Beyond ethnobotany: Tracing back the ancient story of the Ngadha people through the utilisation of bamboo

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Research

Abstract

Background: Traditional ethnobotanical studies have primarily focused on documenting plant species and their uses, often glorifying them as expressions of local wisdom. This paper advances a broader analytical perspective by integrating anthropological and sociological approaches to explore realities beyond ethnobotanical knowledge. It traces the ancient story of the Ngadha people by investigating their use of bamboo and its origins.

Methods: This qualitative research employs multiple methods, including ethnographic techniques such as in-depth interviews and participatory observations, as well as ethnobotanical techniques using semi-structured interviews. Knowledgeable informants from the Ngadha people were selected using the snowball sampling technique.

Results: This study indicates that, although the Ngadha are migrants who believe bamboo predated their ancestors' arrival, they possess a sophisticated body of knowledge concerning bamboo cultivation and utilisation. Bamboo has long served as a medium for survival, social cohesion, creative expression, and moral reflection. However, the penetration of modernisation has altered these relationships. Community preferences have shifted toward materials such as concrete, plastic, and metal. Consequently, traditional bamboo knowledge, along with the social and cultural values it sustained, has been diminished and replaced by growing individualism, monetisation, and reliance on industrial technologies.

Conclusions: Bamboo ethnobotany in Ngadha reveals the ancient narrative of the Ngadha People and their survival through bamboo-based traditional technology. However, their knowledge and practices related to bamboo are now threatened by the penetration of modernisation.

Keywords: Ethnobotany; Bamboo utilisation; Ngadha people; Ancient story; Cultural transformation

Background

Traditionally, ethnobotany focuses on documenting how communities classify and utilise plants within their ecological systems (Cotton 1996, Martin 2010). However, the scope of ethnobotany has expanded in recent decades. Scholars such as Ryan (2011) and Vandebroek and Albuquerque (2024) advocate for integrating symbolic, affective, and cultural dimensions into ethnobotanical analysis. Within this broader framework, ethnobotany research now considers bamboo as part of the cultural biography of materials, tracing how plant-based technologies mediate relationships between people, landscapes, and belief systems, and how these persist in collective memory (Britton 2024, Her & Buley-Meissner 2010, Levaggi & Ibarra 2025, Virtanen *et al.* 2022).

Bamboo has long symbolised resilience, adaptability, and ecological intelligence across many cultures in the Asia and Africa region. Within ethnobotany, bamboo has primarily been studied for its utilitarian functions in architecture, handicrafts, and subsistence livelihoods. For example, in China, there are 17 species of bamboo that are used for various human needs, ranging from construction and architecture to agricultural and fishing tools, as well as food sources (Luo *et al.* 2020). In Japan, bamboo is widely used for mitigating earthquake disasters, serving as a material for constructing earthquake-resistant architecture (Yani & Widaningsih 2015). In India, craftsmen use bamboo to make various types of baskets, agricultural and fishing tools, and household appliances (Nirala *et al.* 2017). Meanwhile, in Africa, bamboo is traditionally used for construction and fencing, handicrafts, and furniture (Kindu & Mulatu 2010).

The Ngadha people inhabit the highlands of central Flores, a region renowned for its megalithic villages, matrilineal kinship, and animistic worldview (Arndt 1958, Smedal 2002). In Ngadha culture, bamboo is omnipresent; it forms the framework of traditional houses (*sao*), serves as the resonance of ritual sound instruments, and acts as a vessel for daily subsistence in the form of baskets and containers (Curnow 2016, Smedal 2000). Beyond its physical utility, bamboo embodies continuity between humans, ancestors, and nature. Through this lens, the ethnobotany of bamboo among the Ngadha people extends beyond species use, revealing how a plant can shape ontological and social relations.

Ethnobotanical studies in Indonesia have largely focused on the taxonomic identification of plant species and their uses in daily life (Raihandhany 2022, Sudirgayasa *et al.* 2025, Walujo 2008), particularly in the context of traditional medicine (Nugraha & Keller 2011, Sianipar 2011) and ethnomedicine (Bhagawan *et al.* 2022, Lestariningsih *et al.* 2023, Ningrat *et al.* 2025). A similar pattern is evident in ethnobotanical research on bamboo in Indonesia (Dewi *et al*. 2016, Ervianti *et al.* 2019, Ihsan *et al.* 2023, Ihsan *et al.* 2024, Irawan *et al.* 2019, Ritonga *et al.* 2023, Sujarwo 2018), which has primarily aimed to identify the uses of bamboo among local communities and often tends to glorify these practices as evidence of local wisdom without critically examining their socio-cultural depth or vulnerability to change (Sianipar 2021, Ihsan *et al.* 2023).

Previous ethnobotanical studies on bamboo have not yet established a discourse that connects bamboo-based technologies with the narrative of the Ngadha people, who maintain a deep socio-cultural, emotional, and mnemonic relationship with bamboo. A critical analysis of modernisation and material substitution reveals that this profound human-bamboo connection is gradually being forgotten. This study investigates the Ngadha people's relationship with bamboo through an interdisciplinary lens that moves beyond descriptive ethnobotany. It combines ethnobotanical fieldwork, ethnographic oral history, and material culture analysis to reconstruct the cultural biography of bamboo as a conduit of identity, cosmology, and adaptation. The research contributes to global discussions on ethnobotany, bamboo, and the Ngadha, as well as to the anthropology of materials, offering new insights into how local ecologies interact with processes of global modernity.

Materials and Methods

Study area

Most people in Ngadha use the Ngadha language for daily communication, while the Indonesian language is primarily used in formal contexts. The languages of East Nusa Tenggara and Maluku are members of the Central Polynesian Malay (CMP) language subgroup (Fernandez, 2007). According to Raharja & Yuwana (2023), the Flores languages are divided into the West and East Flores subgroups. The Ngadha language in Ngadha Regency is placed in the second West Flores subgroup, together with the Lio Language in Ende Regency and Palu'e Language in Sikka Regency, due to its close historical and linguistic relationships (Raharja & Yuwana, 2023). The bamboo species that predominates in Ngadha is *Dendrocalamus asper*, commonly known as *bheto* in the Ngadha Language or betung in Indonesian language. This species thrives in Ngadha due to its suitability for the local climatic and geographical conditions (Sugi *et al.* 2024). Additionally, there is a strong connection between bamboo and socio-culture in the local context, especially regarding social capital (Prasetyo *et al.* 2020) and gender narratives (Prasetyo *et al.* 2021). Since 2012, a laminated bamboo industry has been operating in Ngadha Regency, sourcing

bamboo from the forest surrounding Golewa Sub-District. The bamboo industry cooperates with NGOs in assisting bamboo farmers and owners in supplying materials for industrial use (Ekawati *et al.* 2022).

This study was conducted from 2018 to 2021, from August to September each year in Ngadha Regency, East Nusa Tenggara Province, Indonesia (see Figure 1). Fieldwork was carried out across six village regions, including Bajawa, Ratogesa, Wogo, Radabata, Were, and Ulubelu, and Radabata. The Ngadha Regency has a population of 171,736 people, with a population density of 105.95 persons per km². It covers an area of 1,736.83 km² and is administratively divided into 12 sub-districts and 206 villages (BPS 2024). The majority of the population in Ngadha regency practices the Catholic faith. The average annual rainfall in the Ngadha Regency ranges from 1,000 to 2,500 mm (BPS 2024). The first phase of fieldwork was conducted in Bajawa Town, the capital of Ngadha Regency, located in Bajawa Sub-district. Bajawa lies at an elevation of 1,266 meters above sea level and covers an area of 102.76 km², with a population of 40,564 people (BPS 2024). The second fieldwork was in Ratogesa and Wogo. Ratogesa is located at 1,089 meters above sea level, covers 1.71 km², and has a population of 814, while Wogo lies at 1,099 meters above sea level, covers 2.33 km², and has a population of 1,129. The third phase of fieldwork was in Radabata and Were. Radabata is situated at 1,145 meters above sea level, with an area of 4.20 km² and a population of 1,342. Were lies at 1,211 meters above sea level, covers 3.92 km², and has a population of 1,247. The last phase of fieldwork was in Ulubelu, which is located at 1,058 meters above sea level, covers 1.25 km², and has a population of 750 (BPS 2024a).

