Advances in Bamboo Science 6 (2024) 100054

Contents lists available at ScienceDirect

Advances in Bamboo Science

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

Advancing circular economy for the growth, root development and elemental characteristics of bamboo (Bambusa vulgaris) on galamsey-degraded soil

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A R T I C L E I N F O

Keywords:
Sustainable mining
Biochar
Bamboo
Agroecology
Circular economy
Soil amendment

A B S T R A C T

Landscape restoration of degraded mining sites, crucial for agroecology and carbon farming in Ghana, remains poorly understood and underutilized. Bamboo has historically played a role in restoring such sites, but there is a need to integrate circular economy principles fully into harnessing its ecosystem services potential. In this study, we evaluated the impact of biochar and poultry manure amendments on galamsey-degraded mining sites to operationalize circular economy principles in ecosystem restoration, using *Bambusa vulgaris* as the test crop.

Conducted in the Asikasu mining area of the Amansie Central District of Ashanti, a randomized complete block design (RCBD) experiment was used comprising five treatments: 1) 10 tonnes/ha biochar, 2) 10 tonnes/ha poultry manure, 3) Combined biochar and poultry manure at 10 tonnes/ha each, 4) Galamsey-degraded soil control, and 5) Forest topsoil control. Each treatment and control type was replicated three times. The experiment spanned from February 2020 to March 2021.

The combined application of biochar and poultry manure resulted in the highest root density and average root diameter, demonstrating the potential for restoring galamsey-degraded sites to support bamboo-based agroecology. The elemental profiles of the bamboo varied in response to different treatments, indicating differing availabilities of micro- and macro-nutrients in the soil solution following soil amendments.

This study underscores the viability of circular economy principles in ecosystem restoration, offering a pathway to sustainable land use and agroecological practices in Ghana's mining-impacted landscapes.

1. Introduction

Bamboo, a member of the gramineous plant family *Poaceae*, encompasses a diverse group of about 1575 species distributed across 116 genera worldwide. Its remarkable capacity to thrive and adapt on degraded lands makes it a valuable resource with multifaceted applications. Its products serve as a sustainable alternative to conventional materials such as plastic and wood. This adaptability makes bamboo particularly significant in the context of ecosystem restoration and sustainable land use practices (Sawarkar et al., 2021).

The foundation of sustainable and regenerative agriculture lies in agroecology and the circular economy. Agriculture and food systems are increasingly threatened by climatic, edaphic, cultural and biological stressors. Ecosystems across the globe are at varying levels of reaching their elastic limits with most approaching or reaching their tipping points (Thellmann et al., 2018; Rockström et al., 2021). Agroecology and regenerative agriculture systems ensure simultaneous enhancement of agricultural productivity and forest ecosystems. Regenerative production systems have become critical in environmental remediation as they involve the application of ecological principles to the study, design and management of agroecosystems to achieve natural resource conservation and productivity within a framework of cultural sensitivity, social justice and economic viability (Siegner et al., 2020). From this principle, concepts such as carbon farming, agroforestry, climate-smart agriculture and sustainable agriculture, among others, have been promoted over the past few decades to promote provisioning, regulatory,

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https://doi.org/10.1016/j.bamboo.2023.100054
Received 30 June 2023; Received in revised form 6 December 2023; Accepted 20 December 2023
Available online 22 December 2023

cultural and supportive ecosystem services. The dominant concept so far amongst these competing concepts is agroecology. The key reason for this is that agroecology aims to promote ecosystem services by integrating agriculture and local people with natural processes in a comprehensive manner for the benefit of nature and livelihoods (Melo et al., 2020).

