

Ethnobotanical study on using bamboo for kites making in Sumedang District, West Java, Indonesia

MUHAMMAD IHSAN¹, BUDI IRAWAN², BUDIAWATI SUPANGKAT ISKANDAR³, JOHAN ISKANDAR⁴*

¹Graduate program of Department of Biology, Faculty of Mathematics and Natural Sciences, Universitas Padjadjaran. Jl. Raya Bandung-Sumedang Km 21, Sumedang 45363, West Java, Indonesia

²Department of Biology, Faculty of Mathematics and Natural Sciences, Universitas Padjadjaran. Jl. Raya Bandung-Sumedang Km 21, Sumedang 45363, West Java, Indonesia

³Department of Anthropology, Faculty of Social and Political Sciences, Universitas Padjadjaran. Jl. Raya Bandung-Sumedang Km 21, Sumedang 45363, West Java, Indonesia

⁴Department of Biology, Faculty of Mathematics and Natural Sciences and Center for Environment and Sustainability Science (CESS), Universitas Padjadjaran. Jl. Sekeloa Selatan 1, Bandung 40132, West Java, Indonesia. Tel./fax.: +62-22-7797712 *email: johan.iskandar@unpad.ac.id

Manuscript received: 28 March 2023. Revision accepted: 28 April 2023.

Abstract. *Ihsan M, Irawan B, Iskandar BS, Iskandar J. 2023. Ethnobotanical study on using bamboo for kites making in Sumedang District, West Java, Indonesia. Biodiversitas 24: 2393-2401.* Bamboo has diverse socio-economic, cultural, and ecological roles in rural areas. Residents in Cijambu Village, Tajungsari District, Sumedang Regency, West Java, usually use bamboo for kite crafts based on local or Traditional Ecological Knowledge (TEK). However, currently, the craft activities of the residents of Cijambu Village in making kites tend to decline. This is due to the reduced kite demand, and the younger generation is less interested in kite-making crafts. As a result, it is difficult for the kite-making industry in Cijambu Village to provide jobs and creates an opportunity for the villagers to maintain its sustainability. In addition, the decline in the kite-making industry could cause the gradual erosion and subsequent loss of the TEK. Therefore, this study aims to elucidate the TEK of Cijambu Village on bamboo species and landraces, the utilization of bamboo for the kite-making industry, and its benefits for rural communities. The method used in this study was qualitative with an ethnobotanical approach; there are 12 informants comprising seven men and five women between the ages of 35 and 70 years involved in this study. The result of the study showed that a total of 5 landraces and species of bamboo, i.e.: *awi tali* (*Gigantochloa apus* (Schult.f.) Kurz), *awi bitung* (*Dendrocalamus asper* (Schult.f.) Backer ex K. Heyne), *awi surat* or *awi gombong héjo* (*Gigantochloa verticillata* (Willd.) Munro), *awi temen* (*Gigantochloa atter* (Hassk.) Kurz), and *awi haur* or *haur konéng* (*Bambusa vulgaris* Schrad. ex J.C.Wendl. var. *striata* (Lodd.ex Lindl.) Gamble) in Cijambu Village. The *G. apus* have predominantly been used for making kites, creating many job opportunities for men and women, and diversifying household income. However, the future sustainability of the kite industry in Cijambu Village tends to be very challenging because the demand for kites is declining occasionally. At the same time, the younger generation is less interested in kites making, and the TEK gradually erodes within the younger generation. Thus, it was revealed that the use of bamboo for the kite craft industry had formed biocultural systems, as well as changes in the culture and linguistics of villagers, which can affect the management and conservation of bamboo in rural areas.

Keywords: Bamboo, Cijambu Village, ethnobotany, kites, local knowledge

INTRODUCTION

Bamboo is a plant of the *Poaceae* family that can adapt to various local conditions, from lowlands to highlands (Sujarwo 2018). Furthermore, it is widely distributed globally, spanning temperate, tropical, and subtropical climatic regions. Bamboo can also grow in various ecosystems, including mountain forests and river banks (Cédric et al. 2021). Besides occurring in natural ecosystems, such as forests, it is also commonly cultivated by rural people in various agroecosystems, including gardens, mixed gardens, or *talun* systems, such as in *dukuh lembur* in rural West Java and Banten (Irawan 2020; Iskandar et al. 2022).

Therefore, bamboo serves a multifunctional socio-economic, cultural, and ecological role in rural communities. From an ecological standpoint, it stores water in the ground, controls soil erosion and nutrient leaching, and fertilizes the soil through litter production. It also plays a vital role in sequestering CO₂, one of the greenhouse gases

contributing to global warming and climate change. Furthermore, bamboo is a habitat for wildlife, including insects, birds, and small mammal species (Nath et al. 2015; Noywuli et al. 2019; Terefe et al. 2019; Iskandar et al. 2022). Economically, it can be used for building and construction materials, handicrafts, fencing, household appliances, traditional medicine, food, fuel, and materials for making various traditional toys (Hani et al. 2018; Aswandi and Kholibrina 2021; Kuncari and Setiawan 2021; Siskawati and Sukenti 2021; Abebe et al. 2022; Iskandar et al. 2022). In terms of socio-cultural significance, bamboo also offers numerous benefits, such as being used as a material for traditional musical instruments, children's traditional toys, hunting tools for animals and fish, traditional rituals, and making proverbs (Yeny et al. 2016; Partasmita et al. 2017; Irawan et al. 2019; Iskandar et al. 2022).

