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Review

Mapping Research on Bambara Groundnut (*Vigna subterranea* (L.) Verdc.) in Africa: Bibliometric, Geographical, and Topical Perspectives

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Abstract: While Bambara groundnut (*Vigna subterranea* (L.) Verdc.) originates from Africa and the list of producers is topped by African countries, it is not clear whether research is developed enough to support crop promotion in the continent. Thus, this systematic review of 180 articles presents a comprehensive summary of research on Bambara groundnut (BGN) in Africa. The paper addresses bibliographical metrics, the geographic distribution of the research and themes covered (viz., food and nutrition security, climate resilience, and livelihoods). The analysis shows that BGN can help address different challenges in Africa, such as food and nutrition insecurity and poverty. However, it also highlights gaps in the research from geographical and thematic standpoints. Geographically speaking, the most important producers of BGN in Africa are not sufficiently covered in the research; instead, it is mainly carried out in Nigeria and South Africa. Thematically speaking, the gaps are related to economics and social sciences, the use of BGN in animal production, processing and marketing, irrigation, contribution to climate resilience and livelihoods, and health benefits. Collaborative research and knowledge sharing, including among producing countries and those leading the research field, are highly needed to unlock the potential of BGN and boost its contribution to sustainable development in Africa.

Keywords: neglected and underutilised species; NUS; orphan crops; Bambara nut; Bambara bean; legume; food security; climate change; livelihoods; SUSTLIVES

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1. Introduction

Bambara groundnut (*Vigna subterranea* (L.) Verdc.), also known as Bambara nut [1], Bambara bean [1,2], Congo goober [3], earth pea [2], ground-bean [3], or hog-peanut [3], is a member of the Fabaceae family. It has several synonymous binomial scientific names, including *Arachis africana* Burm. f., *Glycine subterranea* L., *Voandzeia subterranea* (L.) Thouars, and *Voandzeia subterranea* (L.) DC. [4]. Its name originates from West Africa and is from the Bambara tribe in Mali [5]. *V. subterranea* is a geocarpic plant that matures its pods below the ground, similar to peanut. Bambara groundnut is known for its rapid growth; the growth period ranges from 90 to 170 days [6], and under ideal conditions, it takes about 120 to 150 days for the crop to reach pod maturity [1,7]. Bambara groundnut is considered the third most important leguminous crop in the African countries where it is grown, following groundnut (*Arachis hypogaea*) and cowpea [8]. Women are primarily responsible for cultivating, selling, and processing the crop, making it particularly valuable for female subsistence farmers [1,9].

Bambara groundnut is primarily cultivated in the warm tropics of Sub-Saharan Africa [7,10]. Despite its African roots, the crop has been successfully introduced to several non-African countries, including Malaysia [11]. Moreover, the crop is grown in Brazil, where it is believed to have been brought during the 1600s through the slave trade [1]. The ideal conditions for production are found in regions between 20° and 30° latitude, encompassing the tropical wet and dry as well as the subtropical dry summer climate zones [6]. Bambara groundnut thrives in the same areas where groundnut (peanut) is cultivated. The cropping system for Bambara groundnut is semi-permanent, and it can be grown either as a single crop or as an intercrop [6]. Suitable intercrops include sorghum (*Sorghum bicolor*), millet (*Panicum miliaceum*), maize (*Zea mays*), peanuts (*A. hypogaea*), yams (*Dioscorea* spp.), and cassava (*Manihot esculenta*) [6,12]. Despite its ability to fix atmospheric nitrogen, making it well-suited for intercropping systems [13], a significant number of farmers still choose to grow Bambara groundnut as a monoculture [14].

The plant can withstand high temperatures and is appropriate for growing in poor-quality soils where other leguminous crops would not thrive [15]. Indeed, Bambara groundnut can thrive in soils with poor fertility and is said to perform better in such soils compared to fertile ones [1]. It is a crop that has minimal impact on the environment [16]. The whole plant is recognised for its ability to enhance soil quality [6] through nitrogen fixation. Bambara groundnut, like several other legumes, enhances soil fertility by fixing atmospheric nitrogen through the process of biological nitrogen fixation [17]. Therefore, researchers have been exploring its potential as a substitute for chemical fertilizers in agriculture for many years [18]. Bambara groundnut can withstand drought [7]. It needs just about 300 mm of annual rainfall but thrives best with annual rainfall between 750 mm and 1400 mm [6]. The crop is commonly seen as being resistant to pests and diseases. However, there is insufficient evidence to back up this assertion as there have been instances of fungal attacks by *Rhizoctonia solani* in Southern Thailand, as well as by *Cercospora canescens* and *Colletotrichum capsici* in Nigeria, leading to brown blotch disease. Additionally, the crop is vulnerable to infestation by the cowpea weevil (*Callosobruchus maculatus*) [9].

The crop is cultivated across 0.25 million hectares worldwide. Sub-Saharan Africa (SSA) stands as the primary producer of Bambara groundnut, with smaller quantities grown in Southeast Asia (e.g., Thailand and Indonesia), the United States, and Australia [1]. Within SSA, West Africa serves as the main region for Bambara groundnut production [19]. Worldwide production of *Vigna subterranea* has significantly increased in recent decades [19,20]. The leading five African countries in 2022, in terms of production, were Niger, Burkina Faso, Cameroon, Mali, and Togo (Table 1). The yield level of Bambara groundnut in Africa can range from 0.6 to 1 tonne per hectare, depending on the variety and production conditions. However, cultivating certain landraces in the transition agroecological zone in Nigeria has reportedly resulted in unshelled mean yields of up to 3 tonnes per hectare. Ghana reported a low mean yield of 0.85 tonnes per hectare (ha), which is similar to the yield levels of other legumes such as cowpeas (0.80 tonnes per ha) and pigeon peas (0.78 tonnes per ha) [19].

Table 1. Area harvested, yield, and production of Bambara beans in African countries, 2022.

Country *	Area Harvested (ha)	Yield (100 g/ha)	Production (t)
Niger	102,961	5998	61,753.42
Burkina Faso	54,371	10,522	57,208.53
Cameroon	49,040	8287	40,640.84
Mali	37,329	6747	25,186
Togo	27,819	8226	22,883.33
Zimbabwe	85,764	2256	19,347.71
Democratic Republic of the Congo	35,043	3899	13,662.6
Zambia	6388	9125	5828.86

* Only African countries with data relating to Bambara groundnut available from FAOSTAT were considered. Source: FAO [21].

The balanced macronutrient composition of this nutrient-dense legume has led to it being sometimes referred to as a "complete food" [22]; this is due to its abundance of nutritional properties such as crude fibres, iron, proteins, carbohydrates, fats, and minerals [23]. Among flavonoids, the brown hull contains the highest concentrations of rutin and myricetin, while the red hull has the highest concentrations of chlorogenic and ellagic acid among tannin compounds [24]. Bambara groundnut contains a carbohydrate content ranging from 57.9% to 64% and a protein content ranging from 24.0% to 25.5% [25]. In contrast, soybean (*Glycine max*) and chickpea (*Cicer ariteneum*) have 27% and 61% of carbohydrates, respectively [9]. Bambara groundnut contains anti-nutritional factors (ANFs)—e.g., enzyme inhibitors, flatulence factors, tannins, phytic acid, and saponins—that can decrease the digestibility of protein, leading to a potential 50% reduction in the bioavailability of amino acids while affecting the digestibility and bioavailability of other nutrients [9]. Cooking and thermal treatment of pulse seeds can help reduce or eliminate ANFs [26,27].

Bambara groundnut is significant in the diet and traditions of numerous communities [19], especially in Africa. The seeds have a high protein content and are utilised for food and drinks [6,28]. In West Africa, the nuts are consumed as a snack, roasted and salted, made into cake, or cooked as a meal, similar to other beans. The seeds are edible when fresh or can be boiled after drying, and they can be ground into a paste when either fresh or dry to prepare puddings [29]. In Southeastern Nigeria, the dried Bambara beans are finely ground into a powder and then combined with palm oil before being boiled to make a pudding. In various parts of central Nigeria, fresh Bambara beans are cooked with their shells intact and consumed as a snack during the rainy season. Bambara groundnut requires a longer cooking time compared to other legumes, which increases the amount of fuel needed for cooking. Fresh beans typically take 45–60 min to cook, while dry beans may require 3–4 h [30]. This extended cooking time poses a challenge to the widespread adoption of this crop. Additionally, insufficiently cooked beans can lead to stomach bloating, constipation, and flatulence [14]. The production of Bambara groundnut milk [31] can not only enhance the economic value of the nutritious legume but also contribute to addressing malnutrition. The foliage (rich in phosphorus) is utilised as feed for livestock, while seeds are fed to pigs and poultry [19].

Bambara groundnut plays a role in certain traditional African medicinal practices [32]. It has antioxidant properties due to its phytochemical content, including tannins, flavonoids, and phytic acids. These compounds offer health benefits by helping to prevent conditions such as diabetes, stroke, atherosclerosis, heart disease, cancer, Alzheimer's, and cardiovascular diseases [23]. The presence of phytochemicals, such as tannins, flavonoids, and phytic acids, can prolong the shelf life of food products and possess antimicrobial properties that are capable of impeding microbial growth [23]. The composition of Bambara groundnut makes it a candidate for use in functional foods and nutraceuticals [33] as well as an ingredient in probiotic beverages [31].

Germplasms of Bambara groundnut (around 6145) have been gathered and are currently preserved ex situ, providing genetic resources for breeding purposes [34]. The test genotypes showed high protein content and high levels of essential fatty acids, thiamine, ribovin, and vitamin K. The chemical composition is influenced by seed source and crop management practices [9]. The shape and colour of Bambara groundnut were crucial elements for maximising the extraction yield of phytochemicals. To address malnutrition in Africa, strategies such as food fortification, the use of artificial supplements, and food imports are employed. Utilising traditional plant breeding methods to improve the nutritional value of orphan food crops, like Bambara groundnut, is an affordable and economically viable approach to reducing malnutrition in Africa [19]. Finally, developing products with a higher proportion of Bambara groundnut hulls may lead to a product with increased phytochemical content [24].

Bambara groundnut is widely considered a neglected and underutilised crop species [10,22,35]. While Bambara groundnut originates from Africa and the list of producers is topped by African countries, it is not clear whether research is developed enough to support the promotion of the crop. The previous reviews on Bambara groundnut (Table A1) have either been outdated or have only partially addressed the subject from geographical and thematic standpoints. Furthermore, no one has carried out a combined bibliometric and content/topical analysis for the entire African continent. This highlights a significant research gap as there has not been a recent systematic review of Bambara groundnut (Figure A1). Thus, this systematic review aims to present a comprehensive summary of research on Bambara groundnut in Africa. The paper encompasses bibliographical metrics and the geographic distribution of the research. It also sheds light on the themes covered in the scholarly literature about Bambara groundnut with a particular reference to its potential contribution to sustainable development in terms of food and nutrition security, climate resilience, and livelihoods.

