Uses of Bamboos in Two Ecological Regions of Lumbini Province, Nepal

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Abstract

Bamboos (including nigalo and malingo) are indispensable for mankind. These plants use from womb to tomb since the infinite period that made life comfortable in all regions of Nepal. Also, these plants play a crucial role in alleviating poverty and ensuring food security, among others. The widespread applicability of these plants becomes possible mainly because of affordability, availability, and handling-friendly in daily life. This paper tries to explore the ethnobotany and traditional knowledge of diversity in bamboos use in diverse ethnic communities in two ecological regions (Mid-hills and Terai) of Lumbini province, Nepal. All together 7 distinctive species were identified, 60 more traditional use of bamboos were documented and these uses are categorized into broad groups viz. structural use, consumptive use, religious and cultural use, agricultural use, and other use. Apart from these ethnobotanical use, three principal potential uses are noted viz.;vital source of carbon sequestration for mitigating climate-change and option for carbon trading under different carbon financing mechanism, soil quality indexing, and replacement of mine and wood-based constructional product in more effective, efficient with a low level of technical inputs. These findings and discussions would give insights and explore the widediversity in ethnobotany of bamboos of the regions and its potentiality for multiple uses of these species without jeopardizing the environmental and cultural assets. The findings would be a reference to the other communities inside the country and the global communities for application and replication of bamboos'usufruct for diversifying bamboo-based livelihoods options and beyond.

Keywords: Ethnobotany, Food security, Livelihood option, Traditional knowledge

Introduction

Ethnobotany, is the traditional uses of plants and their parts using knowledge of local culture and people, was firstly coined by John W. Harsberger in 1896, the subject of ethnobotany has become an important matter which also includes health care and conservation programs in different parts of the world (Kunwar & Bussmann, 2008). Using traditional knowledge to a particular species is varying, in which, we demonstrate the case of bamboo in Nepal. The origin of the word 'bamboo' is uncertain, but it probably comes from the Dutch or Portuguese language, which originally borrowed it from Malay or Kannada (Kelchner et al., 2013).

Bamboois a diverse group of evergreen perennial flowering plants in the subfamily Bambusoideae of the grass family Poaceae (Soreng et al., 2015), that human usage has a stronger link to introduce and diversify it (Canavan et al., 2017). The absence of secondary growth wood causes the stems of monocots, including the palms and large bamboos, to be columnar rather than tapering (David, 1984). Bamboo includes some of the fastest-growing plants in the world, are the largest member of the grass family. This rapid growth and tolerance for marginal land make bamboo a good candidate for afforestation, carbon sequestration, and climate change mitigation (Kaminski et al., 2016a; 2016b). Bamboo is of notable economic and cultural significance in South Asia, Southeast Asia, and East Asia, for its multi-facet uses (David, 1984).The most widely distributed species comprises 1662 species in 121 genera, of which 232 (14%) have been introduced beyond their native ranges and a non-random selection of bamboo increase the widespread dispersion of species and multiply the utility (Canavan et al., 2017). In Asia, China contains more than 500 species followed by India, Indonesia, Myanmar, and Malaysia, each with more than a hundred species. In Asian countries,

about 84 species are found in Japan, 90 in Myanmar (Barma), 55 in the Philippines, 50 in Thailand, 44 in Malaysia, 31 in Indonesia, 30 in Nepal, and 30 in Srilanka (Nirala et al., 2017).

Bans, nigalo and malingois collectively called bamboo (hereafter 'bamboo') in Nepal (Jackson, 1994). Despite having multi-facet important, limited documentation in Nepal observes. 'Bamboos of Nepal' written by Chris Stapleton reflects their abundance is in the eastern, central, and western parts of Nepal (Shrestha, 1998). In the mid-western region, 48 bamboo species in the far-western region, 31 species recorded (Das & Thapa, 2013). Despite various utilization and aesthetic value of the bamboos, Nepalese people still believe in different taboos, believes, and superstitions regarding bamboos in Nepal (Das & Mitchell, 2005).As Lumbini province, which belongs in the western region, has limited studies in ethnobotany of the bamboo and its uses, the study aims to document the ethnobotany and uses of bamboos available in two different ecological regions of the province, Nepal to contribute to the knowledge of bamboo.