Studies have been conducted on the ecology and use of bamboo based on the knowledge of the local village people, specifically in the rural areas of West Java and

Banten (Partasmita et al. 2017; Setiawati et al. 2017; Irawan et al. 2019; Iskandar et al. 2022). Notably, this plant has a rich cultural significance in the rural Sundanese community of Cijambu Village, where it has been widely used traditionally for the kite craft industry. Local people making kite handicrafts rely on TEK acquired through inheritance from generation to generation (Iskandar 2018). This knowledge is usually unwritten and transmitted orally using the mother tongue. Therefore, it is distinctively local, deep, and vulnerable to extinction. Several factors that cause the extinction of this TEK are: the lack of interest to accept and learn by the younger generation, the fading of the local language as the main medium for transmitting local knowledge, and changes in the livelihood system of rural communities, such as transitioning from farming to a non-farming system (Hidayati et al. 2017; Iskandar 2018).

Overall, the utilization of bamboo for the kite craft industry by rural people in Cijambu Village has been a source of employment and income for the residents. However, due to the increasing population density, the decreasing number of bamboo gardens converted to commercial vegetable monoculture, and the rapid development of the market economic system penetrating the rural areas, the making kites craft in Cijambu village has been less attractive to the younger generation. Consequently, the handicraft business of kites making has become less profitable for the communities. Moreover, the TEK of the villagers regarding using bamboo for the kite-making craft industry is also gradually eroded and may subsequently become extinct. Therefore, studying this precious knowledge of the community associated with various bamboo species is crucial. In addition, the kite craft industry based on the TEK is important to study.

Therefore, this study aimed to elucidate the TEK of Cijambu Village associated with various bamboo species and the landraces of bamboo, as well as its sustainable utilization for the kite-making craft industry and its benefits to the rural community.

MATERIALS AND METHODS

Study area

This study was conducted at Cijambu Village, Tanjungsari District, Sumedang Regency, West Java Province, Indonesia, from April to May 2022. Geographically, Cijambu Village is situated on Mount Manglayang, at coordinates 6°50'38.43"S; 107°47'34.67"E (Figure 1). In general, the vegetation of Mount Manglayang with vertical forest space is four strata of vegetation canopy and no emergent trees as found in lowland tropical rain forests. Forest vegetation with an altitude of more than 1,500 meters above sea level (masl) is lower in type compared to vertical space, which is more complex than forest vegetation at an altitude of 1,200-1,500 masl (Kusmoro et al. 2015).

Mount Manglayang has three vegetation types: pine forest, open land, and natural forest. Pine forests are generally found at different altitudes between 1,000 and 1,375 masl. Open land is generally the result of changes in the shape of the pine forest habitat and natural forest habitat (Putri et al. 2021; Trisnadiansyah et al. 2022). Bamboo forests are found on the rivers' banks and ravines, although some are found in the lowlands of Mount Manglayang. Bamboo grows naturally in the production forest area owned by PT Perhutani. People generally look for bamboo shoots in the bamboo forest on Mount Manglayang to be processed into food.

Topographically, mount Manglayang has undulating and hilly contours with an altitude of 700-1,700 masl and an average rainfall of 1,251 mm annually. The soil type in Mount Manglayang is latosol. The first layer is a layer of latosol soil containing sand, gravel, fine sediments, and loams. The second layer contains fine deposits, sandstone, gravel, sand, fine sand (silt), loam, and clay. These materials result from processes from the eruption of young volcanoes (Luth and Setiyono 2019; Nurashiah et al. 2019).

