Advances in Bamboo Science 16 (2026) 100253

Contents lists available at ScienceDirect

Advances in Bamboo Science

journal homepage: www.journals.elsevier.com/advances-in-bamboo-science

Review

Harnessing the potential of bamboo for sustainable livelihoods in Sub-Saharan Africa: A meta-synthesis

Rusha Begna Wakweya

Ethiopian Forestry Development, Jimma Center, Policy and Socio-Economics Programme, 1187, Ethiopia

A R T I C L E I N F O

Keywords:
Bamboo
Sustainable livelihoods
SDGs
Value chains
Sub-Saharan Africa

A B S T R A C T

Bamboo is a fast-growing, renewable forest resource with the potential to address interconnected social, economic and environmental challenges in Sub-Saharan Africa (SSA). Despite this promise, the bamboo sector remains underdeveloped, and its contributions to sustainable livelihoods and the UN Sustainable Development Goals (SDGs) are not fully realised. This review systematically synthesises evidence on how bamboo enhances rural livelihoods in the five SSA countries with the most significant bamboo resources and sector activity: Ethiopia, Ghana, Nigeria, Tanzania and Uganda. Examining peer-reviewed articles, technical reports, and case studies from 2014 to 2026, I identify four promising bamboo value chains: (1) sustainable energy (charcoal and briquettes) advancing SDG 7 (Affordable and Clean Energy); (2) construction and engineered materials supporting SDG 11 (Sustainable Cities and Communities); (3) furniture and handicrafts fostering SDG 1 (No Poverty) and SDG 5 (Gender Equality); and (4) edible shoots contributing to SDG 2 (Zero Hunger). My comparative analysis reveals distinct national trajectories: Ethiopia possesses vast latent potential constrained by infrastructure deficits; Nigeria demonstrates market-driven construction sector disruption but lacks coherent governance; Tanzania leverages indigenous knowledge for diversified rural livelihoods; and Ghana and Uganda exemplify policy-led value addition where institutional coherence compensates for modest resource endowments. Cross-cutting barriers, fragmented policies, weak processing infrastructure, limited technical capacity and insecure land tenure impede sectoral advancement across all five nations. To overcome these challenges, I propose a "Bamboo-livelihoods nexus" approach emphasizing differentiated, context-specific interventions: Infrastructure investment in Ethiopia, pro-poor value chain formalization in Nigeria, scaling of Ghana's balanced model, and technology transfer in Tanzania and Uganda. My findings underscore that bamboo's ultimate contribution to the 2030 agenda depends less on hectares of standing stock than on the coherence of institutions, policies, and the value chains constructed around it.

1. Introduction

Sub-Saharan Africa (SSA) stands at a critical developmental crossroads, facing a triad of persistent and interconnected crises: Deepening poverty and livelihood insecurity, rampant environmental degradation, and heightened vulnerability to climate change (Baptista et al., 2022). Despite decades of intervention, millions of households across the region remain trapped in a cycle of economic hardship, heavily reliant on the unsustainable extraction of natural resources for survival. This reliance is particularly evident in the energy sector, where more than 60% of the rural population depends on wood fuel for cooking and heating, making it one of the primary drivers of the region's alarming deforestation rate of 3.9 million hectares per year (Mekonnen et al., 2014; Partey et al., 2017). For a significant portion of the region's expanding rural population, charcoal and fuelwood are the major fuel choices due to their low cost and easy availability compared to other energy options (Derebe et al., 2025; Rose et al., 2022). A major obstacle to socioeconomic progress, industrial growth and quality of life in Sub-Saharan Africa (SSA) is the region's persistent electricity instability, characterised by frequent outages, voltage swings and an unreliable supply (Avordeh et al., 2024). These power disruptions have a profoundly destabilising effect on communities (Agoundedemba et al., 2023). Agricultural expansion, logging and wood-fuel demand are driving significant deforestation in the region, where a growing rural population's reliance on affordable but unsustainable charcoal production is accelerating forest loss (Lunku et al., 2025). Consequently, this heavy reliance encourages unsustainable harvesting methods and accelerates deforestation, which in turn exacerbates soil erosion, biodiversity loss

E-mail address: rushab@efd.gov.et.

https://doi.org/10.1016/j.bamboo.2026.100253
Received 29 January 2026; Received in revised form 23 June 2026; Accepted 23 June 2026
Available online 24 June 2026

and watershed disruption. This undermines the agricultural productivity upon which most livelihoods depend, creating poverty and environmental decline (Wassie, 2020). Furthermore, SSA's development challenges are further caused by rapid population growth, pervasive unemployment, food insecurity and rising climate-related risks (Aduloju and Adedoyin, 2024; Wanjohi, 2025).

Identifying sustainable, pro-poor and climate-resilient economic pathways is therefore essential. Bamboo is increasingly recognised as a strategic resource capable of addressing intertwined socio-economic and environmental challenges (Dutta et al., 2025). Bamboo-based interventions can address multiple drivers simultaneously: Providing alternative fuel sources reduces charcoal-driven deforestation; agroforestry systems integrate with agriculture to reduce pressure for land conversion; and value-added processing creates economic incentives for forest conservation (FAO and INBAR, 2018; Solomon et al., 2021). With over 1600 species globally, bamboo is distinguished by its exceptional growth rate (up to 25 cm per day in some species), high strength-to-weight ratio and ability to regenerate from its rhizome system after harvesting, making it a highly renewable resource (Bahru and Ding, 2021; Nfornkah et al., 2023). Native species, primarily from the genera *Oxytenanthera* and *Oldeania*, and introduced species such as *Dendrocalamus asper* (Schult. & Schult.f.) Backer and *Bambusa vulgaris* Schrad. ex J.C.Wendl., thrive across diverse ecological zones on the continent. Bamboo has unique characteristics, including extremely fast growth (some species can grow up to 1 m per day), high tensile strength, ability to regenerate after harvesting and an extensive rhizome root system that binds soil, making it an ideal candidate for sustainable resource management (Mustafa et al., 2021; Solomon et al., 2021).

Conventional development pathways often pose a trade-off between economic growth and environmental sustainability (Marsiglio and Privileggi, 2021; Moyer and Bohl, 2019). In this context, the pursuit of bio-based economies that leverage native, fast-growing resources is imperative (Lange, 2021). The concept of "sustainable livelihoods" provides a holistic lens for this analysis, focusing on the capabilities, assets and activities required for a means of living that can be maintained or enhanced without undermining the natural resource base (Tambe, 2022).

In this context of urgent need for sustainable and inclusive development pathways, bamboo emerges as a remarkably promising yet critically underexploited resource (Dutta et al., 2025; Sapovadia, 2025). While Asia has built a multi-billion-dollar industry around bamboo, leveraging it for everything from construction and textiles to energy and high-value consumer goods, the potential of this resource in SSA remains largely latent (Dlamini et al., 2022; Kumar et al., 2026). The continent is home to approximately 3 million hectares of native and exotic bamboo, a fast-growing, resilient grass with unparalleled regenerative properties and a wide array of commercial applications (Solomon et al., 2021). While this represents a substantial natural asset, it is concentrated in specific ecological zones and is not uniformly distributed across the continent. By comparison, the annual rate of net forest loss in these countries varies significantly, from an estimated 0.8–1.8% per year (FAO, 2021; Yalew, 2015), underscoring both the urgency and the opportunity for bamboo-based landscape restoration and livelihood diversification. Its characteristics include rapid maturation (harvestable in 3–5 years), high tensile strength, exceptional positioning it as an ideal candidate for re-greening landscapes, mitigating climate change, and generating sustainable economic activities (Button et al., 2022).

Bamboo-based sustainable livelihoods are increasingly recognized for their potential to support economic development, environmental sustainability and social well-being (Kumar et al., 2026). Bamboo has rapid growth, versatility and an ability to thrive in diverse climates making it an ideal resource for sustainable development. It provides a wide range of products and services that can enhance livelihoods, particularly in rural and less-developed regions. Bamboo directly augments all five forms of livelihood capital: Natural (soil conservation, carbon sequestration), human (skills development), social (cooperative formation), physical (affordable housing) and financial (diverse income streams) (Alamerew et al., 2024).

However, a significant gap exists between this inherent potential and its tangible realisation in improving livelihoods (Sati, 2025; Wakweya, 2023). While numerous pilot projects and isolated case studies on bamboo exist across SSA, the knowledge is dispersed and has not been systematically synthesised (Sawarkar et al., 2023). Bamboo value chains are often informal, fragmented and characterised by limited technical capacity in sustainable harvesting, processing and product development (Alemayehu and Hido, 2023). There is a lack of a systematic synthesis across SSA value chains that clearly maps viable value chains (e.g., energy, construction, agroforestry), assesses their socio-economic impacts and identifies the specific constraints and success factors across different national contexts. Therefore, this review systematically synthesizes the capacity of bamboo to enhance rural livelihoods, focusing on the five SSA nations with the highest demonstrated potential: Ethiopia, Ghana, Nigeria, Tanzania and Uganda.

2. Methodology

This study employed a systematic literature review methodology to synthesize existing evidence on the potential of bamboo to enhance sustainable livelihoods in Sub-Saharan Africa (SSA). The review was guided by the following core research question: How can bamboo improve rural livelihoods in SSA, and what are the key barriers and enablers across different national contexts? The process followed a structured protocol of identification, screening, eligibility assessment and synthesis (Fig. 1).

2.1. Search strategy

A comprehensive search for relevant literature was conducted from the electronic databases Scopus, Web of Science and Google Scholar. The search utilized Boolean operators with the following core keyword combinations: "bamboo" AND ("livelihood" OR "income" OR "value chain" OR "socio economic") AND ("Ethiopia" OR "Ghana" OR "Nigeria" OR "Tanzania" OR "Uganda" OR "Sub-Saharan Africa"). The search was limited to publications from the year 2014 onward to capture contemporary sector developments. To minimize publication bias, the grey literature was also searched through the online repositories of key international organizations.

2.2. Eligibility criteria (inclusion and exclusion)

Studies identified through the search were screened for eligibility based on pre-defined criteria (Table 1).

2.3. Study selection and data extraction

The selection process adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. Search results were imported into Endnote, a reference manager, and duplicates were removed. Titles and abstracts were screened against the eligibility criteria by the primary author. The full texts of potentially relevant studies were then retrieved and assessed in detail. A standardized data extraction form was used to collect information from each included study on: (1) author(s) and year; (2) geographic focus; (3) primary bamboo value chain examined; (4) key findings related to livelihoods; and (5) identified barriers/enablers.

2.4. Data synthesis and analysis

A total of 1093 records were identified from Scopus, Web of Science, Google Scholar and grey literature sources (INBAR, FAO, national forestry agencies). After removing 204 duplicates, 889 records were screened by title and abstract. Of these, 612 were excluded as they did