The present paper provides valuable insights to both researchers and value chain actors, including policymakers. As for researchers, it clearly shows the existing research gaps and indicates some avenues for future research on Bambara groundnut in Africa. Concerning value chain actors, it pinpoints problems and obstacles to the development of the production and consumption of Bambara groundnut and provides some recommendations to address the identified challenges. Being a continental study, it also prepares the groundwork for strengthened collaboration on the crop in Africa.

2. Methods

This systematic review [36,37] relies on a search conducted using the Web of Science Core Collection on April 4th, 2024. The search was carried out using the following query: (*"Vigna subterranea" OR "V. subterranea" OR "Arachis Africana" OR "Glycine subterranea" OR "Voandzeia subterranea" OR "Bambara groundnut" OR "Bambara nut" OR "Bambara bean" OR "Congo goober" OR "earth pea" OR "ground-bean" OR "hog-peanut" OR voandzou) AND (Africa OR Algeria OR Angola OR Benin OR Botswana OR "Burkina Faso" OR Burundi OR "Cabo Verde" OR "Cape Verde" OR Cameroon OR "Central African Republic" OR Chad OR Comoros OR Congo OR "Côte d'Ivoire" OR "Cote d'Ivoire" OR "Ivory Coast" OR "Democratic Republic of the Congo" OR Djibouti OR Egypt OR "Equatorial Guinea" OR Eritrea OR Ethiopia OR Eswatini OR Gabon OR Gambia OR Ghana OR "Guinea-Bissau" OR Guinea OR Kenya OR Lesotho OR Liberia OR Libya OR Madagascar OR Malawi OR Mali OR Mauritania OR Mauritius OR Morocco OR Mozambique OR Namibia OR Niger OR Nigeria OR Rwanda OR "São Tomé and Príncipe" OR Senegal OR Seychelles OR "Sierra Leone" OR Somalia OR "South Africa" OR "South Sudan" OR Sudan OR Swaziland OR Tanzania OR Togo OR Tunisia OR Uganda OR Zambia OR Zimbabwe*). The search yielded 282 documents. The selection of the eligible documents was informed by the method used by El Bilali [38] and El Bilali et al. [39].

Table 2 outlines the various phases of the selection process. Specifically, three distinct criteria were taken into account for inclusion and eligibility: geographical coverage (i.e., the document pertains to Africa or an African nation), thematic focus (i.e., the document discusses Bambara groundnut), and document type (i.e., only original research articles, chapters, or conference papers were considered, while editorial materials and reviews were excluded). Following the review of the titles, 3 documents were eliminated as they did not pertain to African countries. Additionally, 15 documents were rejected after analysing the abstracts, as they did not meet at least one of the eligibility/inclusion criteria: 10 documents did not address Bambara groundnut, 2 did not relate to Africa or African countries, and 3 did not have abstracts. Regarding geographical coverage, some articles refer to the origin of the material from Africa, but experiments and analyses were carried out in other countries, especially in Europe and Asia. As for the concerned species, some articles refer to Kersting's groundnut or ground-bean (*Kerstingiella geocarpa* Harms). Lastly, 84 documents were excluded after a review of their full papers, including 30 reviews.

Table 2. Selection of the eligible documents on Bambara groundnut in Africa to be included in the systematic review.

Selection Stage	Number of Potentially Eligible Articles	Selection Stage Description
Identification of articles on the Web of Science (WoS)	282	No duplicates
Screening of articles based on titles	282	3 documents were excluded because they deal with countries outside Africa, viz., Indonesia and Malaysia
Screening of articles based on abstracts	279	15 documents were excluded: • 10 documents because they do not address Bambara groundnut • 2 documents because they do not deal with Africa/African countries • 3 documents without abstracts
Scrutiny of full-texts	264	84 documents excluded: • 54 documents because they do not deal with African countries • 30 reviews
Inclusion in the systematic review	180	--

The review systematically analysed a combined total of 180 documents. These comprised 164 journal articles and 16 conference papers. The selected documents are reported in Table 3.

Table 3. Documents dealing with research on Bambara groundnut in Africa.

Year	Number of Documents	References
2024 *	2	Mukaila [40]; Porcuna-Ferrer et al. [41]
2023	18	Ayangbenro et al. [42]; Baloyi and Swanepoel [43]; Bitire et al. [44]; Bitire et al. [45]; Chelangat et al. [46]; Chipeta and Gimode [47]; Djohy et al. [48]; Gichohi-Wainaina et al. [49]; Hassen et al. [50]; Konan et al. [51]; Linus et al. [52]; Mnyambo et al. [53]; Oballim et al. [54]; Odesola et al. [55]; Osundare et al. [56]; Pretorius et al. [57]; Sarkar et al. [58]; Veldsman et al. [59]
2022	24	Adjei et al. [60]; Ajilogba et al. [61]; Ajilogba et al. [62]; Ajilogba et al. [63]; Ayeni et al. [64]; Bitire et al. [65]; Donkor et al. [66]; Govender et al. [67]; Hlanga et al. [68]; Kunene et al. [69]; Majola et al. [70]; Mbuma et al. [71]; Mkhize et al. [72]; Nhamo et al. [73]; Okafor et al. [74]; Olanrewaju and Babalola [75]; Onwubiko et al. [76]; Onwujiogu et al. [77]; Osundare et al. [78]; Pambuka et al. [79]; Paulos et al. [80]; Siwale et al. [81]; Uba et al. [82]; Yahaya et al. [83]
2021	18	Agyeman et al. [84]; Asante et al. [85]; Boulay et al. [86]; Catarino et al. [87]; Dalaba et al. [88]; Dlamini et al. [89]; Hlanga et al. [90]; Minnaar-Ontong et al. [91]; Müller et al. [92]; Okafor et al. [93]; Olanrewaju et al. [94]; Olanrewaju et al. [95]; Oyedeji et al. [96]; Puozaa et al. [97]; Sugri et al. [98]; Tela et al. [99]; Uba et al. [100]; Valombola et al. [101]

Table 3. *Cont.*

Year	Number of Documents	References
2020	10	Abdelmalik and Moneim [102]; Asiwe [103]; James et al. [104]; James et al. [105]; Lengwati et al. [106]; Mbosso et al. [107]; Moneim et al. [108]; Okebalama et al. [109]; Otto et al. [110]; Sidibé et al. [111]
2019	9	Bonny et al. [112]; Chang et al. [113]; Chibarabada et al. [114]; Govender et al. [115]; Govender et al. [116]; Ibny et al. [117]; Mubaiwa et al. [118]; Ouoba et al. [119]; Phiri et al. [120]
2018	11	Balogun et al. [121]; Bernard et al. [122]; Chibarabada et al. [123]; Gbaguidi et al. [124]; Hardy and Jideani [125]; Ibrahim et al. [126]; Mabhaudhi et al. [127]; Mubaiwa et al. [128]; Ogundele and Emmambux [129]; Olagunju et al. [130]; Olagunju et al. [131]
2017	9	Adeleke et al. [132]; Ayogu et al. [133]; Baptista et al. [134]; Chibarabada et al. [135]; Kosini and Nukenine [136]; Maringe et al. [137]; Oseghale et al. [138]; Puozaa et al. [139]; Seetha et al. [140]
2016	4	Adu-Dapaah et al. [141]; Goudoum et al. [142]; Mohammed et al. [143]; Mohammed et al. [144]
2015	6	Alake et al. [145]; Baoua et al. [146]; Forsythe et al. [147]; Karunaratne et al. [148]; Molosiwa et al. [149]; Yao et al. [150]
2014	3	Kamanga et al. [151]; Mabhaudhi et al. [152]; Mohale et al. [153]
2013	9	Adebowale et al. [154]; Ani et al. [155]; Aremu et al. [156]; Berchie et al. [157]; Karunaratne and Azam-Ali [158]; Koréissi-Dembélé et al. [159]; Mukakalisa et al. [160]; Mukakalisa et al. [161]; Ouedraogo et al. [162]
2012	2	Berchie et al. [163]; Olukolu et al. [164]
2011	4	Adu-Dapaah et al. [165]; Kouassi and Zorobi [166]; Rutto et al. [167]; Somta et al. [168]
2010	6	Kamanga et al. [169]; Karunaratne et al. [170]; Kouassi and Zoro Bi [171]; Nyemba and Dakora [172]; Oyiga et al. [173]; Uvere et al. [174]
2009	8	Ampofo et al. [175]; Ijarotimi and Esho [176]; Mtambanengwe and Mapfumo [177]; Nti et al. [178]; Pule-Meulenberg and Dakora [179]; Tingem et al. [180]; Tingem et al. [181]; Tingem et al. [182]
2008	3	Adeniji et al. [183]; Sesay et al. [184]; Tingem et al. [185]
2007	3	Chadha et al. [186]; Ncube et al. [187]; Oluwole et al. [188]
2006	2	Amarteifio et al. [189]; Ntundu et al. [190]
2005	2	Musiyiwa et al. [191]; Matiru and Dakora [192]
2004	2	Karikari and Tabona [193]; Slabbert et al. [194]
2003	4	Abunyewa and Padi [195]; Karikari et al. [196]; Lale and Vidal [197]; Obagwu [198]
2002	2	Oswald et al. [199]; Ramolemana et al. [200]
2001	5	Ajayi and Lale [201]; Ajayi and Lale [202]; Anchirinah et al. [203]; Aregheore [204]; Nnam [205]
2000	3	Brink et al. [206]; Collinson et al. [207]; Mugula and Lyimo [208]
1998	1	Odeigah and Osanyinpeju [209]
1997	5	Amarteifio and Moichubedi [210]; Dike [211]; Kishinevsky et al. [212]; Thottappilly and Rossel [213]; Uguru and Ezeh [214]
1996	1	Ofori [215]
1994	1	Apata and Ologhobo [216]
1993	1	Harris and Azam-Ali [217]
1992	1	Odumodu [218]
1991	1	Ofuya and Bamigbola [219]

* As of 4 April 2024.

The review of the chosen documents began with an analysis of the bibliographical metrics and the geographic spread of the research field in Africa. Subsequently, the selected documents were examined for various themes, including agriculture subsectors, stages of the food chain, as well as the contribution of Bambara groundnut to food security and nutrition, climate and ecosystem resilience, and livelihoods. All analyses were guided by the methodology used by El Bilali et al. [220] in their systematic review on moringa in Africa.

3. Results and Discussion

3.1. Bibliometrics of Research on Bambara Groundnut in Africa

Africa seems to play a central role in the literature on Bambara groundnut, thus supporting the origin of the crop in the continent. A search conducted on the same date (April 4th, 2024) on the Web of Science without specifying any geographical constraints [viz., "*Vigna subterranea*" OR "*V. subterranea*" OR "*Arachis Africana*" OR "*Glycine subterranea*" OR "*Voandzeia subterranea*" OR "*Bambara groundnut*" OR "*Bambara nut*" OR "*Bambara bean*" OR "*Congo goober*" OR "*earth pea*" OR "*ground-bean*" OR "*hog-peanut*" OR *voandzou*] resulted in 685 records. When compared to the 282 records retrieved from the search on Bambara groundnut in Africa, this indicates that Africa accounts for more than two-fifths (viz., 41.17%) of the total research output in this field.