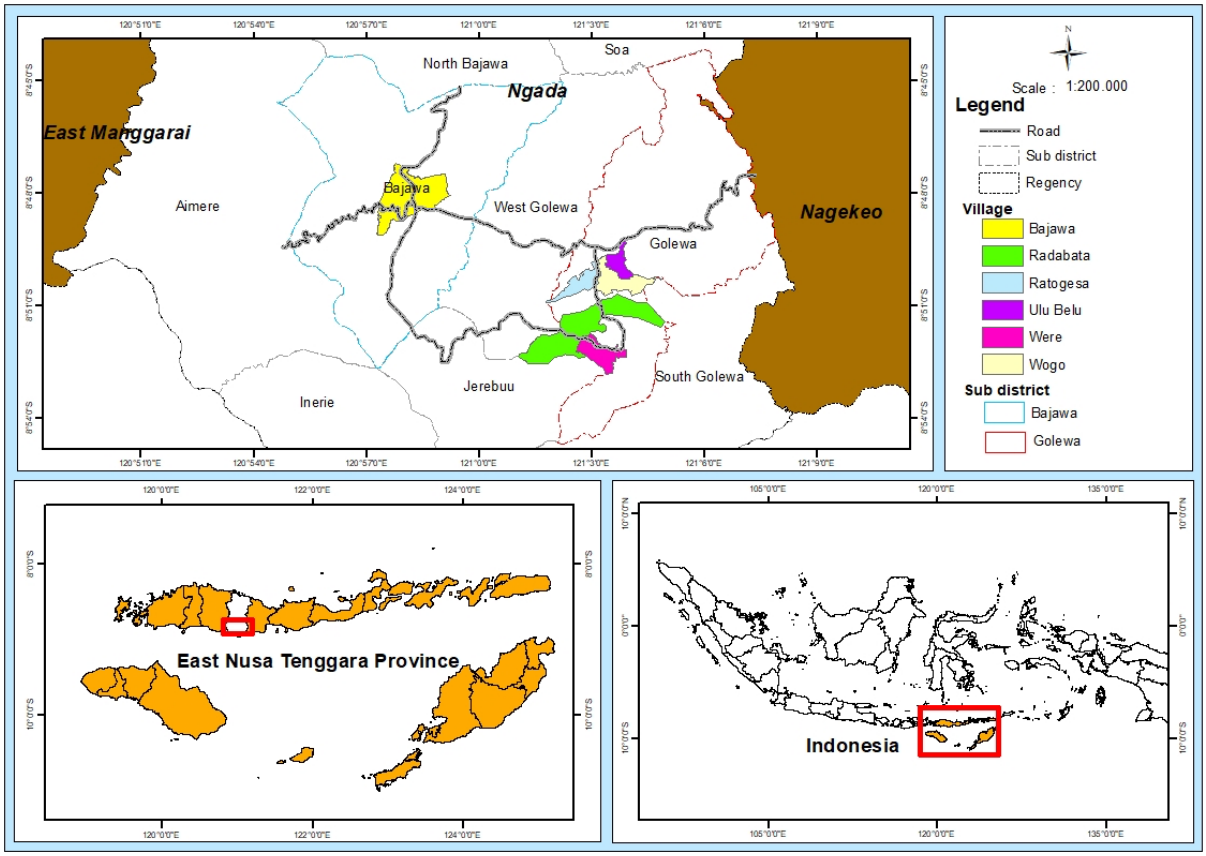

Figure 1. Research location in Ngadha Regency, East Nusa Tenggara Province, Indonesia.

Data Analysis

This qualitative research employs a realist ethnographic perspective, focusing on situational contexts and information obtained from informants (Creswell 2012). Ethnography is the study of humans in their natural settings to capture social meanings and daily activities by directly engaging researchers in the environments and activities of the subjects being studied (Benessaiah 2014, Brewer 2000, Windiani & Rahmawati 2016). While this study utilises ethnography as its primary approach, it also incorporates ethnobotanical techniques to identify bamboo species and their uses among the Ngadha people through semi-structured interviews. Additionally, in-depth interviews were conducted to expand the narrative beyond ethnobotanical data, with the ancient stories of the Ngadha people serving as the focus of investigation. Field observations and photographic documentation were employed to record the traditional knowledge shared by informants, which is manifested in materials or artefacts.

Informants were selected purposively using the snowball sampling technique based on the specific information to be investigated and verified, considering their relevant knowledge. Data collected included the identity of informants, such as gender, occupation, role, village of origin, and their knowledge of the traditional uses of bamboo. This encompassed categories of products, local names, Indonesian names, English names, functions, local bamboo names, Indonesian bamboo names, scientific names, and the parts of bamboo used. Additionally, data related to the ethnographic aspects of bamboo addressed narrative stories beyond ethnobotany, including the origins of bamboo and the Ngadha people, as well as their survival strategies utilising bamboo. This reflects the socio-cultural values associated with bamboo and the modern challenges to its use in Ngadha.

Validation was conducted through triangulation, which involved confirming information obtained from various sources as well as from the relevant literature. This approach aimed to gather saturated information that could be drawn upon to formulate conclusions. Data related to the ethnobotany of bamboo, collected from interviews, were cross-checked with local taxonomies and standard bamboo nomenclature using the book Atlas Bambu Indonesia (Damayanti *et al.* 2019). Meanwhile, data from in-depth interviews were analysed thematically, descriptively, and narratively.

Results

Informant Demographics

During the data collection in the six village regions of Ngada, ten individuals were interviewed. These informants included authors, cultural specialists, tribal leaders, academics, farmers, and representatives of the Environmental Bamboo Foundation (see Table 1).

Table 1. Informant characteristics and roles.

Informant Code	Gender	Backgrounds	Role	Village of origin
P1	M	Author and Cultural Specialist of Ngadha	Indigenous expert	Bajawa
P2	M	Author and Cultural Specialist of Ngadha	Indigenous expert	Bajawa
P3	M	Tribal leader at Wogo	Indigenous expert	Wogo
P4	M	Cultural Specialist of Ngadha	Indigenous expert	Ratogesa
P5	M	Academia at the University of Flores	Indigenous expert	Ratogesa
P6	M	Tribal leader at Were	Community	Were
P7	M	Tribal leader at Ulubelu	Community	Ulubelu
P8	F	Farmer	Community	Wogo
P9	M	Tribal leader at Radabata	Community	Radabata
P10	M	Environmental Bamboo Foundation (EBF)	Non-Governmental Organization	Were

Traditional use of bamboo

Information on 54 traditional Ngadha bamboo tools was gathered through interviews with 10 informants across six villages in Ngadha Regency (see Table 3). Four bamboo species were utilised in crafting these traditional tools: bamboo **betung** (*Dendrocalamus asper* (Schult. & Schult.f.) Backer), bamboo **ampel** or **guru** (*Bambusa vulgaris* Schrad. ex J.C.Wendl.), bamboo **ater** (*Gigantochloa atter* (Hassk.) Kurz ex Munro), and bamboo **wuluh** or **ila wolo** (*Schizostachyum brachycladum* Kurz) (see Table 2 and Figures 2, 3, 4, 5). All bamboo species recorded in this study belong to the family Poaceae, subfamily Bambusoideae. Most traditional tools were made from a single species of bamboo, while only a few were produced using a combination of two or more species.

Figure 2. Bamboo Bheto (*Dendrocalamus asper)* in Wogo Village.

Figure 3. Bamboo Peri (*Gigantochloa atter)* in Wogo Village.

Figure 4. Bamboo Ampel or Guru (*Bambusa vulgaris)* in Wogo Village.

Figure 5. Bamboo Wuluh wolo or Ila wolo (*Schizostachyum brachycladum)* in Wogo Village.

Table 2. The uses of bamboo species in Ngadha.

Species (scientific name and local name)	**Construction uses**	**Household utensils and tools**	**Agricultural tools**	**Hunting tools**	**Traditional games**	**Music instruments**	**Fences and enclosures**
Dendrocalamus asper (*Bheto /betung*)	*Sa'o* (house frames); *Baru lenga* (walls); *Tubo* (granary posts); *Lenga* (roof frames); *Naja* (wall panels); *Lat* (binding straps)	*Maki po'o* (cooking vessel); *Rodho (*Steamer); *Sege/lida* (woven tray for rice); *Zezo (*woven tray for corn); *Fego* (rice paddle); *Zoi ngi'i* (toothpick); *Kodo manu* (chicken basket); *Tuku hui* (meat container); *Rana* (large rice basket); *Tobho ranga* (food container for feeding pigs); *Tuku koro*(chili container); *Tuku si'e* (salt container); *Tuku leko* (Grain container); *Toke/bêla wae* (water container);	*Gheke (*Rice sickle); *Su'a bheto (*Weeder); *Zo'a* (dibble stick); *Ebha* (winnowing fan); *Pepa* (bird repellent); *Dhoka/udo (*temporary hut)	*Laja ngeta* (spear); *Le'e* (bow); *Ana le'e (arrow); Wo'o* (torch); *Fau/eto* (fishing rod handle); *Ghate* (animal snare); *Bhedhi* (bird snare)*; Gala* (Spear with an iron tip); *Bhoru* (bamboo spear); *Sosa* (hedge trap)	*Tempuling (*spear-throwing game); *Lengitana* (bamboo cannon); *Topo(*Bamboo machete); *Bêdi* (Toy gun).	*sowito*, *tobho*, *Laba dera; Laba tok; teko reko.*	*Hala* (field fence); *Folo* (house fence); *Subi* (chicken fence)
Bambusa vulgaris (*guru/ampel*)	*Naja* (wall panels)	*Lêga guru* (woven bags); *Kêpen* (smaller woven bags).	-	*Zupi* (blowpipe);	*Nobe* (spear-throwing game).	*Foy pay*.	-
Gigantochloa atter (*peri/ater*)	-	*Maki po'o* (cooking vessel); *Rodho (*Steamer); *Kêpen* (smaller woven bags).	-	*Laja ngeta* (spear); *Wo'o* (torch);	*Sagu alu* (jumping game).	-	
Schizostachyum brachycladum Kurz (*wuluh* wolo or *ila wolo)*	-	-	-	-	-	*Foy doa* (double flute)	-

Table 3. Ethnobotanical inventory of bamboo utilisation in Ngadha.