Materials and Methods

Study area

The study was carried out in the Bahigaon village of Chhatradev Rural Municipality and Bodgaon village of Banganga Municipality of Arghakhanchi and Kapilbastu districts from Mid-hills and Terai regions of central Nepal, respectively (Figure 1). These municipalities were selected based on a good number of bamboos and their utilization values compared with the other municipalities of the regions. Also, this region (Lumbini province and the districts) was free from the ethnobotanical study of the bamboo so far realize the researchers to carry a research on the topic for this area. The field visit was conducted in October-November 2019.

Chhatradev Rural Municipality

Chhatradev Rural Municipality lies in 28˚00' -28˚01' N and 83˚13' -83˚ 34' E at the north-east belt of Arghakhanchi district (Figure 1). The altitude ranges from 720 to 1800 m asl (above sea level). The whole area of this rural municipality falls in the mid-hills region. Major ethnic groups inhabiting the area are Brahmin, Chhetri, Magar, Newar, Kami, Damai, and Sarki. Major vegetation includes the *Schima-Castanopsis* forest with associated species of *Pinus roxburghii, Myrica esculenta, Alnus nepalensis, Ficus*spp., *Madhuca longifolia*. The Chhatradev has a subtropical type of climate. The temperature ranges from 14.9°C to 25.8°C and the average annual rainfall is 1627.7 mm (DHM, 2017).

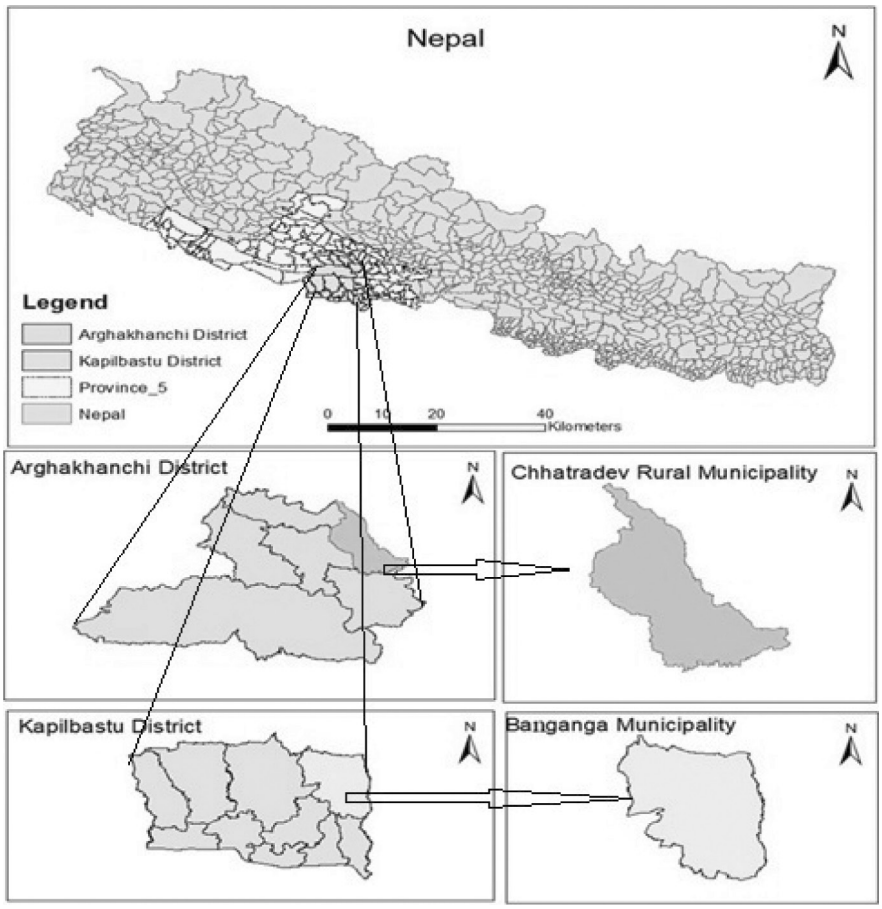

Figure 1: A map showing the study area [top: map of Nepal and an indication of the study area; middle left: Arghakhanchi district; middle right: Chhatradev Rural Municipality; bottom left: Kapilbastu district; bottom right: Banganga Municipality]

