Bamboo as a Valuable Resource and its Utilization in Historical and Modern-day China

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Due to some challenges related to the utilization of wood, such as long growth cycles and severe deforestation, the utilization of bamboo resources has attracted wide attention globally. Bamboo is characterized by remarkable strength and elasticity properties, minimal maintenance requirements, and a fast growth cycle, as it can reach maturity within three to five years. Moreover, bamboo is attractive as a sustainable resource owing to its excellent regeneration ability and high crop yield. A single cultivation of bamboo can remain existent for several years, and the plants can regenerate new shoots shortly after harvesting. Hence, the cultivation, management, trade, and utilization of eco-friendly bamboo resources have become of great importance. Currently, a larger proportion of the world's bamboo forests and approximately 80% of the world's bamboo species are found in east Asia, south Asia, and southeast Asia. China has the richest bamboo resources, with a total of 861 species from 43 genera. Specifically, bamboo forests in China cover a total area of approximately 6.73 million ha (approximately one-third of the world's bamboo forests) scattered across different provinces, including Fujian, Jiangxi, Hunan, and Zhejiang, among others. Herein, this work reviewed the cultivation and utilization of bamboo resources in historical and modern China.

DOI: 10.15376/biores.17.1.Dlamini

Keywords: Bamboo resources; China; Asia; Cultivation; Utilization

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INTRODUCTION

The excessive utilization of wood has been strongly criticized due to the serious environmental challenges caused by the continuous depletion of forest resources around the world. The cultivation of wood is also heavily disadvantaged by the long growth cycles (35 to 45 years) (Ramage *et al.* 2017). Bamboo remains the most versatile and abundant non-wood species for the replacement of wood, owing to its shorter growth cycles, high yield, and remarkable regeneration capability (Chaowana 2013; Li and He 2019). According to the FAO (2007), bamboo is widely grown in the world's tropical and subtropical climatic zones, including in east, southeast, and south Asia (Lobovikov *et al.* 2007). Several provinces in China are located within the subtropical and tropical regions, so the country has plentiful bamboo resources and a wide variety of indigenous genera and species (Liu *et al.* 2018).

Bamboo is an important part of traditional Chinese culture and daily life. In historical China, bamboo was used to produce a wide range of products, including arrowheads, baskets, writing scrolls, pens, paper, boats, shoes, food (shoots), and construction materials (Yeromiyan 2021). Some bamboo species have demonstrated superior properties, such as natural hardness, low density, high compressive strength, and erosion-resistance (Guţu 2013; Dixon and Gibson 2014), compared to the commonly cultivated commercial wood species. Hence, bamboo is a high quality and sustainable material for construction. In the construction industry, bamboo has been extensively used for scaffolding, bridges, structures, and buildings (Mera and Xu 2014). Interestingly, bamboo shoots are also considered an important aspect in the utilization of bamboo. In China, edible bamboo shoots are a special dish, owing to their delicious taste and nutritional value (Liu *et al.* 2018).

Although bamboo offers a wealth of advantages, its utilization is still faced with some drawbacks due to the hollow and highly impermeable structure, which may limit its treatment with reagents for the improvement of mechanical properties (Okokpujie *et al.* 2020). In addition, the shortage of bamboo resources in the rest of the world has remained a challenge for the expansion of the bamboo industry (Desalegn and Tadesse 2014). In modern China, the utilization of bamboo has been greatly enhanced by technological advances. Bamboo resources are now widely used in the production of composite materials for interior design, furniture, and other applications (Huang *et al.* 2019; Sun *et al.* 2020). In a previous study, the application of bamboo weaving in modern furniture was investigated (Zheng and Zhu 2021).

The development of bamboo resources remains a key focus in modern China. As a result, the total bamboo forest area showed a steady increase of 3% annually over recent years (CAF 2020). The main purpose of this paper is to provide a review on the distribution of bamboo resources and their utilization in historical and modern-day China, based on the latest reports. The related data on bamboo resources and applications in historical and modern-day China was obtained from a selection of bamboo-related articles, government databases, and FAO reports. The pictures of bamboo forests, buildings, and structures were photographed by the authors using a Huawei P30 Pro phone camera (Shenzhen, China). Origin 8.5 (Northampton, MA, USA), ArcGIS (Redlands, CA, USA), and Microsoft PowerPoint (Redmond, WA, USA) software were used to draw the resource distribution diagrams, map, and scheme.