Category	Item name (local)	Item name (Indonesian)	Item name (English)	Function/use	Bamboo name (local)	Bamboo name (Indonesian)	Scientific name	Bamboo part used
Construction uses	*Tubo*	tiang	pole	main structural house post	*Bheto*	Betung	*D. asper*	Base to middle
	Lenga	atap	roof	house roofing	*Bheto*	Betung	*D. asper*	Middle
	Naja	dinding	wall panels	house walls and floors	*Bheto/peri*	Betung/ater	*D. asper*/*G. atter*	Middle to tip
	Lat	sabuk	binding strap	binding walls and posts	*Bheto*	Betung	*D. asper*	Middle to tip
Traditional games	*Sagu alu*	-	-	bamboo jumping dance	*Peri*	Ater	*G. atter*	Tip
	Nobe	lembing	spear	spear-throwing game	*Guru*	Ampel	*B. vulgaris*	Base to tip
	Tempuling	tombak (dgn besi)	spear with a metal tip	spear-throwing game	*Bheto*	Betung	*D. asper*	Base to tip
	Lengitana	Meriam bambu	Bamboo cannon	New year fireworks	*Bheto*	Betung	*D. asper*	Base to middle
	Topo	Parang bambu	Bamboo machete	Martial arts games	*Bheto*	Betung	*D. asper*	Base to middle
	Bêdi	Pletokan	Toy gun	Toy gun	*Bheto*	Betung	*D. asper*	Branch
Agricultural tools	*Gheke*	Ani-ani	Rice sickle	Harvesting rice	*Bheto*	Betung	*D. asper*	Middle
	Su'a bheto	Alat pembersih	Weeder	Weeding in fields	*Bheto*	Betung	*D. asper*	Base
	Zo'a	Penugal	Dibble stick	Planting rice	*Bheto*	Betung	*D. asper*	Tip
	Ebha	Pengipas padi	Winnowing fan	Separating grain	*Bheto*	Betung	*D. asper*	Sheath
	Pepa	Pengusir burung	Bird scarer	Scarecrow	*Bheto*	Betung	*D. asper*	Middle
	Dhoka/udo	Pondok ladang	Temporary hut	Storing harvest	*Bheto*	Betung	*D. asper*	Middle to tip
Household and kitchen utensils	*Maki po'o*	Wadah lemang	Lemang container	Cooking sticky rice	*Bheto/peri*	Betung/ater	*D. asper*/*G. atter*	Tip / middle
	Rodho	Kukusan	Steamer	Steaming food	*Bheto/peri*	Betung/ater	*D. asper*/*G. atter*	Outer layer
	Sege/lida	Tampah rapat	Woven tray	Separating rice	*Bheto*	Betung	*D. asper*	Outer layer
	Zezo	Tampah longgar	Sifter	Sifting corn	*Bheto*	Betung	*D. asper*	Outer layer
	Fego	Sendok nasi	Rice paddle	Stirring rice	*Bheto*	Betung	*D. asper*	Middle
	Zoi ngi'i	Tusuk gigi	Toothpick	Cleaning teeth	*Bheto*	Betung	*D. asper*	Middle
	Kodo manu	Keranjang ayam	Chicken basket	Carrying live chicken	*Bheto*	Betung	*D. asper*	Outer layer
	Tuku hui	-	-	Storing pork	*Bheto*	Betung	*D. asper*	Middle

Category	Item name (local)	Item name (Indonesian)	Item name (English)	Function/use	Bamboo name (local)	Bamboo name (Indonesian)	Scientific name	Bamboo part used
	Rana	Bakul besar	Large basket	Holding meat/rice	*Bheto*	Betung	*D. asper*	Outer layer
	Tobho ranga	Wadah pakan	Feed container	Feeding pigs	*Bheto*	Betung	*D. asper*	Middle
	Tuku koro	Wadah cabai	Chili container	Storing chili	*Bheto*	Betung	*D. asper*	Base/middle
	Tuku si'e	Wadah garam	Salt container	Storing salt	*Bheto*	Betung	*D. asper*	Base/middle
	Tuku leko	Wadah padi	Grain container	Storing rice/corn	*Bheto*	Betung	*D. asper*	Middle/tip
	Toke/bêla wae	Wadah air	Water container	Storing water	*Bheto*	Betung	*D. asper*	Tip
	Lêga guru	Tas anyaman	Woven bag	Carrying provisions	*Peri*	Ater	*B. vulgaris*	Outer layer
	Kêpen/kêpe	Tas kecil	Small woven bag	Carrying money	*Peri/guru*	Ater/ampel	*G. atter/B. vulgaris*	Outer layer
Hunting tools	*Laja ngêta*	Tombak	Spear	Hunting wild animals	*Bheto/peri*	Betung/ater	*D. asper/G. ater*	Tip/middle
	Le'e	Busur	Bow	Hunting & combat	*Bheto*	Betung	*D. asper*	Tip
	Ana le'e	Anak panah	Arrow	Hunting & combat	*Bheto*	Betung	*D. asper*	Tip
	Wo'o	Obor	Torch	Night hunting	*Bheto/peri/guru*	Betung/ater/ampel	*D. asper/G. atter/ B. vulgaris*	Tip/middle
	Fau/eto	Gagang pancing	Fishing rod handle	Fishing	*Bheto*	Betung	*D. asper*	Branch
	Ghate	Jerat babi	Animal snare	Trapping pigs/deer	*Bheto*	Betung	*D. asper*	Middle
	Bhedhi	Jerat burung	Bird snare	Trapping quail	*Bheto*	Betung	*D. asper*	Branch
	Zupi	Sumpit	Blowpipe	Hunting	*Guru*	Ampel	*B. vulgaris*	Branch
	Gala	Tombak logam	Spear with an iron tip	Hunting	*Bheto*	Betung	*D. asper*	Middle
	Bhoru	Tombak bambu	Bamboo spear	Hunting	*Bheto*	Betung	*D. asper*	Middle
	Sosa	Perangkap	Hedge trap	Trapping porcupine/prawn	*Bheto*	Betung	*D. asper*	Outer layer
Fences and enclosures	*Hala/sala*	Pagar horizontal	Horizontal fence	Pig pens & gardens	*Bheto*	Betung	*D. asper*	Middle/tip
	Subi	Pagar ayam	Chicken fence	Enclosing poultry	*Bheto*	Betung	*D. asper*	Middle/tip
	Folo	Pagar rumah	House fence	Fencing houses	*Bheto*	Betung	*D. asper*	Middle
Ritual	*Tibo*	Alat ritual	Ritual tool	Divination	*Bheto*	Betung	*D. asper*	Middle
Music instruments	*Foy doa*	Suling ganda	Double flute	Ceremonial music	*Wuluh wolo*	Buluh lemang	*S. brachycladum*	Middle

Category	Item name (local)	Item name (Indonesian)	Item name (English)	Function/use	Bamboo name (local)	Bamboo name (Indonesian)	Scientific name	Bamboo part used
	Tobho	-	-	Ceremonial music	*Bheto*	Betung	*D. asper*	Middle
	Sowito	-	-	Ceremonial music	*Bheto*	Betung	*D. asper*	Middle
	Foy pay	-	-	Ceremonial music	*Guru*	Ampel	*B. vulgaris*	Middle
	Laba dera	Gendang	Large Drum	Ceremonial drum	*Bheto*	Betung	*D. asper*	Middle
	Laba toka	Gendang besar	Long tube drum	Ceremonial drum	*Bheto*	Betung	*D. asper*	Middle
	Teko reko	-	-	Ceremonial music	*Bheto*	Betung	*D. asper*	Middle

The First Settler: The origin of people and bamboo in Ngadha

The bamboo growing in Ngadha is believed by the community to have existed long before their ancestors settled in Flores. “There are no clear signs that the bamboo in Ngada was brought from outside Flores and planted by our ancestors. It seems that the bamboo had already existed here before the Ngadha people themselves arrived,” said P1.

This statement aligns with the verses of the *Su’i Uwi* chant, which are recited during the Reba ceremony (Bhoki *et al.* 2024). Reba is an annual event that marks the Ngadha people’s New Year celebration (Noywuli *et al.* 2020). According to Informant P1, the *Su’i Uwi* chant recounts that the Ngadha people were migrants who originated from a place called Sina, a term often associated with China or the Yunnan region. During their journey, they are said to have stopped in Java, Raba (now Bima in West Nusa Tenggara), and Sumba before finally arriving and settling in Flores, specifically in the Ngadha region. Notably, the word **bheto,** which means “bamboo” in the Ngadha language, is absent from the *Su’i Uwi* narrative.

The Ngadha people collectively refer to all types of bamboo as *bheto*. However, according to Informant P3, the term **bheto** specifically refers to large-sized bamboo of the species *Dendrocalamus asper*. Smaller varieties of bamboo have distinct local names, such as **pring** or **peri** (*Gigantochloa ater*), **aur** or **guru** (*Bambusa vulgaris*), and **wuluh wolo** or **ila wolo** (*Schizostachyum brachycladum* Kurz) (Damayanti *et al.* 2019). “The Ngadha people call bamboo **bheto**. But actually, **bheto** is the name for the largest type of bamboo. In Java, it is called **petung** or **betung**, but here in Ngadha, we call it **bheto**. For smaller types of bamboo, we use the names **peri, guru**, and **wuluh**,” (P3).

The narrative stories about bamboo appeared after the first settler of the Ngadha People arrived and built their civilisation in Flores. According to P2, although bamboo was not explicitly mentioned in the ritual Reba, they admitted that it has helped them survive. “Flores has fertile soil, in which many clumps of bamboo grow very well. It helped our ancestors survive in difficult situations as the first settlers. Using bamboo, they created houses, tools for hunting, food gathering, farming, processing food, as well as musical instruments and games,” (P2).