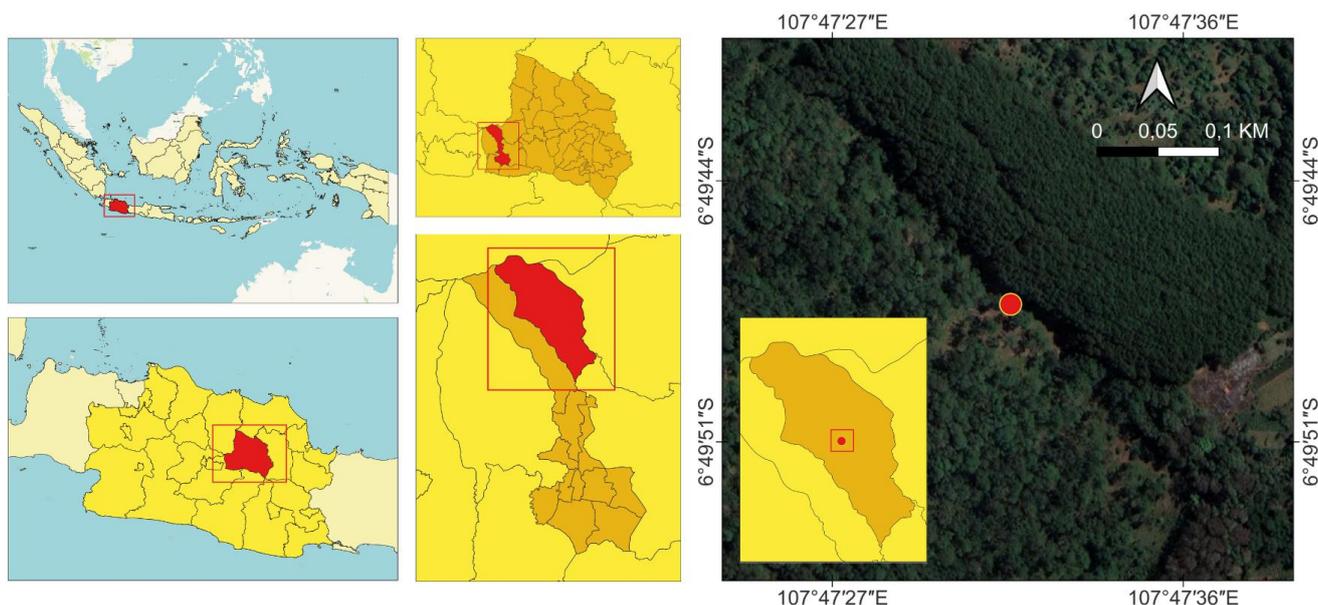


Figure 1. Location of the study site, Cijambu village, Tanjungsari sub-district, Sumedang district, West Java, Indonesia

According to the village data statistics, the population of Cijambu Village, as of 2021, was 4,485 individuals, consisting of 2,332 men and 2,153 women, representing 1,600 households. Although the village is predominantly rural, most residents are engaged in farming. The various cultivated food crops, such as rice, horticulture, and others. Those were grown in several agroecosystems, for example: home garden systems, vegetable gardens, mixed gardens, and wet paddy fields. They also reared livestock, including cows, sheep, and local chickens. Meanwhile, other livelihoods in the village are laborers, farm laborers, civil servants, and traders. In addition, the people of Cijambu Village are also engaged in various other businesses, such as kite-making crafts, small traditional food industries, trading businesses in small village stalls (*warung desa*), rice mills, grocery stores, and two-wheeled vehicle repair shops (Profile of Cijambu Village).

Procedures

This study used a qualitative method with an ethnobotanical approach (Albuquerque et al. 2014a, 2014b; Iskandar 2018). In addition, some field data collection techniques were employed, such as field observation, participatory observation, and semi-structured interviews. Field observations were conducted to investigate the overall study area, including the surrounding village, bamboo gardens, mixed gardens, and forests. The field observation documented various bamboo species that grow in bamboo gardens, mixed gardens, and forests. The observation and the participatory observation were conducted to understand the knowledge and experiences of kite-making crafts reserved in rural people. During the observation, the researcher carefully observed some of the informant's activities: harvesting bamboo in the bamboo and mixed gardens and making kites at their house. While participant observation, the researcher observed the informants harvesting bamboo and making kites and was also involved in some work with the informants and asked various important things that the researchers wanted to know about kite making. Accordingly, during the field study, the researcher visited several traditional practices performed by informants, such as harvesting bamboo, cutting bamboo, and making kite frames. Meanwhile, semi-structured or in-depth interviews were conducted with knowledgeable and more experienced informants after being selected purposively using the snowball sampling technique (Albuquerque et al. 2014). Consequently, local experts with the required knowledge and experience in kite-making were identified and selected during the first stage of the interview process. A total of 12 informants, seven men and five women between the ages of 35 and 70, were purposively sampled and interviewed by semi-structured interview. In semi-structured interviewing, informants gave extensive responses to a series of questions, some of which have been prepared in advance and some of which arose naturally during the relaxed conversation (Iskandar 2018). The information from the key informants was known to several others with TEK and kite-making experience. Consequently, data were gathered

from various sources through multiple referrals. The informants selected for this study were community leaders, bamboo garden owners, kite industry owners, and male and female kite industry workers.

Data analysis

The data from different sources, such as statistical data, reported results, field observations, and in-depth interviews or semi-structure interviews with informants, were analyzed through cross-checking, summarizing, synthesizing, and building up a narrative account with descriptive analysis (Creswell 2014; Iskandar 2018). Cross-checking was performed to validate the information obtained from informants, data from observations, and data from statistics and reports. The validated information was summarized, synthesized, and analyzed narratively with descriptive analysis. Finally, research conducted by Widjaja (2019) in Indonesia was used to identify bamboo species.

RESULTS AND DISCUSSION

Bamboo diversity

The study conducted in-depth or semi-structured interviews with informants and direct observations in the rural community's bamboo gardens. Those activities reveal the existence of five landraces based on the TEK, namely *awi tali*, *awi bitung*, *awi surat* or *gombong héjo*, *awi temen*, and *awi haur* or also called *haur konéng* in Cijambu Village. Therefore, based on five bamboo landraces, it can be identified in terms of the botanical taxonomy as five species, i.e.: *awi tali* (*Gigantochloa apus* (Schult.f.) Kurz), *awi bitung* (*Dendrocalamus asper* (Schult.f.) Backer ex K. Heyne), *awi surat* or *gombong héjo* (*Gigantochloa verticillata* (Willd.) Munro), *awi temen* (*Gigantochloa atter* (Hassk.) Kurz), and *awi haur* or *haur konéng* (*Bambusa vulgaris* Schard. ex J.C. Wendl. var. *striata* (Lodd.ex Lindl.) Gamble) (Table 1).

