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Systematic Review

The Integration of Land Restoration and Biodiversity Conservation Practices in Sustainable Food Systems of Africa: A Systematic Review

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Abstract: Land degradation poses a significant global challenge, adversely affecting soil quality and diminishing the productivity of arable land, which, in turn, impacts food production and ecosystem services. This degradation manifests in various forms, including soil compaction, salinity, nutrient depletion, loss of biodiversity, and contamination, ultimately rendering soil unproductive and exacerbating climate change. Given the challenges arising from conventional farming practices and climate change, there is an urgent necessity to develop agricultural systems that not only enhance agronomic efficiency but also improve environmental performance. This study focuses on addressing food security in Africa by investigating the role of land restoration and biodiversity in sustainable food systems through a comprehensive bibliometric analysis for documents between 2010 to 2023, identifying 64 relevant documents. The analysis reveals insights into the most-cited documents and thematic evolution, underscoring the significant contributions from Ethiopia and advocating for collaborative efforts among African nations. Key themes identified include "climate change", "food security", "biodiversity conservation", and "agroecosystems", all highlighting the importance of sustainable agricultural practices. The study anticipates a continued prioritization of agroecosystems, smart agriculture, and biodiversity conservation to tackle food security challenges in the face of climate change. Collaboration, investment in research, and practical initiatives emerge as essential components for achieving sustainable food security and mitigating climate change impacts in Africa. This research provides valuable insights into the current landscape and future trends regarding the contributions of land restoration and biodiversity to food systems in Africa, emphasizing the critical need for concerted efforts to address these pressing issues.

Keywords: agroecosystems; biodiversity conservation; climate change; food security; land degradation

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1. Introduction

Land degradation is a significant global challenge that comprises the decline in soil quality and its ability to support the production of economic goods and ecosystem services. It is a widespread issue that reduces the productivity and functionality of arable land [1]. Soil degradation can manifest in various forms such as soil compaction, salinity, nutrient depletion, loss of biodiversity, and contamination, ultimately resulting in unproductive soil. This makes the progression one of the principal contributors to climate change, by increasing emissions and reducing carbon sinks [2]. However, the primary contributor to land degradation is reported to be the intensive conventional agricultural production system. For instance, research conducted has shown that the use of pesticides has a negative impact on soil biodiversity. Additionally, Blanco-Canqui and Lal [3] have observed that

the use of mechanical tillage can damage soil structure and accelerate the decomposition process, resulting in nutrient loss through leaching and volatilization, as well as disrupting the balance in nutrient supply.

Furthermore, the severity and impact of land degradation depend on factors like the crops cultivated, soil type, and management practices employed. This issue has global implications, as it not only compromises soil stability but also leads to negative shifts in food systems. This, in turn, directly undermines food security, particularly in developing regions such as Africa that are vulnerable to the effects of climate change [2]. As a result, it has been observed that African current food systems are not following a sustainable path that would allow us to achieve the Sustainable Development Goals by 2030. Consequently, food productivity in Africa is reported to experience a 5% decline for each °C temperature increase. Hence, approximately 22% of Africa's population, totaling 277 million people, currently suffer from hunger, and this figure is stated to rise up to 350 million by 2050 if practical and effective adaptation measures are not taken [4]. Major shortcomings are evident in meeting food production, promoting inclusivity, and reducing environmental impact. The challenges posed by land degradation, resulting from factors such as conventional intensive agricultural production systems and climate change, necessitate innovative solutions and sustainable land management practices. This underscores a clear need for the development of agricultural production systems that can not only increase agronomic efficiency, but also improve environmental performance. This will necessitate enhancing the research on agricultural practical systems that are informed by these risks within the continent [5]. As some studies suggested, farmers, particularly in developing nations, might address climate change by reverting to more natural productive systems, which offer enhanced ecological and societal benefits [6].

Historically, agroecosystems (such as agroecology and agroforestry) worldwide have demonstrated a remarkable resilience in response to the growing pressure to produce food for the expanding human population under climate change. These are considered as primary alternative strategies in achieving sustainable food production within an ecologically friendly ecosystem [7]. These sustainable practices have been demonstrated to enhance farm efficiency, ensure yield stability and resilience in food production, lower production costs, and yield numerous ecosystem benefits [8]. For instance, the implementation of land restoration practices as innovative practices has been observed to allow smallholder farmers to strengthen and double food production even in the face of climate change [9,10]. Explicitly, it has been accentuated that agroecology could be a critical approach to achieving sustainable food systems in Africa [11]. This approach focuses on designing, developing, and promoting the change towards biodiversity and low external input-based, socially comprehensive farming and food systems. Similar benefits were noted in a practical study conducted in Malawi by Nyantakyi-Frimpong et al. [12], where the adoption of agroecological practices led to an enhancement in agricultural productivity within the semi-humid tropics. Simultaneously, agroforestry has also become increasingly attractive for enhancing food production in the face of climate change. By integrating trees and shrubs with crop or livestock production, this practice offers a potentially sustainable solution for promoting healthier soils. This practice can boost agricultural production and improve ecological performance [13]. Additionally, beyond their role in providing essential services like food, fodder, fiber, and fuelwood production, agroforestry offers a multitude of ecosystem benefits. These include regulating nutrient cycling, sequestering carbon, providing habitat for biodiversity, controlling erosion, managing fire and floods, and offering recreational and cultural amenities. Furthermore, these agricultural practices are not only promoting the efficient utilization of land, water, and other vital resources, but also represent some of the most ecologically sustainable approaches to tackling food insecurity [14].

Despite the evident advantages, it is acknowledged that implementing sustainable practices and biodiversity-friendly management systems can be more complex. These systems require a comprehensive understanding of local ecological conditions, as mentioned, which may demand extra efforts in terms of planning and implementation. This complex-

ity, though it may pose challenges, is a testament to the holistic nature of these systems, which take into account the intricate relationships within ecosystems [15,16]. Therefore, addressing the challenges of implementing agroecosystem practices and biodiversity to support sustainable food security requires collaboration and investment in research and innovation. Certainly, emphasizing the need for collaboration and investment in research and innovation is essential for developing appropriate technologies and policies, as highlighted by Smith and Gregory [17]. This requires a comprehensive understanding of the practical work available in the literature, which can assist researchers in enhancing and testing these practices for the resilience of food systems, especially in regions like Africa.

