



Multidimensional Scope, Current Status, Uses and Contribution of Green Gold Bamboo: A Comprehensive Review

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Bamboo is a versatile group of fastest growing plant which is capable of providing ecological, economical, environmental and livelihood security to the people. The study investigates uses, contribution, scope of the green gold plant bamboo. The review of this study showed that bamboo has evolved into a highly valuable and superior plant which serves for food, fodder and many more also bamboo-based products have the potential to replace wood, plastics in a variety of industrial uses without harming the nature by maintaining sustainability. So in this review paper

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comprehensive overview of the recent literatures about multidimensional scope of bamboo in form of its greatest potential is being discussed.

Keywords: Bamboo; Economic; Livelihood; Resources.

1. INTRODUCTION

Bamboos constitute fastest growing tall woody grass with joined stem and are versatile plant on the earth, which have been closely associated with mankind since ancient times. Bamboo belongs to subfamily of bambusoideae of the grass family poaceae [1]. It is one of the most abundant plant found in tropical and subtropical regions between 46°N and 47°S [2,3,4]. Bamboo is a self-regenerating renewable raw material which serves for rendering many ecological services like erosion control, protecting riverbanks, preventing landslides, soil moisture retention, land rehabilitation, biodiversity conservation, carbon sequestration, etc. [5]. Bamboo is a plant having short natural growth cycle and with abundance of its resources available its fiber has attracted attention over other natural fibers. Bamboo fiber has a complex natural structure but offers excellent mechanical properties, which are utilized in the textile, paper making, construction and composites industry [6]. It is popularly known for industrial applications in paper making, furniture making and allied and as a raw material in biotechnology and bioprocesses [7]. Bamboo based industry has vast potential for generating income and employment, especially in the rural areas [8]. They have one or the widest habitats with more than 75 genera and 1500 species worldwide and can thrive in hot, humid rainforest to cold resilient forests. They can tolerate as well as grow in extreme low temperature of about -20°C and precipitation ranging from 800 mm to 1300 mm annual rainfall [9]. As it has wider availability, application and characteristics such as fastest growing nature, strength, light weight, flexibility and potential of technological advancement for value addition bamboo serves as a greatest alternative to timbers [10]. India has third richest bamboo genetic resources after Brazil and China. Several reports have been found regarding the species richness of bamboo [11]. In India it is reported about 113 bamboo species, whereas report on number of bamboos varies from 102 [12]. Latest (ISFR 2019) data

suggests that India has 125 native and 11 exotic bamboo species. In India 12.8% of the total forest area which is about 9.57 million hectare is covered by bamboo plantation [13]. But at the distribution of bamboo is greatly influenced by human interventions [14,15]. Hence, the awareness about this green gold plant must be decipher to each and every individual for making sustainability in the society.

2. MULTIDIMENSIONAL CHARACTERISTICS AND USES OF BAMBOO

2.1 Uniquely Tall and Fast Growing

Bamboos are members of the poaceae /gramineae family, and they are the family's fastest-growing and tallest species [17]. Bamboo is a fast-growing plant with a short growth cycle. Bamboo not only grows far more quickly than wood, but it also requires far less water. It has the fastest growing canopy of any eucalyptus species, growing three times faster than the majority of eucalyptus species.

2.2 Protects Oxygen and Carbon Dioxide On Earth

Bamboo plants, which occupy 40 million hectares globally, have a high biomass stock and carbon storage capacity, and hence play a critical role in reducing climate change [18]. Various research on the significance of bamboo forests in global carbon cycling have been published [19,20]. Bamboos are well-known for their ability to absorb waste water from agriculture, industry, animal husbandry, and pollution, which can be linked to the neutral trait in stress resistance.