CURRENT STATUS OF BAMBOO RESOURCES IN CHINA

China has the largest and most diverse species of bamboo. The total number of bamboo species in China is currently estimated to be 861 species from 43 genera, of which 707 are original species, 52 are varieties, 98 are forma, and 4 are hybrids (Liu *et al.* 2018). Figure 1 shows images of some local bamboo forests in the Xuanwu district, Nanjing, Jiangsu province of China. In China, natural bamboo forests are found in 21 provinces. However, it was reported that the bamboo forests are mainly distributed across 18 provinces (Fig. 2). Based on the data shown in Fig. 3a, the total area of bamboo forests was approximately 3.2 million ha during the First National Forest Inventory (1973 to 1976). However, the total area of bamboo forests gradually increased over the more recent years, which was largely attributed to the government's efforts in developing the bamboo industry and conserving indigenous species (CAF 2020). According to recent statistics from the

Ninth National Forest Inventory (2014 to 2018), the total area of bamboo forests in China was 6.73 million ha, which made up approximately one-third of the world's bamboo forests (CAF 2020). This showed that the total area of bamboo forests doubled since the First National Forest Inventory (CAF 2020). Moso bamboo accounted for over 60% of the total bamboo forest area (approximately 4.43 million ha), while other bamboo species accounted for the remaining portion.

Fig. 1. Bamboo forests in southeast China (photographed by the author in 2021)

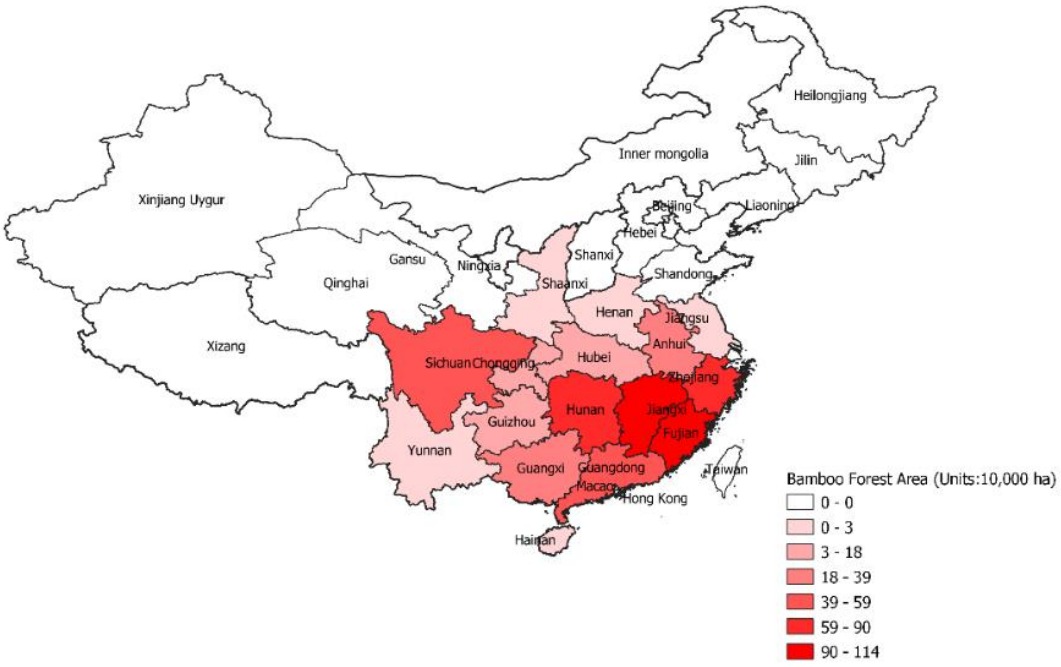

Fig. 2. Distribution of the bamboo forest area in the various provinces of China (2014 to 2018) (CAF 2020)

Figure 3b shows the top 10 provinces with the largest distribution of forest resources in China. The Fujian, Jiangxi, Zhejiang, and Hunan provinces accounted for 3.92 million ha, which corresponded to 58.2% of the national bamboo forest area. Specifically, the Fujian, Jiangxi, Zhejiang, and Hunan provinces had bamboo forest areas of 1,139,600

ha, 1,056,500 ha, 900,600 ha, and 823,100 ha, respectively. Other provinces that contributed significantly to the national bamboo forest area were Sichuan (592,800 ha), Guangdong (446,200 ha), Anhui (388,000 ha), Guangxi (360,200 ha), Hubei (179,200 ha), and Guizhou (160,100 ha). As seen in Table 1, on average, the bamboo forest area in each province increased annually from 1973 to 2018.