However, there is a lack of research that assembles and documents these trajectories for contribution of land restoration and biodiversity in food systems of Africa. Consequently, there is a need for a systematic review to assess the historical application and trends in monitoring perspectives regarding the adoption, successes, and application of land restoration and biodiversity in the food systems of Africa. Therefore, the objective of this study was to offer a comprehensive overview of the evolution of research trends on the contribution of land restoration and biodiversity in food systems of Africa. This is based on the streamlined published research documents that accommodate the niche area, with the following specific objectives:

1. To provide a comprehensive overview of the historical and current trends in research on the contribution of land restoration and biodiversity to food systems in Africa.
2. To analyze the co-occurrence of authors' keywords to gain insights into the research hotspots within this field of study.
3. To identify current research themes and emerging topics related to land restoration, biodiversity, and food systems in Africa.

Therefore, enhancements in the application of these practices could be promoted to ensure sustainable and resilience in food production in Africa. This can be accomplished by utilizing bibliometric analysis, which is a methodical and statistical approach. A bibliometric approach offers an informative and unbiased scientific analysis of the current research trends and future prospects in a particular niche field [18,19]. The fundamentals of this study are to offer an African overview of the practical use and contribution of land restoration, as well as biodiversity practices and their integration for sustainable food systems of Africa. This study also identifies other feasible research topics for current and future land restoration and biodiversity conservation practices for African food systems studies. Furthermore, this study contributes to the literature advancing the use of land restoration and biodiversity management interventions that ensure resilience of food security in Africa under climate change.

2. Contribution of Land Restoration and Biodiversity in Food Systems

2.1. Land Restoration for Sustainable Food Systems

Land degradation, often stemming from unsustainable agricultural practices, negatively impacts the ability to maintain fertile soil and produce food sustainably. This degradation undermines efforts to produce healthy and nutritious food, as highlighted in the UNCCD COP15, 2026 [20,21]. Additionally, land degradation also indirectly affects food productivity through the depletion of ecosystem services [2]. For example, when land is degraded, it loses its ability to retain water and regulate water flows effectively. This can result in decreased soil fertility, reduced food productivity, and increased vulnerability to droughts and floods. These changes in water availability and quality from the soil can have negative effects on food production and the availability (see Figure 1) [22,23]. Therefore, avoiding, reducing, and restoring arable/grazing land can be essential for sustainable of food productivity. The transformation of food systems holds the key to reversing land degradation and promoting land restoration. By adopting a comprehensive approach, it is possible to shift from considering food systems as the primary cause of land degradation to becoming the driving force for restoration and recovery [20,24]. Moreover, as highlighted by Cao et al. [25], making advancement in interventions for land restoration and imple-

menting effective planning and management, supported by appropriate investments, is crucial for achieving sustainable agricultural productivity. Additionally, it emphasizes the importance of prioritizing the protection and restoration of natural environments for the optimal well-being of nature. Consequently, it has been observed that land restoration practices may be beneficial when concentrating exclusively on ecosystem elements that contribute to both current and future food production. Promoting land restoration interventions, to the greatest extent possible, preserves or improves food production; this can effectively minimize the ecological "opportunity costs" associated with food production, allowing for the reversion of certain ecosystems to a state of natural restoration with little or no farming activity [26–28].