The word landrace was used to distinguish local people's categorization of ancestral crop species from the conventional Western taxonomic classification of 'varieties.' In this context, a landrace is a local category for grouping the bamboo plant species according to their different characteristics related to specific vernacular names (Iskandar 2018; Iskandar et al. 2022).

Table 1. Species and landraces of bamboo documented in Cijambu Village, Indonesia

Vernacular name (landrace)	Scientific name
<i>Awi Tali</i>	<i>Gigantochloa apus</i> (Schult.f.) Kurz
<i>Awi Bitung</i>	<i>Dendrocalamus asper</i> (Schult.f.) Backer ex K. Heyne
<i>Awi Surat</i> or also called <i>Gombong Héjo</i>	<i>Gigantochloa verticillata</i> (Willd.) Munro
<i>Awi Temen</i>	<i>Gigantochloa atter</i> (Hassk.) Kurz
<i>Awi Haur</i> or also called <i>Haur Konéng</i>	<i>Bambusa vulgaris</i> Schard. ex J.C. Wendl. var. <i>striata</i> (Lodd.ex Lindl.) Gamble

The species diversity and landraces of bamboo in Cijambu Village are comparatively lower than in other regions of West Java. For example, in Karangwangi Village in Cianjur Regency, 13 species and landraces were recorded (Partasmita et al. 2017); Kampung Naga in Tasikmalaya Regency has seven species and landraces (Irawan et al. 2019); and Sukamenak Village in Sumedang Regency has nine species and landraces of bamboo (Iskandar et al. 2022). Various factors may have contributed to this lower species diversity and landraces of bamboo in Cijambu Village. For example, many bamboo and mixed gardens have been converted to commercial monoculture vegetables. In addition, some forests have been opened and planted with commercial vegetables. Moreover, the village is located on high land. Therefore, it is considered more suitable for cultivating various vegetable crops and is recognized as one of the leading vegetable producers in the Sumedang district.

The TEK categorizes the species and landraces of bamboo in Cijambu Village according to various characteristics, such as culm color, culm thickness, edibility of bamboo shoots, and types of utilization. For example, based on the color of the culm, *awi gombong héjo* (*G. verticillata*) is identified for its green culm color (*hejo*). At the same time, *haur konéng* (*B. vulgaris*) has a yellow culm (*konéng*). Furthermore, regarding the immunity of bamboo culms, *gombong héjo* (*G. verticillata*) and *awi tali* (*G. apus*) are known for their thick and thin culms, respectively. Furthermore, regarding edibility, bamboo shoots of *awi tali* (*G. apus*) are typically not consumed. Still, those of *awi haur konéng* (*B. vulgaris*), *awi bitung* (*D. asper*), and *awi temen* (*G. atter*) are considered edible. Finally, based on its utilization, *awi tali* (*G. apus*) is employed for various purposes within the family, and it is used to create kite crafts in Cijambu Village.

The main part of the *awi tali* used for kite making is the culm (*leunjeur*). According to the informants of Cijambu Village, *awi tali* is suitable material for kites, partly because it has good elasticity and durability for the frames (*rarancang*). In addition, the residents' perception (*emic* categories) aligns with the literature (*ethic* considerations) that this plant is the best material for making various items, including handicrafts and furniture, due to its flexibility (Widjaja 2019). *Awali tali* culms in the kite industry are typically harvested from the bamboo gardens community (Figure 2).

Bamboo as material for kites making

According to the information provided by the informants of Cijambu Village, bamboo of *G. apus* has various ecological, socio-economic, and cultural benefits. From an ecological standpoint, bamboo is useful in preventing erosion and landslides, especially planted by rural communities on steep slope land and riverbanks. In terms of socio-economic function, it serves as building materials, agricultural tools, and materials for stage equipment for people's parties. In addition, the culms are usually sold to village dealers, generating cash income for the households.

An intriguing aspect of the traditional application of *G. apus* bamboo in Cijambu Village is its specific utilization as handicraft materials in the kite (*layangan*) industry, which generates income and employment opportunities for the household. Based on ecological history, it is worth noting that before the 1980s, kites were solely produced by villagers to entertain children in the countryside. However, in the 1980s, kite production in Cijambu Village transitioned to mass production and commercial trade. Nevertheless, some villagers continue to engage in kite-making, given the persistent demand as a source of entertainment, specifically for children and adolescents.

During the 2000s, the kite-making industry grew in Cijambu Village, with many men and women rural inhabitants participating, particularly those from Jaganala, Gombong, and Pasanggrahan hamlet. The local kite-making knowledge is traditionally passed down from parents to their children. Village children usually learn to make kites by watching and practicing; they become proficient enough to carry out this function independently and continue their parents' business. Therefore, the local knowledge system of villagers about kites making can be passed on sustainably from parents to children. The TEK is usually transmitted via three levels of community development: parental, peer, and individual learning (Pam et al. 2017). Parental learning occurs during childhood when parents or older siblings teach their children through observation, practical exercises, or a system of vertical cultural transmission. Peer learning is sharing knowledge within the same age (peer group). Meanwhile, individuals learning involve independent learning by trial and error.