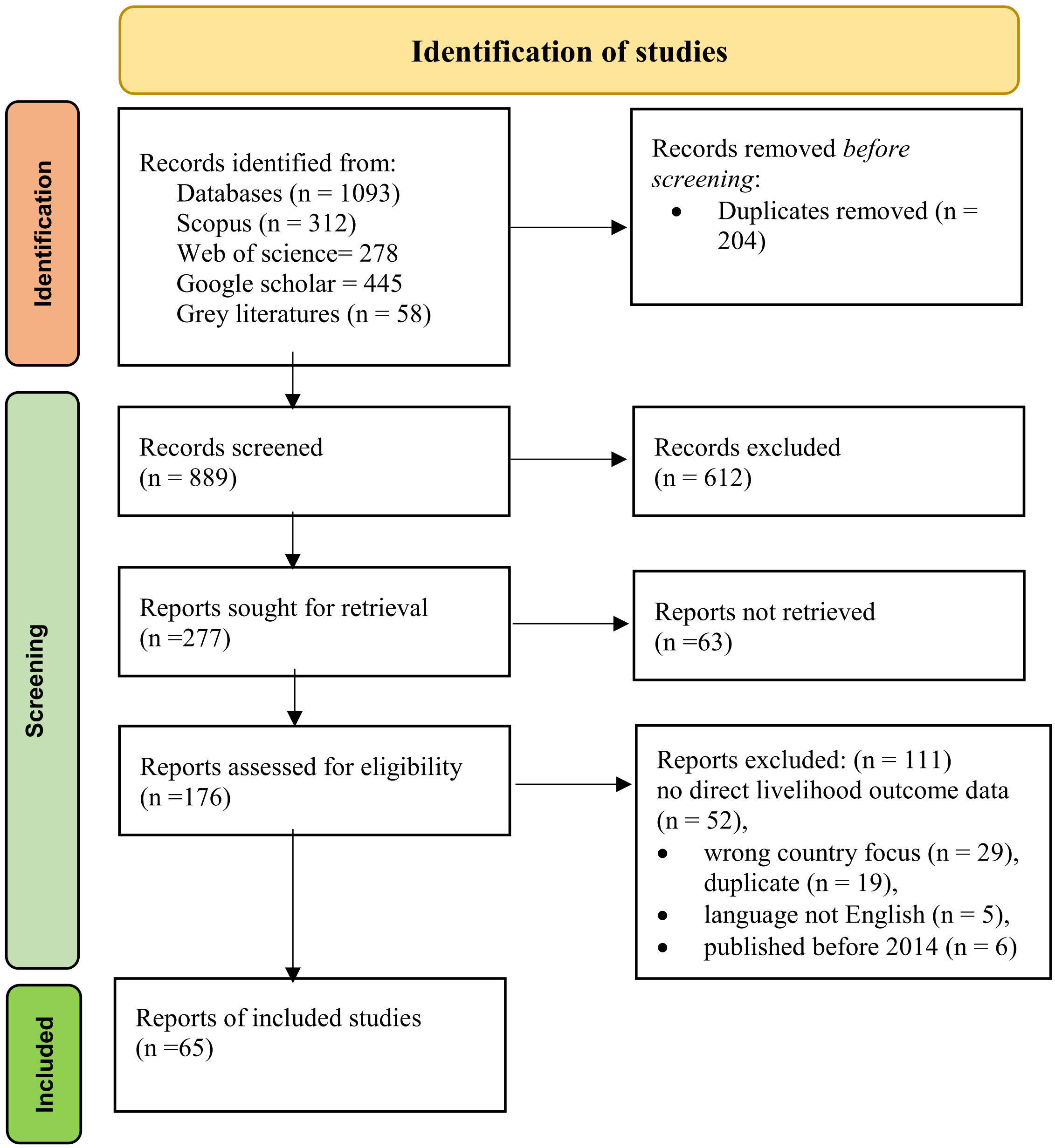

Fig. 1. Included and excluded studies.

not address bamboo-livelihood linkages or fell outside the five focus countries. The remaining 277 full-text reports were sought; 63 could not be retrieved (abstract-only records or inaccessible subscription articles despite institutional and interlibrary loan access). The remaining 214 full-text reports were assessed for eligibility. A further 111 were excluded for reasons including lack of direct livelihood outcomes (62), wrong country focus (39), duplicate findings (25), non-English language (5) or publication before 2014 (18). Consequently, 65 studies were included in the final thematic synthesis. Extracted data were analysed inductively to identify recurring themes, patterns and contradictions related to livelihood impacts and sector development challenges across the five countries. Findings were organized narratively and presented using comparative tables to illustrate convergences and divergences in national contexts.

3. Result and discussion

3.1. Country profiles: bamboo resources and sector status

Sub-Saharan Africa is home to approximately 674 million hectares of forest, representing about 18% of the global forest area (Pekkarinen, 2025). Within this vast forest resource, bamboo occupies an estimated over 3 million hectares, accounting for less than 0.5% of the region's total forest cover. However, the distribution of bamboo is highly uneven across the continent. For instance, within the specified Sub-Saharan African countries, Ethiopia, Ghana, Nigeria, Tanzania and Uganda, bamboo covers 2.7 million hectares (Piazza et al., 2007).

Analysis of bamboo endowments across the five Sub-Saharan African nations reveals that total hectare coverage is a poor predictor of immediate socioeconomic impact; rather, resource accessibility and species characteristics dictate divergent developmental trajectories. Ethiopia's vast 1.4 million hectares of native *Oldeania alpina* (K.Schum.) Stapleton (syn. *Yushania alpina* (K.Schum.) W.C.Lin) and *Oxytenanthera abyssinica* (A.Rich.) Munro (Mulatu et al., 2026*)*, constitutes Africa's

Table 1
Inclusion and exclusion criteria.

Criterion	Inclusion	Exclusion
Publication Date	2014 – 2026.	Published before 2014.
Geographic Focus	Explicit focus on Ethiopia, Ghana, Nigeria, Tanzania or Uganda.	Studies focused on bamboo in other regions without relevant comparative data for the focus countries.
Topic & Content	Direct discussion of bamboo has socio-economic impact, value chains, livelihood outcomes, policy or markets.	Studies focusing solely on silvicultural, pure botany or chemical properties without a livelihood linkage.
Document Type	Peer-reviewed journal articles, academic theses, official technical reports and credible case studies.	Brief news articles, blog posts, promotional brochures without empirical data or clear methodology.
Language	English.	Publications in languages other than English.
Access	Any article (whether open access or subscription-based) for which we could obtain the full text regardless of how access was acquired research gate or author request	Any record available only as an abstract, because critical data or findings could not be reliably ascertained.

largest reserve and provides the critical mass necessary for an industrial-scale, export-oriented manufacturing strategy. However, the remote, highland geography of these native stands creates a significant logistical barrier, rendering much of this resource latent capital rather than active income. In stark contrast, Nigeria's 800,000 to over 1 million hectares of the exotic, naturalized *Bambusa vulgaris*. The prevalence of *B. vulgaris* across Nigeria, Ghana and Uganda (Adu-Poku et al., 2023; Rosulu et al., 2020) creates a low-barrier-to-entry livelihood corridor. This species' rapid growth, ease of propagation and hollow-stemmed workability lower the technical and capital requirements for smallholder farmers and artisans. This explains why Uganda's relatively tiny 55,000 ha plantation sector can support a vibrant network of craft co-operatives and toothpick factories, while Ethiopia's massive 1.4 million ha reserve remains disproportionately underutilised for direct rural income. Therefore, policies aimed at maximizing socioeconomic returns must be calibrated to species biology: Ethiopia requires investment in mechanized extraction and centralized carbonization hubs, whereas Nigeria and Uganda benefit most from distributed micro-enterprise support and craft design innovation.

The socioeconomic potential of bamboo across Ethiopia, Ghana, Nigeria, Tanzania and Uganda diverges sharply along two axes: energy security versus construction substitution, and rural livelihood diversification versus urban affordability. Ethiopia stands as a clear outlier with robust, quantified evidence: It is estimated to have more than 1.4 million hectares of bamboo forest (Alemayehu and Hido, 2023). The Ethiopia's bamboo is considered as a unique biomass energy powerhouse. According to the International Bamboo and Rattan Organization (INBAR), Ethiopia consumes approximately 116 million cubic meters of wood fuel annually to meet demand for 4 million tonnes of charcoal, a figure projected to rise to 142 million cubic meters by 2033. This provides empirical validation for the potential significant socioeconomic role of bamboo, demonstrating its capacity to function as a substantive secondary income source within integrated rural livelihood strategies (INBAR, 2024). The unsustainable extraction of wood fuel drives deforestation and soil erosion, yet Ethiopia's vast bamboo reserves, comprising roughly two-thirds of Africa's total bamboo cover offer a direct substitute. INBAR and the Ethiopian Clean Cooking Alliance are actively developing a national clean cooking roadmap (2025–2030) that prioritizes bamboo charcoal as a renewable alternative, creating potential employment across harvesting, carbonization and distribution value chains (Fig. 2).

Conversely, Nigeria's 800,000 ha of *Bambusa vulgaris* represents a fundamentally different socioeconomic opportunity centred on affordable housing and urban construction. With an estimated housing deficit exceeding 22 million units and building material costs having more than doubled, with iron rods now costing between N10,000 and N 30,000 per piece, Nigerian engineers and policy makers are actively promoting bamboo as a structural alternative (Guardian, 2025; Vanguard, 2024). Unlike Ethiopia's energy-focused model, Nigeria's bamboo economy generates immediate liquidity for smallholder farmers and aggregators who can harvest and sell poles directly to urban construction markets within short timeframes. Tanzania's 127,000 ha in the Southern Highlands offers yet another model: research published in the *Tanzania Journal of Agricultural Sciences* reveals that local communities utilize bamboo not only for construction and furniture but also for food and beverages (bamboo juice and *ulanzi* wine), basketry and medicine, with indigenous knowledge accounting for 42% of product innovation (Lyimo et al., 2024). Ghana and Uganda, despite smaller resource bases

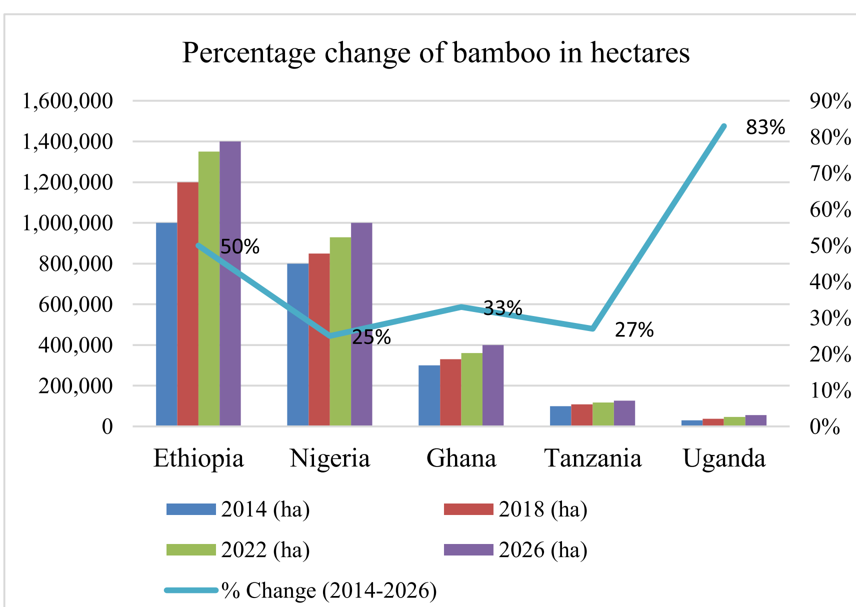

Fig. 2. Bamboo cover 2014 – 2026 in the five selected countries.

(400,000 ha and 55,000 ha respectively), exhibit policy-enabled growth trajectories that maximize value per hectare. Ghana's National Bamboo and Rattan Development Programme, combined with its established wood-furniture export infrastructure, positions it for premium furniture and industrial product manufacturing, with market projections indicating steady growth through 2031. The government's capacity-building programmes and market access initiatives specifically target artisanal-to-industrial scaling, leveraging Ghana's mature timber-sector workforce (Singh, 2025). Uganda's 55,000 ha of *Bambusa vulgaris*, concentrated in accessible districts like Mukono near Kampala, reflects a plantation-led commercialization strategy rather than dependence on remote natural forests. Makerere University research documents that Ugandan farmers primarily access bamboo through NGO-donated seedlings, using it initially for homestead fencing before progressing to value-added products like toothpicks, crafts, and construction materials processed at facilities such as the Bamboo Uganda plant in Mukono. This farm-integrated model, while smallest in total area, generates the highest income density per hectare through proximity to urban markets and targeted processing. In summary, Ethiopia dominates in latent energy potential, Nigeria in construction-sector disruption, Tanzania in diversified rural livelihoods, and Ghana and Uganda in policy-driven value addition each pathway reflecting distinct intersections of species availability, market proximity, and institutional support (Fig. 3).

3.2. Bamboo for livelihood-potential in SSA countries

3.2.1. Bamboo as a sustainable energy source

The conversion of bamboo biomass into charcoal and briquettes represents one of the most immediate pathways for the crop to contribute to both environmental remediation and livelihood enhancement in Sub-Saharan Africa (Lin et al., 2019; Yalew, 2022). The technical foundation is well-substantiated: Bamboo charcoal produced in improved kilns achieves conversion efficiencies of 25–30%, and when compacted into briquettes, delivers a calorific value of ~28 MJ/kg, surpassing traditional wood charcoal with significantly reduced particulate emissions and longer burn duration (Getahun et al., 2024; Tazebew et al., 2023). However, a comparative analysis of Ethiopia, Ghana, Nigeria, Tanzania and Uganda reveals that technical viability is a necessary but wholly insufficient condition for sectoral success. The translation of this bioenergy potential into measurable livelihood gains is mediated by three interlocking variables: Feedstock accessibility, value chain governance and policy coherence, whose specific configurations explain the divergent national trajectories observed across the region. Development and agroforestry stakeholders, including the International Network for Bamboo and Rattan (INBAR), argue that bamboo has rapid growth and high biomass yield, which could reduce deforestation, generate green jobs and supply renewable energy (Daza Montaño and van Dam, 2021). However, this techno-optimistic narrative depends on critical, context-specific analysis. Rather than offering automatic benefits, the success of bamboo success hinges on addressing challenges related to species selection, land tenure, market dynamics and technological access factors that are often understated in the advocacy literature (Alamerew et al., 2024).