Research on Bambara groundnut in Africa has been relatively recent, with the initial publication, indexed in the Web of Science, dating back to 1991 [219]. Since then, the yearly *number of publications* on Bambara groundnut in Africa indicates that interest in the crop is inconsistent and fluctuating. From 1991 to 2023, the annual publication count varied widely from zero in some years (viz., 1995 and 1999) to just one in others, especially during the 1990s (viz., 1991, 1992, 1993, 1994, 1996, and 1998), with a peak of 24 publications in 2022. Interestingly, nine articles related to Bambara groundnut in Africa were published in 2013, which might be due to the publication in Acta Horticulturae of the proceedings of the 2nd International Symposium on "Underutilized Plant Species—Crops for the Future—Beyond Food Security", held on 27 June–1 July 2011 in Kuala Lumpur (Malaysia). In 2023, 18 original articles related to Bambara groundnut in Africa were published, signalling a potential decline in interest in this field (cf. 24 publications in 2022).

The list of *sources and journals* is reported in Figure 1. It is topped by Acta Horticulturae (ten articles, 5.55%), Genetic Resources and Crop Evolution (nine articles, 5%) and Frontiers in Sustainable Food Systems (eight articles, 4.44%). However, the 180 chosen publications were spread across 114 different sources and journals, indicating that research on Bambara groundnut in Africa does not have a specific publication outlet.

The majority of the eligible articles are in the *research areas* of Agriculture (75 articles, 41.66%) and Food science—Technology and Plant sciences (34 articles, 18.89%, each) (Figure 2). It is worth noting that the selected articles cover 31 research areas (including biochemistry, biomedicine, biotechnology, chemistry, development studies, ecology, entomology, genetics, geography, geology, marine freshwater biology, meteorology, microbiology, molecular biology, mycology, nutrition dietetics, and toxicology), indicating a multidisciplinary research field. Nevertheless, it can be suggested that the research field is primarily focused on biological sciences (such as agriculture, food science, and plant sciences), with limited representation of social sciences and economics.

The wide range of sectors and disciplines covered by the research on Bambara groundnut is evident in the *Sustainable Development Goals* (SDGs) it pertains to (Figure 3). The articles analysed in this systematic review about Bambara groundnut are associated with six SDGs, with the most significant ones being SDG 02—Zero Hunger (143 documents, 79.44%), SDG 13—Climate Action (71 documents, 39.44%), SDG 03—Good Health and Well-Being (45 documents, 25%), and SDG 15—Life on Land (39 documents, 21.67%). Additional SDGs of lesser significance include SDG 06—Clean Water and Sanitation (six documents) and SDG 01—No Poverty (three documents).

Figure 1. Research on Bambara groundnut in Africa—top ten journals and sources. The journals/sources are represented by different colours, and the numbers above them show how many articles were published in each journal/source. Source: Authors' elaboration based on data from the Web of Science (WoS) database.

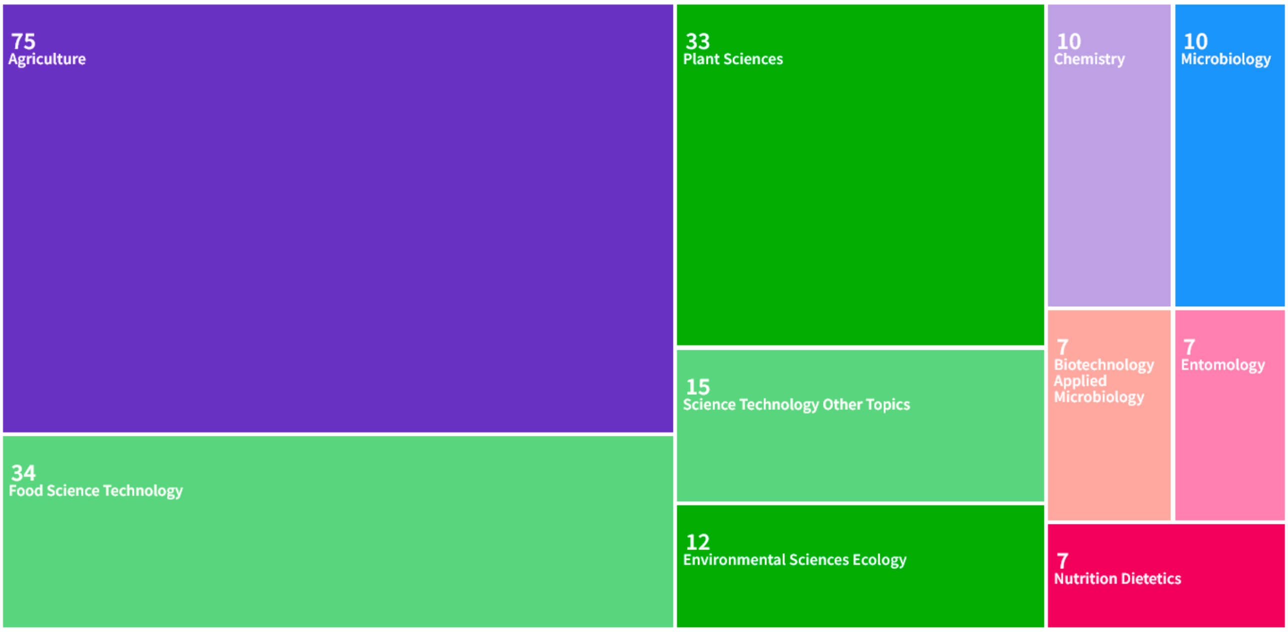

Figure 2. Research on Bambara groundnut in Africa—top ten research areas. Source: Authors' elaboration based on data from WoS database.

The examination of bibliometrics of research on Bambara groundnut in Africa shows that Olubukola Oluranti Babalola (ten articles), Felix Dapare Dakora (nine articles), Michael Abberton (eight articles), Tafadzwanashe Mabhaudhi (eight articles), and Albert Thembinkosi Modi (eight articles) are the most prominent and productive *authors* in the research field (Figure 4). However, the research field lacks consistency, as many authors have only a few articles. Indeed, out of the 585 scholars and researchers that contributed to the 180 selected articles, well 573 scholars (i.e., 97.95%) have only three or fewer articles on Bambara groundnut. This suggests that even authors focusing on Bambara groundnut do so irregularly rather than consistently, possibly due to the absence of structured and long-term national or regional research programs/projects on Bambara groundnut in Africa.

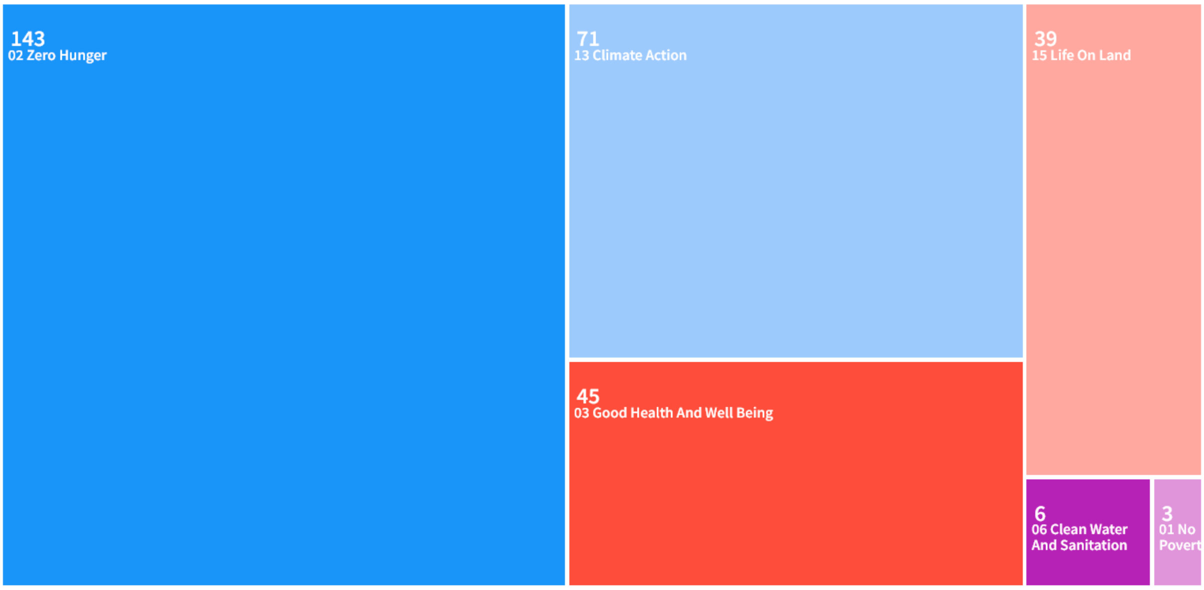

Figure 3. Research on Bambara groundnut in Africa—main SDGs associated with the analysed literature. Source: Authors' elaboration based on data from WoS database.

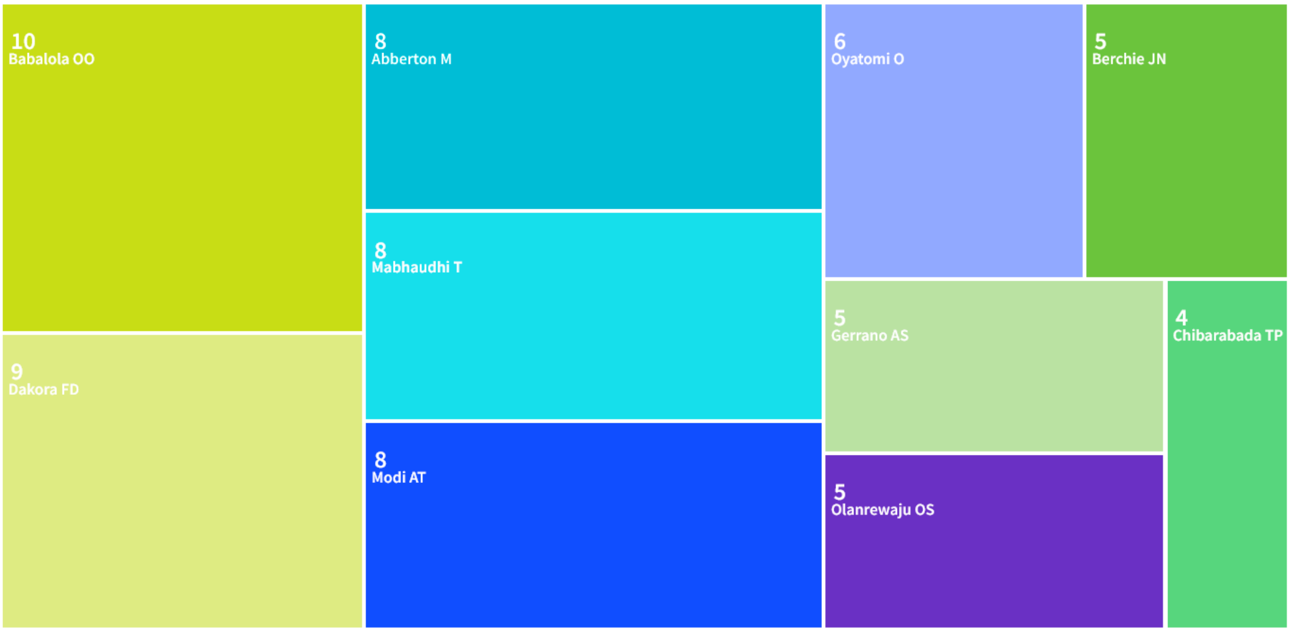

Figure 4. Research on Bambara groundnut in Africa—top ten authors and scholars. Source: Authors' elaboration based on data from WoS database.