The claim of P2 aligns with the narrative of the *Su'i Uwi* chant in the ritual Reba. It tells that when the ancestors of the Ngadha people arrived in Flores and settled in Ngadha, they built villages (*nua*) and houses (*sao)*. Nua is an area with a collection of houses lined up around a field (*loka)*, and on the edge or in the middle of the *loka*, a monument is usually built as a traditional symbol of *ngadhu* and *bhaga* (Curnow 2016). Informant P2 said, “Usually in a *nua,* there is a customary prohibition against building a house on the *loka*. The *loka* area is sacred and can only be used for social and ritual activities, such as ritual *Reba*."

Meanwhile, *Sao* means a traditional house building belonging to a tribe (*woe*). *Sao* is also interpreted as a family institutional entity, which is in the lower strata below *Woe*. A *sao* usually houses several nuclear families, while a *woe* usually consists of a number of *sao*. *Woe* communities gathered in *Sao* usually erect sacred monuments symbolising male (*Ngadhu*) and female (*Bhaga*) ancestors around the *loka*. Therefore, in a *nua*, it is usually easy to find several *ngadhu* and *bhaga* on the edge or in the middle of the *loka* adjacent to the *sao* houses. P1 said "*Nua* is a living place for a group of Ngada people in a *woe*. Nua consists of several *sao*. Each sao has an ancestral symbol of *ngadhu* and *bhaga,* which is built on the edge of the loka. *Ngadhu* is conical in shape, while *bhaga* is shaped like a small house."

Building houses and civilisation

Bamboo is used by the Ngadha people as a vital material for constructing houses. It is the most dominant material in the construction of bamboo houses known as *baru lenga*. This study found that the main components of *baru lenga*, made from bamboo, include poles (*tubo*), roof (*lenga*), walls and floors (*naja*), and belt (*lat*). The bamboo used for these components is obtained from old **bheto**. P3 once witnessed a ceremony to establish a *baru lenga* when he was ten years old. "Our parents who built baru lenga always used old **bheto**. The old **bheto** were usually in the middle of the clumps and were difficult to pick. Our parents used chisels to cut the old **betho** so they didn't sacrifice the young betho growing around them," said P3.

Figure 6. Components of traditional bamboo house (from left to right: lenga, lat, naja, tubo) in Ratogesa village.

Figure 7. Application of *naja*, *tubo*, and *lat* in the house wall in Ratogesa Village.

Figure 8. Application of lenga from the inside in Ratogesa Village.

Figure 9. Application of lenga from the outside in Wogo Village.

This study revealed that building a *baru lenga* measuring 8 x 7.5 meters requires approximately 300 **bheto** stems. Of that amount, 180 **bheto** are used for the roof, and 80 **bheto** are used for the *naja*. The remaining stems are used for lats and other supporting components. The part of the *baru lenga* that is quickly damaged and must be replaced regularly is the lenga or roof. This part is particularly vulnerable to decay due to exposure to weather conditions such as rain and intense sunlight, necessitating replacement at least once every two to three years. Meanwhile, *naja*, which has minimal weather exposure, is claimed by local residents to be able to survive up to 70 years. "We usually replace the *lenga* every two or three years. If it rains a lot, the lenga becomes damp, and when it gets hot, the *lenga* quickly rots. But if it's naja, it rarely gets rainy and hot. So, it can last up to around 70 years," P4 explained the condition of his bamboo house.

From hunting to farming: the emergence of institutions

In *Su'i Uwi's* chants, it is stated that when the ancestors arrived at the mouth of the *Lege Lapu* (currently known as the mouth of the *Wae Mokel* river in Flores), they began their wanderings on the Flores mainland until they found a place to settle in Ngadha (Arndt 2007). At that time, food sources were obtained through hunting. P1 said that in the past, the Ngadha people met their protein needs by eating wild animals that inhabited the forest and the water. "They made hunting tools from bamboo to hunt wild boars, deer, porcupines, shrimp and fish," said P1.

The hunting tools include *laja ngêta* (bamboo spear), *le'e* (bow), *wo'o* (arrow*), fau/eto* (fish catcher), *ghate* (trap for large animals such as pigs and deer), *bhedh*i (bird trap), *zupi* (blowpipe), *gala* (spear with a sharp metal tip), *bhoru* (spear with a sharp bamboo tip), and *sosa* (shrimp or porcupine trap).

The transition from hunting to farming is believed to have occurred after the Ngadha people began to settle in Ngadha for extended periods. An increasing population led to increased food demands, prompting the shift from hunting to agriculture to ensure food security. This is known from the naming of institutions and regions other than *nua* and *sao*, namely *Bo* and *Ngedi Uma Tua Loka.*

According to P2, *Bo* is a small village that historically served as a rice barn for the Ngadha people. The rice barn is a two-level structure, with the upper floor designated for storing rice and the lower floor used for cooking pork. The building on the ground floor has walls to keep it warm so that people from the *nua* can stay under the *bo* until the harvest season is over. "*Bo* is actually a rice barn. In the past, the Ngadha people planted rice. When they harvested, they looked after the rice and stayed temporarily in the *bo* while bringing supplies of livestock meat for cooking. Upstairs was for storing the rice, downstairs was for sleeping and cooking," said P2.

Meanwhile, *ngedi uma loka tua* is a collection of narrow stretches of fields or gardens and stretches where palm or palm trees (*Arenga pinata*) that produce palm wine (*moke*) grow. People who farm and harvest palm wine live in huts at this location. They come from various *woe*. "They are not related to each other by blood but were brought together because of similar jobs and proximity to where they live," said P1.

The Ngadha people have the skills to make agricultural tools from bamboo. This study identifies tools made from bamboo for the agricultural sector. Some of them are *keke* (anai-anai/rice cutter), *kiu* (coffee breaker), *sua bhêto* (grass cleaner), *zo'a* (dible stick), *nêdo* (rice breaker), *ebha* (fan that separates rice from the outer shell) and *pepa* (bird repellent).

The Ngadha people raise livestock by constructing fences from bamboo. These fences serve to prevent livestock from leaving the farmland and to protect them from wild predators. For example, the Ngadha people make *sala* (horizontal fences), *subi* (woven fences) and *folo* (whole-bamboo fences) to protect their pigs. The pig fences are equipped with *gobe ranga*, which is bamboo split into half tubes for the pigs to feed on. "Pig fences are usually built using *sala, subi*, or *folo*. It depends on the person who wants to keep pigs, and which one they choose. *Subi* and *folo* are still used today for pig pens," explained P3.

Securing food, producing tools

The Ngadha people rely heavily on **uwi** *(Dioscorea spp)* to meet their carbohydrate needs. Since their ancestors arrived on Flores, **uwi** has been the main food besides meat from hunting. P1 explained, “According to our belief, the Ngadha people have been farming on a mobile basis for a long time. They always look for places to farm in areas where there are lots of **uwi**. After **uwi** runs out, they move to other places where there are lots of **uwi**."

Apart from **uwi**, this study found that the Ngadha people also grow rice and other types of plants such as pumpkin, banana, taro, palm oil, coffee, ginger, cloves, corn, tubers and nuts. Pigs and chickens are the most preferred types of livestock for meeting protein needs.

The Ngadha people possess extensive knowledge regarding processing food sources. Most of the tools used to process crops in fields and livestock use bamboo as the material. In processing **uwi**, for example, the Ngadha people make a *rodho* (steamer) to cook **uwi**. After cooking, the **uwi** is placed in a *rana* (bamboo basket) to be served and eaten. This process is usually similar to cooking rice and corn.

In processing meat, the Ngadha people typically boil livestock in a large cauldron for consumption. After cooking, the meat is placed in *rana*, *sege*, or *zezo* and then distributed to the plates of the family members who will eat. Apart from boiling, meat is usually grilled as satay using *nusu* (skewers).

The Ngadha people have specific tools for preserving food made from bamboo. In anticipation of the lean season and food insecurity, based on the seasonal calendar, they store pork in *tuku sui* (a container for preserving pork to flavour dishes). In addition, they have communal granaries at the *sao* family level. They store rice or corn in the barn using *tuku leko*, store water using *toke wae* or *po'o wae*, store dried cooked corn flour in *rêmi*, store chillies in *tuku koro* and store salt in *tuku sie*.

Arts and entertainment

The Ngadha people have a strong sense of social cohesion and care deeply about the members of their village. This is illustrated in the story about the *foy doa*, a bamboo flute with two pipes. "*Foy doa* used to be used by parents when advising their children. I was once given advice on looking after gardens and fields. My father advised me by playing the *foy doa* first," said P3.

The raw material for *foy doa* comes from small-diameter bamboo **wuluh wolo** or **ila wolo** (*Schizostachyum brachycladum*). P3 explained that the **wuluh wolo** used were taken from bamboo groves that grow in the mountains. "This is bamboo **wuluh** that grows in the mountains. The sound is better because it is drier than bamboo that grows in valleys or lowlands," explained P3.

In the past, the *foy doa* was played solo, but now it is played alongside other musical instruments such *as thobo, teko reko, sowito, foy pay, laba dera*, and *laba toka*. It is known that these traditional musical instruments are still used by the Ngadha people today, such as during the ritual *wa'e sao* in building traditional houses in Guru Sina Village (Nono *et al.* 2024).

Apart from musical instruments, the social cohesion of the Ngada community in the past can be observed through the numerous traditional games. This study identified six traditional games using bamboo. These traditional games are usually played by children and adults to enjoy their free time and as a form of social interaction. The *Sagu alu* game, or bamboo jumping dance, for example, is a form of expression that showcases the joy and agility of young people as they jump between open and closed bheto stems, following the rhythm of the traditional music being played.