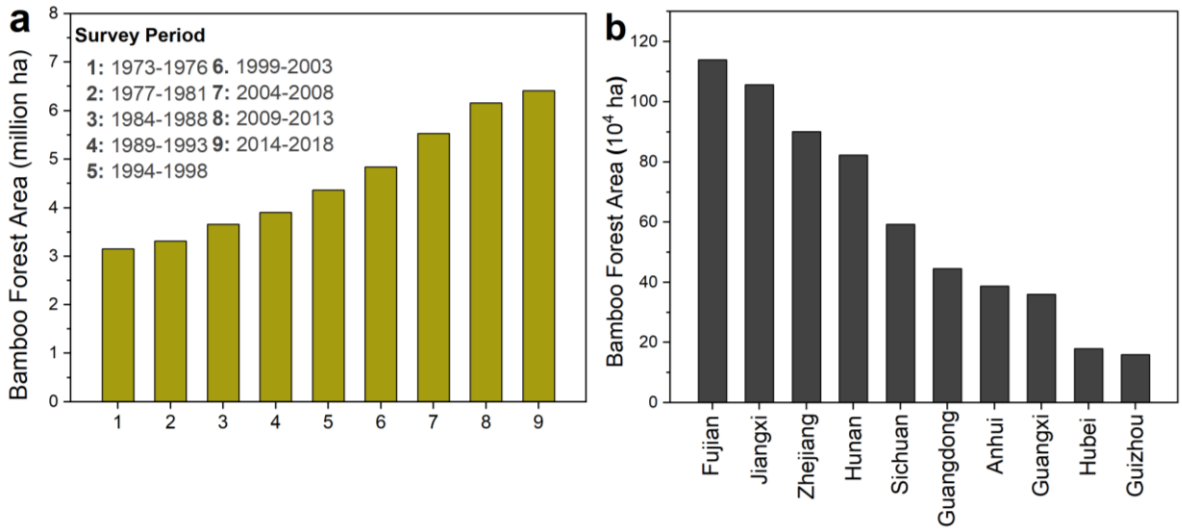

Fig. 3. The a) total bamboo forest area in China and the b) bamboo forest area in the top 10 provinces (CFA 2020).

Table 1. Distribution of Bamboo Resources in China by Province (unit: 10,000 ha)

Provinces	1973 to 1976	1977 to 1981	1984 to 1988	1989 to 1993	1994 to 1998	1999 to 2003	2004 to 2008	2009 to 2013	2014 to 2018
Fujian	55.00	58.04	60.92	68.07	82.03	88.52	99.31	106.75	113.96
Jiangxi	47.00	45.63	53.40	55.16	62.73	80.66	85.16	99.89	105.65
Zhejiang	45.00	48.62	48.62	50.98	62.45	74.25	78.29	83.34	90.06
Hunan	57.00	49.32	52.20	50.60	49.00	52.20	62.78	77.83	82.31
Sichuan	14.00	14.40	34.21	34.56	36.04	37.38	48.60	54.90	59.28
Guangdong	27.00	34.09	31.66	35.5	38.38	37.42	40.78	44.62	44.62
Anhui	13.00	14.34	17.64	20.34	25.08	26.98	32.28	33.72	38.8
Guangxi	14.00	17.28	16.32	24.01	24.98	30.74	29.77	34.09	36.02
Hubei	7.00	8.29	12.38	12.10	13.12	13.76	15.04	14.40	17.92
Guizhou	6.00	5.10	4.96	5.92	5.44	9.61	13.14	15.69	16.01
Chongqing	–	–	–	–	–	11.71	12.51	13.63	15.39
Yunnan	10.00	15.75	14.39	12.48	10.56	8.64	9.12	11.04	11.52
Jiangsu	4.00	4.12	2.30	2.20	2.30	3.73	3.61	3.37	3.13
Henan	3.00	0.73	0.7	1.29	1.94	1.78	2.10	2.74	2.26
Hainan	–	–	0.72	1.08	2.16	1.80	1.56	1.56	1.68
Shanghai	–	0.27	0.27	0.23	0.23	0.27	0.29	0.35	0.31
Taiwan	11.00	11.39	11.39	11.39	15.23	15.23	15.23	15.23	–
Source: China Forest Resources Inventory Data (CAS 2020)									