Bamboo charcoal and briquettes provide a sustainable alternative to traditional wood charcoal, helping to address deforestation and improve indoor air quality. The technology is simple, scalable and suitable for community-level enterprises. Case studies from Ethiopia and Ghana show improved fuel efficiency and income generation for producer groups (Ndegwa et al., 2020; Tazebew et al., 2023). The production of bamboo charcoal and briquettes represents one of the most immediate and scalable opportunities for bamboo to contribute to sustainable livelihoods and environmental remediation in SSA (Yalew, 2022). This value chain directly addresses two critical regional crises: Rampant deforestation driven by wood fuel demand and the public health burden of indoor air pollution from traditional solid fuels. Bamboo charcoal is produced through the pyrolysis of bamboo biomass in kilns, a technology readily transferable to rural communities (Okimiji, 2024). Compared to traditional earth-mound kilns for wood charcoal, modern retort or drum kilns designed for bamboo can achieve higher conversion efficiencies (25–30% by weight) and significantly reduce harmful emissions during production (Tazebew et al., 2023). The resulting charcoal can be compacted with a binder (such as cassava or maize starch) into uniform briquettes. These briquettes offer superior burning characteristics to both wood charcoal and raw bamboo charcoal, including higher calorific value (~28 MJ/kg compared to ~25 MJ/kg for wood charcoal), longer burn time, lower smoke emission and consistent quality (Gitau et al., 2019).

Ethiopia presents the paradigmatic case of policy-led latency. The nation possesses Africa's largest bamboo reserve (~1.4 million ha), a dedicated Bamboo Directorate, an interim FSC National Standard for

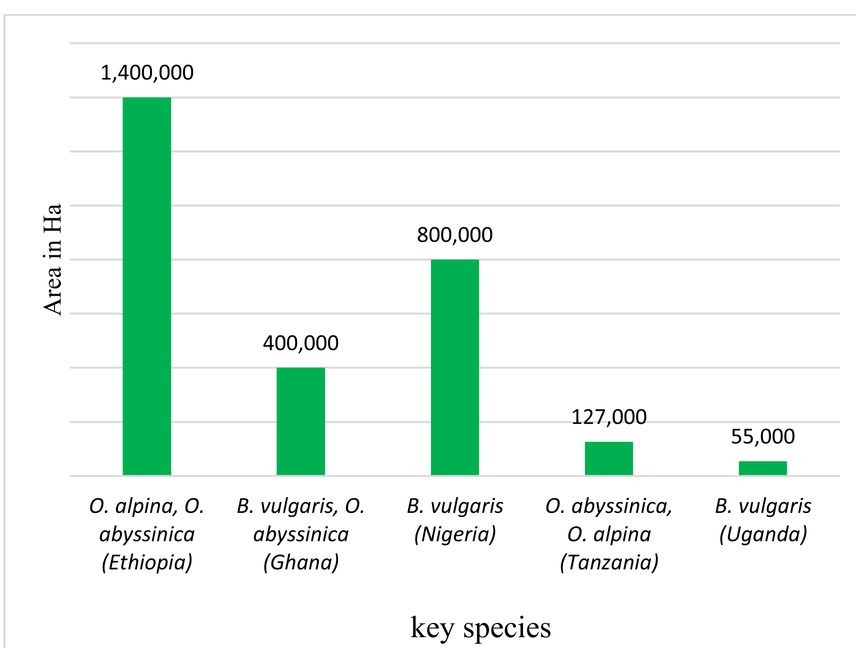

Fig. 3. Bamboo sector profile in the five selected countries.

certification, and a National Clean Cooking Roadmap (2025–2030) that explicitly integrates bamboo charcoal as a sustainable biomass alternative (INBAR, 2024; UNDO, 2025). Pilot initiatives such as the GIZ-supported Africa Bamboo and Renewable Energy Development (ABRDE) project have demonstrated that community-based enterprises can increase group incomes by over 40% while producing fuel that outperforms conventional wood charcoal (Waudo et al., 2023). Yet, despite this robust institutional architecture, widespread adoption remains elusive. The critical bottleneck is feedstock accessibility. Ethiopia's dominant native species (*Oldeania alpina* and *Oxytenanthera abyssinica*) are concentrated in remote highland regions (Assosa, Benshangul-Gumuz) where the rural feeder road infrastructure is severely deficient. This spatial disconnect between resource location and major consumption centres renders Ethiopia's vast bamboo latent capital technically available but economically inaccessible. The policy framework is world-class; the logistics are not.

Ghana occupies a balanced middle ground that yields the most consistent, albeit geographically localised, livelihood returns from bamboo bioenergy. The Bamboo and Rattan Development Programme (BARADEP) has facilitated community-based briquette production in deforestation-prone regions such as Ashanti, with documented household cost savings and competitive market performance (Agyeman et al., 2020). Ghana's resource base (~400,000 ha of mixed *B. vulgaris* and *O. abyssinica*) is modest compared to Ethiopia and Nigeria, but this limitation is offset by stronger institutional support for value chain coordination and a policy environment sufficiently coherent to enable replication of successful models. Ghana's configuration of adequate feedstock, appropriate technology dissemination through development partners and moderate policy support suggests that balanced, coordinated investment across all three variables yields higher marginal returns than excellence in any single dimension. Studies such as Acheampong et al. (2021) and Nalule and Acheampong (2021) in Ghana have reported that while bamboo cultivation can provide income for rural smallholders, the most profitable segments of the bamboo value chain involve producing bamboo briquettes (which requires costly machinery) and marketing them (which requires urban market access). These segments are often captured by urban-based entrepreneurs who can afford the necessary equipment. This creates a "livelihood paradox": The rural poor, who supply the raw labour and material, may see minimal income gains, potentially replicating the very exploitative patterns found in the traditional wood charcoal sector. In Nigeria, where informal charcoal production is a major source of livelihood for millions, formalising the bamboo sector without deliberate pro-poor policies could marginalise existing producers. Consequently, the argument for sustainable livelihoods must extend beyond mere job creation to critically analyse value chain governance, access to capital and the distribution of profits, issues that are frequently side-lined in high-level policy reports advocating for bamboo.

A further challenge is that much of the literature treats the potential of bamboo as a crop separately from the realities of land tenure and cultural contexts. This is especially important in Uganda and Ethiopia, where customary land rights are prevalent and often insecure. Clifton-Brown et al. (2023) and He et al. (2022) emphasise that perennial biomass projects require secure, long-term land access. Establishing bamboo plantations for charcoal on land subject to competing claims or communal ownership, as seen in rural Uganda, can spark social conflicts and threaten local livelihoods the very issue these initiatives seek to resolve. In Ethiopia, bamboo's longstanding image as a "poor man's timber" or a weed may also be discouraging its expansion as a commercial energy source (Zelalem et al., 2019). Bamboo can be used to produce charcoal and briquettes, providing an alternative to traditional wood fuels that contribute to deforestation and environmental degradation. This is particularly relevant in countries like Ghana, where charcoal production is a major driver of deforestation (Partey et al., 2017).

A significant body of literature uncritically promotes bamboo as an inherently sustainable feedstock for charcoal and briquettes, framing it primarily as a fast-growing carbon sink that alleviates pressure on native forests (Embaye, 2000; Lathwal et al., 2024). While this narrative is compelling, it risks oversimplification by neglecting the crucial role of species selection, management practices and local ecological context. As argued by Alemayehu and Hido (2023), the designation of bamboo as "sustainable" is not automatic; certain monopodial, running species can become invasive, outcompeting indigenous vegetation and reducing biodiversity, thereby undermining the very ecological resilience it is purported to support. Furthermore, the localised sustainability of a bamboo stand says little about the energy efficiency and emissions profile of the conversion technology. If harvested bamboo is carbonized in traditional earth mounds, which have low thermal efficiency and high emissions of methane and particulate matter, the net environmental benefit is severely compromised (Tripathi et al., 2024). Therefore, to attribute sustainability to the plant itself, rather than to the integrated socio-ecological system of species, management and technology, is a theoretical misstep that could lead to poorly designed interventions with unintended negative consequences.

Proponents of bamboo energy enterprises often highlight its potential to create pro-poor livelihood opportunities across the value chain, from cultivation and harvest to processing and marketing. However, this optimistic view frequently glosses over the significant structural barriers that can prevent local communities from capturing meaningful economic benefits. As critiqued by Mwampamba et al. (2013), in the context of general biomass energy, the transition from informal, subsistence charcoal production to a formalized, quality-controlled briquette enterprise requires substantial capital investment in processing machinery, which often places ownership and the lion's share of profits in the hands of urban entrepreneurs, not rural smallholders. This creates a "livelihood paradox" where the rural poor, who supply the raw labour and material, remain in a precarious economic position, potentially replicating existing exploitative patterns within the biomass trade. The success of bamboo charcoal and briquettes as a true livelihood enhancer is thus contingent not only on the resource's availability, but also on the development of inclusive business models, access to microfinance and supportive policies that deliberately prioritize benefit-sharing with local communities, factors that are often underemphasized in the techno-centric literature.

A central tenet of the argument for bamboo-based energy is its scalability and potential to compete with, and eventually displace, conventional wood charcoal, a sector often decried as unsustainable (Iroegbu and Ray, 2021). While the theoretical potential is vast, this perspective can be challenged on the grounds of economic viability and consumer preference. As shown by work in Ghana and Ethiopia, the price point of professionally-produced bamboo briquettes is often higher than that of traditional charcoal, making them unaffordable for the low-income households that constitute the primary market (Alemzero et al., 2021). This price disparity is not merely a temporary market inefficiency but is rooted in the nascent and capital-intensive nature of the bamboo processing industry. Moreover, cultural and culinary preferences for the specific burning characteristics and flavour imparted by traditional wood charcoal present a significant, non-economic barrier to adoption that technical reports frequently underestimate (Sharma et al., 2015). Consequently, to assume a straightforward, linear path to scalability ignores the entrenched socio-economic dynamics of the energy market. A more nuanced argument would posit that bamboo briquettes are likely to remain a niche or complementary product for the foreseeable future, serving middle-class urbanites or specific institutional clients, rather than achieving the widespread displacement of conventional charcoal that many advocates envision.

The policy implications are differentiated and actionable. Ethiopia must prioritize rural infrastructure investment, specifically feeder roads connecting highland bamboo stands to processing hubs, to unlock its latent feedstock potential. Nigeria requires deliberate pro-poor policies, including support for cooperative ownership of briquetting machinery and formalization of value chain governance, to ensure that market proximity translates into equitable livelihood benefits. Ghana's balanced model offers a replicable template, suggesting that moderate, coordinated investments across accessibility, technology and policy yield the highest marginal returns. Tanzania and Uganda would benefit most from targeted technology transfer programs focused on affordable, locally-fabricated briquetting equipment and associated skills training. Across all five nations (Table 2), resolving land tenure ambiguities remains foundational: Perennial biomass projects on land subject to competing claims or insecure customary rights risk exacerbating social conflicts and undermining the very livelihood security they seek to enhance (Chappa, 2025).

Table 2
Bamboo contribution to natural capital.

