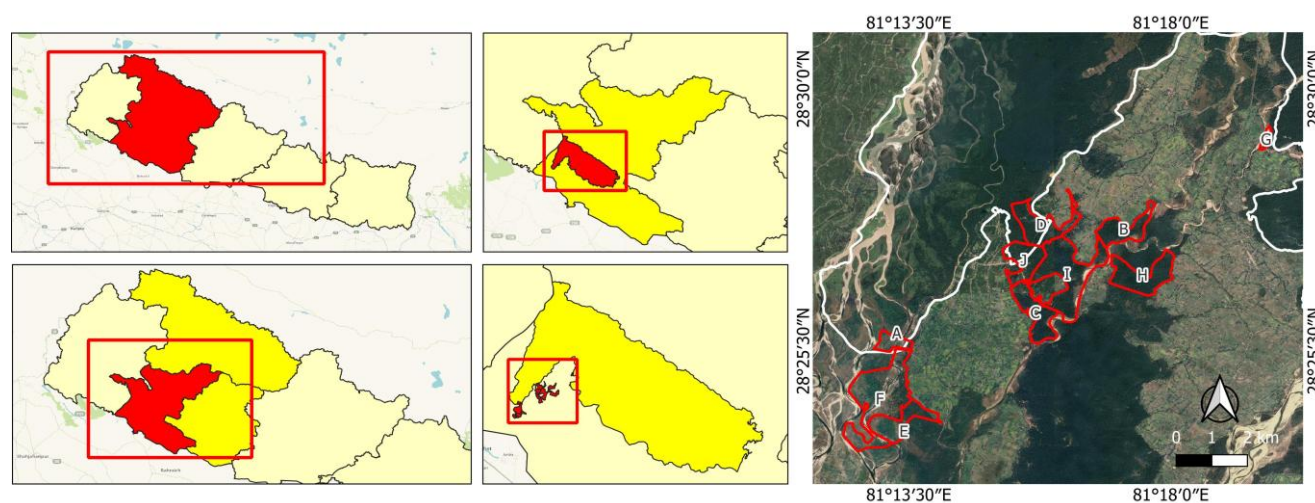


Figure 1. Location map of the selected buffer zone community forests around Bardia National Park, Nepal. A. Bahadurpur, B. Bhudkaiya, C. Bindrapuri, D. Chitkaiya, E. Dalla, F. Kailashi, G. Karmala, H. Newalpur, I. Shukhad Sutaiya, J. Thakurdwara

Data collection

A household survey was conducted, covering approximately 22% of households in each selected BZCF during November 2023 and February 2024. A total of 531 households were selected from 2361 households using stratified random sampling to ensure representation of all socioeconomic and ethnic groups. The lists of the households and their socioeconomic and ethnic categories were obtained from the operational plan of selected BZCFs. All households were stratified into three locally defined well-being categories: wealthy, medium, and poor. Household stratification was based on four criteria: education levels of household members, family income, food security, and land ownership of the household (Table 2). Households' well-being status was coded as an ordinal variable: poor = 1, medium = 2, and wealthy = 3. The poor category was used as the reference group. This was used to analyze how well-being status influences households' interest in entering the national park to collect forest products during the *khar-khadai* event, as well as to examine preferences for forest product extraction across these groups. Likewise, households were classified into five ethnic groups: Brahmin, Chhetri, Dalit, Tharu, and Others. As per the caste system in Nepal, Tharu are an indigenous community in the lowland, Brahmin are the higher caste, Chhetri are the warriors, and Dalit are regarded as the lower caste and treated as untouchable. Some other minorities are included in other categories.

Ethnicity was treated as a categorical variable and entered into the regression model using dummy coding, with the Tharu group representing the largest and most forest-dependent group in the study area and used as the reference. This enabled examination of ethnic differences in access to and reliance on forest products. The household head was the primary respondent. In the absence of the household head, the next adult member who made household decisions was consulted as the respondent.