Landscape restoration is a key prerequisite to commencing and maintaining agroecology on degraded landscapes. Despite the many high level political engagements, the number and diversity of actors and institutions involved across public, private, civil society, local communities, research, and academia from local to global, landscape restoration is not happening at scale (Noordwijk et al., 2020). While regional and local environmental and development institutions recognize the importance of mining, particularly to developing economies, and continue to encourage member countries to address their associated negative environmental and social impacts, not much is actually being done to restore degraded landscapes for agroecological land-use (Daum et al., 2020). It is often argued that the stabilization and restoration of abandoned mining sites typically require long-term efforts focused not only on local site conditions but also on adjacent waste-disposal sites, fringe areas affected by water pollution and distant areas affected by dust emissions and chemical-polluting heavy-duty machinery (Manero et al., 2020). To achieve such restoration, it is important to underscore the role of landscape management and its integration into the circular economy (defined here as recycling biomass or organic waste by soil incorporation) in agriculture. Farm-yard manure and biochar have proven useful in a couple of studies (Kumar et al., 2021a, 2021b; Faloye et al., 2019; Yan et al., 2019 and Zhang et al., 2019) not only to enrich soil carbon and restore soil fertility but also immobilize hazardous substances and prevent them from circulation. What is, however, unclear is whether the use of manure and/or biochar in mining-degraded landscape can improve the soil condition for the practice of agroecological activities.

According to Ballet et al. (2011), environmental quality and natural resource stocks are key components of well-being. These resources, however, are deteriorating at an alarming rate. Deforestation is a major environmental issue that contributes to biodiversity loss, land degradation, desertification, flooding, soil erosion, and climate change, among others. Culas (2007) notes that deforestation affects the economic activities of a country through its negative impact on cultural integrity and livelihoods.

The utility of *Bambusa vulgaris* Schrad. ex J.C.Wendl is well documented in the agroecological and sustainability literature. *B. vulgaris*, for example, enables enhanced carbon sequestration due to its rapid growth rate (Gu et al., 2019). It is also an excellent inhibitor of soil erosion (Gupta et al., 2018). Terefe et al. (2019) emphasized its growth in a wide range of environments. Its importance as a construction material has received much attention in literature (Sawarkar et al., 2020). According to Rocky and Thompson (2019) the use of bamboo fibre involves lower environmental impacts than other forms of fibre, especially synthetic ones. It can be grown without pesticides or chemical fertilizers (Kumar et al., 2023; Akoto et al., 2020). According to Kalamandeen et al. (2020) it does not require irrigation, it sequesters carbon dioxide and produces 35% more oxygen than an equivalent stand of trees. Fuke et al. (2021) found that rhizospheric microbial communities of bamboo played a significant role in the immobilization of various soil nutrients and also enhanced the phytoremediation and environmental restoration capability of the plant. Kumar et al. (2021a, 2021b) also demonstrated the efficacy of soil amendment remediation technologies in landscape restoration. Despite these beneficial qualities, there has been little research on the performance and growth characteristics of bamboo on mining-degraded landscapes. Consequently, environmental policies and management practices do not adequately address the ecosystem services potential of restoring degraded mining landscapes for bamboo agroecology.

Presently, efforts to develop *B. vulgaris* and incorporate it into local economic development and environmental remediation measures globally and particularly in Ghana continue to receive the attention of many advocates. Civil society, multilateral institutions and public sector institutions such as The World Bank, Deutsche Gesellschaft für Internationale, Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), European Forest Institute, Ghana Forestry Commission, Center for International Forestry Research (CIFOR), the UN-REDD Programme, Ghana's Ministry of Lands and Natural Resources, International Bamboo and Rattan Organisation (INBAR) and Syngregate Ghana Ventures among others have persistently and historically advocated for bamboo sector development. This includes advocacy for a dedicated fund to prioritize issues of policy, smallholder development, markets, processing and the entire value chain activities associated with *B. vulgaris* and its products.