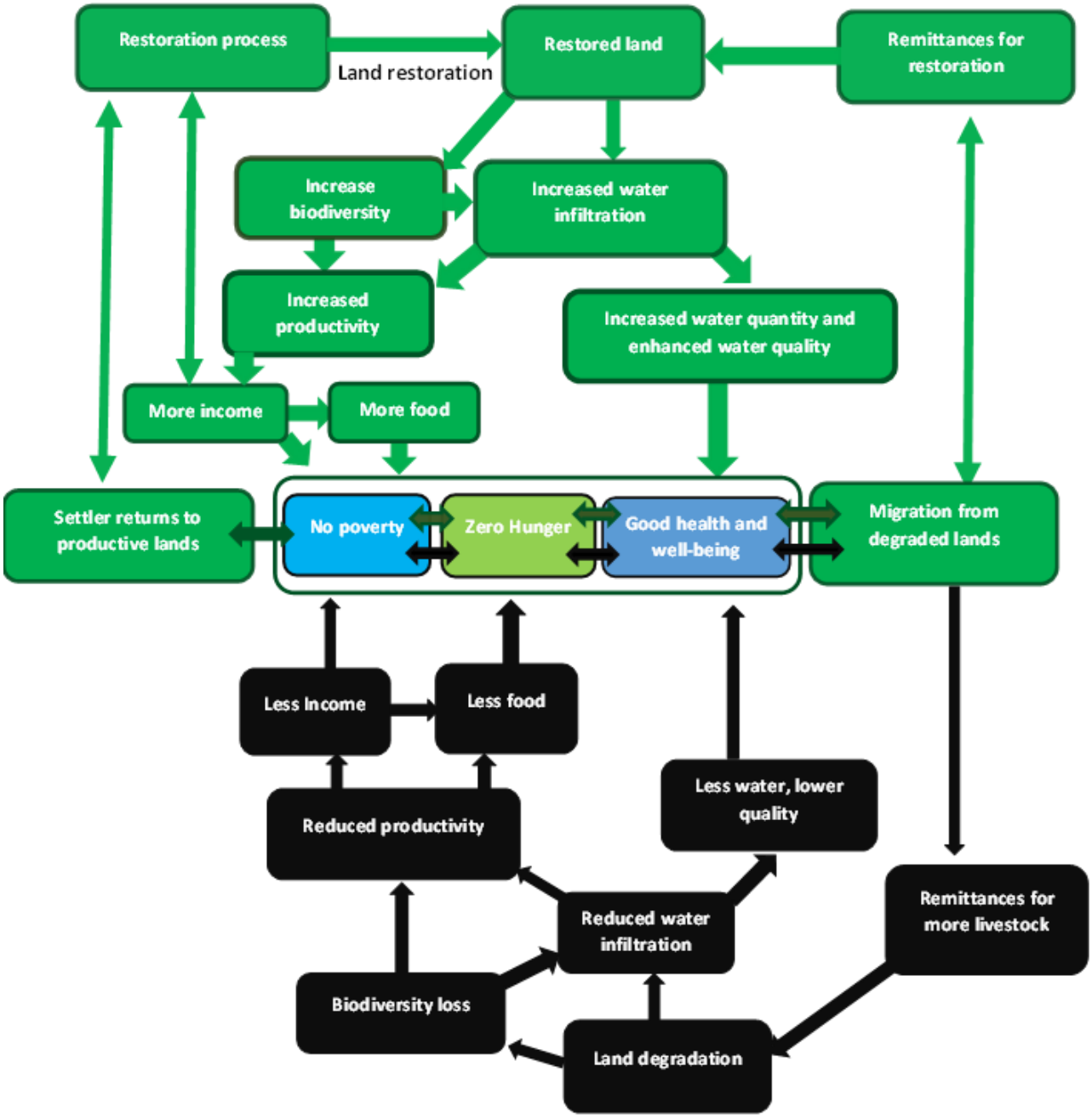

Figure 1. The impact of land restoration (depicted in green) and land degradation (represented in black) on livelihoods. Source: International Resource Panel-IRP [29].

Several studies have demonstrated the success of land restoration practices in enhancing food security. For example, a study by Sawadogo [30], in Burkina Faso, showed how land restoration interventions, especially focusing on forest landscape restoration, can mitigate food insecurity among smallholder farmers. By improving land productivity, these interventions increase agricultural yields and contribute to increased food production and availability. Land restoration practices provide essential ecosystem services like water regulation, biodiversity conservation, and microclimate control, supporting agricultural productivity, particularly in lean seasons. Integrating land restoration interventions into policy and practice is crucial for scaling up these practices and ensuring sustained adoption. This study highlights the potential of ecosystem restoration to enhance food security and can inform policymakers and practitioners in implementing similar interventions in other regions under climate change. A similar study conducted by Woolf et al. [31] in Ethiopia examined the opportunities and constraints in scaling up the impact of land restoration practices on food resilience. The study highlighted the integration of aid in food security programs, such as Ethiopia's Productive Safety Net Program (PSNP), which aims to reduce long-term dependence by investing in the productive capacity and resilience of communities. The study explored how these programs incorporate aid in exchange for labor on public works, which can contribute to land restoration efforts and enhance food security. By examining the interactions between land restoration practices, food security programs, and community resilience, the study provides valuable insights for policymakers and practitioners aiming to scale up the impact of land restoration interventions on food security.

Furthermore, another study by Paul et al. [32] aimed to clarify the potential of livestock production systems in facilitating sustainable transformations in agri-food systems through the regeneration of soils and restoration of degraded landscapes. The study concludes that livestock has the capacity to regenerate soils and restore landscapes, which, in turn, contributes to the development of nature-positive production systems. This is considered a crucial element for achieving sustainable transformations in agri-food systems. The study highlights the importance of recognizing and harnessing the regenerative potential of livestock systems to enhance the sustainability of agricultural practices and improve overall land health. Consequently, the extensive promotion and adoption of land restoration measures, as advocated by Chidumayo and Gumbo [33], has been implemented to restore or augment the provision of ecosystem goods and services. This aligns with the broader goal of meeting food security and livelihood needs. Due to the tangible benefits offered by land restoration practices, there is notable support from governments, donors, and non-governmental organizations [34–36] for the implementation of these practices by farmers and communities.

2.2. Biodiversity Conservation for Sustainable Food Systems

Biodiversity refers to the diversity present at different levels of biological organization (genes, populations, species, and ecosystems) and across various terrestrial scales (local, regional, or global) [37,38]. Biodiversity serves as the essential basis for ecosystems, which offer a range of essential services crucial for the well-being of humans and food production [39]. These services include the provision of essential resources, such as food production and the stability of the hydrological cycle, along with the regulation of climate and water quality. Also, they support soil nutrient cycling, soil formation, and photosynthesis, leading to increased biodiversity (Figure 2). Additionally, they provide the cultural benefits of aesthetic pleasure, recreation, and spiritual fulfillment [37,40]. According to a study by Potts et al. [38], biodiversity plays a crucial role in attaining food security and sustainable development, particularly in developing regions like Africa. The study emphasizes that effectively managing biodiversity is pivotal for the foundational aspect of agriculture and food production. This concept of "biodiversity in agriculture" was first introduced by Hanson [41] and underscores the importance of ecologists extending their

scope beyond wild native plants to include domesticated, exotic, and cultivated plants in order to enhance food production [42].