The survey instrument was designed to examine households' interest in *khar-khadai* permits and to identify economic, social and cultural factors affecting their interest in and preferences for forest product extraction from BNP. The questionnaire consisted of three sections. The first section was designed to collect information on respondents' socioeconomic characteristics, including household size, landholdings, education, and well-being status. The second section was focused on households' interest in obtaining *khar-khadai* permits and their preferences for different forest products, which were recorded as binary ("Yes" = 1; "No" = 0) and used as

dependent variables in subsequent analyses. The third section explored the intended households' alternative actions in the conditions of the restriction or discontinuation of the *khar-khadai* event. Prior to conducting the main survey, the questionnaire was pre-tested with 30 households from the nearby BZCF who were not included in the main household survey. Following the pre-test, necessary revisions were made, and then the main household survey was carried out. Based on the pilot test, some modifications were made, including simplifying question wording, reordering questions to improve logical flow, and clarifying the local names of extracted forest products and measurement units. These modifications increased clarity and reliability and reduced respondents' uncertainty during the main survey.

The quantity of extracted forest products was estimated following the standard procedure proposed by Rai et al. (2017), which has been widely applied in forestry research in Nepal. This approach allows for consistent and reliable reporting of household-level forest product consumption. Local users use the term "*bhari*" to quantify the forest products collected in rural areas of Nepal. One *Bhari* (The head load a person can carry at once) of fuelwood was standardized at 30 kg (Rai et al. 2017). For thatch grass, grass cane, and *Sabai* grass, some samples (n=100) were directly measured at seven collection points located immediately outside the national park boundary during the *khar-khadai* permit period in February 2024. The mean value after repeated measurements was used to estimate the amount of collected products for each *Bhari*. The mean value for each *Bhari* of these products was 60±10 kg, which was used to provide a representative extraction level and to minimize individual differences. The conversion factors used to analyze the data are summarized in Table 3.

Table 3. Conversion factors used for local units to convert to the standard unit (SI Unit)

Particulars	Local unit	Standard unit (SI unit)	Conversion factors
Currency	Nepalese Rupee (NPR)	US Dollar (US\$)	1 NPR= 0.0074 US\$
Fuelwood	<i>Bhari</i>	Kilogram (kg)	1 <i>Bhari</i> =30 kg
Land	<i>Katha</i>	Hector (ha)	1 <i>Katha</i> = 0.034 ha
Thatch grass, grass cane and <i>sabai</i> grass	<i>Bhari</i>	Kilogram (kg)	1 <i>Bhari</i> = 60 kg

Source: Rai et al. (2017), Field Survey (2024) and NRB (2024)

Table 2. Household stratification criteria for well-being status

Criteria	Wealthy	Medium	Poor
Education	Tertiary-educated member of the family	At least a secondary-educated member of the family	An illiterate or a primary-educated member of the family
Family income	Family members in official or high-paid jobs	Family member has a permanent job or regular off-farm income	Family member has no regular income
Food security	Surplus food availability from own land	Food available for more than six months from own land	Depends on daily wages for family income
Land ownership	>0.68 ha	0.3 ha to 0.68 ha	Food availability to households for less than six months from agriculture
			Landless or family land ownership <0.3 ha

Source: BZCF Operational Plans of the selected buffer-zone community forests (2020-2024)

Data analysis

Descriptive statistics, including frequencies, means, and standard deviations, were used to analyze the field-collected data. The analysis summarizes the socioeconomic information, household characteristics, forest product preferences, and extraction patterns. Similarly, the economic value of collected forest products was estimated based on the local market price for each forest product at *Bhurigaun Bazar*, the local marketplace, in February 2024. Local market prices best reflect the opportunity cost and replacement value of collected forest products for local users. The unit price applied for fuel wood was Nepalese Rupee (NPR) 10 per kg. Similarly, the market prices for thatch grass and grass cane were NPR 12 per kg, and for *sabai* grass NPR 15 per kg. The monetary value in Nepalese Rupees (NPR) was converted to US dollars (US\$) using the official exchange rate (1 US\$ = NPR 135), set by the Nepal Rastra Bank for February 2024. The conversion factors used to standardize local units and monetary values are presented in Table 3.