Unregulated, irregular and illegal mining, often referred to in Ghana as galamsey, is a major threat to the both the biotic and abiotic parameters of aquatic and terrestrial ecosystems. This is often attributable to the associated loss of vegetation, topsoil removal, and dumping of harmful chemicals (Barreto et al., 2018). According to Obeng et al. (2019), tropical forest ecosystems are being lost at a rate of 10 million hectares per year around the world. Because of its high growth performance, *B. vulgaris* could have significant restorative effects on degraded landscapes and offers better livelihood opportunities and an alternative to wood extraction. However, information on whether the mining-degraded landscape will be supportive of bamboo production or requires amendment and which type of amendment if required is not available. This study was therefore designed to evaluate the effects of biochar and poultry manure amendment on the root growth, shoot development and elemental characteristics of bamboo in a mining-degraded landscape. The Asikasu galamsey site in Amansie Central District was chosen for the field experimentation because of the intensity of illegal mining activities and available support from the traditional authority.

2. Materials and Methods

2.1. Description of experimental site

The experiment was carried out at Asikasu galamsey site and a forest site (400 m away) in the Amansie Central District of Ashanti (Latitudes 6°00 N and 6°30 N and Longitudes 1°00 W and 2°00 W), Ghana located in the forest–savannah transitional zone of Ghana. The area is characterized by two rainfall seasons. Annual rainfall in the ecological zone ranges from 1600 mm to 1800 mm. Temperature ranges from 20.0 °C to 32.0 °C, with a mean of 28.0 °C. During the dry season, the relative humidity ranges between 70% and 80%.

2.2. Baseline characteristics of the experimental site and treatment materials

Prior to the experiment, an initial soil analysis was conducted just at the beginning of the major rainy season (April 2019). A comparative analysis of soil properties between the Galamsey site and the forest site revealed noteworthy distinctions (Table 1). At the Galamsey site, the bulk density of the soil measured 1.65 g/cm^3 , indicating a slightly restrictive condition for root growth. In contrast, the forest site exhibited a more favorable bulk density of 1.32 g/cm^3 , which is likely to promote better root development.

Porosity, a crucial factor for root vitality, was 41.6% at the Galamsey site and notably higher at the forest site (50.3%), signifying a more conducive environment for root expansion. The gravimetric moisture content of the Galamsey site was relatively low at 11.4%, while the forest site maintained a substantially higher moisture level of 21.4%, enhancing its suitability for plant growth.

The available phosphorus (P) in the soil was 12.3 mg/kg at the Galamsey site and 16.5 mg/kg at the forest site, indicating a moderate

Table 1
Soil physical and chemical properties of experimental sites taken at 20 cm depth prior to treatment application in 2019.

Soil Properties		Galamsey Site	Forest Site
Bulk Density (g/cm^3)		1.65	1.32
Porosity (%)		41.62	50.16
Gravimetric Moisture Content (%)		11.35	21.42
Available P (mg/kg)		12.33	16.5
pH 1:1H2O		5.15	5.33
%Total N		0.12	0.35
Exch. Bases (cmol/kg)	K	0.1	0.33
	Ca	1.8	3
	Mg	0.2	1.2
	Na	0	0.04
Exch. Acidity	Al	0.59	0.57
	H	0.38	0.35
% Org. Carbon		0.24	2.23
% Org. Matter		0.41	3.85
ECEC		2.68	5.14
Soil Particle Characteristics	% Sand	86.44	81.44
	% Clay	9.64	12.64
	% Silt	3.92	5.92
	Textural Class	Sandy Loam	Loamy Sand
Heavy Metal Concentration (mg/kg)	Cd	5.53	3.45
	As	3.52	3.28
	Pb	5.44	4.61
	Hg	4.52	3.36

supply of this essential nutrient at both locations. Soil pH values were slightly acidic, 5.15 at the Galamsey site, and 5.33 at the forest site.

The forest site exhibited significantly higher levels of organic carbon (2.23%) compared to the Galamsey site (0.24% organic carbon), contributing to improved soil fertility and structure.