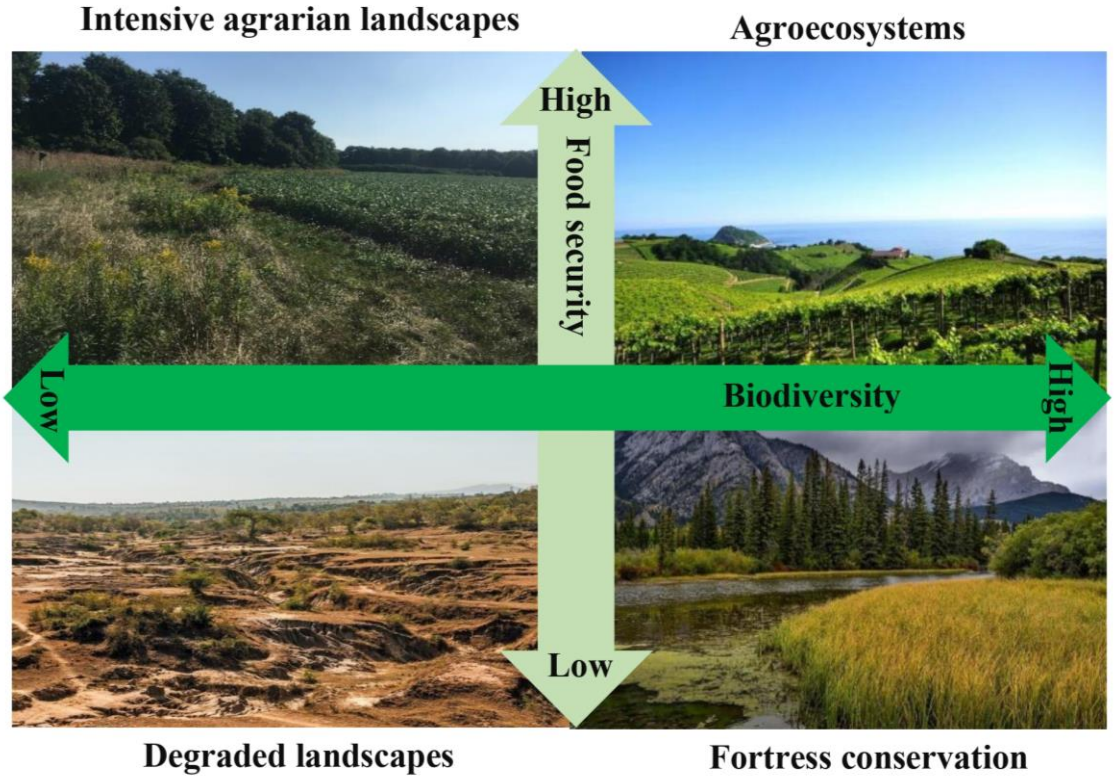

Figure 2. The synergetic influence of agroecological systems on biodiversity conservation and food security.

However, over the past few decades, there has been a significant global acceleration in biodiversity loss [43]. This loss of biodiversity raises significant concerns about the potential consequences for the resilience and stability of food systems and production [44]. This decline could have huge effects on food security, with potential negative impacts on the availability and accessibility of food resources, particularly in regions like Africa [37,45–47]. Furthermore, some studies have highlighted that the loss of biodiversity poses a significant threat to the sustainability of food systems and the achievement of various Sustainable Development Goals (SDGs), including the goal of "Zero Hunger" (SDG2) [48,49]. Ironically, food systems themselves contribute significantly to the decline of biodiversity [50,51]. The expansion of current food systems is a significant driver of land use change [52,53] and a major contributor to greenhouse gas emissions, leading to climate change [54] and exacerbating biodiversity loss [43,55]. Consequently, biodiversity loss carries significant economic and social implications, including increased poverty and hunger [37]. This impact is particularly pronounced in developing regions such as Africa, where a substantial proportion of the population directly depends on agriculture for both food security, and livelihoods [46,56].

Therefore, prioritizing the development of effective practices and policies is crucial for supporting biodiversity conservation and fostering sustainable food production [54,57]. By adopting biodiversity conservation approaches such as agroecological practices and breeding for biodiversity, farmers can reduce their reliance on chemical inputs, enhance soil health, and promote sustainable food production [13,58]. For instance, the study conducted by Mburu et al. [59] in Kenya revealed that increasing agricultural diversity not only enhances food resilience but also positively impacts the economy. They found that production systems with high levels of agrobiodiversity significantly improve food security among smallholder farmers. Similarly, Kerr [15] and Wezel et al. [58], highlight

the importance of implementing these practices at the grassroots level to enhance farm production and the overall food system. Multiple studies advocate for increasing awareness regarding the importance of conserving biodiversity while simultaneously ensuring food security [58–60]. These studies underscore the necessity for future food security strategies, particularly for small-scale farmers, to incorporate the sustainable use of biodiversity in agriculture while optimizing limited resources. By integrating biodiversity into agricultural practices, farmers can bolster the resilience and productivity of their farming systems, contributing to sustainable food security under changing climatic conditions.

2.3. Integration of Land Restoration and Biodiversity Conservation into Food Systems

Globally, ecosystems face threats from unsustainable land management practices in agriculture, human activities, and climate change, resulting in land degradation that disrupts food systems. Adopting sustainable practices to restore ecosystem productivity and promote conservation can potentially mitigate or reverse these adverse effects on landscapes [61,62]. However, such efforts operate within a complex mosaic of ecological dynamics, requiring dynamic land use designs and adaptive management strategies to effectively address these challenges. Some studies have emphasized that land restoration measures, such as agroecological practices, along with ecological biodiversity protection, have led to improvements in food production through water and fertilizer use efficiency by reducing input requirements [63,64]. However, there has been a relatively limited focus on stabilizing and enhancing crop yields through these methods. It is crucial to consider the efficient utilization of intensive agricultural resources, including land, water, energy, and nutrients, in endeavors to augment food production [65,66]. These strategies are gaining importance on a global scale as society recognizes their multifaceted benefits and services: biodiversity protection, capturing carbon, addressing climate change through adaptation and mitigation, rehabilitating degraded ecosystems, and supporting rural development initiatives [67].

Individually, land restoration and biodiversity conservation are recognized as crucial components in achieving sustainable food systems worldwide [20,21,43,55,68,69]. WWF [20], Chan, et al. [21], IPBES [43] and Crippa [55] have extensively documented their respective contributions to this goal. However, there exists a significant lack of practical studies focusing on the integrated approach of combining land restoration and biodiversity conservation for enhancing food systems sustainability globally. Despite this gap, various scholars have highlighted the potential synergies that can emerge from integrating land restoration and biodiversity conservation efforts within the context of sustainable food systems. Leakey [70], for instance, has emphasized the pivotal role of agroecosystems, such as agroecology and agroforestry, in enhancing ecosystem attributes and food system sustainability in developing regions like Africa. These agroecosystems contribute to land and biodiversity restoration while fostering connectivity in fragmented ecosystem.