Socioeconomic and institutional factors influencing households' interest in participating in BNP during the *khar-khadai* period were investigated using a binary logistic regression model. For regression purposes, households' interest in entering the national park during *khar-khadai* was treated as the dependent variable. Different independent variables, including socioeconomic characteristics (well-being status, ethnicity, landholding size, household size, and education level), institutional factors (membership in a BZCF), and spatial variables (travel time to the park boundary). Similarly, Ethnicity and well-being status were dummy-coded, with Tharu and "Poor" serving as the reference categories. Model fit was evaluated using the Hosmer–Lemeshow goodness-of-fit test ($\chi^2=8.28$, $p=0.41$), and multicollinearity was checked using variance inflation factors (VIFs), with all variables showing $VIF<5$, indicating no serious multicollinearity. Regression results are reported as unstandardized coefficients (B) and standardized coefficients (β), along with associated p-values. All analyses were conducted at a 95% confidence level.

Limitations of the method

Several limitations may affect this study. Time and resource restrictions are the main challenges for research conducted in rural Nepal. Data collected during a single *khar-khadai* permits provide only a temporal snapshot. Similarly, dispersed settlement patterns, limited accessibility due to poor infrastructure, and low literacy rates of the respondents were identified as other limitations for this study. As this study is primarily based on a household survey, self-report bias may lead to under-reporting of illegal extraction. Due to these limitations, the estimation of the quantity of the forest products reflects stated rather than actual behaviors. This study is unable to capture illegal extraction patterns and quantities, leading it to reflect socially desirable responses rather than accurately reflect their experience. Memory recall limitations may also cause respondents to underestimate or overlook actual consumption patterns. To resolve these limitations,

triangulation was used to verify the interview data with field measurements, and the findings are interpreted with appropriate caution.

RESULTS AND DISCUSSION

Socioeconomic characteristics of respondents

The majority of respondents were female, accounting for 57.5% of the total surveyed households ($n=531$). The Tharu were the major ethnic group (61%), followed by Chhetri (18.4%), Brahmin (10.4%), Dalit (8%), and Others (2.6%). The average household size was 5.22 (± 2.25) persons per household. Mean household size varied slightly across ethnic groups, with Tharu households averaging 5.31 (± 2.27) and Dalit households averaging 5.23 (± 2.09) members.

Of the surveyed households, 44.25% were classified as Poor, 44.06% as Medium, and 11.69% as Wealthy, with variation across the BZCFs. Higher proportions of poor households were observed in Karmala, Shukhad-Sutaiya, Bahadurpur, and Neulapur BZCFs. Similarly, the concentration of medium households was observed in Kailashi, Bhudkaiya, Chitkaiya, and Thakurdwara BZCFs. Likewise, the concentration of wealthy households was found in Dalla and Brindapuri BZCFs.

Agriculture was the primary occupation of the respondent's households (61%), followed by service (12%) and livestock farming (10%). A small percentage of the selected households (6%) were entrepreneurs. Similarly, 13% of respondents had other occupations, including wage labor. As the majority of respondents were engaged in agricultural or livestock-rearing occupations, landholding size and livestock ownership play a significant role in household socioeconomic status. The average landholding size was 0.38 ha per household, with variation by ethnicity. Similarly, variation in livestock units (LSU) was observed across ethnicity. Dalit households had the smallest average landholdings (Mean=0.11 \pm 0.15 ha). Likewise, the average LSU was found (2.55 \pm 0.21) per household, with the lowest sharing from Dalit households (LSU=1.37 \pm 1.47). Table S1 presents detailed socioeconomic characteristics of the surveyed households for the selected 10 BZCFs.