The gradual increase in China's bamboo forest area was reportedly attributed to improved forest management techniques and the increased demand for bamboo-based products (Mera and Xu 2014). As part of the government's efforts to increase bamboo production, most bamboo plantations have adopted intensive management to maximize the income per unit of bamboo land. According to data obtained from a recent industrial report, the output of bamboo forests in China increased from 2.51 billion trees in 2016 to 3.77 billion trees in 2020, with an average annual compound growth rate of 10.7% (Wu 2020).

The China Commercial Industry Research Institute predicts that with the continuous expansion of the country's bamboo forest area, bamboo production will reach 4.10 billion trees in 2021 (Wei *et al.* 2021). China's bamboo pulp papermaking is mainly distributed in the Chinese provinces of Sichuan, Guangxi, Guizhou, and Chongqing. The output of bamboo pulp in the four provinces accounts for more than 80% of the country's total bamboo pulp production (Wu 2020). Recent data showed that the domestic output of bamboo pulp in 2019 was 20.91 million tons, and it was expected to reach 2.44 million tons in 2021, owing to the advances in bamboo pulp papermaking technology (Wei *et al.* 2021).

As previously mentioned, China remains the world's leading bamboo producer, with a wide range of indigenous species. Table 2 shows a list of the commonly cultivated indigenous genera in China. The country's south and southwest regions (Fujian, Yunnan, Guangdong, Guangxi, and others) lie within the tropical monsoon climatic region, while the central and eastern provinces fall under the subtropical climatic region. Therefore, several provinces of China are considered part of the world's bamboo zones. The bamboo genera can be classified into three categories: sympodial, monopodial, and amphipodial (Liu *et al.* 2018). Sympodial bamboos usually grown in clusters and produce buds from their nodes at short intervals in different directions, forming clumps. Monopodial bamboos (also called running bamboos) spread by developing horizontal rhizomes that extend beneath the ground surface, and they have the capability to naturally invade. One of the major advantages of monopodial genera is that they can be facilely propagated using simple cuttings from the rhizomes, which is challenging for sympodial bamboo. Finally, amphipodial bamboo refers to the type of rhizome that is composed of both sympodial and monopodial bamboos. Amphipodial bamboo is also referred to as mixpodial bamboo.

In China, a larger proportion of the cultivated or indigenous bamboos are classified as sympodial genera. Sympodial bamboos such as *Bambusa*, *Chimonocalamus*, *Dendrocalamopsis*, *Dendrocalamus*, *Fargesia*, *Gigantochloa*, *Melocalamus*, *Melocanna*, *Schizostachyum*, *Thyrsostachys*, and *Thamnocalamus* form the country's largest natural bamboo forests in the southern and southeastern regions. Monopodial genera such as *Acidosasa*, *Brachystachyum*, *Indosasa*, and *Phyllostachys* are widely cultivated in the eastern parts of China. *Phyllostachys* is considered the most commercially grown bamboo genera in east China. Specifically, *Phyllostachys pubescens* form the largest cultivated bamboo forests along the Yangtze River, occupying approximately 59% of the national bamboo forest area (Liu *et al.* 2018). Monopodial and amphipodial genera such as *Acidosasa*, *Bashania*, *Phyllostachys*, *Pseudosasa*, and others are found in the northern regions. Cultivated or natural bamboo forests are beneficial for economic purposes, and they play a key role in biodiversity conservation, the prevention of soil erosion, and they serve as natural windbreakers. Hence, intensive bamboo forest management practices such as regular irrigation have been implemented in most parts of south, east, and southeast China.