2.3. Preparation of planting materials

Cuttings of basal nodal branches of *Bambusa vulgaris* were collected from the 5th to 7th nodes of 2 to 3 year old plants located at Ntonso in the Kwabre East District of Ashanti. Cuttings were 40 cm long and had three nodes apiece. Clean and sharp cutting tools were used to avoid splitting the stumps or cut culms. The culms were cut into cuttings from the mother culm's basal nodes using a sharp machete, with great care taken to avoid splitting at the cut. Branches on selected culms were clipped with care to avoid injuring existing buds. To make handling easier, a space of roughly 7–10 cm was left at the end of the nodes. The cuttings were soaked in water for around 6 h before being planted in two beds, each measuring 1 m x 7 m. The plantlets were mulched and shaded in the nursery. In the nursery, planting was done using a slanted-horizontal planting method, with the first two nodes submerged in soil. Each nursery bed was watered once a day with 60 liters of water except when it rained. On the nursery bed, the cuttings were spaced 30 cm apart. After 4 weeks of sprouting and 4 weeks of gradual hardening, the plants were transplanted into the field. Transplanting was done in April 2020 and growth observed for 12 months.

2.4. Field management

Both galamsey-degraded and forest control sites were cleared of all vegetation and leveled to commence the study. A Randomized Complete Block Design (RCBD) was used to minimize bias and enhance the accuracy of results. As part of the design, experimental units were divided into homogeneous groups or blocks. Treatments are then randomly assigned within each block, ensuring that potential sources of variability were evenly distributed, and enabling more reliable comparisons.

Within the RCBD, the experiment was laid out in 3 replications and 5 treatments (T1: 10 tonnes/ha biochar; T2: 10 tonnes/ha poultry manure; T3: Combined biochar and poultry manure @ 10 tonnes/ha each; T4: Galamsey-degraded soil control; and T5: Forest topsoil control). A 24 m x 20 m area was allocated for T1–T4 and 6 m x 20 m area for T5 for comparative control purposes. Each bed measured 6 m x 6 m and with a 1 m wide walking path between plots and within blocks. 45 bamboo seedlings were transplanted onto each block planted at 2 m between plants. Weeding was done manually with a hoe once every month.

2.5. Data collection and analysis

During the data collection process, three plants were tagged for each treatment and replication. Average root diameter was measured with vernier caliper at 3 cm away from the base of the tallest root. The number of root buds per plant were counted; the number of roots per plant was also counted manually; root biomass was measured with a chemical balance after airdrying the roots for 48 h. Root length was measured with a 30 cm rule; culm diameter with a vernier caliper and culm height with a tape measure. The number of leaves was manually counted. The shoot and total biomass were determined with a chemical balance after airdrying for 48 h.

Elemental analysis for Ca, K, Mg, organic carbon, P and total N followed methods described in Blanchard et al. (2020).

The data were processed and analyzed using GenStat v.11 software. The data were analyzed using a one-way ANOVA with two factors (block and treatment factors). Mean separation was done using the LSD (least significant difference) method. Post-Hoc analysis was done using a Bonferroni Test.

3. Results

3.1. Effect of biochar and poultry manure on bamboo root and shoot characteristics

The average root diameter, number of roots and root biomass responded significantly to biochar and poultry manure treatments (Table 2). The unamended galamsey soil produced had the smallest root diameter and number of roots (Fig. 1). Differences in the number of root buds and root length were not significant. Plots amended with combined biochar and poultry manure resulted in the greatest average root diameter and number of roots. However, post-hoc analysis did not reveal any differences in the root biomass across treatments. Additionally, culm height, number of leaves, shoot biomass and total biomass responded significantly to biochar and poultry manure treatments (Table 3). The forest topsoil control produced the greatest culm height (176 cm) and number of leaves (170) while 10 tonnes/ha biochar resulted in the least. Plots amended with combined biochar and poultry

Table 2
Influence of biochar and poultry manure on bamboo root characteristics.