Figure 2. A. Garden of *awi tali*. B. Culm (*leunjeur*) of *awi tali*. C. Frames (*rarancang*) of kites made of *awi tali*

Kite making process

The in-depth interviews with informants showed that the kites-making process went through several stages, such as: selecting bamboo from standing clump (*milih tangkal awi*); harvesting or cutting bamboo culms (*nuar awi*); softly chopping them (*ngaraut awi*); tying the kite frame (*ngabengkeut rarancang layangan*); attaching paper (*nempelkeun kertas*); drying in the hot sun (*moé dinu panas panon poé*); and selling the end (processed) product (*ngical hasil*). It takes around 2-3 days to complete 1,000 pieces of kites, from cutting bamboo culms to the end product. Typically, kites are made in the morning between 8.00 and 12.00 o'clock because, at this time, the village people traditionally work time. This time is also a suitable time for kites making that requires sunlight; the afternoon is the time for rest and lunch, but sometimes it is adjusted to the time after working in the garden.

Kite craftsmen obtain bamboo material for kite making from their gardens through culms harvesting. However, some craftsmen who do not own gardens purchase bamboo culms from other village people. Workers employed by the industry owner perform the process of chopping bamboo to drying the kites. After making the kite, the end products are returned to the industry owner, who then sells them to the consumers. Finally, the wages to pay workers usually vary greatly depending on the type and amount of work carried out.

The process of selecting bamboo culms for kite making (*milih tangkal awi*) starts with the seedling process. The bamboo seedling is usually obtained from privately owned gardens. Furthermore, they can come from other land uses, including the forest of Perhutani. However, bamboo seeds for kite-making materials are mostly obtained from personal gardens. Traditionally, the plant in the garden is properly managed during the stalk growth by applying organic and inorganic fertilizers, such as Urea, in a 50:50. The length of bamboo culms depends on the soil fertility in the garden. For example, people usually apply fertilizer to the culms in a bamboo garden with infertile soil. The terrestrial weeds rarely growing around bamboo culms are not removed but only cleaned on the usual path passed to get to the bamboo garden to facilitate access. In general, weeds do not grow much in bamboo gardens because the sun does not have much on the ground. After all, it is dense with bamboo clumps.

The harvesting or felling of bamboo culms (*nuar awi*) for kite frame material was performed using selective cutting by considering bamboo culms that are old and suitable for felling. The first set of culms was harvested five years after planting. Afterward, each bamboo stalk suitable for kite material was cut down selectively without clear-cutting yearly, according to kite frame material needs. Some tools, including machetes and small saws, are commonly used to cut bamboo culms. After harvesting, the bamboo culms are cleaned of twigs and leaves and cut into shorter lengths of 70-80 cm. Finally, the cut and cleaned culms are brought home to be softly chopped (Figure 3).

Workers performed the process of finely chopping bamboo culms, known as *ngaraut awi*, in small, medium, and large sizes, which the buyers determine. The culms from the garden were then split into smaller sticks and

whittled into cylindrical shapes between 7-8 mm in diameter. After being softly chopped, the pieces are dried in the sun for about 6 hours, depending on the weather. The results of the bamboo shavings are then counted and tied per rim of 1,000 pieces, with 500 horizontal and 500 vertical parts of the frame. The work of cultivation, harvesting, cutting, and carrying from the garden to the place of production is carried out by men (Figure 3). In comparison, the work of finely chopping bamboo, tying up, and drying kite frames is predominantly undertaken by women workers (Figure 4). Therefore, in general, the division of labor in making kites is based on gender, namely that some jobs that require a strong workforce, such as planting and cutting bamboo, are undertaken by men. While some work that requires precision and perseverance, such as smoothing bamboo for kite frames, sticking paper to kite frames, and drying kites, is done by women.

When tying a kite frame, known as *ngabengkeut rarancang layangan*, the soft chopped bamboo pieces are tied crosswise in the middle using nylon thread. At each end, they are tied to form a rhombus-like shape with one long side, and the rope used was made of nylon thread. Finally, multipurpose glue (*fox*), which adds white and yellow colors, was used as an adhesive component (Figure 5).

Paper (*nerapkeun kertas*) was fixed to a kite frame (*rarancang*) through gluing, and the glue used is typically made from tapioca flour (*tipung aci sampeu*) and all-purpose glue (*fox*). Once the paper is fixed, it is folded on each side to ensure proper adhesion. Additionally, plastic can be used as a substitute for oil paper to create more durable kites, as shown in Figure 6. Finally, finishing involves drying the kite in the hot sun (*moé*) to dry the glue. That takes about 3-6 hours, depending on the weather condition of the particular day.

The final stage in the kite-making process is selling the product, known as *ngical hasil*. The dealer or owner of the kite industry is responsible for this process. According to the informant's response, selling the product in the kite distribution includes kite workers to the kite industry (*bandar*), then company/grocery, stalls/small shops, and kite consumers.

The kites made by the community vary in size and shape according to the people's creativity, skills, and experiences obtained from hereditary knowledge. Traditionally, residents of Cijambu Village have obtained the local knowledge of kites making from the inheritance from parents and practice their own experiences. Initially, making kites was only for personal use, and flying kites was a hobby. Moreover, because kites were highly demanded and sold, and the kite industry developed there, they were made not for their own needs but for selling trading materials to other cities or places. Therefore, some villagers are involved as kite-making workers and make the type of kite following the kite industry owners' requirements. The three sizes of kites commonly made by people are small (57x49 cm), medium (65x55 cm), and large (75x71 cm), as presented in Figure 7. Similarly, the shape made depends on the design dealers requested. These kites are two-dimensional in shape, with a flat rhombus-shaped frame.