2.3 Phytoremediation Potential

Bamboos can clean up polluted soils and collect silicon in their bodies to alleviate metal toxicity, with a natural buildup of up to 183 mg·g⁻¹ SiO₂ [21]. The results of a two-year experiment on the efficacy of three bamboo species for wastewater

removal revealed that the soil-bamboo system could remove 98 percent of organic matter and 99 percent of nutrients, respectively [22]. As a result, bamboo is an excellent choice for

reducing the negative effects of climate change, as well as a large carbon sink in nature that aids in the adjustment and improvement of human ecosystems [23].

Table 1. Genera and number of species of bamboo naturally occurring and cultivated in India

Sr No.	Genus	Naturally Occurring	Introduced/Cultivated	Total No. of Species
1	<i>Arundinaria</i>	2	0	2
2	<i>Bambusa</i>	12	14	26
3	<i>Chimonobambusa</i>	1	0	1
4	<i>Dendrocalamus</i>	7	8	15
5	<i>Dinochloa</i>	5	1	6
6	<i>Gigantochloa</i>	2	5	7
7	<i>Melocanna</i>	0	2	2
8	<i>Ochlandra</i>	9	0	9
9	<i>Oxytenanthera</i>	1	1	2
10	<i>Phyllostachys</i>	2	3	5
11	<i>Pleioblastus</i>	1	0	1
12	<i>Pseudosasa</i>	0	1	1
13	<i>Pseudoxytenanthera</i>	4	0	4
14	<i>Racembambos</i>	3	0	3
15	<i>Schizostachyum</i>	17	1	18
16	<i>Sinarundinria</i>	18	3	21
17	<i>Thamnocalamus</i>	3	0	3
18	<i>Thyrostachys</i>	0	2	2
Total		87	41	128

Source: *Bamboos of India A Compendium (K.K Sheetalaxmi) [16].*

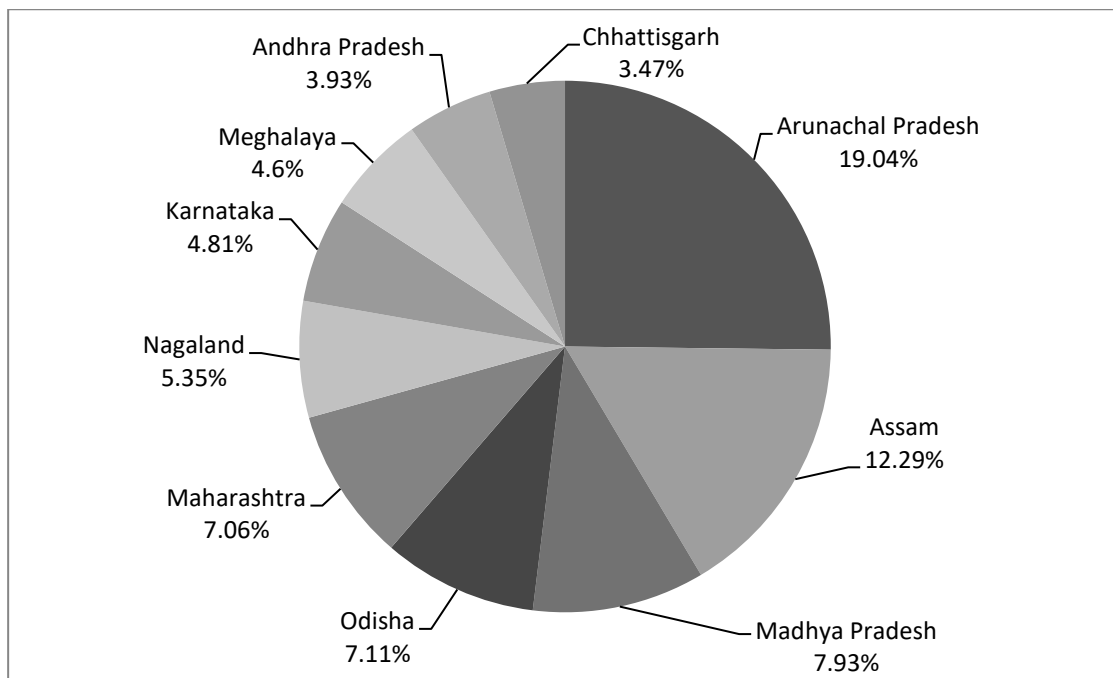


Fig. 1. Maximum coverage of bamboo culms

Source: *Indian State of Forest Report 2021 [13].*

Table 2. Top ten states in terms of bamboo bearing area (%)