Banganga Municipality

The Banganga Municipality lies in 27°35'-27°48' N and 83°03'-83°14' E at the north-east belt of Kapilbastu district. The altitude ranges from 100 to 350 m asl. The area of this municipality belongs to the Terai region. Major ethnic groups residing in the area are Brahmin, Chhetri, Gurung, Magar, and Tharu. The vegetation of the area is dominated by riverine deciduous forest with *Dalbergia sissoo* and *Bombax ceiba* species. Other major tree species include *Shorea robusta, Leucaena leucocephala, Artocarpus lakoocha, Morus alba, Artocarpus heterophyllum*. The Banganga has a hot and humid climate during the summer and cold during the winter. The temperature ranges from 18°C to 30.3°C and, the average annual rainfall is 1532.0 mm (DHM, 2017).

Data collection and presentation

Informal consultation with local people and field observation were the major approaches for data collection for the study in study areas. Age-old people were consulted to document the customary use and ethnobotany of the bamboos of the region. The species of the bamboos were recorded during the field observation in the first-hand sites or the used site of the bamboos products. A total of 50 individuals from 150 and 30 households from 200 were taken from the mid-hills and Terai region, respectively for individual consultation from separate households on a sporadic and random basis without overlapping the same family member of a household. The responses on the utilizations of bamboos were recorded and triangulated.

Results and Discussion

Type of bamboo available in the study area

The following seven types of bamboos were identified in the study area (Table 1). The major dominant species in the hills was *Bambusa balcooa* and Terai was *Dendrocalamus strictus.*

Uses of bamboo

The uses of bamboo traditionally in the study area are summarized in tabular form (Table 2). Figures in the remark column refer to the serial number of Table 1 and corresponding species of bamboos used for that particular purpose but not confined to.

Ethnobotany of bamboos is a site, locality, and culture-specific. This is not unique from other studies reveals in this regard. Jackson (1994), explores a dozen of the traditional use of bamboos in the Midhills of Nepal prevails. But these are very general use explore by that study but the minor and detailed use are presented by this study from the Midhills and the Terai region of Nepal. In recent decades, the growing trend of diversifying household income sources is based on the bamboos for a poor and ultra-poor household in the lowland of Nepal (Jha & Yadav, 2015). This exercise not only would support the protection and reproduction of bamboos in any locality but also diversify the options for households' livelihood. This study further broadens the knowledge on ethnobotanical use of the bamboos and explores the potential use. Bamboos are being used in many aspects of the study area. These species have very important support in rural livelihoods

Table 1: The species of bamboos found in the study area

S.N.	Local Name	Botanical Name	Ecological Region	Remarks
1	Tame bans	*Bambusa nepalensis* Stapleton	Mid-hills	The best clumps consumption
2	Lebans	*Ampelocalamus patellaris* (Gamble) Stapleton	Mid-hills	Relatively medium size
3	Dhanu bans	*Bambusa balcooa* Roxb.	Mid-hills	Better for fodder
4	Mal bans	*Dendrocalamus strictus* (Roxb.) Nees	Terai	Better for structural use
5	Tite-nigalo	*Drepanostachyum falcatum* (Nees.) Keng.	Mid-hills	Relatively the smallest size
6	Thulo-nigalo	*Drepanostachyum intermedium* (Munro) Keng.	Mid-hills	Better for basket weaving
7	Choya Bans	*Dendrocalamus hamiltonii* Gamble	Mid-hills and Terai	Better for basket weaving