Table 2. Indigenous Bamboo Genera Cultivated in China (Liu *et al.* 2018; Li and He 2019)

Classification	Bamboo Genera
Monopodial	*Acidosasa*, *Brachystachyum*, *Ferrocalamus*, *Indosasa*, *Netasasa*, *Phyllostachys*, *Semiarundinaria*, *Chimonobambusa*, *Oligostachyum*, and *Pleioblastus*
Sympodial	*Ampelocalamus*, *Bambusa*, *Cephalostachyum*, *Chimonocalamus*, *Dendrocalamopsis*, *Dendrocalamus*, *Drepanostachyum*, *Fargesia*, *Gigantochloa*, *Melocalamus*, *Melocanna*, *Monocladus*, *Neohouzeaua*, *Neomicrocalamus*, *Neosinocalamus*, *Pseudostachyum*, *Schizostachyum*, *Thyrsostachys*, *Thamnocalamus*, and *Yushania*
Amphipodial	*Bashania*, *Gelidocalamus*, *Indocalamus*, *Monstruocalamus*, *Pseudosasa*, *Qiongzhuea*, *Sasa*, *Shibataea*, and *Sinobambusa*

BAMBOO UTILIZATION IN HISTORICAL CHINA

Bamboo has always been a key element of Chinese historical culture and daily lives. It is one of the major symbols of the development of Chinese culture and civilization. The first utilization of bamboo can be traced back to 4,000 to 5,000 years ago where it was used to carve arrowheads (Li and Kobayashi 2004). Bamboo utilization gained great attention from the Chinese people during the period of the Song Dynasty (A.D. 960). According to one of most popular historical Chinese writers and poet, Su Shi, bamboo played a major role in the daily lives of Chinese people even in ancient times (Lam and Qiu 2011).

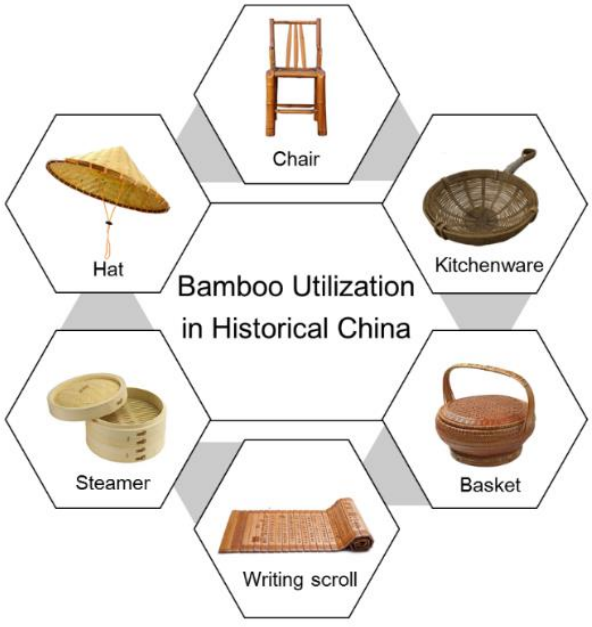

Fig. 4. Bamboo applications in historical China

Some of the major uses of bamboo included edible bamboo shoots, bamboo timber for building construction, bamboo baskets for storing food stuffs, bamboo firewood for cooking, bamboo hats for protection from severe weather, bamboo scrolls for writing, bamboo pulp for making paper, and even bamboo skin for making clothes and shoes. It is noteworthy that different parts of the bamboo plant were used for various applications. One

of the most interesting inventions in the utilization of bamboo in historical China was the development of a bamboo hydraulic system by Du Jiangyuan approximately 2,000 years ago. The hydraulic system, which employed a bamboo rope, was used to successfully dig a 160 m deep salt well in Sichuan province during the period of Han Dynasty (Fu 2009). Bamboo shoots were also a major part of the utilization of bamboo in historical times, owing to their delicious taste and high nutritional value. During the Tang Dynasty (618 to 906 A.D.), bamboo shoots were considered an exquisite dish served in special banquets. This shows that bamboo shoots have always been of great value to the Chinese people. Bamboo shoots usually contain at least 1.5% to 4.0% of proteins, with an abundance of different types of amino acids. They are also considered a healthy and sustainably sourced dish, so the global production of bamboo shoots continues to escalate annually. It is undoubtable that bamboo is one of the most valuable forest resources and it will always remain a key part of civilization and the daily lives of Chinese people.