Country	Contribution to the natural capital	Key citations
Ethiopia	Bamboo offers significant environmental benefits by rapidly sequestering carbon to mitigate climate change, while its extensive root system prevents soil erosion and rehabilitates degraded land, protecting watersheds and regulating water cycles. Additionally, it supports biodiversity by providing unique habitat and food sources for endemic wildlife.	(Tesfaye et al., 2022; Wakweya, 2023)
Ghana	Combating deforestation and desertification: Acts as a green barrier in northern savannas, restoring cover and reducing wind erosion. Sustainable biomass energy: Provides a fast-growing alternative to timber for charcoal, reducing pressure on natural forests. Rehabilitation of mined lands: Used for phytoremediation and revegetation of degraded artisanal gold mine sites. Riparian zone restoration: Stabilizes riverbanks and filters agricultural runoff, improving water quality.	(Asare et al., 2021; Nketiah et al., 2022)
Nigeria	Bamboo provides multifaceted environmental benefits across Nigeria. Its robust root system stabilizes erosion-prone coastlines, riverbanks and infrastructure in the Niger Delta. In cities such as Lagos, it mitigates pollution and urban heat by absorbing particulates and CO_2. When integrated into farms, bamboo enhances soil fertility through improved structure and organic matter. Additionally, it creates vital habitat corridors, reconnecting fragmented forests for wildlife	(Isukuru et al., 2023; Onyekwelu et al., 2021)
Uganda	Bamboo serves multiple critical environmental functions in Uganda, particularly in its highland regions. It stabilizes steep slopes such as those of Mount Elgon, preventing landslides and soil erosion, while its forests in these vital watersheds protect and filter water for the Nile's headwaters. Furthermore, bamboo stands act as buffer zones around protected areas, reducing human-wildlife conflict, and increase carbon storage when integrated into agricultural landscapes.	(Abebe et al., 2026; Emamverdian et al., 2020)
Tanzania	Bamboo plays a vital role in Tanzania's dryland and woodland ecosystems, leveraging its natural resilience to drought and fire to restore vegetation and soil in degraded areas such as the miombo woodlands. It serves as a natural protector of vital water sources, safeguarding catchment areas for rivers and lakes that feed major systems like Lake Victoria, thereby regulating water quality and flow. Its dense stands enhance biodiversity by providing specialized habitat and food sources within these woodlands. Furthermore, bamboo functions as a key sustainable local resource, supplying construction and fuel materials to communities, which in turn alleviates harvesting pressure on native forests.	(Masisi et al., 2022)

The energy sector in SSA is dominated by biomass, with traditional wood charcoal being a primary cooking fuel for urban and peri-urban populations, driving widespread deforestation. Bamboo presents a compelling renewable alternative (Derebe et al., 2025; Waudo and Waswa, 2024). Its high calorific value and rapid regeneration cycle (3–5 years to harvestable maturity) make it an ideal feedstock for sustainable charcoal and briquette production (Antwi-Boasiako and Acheampong, 2016).

Projects in Ghana and Ethiopia have demonstrated that bamboo briquettes can perform equivalently to traditional charcoal, offering a cleaner-burning option with lower smoke emissions (Acheampong et al., 2021). The establishment of decentralized, community-based briquetting enterprises could thus address both environmental degradation and energy poverty. Nonetheless, significant barriers persist. The initial capital cost for mechanized briquetting machines is high, often pushing control of the most profitable value chain segments toward urban entrepreneurs, a phenomenon Mwampamba et al. (2013) identified in the broader biomass sector (Table 3). This creates a "livelihood paradox" where rural producers risk being relegated to low-margin raw material suppliers. Overcoming this requires innovative financing models and technologies for low-cost, locally fabricated processing equipment to ensure broader livelihood benefits.

3.2.2. Bamboo for construction, material innovation and economic diversification

The utilization of bamboo in construction and material innovation represents a paradigm shift from its perception as a "poor man's timber" to its recognition as a cornerstone of a modern, sustainable bio-economy in SSA (Taib et al., 2023). The scholarly literature is increasingly highlighting bamboo's exceptional mechanical properties, notably its high tensile strength-to-weight ratio, which surpasses that of many softwoods and even rivals mild steel, making it an ideal material for cost-effective, earthquake-resilient construction (Sreadha and Pany, 2020). This engineering potential is being operationalized across SSA through initiatives promoting its use in housing, scaffolding and rural infrastructure, directly addressing the region's critical infrastructure deficit with a low-carbon, locally sourced alternative to imported steel and concrete (Peng et al., 2025). However, the transition from traditional use to modern engineered application faces significant headwinds, primarily rooted in a lack of standardized processing and treatment protocols. As noted by Sharma and van der Vegte (2020), the durability of bamboo structures is contingent upon effective treatment against insect and fungal attack, yet the dissemination of affordable and safe preservation technologies, such as boron-based dipping systems, remains inconsistent, leading to variable quality and undermining market confidence.

Beyond primary construction, the sector's potential for economic

Table 3
Analysis of wood charcoal vs. bamboo briquettes.

Characteristic	Traditional wood charcoal	Bamboo briquettes
Feedstock renewability	Slow (decades), often unsustainably harvested	Rapid (3–5 year cycles), sustainably managed
Calorific value	~25 MJ/kg	~28 MJ/kg
Burn Time	Standard	Longer, more consistent
Smoke and & PM 2.5 emissions	High	Significantly lower
Production technology	Often, inefficient earth mounds	Improved kilns (retorts) and briquetting
Primary livelihood benefit	Informal, often exploitative value chains	Structured, community-enterprise potential

diversification is deeply connected to material innovation and value-added processing. The development of engineered bamboo products, such as laminated bamboo lumber (LBL), cross-laminated bamboo (CLB) and bamboo-based composites, opens pathways for industrial-scale manufacturing and entry into high-value export markets. These innovations convert the raw culm into a standardised, durable and versatile industrial material suitable for flooring, panelling and furniture, thereby creating opportunities for specialised small and medium enterprises (SMEs). Research by Gelaw et al. (2025) on Ethiopian bamboo value chains shows that such secondary processing can increase the economic value of the raw material by 300% or more, significantly boosting its livelihood generation potential. This shift from a commodity to a specialised product is vital for economic diversification, as it elevates the regional economy up the value chain, creating skilled jobs in design, manufacturing and marketing, and reducing dependence on raw material exports.

A comparative analysis of the five focus countries reveals distinct trajectories, innovation hotspots and shared systemic barriers in the development of bamboo-based construction and engineered materials. While all nations recognize the potential, their advancement is uneven, shaped by differing levels of policy support, investment and integration into formal economic systems (Table 4).

Ethiopia demonstrates the technical end-point of industrial processing but highlights the challenge of market creation. Ghana and Uganda show viable pathways for incremental upgrading of traditional uses through skills development and treatment. Nigeria and Tanzania underscore the foundational need for coherent policy and raw material base development.

3.2.3. Bamboo furniture and handicrafts: artisanal foundations and the innovation imperative

The furniture and handicrafts value chain represents a significant application of bamboo across Sub-Saharan Africa, particularly benefiting women, youth and rural communities. However, a comparative analysis of Ethiopia, Ghana, Nigeria, Tanzania and Uganda reveals several common challenges that hinder sustainable growth, such as product standardization, quality and market access. In Ethiopia, women's associations primarily weave highland bamboo into household items. While this provides essential income, low market prices and traditional designs limit profitability and appeal in higher-value markets (Girma and Senapathy, 2022; Wakweya, 2023). Efforts by the Bako National Agricultural Research Centre to introduce improved splitting and weaving tools have increased productivity, but design remains largely traditional, limiting appeal in higher-value markets. Formal furniture making is nascent, often replicating wooden designs without adapting to bamboo's aesthetic and mechanical properties (Jiang, 2025).

In Ghana, there has been successful design-led upgrading, with artisans transitioning from basic furniture to contemporary designs, supported by institutions like KNUST and initiatives such as "Job 600", which increased bulk production for institutions (Eri et al., 2019). Furthermore, exporters in Accra have successfully adapted products for the international "natural aesthetic" market, although they face challenges with volume consistency and phytosanitary certification (Osei-Kufuor et al., 2024).

Nigeria's large bamboo sector is mostly informal and urban-focused, but it faces challenges, including the use of untreated bamboo. Nevertheless, high-end designers in major cities show potential for market differentiation. In Tanzania, bamboo handicrafts linked to tourism have increased artisan incomes, but challenges such as seasonality and a lack of design innovation remain. Uganda's cooperative models, such as the "Basket of Bunyoro", highlight the benefits of organization, successfully producing standardized furniture for both domestic and export markets. These cases illustrate the importance of transitioning from individual artisan efforts to organized, business-oriented structures for sector transformation (Table 5).

The furniture and handicrafts chain is the "beating heart" of the bamboo livelihood economy in SSA, offering immediate and inclusive employment. The comparative analysis reveals a sector at a crossroads. While countries like Nigeria and Ethiopia illustrate the risks of informality and stagnation, the cases of Ghana and Uganda provide a roadmap for upgrading based on design innovation, cooperative enterprise and strategic market linkage. The priority intervention is not simply increasing production, but curating a systemic upgrade: Enhancing capabilities (design, business and technical), improving access to

Table 4
Comparative analysis of construction and engineered materials value chain.

Country	Primary applications	Policy and strategy support	Key innovation/ Case study	Major constraint
Ethiopia	Laminated boards, flooring (industrial).	High (integrated in CRGE, National Strategy).	Gurage BMB Factory for export-oriented production.	Weak local market; high cost vs. imports.
Ghana	Scaffolding, affordable housing pilots.	Medium (BARADEP under Forestry Commission).	KNUST research on structural connections & standards.	Dominance of informal, low-value use; safety issues.
Nigeria	Interior design, prospective structural use.	Medium (Draft National Policy).	Youth-led startups in urban centres (Lagos, Abuja).	Lack of raw material supply chain; low industry awareness.
Tanzania	Erosion control, traditional rural housing.	Low (strategy exists, weak implementation).	Bamboo-cement composites pilot in Morogoro.	Niche use; limited processing technology and market access.
Uganda	On-farm construction, community projects.	Low (aligned with agroforestry, not industry).	Youth groups producing treated poles and trusses.	Absence of industrial strategy; limited value addition.

Table 5
Comparative analysis of furniture and handicrafts value chain.

Country	Sector focus and strength	Key innovation/ Case study	Major constraint	Policy/ support context
Ethiopia	Women-led traditional weaving (baskets, mats).	Improved tool introduction by research centres (e.g., Bako).	Deeply traditional designs; low-value local markets.	Limited, part of broader SME support.
Ghana	Design innovation; institutional and export markets.	"Job 600" parliamentary furniture contract.	Scaling production while maintaining quality.	Active support via NBSSI and KNUST partnerships.
Nigeria	Large-scale, low-cost urban furniture.	Emerging high-end fusion furniture niche in Lagos.	Pervasive use of untreated bamboo; low quality.	Lacks targeted policy or support programmes.
Tanzania	Tourist-oriented handicrafts; women's groups.	Kilimanjaro Women's Group accessing tourist markets.	Market seasonality; derivative souvenir designs.	Linked to tourism policy, but not industrial policy.
Uganda	Organized cooperatives for export and high-end domestic consumption.	"Basket of Bunyoro" cooperative model for contract sales.	Maintaining consistent supply of quality raw material.	Strong NGO/ development partner project support.

appropriate technology and forging direct connections to higher-value markets (Fig. 4).

3.2.4. Edible bamboo shoots for nutrition

The consumption and nutritional value of edible bamboo shoots present a varied but promising picture across several African nations, blending traditional foodways with emerging agricultural policy. As a nutritious, non-timber forest food, bamboo shoots provide an opportunity to enhance dietary diversity, improve food security and generate income through both fresh and processed markets. However, their development is still in its early stages, constrained by low awareness, limited technical knowledge on processing and underdeveloped market systems. A comparative analysis shows sporadic, project-driven initiatives across five focus countries, indicating significant potential for systematic upscaling. In Ethiopia, the tradition of consuming bamboo shoots (from *Oldeania alpina* (syn. *Arundinaria alpina* K.Schum.) and *Oxytenanthera abyssinica*) is most established within the Sidama and Gurage zones (Feleke, 2013). Here, shoots are processed through fermentation to create preserved foods known as *"Sasa"* or *"Kotcho"*, which serve as a crucial buffer against seasonal food insecurity. These fermented shoots retain valuable dietary fibre, potassium and amino acids, contributing to local micronutrient intake. This longstanding practice is now being reinforced by modern initiatives that promote bamboo agroforestry for its dual benefits in land restoration and sustainable nutrition (Embaye et al., 2005; Tavani, 2019).