The 180 chosen articles on Bambara groundnut have been authored by scholars affiliated with 214 research centres and universities. The list of *affiliation institutions* (Figure 5) is topped by international ones such as CGIAR (Consultative Group for International Agricultural Research, 22 articles) and the International Institute of Tropical Agriculture (IITA, 16 articles). Prominent African institutions are mainly based in South Africa (viz., University of Kwazulu Natal, North-West University South Africa, Agricultural Research Council of South Africa, University of Pretoria, Tshwane University of Technology, University of the Free State, and Cape Peninsula University of Technology) and Nigeria (viz., University of Nigeria, Ahmadu Bello University, Federal University of Technology Akure, University of Agriculture Abeokuta, University of Ibadan). However, the top 25 institutions also include some based in other African countries such as Botswana (viz., Botswana College of Agriculture), Tanzania (viz., Sokoine University of Agriculture), Ghana (viz., Kwame Nkrumah University of Science Technology), Namibia (viz., University of Namibia) and Zimbabwe (viz., University of Zimbabwe). Further institutions dealing with research on Bambara groundnut in Africa are based outside the continent, such as in the United Kingdom (viz., University of Nottingham, James Hutton Institute), the Netherlands (viz., Wageningen University Research), India (viz., Council of Scientific & Industrial Research, CSIR), Malaysia (viz., University of Nottingham Malaysia) and France (viz., Agricultural Research Centre for International Development, CIRAD).

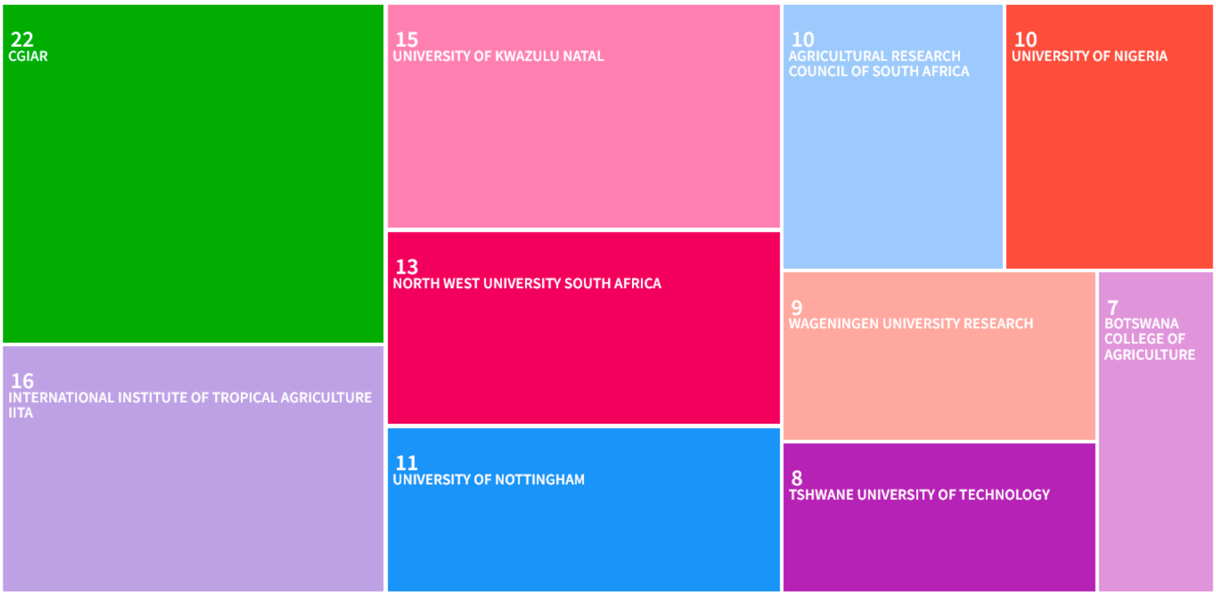

Figure 5. Research on Bambara groundnut in Africa—top ten affiliation institutions. CGIAR: Consultative Group for International Agricultural Research. Source: Authors' elaboration based on data from WoS database.

The results relating to the institutional affiliations align with those for the *affiliation countries* (Figure 6). South Africa leads the list of affiliation countries with 59 documents, so about a third of all published articles on Bambara groundnut in Africa (32.78%), followed by Nigeria with 53 documents (29.44%). Other notable African countries represented in the top 25 list include Ghana (seventeen articles), Botswana (nine articles), Malawi and Tanzania (eight articles each), Zimbabwe (seven articles), Cote d'Ivoire and Kenya (six articles each), Benin and Namibia (four articles each), and Cameroon, Ethiopia and Mali (three articles each). Additionally, many authors are affiliated with institutions located in Europe (e.g., England, Netherlands, Germany, Italy, Scotland, and France), Asia (e.g., Malaysia, Saudi Arabia, and Sri Lanka), North America (e.g., USA), and Oceania (e.g., Australia).

The data analysis indicates that, interestingly, the leading *funding agency* is African, namely the National Research Foundation in South Africa (19 articles). Other prominent South African funding agencies include the South African Research Chair in Agrochemurgy and Plant Symbioses (six articles), Tshwane University of Technology (six articles), North-West University (two articles), South African Department of Science and Technology (two articles), and Water Research Commission of South Africa (four articles). However, research on Bambara groundnut in Africa is also funded by some non-African sources such as the European Union (six articles) and some international organisations and funds (e.g., CGIAR—three articles, Adaptation Fund—two articles, Global Crop Diversity Trust—two articles). This suggests that a significant portion of the funding for Bambara groundnut research in Africa originates from African countries that are not big producers of Bambara groundnut (e.g., South Africa) or overseas, particularly from Europe. As a result, this highlights the lack of domestic African funding for research on Bambara groundnut in producing countries in West Africa, posing a risk and potentially impeding the establishment of sustainable domestic research initiatives.

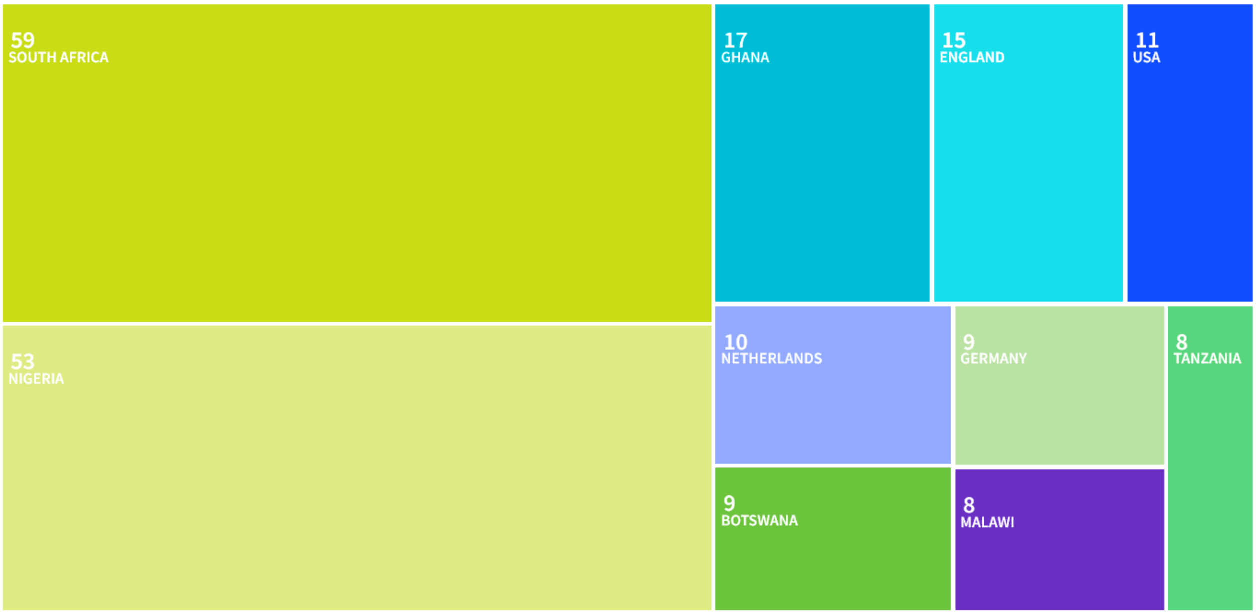

Figure 6. Research on Bambara groundnut in Africa—top ten affiliation countries. Source: Authors' elaboration based on data from WoS database.

3.2. Geography of the Research on Bambara Groundnut in Africa

The research on Bambara groundnut varies significantly across Africa (Table 4). A few countries, such as Nigeria, South Africa, and Ghana, which dominate the list of affiliation countries, have conducted the majority of studies. Indeed, the three countries (viz., Nigeria, South Africa, and Ghana) add up to more than half of all studies on Bambara groundnut in Africa. Nigeria has the highest number of studies on Bambara groundnut (46 articles, accounting for 25.56% of the selected ones), followed by South Africa (40 articles, 22.22%) and Ghana (17 articles, 9.44% each). The high number of studies from Nigeria, being a large and populous country, and South Africa, which is a leading country in the field of research in Africa, are somewhat expected, while the performance of Ghana may indicate a certain dynamism in its research system. Other notable African countries include Botswana (nine articles), Cameroon, Malawi, Tanzania and Zimbabwe (six articles each), and Cote d'Ivoire and Kenya (five articles each).

Table 4. Geography of the research on Bambara groundnut in Africa.