BAMBOO UTILIZATION IN MODERN-DAY CHINA

In modern-day China, the main utilization of bamboo can be classified into two categories (socio-economic and environmental values) based on the relative benefits to the people or the environment. In Table 3, the various applications of bamboo-based products are listed. The economic value of bamboo can be derived from a wide range of products, including bamboo shoots, bamboo ceiling/interior, bamboo paper, bamboo furniture and handicraft, sculptures, and many others. In China, it is common to come across these bamboo-based products, especially in the old villages located in southeast China. Bamboo timber is widely used in building construction as scaffolding poles, walls, columns, ladders, and simple support beams. Figure 5 shows an example of a bamboo building located within the campus of Nanjing Forestry University in the Jiangsu province. The building illustrates different applications of bamboo material in building and structure construction.

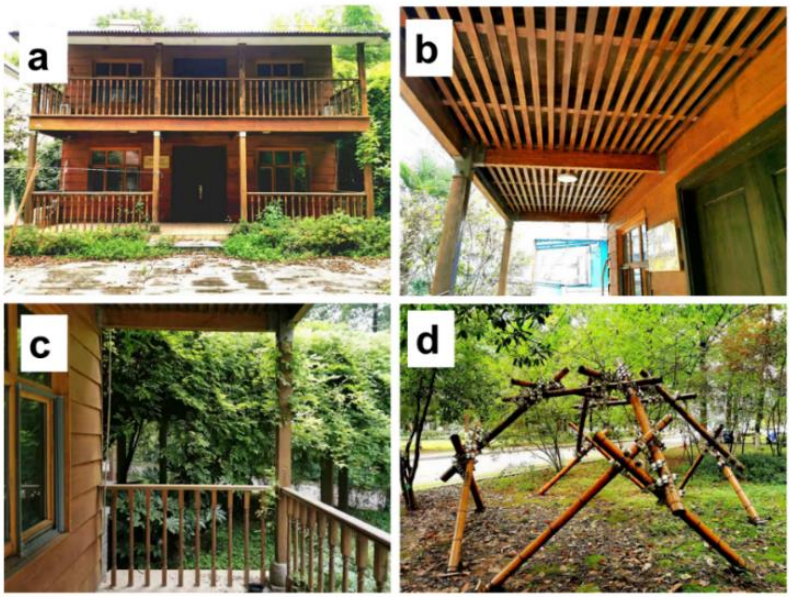

Fig. 5. Bamboo use in buildings and structural construction: a) bamboo building, b) bamboo ceiling, c) bamboo exterior, and a d) bamboo structure (Location: Nanjing, Jiangsu Province).

Table 3. Economic and Ecological Utilization of Bamboo in China (Liu *et al.* 2018; Li and He 2019)

Benefit	Utilization	Main Application	Scientific Name
Socio-economic Value	Timber and paper	Bamboo ceilings and floors, paper or pulp, and support poles in construction	*Bambusa lapidea*, *Bambusa sinospinosa*, *Bambusa rigida*, *Phyllostachys edulis*, *Chimonocalamus delicates*, *Chimonocalamus fimbriatus*, *Chimonocalamus pallens*, *Chimonocalamus makunensis*, *Dendrocalamus giganteus*, *Dendrocalamus sinicus*, *Dendrocalamus membranaceus*, *Chimonobambusa utilis*, *Fargesia yunnanensis*, *Indosasa sinica*, *Phyllostachys edulis*, and *Schizostachyum funghomii*
	Food	Dried shoots, canned and flavored shoots, and fresh shoots	*Phyllostachys edulis*, *Dendrocalamus giganteus*, *Dendrocalamus sinicus*, *Dendrocalamus brandisii*, *Dendrocalamus latiflorus*, *Dendrocalamus membranaceus*, *Dendrocalamus hamiltonii*, *Phyllostachys praecox*, *Phyllostachys vivax*, *Fargesia nitida*, *Fargesia robusta*, and *Fargesia denudata*
	Furniture and housewares	Bamboo baskets, bamboo steamers, chairs and tables, writing scrolls, and interior walls	*Neosinocalamus affinis*, *Bambusa textilis*, *Bambusa chungii*, *Indosasa sinica*, and *Schizostachyum funghomii*
	Handicraft and art	Sculptures, houseplant pots, and guitars and marimbas	*Qiongzhuea tumidissinoda*, *Chimonobambusa quadrangularis*, *Pseudosasa amabilis*, and *Phyllostachys nigra*
Environmental Value	Ecological conservation	Carbon storage/sink and biodiversity preservation	*Bambusa sinospinosa*, *Phyllostachys edulis*, and *Dendrocalamus giganteus*
	Ecotourism	Scenery enhancement	*Cephalostachyum pergracile*, *Phyllostachys nigra*, *Phyllostachys aurea*, *Bambusa ventricosa*, *Bambusa tuldoides*, *Thyrsostachys siamensis*, *Chimonobambusa szechuanensis*, and *Chimonobambusa quadrangularis*