Moving to East Africa, Tanzania and Uganda also incorporate bamboo shoots into local diets. In Tanzania, communities in the Usambara and Uluguru Mountains harvest species such as *Oldeania alpina*, typically boiling and soaking the shoots before adding them to stews. This practice provides a supplementary vegetable rich in fibre, vitamins B6 and E, potassium and zinc (Mulatu et al., 2019). Similarly, in Uganda, shoots from species such as *Bambusa vulgaris* are consumed in bamboo-rich highland areas after careful processing to remove natural toxins (Wang et al., 2020). The resulting vegetable is a source of fibre, protein and beneficial antioxidants, highlighting its potential role in addressing malnutrition (Bajwa et al., 2021). Both countries are now framing bamboo within national strategic plans, linking its sustainable harvest to community nutrition and economic resilience. In Ethiopia, there is localized consumption alongside initial agronomic research, but significant gaps in processing knowledge and market development remain. In Ghana, there is a complete awareness gap, presenting a unique opportunity for the introduction of bamboo shoots given the country's horticultural capacity (Addo-Danso et al., 2019; Adebowale & Agumba, 2025).

In West Africa, the use of bamboo shoots is more emergent but equally significant. In Ghana, the primary focus is on *Bambusa vulgaris*. Research has identified the processed shoots as a valuable functional food, high in protein, fibre and minerals like potassium and phosphorus, yet low in fat (Sasu et al., 2025). Its promotion as a non-timber forest product aligns with goals for climate-smart agriculture and improved rural nutrition. Nigeria shares a similar context, where species such as *Bambusa vulgaris* offer shoots containing protein, carbohydrates, calcium, magnesium and iron (Isukuru et al., 2023). Despite being underutilized, these shoots are recognized within national agricultural policy for their potential to enhance food and nutrition security through agroforestry systems.

Across these countries, edible bamboo shoots represent a convergent point of traditional knowledge, nutritional science and sustainable development policy, offering a resilient food source with substantial potential for improved dietary outcomes (Table 6).

Ethiopia is repeatedly identified in the literature as the largest bamboo holder in Africa and the country with the most detailed published assessments; measured area, species signals, and distribution, current uses, quantified livelihood contributions and reported management challenges (Gelaw et al., 2025).

3.2.5. Bamboo for environmental protection

Across Sub-Saharan Africa (SSA), bamboo is emerging as a critical resource for enhancing natural capital and building socio-ecological resilience (Wakweya, 2023). As a fast-growing, perennial grass, it provides a suite of ecosystem services that directly address the region's pressing challenges of land degradation, deforestation, climate change and water scarcity (Asbjornsen et al., 2014). To accelerate the adoption of bamboo, policy levers such as incentives for sustainable cultivation,

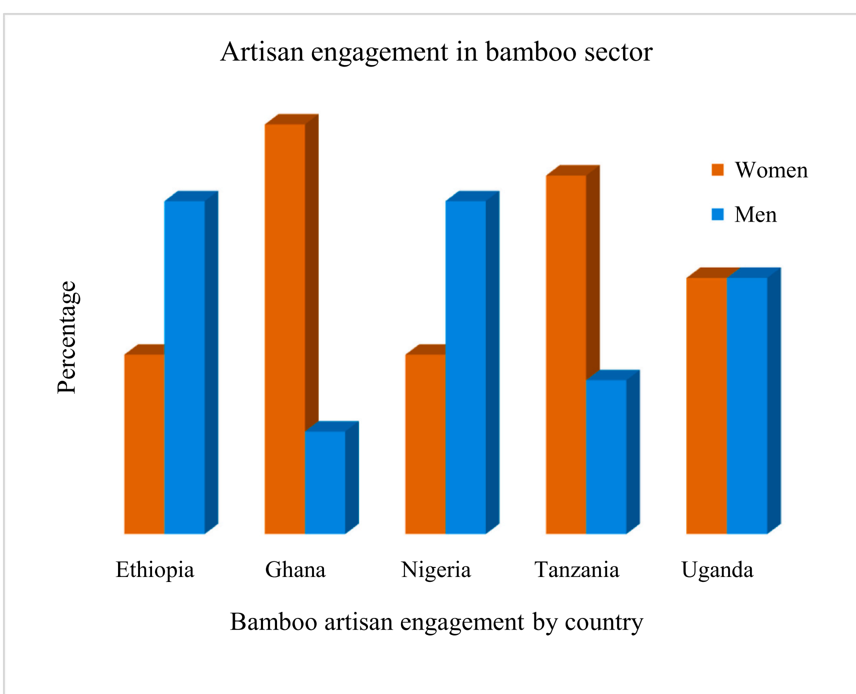

Fig. 4. Artisans of bamboo across the countries by gender.

Table 6
Comparative analysis of edible shoots value chain.

Country	Stage of development	Key driver/ initiative	Primary market	Major constraint
Ethiopia	Traditional/ R&D Stage	EIAR/BNMRC agronomic research.	Localized, non-commercial consumption.	Low public awareness of processing; no market chain.
Ghana	Awareness gap	None currently; latent opportunity.	Non-existent.	Complete lack of knowledge and cultivation practice.
Nigeria	Import-substitution opportunity	NIHORT species evaluation; urban demand.	Urban restaurants (imports currently).	No commercial cultivation; reliance on imported know-how.
Tanzania	Pilot commercial processing	NGO/TAFORI processing project (canning/ pickling).	Urban supermarkets (niche).	Supply chain consistency; food safety standards.
Uganda	Nutrition-security Integration	ICRAF agroforestry and nutrition programmes.	Household consumption, local barter.	Absence of processing and formal market structures.

regulations that promote environmental conservation and public-private partnerships can play a crucial role (Oduro et al., 2020). These tools will enable policymakers to envision practical steps, creating a supportive framework for bamboo the strategic cultivation and management. This encompasses both native species like *Oxytenanthera abyssinica* and *Oldeania alpina* and well-managed introduced species, offering a multifaceted pathway to restore and sustain the ecological foundations upon which African economies and livelihoods depend (Ahmad et al., 2025).

A primary contribution of bamboo across the SSA region is its profound capacity for land restoration and erosion control. In the erosion-prone highlands of Ethiopia and Uganda, the extensive rhizome systems of bamboo bind soil particles, stabilising steep slopes and preventing landslides, thereby protecting vital agricultural land and infrastructure downstream (Anjulo et al., 2022; Tardio et al., 2018). Similarly, in the Niger Delta of Nigeria and the savanna regions of Northern Ghana, bamboo plantations act as bio-shields against coastal and wind erosion, while also demonstrating significant potential for the phytoremediation of degraded lands, including those abandoned by artisanal mining activities (Akwada & Akinlabi, 2018; E. J. Isukuru et al., 2023). This restorative function is coupled with a critical role in watershed protection and hydrological regulation. Bamboo forests in the highland catchments of Uganda and Ethiopia, and the miombo woodlands of Tanzania, enhance groundwater recharge, reduce surface runoff and filter water, thereby regulating the flow and quality of water for major river systems, including the Nile Basin and the waterways feeding Lake Victoria (Mubiru et al., 2025; Nadir et al., 2024). Furthermore, bamboo stands are powerful agents for climate change mitigation and adaptation. Their rapid growth rate translates into high rates of carbon sequestration, making them valuable carbon sinks that contribute to national climate goals under the Paris Agreement (Abebe et al., 2023; Ayer, 2025). This mitigation capacity is complemented by its role in adaptation; by providing a sustainable, rapidly renewable source of biomass, bamboo directly reduces pressure on native forests for fuelwood, thus combating deforestation a key driver of emissions in countries like Ghana and Tanzania. This provision of sustainable biomass energy in the form of charcoal and briquettes not only conserves forest capital but also addresses energy poverty, creating a virtuous cycle for natural resource management.

3.3. Bamboo for sustainability

Bamboo is a strategic resource for achieving the 2030 Agenda, with the potential to contribute directly to multiple SDGs. Research from Ethiopia confirms that bamboo biomass utilization for energy directly contributes to SDG 7 (Affordable and Clean Energy) by providing a renewable alternative to wood fuel, reducing deforestation and creating employment in the value chain (Lohani et al., 2024; Mandaliya, 2026). Likewise, bamboo has a significant role as an excellent carbon sink, absorbing almost double the carbon dioxide of trees, while its extensive root systems bind soil and prevent erosion, advancing SDG 13 (Climate Action) (IFAD, 2020). Furthermore, bamboo has proven ability to quickly revegetate severely damaged landscapes including former brickmaking sites in India and degraded mining areas in Ghana, directly supports SDG 15 (Life on Land) and the UNCCD's Land Degradation Neutrality targets (Garai et al., 2025). From a socioeconomic perspective, the Dutch-Sino-East Africa Bamboo Development Programme demonstrated bamboo has cross-cutting impact by supporting 31 co-operatives, creating employment for over 3100 youth and women, and specifically training 5100 women in bamboo charcoal and cook stove technologies, thereby advancing SDG 1 (No Poverty) and SDG 5 (Gender Equality) (Table 7).

A comparative assessment reveals that while all five countries leverage bamboo for sustainable development, Uganda and Ethiopia demonstrate the most advanced and institutionalised approaches to SDG attainment (INBAR (2018)b). Uganda stands out for its comprehensive policy integration and multi-sectoral partnership model. The country has established a dedicated Bamboo Unit within the National Forestry Office and developed a 10-year Bamboo Strategy targeting the planting of 2.5 million hectares by 2030. Critically, stakeholders are now actively convening to translate this strategy into a formal National Bamboo Policy to guide investment and industrialisation, with over 1000 bamboo nurseries now operating nationwide. This institutional anchoring, combined with private-sector commitments such as Housing Finance Bank's initiative to plant one million bamboo plants, represents tangible progress toward SDG 17 (Partnerships for the Goals) and SDG

Table 7
Bamboo for sustainability.

Country	Primary SDG Focus	Key Achievements & Policy Status
Uganda	Policy mainstreaming and green economy (SDG 11, 13, 17)	Established Bamboo Unit in National Forestry Office; National Bamboo Policy under development; 1000 + nurseries operating; active multi-stakeholder platform coordinating sector growth.
Ethiopia	Clean energy and livelihoods (SDG 1, 7, 13)	~1.4 million ha bamboo resource; National Clean Cooking Roadmap (2025–2030) integrating bamboo charcoal; Interim FSC National Standard approved for bamboo certification; Bamboo Directorate operational.
Ghana	Land restoration and ecosystem repair (SDG 15)	Proven use of bamboo to restore degraded mining sites; research confirms the effectiveness of biochar and poultry manure amendments for bamboo establishment on degraded lands.
Tanzania	Integrated rural development (SDG 1, 2)	Beneficiary of EU-IFAD poverty alleviation programs targeting bamboo productivity; focus on sustainable rural development and food security integration.
Nigeria	Sustainable construction and housing (SDG 9, 11)	800,000 ha of *B. vulgaris*; growing recognition of bamboo for affordable housing to address 550,000-unit annual deficit; sector awaiting formal standards integration into National Building Code.

11 (Sustainable Cities) (FAO, 2026). Ethiopia, possessing the continent's largest bamboo reserve, channels its resources primarily toward energy security and rural livelihoods (SDG 7). The government is developing a national clean cooking roadmap (2025–2030) that prioritises bamboo charcoal as a sustainable biomass alternative to address the 116 million cubic meters of wood fuel consumed annually, a figure projected to rise to 142 million by 2033 (UNDO, 2025). With support from EU-IFAD and Dutch-Sino programmes, Ethiopia has also established a Bamboo Directorate and developed interim national FSC standards, strengthening the enabling environment for sustainable management. Ghana and Nigeria, while showing strong momentum in industrial application, particularly in land restoration and construction, respectively, have yet to achieve the same level of policy mainstreaming as their East African counterparts (UNCCD, 2026). Therefore, Uganda emerges as the current leader in bamboo-related SDG attainment due to its deliberate and coordinated policy development, robust stakeholder engagement, and integration of bamboo into national green growth strategies. Ethiopia follows closely with immense resource-based potential now being unlocked through a targeted clean energy policy. Nigeria possesses significant potential for construction-sector transformation but requires regulatory action to formalize bamboo role (INBAR, 2024). This comparative analysis underscores that while natural resource endowment is important, institutional commitment and policy coherence are the decisive factors in translating bamboo has potential into measurable progress on the 2030 Agenda.