Treatments	Av. Rt Dia (cm)	No. of Rt Buds	No. of Roots	Root biomass (g)	Root Length (cm)
10 tonnes/ha biochar	1.425bc	2.33	18.3b	116.5a	29.84
10 tonnes/ha CM	1.224b	3.67	7.12a	101.8a	35.81
1:1 Biochar+CM @ 10 tonnes/ha	2.328d	3.33	49.82c	150.2a	31.34
Galamsey Soil control	0.956a	2.67	8.2a	84.2a	36.06
Forest topsoil control	1.565c	3.33	17.28b	139.6a	33.31
Mean	1.499	3.07	20.14	118.5	33.27
S.E.D	0.0679	0.483	1.971	18.26	2.628
LSD0.05	0.1566**	1.114	4.545**	42.11*	6.059

**Mean significant at 1% probability level, *Mean significant at 5% probability level

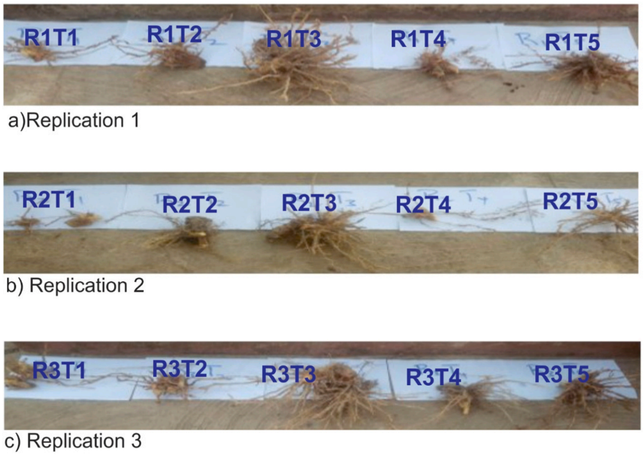

Fig. 1. Bamboo root response to biochar and poultry manure amendments (author's construct).

Table 3
Influence of biochar and poultry manure on bamboo shoot characteristics.

Treatments	Culm Diameter (cm)	Culm Height (cm)	No. of Leaves	Shoot Biomass (g)	Total Biomass (g)
10 tonnes/ha biochar	1.0	66a	79.2a	163.2abc	280abc
10 tonnes/ha CM	1.1	88c	98.0b	142.5ab	244ab
1:1 Biochar+CM @ 10 tonnes/ha	1.1	117d	120.0c	210.2c	360c
Galamsey Soil control	1.2	75b	96.0b	117.9a	202a
Forest topsoil control	0.967	176e	170.0d	195.5bc	335bc
Mean	1.073	104.4	112.64	165.9	284
S.E.D	0.1476	1.814	1.437	25.57	43.8
LSD0.05	0.3403	4.182**	3.313**	58.96*	101.1*

**Mean significant at 1% probability level, *Mean significant at 5% probability level

manure however produced the highest shoot biomass (210 g) and total biomass (360 g), while the unamended galamsey soil control gave the least. Fig. 1 shows the root density characteristics over the growing period.

3.2. *Influence of biochar and poultry manure on bamboo elemental characteristics*

During the evaluation period, the % K, % Mg, % organic carbon, % P and % total nitrogen responded significantly to the biochar and poultry manure treatment (Table 4). The treatment effect on the % Ca was, however, not significant. Plots treated with 10 tonnes/ha poultry manure produced the highest % K in bamboo. 10 tonnes/ha biochar produced the least % K, and was similar to the bamboo grown on the galamsey soil control plots and combined biochar and poultry manure plots. The forest topsoil control plots produced the highest % Mg, % organic carbon and % P. The least % Mg was similar to that of bamboo grown on plots treated with 10 tonnes/ha biochar, 10 tonnes/ha poultry manure and combined biochar-poultry manure. Bamboo grown on plots treated with 10 tonnes/ha biochar showed the least % organic carbon and % P content. % Total N was highest for bamboo grown on plots treated with combined biochar and poultry manure and least for plots treated with 10 tonnes/ha poultry manure alone.