The other five bamboo games seem to be more identical in their replication of the atmosphere of war between tribes. They are *nobe* (javelin), *tempuling* (bamboo spear), *lengi tana* (kerosene-fueled bamboo cannon), *topo* (bamboo machete), and *bedi* (bamboo gun). These tools come from the types of tools or weapons that the Ngada people usually use during war. Kids love this game because they want to be like their brave predecessors. "These are actually toy war tools. Because children often hear stories about the Ngadha people's prowess in fighting, they want to be like their ancestors. Being able to use weapons, even if they are just toys made of bamboo," said P1.

Traditional sustainable bamboo management of the Ngadha People

Although the Ngada people claim that the bamboo growing around their homes is natural, this study revealed that they possess knowledge of sustainable bamboo cultivation techniques. This is proven by the fact that **bheto** is still the dominant bamboo species in the Ngadha population to this day.

According to information from P1, P3, P5 and P6, the traditional method of bamboo cultivation generally involves several stages. First, bamboo shoots are taken from the culm, ensuring that at least three nodes are located above the last root bulb. The shoots must then be transported to the planting site within three hours. During planting, the bamboo is positioned at a slight angle, with the shoot facing sideways. The open nodes are filled with water to maintain moisture. The most favourable time for planting bamboo is known as *peli loa*, the period when *larons* (*Isoptera: termitidae*) emerge from their nests, which marks the onset of the rainy season.

The Ngadha people do not give special treatment to their bamboo during the period from the emergence of the bamboo shoots until just before harvest. However, the Ngada people have customary laws in place to protect bamboo from being damaged, stolen, or used by others without permission. This customary law is called *Ri'i* or *Waja*. According to P1, the meaning of *ri'i* and *waja* is actually the same. He said that the Ngadha people around Bajawa call it *'ri'i,* while those living around Golewa call it *'waja'*.

Ri'i is a system for ordering (reserving) bamboo from one or more clumps, intended for activities that require large quantities of bamboo, such as building houses (*baru lenga*), traditional houses (*sao*), churches, or holding traditional ceremonies and rituals. Apart from that, *ri'i* is also applied as a way to restore the bamboo ecosystem after a fire. "If a bamboo forest burns, they have to *ri'i* for four years. However, if there are Sao members who wish to build a traditional Sao house or host a traditional party, the *ri'i* in the bamboo forest can be prepared a year in advance. So, the bamboo will be available for more time when the activities are carried out," explained P1.

The areas or clumps of bamboo where *ri'i* is applied are marked with a mark called *tada*. *Tada* is made from two bamboo strips tied with palm leaves and hanging animal body parts. The type of animal that is hanged becomes a symbol for *ri'i*

violators to pay a fine in the form of a live animal of the type found in *tada*. "On the *tada* poles are hung the body parts of chickens, dogs, pigs or buffalo. The greater the number of ri'i bamboo clumps, the greater the type of animal used to pay the fine," said P1.

Ri'i is applied from the time the series of rituals for enforcing the prohibition begins until the period for which the prohibition on taking bamboo is completed. When the appointed time has arrived, there will be another ritual to stop the *ri'i.* "The implementation of the *ri'i* is according to needs. In the ritual of installing the *ri'i,* the customary leader will state how long the prohibition is in effect. For example, four years. When four years have passed, the ritual of stopping the *ri'i* will be done," added P3.

The ancestors of the Ngadha people possessed unique knowledge about bamboo harvesting, particularly for the **bheto** variety. This study found that **bheto** is harvested with consideration of three main factors, which are age, cutting technique, and timing.

The age of **bheto** is determined to ensure that only four-year-old bamboo is harvested. The Ngadha believe that a four-year-old *bheto* represents the "great-grandparent" (*buyut*) in the bamboo clump's family structure. "Bamboo is like a family. A new generation grows every year. The oldest is the great-grandparent, then the grandmother, mother, child, and baby. Each generation nourishes the one below it," explained Informant P6.

According to P6, the knowledge of identifying the age of **bheto** was passed down from his parents. He was taught that the **bheto buyut** grows in the centre of the clump. "The **bheto buyut** is always in the middle. It can be cut because it is old, contains little water, and will not harm the younger bamboos," he added.

Because the **bheto buyut** grows in the centre surrounded by younger bamboos, it is difficult to cut down. The Ngadha use a chiselling technique to overcome this challenge. The cutting point is selected about 10-15 centimetres above the rhizome. Informant P7 stated, "We never sacrifice other bamboo stems just to reach the **bheto buyut** in the middle. Our elders used chisels. The middle stem is chiselled from the outside and pulled out of the clump. It requires four people to do this," explained P7.

The age of the bamboo can also be identified by the ring-like fungal spots on its culm. One layer of these spots is believed to appear after the bamboo is one year old, with additional layers forming annually after each rainy season. "Bamboo between zero and one year old has no spots because the stem has just detached from the shoot sheath. Between one and two years old, a single layer of spots appears, and so on," said P10.

Another method is by listening to the sound produced when the bamboo is struck. If it produces a high and resonant tone, the Ngadha believe it is old bamboo with reduced moisture content. "Old bamboo usually sounds high-pitched when struck, probably because it has less water," explained P10.

In terms of timing, the Ngadha prefer to harvest bamboo during the dark moon phase, when the moon is not full, usually between the sixth and eighth day after the full moon. According to P3, bamboo harvested during the dark moon phase is lighter, contains less water, and lasts longer when used. "If we harvest during the dark moon, the bamboo feels lighter to carry, dries quickly, and can be used right away. It also lasts longer because termites won't eat it," said P3.

Current challenges from modern materials and values

The traditional use of bamboo in Ngadha is gradually being abandoned. Most bamboo-based tools have now been replaced by those made of plastic and metal. Modern, non-bamboo tools are easier to find, cheaper, and more durable. Informant P8 stated, "Nowadays, almost all of my kitchen utensils are no longer made of bamboo. Spoons, rice steamers, baskets, and containers for chilli, salt, and spices are all made of aluminium or plastic. I buy my kitchenware at Mataloko market. It's cheap and long-lasting," she said.

A similar shift is occurring in the materials used for housing. The use of bamboo in home construction has declined significantly, with concrete now preferred for its durability, cost-effectiveness, and modern appearance. Informant P9 explained that he replaced his *naja* (bamboo wall) with brick, *tubo* (bamboo poles) with reinforced concrete, and *lenga* (bamboo roof) with corrugated metal sheets to make his house more durable and up-to-date. "Bamboo houses need

frequent renovation. The kitchen bamboo must be replaced every three years, and other parts every four to five years. But concrete houses with metal roofs can last more than fifteen years before needing renovation," said P9.

The substitution of bamboo with modern materials such as plastic, concrete, and metal has gradually transformed the socio-cultural values of the Ngadha people. The traditional practice of *gotong royong* (mutual cooperation), which once served as a form of social capital in house construction, is disappearing. Building a concrete house now relies entirely on money, from purchasing materials to paying labourers. "There's no *gotong royong* in concrete house construction. Everything must be paid for. With 300 million rupiah, you can have a concrete house built instantly. But with bamboo houses, it's a communal process, from rituals, cutting bamboo, building together, to the *ka sao* ceremony. It carries cultural meaning," explained P1.

In agriculture, modernisation has replaced traditional tools with mechanised ones such as hand tractors. Hunting culture has vanished, replaced by livestock farming, with pig pens now built from concrete. "My pigsty is now made of cement because it's stronger and lasts longer. It saves me both time and effort," said P9.

Moreover, modern technology has transformed the way the Ngadha people experience music and entertainment. Today, especially among the younger generation, mobile games have replaced traditional bamboo-based games and music. P8 recalled, "I used to play *sagu alu* with my friends, sometimes from noon until dark. But now, *sagu alu* is rarely played, only during government ceremonies, not because people really want to play it," she reminisced.

The fate of *sagu alu* and other bamboo-based games is similar to that of the bamboo musical instrument *foy doa*. People now prefer listening to music through various platforms, including radio, television, and online services like YouTube. "Maybe I'm the only one left in this village who can play *foy doa*. I never hear its sound anymore. Even in schools, only a few teachers know how to play it," explained P3.

Discussion

Traditional use of bamboo

The selection of the four bamboo species in Ngadha culture is supported by systematic differences in their structural and mechanical properties. *Dendrocalamus asper* and *Bambusa vulgaris* exhibit excellent compressive and tensile strength, indicating their broad utility as load-bearing materials (Awaluddin *et al*. 2017), while *D. asper* is further distinguished by its large culm diameter and thicker walls relative to *B. vulgaris* (Adam & Jusoh 2019). *Gigantochloa atter* has a relatively thinner culm wall and lighter anatomical structure than *D. asper*, making it suitable for light construction, handicrafts, and composite materials (Putri *et al*. 2023). In contrast, *Schizostachyum* species are small-diameter bamboos with high tensile strength, indicating superior fibre stiffness despite their relatively low fibre length and thin culm walls (Augustina *et al*. 2025). The technique of utilising bamboo according to its intended function based on the material's characteristics can also be found in communities in Southeast and South Asia (Ayer *et al*. 2023, Sharma *et al*. 2021).

This study found that tools for hunting, farming, and animal husbandry are the most common bamboo-based items, followed by household tools, art, and entertainment objects. The diversity of bamboo tools demonstrates that traditional societies possess strong survival capabilities supported by traditional knowledge, Similar findings were observed in the mountain societies of Yunnan Province, China, which have maintained their traditional knowledge of bamboo for survival and regional development (Yuming *et al.* 2004). However, ethnomedicinal studies in Ngadha have not discussed bamboo use (Sada & Jumari 2018), unlike research in Nepal that documented bamboo-based ethnomedicine for treating snake and scorpion bites (KC *et al.* 2024) and in the Thai ethnic group that uses bamboo as medicine for treating dissolve phlegm, diarrhoea, expel wind, urinate, menstruate, and cure endometritis, treating liver and spleen diseases, diabetes, high blood pressure, gout, paresis, trigger finger, and gallstones (Sudchaleaw *et al.* 2023).