After the workers have made the kites, the design industry entrepreneurs collect them for sale and distribute them to other places (Figure 8). The industry in Cijambu Village has established local and international buyers networks to market their kite products. The channel for selling kites are local industry – craft shops – export companies – buyers. Most kite industry handicrafts are sold in the Cipacing area, Jatinangor District, Sumedang Regency. Meanwhile, on an international scale, kite produced at Cijambu Village is being exported to Thailand. In addition, the kite-making industry has survived sustainably until now, partly due to continued demand from outside the village.

The bamboo kite frame industry can be characterized as a home-based industry that involves many workers, including women. The manufacturing industry is owned

and operated by a frame middleman (*bandar rarancang*), who supplies raw materials from a personal garden or others by buying bamboo culms. Furthermore, the dealer plays a role in managing the number of kites to be made, collecting the processed kites, and marketing them outside the area.

The bamboo kite frames industry has formed a biocultural system characterized by a strong relationship between biology (bamboo), culture, and linguistics in Cijambu Village. For example, the bamboo *G. apus*, a component of the bamboo species in gardens, is culturally used by rural people to make kite frames based on TEK transmitted orally with the linguistics of the Sundanese local language. Therefore, there is a close relationship between cultural diversity, linguistics, and biodiversity in rural ecosystems (Maffi 2014).



Figure 4. A. Bamboo is softly chopped into a cylindrical shape. B. Bamboo sticks for kite frame material (*rarancang*). C. Soft bamboo chopped sticks are dried in the sun



Figure 3. A. Process of selecting bamboo culms on the standing clump. B. Harvested bamboo culms are being carried to the hamlet. C. Bamboo culms are cut and made into small and short sizes



Figure 5. The frame (*rarancang*) of kites are tied by crossing the chopped bamboo pieces



Figure 6. The frame of kites is affixed to paper



Figure 7. Various sizes of kites; A. Small kite size, B. Medium kite size, C. Big kite size



Figure 8. The kites have been bundled and stored in the warehouse and are ready to be sold

Benefits of kites making the village industry

The industry of making kites in Cijambu Village offers some socio-economic benefits for both the owners and workers. Regarding the social system, the TEK for managing and using bamboo as kite-making materials is passed down across generations from parent to child. It starts from bamboo culms management to culms chopping into the required kite designs/frameworks. This is a long-lasting means of transferring the TEK within the culture of Cijambu Village. Regarding economic benefits, the village kite industry provides income to garden owners, who supply bamboo for kite production and create employment opportunities for villagers.

Some workers in the village rely on the kite industry as their main source of income, while others use it as an alternative option. Men in the village work as vegetable

farmers and cultivate paddy fields, while women stay at home. However, many wives engage themselves as laborers in making kites. In their free time, they work as vegetable farmers and some as bamboo harvesters, a task usually reserved for men. Harvesters transport bamboo to the production site, either sold by the garden owners or purchased by the village kite industry dealer. The price of bamboo culms sold by garden owners ranges from IDR 5,000 to 7,000 (USD 1 = IDR 14,673) per bamboo culm (*leunjeur*), depending on their diameter. Furthermore, harvesting tasks, such as cutting and cleaning bamboo culms, are performed by men. On the other hand, women carry out other tasks, namely soft chopping, lacing, and pasting paper until kite-making is completed.

The wages of workers that produce kite frames (*rarancang*) is IDR 40,000/rim (500 pieces). The average wage for making a complete kite is IDR 210,000/rim, particularly for small sizes; it is paid IDR 220,000/rim. Meanwhile, IDR 240,000/rim is paid for medium and large sizes. The dealer pays to kite industry workers according to the stages of production. For example, the payment for tying the kite framework (*ngabeungkeut rarancang*) is IDR 25,000/rim/person, while folding (*ngalepé*) and attaching paper (*nerapkeun kertas*) are paid IDR 15,000/rim/person each. It takes about three days to complete one rim (500 pieces) of the kite frame (*rarancang*). Therefore, kite industry workers can earn an average monthly income of IDR 2,000,000 to 2,300,000. Compared to individuals engaged in gardening and agricultural cultivation, where crop yields can only be realized after harvest, an industrial worker making kites is more economically profitable. Vegetable farming typically incurs high costs, while kite-making provides a more consistent profit. As a result, many rural people benefit economically from making kites, indirectly enhancing their village's maintenance of bamboo gardens. That differs from the gardens in the upstream rural areas of the Citarum River Basin, West Java, which were converted into commercial gardens because there is no bamboo processing industry for various handicrafts (Irawan 2020).

Despite the socio-economic and cultural benefits the village kite industry provides for the people of Cijambu Village, there are various obstacles to maintaining its sustainability due to environmental changes. For example, a long rainy season can interfere with the drying of kites. Furthermore, driving the intensive penetration of the market economic system into rural areas, traditional rural games, such as flying kites, are no longer interesting to children and adolescents. Instead, they switch to smartphone games; others generally play at home. As a result, the demand for kites for games in rural and urban areas is reduced, leading to a decline in the kite-making industry and the loss of livelihoods and income sources for people in the off-farm sector. It could also increase environmental pressure, with villagers exploiting forest areas and causing forest damage. Therefore, the kite-making industry must be integrated into a biocultural system that utilizes *G. apus* bamboo for kite frames (Maffi 2014). Therefore, the cultural and linguistic changes in the Cijambu Village community can be analyzed as to whether they affect

biological aspects, such as villagers' bamboo cultivation and conservation.