4. Discussion

4.1. *Influence of biochar and poultry manure on bamboo root and shoot characteristics*

Unamended galamsey soil produced the smallest root diameters and number of roots, probably because of insufficient accumulation and translocation of photosynthetic assimilates to roots arising from the limited uptake of micro and macronutrients from the degraded soils. Boldrin et al. (2017) explained that root diameter decreases with a decrease in the lignin/cellulose ratio arising from limited photosynthates. On the other hand, Awad et al. (2018) argued that soil and drought stressors have the potential to promote intense root expansion by diameter and number to help plants to adapt well to stressors, although Boldrin et al. (2017) found that that root tensile strength-diameter relationships often depend strongly on taxa and were strongly related to tensile strength of roots for certain species. In their work on biomass recovery from gold mining landscapes, Kalamandeen et al. (2020) and Seo et al. (2020) found that recovery and reclamation is dependent on nitrogen availability, soil microbial activities and plant enzymatic activities.

Plots treated with combined biochar and poultry manure gave the highest average root diameters and numbers of roots, probably because of improved nutrient contribution from biochar and poultry manure within the bamboo rhizosphere. Zhang and Sun (2020) found that degradation-induced cohesionless soils with insufficient water and nutrients together with the divergent root morphological traits of plants determine the plant community structure and that effective management of degraded soils with adequate carbon and nitrogen-rich products can improve root performance within the rhizosphere. The forest topsoil control gave the highest culm height and number of leaves, probably because of the combined effect of soil physicochemical characteristic and microclimate which promote improved nutrient uptake, photosynthesis and photomorphogenesis. Silva et al. (2020) observed that protected environments irradiated with blue light and phytohormones applied at concentrations of 25% and 50% enabled the shooting and survival of cuttings. Plots treated with 10 tonnes/ha biochar alone gave the lowest culm height and number of leaves, probably due to temporal immobilization of nutrients by biochar and/or insufficiency of nutrient and poor water-holding capacity of the pre-treated galamsey-degraded

Table 4
Influence of biochar and poultry manure on bamboo elemental characteristics.

Treatments	% Ca	% K	% Mg	% Organic Carbon	% P	% Total N
10 tonnes/ha biochar	0.32	1.357a	0.279a	52.97a	0.06a	1.86b
10 tonnes/ha CM	0.36	1.943c	0.276a	54.83a	0.128a	1.75a
1:1 Biochar+CM @ 10 tonnes/ha	0.32	1.42a	0.276a	54.71a	0.107a	2.46c
Galamsey Soil control	0.33	1.413a	0.276ab	53.52a	0.079a	1.79ab
Forest topsoil control	0.28	1.727b	0.276b	55.35a	0.27	1.76ab
Mean	0.32	1.57	0.28	54.27	0.13	1.93
S.E.D	0.04	0.05	0.28	0.64	0.03	0.03
LSD0.05	0.08	0.1255**	0.276**	1.48*	0.0744**	0.06

**Mean significant at 1% probability level, *Mean significant at 5% probability level soils. The shoot biomass of bamboo cultivated on forest topsoil and combined biochar-poultry manure treatment were similar largely because of their improved physicochemical characteristics over the unamended galamsey-degraded soil and the individuall biochar and poultry manure treatments.