Despite the variety of bamboo tools, bamboo houses remain the most crucial survival strategy for the Ngadha people. While the variation of bamboo use in house construction is fewer than in livelihood or entertainment, the Ngadha consistently use bamboo in large quantities to build dwellings, traditional houses, *kampung-nua*, and *loka* (Curnow 2016). Garcia-Saenz (2012) found that the dominance of bamboo in construction has long been observed among Indigenous peoples across Asia, Africa, and the Americas. This is supported by archaeological discoveries of bamboo-and-clay wall remnants in Valdivia, Ecuador, dating back between 7,550 and 5,500 years ago (Garcia-Saenz 2012). Detailed histories of bamboo as a construction material have also been documented in China and Japan (Erkol 2021).

Tracing back the ancestors of Ngadha

This research reveals that the Ngadha people are descendants of migrants. In addition to the narrative in the *Su'i Uwi* chant, all key informants acknowledged that their ancestors came from outside Flores. Ethnographic studies by Arndt (1958) described that the Ngadha ancestors originated from South Asia, carrying elements of megalithic Hindu culture from northeastern India. Recent genetic research also suggests that populations across the Indonesian archipelago, including Flores, are descendants of mixed African ancestors who migrated in multiple waves over tens of thousands of years (Sudoyo *et al.* 2017). Therefore, Indonesia, particularly in the eastern region, is characterised by multi-layered migration rather than a single migration route (Oliveira *et al.* 2022).

Crucially, this study offers a material perspective on this history of migration. The deep bond between the Ngadha and bamboo likely began when these early settlers encountered and adapted to the pre-existing bamboo ecology of Flores. This process of incorporating a new environmental resource into their culture exemplifies how traditional ecological knowledge (TEK) systems emerge from direct, long-term interaction with the landscape (Berkes 2018). This TEK produces a cultural archive that stores ancestral memories and the meaning of space (Pretty *et al.* 2009, Joseph 2021). Local belief holds that bamboo existed before their ancestors settled, a notion consistent with the *Su'i Uwi* narrative and supported by the documented endemism of 18 bamboo species in Flores (Widjaja 2023). This study thus highlights bamboo as a material anchor point for migrant identity and adaptation, a theme also observed in other bamboo-dependent cultures (Levaggi & Ibarra 2025). The deep bond between the Ngadha and bamboo likely began when the early settlers developed survival knowledge based on this plant. Berkes *et al.* (1994) argue that human knowledge systems emerge from the challenges they face within their environment.

This pattern of deep bamboo integration is not unique to Ngadha but reflects a broader biocultural phenomenon across the Indonesian archipelago. Similar narratives appear in ethnobotanical studies on bamboo among other Indigenous communities in Indonesia, such as in Aceh (Ritonga *et al.* 2023), Bali (Sujarwo 2018), West Java (Ihsan *et al.* 2023, Ihsan *et al.* 2024, Irawan *et al.* 2019), Kalimantan (Dewi *et al.* 2016), Sulawesi (Ervianti *et al.* 2019), and Papua (Damayanto *et al.* 2016). This confirms bamboo's role as a widespread biocultural keystone resource, with specific knowledge and uses adapted to diverse local ecological and social contexts (Bystriakova *et al.* 2003). The Ngadha case provides a detailed lens into this universal process of human-plant co-evolution following migration.

Knowledge on sustainable bamboo management

The Ngadha practice traditional vegetative propagation of bamboo using shoots, transferring them to planting sites within three hours to maintain moisture, and performing planting at the onset of the rainy season. Similar vegetative propagation techniques are used by Indigenous communities in Northeast India and West Java through the "offset method," in which 1-2-year-old culms are cut 1.5 to 2 meters above the ground and replanted with rhizomes during the rainy season (Irawan *et al.* 2019, Nath *et al.* 2009).

Bamboo planted vegetatively grows into a new individual and develops into a new clump. This study found that existing clumps are protected under the customary law *of ri'i or waja*, which forbids harvesting for a period of four years. The four-year cycle ensures that one clump has four generations, allowing the oldest generation to be harvested while younger ones mature. This practice embodies the intergenerational stewardship inherent in TEK, ensuring resource availability for future generations through culturally encoded governance systems (Tengö *et al.* 2014). The practice of such TEK resembles *Sasi* in Ambon, Maluku, which suspends harvesting to allow nature to recover (Mantjoro 1996, Saptenno & Timisela 2024).

Harvesting techniques among the Ngadha include identifying mature bamboo by its central position in the clump, the presence of fungal rings on the culm, and the sound produced when struck, ensuring the bamboo is at least four years old. Sutiyono (2013) cited in Irawan *et al.* (2019), notes that bamboo is generally ready for its first harvest at five years old, during the third generation, and should be harvested in the dry season for better stem quality. The Ngadha, however, select cutting points 10-15 cm above the rhizome, which is more precise than the 30 cm height recommended by Achmed (1957) as cited in Irawan *et al.* (2019), to avoid damaging young shoots and roots.

Modern materials: competitor or complement?

Although the Ngadha possess rich bamboo knowledge, this study found that bamboo use has significantly declined due to the rise of modern manufacturing industries producing plastic and aluminium tools. These factory-made tools are cheaper, more durable, and widely available. Between 2021 and 2025, the number of shops and kiosks in Ngadha doubled, even as traditional markets remained constant (BPS 2025). The shift extends to construction, with many homes now using concrete

walls and aluminium roofs. In Golewa Subdistrict, bamboo-walled houses fell from 1,903 in 2015 to 1,165 in 2020, while aluminium roofs rose from 3,112 to 3,482 (BPS 2015, 2020). This shift and its complex dynamics are extensively documented in the local context of Ngadha, where the transition from traditional to industrial bamboo use involves specific drivers and barriers (Ekawati et al. 2022). Furthermore, this transition is part of a broader global trend wherein industrial supply chains displace locally adapted, renewable material cultures, severing the connection between community practices and their ecological base (Bryant & Goodman 2004).

However, the consequences of this material substitution extend far beyond mere utility or economics. They strike at the core of the community's social and cultural fabric. This material transition has not only reduced bamboo's popularity but also weakened social capital and diminished *gotong royong* (collective labour) traditions in house building (Prasetyo *et al*. 2020). The loss of *gotong royong* signifies the erosion of a key form of social capital that was intrinsically linked to the material practice of bamboo construction (Pretty & Ward 2001). This erosion disrupts not only practical knowledge but also the collective memory, identity, and social structures that were sustained through shared material practices (Levaggi & Ibarra 2025). Digital technology has further altered social interaction patterns, with leisure increasingly spent online rather than in communal play or music-making (Bargh & McKenna 2004, Chan & Fang 2007). As a result, the sacred and artistic value of bamboo is fading, with its presence surviving mainly in ceremonial contexts.

Conclusion

The ethnobotany of bamboo in Ngadha offers a new perspective on the origins of the Ngadha people and their enduring relationship with bamboo. While the Ngadha are migrants who believe bamboo predated their arrival, they have developed extensive knowledge of bamboo through historical interactions with their environment. Bamboo has supported their survival as a primary material for housing, hunting, farming, food preparation, and entertainment. Beyond its utilitarian uses, the Ngadha have developed sustainable management practices, including vegetative propagation, customary protection laws (*ri'i* and *waja*), and selective harvesting, which ensure long-term regeneration. Additionally, bamboo serves as a form of social capital, a manifestation of local intelligence, and a medium for art, entertainment, and social critique. However, modernisation has gradually shifted material preferences toward concrete, plastic, and metal. Consequently, traditional bamboo knowledge, social cohesion, and artistic expressions are fading, replaced by individualism, market orientation, and mass-produced technologies.

Declarations

List of abbreviations: BPS: Badan Pusat Statistik, EBF: Environmental Bamboo Foundation, TEK: Traditional Ecological Knowledge.

Ethics approval and consent to participate: This research was conducted (2018-2021) prior to the establishment of BRIN's national ethical approval system. Ethical approval was obtained through the internal review mechanisms of the Research, Development, and Innovation Agency (BLI-KLHK), aligned with international standards, including the Declaration of Helsinki. No approval number was issued as BLI-KLHK did not maintain a permit numbering system, but approval was documented in project reports. All participants provided written or verbal informed consent, depending on cultural appropriateness. Community elders and ritual authorities granted approval to document traditional knowledge. Consent was recorded in fieldnotes; no standardised forms were used.

Consent for publication: Not applicable.

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Literature cited

Arndt P. 1958. Hinduismus der Ngadha. Folklore Studies. 17, Pp.99-136. doi: 10.2307/1177379

Adam N, Jusoh I. 2019. Physical and mechanical properties of *Dendrocalamus asper* and Bambusa vulgaris. Transactions on Science and Technology 6(1-2): 95-101.

Arndt P. 2007. Agama Orang Ngadha: Kultus, Pesta dan Persembahan. in: Nama PS (trans.), Embu EJ, Ghono Y (eds) Vol. 2. Die Religion der Nad'a (West Flores, Kleine Sunda-Inseln)] Pusat Penelitian Agama dan Kebudayaan Candraditya, Flores. Indonesia.