Country or Region (Articles Number)	Documents
Angola (1)	Catarino et al. [87]
Benin (2)	Djohy et al. [48]; Gbaguidi et al. [124]
Botswana (9)	Amarteifio and Moichubedi [210]; Bernard et al. [122]; Harris and Azam-Ali [217]; Karikari and Tabona [193]; Karikari et al. [196]; Karunaratne and Azam-Ali [158]; Molosiwa et al. [149]; Pule-Meulenberg and Dakora [179]; Ramolemana et al. [200]
Burkina Faso (2)	Ouedraogo et al. [162]; Ouoba et al. [119]
Cameroon (6)	Goudoum et al. [142]; Kosini and Nukenine [136]; Tingem et al. [180]; Tingem et al. [185]; Tingem et al. [181]; Tingem et al. [182]
Côte d'Ivoire/Ivory Coast (5)	Bonny et al. [112]; Konan et al. [51]; Kouassi and Zoro Bi [171]; Kouassi and Zorobi [166]; Yao et al. [150]

Table 4. *Cont.*

Country or Region (Articles Number)	Documents
Eswatini/ Swaziland (2)	Dlamini et al. [89]; Sesay et al. [184]
Ethiopia (2)	Paulos et al. [80]; Uba et al. [100]
Ghana (17)	Abunyewa and Padi [195]; Adjei et al. [60]; Adu-Dapaah et al. [141]; Adu-Dapaah et al. [165]; Agyeman et al. [84]; Ampofo et al. [175]; Anchirinah et al. [203]; Asante et al. [85]; Berchie et al. [163]; Berchie et al. [157]; Dalaba et al. [88]; Donkor et al. [66]; Nti et al. [178]; Ofori [215]; Puozaa et al. [97]; Sugri et al. [98]; Yahaya et al. [83]
Kenya (5)	Chang et al. [113]; Chelangat et al. [46]; Oswald et al. [199]; Rutto et al. [167]; Somta et al. [168]
Malawi (6)	Chipeta and Gimode [47]; Forsythe et al. [147]; Kamanga et al. [169]; Kamanga et al. [151]; Kishinevsky et al. [212]; Phiri et al. [120]
Mali (2)	Mbosso et al. [107]; Sidibé et al. [111]
Mozambique (1)	Baptista et al. [134]
Namibia (4)	Mukakalisa et al. [160]; Mukakalisa et al. [161]; Sarkar et al. [58]; Valombola et al. [101]
Niger (2)	Baoua et al. [146]; Ibrahim et al. [126]
Nigeria (46)	Adebowale et al. [154]; Adeleke et al. [132]; Adeniji et al. [183]; Ajayi and Lale [201]; Ajayi and Lale [202]; Alake et al. [145]; Ani et al. [155]; Apata and Ologhobo [216]; Aremu et al. [156]; Ayeni et al. [64]; Ayogu et al. [133]; Balogun et al. [121]; Bitire et al. [65]; Bitire et al. [44]; Bitire et al. [45]; Dike [211]; Ijarotimi and Esho [176]; James et al. [104]; James et al. [105]; Lale and Vidal [197]; Linus et al. [52]; Mohammed et al. [143]; Mukaila [40]; Nnam [205]; Obagwu [198]; Odeigah and Osanyinpeju [209]; Odesola et al. [55]; Odumodu [218]; Ofuya and Bamigbola [219]; Okebalama et al. [109]; Olanrewaju et al. [94]; Olanrewaju et al. [95]; Olukolu et al. [164]; Oluwole et al. [188]; Onwubiko et al. [76]; Onwujiogu et al. [77]; Oseghale et al. [138]; Osundare et al. [78]; Osundare et al. [56]; Oyedeji et al. [96]; Oyiga et al. [173]; Tela et al. [99]; Thottappilly and Rossel [213]; Uba et al. [82]; Uguru and Ezeh [214]; Uvere et al. [174]
Senegal (1)	Porcuna-Ferrer et al. [41]
South Africa (40)	Ajilogba et al. [62]; Ajilogba et al. [61]; Ajilogba et al. [63]; Asiwe [103]; Ayangbenro et al. [42]; Baloyi and Swanepoel [43]; Chibarabada et al. [135]; Chibarabada et al. [123]; Chibarabada et al. [114]; Govender et al. [115]; Govender et al. [116]; Govender et al. [67]; Hardy and Jideani [125]; Hassen et al. [50]; Hlanga et al. [90]; Hlanga et al. [68]; Kunene et al. [69]; Lengwati et al. [106]; Mabhaudhi et al. [152]; Majola et al. [70]; Matiru and Dakora [192]; Mbuma et al. [71]; Minnaar-Ontong et al. [91]; Mkhize et al. [72]; Mnyambo et al. [53]; Mohale et al. [153]; Mohammed et al. [144]; Nhamo et al. [73]; Ogundele and Emmambux [129]; Okafor et al. [93]; Okafor et al. [74]; Olagunju et al. [130]; Olagunju et al. [131]; Olanrewaju and Babalola [75]; Otto et al. [110]; Pambuka et al. [79]; Pretorius et al. [57]; Siwale et al. [81]; Slabbert et al. [194]; Veldsman et al. [59]
Sudan (2)	Abdelmalik and Moneim [102]; Moneim et al. [108]
Tanzania (6)	Boulay et al. [86]; Collinson et al. [207]; Gichohi-Wainaina et al. [49]; Mugula and Lyimo [208]; Ntundu et al. [190]; Seetha et al. [140]
Uganda (1)	Oballim et al. [54]
Zambia (2)	Aregheore [204]; Nyemba and Dakora [172]
Zimbabwe (6)	Maringe et al. [137]; Mtambanengwe and Mapfumo [177]; Mubaiwa et al. [128]; Mubaiwa et al. [118]; Musiyiwa et al. [191]; Ncube et al. [187]
Southern Africa (3)	Amarteifio et al. [189]—Botswana, Swaziland and Namibia; Karunaratne et al. [148]—Botswana, South Africa and Namibia; Mabhaudhi et al. [127]
Western Africa (1)	Koréissi-Dembélé et al. [159]—Benin and Mali

Table 4. *Cont.*

Country or Region (Articles Number)	Documents
Africa (3)	Chadha et al. [186]; Ibny et al. [117]—Ghana, Mali and South Africa; Puozaa et al. [139]—Ghana and South Africa
Global (3)	Brink et al. [206]—The Netherlands, Tanzania and Botswana; Karunaratne et al. [170]—UK and Botswana; Müller et al. [92]—22 countries from Africa, Asia, the Americas and Europe

Meanwhile, many African countries have had minimal or no coverage in the research field. For Instance, several countries, viz., Angola, Benin, Burkina Faso, Eswatini, Ethiopia, Mozambique, Mali, Niger, Senegal, Sudan, Uganda and Zambia, have only had one or two studies on Bambara groundnut. Furthermore, about two-thirds of African countries (32 out of 54 countries), viz., Algeria, Angola, Burundi, Cabo Verde, Central African Republic, Chad, Comoros, Congo, Democratic Republic of Congo, Djibouti, Egypt, Equatorial Guinea, Eritrea, Gabon, Gambia, Guinea, Guinea-Bissau, Lesotho, Liberia, Libya, Madagascar, Mauritania, Mauritius, Morocco, Rwanda, São Tomé and Príncipe, Seychelles, Sierra Leone, Somalia, South Sudan, Togo and Tunisia, have not been specifically the subject of any research related to Bambara groundnut, indicating a significant lack of research in this field. In general, almost all the most important producers of Bambara groundnut in Africa (viz., Niger, Burkina Faso, Cameroon, Mali, Togo, Zimbabwe, Democratic Republic of the Congo, and Zambia) are not covered enough in the research field, which denotes a research gap that might jeopardise the production of the crop in these countries.

There is a general lack of comprehensive studies on Bambara groundnut encompassing the entire African continent or different African countries, with only a few exceptions. For example, Puozaa et al. [139] assess the diversity of micro-symbionts nodulating Bambara groundnut landraces of different seedcoat colours in Ghana and South Africa. Meanwhile, Chadha et al. [186] examine the effects of promoting various indigenous vegetables (such as Bambara groundnut, amaranth, African eggplant, okra, roselle, moringa, and cowpea) on food and nutrition security, health, and income generation in Africa. The low number of regional studies relating to Bambara groundnut might denote a lack of collaboration among African countries. Some studies are rather global. For instance, Müller et al. [92] cast light on the diversity of wild relatives of various crops, including Bambara groundnut, in 22 countries in Africa (viz., Ethiopia, Ghana, Kenya, Nigeria, Sudan, and Uganda), Asia (viz., Lebanon, Malaysia, Nepal, Pakistan, and Vietnam), the Americas (viz., Chile, Costa Rica, Ecuador, and Guatemala), and Europe (viz., Armenia, Azerbaijan, Cyprus, Georgia, Italy, Portugal, and Spain).

3.3. Agriculture Subsectors and Food Chain Stages

In relation to *agriculture subsectors*, it is not surprising that the majority of the selected articles focus on crop production, given that *V. subterranea* is a crop/plant. There are only a few exceptions [48,204]. Djohy et al. [48] explore the contribution of crop residues, including those of voandzou/Bambara groundnut, to reducing the food deficit of ruminants in the Upper Oueme (Benin). Aregheore [204] analyses the effects of rations based on residues of three oilseeds (viz., shells of Bambara groundnut, shells of groundnut and heads of sunflower) on the growth rate of *gwembe* valley goats in Zambia. This finding might imply that Bambara groundnut is not commonly used in animal feeding or simply that there is a research gap on this subject.

Production is by far the most addressed *stage of the food chain*, followed by consumption, while intermediate stages such as processing and, especially, marketing and distribution are frequently overlooked in the academic literature (Table 5).

Table 5. Food chain stages.