Table 2: The ethnobotany of bamboos in the study area

S.N.	Uses	Major Part	Value of Uses	Remark*
1	Rainwater disposal from CGI sheet, slate roof	Stem	Tools accessories	1, 3
2	Ropes making - fiber and slicing	Stem, an early age	Tools and accessories	2, 5, 6
3	Water canal, water tap	Stem	Tools and accessories	1
4	Chair, stools, canket (Khatiya)	Stem	Structural use- Construction	3, 5, 6, 7
5	Soil conservation and fencing, Wall support	Stem	Ecological use - soil conservation Safeguarding use - fencing	1-7
6	Support for climber vegetables	Stem	Farm-field	3, 5, 7
7	Decorative use	Rhizomes	Ethical/cultural value	3
8	Vegetable - new shoots/culms and pickle	Clumps	Consumptive value	1
9	Souvenir, handcrafts, gifts articles	Rhizomes, stems, branches, leafs	Consumptive value	3, 7
10	Scales for fueling	Scales, branches	Consumptive value	1-7
11	Fuel wood	stem	Consumptive value	1-7
12	Fodder	leaves	Consumptive	1, 2, 3, 5, 6
13	Stick and support	Stem, branches	Tools and accessories	2, 3, 4, 7
14	Bow and arrow	stem	Decorative/recreational value	3
15	Cradle and rope	stem	Tools and accessory	2, 5, 6, 7
16	Swinging	stem	Recreational	3, 4, 7
17	Nesting and resting places for birds and bats	Nodes, stems, rhizomes	Ecological value	1, 3, 4, 7
18	Stick for bells	Stem, branches	Consumptive	3, 4
19	Hut construction	Stems	Structural	2-7
20	Hut for hey and dry grass storage	Stems	Structural value	3, 4
21	Furniture and construction wood	Stems	Tools and accessories	5, 6
22	Cooking pot (Dhungre-khaja)	Stems	Recreational	3
23	Hooking instruments	Stems	Tools and accessories	2, 3, 4
24	Plowing main beam, shaft, and support	Branches, stem	Tools and accessories	3, 4, 7
25	The fixed peg for fixing domestic animals	Stems, branches	Tools and accessories	3, 4
26	Scaffolding	Stem	Structural value	3, 4
27	Bedding materials	Leaves	Tools and accessories	1-7
28	Flute making	Stem/branch	Recreational	1
29	Ladder making	Stems	Structural value	3, 4, 7
30	Flooring and ceiling	Stems	Structural value	3, 4, 7
31	Goat cage, cowshed	Stems	Structural value	3, 4, 7
32	Weaving for Doko, dalo, soli, phugo, store-grain, basket, cage, umbrella (Siu)	Stems	Tools and accessories	5, 6
33	Religious use - during marriage and other God offering ceremonies in Hinduism, god effigy	Stems	Religious/cultural value	1, 4
34	Bow and arrow as a symbol of dignity	Stems	Cultural value	4
35	Electrification - electric poles in rural areas	Stems	Structural value	3, 4
36	Maize and hay storing structure	Stems	Structural value	3, 4
37	Funeral time -dead body tying and carrying to the burning or burying sites	Stems	Cultural value	3, 4, 7
38	Liquid carrier, carrying vegetable for selling or fetching from farm - hanger	Stems	Structural value	3, 4
39	Nest for birds	Leaves	Structural value	1, 3, 4, 7
40	Kids playing things -dandibigo	Stems	Recreational value	3
41	Fixing/joining the drinking water pipes in steeped terrains	Stems	Structural value	2