3.4. Policy implications and practical recommendations

Translating these insights into action requires differentiated, context-specific strategies. Ethiopia should prioritize rural infrastructure investment, particularly feeder roads connecting highland bamboo stands to processing hubs, to unlock its latent industrial potential. Nigeria requires deliberate pro-poor policies, including support for cooperative ownership of briquetting machinery and formalization of the bamboo construction supply chain, to ensure that market proximity translates into equitable livelihood benefits. Ghana's balanced configuration of adequate feedstock, institutional support, and market linkages offers a replicable template for coordinated, moderate-scale investment yielding high marginal returns. Tanzania and Uganda would benefit most from targeted technology transfer programmes focused on affordable, locally fabricated processing equipment and skills training. Across all five nations, resolving land tenure ambiguities and addressing the persistent perception of bamboo as a "poor man's timber" remain foundational prerequisites for sectoral transformation.

3.5. Limitations and future direction

This review is constrained by several limitations: reliance on English-language publications excluded potentially relevant non-English sources; 63 full-text reports were inaccessible, introducing possible publication bias; data quality varied substantially across countries, with Ethiopia and Ghana benefiting from more robust inventories than Nigeria and Tanzania; the geographic focus on five nations limits generalizability to other Sub-Saharan African contexts; the temporal scope (2014–2026) cannot capture long-term ecological dynamics or policy maturation; and the synthesis of existing evidence does not substitute for primary data generation through household surveys or controlled trials.

Future research should prioritize mixed-methods approaches that combine household-level socioeconomic surveys with value chain mapping and controlled agronomic trials to generate robust, comparable data across the five countries. Longitudinal studies are needed to assess the durability of livelihood impacts from bamboo-based interventions over time, particularly the extent to which cooperative ownership models and technology transfer programs produce sustained income gains versus short-term project-driven benefits. Additionally, research on climate-resilient species selection and management practices is essential to inform adaptation strategies as rainfall patterns and temperature regimes shift across Sub-Saharan Africa. Comparative policy analysis examining the institutional conditions under which national bamboo strategies translate into measurable sectoral growth would provide valuable guidance for policymakers. Finally, life-cycle assessments of bamboo charcoal and construction materials relative to conventional alternatives would strengthen the evidence base for the environmental claims and support integration into carbon markets and green building standards of bamboo.

4. Conclusion

This review confirms that bamboo holds significant, yet conditional, potential for fostering sustainable livelihoods across Sub-Saharan Africa. The five countries profiled stand at the forefront of a potential bamboo revolution in Sub-Saharan Africa. The multi-functionality of this versatile grass, spanning renewable energy, affordable housing, artisanal employment, nutritional supplementation and ecosystem restoration, positions it uniquely to address the interconnected crises of energy poverty, environmental degradation and rural livelihood insecurity. Ethiopia's policy-led approach and Ghana's innovation-driven model provide compelling proof-of-concept. Uganda's institutional mainstreaming demonstrates the primacy of governance over resource scale. Nigeria's market-driven momentum signals the latent demand awaiting formalization. However, realizing this potential requires moving beyond generalized advocacy and isolated pilot projects toward integrated, systemic interventions. The "bamboo-livelihoods nexus" framework proposed here in emphasizing synergistic action across policy alignment, decentralized processing infrastructure, inclusive business models and climate-resilient species research offers a roadmap for this transition. Bamboo should therefore be recognized not as a marginal forest product or a panacea for rural poverty, but as a strategic cornerstone of a green, inclusive and climate-resilient future for Sub-Saharan Africa. Its ultimate contribution to the 2030 Agenda and beyond will be determined less by the hectares of standing stock than by the coherence of the institutions, policies, and value chains constructed around it.

CRediT authorship contribution statement

Rusha Begna Wakweya: Writing – original draft, Visualization, Validation, Supervision, Project administration, Methodology, Investigation, Formal analysis, Conceptualization.

Declaration of Generative AI and AI-assisted technologies in the writing process

The author used AI to improve the grammar and readability of the manuscript.

Funding

The author didn't receive any funding.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The data that has been used is confidential.

References

Abebe, S., Gebeyehu, G., Teketay, D., Long, T.T., Jayaraman, D., 2023. Allometric models for estimating biomass storage and carbon stock potential of *Oldeania alpina* (K. Schum.) Stapleton forests of south-western Ethiopia. Adv. Bamboo Sci. 2, e100008. https://doi.org/10.1016/j.bamboo.2022.100008.

Abebe, S., Jayaraman, D., Malinga, M., Perry, A., Reza, S., 2026. Carbon stock of *Oxytenanthera abyssinica* (A.Rich.) Munro forests in northern Uganda: A vital nature-based climate solution. Adv. Bamboo Sci. 14, e100216. https://doi.org/10.1016/j.bamboo.2025.100216.

Acheampong, T., Menyeh, B.O., Agbevivi, D.E., 2021. Ghana's changing electricity supply mix and tariff pricing regime: implications for the energy trilemma. Oil Gas. Energy Law 3 (2021).

Addo-Danso, A., Bulkan, J., Innes, J.L., 2019. Incentives for the development of bamboo plantations in Ghana a case study of the Ashanti and Brong-Ahafo regions. Int. J. For. Res. 21 (2), 131–148. ⟨https://www.jstor.org/stable/27101465⟩.

Adebowale, O.J., Agumba, J.N., 2025. Bamboo in sustainable construction: effects on productivity and safety. Int. J. Product. Perform. Manag. 74 (11), 1–20. https://doi.org/10.1108/IJPPM-06-2023-0307.

Adu-Poku, A., Yaw Obeng, G., Mensah, E., Kwaku, M., Acheampong, E., Gyamfi, A., Adu-Bredu, S., 2023. Assessment of aboveground, belowground, and total biomass carbon storage potential of *Bambusa vulgaris* in a tropical moist forest in Ghana, West Africa. Renew. Energy Environ. Sustain. 8, e3. https://doi.org/10.1051/rees/2023001.

Aduloju, A.A., Adedoyin, T.A., 2024. Economic crisis in Sub-Sahara Africa and its (un) sustainable development implications. In: Jain, V., Mittal, A. (Eds.), Management for Sustainable Development. Apple Academic Press, New York, USA, pp. 117–136.

Agoundedemba, M., Kim, C., Kim, H.-G., 2023. Energy status in Africa: Challenges, progress and sustainable pathways. Energies 16 (23), e7708. https://doi.org/10.3390/en16237708.

Agyeman, Y.N., Newton, S.K., Annor, R.B., Owusu-Dabo, E., 2020. The effectiveness of the revised intermittent preventive treatment with sulphadoxine pyrimethamine (IPTp-SP) in the prevention of malaria among pregnant women in northern Ghana. J. Trop. Med. 2020, e2325304. https://doi.org/10.1155/2020/2325304.

Ahmad, Z., Kumari, R., Mir, B., Saeed, T., Firdaus, F., Vijayakanth, V., Keerthana, K., Ramakrishnan, M., Wei, Q., 2025. Bamboo for the future: From traditional use to industry 5.0 applications. Plants 14 (19), e3019. https://doi.org/10.3390/plants14193019.

Akwada, D.R., Akinlabi, E.T., 2018. Bamboo an alternative wood to reducing tropical deforestation in Ghana. Proc. DII-2018 Conf. Infrastruct. Dev. Invest. Strateg. Afr. Readying Afr. Sustain. Dev. A Capacit. Build. /Empower. Strategy Discourse Livingstone Zamb. 11 13 July 2018 12.

Alamerew, A.N., Kozak, R., Shrestha, A.K., Zhu, Z., Wang, G., 2024. A way for livelihood improvement: Systematic review on bamboo forest research. Trees For. People 16, e100571. https://doi.org/10.1016/j.tfp.2024.100571.

Alemayehu, A., Hido, A., 2023. Determinants and governance of bamboo production and marketing in Ethiopia: A critical review. Adv. Bamboo Sci. 5, e100047. https://doi.org/10.1016/j.bamboo.2023.100047.

Alemzero, D., Acheampong, T., Huaping, S., 2021. Prospects of wind energy deployment in Africa: technical and economic analysis. Renew. Energy 179, 652–666. https://doi.org/10.1016/j.renene.2021.07.021.

Anjulo, A., Mulatu, Y., Kidane, B., Reza, S., Getahun, A., Mulat, S., Abere, M., Teshome, U., 2022. *Oxytenanthera abyssinica* A. Rich. Munro species-site suitability matching in Ethiopia. Adv. Bamboo Sci. 1, e100001. https://doi.org/10.1016/j.bamboo.2022.100001.

Antwi-Boasiako, C., Acheampong, B.B., 2016. Strength properties and calorific values of sawdust-briquettes as wood-residue energy generation source from tropical hardwoods of different densities. Biomass-.-. Bioenergy 85, 144–152. https://doi.org/10.1016/j.biombioe.2015.12.006.

Asare, A., Appiah-Adjei, E.K., Ali, B., Owusu-Nimo, F., 2021. Assessment of seawater intrusion using ionic ratios: the case of coastal communities along the Central Region of Ghana. Environ. Earth Sci. 80 (8), e307. https://doi.org/10.1007/s12665-021-09601-x.

Asbjornsen, H., Hernandez-Santana, V., Liebman, M., Bayala, J., Chen, J., Helmers, M., Ong, C.K., Schulte, L.A., 2014. Targeting perennial vegetation in agricultural landscapes for enhancing ecosystem services. Renew. Agric. Food Syst. 29 (2), 101–125. https://doi.org/10.1017/S1742170512000385.

Avordeh, T.K., Salifu, A., Quaidoo, C., Opare-Boateng, R., 2024. Impact of power outages: Unveiling their influence on micro, small, and medium-sized enterprises and poverty in Sub-Saharan Africa - An in-depth literature review. Heliyon 10 (13), e33782. https://doi.org/10.1016/j.heliyon.2024.e33782.

Ayer, S., 2025. Potential barriers to bamboo-based carbon credit initiatives in Nepal: What stands in the way? Adv. Bamboo Sci. 12, e100179. https://doi.org/10.1016/j.bamboo.2025.100179.

Bahru, T., Ding, Y., 2021. A review on bamboo resource in the African Region: A call for special focus and action. Int. J. For. Res. 2021, e8835673. https://doi.org/10.1155/2021/8835673.

Bajwa, H.K., Santosh, O., Nirmala, C., 2021. Bamboo shoot for food and nutritional security. J. Pharmacogn. Phytochem. 10, 24–30. ⟨https://www.phytojournal.com/archives/2021/vol10issue4S/PartA/S-10-3-37-369.pdf⟩.

Baptista, D., Farid, M., Fayad, D., Kemoe, L., Lanci, L., Mitra, P., Muehlschlegel, T., Okou, C., Spray, J., Tuitoek, K., Unsal, F., 2022. Climate Change and Chronic Food Insecurity in Sub-Saharan Africa. Departmental Paper DP/2022/016. International Monetary Fund, Washington DC, USA. https://doi.org/10.5089/9798400218507.087.

Button, E.S., Pett-Ridge, J., Murphy, D.V., Kuzyakov, Y., Chadwick, D.R., Jones, D.L., 2022. Deep-C storage: Biological, chemical and physical strategies to enhance carbon stocks in agricultural subsoils. Soil. Biol. Biochem. 170, e108697. https://doi.org/10.1016/j.soilbio.2022.108697.

Chappa, L.R., 2025. Assessing Stakeholder's Willingness to Adopt Agroforestry for Land Reclamation in Gold Mining-Affected. Areas: A Case Study of Chunya Disrict, Tanznia. Second cycle, A2E. SLU, Dept. of Economics, . Uppsala, Sweden. Available at ⟨https://stud.epsilon.slu.se/20849/⟩.

Clifton-Brown, J., Hastings, A., von Cossel, M., Murphy-Bokern, D., McCalmont, J., Whitaker, J., Alexopoulou, E., Amaducci, S., Andronic, L., Ashman, C., Awty-Carroll, D., Bhatia, R., Breuer, L., Cosentino, S., Cracroft-Eley, W., Donnison, I., Elbersen, B., Ferrarini, A., Ford, J., Greef, J., Ingram, J., Lewandowski, I., Magenau, E., Mos, M., Petrick, M., Pogrzeba, M., Robson, P., Rowe, R.L., Sandu, A., Schwarz, K.-U., Scordia, D., Scurlock, J., Shpherd, A., Thornton, J., Trindade, L.M., Vetter, S., Wagner, M., Wu, P.-C., Yamada, T., Kiesel, A., 2023. Perennial biomass cropping and use: Shaping the policy ecosystem in European countries. Glob. Change Biol. Bioenergy 15 (5), 538–558. https://doi.org/10.1111/gcbb.13038.