Heterogeneity among selected households in terms of ethnicity, household size, landholding size, livestock ownership, occupation and proximity to the park boundary was observed. The Tharu and Dalit households had larger household sizes but smaller average landholdings and livestock units, highlighting the disparities faced by marginal communities. A substantial proportion of households (43%) were located more than one hour's walking distance from the park boundary, while 16% were located near the boundary.

Factors influencing household entry into BNP for *khar-khadai*

Multiple regression analysis was used to identify socioeconomic and institutional factors associated with households' interest in entering into BNP for *khar-khadai*. The model included ten explanatory variables: ethnicity,

education level, gender, age of the household head, primary occupation, household size, landholding size, household socioeconomic status, travel time to the park boundary, and BZCF membership. The overall model was statistically significant [$F(10, 339)=9.10, p<0.001$]. The model accounted for 21.2% of the variance in household entry into the park (Adjusted $R^2=0.188$).

Table 4 presents the multiple regression results. Among the predictors, ethnicity ($\beta=0.399, p<0.001$), BZCF membership ($\beta=-0.152, p<0.010$), and education level ($\beta=-0.160, p<0.005$) were statistically significant. In contrast, age, occupation, household size, landholding size, and well-being status were not significantly associated with park entry ($p>0.005$). A statistically significant negative correlation was observed between households' perceptions of fuelwood sufficiency from BZCFs and their interests in entering the national park for *khar-khadai* ($r=-0.247, p<0.001$).

Households' interest in entering the national park for forest products collection was significantly different across BZCFs ($\chi^2=95.233, df=9, p<0.001$) as well as the ethnic composition ($\chi^2=52.685, df=6, p<0.001$). Tharu (74.07%) and Dalit (65.31%) households showed the highest interest, while Brahmins (44%) and Chhetris (42%) showed the lowest. Regression results indicated that ethnicity ($\beta=0.399, p<0.001$) and BZCF membership ($\beta=-0.152, p=0.010$) were significant predictors of interests. A higher proportion of households from Karmala, Chitkaiya, Bahadurpur, and

Thakurdwara BZCFs expressed greater interest, while those from Brindapuri, Shukhad-Sutaiya, and Dalla reported lower levels of interest.

Preferences for forest products extracted from the National Park

Among the surveyed households, 63.7% expressed interest in collecting forest products from the national park during *khar-khadai*, preferences varied by product type, BZCFs, and ethnicity. One-third of the total respondents (33.13%) were interested in collecting fuelwood, 27.81% in collecting *khadai*, and 23.07% in collecting *khar* from the BNP. Additionally, 12.73% showed interest in collecting *Sabai* grass. A smaller percentage (3.35%) showed interest in collecting timber. The preferences differed significantly by ethnicity and BZCF membership. *Sabai* grass was preferred by households affiliated with Karmala and Neulapur BZCFs. Regarding ethnicity, *sabai* grass was preferred by Tharu households (>90%), and Tharu and Dalit households reported greater interest in fuelwood (65%) collection than Brahmins (10%) and Chhetris (15%). Table 5 shows the local name and reported use of major species collected during the *khar-khadai* in alphabetical order. The use of the collected products is based on respondents' responses from household surveys and key informant interviews, and supplemented by traditional practices in the study area.

Table 4. Multiple regression results for factors influencing households to enter Bardia National Park, Nepal for *khar-khadai*

Predictor variables	Unstandardized coefficient (B)	Standard error	Standardized coefficient (β)	t-value	p-value
Age	0.000	0.001	-0.026	-0.446	0.656
BZCF membership	-0.012	0.005	-0.152	-2.280	0.010
Constant	0.755	0.121	-	6.262	<0.001
Education level	-0.035	0.013	-0.160	-2.831	0.005
Ethnicity	0.140	0.018	0.399	7.890	<0.001
Household size	-0.003	0.006	-0.028	-0.546	0.585
Landholding size (ha)	-0.015	0.032	-0.026	-0.462	0.645
Occupation	-0.009	0.006	-0.072	-1.483	0.139
Travel time to park boundary	-0.011	0.014	-0.045	-0.775	0.439
Well-being status	0.033	0.023	0.082	1.456	0.146