Augustina S, Anggraini R, Charisma FS, Ridho MR, Kemala P, Lee SH, Fatriasari W. 2025. Comparative analysis of fiber characteristics and chemical, physical, and mechanical properties of six indigenous bamboo species from Indonesia. BioResources 20(4). doi: 10.15376/biores.20.4.8493-8514

Awalluddin D, Ariffin MAM, Osman MH, Hussin MW, Ismail MA, Lee HS, Lim NHAS. 2017. Mechanical properties of different bamboo species. MATEC web of conferences138:01024. EDP Sciences.

Ayer S, Timilsina S, Aryal A, Acharya AK, Neupane A, Bhatta KP. 2023. Bamboo forests in Nepal: Status, distribution, research trends and contribution to local livelihoods. Advances in Bamboo Science 4:100027. doi: 10.1016/j.bamboo.2023.100027

Bargh JA, McKenna KY. 2004. The Internet and social life. Annual Review. Psychology 55(1):573-590. doi: 10.1146/annurev.psych.55.090902.141922

Benessaiah N. 2014. An Interview with Roy Ellen. Ethnobiology Letters 5:31-39. https://www.jstor.org/stable/26423579

Berke F, Folke C, Gadgil M. 1994. Traditional ecological knowledge, biodiversity, resilience and sustainability. In Perrings CA, Mäler KG, Folke C, Holling CS, Jansson BO. (eds). Biodiversity conservation. Ecology, Economy & Environment, vol 4. Springer, Dordrecht. Papers from the biodiversity programme beijer international Institute of ecological economics royal Swedish academy of sciences 269-287. doi: 10.1007/978-94-011-1006-8_15

Berkes, F. 2017. Sacred Ecology (4th ed.), Routledge, New York. doi: 10.4324/9781315114644

Bhagawan W S, Suproborini A, Putri DLP, Nurfatma A, Putra RT. 2022. Ethnomedicinal study, phytochemical characterization, and pharmacological confirmation of selected medicinal plant on the northern slope of Mount Wilis, East Java, Indonesia. Biodiversitas: Journal of Biological Diversity 23(8):4303-4313. doi: 10.13057/biodiv/d230855

Bhoki M, Sulaiman H, Wasa DR. 2024. Nilai pendidikan karakter Su'i Uwi dalam Ritual Adat Reba pada masyarakat Desa Wogo, Kecamatan Golewa, Kabupaten Ngada. Sajaratun: Jurnal Sejarah dan Pembelajaran Sejarah 9(2):190-202.

BPS. 2015. Kecamatan Golewa Dalam Angka 2015. BPS Kabupaten Ngada. Indonesia.

BPS. 2020. Kecamatan Golewa Dalam Angka 2020. BPS Kabupaten Ngada. Indonesia.

BPS. 2024. Kabupaten Ngada dalam angka 2024. BPS Kabupaten Ngada. Indonesia.

BPS. 2024a. Kecamatan Golewa dalam angka 2024. BPS Kabupaten Ngada. Indonesia.

BPS. 2025. Kabupaten Ngada dalam angka 2024. BPS Kabupaten Ngada. Indonesia.

Brewer J. 2000. Ethnography. Open University Press. Buckingham, U.K.

Britton TL. 2024. Bamboo for people and rimates: An ethnography of 'Convivial Connections' between conservation, development and identity on the Ecuadorian coast. PhD dissertation, The University of Western Ontario. https://ir.lib.uwo.ca/etd/10363

Bryant R, Goodman M. 2004. Consuming narratives: the political ecology 'alternative' consumption. Institute of British Geographers, Transactions 29(3):344-366. doi: 10.1111/j.0020-2754.2004.00333.x

Bystriakova N, Kapos V, Stapleton C, Lysenko I. 2003. Bamboo Biodiversity. UNEP-WCMC/INBAR.

Chan K, Fang W. 2007. Use of the internet and traditional media among young people. Young Consumers 8(4):244-256. doi: 10.1108/17473610710838608

Cotton CM. 1996. Ethnobotany: principles and applications. John Wiley & Sons, Chichester, U.K.

Creswell JW. 2002. Educational research: Planning, conducting, and evaluating quantitative. Prentice Hall Upper Saddle River, New Jersey.

Curnow J. 2016. Ngadha being-in-common: Emotional attachment to people and place in Flores, Indonesia. In Hemer SR, Dundon A. (eds). Emotions, Senses, Spaces: Ethnographic Engagements and Intersections. The University of Adelaide, Adelaide, South Australia 159-174. doi: http://dx.doi.org/10.20851/emotions

Damayanti R, Jasni, Sulastiningsih IM, Djarwanto, Suprapti S, Pari G, Basri E, Komarayati S, Abdurahman. 2019. Atlas Bambu Indonesia 1, PT Penerbit IPB Press, Bogor, Indonesia.

Damayanto IPGP, Mambrasar YM, Hutabarat P. 2016. Bamboos (Poaceae: Bambusoideae) of Papua, Indonesia. Jurnal Biologi Papua 8(2):57-61. doi: 10.31957/jbp.52

Dewi AP, Ariyanti NS, Walujo EB. 2016. Diversity of plants used for plaited crafts by Dayak Iban-Desa in Kabupaten Sintang Kalimantan Barat. Reinwardtia 15(2):67-79.

Ekawati D, Karlinasari L, Soekmadi R. 2022. Drivers, barriers, and strategies in the community-based supply of bamboo for industrial-scale bamboo utilisation in Ngada regency, East Nusa Tenggara, Indonesia. Sustainability 14(10):5970. doi: 10.3390/su14105970

Erkol YA. 2021. Bamboo: A socio-material approach to past and present bamboo cultures. PhD dissertation, Technische Universitaet Berlin.

Ervianti D, Widjaja EA, Sedayu A. 2019. Bamboo diversity of Sulawesi, Indonesia. Biodiversitas Journal of Biological Diversity 20(1),:91-109. doi: 10.13057/biodiv/d200112

Fernandez IY. 2007. Inventarisasi bahasa-bahasa daerah di Propinsi Nusa Tenggara Timur. Humaniora, 19:3.

Garcia-Saenz M. 2012. Social and cultural aspects of constructions with bamboo. Tenth LACCEI Latin American and Caribbean Conference (LACCEI'2012). Panama City, Panama.

Gupta A, Kumar A. 2008. Potential of Bamboo in Sustainable Development. Asia Pacific Business Review 4(3):100-107. Doi: 10.1177/097324700800400312

Her VK, Buley-Meissner ML. 2010. Hmong voices and memories: An exploration of identity, culture, and history through Bamboo among the Oaks: Contemporary writing by Hmong Americans. Journal of Asian American Studies 13(1): 35-58. doi: 10.1353/jaas.0.0070

Ihsan M, Irawan B, Iskandar BS, Iskandar J. 2023. Ethnobotanical study on using bamboo for kites making in Sumedang District, West Java, Indonesia. Biodiversitas Journal of Biological Diversity 24(4). doi: 10.13057/biodiv/d240454

Ihsan M, Irawan B, Iskandar J. 2024. The traditional ecological knowledge of the local people of Cijambu Village, Sumedang, Indonesia, on the diversity, utilization, management, and conservation of bamboo. Biodiversitas Journal of Biological Diversity 25(4). doi: 10.13057/biodiv/d250446

Irawan B, Partasasmita R, Rahayu N, Setiawati T, Iskandar J. 2019. Indigenous knowledge of bamboos by Naga community, Tasikmalaya District, West Java, Indonesia. Biodiversitas Journal of Biological Diversity 20(5). doi: 10.13057/biodiv/d200535

Joseph L. 2021. Walking on our lands again: Turning to culturally important plants and Indigenous conceptualisations of health in a time of cultural and political resurgence. International Journal of Indigenous Health 16(1): 165-179. doi: 10.32799/ijih.v16i1.33205

KC BM, Lamichhane J, Khanal SN, Gauchan DP. 2024. Traditional utilization of bamboo in the Central Siwalik region, Nepal. Plos one 19(1). doi: 10.1371/journal.pone.0296886

Kindu M, Mulatu Y. 2010. Status of bamboo resource development, utilization, and research in Ethiopia: A review. Ethiopian Journal of Natural Resources 1: 79-98.

Lestariningsih N, Jalil M, Ayatusa A, Nirmalasari R. 2023. Ethnomedicine exploration of medicinal plants in Dayak Bakumpai and Ngaju Tribes, Central Kalimantan, Indonesia. Biodiversitas: Journal of Biological Diversity 24(2). doi: 10.13057/biodiv/d240257

Levaggi AJ, Ibarra JT. 2025. Nurturing forest memory: native bamboo as an assemblage of biocultural keystone species in the southern Andes. Ecology and Society 30(3). doi: 10.5751/ES-16332-300327

Luo B, Ahmed S, Long C. 2020. Bamboos for weaving and relevant traditional knowledge in Sansui, Southwest China. Journal of Ethnobiology and Ethnomedicine 16(63). doi: 10.1186/s13002-020-00418-9

Machua J, Kimani P, Karani S, Oduor N, Njuguna J, Musya M, Ondieki T, Barathi N, Bekele Biliso W, Reza S, Qinghui L, Jayaraman D. 2024. INBAR Working Paper Technical Manual on Tissue Culture Protocol for Bamboo. www.inbar.int.