Food Chain Stage *	Documents
Production	Abdelmalik and Moneim [102]; Abunyewa and Padi [195]; Adeleke et al. [132]; Adeniji et al. [183]; Adjei et al. [60]; Adu-Dapaah et al. [141]; Adu-Dapaah et al. [165]; Agyeman et al. [84]; Ajilogba et al. [62]; Ajilogba et al. [61]; Ajilogba et al. [63]; Alake et al. [145]; Amarteifio and Moichubedi [210]; Amarteifio et al. [189]; Ampofo et al. [175]; Anchirinah et al. [203]; Ani et al. [155]; Asante et al. [85]; Asiwe [103]; Ayeni et al. [64]; Baloyi and Swanepoel [43]; Berchie et al. [163]; Berchie et al. [157]; Bernard et al. [122]; Bitire et al. [65]; Bitire et al. [44]; Bitire et al. [45]; Bonny et al. [112]; Boulay et al. [86]; Brink et al. [206]; Catarino et al. [87]; Chadha et al. [186]; Chelangat et al. [46]; Chibarabada et al. [135]; Chibarabada et al. [123]; Chibarabada et al. [114]; Chipeta and Gimode [47]; Collinson et al. [207]; Dike [211]; Dlamini et al. [89]; Donkor et al. [66]; Harris and Azam-Ali [217]; Hlanga et al. [68]; Ibrahim et al. [126]; Kamanga et al. [169]; Kamanga et al. [151]; Karikari and Tabona [193]; Karunaratne and Azam-Ali [158]; Karunaratne et al. [170]; Kishinevsky et al. [212]; Konan et al. [51]; Kouassi and Zoro Bi [171]; Kouassi and Zorobi [166]; Kunene et al. [69]; Lengwati et al. [106]; Linus et al. [52]; Mabhaudhi et al. [152]; Majola et al. [70]; Mbosso et al. [107]; Mbuma et al. [71]; Minnaar-Ontong et al. [91]; Mkhize et al. [72]; Mnyambo et al. [53]; Mohale et al. [153]; Mohammed et al. [144]; Molosiwa et al. [149]; Mtambanengwe and Mapfumo [177]; Mukakalisa et al. [160]; Müller et al. [92]; Musiyiwa et al. [191]; Ncube et al. [187]; Nhamo et al. [73]; Nyemba and Dakora [172]; Obagwu [198]; Oballim et al. [54]; Odesola et al. [55]; Ofori [215]; Okebalama et al. [109]; Olanrewaju and Babalola [75]; Olanrewaju et al. [94]; Onwubiko et al. [76]; Oseghale et al. [138]; Osundare et al. [56]; Oswald et al. [199]; Ouedraogo et al. [162]; Ouoba et al. [119]; Oyiga et al. [173]; Pambuka et al. [79]; Paulos et al. [80]; Porcuna-Ferrer et al. [41]; Pule-Meulenberg and Dakora [179]; Puozaa et al. [139]; Ramolemana et al. [200]; Rutto et al. [167]; Sarkar et al. [58]; Seetha et al. [140]; Sesay et al. [184]; Sidibé et al. [111]; Siwale et al. [81]; Tela et al. [99]; Thottappilly and Rossel [213]; Tingem et al. [180]; Tingem et al. [185]; Tingem et al. [181]; Tingem et al. [182]; Uba et al. [82]; Uguru and Ezeh [214]; Valombola et al. [101]
Processing (including post-harvest storage)	Adebowale et al. [154]; Adeleke et al. [132]; Ajayi and Lale [201]; Ajayi and Lale [202]; Apata and Ologhobo [216]; Baoua et al. [146]; Goudoum et al. [142]; Ibrahim et al. [126]; Ijarotimi and Esho [176]; James et al. [104]; Kosini and Nukenine [136]; Lale and Vidal [197]; Maringe et al. [137]; Mubaiwa et al. [128]; Mubaiwa et al. [118]; Mugula and Lyimo [208]; Nnam [205]; Nti et al. [178]; Ofuya and Bamigbola [219]; Ogundele and Emmambux [129]; Okafor et al. [74]; Olagunju et al. [130]; Oluwole et al. [188]; Oyedeji et al. [96]; Pretorius et al. [57]; Sugri et al. [98]; Yahaya et al. [83]
Marketing/commercialisation	Ibrahim et al. [126]; Mbosso et al. [107]; Mukaila [40]
Consumption	Adebowale et al. [154]; Adeleke et al. [132]; Adu-Dapaah et al. [141]; Amarteifio et al. [189]; Apata and Ologhobo [216]; Aremu et al. [156]; Ayogu et al. [133]; Baptista et al. [134]; Chadha et al. [186]; Chibarabada et al. [135]; Dalaba et al. [88]; Donkor et al. [66]; Forsythe et al. [147]; Gichohi-Wainaina et al. [49]; Goudoum et al. [142]; Govender et al. [115]; Govender et al. [116]; Govender et al. [67]; Hlanga et al. [90]; Ibrahim et al. [126]; Ijarotimi and Esho [176]; James et al. [105]; Koréissi-Dembélé et al. [159]; Maringe et al. [137]; Mbosso et al. [107]; Mbuma et al. [71]; Mkhize et al. [72]; Mubaiwa et al. [128]; Mugula and Lyimo [208]; Nti et al. [178]; Odumodu [218]; Okafor et al. [93]; Okafor et al. [74]; Olagunju et al. [130]; Olagunju et al. [131]; Onwujiogu et al. [77]; Otto et al. [110]; Pretorius et al. [57]; Seetha et al. [140]; Uvere et al. [174]; Veldsman et al. [59]; Yahaya et al. [83]; Yao et al. [150]

* Several documents address various stages of the food chain.

Studies addressing *production* include several ones that dealt with the diversity of Bambara groundnut in several countries such as Nigeria [56,76], South Africa [43,68,144], Malawi [47], and Kenya [46]. Onwubiko et al. [76] performed an agronomic evaluation of 33 accessions of Bambara groundnut in Nigeria. Agyeman et al. [84] found that, according to farmers, the most important constraints to Bambara groundnut production in Ghana include inadequate capital and difficult access to improved varieties. They added that "*the key attributes farmers desired in an improved Bambara variety were, ease to harvest mechanically, drought tolerance, disease tolerance, tolerance to waterlogging, ability to fix nitrogen, high yields, early maturing and ease of cooking*" [84]. Referring to northern Namibia, Valombola et al. [101] postulate that "*The major production constraints of Bambara groundnut were insect pests, low yield and lack of improved varieties*" (p. 789).

Only a few studies dealt with the *processing* of Bambara groundnut. Apart from cooking [129], enumerated processing techniques include dehulling [83], milling [83,130,132], fermentation [130,176], roasting [83,130,176], soaking [83,129,154], infrared heating [129], steaming [83] and boiling [128]. Bambara groundnut seeds have been processed, among others, into flour [96,130,132,154,205], starch [96], and milk powder [125]. Yahaya et al. [83] analyse the effects of different processing techniques (viz., soaking, steaming, and dehulling) on the nutritional quality of Bambara groundnut in Ghana. Sugri et al. [98] provide a mapping of technologies used to reduce losses during post-harvest and storage in the Upper East Region of Ghana. In semi-arid regions of Zimbabwe, Mubaiwa et al. [128] found that processing techniques included milling, boiling, soaking and roasting and highlighted that the "*Reported constraints to processing and consumption included long cooking time, difficulties with milling and high firewood and water requirements*".

Similarly, there is only a limited number of papers focusing on the *marketing* of Bambara groundnut and its products. For instance, Mukaila [40] focuses on women Bambara nut farmers in Nigeria and assesses their market participation as well as the implications of this in terms of food security. Meanwhile, in terms of *consumption*, studies dealt with the use of Bambara groundnut as food as well as its potential therapeutic benefits. Most articles in this area explore Bambara groundnut's contribution to food and nutrition security. These studies also include the use of Bambara groundnut in food fortification.

Some authors adopt a more comprehensive approach, examining different stages of the food chain. For instance, Mbosso et al. [107] examine fonio (*Digitaria exilis*) and Bambara groundnut value chains in Mali, focusing on needs and opportunities for their development and promotion. Meanwhile, Forsythe et al. [147] shed light on the beliefs and taboos hampering the development of the Bambara groundnut value chain in Malawi. Ibrahim et al. [126] investigate the production (e.g., source of seeds and farmers' management practices), utilisation and consumption, storage and conservation, and marketing of Bambara groundnut in the Dosso region (western Niger).

Bambara groundnut has been grown in various *agricultural systems* such as single-crop or intercrop farming. It has been intercropped with several crops such as cassava in Cote d'Ivoire [51], sorghum in South Africa [79], and maize in Kenya [167,199]. This demonstrates the adaptability of the crop to intercropping in different environments and agricultural practices.

Regarding *production*, some studies address fertilisation and pest management, while irrigation is generally disregarded (Table 6).

Table 6. Agronomic aspects addressed in studies dealing with the production of Bambara groundnut.

Agronomic Practice *	Documents
Fertilisation and soil fertility management	Ajilogba et al. [62]; Ajilogba et al. [61]; Bitire et al. [65]; Bitire et al. [44]; Bitire et al. [45]; Kamanga et al. [169]; Kishinevsky et al. [212]; Konan et al. [51]; Lengwati et al. [106]; Mohale et al. [153]; Pambuka et al. [79]; Pule-Meulenberg and Dakora [179]; Ramolemana et al. [200]; Rutto et al. [167]

Table 6. *Cont.*

Agronomic Practice *	Documents
Pest management (including weeds)	Abunyewa and Padi [195]; Ajayi and Lale [201]; Ajayi and Lale [202]; Ampofo et al. [175]; Asiwe [103]; Ayeni et al. [64]; Baoua et al. [146]; Dike [211]; Kosini and Nukenine [136]; Lale and Vidal [197]; Mnyambo et al. [53]; Obagwu [198]; Ofuya and Bamigbola [219]; Olanrewaju and Babalola [75]; Onwujiogu et al. [77]; Ouoba et al. [119]; Tela et al. [99]; Thottappilly and Rossel [213]
Irrigation	Chibarabada et al. [114]; Karunaratne and Azam-Ali [158]; Karunaratne et al. [170]; Mabhaudhi et al. [152]

* Some documents address various agronomic practices.

In general, there is a lack of studies dealing with *irrigation* on Bambara groundnut, with a few exceptions. For instance, Chibarabada et al. [114] compare the adaptation, yield, water use and water productivity (WP) of Bambara groundnut and two major grain legumes (viz., dry bean and groundnut) under different irrigation conditions (viz., rainfed, deficit, and optimum). They found that dry bean and groundnut outperformed Bambara groundnut with respect to WP and highlighted the need for breeding to improve the WP of Bambara groundnut in view of its promotion as an alternative crop. Other studies refer to the application of the AquaCrop model to Bambara groundnut [152,158].

The studies focusing on *pest management* cover a range of pests and diseases such as bruchids in stored grains in Cameroon [136], Niger [146] and Nigeria [201,202,219], viruses (e.g., cowpea aphid-borne mosaic potyvirus, blackeye cowpea mosaic potyvirus, peanut mottle potyvirus, cowpea mottle carmovirus, cowpea mosaic comovirus, cowpea mild mottle carlavirus, southern bean mosaic sobemovirus) in Nigeria [213], root-knot nematodes in South Africa [53] and Nigeria [64], *Macrophomina phaseolina* fungal pathogen in Burkina Faso [119] and Cercospora leaf spot in Nigeria [198]. Also, the management of weeds has been addressed in some studies such as those in South Africa [103].

Many articles discuss the *fertilisation* of Bambara groundnut and soil fertility management in relation to the crop. These topics are generally addressed with a particular reference to nitrogen fixation. Indeed, studies dealing with the nodulation of Bambara groundnut and its capacity to fix atmospheric nitrogen have been performed across Africa in countries such as Namibia [58], Nigeria [44,45,65,214], South Africa [50,61,62,117,139], Ghana [60,97,139], Eswatini [89], Botswana [122,179], Zambia [172] and Malawi [212]. Furthermore, the use of Bambara groundnut in intercropping [51,79,167,199] is another strategy to exploit the crop in fertilisation and soil fertility management strategies. Residues of the seeds of Bambara groundnut have been used as a fertiliser on different crops such as cucumber in Nigeria [109].

3.4. Climate and Ecosystem Resilience

Only a small number of articles discuss the potential of Bambara groundnut in addressing various environmental challenges in Africa, such as climate change and land degradation. In general, the scholarly literature on Bambara groundnut in Africa pays little attention to *climate change and variability*. Some studies dealt with the distribution of the production areas of Bambara groundnut under climate change in different countries and regions such as Limpopo Province in South Africa [73]. Other studies modelled the impacts of climate change on Bambara groundnut (using different parameters such as yield, water use and water productivity) in Southern Africa [127,148] and Cameroon [180–182,185]. Following their modelling of the yield of Bambara groundnut in Southern Africa, Karunaratne et al. [148] concluded that "*Bambara groundnut shows positive yield potential at temperatures of up to 31 degrees C, with further warming pushing yields down*" (p. 193). Other studies dealt with the parameterisation and testing of the crop model AquaCrop on Bambara groundnut in South Africa [152] and Botswana [158].