The study concluded that the local community of Cijambu Village has untapped TEK of various species and landraces of bamboo. A total of 5 species and landraces of bamboo have been recorded, namely *Gigantochloa apus* (Schult.f.) Kurz (*awi tali*), *Dendrocalamus asper* (Schult. f.) Backer ex Heyne (*awi bitung*), *Gigantochloa verticillata* (Willd.) Munro (*awi surat* or *gombong héjo*), *Gigantochloa atter* (Hassk.) Kurz (*awi temen*), and *Bambusa vulgaris* Schard. ex J.C. Wendl. var. *striata* (Lodd. ex Lindl.) Gamble (*awi haur* or *haur konéng*). The rural people of Cijambu Village categorize these species and landraces of bamboo based on the culm color, the thickness of the bamboo culm, the edible and non-edible bamboo shoots, and their various applications. Furthermore, the people specifically use *G. apus* for constructing kite frames. This practice is based on TEK passed down from generation to generation, from parents to their children. The industry in Cijambu Village is still thriving, partly due to the demand for kites outside the village.

The development of the village kite frame manufacturing industry has contributed to the participation of numerous villagers, both men, and women. This industry has also provided a source of income for the local community. Therefore, making kite frames from bamboo of *G. apus* in Cijambu Village offers socio-economic benefits, such as providing employment opportunities, additional sources of income for village residents, and income from agricultural production. However, sustaining the kite-making industry in Cijambu Village can be challenging due to the declining demand for kites and the younger generation's lack of interest in working there.

ACKNOWLEDGEMENTS

The authors would like to thank the village head, his staff, and informants who kindly assisted us in providing various data on aspects of the bamboo and kite industry during field research. This research was supported by the ALG (Academic Leadership Grant) Program of Prof. Johan Iskandar, which is supported financially by Padjadjaran University. On this occasion, we would like to thank the Rector of Padjadjaran University for supporting the ALG program. We also would like to thank the Dean of the Faculty of Mathematics and Natural Sciences and the Head of the Biology Department for supporting the research.