S.N.	Uses	Major Part	Value of Uses	Remark*
42	Religious value - symbols of god and goddess in worshiping grandeur	Whole parts	Cultural value	3
43	Pens and pencils using for painting and writing - horoscope	Stems	Study purpose	5, 6
44	Teeth brushing and Comb	Stems	Personal uses and health care	3, 5, 6
45	Key for making a traditional mattress	Stems	Structural value	3
46	Lingo in Falgu Purnima (Holy)	Stems	Cultural and recreational value	1, 4
47	Bamboo gardening	Whole plant	Decorative purpose	5, 6
48	Swinging for kids/ Fixing a rope for a swing	Stems	Recreational purpose	3, 7
49	Hand fans	Stems	Personal use	2, 5, 6
50	Pulping for paper	Whole plant	Industrial purposes	4, 7
51	Water source protection/CO2 sequestration (13% faster than woody trees)	Whole plant	Environment conservation	1-7
52	Winnows and sieves for cleaning grains	Stems	Agricultural uses	5, 6
53	welcoming gate (both live-permanent and felled-temporary)	Stems	Decorative and structural value	3, 5, 6
54	Rhizomes for making a pot to put ambrosia during the offering	Rhizome	Religious	3
55	Landslides and stream bank protection	Rhizome	Environment conservation	1-7
56	Effigy (lingo) making in Tulasi (Ocimum) marriage ceremony	Stem	Cultural use	2, 4
57	Raft making	Stem	Structural use	4, 7
58	Nailing	Sawn stem	Structural use	1, 5, 7
59	Bridge/culvert	Stem	Structural use	3, 4
60	Tying material	Split stem / rhizome's hairs	Other use	5, 6
61	Thatch supporting/lattice	Split stem	Structural use	2, 3, 7

and facilitate income generation activities in many instances to the rural dwellers. These are the sources of income in rural areas in the study areas.

Due to the fastest growth rate and has acclimatize to diverse climates; these plants are widely adapted in the regions. These plants are useful for several purposes so that rural people can accept these plants as a source of income. Replications, application, and use of ethnobotany of bamboos would be very crucial to diversify livelihood options in the regions where these plants are available and make available. These utilitarian values of the bamboos in these regions give insight and explore the wide diversity in ethnobotany of bamboos of the regions. This knowledge would be a reference to the other communities inside the country and to the global communities for application and replication of bamboos' usufruct for diversifying bamboo-based livelihoods options. In other words, the potential diversified use of bamboos in changing context without jeopardizing the traditional indigenous knowledge would be a great asset for a nation.

Despite bamboos have many ethnobotanical values in the locality; they have high carbon sequestration and storage potentiality. This invites international attention for mitigating global environmental problems through local action by simply the management of bamboos, and become a means of carbon trading. This is highlighted by different studies as well. A study in India indicates that mean carbon storage and sequestration rate in woody bamboos range from 30–121 Mg ha^{-1} and 6–13 Mg ha^{-1} yr^{-1}, respectively. Bamboo has vigorous growth, with completion of the growth cycle between 120 and 150 days. Because of its rapid biomass accumulation and effective fixation of CO_2, it has a high carbon sequestration capacity. Over and above the high biomass carbon storage, bamboo also has a high net primary productivity (12–26 Mg ha^{-1} yr^{-1}) even with regular selective harvesting, thus making it a standing carbon stock and a living ecosystem that continues to grow (Nath et al., 2015a). Such potentiality also poses in the study area as well and can be a great source of carbon sink in the area in a very short period as compared to the similar sink by trees.

Bamboos have become an indicator for soil quality indexing (SQI) in the modern context. A study reveals that Farmers' hierarchal folk soil classification was consistent with the laboratory scientific analysis in Assam, India. Culm production was the highest (27 culms clump^{-1}) in kalo mato (black soil) and the lowest (19 culms clump^{-1}) in *balaute mati* (sandy soil). Development of SQI from ten relevant soil quality parameters and its correlation with bamboo productivity explained the 64% of the variation suggests SQI as the best determinant of bamboo yield. Data presented indicate that the *kalo mati* (black soil) is sustainable or sustainable with high input. However, the other three folk soil types (red, stony and sandy soil) are also sustainable but for other land use (Nath et al., 2015b). Such soil quality indexing assessment is not the scope of this study but opensa new area for the given sites to the researcher in this field using this species without jeopardizing the ethnobotany of bamboos, as noted.