Some authors highlight the climate-resilience of Bambara groundnut [70,148]. Siwale et al. [81] argue that Bambara groundnut "*can significantly contribute to climate-smart agriculture*". Conversely, the long cooking time associated with the grains of Bambara groundnut might be problematic in terms of climate change as it could imply high firewood requirements [128], which means higher greenhouse gas emissions with respect to other legumes but also the risk of deforestation. Anyway, while climate change is becoming more tangible and its effects are more visible across Africa, Porcuna-Ferrer et al. [41] drew attention to the ongoing decline of drought-tolerant crops, such as Bambara groundnut, in Senegal. Referring to the Bassari area in south-eastern Senegal, Porcuna-Ferrer et al. [41] postulate that "*These crops are now on the verge of disappearance from the fields of the Bassari despite their potential fit in the predicted drier climate in the area*" and warn that "*current trends in crop diversity might threaten climate resilience in the long-term*" while calling for paying more attention to drought-tolerant crops in policy and research agendas alike.

The tolerance of Bambara groundnut to *drought* makes it particularly interesting in arid and semi-arid regions in Africa. Indeed, numerous authors point out the drought tolerance of the crop to justify its potential and relevance [41,46,55,58,63,69,91,94,117,141,147,154,157,160,161,163,194]. Furthermore, different studies dealt with the tolerance of Bambara groundnut to drought conditions [55,69,160,170,193]. For instance, Kunene et al. [69] performed drought tolerance screening at the germination stage of 24 Bambara groundnut genotypes in South Africa.

Similarly, the significance of Bambara groundnut in combating *land degradation* has been generally overlooked in the current literature. Nevertheless, as stated above, many articles across the African continent deal with the nodulation of Bambara groundnut and its capacity to fix atmospheric nitrogen [44,45,50,58,60–62,65,89,97,117,122,139,172,179,212,214] thus recognising, implicitly or explicitly, its important role in maintaining, or enhancing, soil fertility. This makes Bambara groundnut a valuable asset in maintaining soil quality and health and contrasting soil/land degradation. The challenge ahead is how to benefit from this capacity of nitrogen fixation even in the context of climate change inducing high soil temperatures and drought [58]. Different scholars put forward the ability of Bambara groundnut to grow in harsh soil conditions [63,70,126]. Therefore, Bambara groundnut possesses the potential to become a valuable resource in marginal agroecosystems. In this respect, referring to the case of Bambara groundnut in Limpopo Province (South Africa), Nhamo et al. [73] argue that "*Large tracts of degraded agricultural land deemed unsuitable for adapted crops, and which may require costly land reclamation practices, can be used to cultivate underutilized crops that are adapted to extreme local conditions*". Meanwhile, referring to the context of Ghana, Agyeman et al. [84] found that "*farmers strongly agree that Bambara groundnut is disease tolerant, able grow on poor soils, can grow with minimal fertilizer, fixes nitrogen, high in nutrients*".

3.5. Food and Nutrition Security

The academic research indicates that Bambara groundnut has the opportunity to contribute significantly to securing food and nutrition in Africa by enhancing food availability, increasing food accessibility, and improving food utilisation and diets.

The literature on Bambara groundnut in Africa only briefly touches on the topic of *food availability*. Despite this, the limited available research indicates that Bambara groundnut is an important food source for African households. The availability of Bambara groundnut and its products depends on yield. In this respect, several studies show that the yield of Bambara groundnut is affected by many factors such as cultivar/accession [44,47,52,65,66,76,80,81,94,95,124,166,196], sowing date/season [157,160,163,184,207], sowing density and row spacing [103,166,171], seedbed type [171], timing of mounding [162] and agronomic practices (e.g., fertilisation, weeding, and irrigation) [65,103,114]. Yield changes from one cultivar/accession/landrace to another depending, among others, on the number of pods per plant [43]. Apart from yield, the availability of Bambara groundnut on markets also depends on the effectiveness of the management of postharvest and storage losses [98].

Research on Bambara groundnut in Africa has been given limited attention with regard to *food access*; however, research shows that households that have access to Bambara groundnut experience improved food and nutrition security. This is especially true for poorer households [186]. Bambara groundnut has been grown in urban and peri-urban areas in countries like South Africa [72], allowing urban populations to easily access a valuable source of proteins. However, the contribution of Bambara groundnut to food security depends on access to markets and commercialisation [40].

The majority of the articles chosen for discussion on food security in connection with Bambara groundnut focus on its role in nutrition, emphasising *food utilisation*. Many authors underline the outstanding nutritional quality and profile of Bambara groundnut [58,71,90,93,105,128,133,141,150,154,157,163,176] to justify the need for its promotion. Bambara groundnut is rich in proteins [46,59,71,83,90,132–134,150,154,176] and minerals [46,59,71,83,90,150,176,189]. The nutritional value of Bambara groundnut can be influenced by various factors such as varieties/cultivars [46,66,90,134,178,189] and processing and preparation methods [57,83,118]. However, following their analysis of the nutritional profile and protein quality of Bambara groundnut in Mpumalanga province (South Africa), Veldsman et al. [59] concluded that "*The protein quality is lower than some other commonly consumed pulses but can still be valuable as a complementary protein in the current traditional diet of the region*". Furthermore, the nutritional quality and profile change during the storage of grains [142]. Additionally, the grains of Bambara groundnut contain some antinutrients [57,83,132,176,210,218], such as phytate and tannins, that can be managed and reduced through appropriate processing techniques [57,83,132,176]. For instance, Pretorius et al. [57] found that "*The cooking process resulted in a significant decrease ($p < 0.05$) in the phytate and tannin content as well as an increase in the health-associated phenolic compounds*" (p. 3435).

Despite its interesting nutritional profile, the use of Bambara groundnut is affected by some negative perceptions and beliefs [88], which suggests the need for tailored nutrition education actions. In many African countries, the adoption of Bambara groundnut in *fortification* and supplementation programs is attributed to its remarkable nutritional profile. Bambara groundnut has also been employed as a dietary supplement in porridges made from different cereals like maize in South Africa [67,115,116], fonio in Mali [159] and sorghum in Tanzania [208].

Maintaining *food safety* is essential for maximising the use of food. Some researchers have pointed out that Bambara groundnut, along with its products, might contain microbial contaminants, especially mycotoxins [49,110,130,131,137,140], and pesticides [77], which could pose a potential risk to human health and well-being. Studies demonstrating these health hazards have been conducted in countries such as Tanzania [49,140], Nigeria [77], South Africa [110,130,131] and Zimbabwe [137]. Following their assessment of pesticide residue in freshly harvested Bambara groundnut in Nsukka (south-eastern Nigeria), Onwujiogu et al. [77] indicate that "*organophosphate pesticides in the freshly harvested white and mixed Bambara nut could pose a great health risk to children within these areas*".

Only a few of the chosen articles discuss claims about the health benefits of Bambara groundnut (BGN). Okafor et al. [74] argue that "The rich flavonoid and phenolic acid content of BGN seeds highlights the fact that it is a good source of dietary phenolics with potential health-promoting properties". Trials using Bambara groundnut and its products have been performed for some illnesses and diseases such as gastric mucosal injury [121].

There is no specific article that focuses on the aspect of food security related to *stability*. Nevertheless, it is important to highlight the contribution of Bambara groundnut to feeding the population during periods of food scarcity. Furthermore, the capacity of Bambara groundnut to fix nitrogen and, consequently, improve or maintain soil fertility, as well as its tolerance to drought, can contribute to preserving the stability of food production in the face of climate change.

3.6. Socio-Economic Impacts and Livelihoods

The research indicates that the literature on Bambara groundnut in Africa minimally addresses social and economic factors. The results of the bibliometric analysis align with this expectation. Indeed, it showed that the research field predominantly focuses on biological and environmental sciences, with insufficient attention to social sciences and economics. However, the examination of the scholarly literature on Bambara groundnut in Africa in relation to the SDGs revealed that SDG 2, "Zero Hunger", which falls within the socio-economic domain of SDGs, is the most prominent one. Meanwhile, other SDGs related to socio-economic aspects (e.g., SDG 01—No poverty and SDG 05—gender equality) are only marginally addressed. Some studies suggest that Bambara groundnut can positively impact local populations, especially small-scale farmers, by contributing to income generation, gender empowerment and rural livelihoods. However, these studies are limited in number and scope.

Bambara groundnut is considered a crucial source of livelihood and income in multiple African nations. Indeed, some academics regard Bambara groundnut as a crop of significant economic importance in various African countries and regions, including South Africa [106], sub-Saharan Africa [82], Tanzania [86], Mali [107], Niger [126] and Nigeria [155]. Chadha et al. [186] suggest that promoting native vegetables, including Bambara groundnut, is advantageous not only for ensuring food security and health but also for generating income in Africa. Ani et al. [155] found that the cultivation of Bambara groundnut is profitable in Benue State (Nigeria). Additionally, Bambara groundnut could present opportunities for diversifying income-generating activities through processing. In this regard, Hardy and Jideani [125] argue that the development of Bambara groundnut milk powder will promote the cultivation and use of Bambara groundnut in South Africa, which, in turn, "*will result in the social development of the country, by creating job opportunities for woman farmers and improve lives of individuals and providing gender empowerment*".

The value of Bambara groundnut for impoverished and poor individuals, including smallholders, is significant [101,141,186]. The crop is commonly cultivated by small-scale and economically disadvantaged farmers. Bambara groundnut's importance and adaptability make it a suitable element of programs aimed at developing agriculture. Bambara groundnut is even sometimes considered a "poor man's crop" [80]. It serves as a source of revenue. Thanks to its nitrogen fixation capacity, Bambara groundnut can increase the income of farmers even from other cash crops (e.g., maize). For instance, in South Africa, Lengwati et al. [106] found that "*There was a 225, 222, 154, 149, and 108% increase in marginal returns of maize after groundnut, Bambara groundnut, cowpea, mung bean, and black gram, respectively, without N fertilizer*". However, Boulay et al. [86] suggest that the absence of markets and marketing difficulties deter many farmers from growing Bambara groundnut.

According to certain studies, Bambara groundnut may play a role in advancing gender empowerment. Indeed, different studies suggest that women are engaged in the cultivation, processing and marketing of Bambara groundnut and its products in countries such as Nigeria [40], South Africa [72] and Botswana [158]. Bambara groundnut is even considered in some studies as a "women's crop" [80]. However, Mukaila [40] found that smallholder woman farmers in Nigeria suffer from a commercialisation gap and posits "*The significant factors responsible for their level of market participation were farm size, credit, cooperative membership, output, fertilizer usage, farm machinery, household size, and distance to market*". The author also found a positive correlation between women's involvement in commercialisation and their food security status and put "*their food security level increases as the commercialization level increases, indicating that agricultural commercialisation improved household food security*" [40]. Therefore, it is necessary to provide small-scale female farmers with financial assistance, discounted agricultural equipment, and fertilizer to encourage their engagement in commercial activities, which is necessary to ensure food security [40]. Porcuna-Ferrer et al. [41] argue that socio-economic changes and gender dynamics contributed to the switch from drought-tolerant traditional crops (e.g., sorghum, fonio, and Bambara groundnut) to more water-demanding exotic crops (e.g., peanut, rice, cotton, horticultural crops) in south-eastern Senegal.