Source: Field Survey (2024)

Table 5. Community preferences for forest products collected from Bardia National Park, Nepal

Species	Local name	Use
<i>Bauhinia vahlii</i> Wight & Arn.	<i>Bhorla, Maluk</i>	Bark, used for making rope for tying beds and tying livestock
<i>Eulaliopsis binate</i> (Retz.) C.E. Hubb.	<i>Babiyo</i> or <i>Bancas</i> or <i>Sabai</i>	Making rope for bullock carts, tying thatch and other
<i>Imperata cylindrica</i> (L.) Raeusch.	<i>Khar</i>	Thatch, brooms
<i>Narenga porphyrocoma</i> (Hance.exTrin.) Bor	<i>Khadai</i> or <i>Kharai</i>	Used for building walls with mud
<i>Saccharum bengalense</i> Retz.	<i>Narkat</i>	Canes for making walls
<i>Saccharum spontaneum</i> L.	<i>Kans</i>	Canes for making walls, beds and thatch. Fodder
<i>Shorea robusta</i> Gaertn.f.	<i>Sal, Sakhwa</i>	Fuelwood, timber

Source: Field Survey (2024)

Quantification of collected forest products

The study documented a well-organized forest products collection process during the *khar-khadai*. The *khar-khadai* permit is valid for two days, during which various forest products can be collected within the specified areas of BNP. Fuelwood collection per permit holder ranged from 60 to 180 kg per day. The average was 122.7 (± 28.11) per person per day. Based on a two-day permit, the collected fuelwood quantity was 245.40 kg over the permit period. Similarly, an average of 118.80 (± 22.8) kg of thatch grass or grass cane was collected each day, for a total of 238 kg over two days. Likewise, 60 kg of *sabai* grass could be collected per day, with a maximum of 120 kg collected over the two days of the permit period.

Significance of *khar-khadai* for the local economy

Each individual must obtain a *khar-khadai* permit from BNP by paying NPR 100.00 (US\$0.74) before entering the national park to collect forest products. Fifty per cent of this fee goes to the government treasury as royalty, and the remaining fifty per cent is used as a conservation fee. The average daily wage for unskilled labor in the study area during the survey period was NPR 800 (US\$5.92). Due to the loss of their regular income, each permit holder costs the equivalent of NPR 900 (US\$6.66) for one day and NPR 1,700 (US\$12.58) for two days. The BNP office informed us that all permits were fully utilized for two days. If anyone was not interested in entering the national park on the second day, the permit was usually transferred to another household member or a neighbour for forest products collection. This provides an overview of the economic implications of the *khar-khadai* activities. The average total monetary value of collected products per permit holder over two days was US\$18.52 for fuelwood, US\$21.15 for thatch grass, and US\$13.57 for *sabai* grass.

The average value of material collected by each *khar-khadai* permit ranged from US\$13.57 to US\$21.15. Assuming the opportunity cost equals the prevailing daily wage, the net gain ranged from US\$0.99 to US\$8.57, depending on the harvested products. Variations may occur for households not engaged in daily wage labor. Though the financial gain from the collected product was marginal, the products were available only within the national park, so people were motivated to obtain a harvesting permit. Altogether, 22,850 entry permits were issued in 2024 (BNP 2024), with a royalty of NPR 11,42,500 (US\$8,618.73) and an additional similar amount as a conservation fee.

Alternatives to forest products

We also discussed the alternative of *khar-khadai* and asked what they would do if BNP denied a collection permit. More than half (51.31%) said they would explore alternatives, 5.84% said they might take an illegal path to collect from BNP, and 42.85% preferred to purchase from the market. Direct observation in villages indicates that local households have already begun using alternative resources, such as nylon rope instead of *sabai* grass rope and corrugated zinc in place of thatch grass roofs. The direct observation also reflects the changing house pattern. However, fuelwood remains the primary source of cooking

and heating in the study area, particularly during the winter season. Most of these products are supplied by BZCFs; *khar-khadai* made up the deficit. Nearly one-third of households (33.13%) remained interested in collecting fuelwood from the national park during the *khar-khadai*, which is crucial for households that rely on fuelwood for subsistence.