Moreover, they provide essential hydrological services, such as regulating water flow and preventing sediment pollution in watersheds, which are crucial for enhancing the resilience and sustainability of food systems [71]. Montagnini [72] highlighted that by integrating land restoration practices like agroforestry or agroecology with biodiversity conservation efforts, it is possible to create multifunctional ecosystems that not only support food productivity but also enhance ecosystem services, biodiversity, and resilience to environmental stressors (as shown Figure 3). As emphasized, food production systems necessitate a diverse range of plants, animals, bacteria, and fungi to directly supply food and support the essential ecosystem processes that enable agriculture. These processes include water supply, soil fertility enhancement, pollination, and natural pest control, all of which are crucial for sustainable agricultural practices [73]. Therefore, by applying a suite of solutions across food systems in regions like Africa, it is possible to transform them from being the primary cause of land degradation to the principal catalyst for restoration and biodiversity recovery in response to climate change [74].

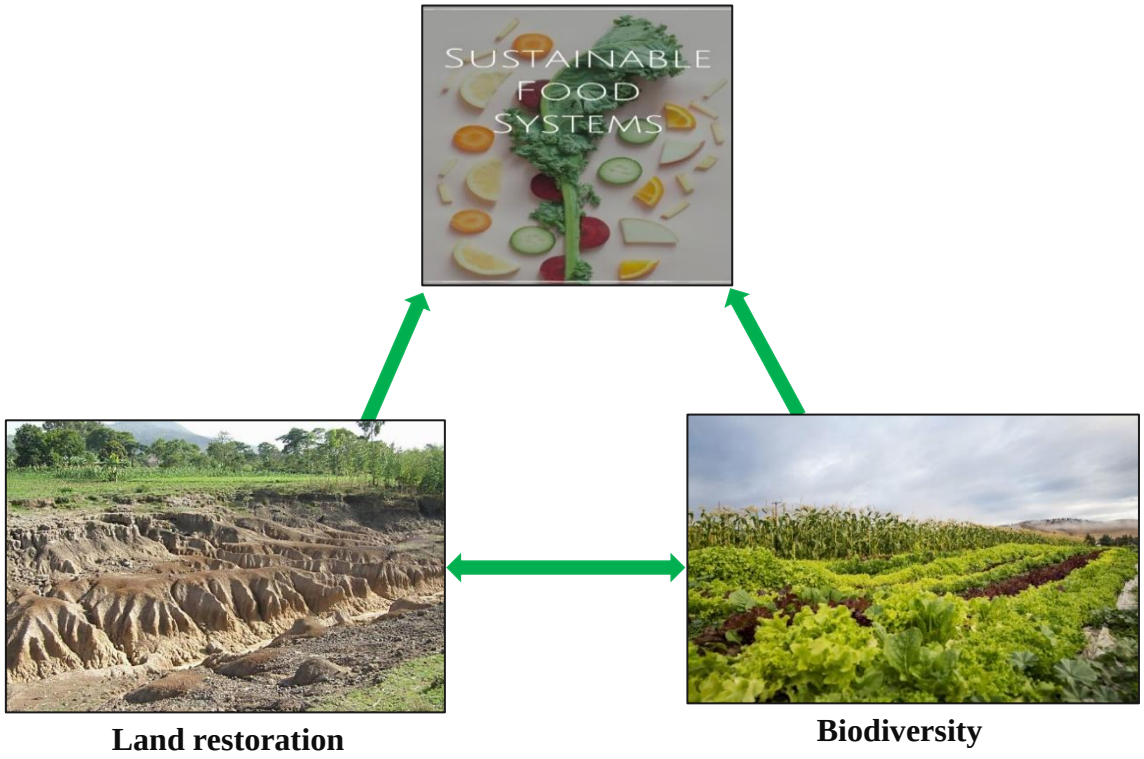

Figure 3. Integration of land restoration and biodiversity practices for sustainable food system.

3. Materials and Methods

Data Collection, Preparation, and Methods

This study utilizes three databases to compile a comprehensive dataset of scientific literature for bibliometric analysis. The Web of Science (WOS), Scopus, and Dimensions databases were scientifically extracted from 2010 to 30 October 2023. Then, we integrated the aforementioned three databases. Figure 4 provides information on the selection criteria used for identifying and selecting studies on land restoration, biodiversity, and food systems in Africa that were subjected to bibliometric analysis. The bibliometric analysis was carried out using bibliometric R-package (RStudio v4.2.3), biblioshiny [75,76].

The bibliometric search for the period from 2010 to 2023 was guided by specific criteria and combinations of search terms, focusing on Africa to profile experts and their contributions to Land Restoration, Biodiversity Conservation, and Sustainable Food Systems (SFSs). The geographical restriction to Africa was aligned with the research objective of identifying regional expertise to foster future collaborations and multidisciplinary studies. The timeframe of 2010–2023 was selected to capture contemporary developments and current experts in the field. The focus was on peer-reviewed publications, including research articles, review articles, and conference papers, ensuring the inclusion of rigorously vetted work. The search was limited to English, the predominant academic language, to enhance accessibility and relevance. The search terms included the following: "Food systems" OR "Food security" OR "sustainable food systems" OR "Sustainable Food security" OR "Sustainable livelihoods" AND "Biodiversity conservation" OR "Biodiversity Protection" AND Agroforestry OR Agroecology OR "Land restoration" OR "Ecological restoration" OR "Ecosystem restoration" AND Africa* OR "Sub-Saharan Africa". The use of an asterisk (*) added to the main concepts was essential to widen the search and ensure the inclusion of all relevant articles befitting the search criteria.