4.2. Effect of biochar and poultry manure on bamboo elemental characteristics

The highest bamboo % K observed for plots treated with 10 tonnes/ha poultry manure is largely attributable to the high K content of the manure. Mathot et al. (2020) found that the addition of poultry manure increases the soil K concentration in solution with increasing precipitation and high soil moisture. Otieno and Mageto (2021) proposed that infertile and degraded soils could be improved by the incorporation of adequate potassium sources such as poultry manure. Bamboo grown on galamsey-degraded plots amended with 10 tonnes/ha produced the least K possibly because of the limited ability of biochar to adsorb to cations as a result of limited and unavailable K on soil cation exchange sites following increased acidity from acid mine drainage (Ofori-Sarpong, 2019). Galamsey soil control plots produced plants with the least K contents largely because of the limited the nutrient-supplying ability resulting from the loss of topsoil, leaching, erosion and increased acidity from acid mine and acid rock drainage (Skousen et al., 2019). The release of K into the soil solution by combined biochar and poultry manure was possibly retarded by the increased presence of other metals and high affinity of biochar surface area for K^+ ions. Bamboo cultivated on forest topsoil produced the highest % Mg, % organic carbon and % P largely because of its ideal physicochemical conditions characterized by elevated organic matter from litter decomposition which drive phosphate mobility and availability for vegetative growth. The % Mg was also highest in the forest largely because of increased soil cation exchange which makes more Mg available for bamboo in the forest topsoil than the other soil amendments. The highest % N was observed for bamboo cultivated on galamsey-degraded soil amended with combined biochar and poultry manure because of the complimentary contribution of biochar and poultry manure to nitrogen availability to bamboo roots. Wisnubroto et al. (2017) argued that biochar enhances the release of nitrogen with enrichment from ammonium nitrate sources in manure-based soil amendment.

4.3. Implications for Circular Economy Integration

Our findings demonstrate the potential of using biochar and poultry manure at degraded mining sites, which would promote the principles of the circular economy in ecosystem restoration. By recycling these organic materials, waste and environmental impacts would be reduced while simultaneously improving soil health and supporting sustainable land-use practices such as bamboo cultivation. Prasad et al. (2022) made a similar observation in their work on phytoremediation technology for sustainable management of contaminated sites. This approach aligns with circular economy ideals of resource recovery, reuse, and local economic development. To fully integrate these practices into broader strategies, supportive policies and continued research are essential. Our study serves as a valuable model for scaling up circular economy initiatives in ecosystem restoration, offering practical solutions for mitigating the environmental impact of mining activities while promoting sustainable land use and community engagement.

This study acknowledges limitations, including its site-specific focus in the Asikasu mining area of Ghana, a relatively short research duration, and exclusive use of *Bambusa vulgaris*. Future research directions could involve conducting long-term studies for comprehensive insights, comparing various bamboo species, and conducting economic analyses. Scaling up circular economy strategies and actively involving local communities are suggested for more sustainable landscape restoration efforts.

5. Conclusion

Our study showed that treatment with combined biochar and poultry manure led to the highest root density and average root diameter. The forest topsoil control had the highest culm height and number of leaves. Shoot and total biomass were highest for plots amended with combined biochar and poultry manure. Different treatments presented different elemental profiles. Although the global discourse between 2021 and 2030 is now focused on ecosystem restoration, the incorporation of bamboo into restoration plans has not gained much consideration. As part of Ghana's Plantation Development Strategy includes bamboo development, it is important to factor in soil amendments of galamsey-degraded sites for bamboo production. By this, Ghana would be able to contribute significantly to the achievement of targets set in the African Forest Landscape Restoration Initiative (AFR100), Paris Agreement, Ghana's Nationally-Determined Contributions and Forest Resource Policy as well as the targets laid out in Africa's Mining Vision.

CRediT authorship contribution statement

Abugre Simon: Conceptualization, Formal analysis, Methodology, Writing – review & editing. **Derkyi Nana Sarfo Agyemang:** Methodology, Supervision, Writing – review & editing. **Akoto Daniel Sarfo:** Methodology, Supervision, Writing – review & editing. **Asante Kwaku Onwona-Hwesofour:** Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Writing – original draft.

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

Data will be made available on request.

Acknowledgments

The authors are most grateful to the management of the traditional leaders of the Asikasu mining enclave in the Amansie Central District of Ghana for granting access to a mining-degraded site for the study. The authors are also grateful to Agency for Health and Food Security (AHEFS) for the sponsorship provided to make this study a reality.

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