Mantjoro E. 1996. Traditional management of communal-property resources: The practice of the Sasi system. Ocean & Coastal Managemen. 32(1): 17-37. doi: 10.1016/S0964-5691(96)00013-0

Martin GJ. 2010. Ethnobotany: a methods manual. Routledge, London, U.K. doi: 10.4324/9781849775854

Nath A, Das G, Das A. 2009. Traditional knowledge base in the management of village bamboos: A case study in Barak Valley, Assam, Northeast India. Indian Journal of Traditional Knowledge 8(2):163-168.

Ningrat IKJ, Melani NKLS, Brahmantya IBY, Santosa IGNPE. 2025. Transformation of ethnomedicine across generations: Bridging tradition and modernity. Journal of Ethnomedicine and Medical Wellness 1(1): 18-21.

Nirala DP, Ambasta N, Kumari P. 2017. A review on uses of bamboo including ethno-botanical importance. International Journal of Pure & Applied Bioscience 5(5):515-523. doi: 10.18782/2320-7051.5398

Nono F, Dopo F , Dopo, FB. 2024. Struktur dan bentuk penyajian musik Go Laba dalam ritual pembuatan rumah adat di Guru Sina. Jurnal Citra Pendidikan 4(3):1869-1879. doi: 10.38048/jcp.v4i3.458

Noywuli JAW, Leo FRR, Pala MAET. 2025. Konsep kosmoteologis dalam Ritus Reba pada masyarakat Ngada. Apostalicum: Jurnal Pendidikan Keagamaan Katolik Ledalero 1(1):77-102.

Nugraha AS, Keller PA. 2011. Revealing indigenous Indonesian traditional medicine: anti-infective agents. Natural Product Communications 6(12). doi: 10.1177/1934578X110060124

Oliveira S, Nägele K, Carlhoff S, Pugach I, Koesbardiati T, Hübner A, Meyer M, Oktaviana AA, Takenaka M, Katagiri C, Murti DB, Putri RS, Mahirta, Petchey F, Higham T, Higham CFW, O'Connor S, Hawkins S, Kinaston R, Bellwood P, Ono R, Powell A, Krause J, Posth C , Stoneking M.2022. Ancient genomes from the last three millennia support multiple human dispersals into Wallace. Nature Ecology and Evolution 6. doi: 10.1038/s41559-022-01775-2

Prasetyo B, Ekawati D, Handoyo, Djaenudin D, Indartik, Suryandari E, Sari G. 2021. The social construction of gender relation reality: an analysis of time management applied on sustainable bamboo forestry among families in Ngadha, East Nusa Tenggara, Indonesia. IOP Conference Series: Earth and Environmental Science doi: 10.1088/1755-1315/917/1/012016

Prasetyo B, Ekawati D, Djaenudin D, Suryandari E, Indartik, Handoyo, Sari G, Pamungkas D. 2020. Knowledge transfer on sustainable bamboo forest management through social capital approach in Ngada Regency, Indonesia. IOP Conference Series: Materials Science and Engineering. doi: 10.1088/1757-899X/935/1/012073

Pretty J, Adams B, Berkes F, de Athayde SF, Dudley N, Hunn E, Maffi L, Milton K, Rapport D. 2009. The Intersections of biological diversity and cultural diversity: Towards integration. Conservation and Society 7(20):100-112.Pretty J, Ward

H. 2001. Social capital and the environment. World Development, 29:2, Pp. 209-227. doi: 10.1016/S0305-750X(00)00098-X

Putri AR, Alam N, Adzkia U, Amin Y, Darmawan IW, Karlinasari L. 2023. Physical and mechanical properties of oriented flattened bamboo boards from Ater (*Gigantochloa atter*) and Betung (*Dendrocalamus asper*) bamboos. Jurnal Sylva Lestari 11(1):1-21. doi: 10.23960/jsl.v11i1.614

Raharja S, Yuwana, RY. 2023. Historical relations of Flores language kinship: A comparative historical linguistic study of nine languages in Flores. Acceleration: Multidisciplinary Research 1(1):16-23.

Raihandhany R. 2022. A review on ethnobotanical aspects of *Artocarpus altilis* (Park.) Fosberg (Syn: *Artocarpus communis* JR Forst. & G. Forst.)(Breadfruit) in Indonesia. Genbinesia Journal of Biology 1(3):107-119. doi: 10.55655/genbinesia.v1i3.19

Reeves S, Kuper A, Hodges BD. 2008. Qualitative research methodologies: ethnography. Bmj 337. doi: 10.1136/bmj.a1020

Ritonga MA, Syamsuardi N, Nurainas N, Damayanto I. 2023. Ethnobotany of bamboo on Weh Island, Aceh, Indonesia. Ethnobotany Research and Applications, 26(75): 1-19. doi: 10.32859/era.26.75.1-19

Ryan JC. 2011. Cultural botany: toward a model of transdisciplinary, embodied, and poetic research into plants. Nature and Culture 6(2):123-148. doi: 10.3167/nc.2011.060202

Sada M, Jumari J. 2018. Ethnobotany of the plant in ceremonies of Ngadha ethnic Jerebu'u Sub District, Ngada District, Nusa Tenggara Timur Province. Jurnal Saintek Lahan Kering 1(2):19-21.

Saptenno MJ, Timisela NR. 2024. Assessing the role of local Sasi practices in environmental conservation and community economic empowerment in Maluku, Indonesia. International Journal of Sustainable Development and Planning 19(4). doi: 10.18280/ijsdp.190418

Sharma B, Eley D, Emanuel O, Brentnall C. 2021. Mechanical properties of laminated bamboo designed for curvature. Construction and Building Materials 300:123937. doi: 10.1016/j.conbuildmat.2021.123937

Sianipar EA. 2021. The potential of Indonesian traditional herbal medicine as immunomodulatory agents: a review. International Journal of Pharmaceutical Sciences and Research 12(10). doi: 10.13040/IJPSR.0975-8232.12(10).5229-37

Smedal OH. 2000. Sociality on display: The aesthetics of Ngadha Houses. RES: Anthropology and Aesthetics 37(1): 106-126.

Smedal OH. 2002. Ngadha relationship terms in context: Description, analysis, and implications. Asian Journal of Social Science 30(3):493-524. https://www.jstor.org/stable/23654604

Sudirgayasa IG, Sulistijono S, Mahanal S, Gofur A, Surata IK, Sudiana IM, Maduriana IM. 2025. A bibliometric analysis of research gaps on ritual plants within ethnobotanical studies in Indonesia. Asian Journal of Ethnobiology 8(2).

Sudchaleaw S, Saensouk S, Saensouk P, Sungkaew S. 2023. Species diversity and traditional utilization of bamboos (Poaceae) on the Phu Thai Ethnic Group in northeastern Thailand. Biodiversitas, 24:4, Pp 2261-2271. doi: 10.13057/biodiv/d240439

Sudoyo H, Sabarini P, Nurhasim A. 2017. Dari mana manusia Indonesia berasal? The Conversation Indonesia. Retrieved 17 October from https://theconversation.com/dari-mana-manusia-indonesia-berasal-72803 (Accessed 20/01/2026).

Sugi FAR, Pellondo'u ME, Kaho NPR. 2024. Analysis of the Suitable of Betung Bamboo Habitat (*Dendrocalamus asper*) with a Geographic Information System approach and maxent: Case study of Golewa District and Soa District, Ngada Regency. Journal of Scientech Research and Development. 6(1): 513-528. doi: 10.56670/jsrd.v6i1.288

Sujarwo W. 2018. Bamboo resources, cultural values, and ex-situ conservation in Bali, Indonesia. Reinwardtia 17(1):65-75. doi: 10.14203/reinwardtia.v17i1.3569%20

Tengö M, Brondizio ES, Elmqvist T, Malmer P, Spierenburg M. 2014. Connecting Diverse Knowledge Systems for Enhanced Ecosystem Governance: The Multiple Evidence Base Approach. Ambio 43: 579-591. doi: 10.1007/s13280-014-0501-3

Vandebroek I, Albuquerque UP. 2024. Ethnobotany for the future-theory, methods, and social engagement (Part 2). Economic Botany 78(2): 105-108. doi: 10.1007/s12231-024-09601-5

Virtanen PK, Apurinã F, Ruokolainen K, Manchineri L. 2022. The role of Guadua bamboo in land management and Indigenous perspectives on Bamboo ecosystems in Southwestern Amazonia. Human Ecology 50(6): 1077-1088. doi: 10.1007/s10745-022-00376-8

Walujo EB. 2008. Research ethnobotany in Indonesia and the future perspectives. Biodiversitas Journal of Biological Diversity 9(1). doi: 10.13057/biodiv/d090114

Widjaja EA. 2023. *Fimbribambusa jokowii* Widjaja (*Poaceae: Bambusoideae*), a new scrambling bamboo from Flores, Indonesia. Advances in Bamboo Science 4:100033. doi: 10.1016/j.bamboo.2023.100033

Windiani W, Rahmawati FN. 2016. Menggunakan metode etnografi dalam penelitian sosial. Dimensi-Journal of Sociology 9(2). doi: 10.21107/djs.v9i2.3747

Yani A, Widaningsih L. 2015. Local wisdom of traditional house in earthquake risk mitigation (Comparison of traditional house in Kampung Naga, West Java and Minka Gassho-Zukuri architecture in Shirakawa Village, Gifu Perfecture, Japan). Proceedings of the 2015 International Conference on Innovation in Engineering and Vocational Education. doi: 10.2991/icieve-15.2016.4

Yuming Y, Kanglin W, Shengji P, Jiming H. 2004. Bamboo diversity and traditional uses in Yunnan, China. Mountain Research and Development. 24(2): 157-165. doi: 10.1659/0276-4741(2004)024[0157:BDATUI]2.0.CO;2