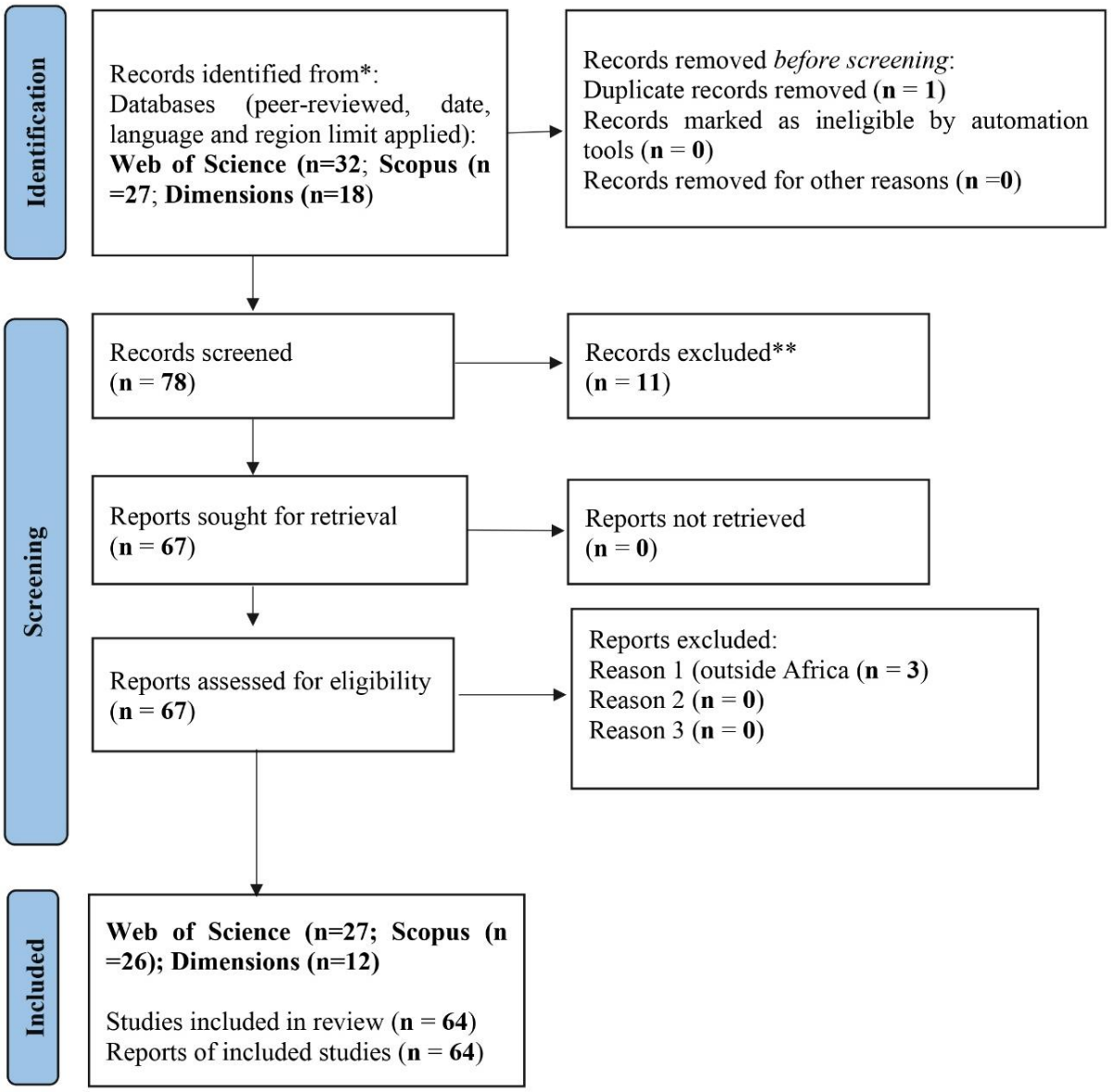

Figure 4. Systematic review process flow diagram of the selection process of publications for WoS, Scopus, and Dimensions databases based on PRISMA (Supplementary Materials). * Indicate the number of documents from each databases. ** indicate the number of documents excluded.

4. Results

4.1. Spatial Distribution and Most-Cited Scientific Research Contributions Per Country

In Figure 5, the top 10 countries with Single Country Publications (SCP) are depicted, with Ethiopia leading as the most prolific, followed by South Africa. This ranking underscores the significant individual contributions of these nations to the research landscape in land restoration and biodiversity within African food systems. Notably, Kenya, Mozambique, and Burkina Faso stand out as the only countries with Multiple Country Publications (MCP), highlighting collaborative efforts in research endeavors. Intriguingly, despite their high productivity, the top two countries, Ethiopia and South Africa, exhibit a notable absence of collaborations beyond their respective borders. These findings provide valuable insights into the publication patterns and collaborative dynamics among nations. They shed light on the research landscape and cooperative efforts in advancing knowledge on land restoration and biodiversity in African food systems.