Bambara groundnut holds significant importance for women's nutrition. Nevertheless, there are some negative perceptions and beliefs that limit the consumption of Bambara groundnut among women. For instance, referring to Northern Ghana, Dalaba et al. [88] found that it is a common and widespread opinion that "*Lactating mothers are not to eat foods such as Vigna subterranea known locally as Bambara bean and "gari" (local meal made from cassava) because it is believed to inhibit breastmilk production*". Interestingly, Forsythe et al. [147] suggest that existing beliefs and taboos give women significant control over Bambara groundnut in Malawi.

The development of Bambara groundnut value chains can have far-reaching socio-economic impacts, thus improving the livelihoods of populations. It has the potential to address different issues and support long-term rural development in Africa. Indeed, the production and processing of underutilised crops, like Bambara groundnut, can increase the earnings of small-scale farmers, improve food security, and help with sustainable rural development.

4. Conclusions

Africa seems to play a central role in the literature on Bambara groundnut, thus supporting the origin of the crop in the continent. Indeed, Africa accounts for more than two-fifths of the total research output in this field. Research on Bambara groundnut in Africa has only been relatively recent. The fluctuating yearly number of publications indicates that interest in the crop is inconsistent. The research field is multidisciplinary but is primarily focused on biological sciences, with limited representation in social sciences and economics. The analysed literature is associated with six SDGs, with the most significant one being SDG 02 (Zero Hunger). The chosen articles have been authored by scholars affiliated with 214 research centres and universities. The list of affiliation institutions is topped by international ones such as CGIAR and IITA. Prominent African institutions are mainly based in South Africa and Nigeria. Additionally, many authors are affiliated with institutions located in Europe, Asia, North America, and Oceania. A significant portion of the funding for Bambara groundnut research in Africa originates from African countries that are not big producers of Bambara groundnut (e.g., South Africa) or overseas, particularly from Europe. This highlights the lack of domestic African funding in the producing countries in West Africa.

The research on Bambara groundnut varies significantly across Africa. A few countries, such as Nigeria, South Africa and Ghana, have conducted the majority of studies; the three countries add up to more than half of all studies on Bambara groundnut in Africa. Meanwhile, many African countries have had minimal or no coverage in the research field; about two-thirds of African countries (32 out of 54 countries) have not been the subject of any research related to Bambara groundnut. In general, almost all the most important producers of Bambara groundnut in Africa (viz., Niger, Burkina Faso, Cameroon, Mali, Togo, Zimbabwe, DRC, Zambia) are not covered enough in the research field, which denotes a research gap that might jeopardise the production of the crop in these countries. The low number of regional studies relating to Bambara groundnut might denote a lack of collaboration among African countries.

In relation to agriculture subsectors, it is not surprising that the majority of the selected articles focus on crop production. Production is by far the most addressed stage of the food chain, followed by consumption, while intermediate stages such as processing and, especially, marketing and distribution are frequently overlooked in the academic literature. Regarding production, some studies address fertilisation and pest management, while irrigation is generally disregarded. Many articles discuss the fertilisation of Bambara groundnut and soil fertility management with a particular reference to its capacity to fix atmospheric nitrogen.

Only a small number of articles discuss the potential that Bambara groundnut has in addressing various environmental challenges in Africa, such as climate change and land degradation. However, numerous authors point out the drought tolerance of the crop to justify its potential and relevance in arid and semi-arid regions in Africa. Its recognised capacity to fix atmospheric nitrogen makes Bambara groundnut a valuable asset in maintaining soil quality and health and contrasting with soil/land degradation. Its ability to grow in harsh soil conditions makes it a valuable resource in marginal agroecosystems. Academic research indicates that Bambara groundnut can contribute to securing food and nutrition in Africa by enhancing food availability, increasing food accessibility, and improving food utilisation and diets. However, the majority of the chosen articles that address Bambara groundnut and its connection to food security mainly concentrate on its contribution to nutrition, specifically emphasising food utilisation. Only a few of the chosen articles discuss the health benefits of Bambara groundnut. The literature on Bambara groundnut in Africa minimally addresses social and economic factors. Some studies suggest that Bambara groundnut can positively impact local populations, especially small-scale farmers, by contributing to income generation, gender empowerment and rural livelihoods. However, these studies are limited in number and scope.

Despite the many confirmed benefits of the crop, ranging from ecosystem resilience to food and nutrition security and livelihoods, there are many constraints that hinder the development of its supply chains in the continent. Those constraints relate to all the stages of the supply chain, from production to consumption through processing and marketing. As for production, the main constraints concern the difficult access to quality seeds as well as difficulties in the management of several pests and diseases. When it comes to processing, there is a lack of appropriate techniques. Value chain actors also face problems in marketing due to the disorganisation of value chains and lack of market information. Meanwhile, the consumption of Bambara groundnut is hindered by many negative cultural beliefs and taboos. In this context, it is crucial to develop research on Bambara groundnut in Africa in order to address these challenges and constraints. In particular, there is a need to better characterise the genetic diversity of the crop in order to foster its breeding programs and to define production specifications and good agronomic practices that should be shared and disseminated to farmers. Research is also crucial to designing acceptable and affordable processing and transformation techniques and conserving the quality of Bambara groundnut while meeting the highest safety standards. Improvement in terms of quality and safety should enhance the marketing and consumption of Bambara groundnut. However, research is also needed to provide the necessary scientific evidence to address taboos and negative perceptions about the crop and foster its genuine promotion.

The paper at hand offers valuable theoretical/scientific and practical insights that make it useful for a wide range of stakeholders interested in the development of the production of Bambara groundnut and its value chains in Africa and beyond. Scientifically speaking, it is useful for researchers since it clearly outlines the current research gaps and suggests potential areas for future research on Bambara groundnut in Africa. Practically speaking, it results in a valuable asset and resource for value chain stakeholders (including policymakers) since it identifies the issues and challenges hindering the advancement of Bambara groundnut production and consumption and puts forward recommendations to tackle those challenges. Furthermore, as a comprehensive study spanning the whole continent, it also sets the stage for enhanced collaboration on the crop in Africa.

Nevertheless, the present systematic review on research dealing with Bambara groundnut in Africa had some potential limitations that should be disclosed. To start, by selecting the Web of Science (WoS) database for the search process, it was implied that only high-quality scholarly literature was taken into account. However, this also meant that any grey literature (e.g., reports) as well as articles published in journals not indexed in WoS were not considered. Additionally, the search terms used may have impacted the results, despite the use of various synonyms of Bambara groundnut and all the names of 54 African countries to broaden the initial screening process and make it as comprehensive as possible. Nonetheless, this study is significant as it is the first of its kind and serves as a foundation for future studies as well as for research and development projects on Bambara groundnut in Africa and other regions.

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Appendix A

Table A1. Earlier reviews partially dealing with Bambara groundnut in Africa.

Review	Publication Date	Review Type	Geographical Coverage	Thematic Focus
Ramatsetse et al. [23]	December 2023	Narrative	Global	Health benefits and antioxidant properties of Bambara groundnut
Adelabu and Franke [221]	April 2023	Systematic	Global	Research on seed improvement in underutilised crops
Popoola et al. [222]	April 2023	Narrative	Africa	Properties of underutilised legumes
Maphosa et al. [223]	October 2022	Narrative	Global	Production, composition, and nutritional value of Bambara groundnut
Fwanyanga et al. [224]	September 2022	Narrative	Global	Rhizobial inoculation on Bambara groundnut
Popoola et al. [225]	May 2022	Narrative	Sub-Saharan Africa	Orphan legumes for food security and income generation
Abberton et al. [226]	April 2022	Narrative	Sub-Saharan Africa	Potential of indigenous African orphan legumes for food and nutrition security
Pasipanodya et al. [227]	April 2022	Narrative	Global	Utilisation of genetic resources of Bambara groundnut conserved ex situ for production in semi-arid areas
Ajilogba et al. [228]	March 2022	Narrative	Global	Role of omics and beneficial bacteria improving production of Bambara groundnut
Pui et al. [28]	December 2021	Narrative	Global	Properties of Bambara groundnut and its applications in food
Soumare et al. [10]	November 2021	Narrative	Sub-Saharan Africa	Overview of the potential of Bambara groundnut
Peoples et al. [17]	October 2021	Narrative	Global	Nitrogen fixation by grain legumes
Majola et al. [19]	July 2021	Narrative	Sub-Saharan Africa	Production, utilisation and genetic improvement of Bambara groundnut
Franke [229]	April 2021	Systematic	Southern Africa	Impact of climate change on crop production
Teye et al. [230]	December 2020	Narrative	Africa	Use of underutilised species in the fortification of staples
Tan et al. [231]	December 2020	Narrative	Global	Potential of Bambara groundnut for food security and nutrition
Udeh et al. [33]	October 2020	Systematic	Global	Antimicrobial and nutraceutical potentials of Bambara groundnut
Paliwal et al. [232]	August 2020	Narrative	West Africa	Resilience of legumes under climate change
Jaiswal and Dakora [233]	February 2019	Narrative	Africa	Distribution of Bradyrhizobium species nodulating legumes

Table A1. *Cont.*

Review	Publication Date	Review Type	Geographical Coverage	Thematic Focus
Oyeyinka and Oyeyinka [234]	February 2018	Narrative	Global	Bambara groundnut starch
Mubaiwa et al. [235]	2017	Narrative	Global	Hard-to-cook phenomenon in Bambara groundnut
Smýkal et al. [236]	June 2015	Narrative	Global	Phylogeny and genetic diversity of legume crops
Ahmad et al. [237]	2015	Narrative	Global	Domestication of Bambara groundnut
Emmambux and Taylor [238]	September 2013	Narrative	Africa	Properties of starches from legumes, cereals and tubers
Dakora [239]	2013	Narrative	Africa	Nutritional attributes, distribution and nodulation of underutilised indigenous legumes
Gwata and Mzezewa [240]	2013	Narrative	Southern Africa	Crop technologies in semi-arid areas
Murevanhema and Jideani [241]	2013	Narrative	Global	Milk of Bambara groundnut as a probiotic beverage
Azam-Ali [242]	April 2007	Narrative	Africa	Potential of underutilised crops in agricultural diversification and climate adaptation
Massawe et al. [243]	June 2005	Narrative	Global	Breeding in Bambara groundnut
Aregheore [244]	February 1998	Narrative	Nigeria	Toxicity of unconventional feedstuffs used in animal production
Aregheore [245]	February 1998	Narrative	Nigeria	Toxicity of some foods and feeds

Figure A1. Multiple plate pictures of Bambara groundnut showing the diversity of individual nuts (upper part), harvested Bambara groundnuts with the plant (bottom left), and the plant (bottom right). Source: Mahcap [246].

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