Discussion

We examined household interests, preferences, collection quantities, and the economic value of collected forest products from the BNP during the regulated *khar-khadai*. Similarly, the findings explain how the socioeconomic characteristics of households, institutional frameworks, and the availability of alternative resources influence reliance on resources within the controlled access system.

Nearly two-thirds of the surveyed households expressed interest in visiting the national park for *khar-khadai*. This indicates that regulated access to park resources is relevant to the majority of buffer zone residents in BNP. The regression analysis identified ethnicity, education level, and membership in a buffer-zone community forest as significant predictors of park entry.

Tharu and Dalit households showed significantly greater interest than other ethnic groups. Tharu represents the indigenous community in the area that traditionally practices subsistence agriculture and fishing, and maintains rich cultural traditions that require greater access to natural resources for their subsistence.

In contrast, the Dalit households face social discrimination and exclusion. Due to lower land ownership, most Dalit households worked in low-wage manual labor and traditional crafts. Both the Tharu and Dalit communities have larger household sizes and lower private land ownership, making them more dependent on park resources for their subsistence forest product needs. Consequently, households from the Tharu and Dalit communities reported high interest in harvesting forest products within the national park, similar findings reported by Thapa and Chapman (2010).

Household size alone was not a significant determinant for forest product harvesting from the national park. Still, the availability of forest products within their BZCFs appeared to be more influential than the household size. The observed negative association between BZCF membership and interest in entering the national park indicates that community-managed forests help to reduce pressure on protected areas. This is consistent with the findings of Baral and Heinen (2007) and Thapa and Chapman (2010), who found that national park areas near managed BZCFs experience lower levels of disturbance than adjacent areas without BZCFs. These results suggest that effective management of BZCFs helps reduce pressure on national park resources. Global protected-area dependence frameworks (Bowler et al. 2012; Hanson 2025) further support our result that community-managed forests can mitigate extraction pressures on protected areas by enhancing diverse resource availability to locals. Oldekop et al. (2016) also claimed that protected areas associated

with positive socioeconomic outcomes were more likely to report positive conservation outcomes. Such positive conservation and socioeconomic outcomes were more likely to occur when protected areas adopted community-based management regimes that empowered local people to reduce economic inequalities, and maintained cultural and livelihood benefits. Our findings suggest that management of BZCFs reduces pressure on national park resources from surrounding communities. Therefore, recognizing these findings may enable policymakers to tailor management strategies to address local needs and enhance the resource availability for residents.

Fuelwood was identified as the most preferred forest product collected from the BNP. Other preferred products were thatch grass, grass cane, and *sabai* grass. The interest in timber extraction was found to be minimal. These preferences indicate that household demand during *khar-khadai* is primarily oriented towards low-cost subsistence materials rather than high-value commercial products. Similar patterns have been documented in other protected areas of Nepal, where regular harvesting meets the basic household needs rather than generating income (Lehmkuhl et al. 1988; Thapa and Chapman 2010). The observed lower interest in timber harvesting may be due to the limitations of the study. This study is based on self-reported information by the respondents. The collection of timber from the national park is not allowed under the existing regulatory framework and/or *khar-khadai* obligations, so timber harvesting from the national park is an illegal activity that may not be documented in the present study. The greater interest of Tharu and Dalit households in entering the national park for resources, mainly to obtain fuelwood for cooking and heating, to produce local domestic alcohol, and to perform various cultural and religious practices, highlights their essential needs. Thus, the strong cultural and social ties of Tharu and Dalit households to national park resources are inspiring empathy and understanding among policymakers and stakeholders. The Kami, a Dalit caste traditionally engaged in forest-dependent occupations, use charcoal in their workshops to fabricate and repair agricultural tools, essential to subsistence farming. Recognizing these cultural and social factors helps us understand community behaviors regarding forest use. Therefore, acknowledging these community preferences may also build trust and transparency between the park authority and local communities.