Apart from minor constructional, ethnopedological, ethnobotanical, and carbon sequestration use, bamboo could be a replacement material for many mine-based structural materials and replacement of timber (tree-based), as noted in this study. Other researchers are consistent with our assumption that bamboo units had strengths in heat storage and vapor resistance but weakness in heat transport performance, which varied with climate condition, building function, and construction type. Bamboos have advantages in full bamboo/timber constructions in hot and temperate regions (Huang et al., 2017). Moreover, the status of wood as a sustainable construction material has been reflected upon concerning different features such as environmental friendliness, durability, waste disposal, and recycling, is bamboo for structural and constructional relatively good properties (Asif, 2009).

The construction groups with bamboo particleboard as interior or (thickened) interlayer boards show overall better hygrothermal performance than those with timber units given the same construction and space size. For example, the annual total cooling demand and cooling peak are reduced by up to 14%, respectively. Moreover, the combination of bamboo mat board and bamboo particleboard in bamboo groups shows better performance in most indicators than the combination of other substance-based materials and Spruce in timber groups. These advantages of bamboos in addition to lower cost and technical requirements, bamboo particleboard and bamboo mat board have the potential to be local climate adaptive building materials and are competitive compared with the corresponding timber products (Huang & Sun, 2021). Furthermore, the multi-level comparison between bamboo and timber units demonstrates the feasibility to 'substitute timber with bamboo' in terms of hygrothermal performance, identifies the dominant bamboo variants, and offers suggestions on its market competition with timber (Huang & Sun, 2021).

The utilization of bamboo (including nigalo, *Drepanostachyum falcatum* (Nees) Keng, which is commonly known as Himalayan bamboo) grows naturally as well as planted artificially in community and state-owned forests, and is also cultivated in people's backyards. The stem of bamboos is collected and traded for manufacturing household items such as doko (big basket), dalo (small basket), suppa (tray), chakaties (small mats), and matta (sleeping mats) (ICIMOD, 2020).Also, bamboo growing is strongly associated with farm size (landholding), wealth, household size, food sufficiency, irrigation facility, livestock owned, land tenure, household off-farm and on-farm incomes, physiography of the land, and access to forests. Landholding is the most important socioeconomic factor that influences households' decision to grow bamboos (Das, 1998).

Increasing concern of bamboos and networking (eg. INBAR - International Network on Bamboos and Rattan) of the country with international communities regarding bamboos growing the opportunities to explore the multiple uses of bamboos in upcoming days. As the climate and diverse species favor in the Nepalese climate for bamboos (Jackson, 1994), this species could be one of the best fast-growing plant species for socio-economic as well as environmental transformation for livelihood support as well as industrializing the product's base on bamboos in Nepal without compromising environmental and ecological

integrity. As result suggested, the government policy is required to shape accordingly and bamboos-based infrastructure is required for materializing the policy for the prosperity of the country. This lesson could be learned by other countries where the bamboos are distributed naturally and/or artificially.

Conclusion

All together 7 distinct species were identified, 60 more traditional uses of bamboos were documented and these uses are categorized into broad groups viz. structural use, consumptive use, environmental value, religious and cultural use, agricultural use, and other use. Apart from these ethnobotanical uses, Nepal has already become parties of many national and international networks regarding bamboos to explore potential opportunities regarding the species. These opportunities could be, in principle, climate change mitigation and carbon trading, soil quality indexing, and replacement of mine and wood-based products in more effective, efficient, and with a low level of technical inputs. Grasping such opportunities without jeopardizing indigenous traditional knowledge in bamboo use would be a great achievement for the locality as soon as for the country as a whole. These findings would be a reference for shaping appropriate policy to the country and other countries where the bamboos are distributed for materializing bamboo-based prosperity.

Author Contributions

We, both authors were involved in designing the concept, model of research, data collection in the field. The first author prepared the manuscript, edited it, and proofing whereas the second author thoroughly copy-edited polished, and proofing. Both authors read the manuscript and agreed to take public responsibility regarding this paper.

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