State	Percentage coverage of bamboo (%)
Madhya Pradesh	12.30
Arunachal Pradesh	10.53
Maharashtra Assam	9.05
Assam	7.13
Chhattisgarh	7.00
Odisha	7.49
Karnataka	5.77
Manipur	5.60
Andhra Pradesh	4.08
Telangana	3.03

Source: Indian State of Forest Report, 2021[13].



Fig. 2. Bamboo Clump Being Grown At Bambusetum, FRI Campus, Dehradun

2.4 Provides Edibles in the form of Bamboo Shoots

Bamboo shoots have supplied nutrition to millions of people throughout the world as a food source. Bamboo shoots are a good source of dietary fiber, which is a type of fiber. Bamboo shoots are low in fat and calories [24]. Bamboo also contains essential amino acids, potassium, antioxidants, selenium, vitamins, carbs, and protein [25]. However, the Bamboo Age Index is significant; in one study it is found that the amount of vitamins and minerals in bamboo decreases as the age of the plant increases [26].

As a result, young bamboo culms can provide fiber and starch for culinary products such as bamboo flour, pasta, meat products, cheese, yoghurt, and bread.

2.5 Prevents Soil Erosion

Bamboo has a protective effect in reducing soil deterioration, such as biodiversity loss, soil nutrient depletion, and soil erosion [27]. Its anti-erosion characteristics act as a watershed, holding soil together along vulnerable river banks, deforested areas, and locations prone to earthquakes and mud slides. Bamboos help

manage landslides, preserve flooded rivers on their natural path, and limit the speed of water flow by considerably reducing rain run-off and preventing massive soil erosion.

3. BAMBOO AS A SOURCE OF LIVELIHOOD

For millions of people in India and around the world, bamboo is a tremendous source of income. There is a lot of literature on the diverse uses of bamboo, and emphasizes the importance of bamboo in terms of supporting livelihoods. Bamboo is used for building houses, making bamboo ply, agricultural implements, handicrafts, irrigation, brooms, medicine, food, fuel, fodder, paper & pulp, and many other things [28]. Bamboo is also utilized as a perfect substitute for several wood-based items. Bamboo goods that provide livelihoods can be broadly classified as follows:

3.1 Wood Substitutes and Composites Bamboo Housing

Bamboo housing can be divided into three categories: Traditional bamboo houses are made of bamboo culms; traditional bahareque bamboo buildings are composed of bamboo frames coated with cement or clay and modern pre fabricated bamboo houses are made of bamboo laminated boards, veneers, and panels. Traditional bamboo dwellings are home to nearly one billion people, according to experts. Unlike brick or cement constructions, these structures are usually less expensive than timber dwellings, are light, sturdy, and earthquake resistant. Engineered bamboo-based prefabricated buildings have a number of advantages. They can be packed flat and transported for a low cost over large distance. They are more aesthetically pleasing and environmentally friendly. Bamboo materials are commonly available and can be grown for a reasonable price.

3.2 Bamboo Raw Materials

Bamboo is a non-permanent material. Its use in exposed settings necessitates prior treatment and it can be improved further with the use of current engineering techniques. Bamboo may be

turned into modern items (engineered bamboo) that can compete in price and performance with wood products. The use of bamboo in composite panels and boards overcomes culm-related quality discrepancies and allows for the development of uniform products. Engineered bamboo has the potential to replace wood, steel, and concrete in a variety of applications [28].