REFERENCES

- Abebe S, Minale AS, Teketay D. 2022. Socio-economic importance of the bamboo resources in the Lower Beles River Basin, north-western Ethiopia. *Environ Dev Sustain* 24 (10): 12162-12181. DOI: 10.1007/s10668-021-01938-4.
- Albuquerque UP, da Cunha LVFC, de Lucena RFP, Alves RRN. 2014. *Methods and Techniques in Ethnobiology and Ethnoecology*. Humana Press, New York. DOI: 10.1007/978-1-4614-8636-7.
- Albuquerque UP, Paiva de Lucena RF, de Frietas Lins Neto EM. 2014. Selection of Research Participants. In: Albuquerque UP, da Cunha LVFC, de Lucena RFP, Alves RRN (eds). 2014. *Methods and Techniques in Ethnobiology and Ethnoecology*. Humana Press, New York.
- Aswandi A, Kholibrina CR. 2021. Empowering women on bamboo utilization and conservation in the Lake Toba catchment area of the North Sumatra Province of Indonesia. *Environ Sci Proc* 3 (1): 47. DOI: 10.3390/iecf2020-08026.
- Cédric CD, Nfonkahl BN, Forje GW, Princely AN, René K, Jovis NA, Maurice T, Malik AA, Cynthia ZGJ, Bruno TMR, Léocadie IS, Louis Z. 2021. Indigenous knowledge of bamboo products and uses in the Western Highlands of Cameroon. *Asian J Res Agric For* 7 (2): 22-30. DOI: 10.9734/ajraf/2021/v7i230125.
- Creswell J W. 2014. *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches* (Fourth Edition). SAGE Publications Inc, California.
- Hani A, Fauziyah E, Widyaningsih TS, Kuswanto DP. 2018. Potency and agroforestry patterns that support bamboo sustainability in Sukaharja Village, Ciamis District. *Jurnal Wasian* 5 (2): 115-125. DOI: 10.20886/jwas.v5i2.4559. [Indonesian]
- Hidayati S, Suansa NI, Samin, Franco FM. 2017. Using ethnotaxonomy to assess traditional knowledge and language vitality: A case study with the *Urang Kanekes (Baduy)* of Banten, Indonesia. *Indian J Knowl* 16 (4): 576-582.
- Irawan B, Partasasmita R, Rahayu N, Setiawati T, Iskandar J. 2019. Indigenous knowledge of bamboos by Naga community, Tasikmalaya District, West Java, Indonesia. *Biodiversitas* 20 (5): 1423-1434. DOI: 10.13057/biodiv/d200535.
- Irawan B. 2020. Conversion and Conservation of Bamboo Garden in Sundanese Cultural Landscape Based Differences in Ecological Conditions and Social Cultural Background. [Dissertation]. Universitas Padjadjaran, Sumedang, Indonesia. [Indonesian]
- Iskandar J, Suwartapradja OS, Iskandar BS, Budiyantri D, Permana S. 2022. Landraces, utilization, and management of bamboo in Sukamenak Village, Sumedang, West Java. *Sosiohumaniora: Jurnal Ilmu-Ilmu Sosial dan Humaniora* 24 (1): 35-42. DOI: 10.24198/sosiohumaniora.v24i1.35487.
- Iskandar J. 2018. *Ethnobiology, Ethnoecology, and Sustainable Development* (1st Edition). Plantaxia, Yogyakarta. [Indonesian]
- Kuncari ES, Setiawan M. 2021. Ragam bambu dan kayu kentongan: Sebuah kajian etnobotani di Jawa, Bali, dan Lombok. *Buletin Kebun Raya* 24 (2): 85-92. DOI: 10.14203/bkr.v24i2.731. [Indonesian]
- Kusmoro J, Partasasmita R, Santoso P. 2015. Vegetation conditions of mountainous tropical rainforest in the red New Block of Mount Manglayang Sumedang West Java. *BIOTIKA Jurnal Ilmiah Biologi* 13 (1): 1. DOI: 10.24198/bjib.v13i1.10094. [Indonesian]
- Luth F, Setiyono H. 2019. The ability of coffee-based agroforestry (coffee arabica) to store carbon reserves. *Paspalum: Jurnal Ilmiah Pertanian* 7 (1): 34-41. DOI: 10.35138/paspalum.v7i1.109. [Indonesian]
- Maffi L. 2014. Biocultural Diversity at a Glance. In: Maffi L and Dilts O (eds). *Biocultural Diversity Toolkit. Introduction to Biocultural Diversity*. Terralingua, Salt Spring Island, Canada.
- Nath AJ, Lal R, Das AK. 2015. Managing woody bamboos for carbon farming and carbon trading. *Glob Ecol Conserv* 3: 654-663. DOI: 10.1016/j.gecco.2015.03.002.
- Noywuli N, Sapei A, Pandjaitan NH, Eriyatno E. 2019. Bamboo cultivation development policy for the sustainability management of Watershed Aesesa Flores. *Journal of Nat Res EnvMan* 9 (4): 946-959. DOI: 10.29244/jpsl.9.4.946-959. [Indonesian]
- Nurasiah S, Muhammad FH, Agustina RD, Sugilar H. 2019. Interpretation of Conventional Reciprocal Method (CRM) refraction data for identification of subsoil structure in the tourism area at Batu Kuda Bandung. *J Phys Conf Ser* 1402: 044093. DOI: 10.1088/1742-6596/1402/4/044093.
- Pam GAB, Zeitlyn D, Gosler A. 2017. Ethno-ornithology of the mushere of Nigeria: Children's knowledge and perceptions of birds. *Ethnobiol Lett* 9 (2): 48-64. DOI: 10.14237/ebl.9.2.2018.931.
- Partasasmita R, An'Amillah A, Iskandar J, Mutaqin AZ, Annisa, Ratningsih N. 2017. Karangwangi people's local knowledge of bamboo and its role: Implications for management of cultural keystone species. *Biodiversitas* 18 (1): 275-282. DOI: 10.13057/biodiv/d180136.
- Profile of Cijambu Village 2021. Profile of Cijambu, Village Statics. [Indonesian]
- Putri ES, Widiasari A, Karim RA, Somantri L, Ridwana R. 2021. Utilization of sentinel-2 image for vegetation analysis in Mount Manglayang area. *Jurnal Pendidikan Geografi Undiksha* 9 (2): 133-143. DOI: 10.23887/jjppg.v9i2.35357. [Indonesian]

- Setiawati T, Mutaqin AZ, Irawan B, An'Amillah A, Iskandar J. 2017. Species diversity and utilization of bamboo to support life's the community of Karangwangi village, Cidaun Sub-District of Cianjur, Indonesia. *Biodiversitas* 18 (1): 58-64. DOI: 10.13057/biodiv/d180109.
- Siskawati, Sukenti K. 2021. Ethnobotanical study of bamboo types as materials for household equipment and construction in West Lombok Regency. *Prosiding Seminar Nasional Perhimpunan Masyarakat Etnobiologi Indonesia*. November 2021. [Indonesian]
- Sujarwo W. 2018. Bamboo resources, cultural values, and ex situ conservation in Bali, Indonesia. *Reinwardtia* 17 (1): 67-75. DOI: 10.14203/reinwardtia.v17i1.3569.
- Terefe R, Jian L, Kunyong Y. 2019. Role of bamboo forest for mitigation and adaptation to climate change challenges in China. *J Sci Res Rep* 24 (1): 1-7. DOI: 10.9734/jsrr/2019/v24i130145.
- Trisnadiansyah MR, Listiawan Y, Barkah MN, Sukiyah E, Hadian MSD. 2022. Groundwater's and surface water's physical properties and their relationship to geological conditions of the southern slopes of Mount Manglayang, Sumedang, West Java. *Jurnal Pendidikan Geografi* 27 (2): 88-101. DOI: 10.17977/um017v27i12022p88-101. [Indonesian]
- Widjaja EA. 2019. *The Spectacular Indonesian Bamboos*. Polagadre, Jakarta.
- Yeny I, Yuniati D, Khotimah H. 2016. Local wisdom and practice of bamboo forest management in Bali society. *Jurnal Penelitian Sosial dan Ekonomi Kehutanan* 13 (1): 63-72. DOI: 10.20886/jpsek.2016.13.1.63-72. [Indonesian]