Bamboo is also considered one of the most water-conservative plants due to its ability to store water for long periods, thereby allowing the continuous flow of ground water. Furthermore, bamboo is ideal for ecological conservation, as it controls soil erosion and serves as a carbon sink, releasing plentiful oxygen into the atmosphere (Tardio *et al*. 2018). Bamboo forests also provide a beautiful scenery, so they are ideal for boosting eco-tourism in certain areas.

As the various applications of bamboo are widely dependent on physical and structural properties, selected bamboo species are used in any specific application. For instance, *Phyllostachys edulis* (Moso bamboo) and *Bambusa vulgaris* are some of the common bamboo species used for timber production in China. *Phyllostachys edulis* is

reportedly one of the major commercially cultivated bamboo species in subtropical climatic regions. Moso bamboo is mainly cultivated in plains and mountainous areas located in the southern parts of China, approximately 800 to 1,200 m above sea level. Many bamboo species can be used for pulp production because almost all bamboo species provide fibers that are ideal for pulp production. Bamboo can contain up to 50% of cellulose with a fiber length of approximately 3 mm, suggesting that it is an excellent raw material for pulp production. *Dendrocalamus membranaceus* and *Schizostachyum funghomii* are among the commonly grown species for bamboo pulp production. In China, the output of bamboo pulp reached 2.09 million tons in 2019, following an increase of 9.42% from the previous year.

Dendrocalamus sinicus is another commonly cultivated bamboo species in China, characterized by its unique features such as the large and tall trunk (diameter of 35 cm and height of 30 m). *Dendrocalamus sinicus* is an ideal species for water conservation due to its ability to keep enough water within its trunk for a long time. *Dendrocalamus sinicus* is also capable of controlling soil erosion, as the roots can penetrate up to 10 m beneath the ground surface. In China, *Dendrocalamus sinicus* is only found in the Yunnan province, in the southern region. As previously mentioned, bamboo shoots are a special delicious dish in China, so they are widely cultivated in most of China's bamboo growing regions. The commonly cultivated species for bamboo shoots are *Phyllostachys edulis, Dendrocalamus giganteus, Dendrocalamus sinicus*, *Dendrocalamus brandisii*, *Dendrocalamus latiflorus*, *Dendrocalamus membranaceus*, *Dendrocalamus hamiltonii*, and *Phyllostachys praecox*. However, it is worth noting that over 50 species of bamboo are cultivated for bamboo shoot production in China. Other bamboo species such as C*himonobambusa quadrangularis*, *Pseudosasa amabilis*, *Neosinocalamus affinis*, *Bambusa textilis*, *Bambusa chungii*, *Indosasa sinica*, and *Phyllostachys nigra* are used to manufacture furniture and crafts. Specifically, *Bambusa textilis* and *Neosinocalamus affinis* are widely cultivated to produce material for weaving bamboo baskets and some kitchenware.