The collection of forest products during the two-day *khar-khadai* period provides a generic trend on the quantity of resource use under current management rules. The average quantity of daily collected fuelwood and grasses was consistent with earlier reports (Lehmkuhl et al. 1988; Baral and Heinen 2007). The monetary value of collected forest products was found to be minimal, given the opportunity costs to the permit holder and the permit fee. We found that opportunity costs and permit fees significantly influence net benefits, allowing stakeholders to assess the economic value of collection activities more accurately. This study shows that both opportunity costs and permit fees make a big difference in how much people

actually gain. Market values and alternative income sources play a substantial role in shaping the economic benefits derived from forest resources (Luintel and Dhakal 2002). Transparent cost-benefit analyses can help build trust with local communities and conservationists by clarifying how opportunity costs and permit fees affect net benefits and the actual economic value of collection activities. Collection of forest products during the allowed period was found concentrated in an accessible area along the river, consisting of driftwood and deadwood. Removing dead wood and dry grasses from the national park not only reduces the risk of fire hazards but also provides an opportunity for new grasses to sprout, as *khar-khadai* permits are usually issued in the winter season (ILRI 2021).

Our findings suggest a declining trend in forest products collection from the BNP over time. Baral and Heinen (2007) reported that 93% of people, primarily Tharu, collected forest products from the BNP. In contrast, we found that only 63.70% of households were interested in collecting forest products from the BNP. Prior to its designation as a protected area, the national park was openly accessible to locals for resource use. Following the establishment of the Royal Karnali Wildlife Reserve, about 1572 families were relocated outside the reserve boundary (Brown 1998). Historically, the surrounding population has been heavily dependent on the park's resources. Previously, the *khar-khadai* was available to all individuals in the districts. However, the permits have been restricted to residents of the buffer zone in recent years. The number of *khar-khadai* permits reached a high of 45,500 in 1993 (Brown 1998), which gradually declined to 22,850 in 2024 (BNP 2024). Although people's dependence on park resources has decreased, they remain a significant source of subsistence forest products for residents of the BZ, particularly for the ethnic Tharu and the less-advantaged Dalit communities. These variations across BZCFs highlight the need for socio-culturally sensitive management strategies to address diverse community interests and promote sustainable resource use.

As our first hypothesis, forest product preferences and dependence during *khar-khadai* differ significantly across user groups. The differences in preferences and dependence are primarily based on accessibility, socioeconomic status, and household-level livelihood strategies. The socioeconomic variables, namely ethnicity, BZCF membership, and education level, were found statistically significant. However, other variables, namely gender, age, occupation, household size, landholding size, and household well-being status, were not identified as significant predictors of park entry. A significant negative correlation was observed between households' perceptions of fuelwood sufficiency from BZCFs and park entry for *khar-khadai*. Households with limited access to buffer-zone community forest resources are more dependent on park resources. Our findings support similar research by Thapa and Chapman (2010), which documented that surrounding population pressure on the national park can be reduced through proper management of buffer-zone community forests. The extraction of forest products remains a crucial livelihood strategy for many households,

though the adoption of alternatives has been increasing. A significant number of households, particularly Tharu and Dalit households, expressed interest in collecting fuelwood, underscoring the continued importance of *khar-khadai* despite the increasing number of BZCFs and benefited households in these BZCFs since the declaration of buffer zone of BNP in 1997 (MoFE 2020).

In conclusion, the BZCF program in BNP was initiated to balance sustainable biodiversity conservation with meeting the basic forest product needs of forest-dependent buffer zone communities. The finding highlights the significant dependence of local communities, particularly the Tharu and Dalit, on BNP for essential forest products, including fuelwood, thatch grass, grass cane, and *sabai* grass. Identifying preferences, uses, and the value of forest resources, and the dependencies on local rural livelihoods, may assist policy-makers in balancing conservation objectives with the socioeconomic well-being of local communities, thereby promoting support for sustainable conservation strategies.