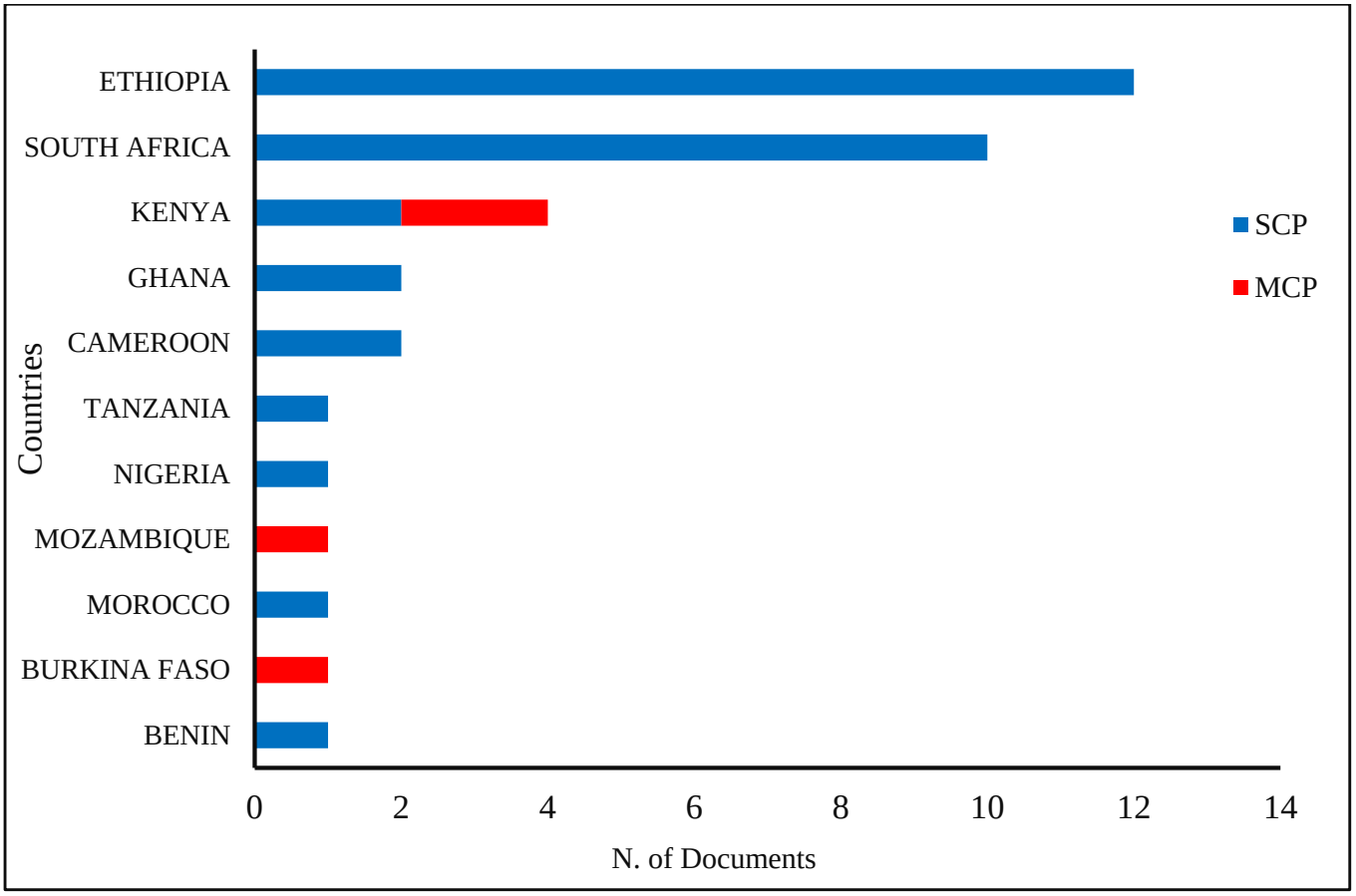

Figure 5. The contribution by country of the corresponding author's country, representing inter-country (**MCP**) collaboration and intra-country (**SCP**) collaboration.

4.2. Contribution of Documents in Terms of Impact/Summary of Top Most-Cited Published Documents

The top 10 most highly cited documents on land restoration, biodiversity, and food systems in Africa were explored (Table 1), with the leading document authored by Gliessman [11]. This study proposes a five-level approach for transforming the global food system, including Africa's food system, through the application of agroecology. The first level emphasizes improving the efficiency of industrial and conventional practices to minimize the use of costly and environmentally damaging inputs. It also introduces the concept of fostering ecological awareness. The second level involves transitioning towards alternative practices, substituting conventional inputs and methods to promote sustainability and reduce environmental impact. The third level advocates for the redesign of agroecosystems by embracing new ecological processes, thereby transforming agricultural systems to function harmoniously with nature. The fourth level focuses on establishing a more direct connection between food producers and consumers, fostering relationships that prioritize sustainability, equity, and justice. At the fifth level, the approach is to build a global food system on the foundation of sustainable agroecosystems and equitable relationships. This involves emphasizing democracy, participation, and justice to protect and restore the Earth's life support systems.

Table 1. Top most-cited documents on the contribution of land restoration and biodiversity in food systems of Africa.

Rank	Paper	PY	Document Title	TC/Y	TC
1	[11]	2016	Transforming food systems with agroecology	19.88	159
2	[77]	2021	Impact of climate change on biodiversity and food security	15.33	46
3	[78]	2017	Farmland tree species diversity and spatial distribution pattern	6.43	45
4	[79]	2014	Gender, agroforestry and food security	4.1	41
5	[80]	2014	Can agroforestry option values improve the functioning of drivers of agricultural intensification	3.3	33
6	[81]	2018	Does adaptation to climate change and variability provide household food security?	4.5	27
7	[82]	2015	Perspective on crop modelling in the management of intercropping systems	2.67	24
8	[83]	2021	Assessing Land Use and Land Cover Change and Farmers' Perceptions of Deforestation and Land Degradation.	7	21
9	[84]	2019	Implications of environmental sanitation management for sustainable livelihoods	3.6	18
10	[85]	2021	Food security and environment conservation through sustainable use of wild and semi-wild edible plants	5.33	16

PY = publication year; **TC/Y** = Total citation per year, **TC** = Total citation.

A comprehensive review conducted by Muluneh [77] employs secondary data encompassing climate models, emission data, migration patterns, and extinction scenarios. It systematically examines the intricate relationship between climate change, biodiversity, and food security. The findings indicate that climate change-induced shifts in species distributions are characterized by a median rate of 11.0 m and 16.9 km per decade towards higher elevations and latitudes. These shifts, coupled with diverse migration scenarios, underscore extinction risks ranging from 21–23% (under unlimited migration) to 38–52% (with no migration) among 1103 species. These shifts have simultaneous repercussions on food security, particularly in rain-fed agriculture-dependent communities. The author emphasizes that a strategic approach to harmonizing food security and biodiversity conservation necessitates prioritizing conservation efforts. This approach should be favored over resource-intensive strategies, such as expanding agriculture and exploiting new fish stocks. Instead, the study advocates for the adoption of more sustainable practices, including the reduction of food waste and support for food-insecure populations. It also emphasizes the importance of biodiversity conservation, optimized utilization of genetic resources, and the integration of traditional ecological knowledge.

In a study conducted in Ethiopia by Endale et al. [78], the spatial occurrences of tree species biodiversity were examined to inform interventions for enhancing food productivity. The research revealed significant positive relationships between land-holding proportions and the abundance and basal area of tree species, though no such correlation was observed with species richness. The authors recommended specific interventions, including the utilization of seedlings from diverse tree species to enhance planting across farm ranges, given their high quality. Additionally, they underscored the importance of prioritizing water and grazing-land considerations to enhance the seedling and regeneration of newly planted trees. Ultimately, the authors emphasized that implementing these interventions would contribute to an enhanced resilience of the farming system in the face of climate change.