Structural Properties of Bamboo

Many researchers have explored the physical and mechanical properties of different bamboo species (Wang *et al.* 2014; Xu *et al.* 2014). Naturally, bamboo culm is characterized by lower weights compared to most wood species, owing to the hollow structure (Bahtiar *et al.* 2019). The high flexibility and tensile strength of matured bamboo culms make bamboo materials more attractive for structural and building construction (Bhonde *et al.* 2014). Table 4 shows the physical and mechanical properties of selected bamboo species. Note-worthily, some bamboo species such as *Dendrocalamus giganteus*, popularity known as "Giant bamboo", can have extremely robust culms of up to 30 m in height and up to 30 cm thickness. Such large dimensions make it possible to produce rectangular boards from single pieces of *Dendrocalamus giganteus*. In addition, giant bamboo is often accompanied by superior mechanical properties compared to most commercial wood species such as *Pinus massoniana*. *Bambusa vulgaris* (also known as "common bamboo") is also classified as large bamboo, with a tall culm of up to 20 m, thickness of 10 cm (Borisade *et al.* 2018), and highly impressive bending strength of 1081.6 kg/cm^2. Although small in size, Moso bamboo (*Phyllostachys edulis)* is extremely hard; hence it can be used can be used in the production of lumber through the application of various adhesives.

Table 4. Comparison of the Physical Properties of Some Bamboo Species to Wood

Species	Moisture Content (%)	Volume Weight (g/cm^3)	Horizontal Hardness (MPa)	Bending Strength (kg/cm^2)
Bambusa vulgaris	12.2	610.0	-	1081.6
Dendrocalamus giganteus	10.0	788.5	0.139	1405.0
Wood *(Pinus massoniana)*	14.6	450.0	0.169	883.0

Engineered Bamboo for Structural Applications

The production of bamboo-based products in China has significantly improved over the years, due to the development of new advanced equipment and techniques for bamboo processing. China's bamboo processing technology is also used in countries such as Indonesia and India, promoting the growth of the global bamboo industry. Currently, bamboo can be processed into various products such as particleboards, plywood, laminated bamboo, and some bamboo composite materials (Sharma *et al.* 2015; Liu *et al.* 2016). However, due to the waxy skin, some bamboo culm can be highly impervious to certain types of chemical reagents, which can limit the potential applications of bamboo material. Hence, it is often advisable to remove the bamboo skin prior to treatment. Bamboo plywood is manufactured by gluing strips of bamboo together vertically or horizontally. The produced plywood is often used for wall panels in building construction. Notably, bamboo plywood possesses similar mechanical properties to conventional plywood produced by wood. Bamboo particleboards have gained enormous attention over the past decades, owing to their affordability and eco-friendliness compared to traditional wood particleboards. They are produced using waste bamboo particles and resin. In recent years, laminated bamboo lumber (LBL) has also attracted great demand from building contractors, owing to its superior mechanical strength and structural stability (Tang *et al.* 2021). Laminated bamboo lumber is characterized by its excellent modulus of rupture (98 to 138 MPa) and modulus of elasticity (9,000 to 21,000 MPa), suggesting that the material is super strong compared to typical laminated wood lumber.

Even though bamboo can be effectively used to produce a wide range of products, there is still a need to invest into the research and development of bamboo cultivation, management, and processing. Other countries located in the subtropical and tropical climatic regions should also consider methods to improve the production of bamboo to minimize the use of wood globally.

CONCLUSIONS

1. The development of bamboo utilization techniques is of great importance to the world. As a sustainable material, bamboo can be applied in a wide range of applications including food, building and structure construction, fiber and pulp, furniture, tools, musical instruments, kitchenware, decorations, and interior design. In addition, bamboo forests play an important role in ecological conservation and the promotion of ecotourism.
2. Bamboo resources have great potential in the southern and southeastern parts of China, owing to the favorable tropical monsoon climatic conditions. To further improve the production and utilization of bamboo resources in provinces such as Fujian, Sichuan,

Zhejiang, and others, it is recommended that the government and other forestry organizations should work towards the establishment of more intensively managed bamboo plantations to produce bamboos with higher yields and better quality.

3. The government of China can also implement a strategic development plan to strengthen the bamboo industry. Furthermore, strong cooperation between academic research institutes and bamboo industries should be implemented.
4. Bamboo is undoubtedly the best alternative material for wood, so appropriate efforts should be applied to promote its utilization throughout the world.

ACKNOWLEDGMENTS

The authors are grateful for the support of the Joint Research program of Sino-foreign Cooperation in Running Schools of Jiangsu Province, China.

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Article submitted: November 5, 2021; Peer review completed: November 30, 2021; Revised version received and accepted: December 6, 2021; Published: December 13, 2021.
DOI: 10.15376/biores.17.1.Dlamini