Daza Montaño, C., van Dam, J.E.G., 2021. Potential of Bamboo for Renewable Energy: Main Issues and Technology Options. INBAR Working Paper, Beijing, China. ⟨https://www.inbar.int/wp-content/uploads/2021/10/October-2021_Potential-of-Bamboo-for-Renewable-Energy.pdf⟩.

Derebe, B., Alemu, A., Asfaw, Z., 2025. Fuelwood dependence and alternative energy sources in Ethiopia: a systematic review. Discov. Sustain. 6 (1), e99. https://doi.org/10.1007/s43621-024-00721-5.

Dlamini, L., Fakudze, S., Makombe, G., Muhamed, S., Zhu, J., 2022. Bamboo as a valuable resource and its utilization in historical and modern-day China. Bioresources 17 (1), 1926–1938. https://doi.org/10.15376/biores.17.1.Dlamini.

Dutta, S., Gorain, S., Roy, J., Das, R., Banerjee, S., Gorai, S.K., Choudhury, M.R., Das, S., 2025. Bamboo for global sustainability: A systematic review of its environmental and ecological implications, climate action, and biodiversity contributions. Environ. Rev. 33, 1–26. https://doi.org/10.1139/er-2025-0032.

Emamverdian, A., Ding, Y., Ranaei, F., Ahmad, Z., 2020. Application of bamboo plants in nine aspects. Sci. World J. 2020 (1), e7284203. https://doi.org/10.1155/2020/7284203.

Embaye, K., 2000. The indigenous bamboo forests of Ethiopia: an overview. AMBIO A J. Human. Environ. 29 (8), 518–521. https://doi.org/10.1579/0044-7447-29.8.518.

Embaye, K., Weih, M., Ledin, S., Christersson, L., 2005. Biomass and nutrient distribution in a highland bamboo forest in southwest Ethiopia: implications for management. For. Ecol. Manag. 204 (2), 159–169. https://doi.org/10.1016/j.foreco.2004.07.074.

Eri, G.D.-L., Osei, J.B., Adom-Asamoah, M., 2019. Behaviour of bamboo reinforced concrete beams with 100% recycled coarse aggregate. J. Ceram. Concr. Sci. 4, 4–13. ⟨https://matjournals.co.in/index.php/JoCCS/article/view/7144⟩.

FAO, 2021. Forest Monitoring: Putting bamboo on the map. United Nations Food and Agricultural Organization, Rome, Italy. ⟨https://www.fao.org/forest-monitoring/news-and-events/news/news-detail/Putting-bamboo-on-the-map/en⟩.

FAO, 2026. Uganda National Bamboo Strategy and Action Plan 2019-2029. United Nations Food and Agriculture Organization, Rome, Italy. ⟨https://www.fao.org/wood-energy-info-portal/search/detail/fr/c/1365805/#:~:text=The%20overall%20goal%20of%20the,and%20Rattan%20Organisation%20⟩ (INBAR).

FAO and INBAR, 2018. Bamboo for Land Restoration: Drawing Recommendations and Best Practices from Case Studies. Policy Synthesis Report 4. INBAR, Beijing, China. ⟨https://www.globallandscapesforum.org/publication/bamboo-for-land-restoration/⟩.

Feleke, S., 2013. Site factor on the nutritional content of *Arundinaria alpina* and *Oxytenanthera abyssinica* bamboo shoots in Ethiopia. J. Hortic. For. 5 (9), 115–121. https://doi.org/10.5897/JHF2013.0303.

Garai, S., Malakar, A., Mishra, Y., Kumar, R., Kumar, L., 2025. Where to grow "Green-Gold" to mitigate land degradation? Identifying appropriate habitat for three economically important bamboo species in eastern India. Discov. For. 1 (1), e14. https://doi.org/10.1007/s44415-025-00016-1.

Gelaw, Y., Kassa, G., Abebaw, D., Kassa, H., Abdelkadir, A., 2025. Value chain analysis of smallholder highland bamboo products: The case of Hula and Gumer districts, Ethiopia. Clean. Circ. Bioeconomy 12, e100177. https://doi.org/10.1016/j.clcb.2025.100177.

Getahun, Z., Abewaa, M., Mengistu, A., Adino, E., Kontu, K., Angassa, K., Tiruneh, A., Abdu, J., 2024. Towards sustainable charcoal production: Designing an economical brick kiln with enhanced emission control technology. Heliyon 10 (6), e27797. https://doi.org/10.1016/j.heliyon.2024.e27797.

Girma, G., Senapathy, M., 2022. Women'S. Particip. Non-Farm. Income-Gener. Act. South. Ethiop. https://doi.org/10.36074/wpinfigaise-monograph.2022.

Gitau, J., Sundberg, C., Ruth, M., Mutune, J., Njenga, M., 2019. Use of biochar-producing gasifier cookstove improves energy use efficiency and indoor air quality in rural households. Energies 12, e4285. https://doi.org/10.3390/en12224285.

Guardian, 2025. Bamboo Homes: Can Nigeria build a future on grass. ⟨https://guardian.ng/property/bamboo-homes-can-nigeria-build-a-future-on-grass/⟩.

He, Y., Jaiswal, D., Liang, X.Z., Sun, C., Long, S.P., 2022. Perennial biomass crops on marginal land improve both regional climate and agricultural productivity. Glob. Change Biol. Bioenergy 14 (5), 558–571. https://doi.org/10.1111/gcbb.12937.

IFAD (International Fund for Agricultural Development), 2020. Five ways bamboo can fight climate change. ⟨https://www.ifad.org/en/w/explainers/five-ways-bamboo-can-fight-climate-change#:~:text=Bamboo's%20fast%2Dgrowing%20and%20renewable,such%20as%20charcoal%20or%20briquettes⟩.

INBAR, 2018. Fight. Poverty Bamboo. ⟨https://www.ifad.org/documents/48415603/49805253/poverty_bamboo.pdf/efb1cbda-f941-a96f-2353-725818d9e0a6?t=1764086699093⟩.

INBAR, 2024. Contributing to Ethiopia's clean cooking transition with bamboo. ⟨https://www.inbar.int/contributing-to-ethiopias-clean-cooking-transition-with-bamboo/⟩.