Although the number of BZCFs and alternative options in the buffer zone has increased, many households, especially those from the Tharu and Dalit communities, are projected to continue collecting forest products due to their cost-effectiveness and availability. Promoting the implementation of alternative renewable energy sources through developing integrated policies and strategies, including exploring and adopting sustainable alternative fuel sources, conducting community awareness initiatives, and offering economic incentives, are focused measures to create an enabling environment for achieving dual objectives of conservation as well as satisfying the needs of the local people in the buffer zone.

The study indicates a long-term decline in dependence on national park resources as buffer zone residents gradually adopt alternatives. However, national park resources remain crucial for immediate use as they are essential for the subsistence livelihoods of the Tharu and Dalit communities. Therefore, this study recommends that policy-makers give high priority to developing and implementing appropriate policies, strategies, and plans for the sustainable management and development of BZCFs, by providing adequate technical and financial support for the equitable supply of fuelwood, the continuation of *khar-khadai*, and the conservation of biodiversity through the promotion of alternative sources.

ACKNOWLEDGEMENTS

We would like to express our sincere appreciation to the University Grants Commission of Nepal for its financial support. We would like to acknowledge the Department of National Parks and Wildlife Conservation for granting research permission and Bardia National Park, Nepal, for field support and coordination. We appreciate the respondents for their insightful information despite their busy household schedules. Thanks are due to Professor Dr. Neelam Chandra Paudyal and Professor Dr. Omkar Joshi for invaluable feedback on the manuscript. Last but not

least, we are thankful to Dr. Rebecca Ford for checking the English-language and Mr. Om Prakash Prasad Kalwar for his support in preparing the map.

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Table S1. Socioeconomic characteristics of the selected households

Socioeconomic characteristics	Bahadurpur	Bhudkaiya	Brindapuri	Chitkaiya	Dalla	Kailashi	Karmala	Neulapur	Sukhad-Sutaiya	Thakurdwara	Total
Total involved HH	178	200	127	295	47	307	269	349	308	281	2361
Number of HH Interviewed	40	47	29	66	11	65	60	81	69	63	531
Average HH size	4.93	5.47	6.21	4.47	6.09	4.86	5.60	5.28	5.19	5.03	5.22
Ethnicity (in %)											
Tharu	77.5	85	48	64	91	57	52	70	33	62	61
Brahmin	7.5	9	21	8	0	8	10	16	9	11	10.4
Chhetri	5	4	24	26	9	25	10	9	35	17	18
Dalit	7.5	2	3	2	0	9	27	2	12	8	8
Others	2.5	0	3	2	0	1	2	2	12	2	3
Average Land holdings size (ha)	0.51	0.56	0.52	0.42	0.65	0.33	0.36	0.23	0.28	0.34	0.38
Average Livestock (LSU)	1.91	2.74	2.73	1.96	3.16	2.83	2.72	2.37	3.04	2.51	2.55
Gender (in %)											
Male	42.5	49	55	44	64	31	38	33	39	59	43
Female	57.5	51	45	56	36	69	62	67	61	41	57
Occupation (in %)											
Agriculture	60	55	41	62	82	63	55	53	83	60	61
Livestock farming	0	11	10	24	0	9	23	13	2	0	10
Service	27.5	6	3	2	0	9	8	9	3	24	12
Entrepreneur	0	15	10	5	0	3	5	19	7	4	6
Other	12.5	13	34	8	18	15	8	9	11	15	13
Distance from Park boundary (in %)											
Nearby park boundary	0	12	08	67	00	15	08	02	05	00	16
< half an hour walking distance	12	16	54	25	00	43	00	02	14	32	19
≤ 1-hour walking distance	27	40	31	02	00	08	00	43	29	40	22
> 1-hour walking distance	61	32	08	05	100	35	92	53	52	28	43

Source: Field Survey (2024)