3.3 Industrial Use and Products

3.3.1 Bamboo pulp, paper and cloth

Bamboo is used as pulp, paper, and more recently fabric in several bamboo-producing countries, including China and India. Bamboo paper is nearly identical to wood-based paper in terms of quality. Its brightness and optical qualities stay steady over time, whereas those of wood-based paper may deteriorate.

3.4 Food Products

3.4.1 Bamboo Shoots

Bamboo shoots are tasty and nutritious, with a high fibre content. Bamboo vegetables are available at Chinese grocery stores and restaurants all over the world. Because cooking does not alter the texture of the shoots, they remain crisp after cooking. Bamboo shoots that have been cooked can be preserved in containers and exported all over the world.

3.5 Construction and Structural Application

3.5.1 Bamboo Charcoal

Bamboo charcoal has long been used as a replacement for wood charcoal and mineral coal. It has the ability to act as a fuel, absorbent, and conductor and are comparable to or better than wood charcoal and it is cheaper and easier to make [29].

3.5.2 Bamboo Panels

Bamboo panels were first produced in China in the early 1800s. In Asia, more than 20 different types of panels are currently produced. Bamboo has a longer fiber than wood, which gives it

technological advantages. The panels are commonly utilised as structural elements or as shapes for concrete mouldings in modern building. Flooring, roofing, partitions, doors, and window frames are just a few of the applications. Due to their rigidity and endurance, bamboo panels have several advantages over wooden boards. Veneers, strip boards, matboards, fibreboards, particle boards, medium density boards, mixtures of these, and combinations of these with wood and other ligno-cellulose materials and inorganic substances are all examples of bamboo veneers, panels, and boards.

3.5.3 Bamboo Flooring

Bamboo flooring is a high-quality product with a wide range of applications and a significant worldwide consumer market. Because of its smoothness, brightness, stability, high resistance, insulating capabilities, and flexibility, it offers some advantages over timber flooring. Bamboo flooring has a smooth natural shine that preserves the natural gloss and elegance of bamboo fiber.

3.6 Bamboo Fuel

Bamboo may be pyrolyzed to produce three useful products: bamboo charcoal, oil, and gas.. Bamboo extracts are rich in nutrients and can be used in medications, cosmetics, and beverages. Bamboo gas can be utilised as a petroleum alternative. Bamboo charcoal is a fantastic cooking and barbecuing fuel. Activated charcoal is used as a deodorant, a purifier, a disinfectant, a pharmaceutical, an agricultural chemical, and a pollutant and moisture absorbent.

4. DISCUSSION AND CONCLUSION

Bamboo is a versatile plant that has a wide range of uses and provides services to millions of people all over the world, including in India. Bamboo has a wide range of applications, which is why it is known as "green gold," and it has enormous potential to offer rural populations with a source of income and economic security. Bamboos are widely distributed woody grass which produces fastest biomass and are widely distributed across the globe. Bamboos are widely

used for house making, house hold product making and provides raw material for handicraft, pulp and paper industries.

Bamboos are considered as most sustainable alternative to wood which matches steel and plastic in terms of strength and elasticity. When it comes to nutrition bamboo shoots serves as good source of food and can be used for making pickles, sweets etc. As a result, a concerted effort should be undertaken to realize bamboos full potential. There are numerous obstacles, such as a lack of planting material, overexploitation of resources, a lack of awareness about conservation practices, a lack of storage and warehousing, and so on, and a significant amount of work must be done to address these flaws in bamboo farming. Bamboo farming should be enhanced by expanding bamboo research and development operations in order to improve its genetics and produce high-quality planting material. Also, at the farm level, commercialization of bamboo as an enterprise should be pursued, as should raising awareness among farmers by informing them of the vast applications of bamboo cultivation and providing them with quality planting material. Keeping all these above mentioned point into consideration the current review study discusses its enormous potential and aspects of the green gold bamboo.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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