Iroegbu, A.O.C., Ray, S.S., 2021. Bamboos: from bioresource to sustainable materials and chemicals. Sustainability 13 (21), e12200. https://doi.org/10.3390/su132112200.
Isukuru, E.J., Ogunkeyede, A.O., Adebayo, A.A., Uruejoma, M.F., 2023. Potentials of bamboo and its ecological benefits in Nigeria. Adv. Bamboo Sci. 4, e100032. https://doi.org/10.1016/j.bamboo.2023.100032.
Jiang, R., 2025. Research on the modern product transformation of traditional bamboo weaving craft from the perspective of sustainable design. Social. Sci. Humanit. 2 (2), 50–62. https://doi.org/10.63313/SSH.9047.
Kumar, R., Kumari, P., Pandey, M., Panda, T., Dubey, K., Kumar, M., 2026. Bamboo for rural development and livelihood in India: Opportunities and challenges. Ecol. Environ. Conserv. 32, S214–S226. https://doi.org/10.53550/EEC.2026.v32.i01s.033.
Lange, L., 2021. Strategies for a rapid transition to a circular, biobased society. In: Koukios, E., Sacio-Szymańska, A. (Eds.), Bio# Futures: Foreseeing and Exploring the Bioeconomy. Springer Nature, Cham, Switzerland, pp. 55–71.
Lathwal, M., Rani, M., Indira, A., Joshi, B., Kalyan, N., Vikas, Chongtham, N., 2024. Bamboo biochar as a viable source for carbon sequestration and climate change mitigation. Proc. 12th World Bamboo Congr. Taiwan. ⟨www.worldbamboo.net⟩ (Available at).
Lin, J., Gupta, S., Loos, T.K., Birner, R., 2019. Opportunities and challenges in the Ethiopian bamboo sector: A market analysis of the bamboo-based value web. Sustainability 11 (6), e1644. ⟨https://www.mdpi.com/2071-1050/11/6/1644⟩.
Lohani, T.K., Seboka, Y., Biliso, W.B., Reza, S., Jayaraman, D., 2024. An assessment of bamboo charcoal briquettes derived from the two main bamboo species in Ethiopia. Adv. Bamboo Sci. 9, e100106. https://doi.org/10.1016/j.bamboo.2024.100106.
Lunku, H.S., Li, Z., Tebo, F.E., 2025. Deforestation and economic dynamics in sub-Saharan Africa: Does electricity fluctuations matter on forest conversion? For. Policy Econ. 174, e103478. https://doi.org/10.1016/j.forpol.2025.103478.
Lyimo, P.J., Japhet, J.S., Kaaya, G.E., Ntenga, F.M., Masaka, K., Mbeyale, G., Nyefwe, S., 2024. Indigenous knowledge, innovation and utilization technologies of bamboo: A case of Southern Highlands of Tanzania. Tanzan. J. Agric. Sci. 22 (2), 247–257. ⟨https://www.ajol.info/index.php/tjags/article/view/263124⟩.
Mandaliya, V.B., 2026. Bamboo for climate resilience: green gold of ecosystems in the UN SDG framework. Front. Ecol. Evol. 13, e1723994. https://doi.org/10.3389/fevo.2025.1723994.
Marsiglio, S., Privileggi, F., 2021. On the economic growth and environmental trade-off: A multi-objective analysis. Ann. Oper. Res. 296 (1), 263–289. https://doi.org/10.1007/s10479-019-03217-y.
Masisi, B., Zabel, A., Blaser, J., Augustino, S., 2022. Fighting climate change with bamboo in Africa: The case of Kyela, Rungwe and Mufindi districts – Tanzania. Adv. Bamboo Sci. 1, e100009. https://doi.org/10.1016/j.bamboo.2022.100009.
Mekonnen, Z., Worku, A., Yohannes, T., Tesfaye, M., Teketay, D., Habtemariam, K., 2014. Bamboo resources in Ethiopia: Their value chain and contribution to livelihoods. Ethnobot. Res. Appl. 12, 511–524. https://doi.org/10.17348/era.12.0.511-524.
Moyer, J.D., Bohl, D.K., 2019. Alternative pathways to human development: Assessing trade-offs and synergies in achieving the Sustainable Development Goals. Futures 105, 199–210. https://doi.org/10.1016/j.futures.2018.10.007.
Mubiru, D., Kalanzi, F., Syofuna, A., Mwanja, C.K., Kiyingi, I., 2025. Assessment of *Bambusa vulgaris* Schrad. ex J.C. Wendl., *Dendrocalamus asper* (Schult. & Schult.f.) Backer and *Dendrocalamus strictus* (Roxb.) Nees charcoal for biomass energy applications in Uganda. Adv. Bamboo Sci. 13, e100205. https://doi.org/10.1016/j.bamboo.2025.100205.
Mulatu, Y., Bahiru, T., Kidane, B., Getahun, A., Belay, A., 2019. Proximate and mineral composition of indigenous bamboo shoots of Ethiopia. Greener J. Agric. Sci. 9 (2), 215–221. https://doi.org/10.15580/GJAS.2019.2.032319049.
Mulatu, Y., Kidane, B., Mekonnen, Z., Kassa, H., Abdelkadir, A., Teketay, D., Abebe, S., 2026. Towards upgrading the lowland bamboo (*Oxytenanthera abyssinica* (A.Rich.) Munro) value chains in Ethiopia: Available resources versus economic development perspectives. Adv. Bamboo Sci. 15, e100231. https://doi.org/10.1016/j.bamboo.2026.100231.
Mustafa, A.A., Derise, M.R., Yong, W.T.L., Rodrigues, K.F., 2021. A concise review of *Dendrocalamus asper* and related bamboos: Germplasm conservation, propagation and molecular biology. Plants 10 (9), e1897. https://doi.org/10.3390/plants10091897.
Mwampamba, T.H., Owen, M., Pigaht, M., 2013. Opportunities, challenges and way forward for the charcoal briquette industry in Sub-Saharan Africa. Energy Sustain. Dev. 17 (2), 158–170. https://doi.org/10.1016/j.esd.2012.10.006.
Nadir, S., Kaushal, R., Kumar, A., Durai, J., Reza, S., Ndufa, J., Ronoh, E., Elema, M., Thiga, J., Kumar, M., 2024. Hydrological response of bamboo plantations on soil–water dynamics in humid and semi-arid coastal region of Kenya. Water 16 (13), e1894. https://doi.org/10.3390/w16131894.
Nalule, V., Acheampong, T., 2021. Energy transition indicators in African countries: Managing the possible decline of fossil fuels and tackling energy access challenges. J. Sustain. Dev. Law Policy 12 (1), 1–48. https://doi.org/10.4314/jsdlp.v12i1.2.
Ndegwa, G., Sola, P., Iiyama, M., Okeyo, A.I., Njenga, M., Ignatius, S., Muriuki, J., 2020. Charcoal Value Chains in Kenya: A 20-year Synthesis. Working Paper No. 307. World Agroforestry, Nairobi, Kenya. https://doi.org/10.5716/WP20026.PDF.
Nfornkah, B.N., Nath, A.J., Kaam, R., Chimi, C.D., Mezafack, K.L., 2023. Bamboo-based forest landscape restoration: practical lessons and initiatives to upscale in Africa. In: Palombini, F.L., Nogueira, F.M. (Eds.), Bamboo Science and Technology. Environmental Footprints and Eco-design of Products and Processes. Springer, Singapore, pp. 329–356. https://doi.org/10.1007/978-981-99-0015-2_12.
Nketiah, E., Song, H., Adu-Gyamfi, G., Obuobi, B., Adjei, M., Cudjoe, D., 2022. Does government involvement and awareness of benefit affect Ghanaian's willingness to pay for renewable green electricity? Renew. Energy 197, 683–694. https://doi.org/10.1016/j.renene.2022.07.139.
Oduro, K.A., Obeng, E.A., Abukari, H., Pentsil, S., 2020. Bamboo Policy Integration Analysis. Ghana. INBAR Working Paper No. 83. INBAR, Beijing, China.
Okimiji, O., 2024. Charcoal-production, air pollutant impacts on ambient environment and associated health risks: A systematic review. Glob. Environ. Eng. 11, 13–36. https://doi.org/10.15377/2410-3624.2024.11.2.
Onyekwelu, J.C., Lawal, A., Mosandl, R., Stimm, B., Agbelade, A.D., 2021. Understory species diversity, regeneration and recruitment potential of sacred groves in south west Nigeria. Trop. Ecol. 62 (3), 427–442. https://doi.org/10.1007/s42965-021-00157-2.
Osei-Kufuor, P., Tenkorang, E.Y., Koomson, F., Ntiri, R.O., 2024. Assessing the effectiveness of social accountability interventions in selected district assemblies in Ghana. Cogent Social. Sci. 10, e2361673. https://doi.org/10.1080/23311886.2024.2371673.
Partey, S., Akoto Sarfo, D., Frith, O., Kwaku, M., Thevathasan, N., 2017. Potentials of bamboo-based agroforestry for sustainable development in Sub-Saharan Africa: A review. Agric. Res. 6, 22–32. https://doi.org/10.1007/s40003-017-0244-z.
Pekkarinen, A., 2025. Global Forest ResourcesAssessment 2025. Statistical Process and Key Findings. Presente Afr. Comm. Agric. Stat. Hammamet Tunis. 2428 Novemb. 2025. ⟨https://sfcs.fao.org/media-cnt/docs/statisticslibraries/afcas29/raf-afcas29-e-11-4.pdf?sfvrsn=804e2ce1_1&Status=Master⟩.
Peng, J., Su, Z., Liu, X., Ma, C., 2025. Promoting low-carbonization in the construction supply chain: Key influencing factors and sustainable practices. Sustainability 17 (8), e3375. https://doi.org/10.3390/su17083375.
Piazza, M., Lobovikov, M., Paudel, S.K., 2007. World Bamboo Resources – A Thematic Study Prepared in the Framework of the Global Forest Resources Assessment 2005. Non-Wood Forest Products 18. INBAR, Beijing, China and UN Food and Agriculture Organization, Rome, Italy. https://doi.org/10.13140/RG.2.1.1042.3764.
Rose, J., Bensch, G., Munyehirwe, A., Peters, J., 2022. The forgotten coal: Charcoal demand in sub-Saharan Africa. World Dev. Perspect. 25, e100401. https://doi.org/10.1016/j.wdp.2022.100401.
Rosulu, H.O., And, B.E.O., Temidayo, H., 2020. Exploring the Neglected Potential of Bamboo Cultivation and Utilization in Nigeria for Sustainable Development: An Overview. Int. J. Res. Innov. Social. Sci. 6 (11), 229–237.
Sapovadia, V.K., 2025. Unlocking Bamboo's Potential: Diversifying Products and Driving Sustainable Development Through Innovation (Available at SSRN). Sapovadia Vrajlal K. Unlocking Bamboo's Potential Diversifying Products Driving Sustainable Development Innovation (April 16 2025).. https://doi.org/10.2139/ssrn.5285960.
Sasu, P., Opara, E., Ellison, F.E., Koblah, R.A., Adjei-Mensah, B., Anim-Jnr, A.S., Attoh-Kotoku, V., Kwaku, M., 2025. Valorising bamboo leaves for climate-smart livestock production: Nutritional profile, emission reduction, and farmer adoption in Ghana's transitional zones. Adv. Bamboo Sci. 11, e100151. https://doi.org/10.1016/j.bamboo.2025.100151.
Sati, V.P., 2025. The role of bamboo in promoting sustainable livelihoods in Mizoram, eastern extension of the Himalaya. J. For. Nat. Resour. 4 (1), 44–54. https://doi.org/10.20372/x4czkw29.
Sawarkar, A., Shrimankar, D., Kumar, M., Kumar, P., Singh, L., 2023. Bamboos as a cultivated medicinal grass for industries: A systematic review. Ind. Crops Prod. 203, e117210. https://doi.org/10.1016/j.indcrop.2023.117210.
Sharma, B., Gatóo, A., Ramage, M., 2015. Effect of processing methods on the mechanical properties of engineered bamboo. Constr. Build. Mater. 83, 95–101. https://doi.org/10.1016/j.conbuildmat.2015.02.048.
Sharma, B., van der Vegte, A., 2020. Engineered bamboo for structural applications. In: Harries, K.A., Sharma, B. (Eds.), Nonconventional and Vernacular Construction Materials. Characterisation, Properties and Applications. Elsevier, Amsterdam, The Netherlands, pp. 597–623.
Singh, B., 2025. Ghana Bamboos Market (2025-2031) Outlook, Share, Growth, Value, Companies, Size, Industry, Analysis, Trends, Revenue & Forecast. ⟨https://www.6wresearch.com/industry-report/ghana-bamboos-market-outlook⟩.
Solomon, T., Moon, H., Abebe, S., Minale, A.S., Teketay, D., 2021. Promoting bamboo-based agroforestry for enhancing ecosystem services from degraded lands. In: Dagar, J.C., Gupta, S.R., Teketay, D. (Eds.), Agroforestry for Degraded Landscapes: Recent Advances and Emerging Challenges - Vol. 2. Springer, Singapore, pp. 423–444. https://doi.org/10.1007/978-981-15-6807-7_16.
Sreadha, A.R., Pany, C., 2020. Review on fabrication of bamboo composite materials reinforced concrete. J. Sci. Technol. 5 (3), 258–279. https://doi.org/10.46243/jst.2020.v5.i3.pp258-279.
Taib, M., Ahmad, S., Nogroho, W., 2023. A new paradigm in using bamboo as sustainable material for future building construction. Environ. -Behav. Proc. J. 8, 195–200. https://doi.org/10.21834/ebpj.v8i23.4512.
Tambe, S., 2022. Teaching and Learning Rural Livelihoods: A Guide for Educators, Students, and Practitioners. Springer Nature, Cham, Switzerland.
Tardio, G., Mickovski, S.B., Fenandes, J.P., Rauch, J.P., Acharya, M.S., 2018. The use of bamboo for erosion control and slope stabilization: Soil bioengineering works. In: Abdul Khalil, H.P.S. (Ed.), Bamboo - Current and Future Prospects. IntechOpen, London, UK. https://doi.org/10.5772/intechopen.75626.
Tavani, R., 2019. Guid. Sustain. Bamboo For. Manag. Ethiop. ⟨https://www.fao.org/redd/news/detail/en/c/1197076/#:~:text=To%20support%20the%20development%20of,by%20policy%20makers%20in%20Ethiopia⟩.
Tazebew, E., Sato, S., Addisu, S., Bekele, E., Alemu, A., Belay, B., 2023. Improving traditional charcoal production system for sustainable charcoal income and environmental benefits in highlands of Ethiopia. Heliyon 9 (9), e19787. https://doi.org/10.1016/j.heliyon.2023.e19787.
Tesfaye, W., Misgana, W., Alemu, S., Yasin, A., 2022. Bamboo development rehabilitation degraded land Benshangul Gumuz Region Asosssa zone Oura woreda.

⟨http://slmpkmis.gov.et:8080/jspui/bitstream/123456789/125/1/Final_best_practice_benshagul_on_bamboo_for_rehabilitation_of_degreaded.pdf⟩.
Tripathi, A., Yadav, S., Nishtha, Nkengnamai, M., Thakur, A., 2024. Bamboo: A fast-growing species to mitigate carbon footprint. In: Singh, H. (Ed.), Forests and Climate Change: Biological Perspectives on Impact, Adaptation, and Mitigation Strategies. Springer Nature, Singapore, pp. 469–487. https://doi.org/10.1007/978-981-97-3905-9_23.
UNCCD, 2026. Green gold: bamboo is a winner when it comes to land restoration. ⟨https://www.unccd.int/news-stories/stories/green-gold-bamboo-winner-when-it-comes-land-restoration#:~:text=With%20its%20long%20root%20systems,degraded%20mining%20areas%20in%20Ghana⟩.
UNDO, 2025. Natl. Clean. Cook. Road. Map. ⟨https://ndcpartnership.org/news/government-ethiopia-launches-clean-cooking-roadmap-advance-health-and-climate-goals⟩.
Vanguard, 2024. Why bamboo is a good replacement for costly iron rod – Experts. ⟨https://www.vanguardngr.com/2024/03/why-bamboo-is-a-good-replacement-for-costly-iron-rod-experts/amp/⟩.
Wakweya, R.B., 2023. The socioeconomic and environmental benefits of bamboo forest in Ethiopia: A review. Indones. J. Social. Environ. Issues (IJSEI) 4 (2), 150–159. https://doi.org/10.47540/ijsei.v4i2.934.
Wang, Y., Chen, J., Wang, D., Ye, F., He, Y., Hu, Z., Zhao, G., 2020. A systematic review on the composition, storage, processing of bamboo shoots: Focusing the nutritional and functional benefits. J. Funct. Foods 71, e104015. https://doi.org/10.1016/j.jff.2020.104015.
Wanjohi, A.M., 2025. Environmental, social, economic, and political sustainability in Sub-Saharan Africa. In: Brinkman, R., Oo, C.W. (Eds.), The Palgrave Handbook of Practical Sustainability. Palgrave Macmillan, London, UK, pp. 31–58.
Wassie, S.B., 2020. Natural resource degradation tendencies in Ethiopia: a review. Environ. Syst. Res. 9 (1), e33. https://doi.org/10.1186/s40068-020-00194-1.
Waudo, S., Koske, J., Waswa, F., 2023. More trees and more biomass energy options for increased energy security within households in Navakholo Sub-County, Kenya. East. Afr. J. Environ. Nat. Resour. 6, 178–197. https://doi.org/10.37284/eajenr.6.1.1278.
Waudo, S.N., Waswa, F., 2024. Value-addition in biomass for enhanced household energy security in Navakholo Sub-County, Kenya. J. Kenya Natl. Comm. UNESCO 4 (1). https://doi.org/10.62049/jkncu.v4i1.52.
Yalew, A.W., 2015. The perplex of deforestation in sub-Saharan Africa. J. Trop. For. Environ. 5, 19–30. https://doi.org/10.31357/jtfe.v5i1.2494.
Yalew, A.W., 2022. The Ethiopian energy sector and its implications for the SDGs and modeling. Renew. Sustain. Energy Transit. 2, e100018. https://doi.org/10.1016/j.rset.2022.100018.
Zelalem, S., Gemechu, A., Tesso, A., 2019. Farm households' willingness to contribute labor for conservation of bamboo forest ecosystem: The case of Mao Komo special woreda Benishangul Gumuz Regional State, Ethiopia. Financ. & Econ. Rev. 1 (1), 41–63. ⟨https://riiopenjournals.com/index.php/finance-economics-review/article/view/19⟩.