In a study by Kiptot et al. [79], the contribution of agroforestry to food security was explored from a gender perspective, highlighting its significant impact on food production with active involvement from both men and women. However, the study revealed that women's participation and benefits are constrained by cultural norms and resource limitations. This emphasizes the need for the implementation of recommended policies, technological advancements, and institutional interventions to maximize women's contributions to food security through agroforestry.

Carsan et al. [80] explored agroforestry's potential to strengthen the resilience of agricultural commodity production systems, demonstrating that resource-conserving practices, such as improved fallows featuring legumes in rotations or intercrops, not only restores

soil nutrients and increases soil carbon but also reduces fertilizer dependence by 50%. The study advocates for further research, emphasizing the need to integrate ecological knowledge with an understanding of socio-economic constraints. This integration is essential to answer the full potential of diversification in enhancing productivity, ecosystem functions, and adaptability across diverse African farm settings.

Amare and Simane [81] employ a propensity score matching approach in Ethiopia to assess the impact of adopting climate change adaptation options on household food security. Their findings reveal an alignment with factors such as male household heads, larger family size, access to extension services, increased landholding, and a history of frequent droughts and floods. The authors recommend policy interventions focusing on soil and water conservation, small-scale irrigation, agronomic practices, and livelihood diversification as integral elements of a holistic food security strategy. These recommendations are applicable not only in similar contexts but also transferable to other developing countries facing analogous challenges.

In South Africa, Chimonyo et al. [82] conducted a study examining the concepts of intercropping and elucidating the capture and utilization of resources within such systems. Their findings indicated that increased crop biodiversity through intercropping contributes to improved resilience, food security, and nutrition. The authors emphasized the importance of farmers possessing comprehensive knowledge regarding species combinations, arrangements, and proportions to maximize the benefits of intercropping. They noted that existing agronomic recommendations predominantly focus on monoculture practices, which hinders the optimization of intercrop systems. As a result, it is concluded that there is a critical need to advance agricultural research on intercrop systems by integrating both conventional and modern research approaches.

Kouassi et al. [83] conducted a study in Cote d'Ivoire to examine land use and land cover (LULC) changes and farmers' perceptions of the drivers and effects of deforestation and land degradation. Their findings revealed that the primary impacts associated with deforestation included land degradation (70.6%), loss of biodiversity (63.8%), global warming (56.9%), and loss of livelihood assets (54.3%). In response to these challenges, the authors recommend the implementation of participatory landscape planning, reforestation initiatives, and capacity building for stakeholders. These measures aim to promote sustainable intensification of production systems, thereby mitigating LULC issues and enhancing the productive and protective functions of remaining forests. In another study conducted in Ghana, Mensaha and Enu-Kwesi [84] examined the consequences of environmental sanitation on three coastal livelihood activities: fishing, tourism, and salt production. Their findings indicated that sanitation exerted a significant influence on the livelihoods associated with these activities. This impact affected various aspects, including health, productivity, income, job security, and the sustainability of the physical environment. The study underscores the need for sanitation behavioral change communication messages from responsible stakeholders. These messages should emphasize not only the intrinsic value of sanitation for human health, but also highlight the intricate linkages between sanitation practices and the comprehensive sustainability of livelihoods. This connection is particularly relevant within the context of tourism, fishing, and salt production.

Kidane and Kejela [85] conducted an ecological study in Ethiopia to ascertain and record wild and semi-wild edible plants (WSWEPs) along with their conservation statuses. The findings revealed a predominant presence of tree species (14 species; 41.2%), succeeded by herbs and shrubs, each comprising 10 species (29.4%).

The study emphasizes the imperative of collaborative efforts between local communities and the Forest Administration. This collaboration is essential for the sustainable utilization of edible plant species in the study area. Such collaboration is deemed crucial to prevent the escalation of these resources to a critically endangered status.

The selected top 10 articles analyzed in this study underscore the crucial importance of integrating sustainable practices in agriculture to enhance food security, biodiversity conservation, and overall resilience of farming systems in Africa. These studies emphasize

the potential of agroecology, agroforestry, intercropping, and land restoration initiatives in mitigating the adverse impacts of climate change on agricultural productivity and food security. Furthermore, the roles of gender equity, policy interventions, and institutional support are highlighted as essential components to maximize the contributions of women to food security and sustainable farming practices. The findings also stress the significance of conservation efforts, participatory planning, and behavioral change communication strategies to address challenges such as deforestation, land degradation, and environmental sanitation. Ultimately, these efforts promote the sustainable management of natural resources and the protection of livelihoods within diverse African farm settings, as highlighted by Djenontin et al. [86] and Ziadat et al. [87]. Through a comprehensive and holistic approach, these studies provide valuable insights and recommendations to guide agricultural practices towards a more sustainable, resilient, and equitable food system in Africa.

4.3. Authors Keywords and Co-Occurrence Network

Through keyword co-occurrence analysis, we can identify research hotspots in land restoration, biodiversity, and food systems in Africa by focusing on high-frequency keywords. This analysis illustrates the connections between keywords in the literature, highlighting the knowledge structure of the field, and can inform decisions in agriculture by identifying emerging trends and areas for further research [88]. Figure 6 shows the co-occurrence of keywords found in the selected papers. The selection of the number of authors' keywords was based on Zipf's law. The arrangement of keywords reveals their interrelationships, leading to the identification of clusters based on shared characteristics, namely red, blue, brown, yellow, purple, and green. While the lines between the nodes indicate the strength and relationship of the clusters, the color coding highlights distinct thematic areas within the network. Moreover, the larger nodes, such as climate change, food security, biodiversity conservation, and species diversity, indicate a higher frequency of the authors' keywords. This underscores their significance in land restoration and biodiversity studies aimed at improving food systems in Africa. The impact of climate change was the most considered and monitored feature for food security improvement in Africa during this study period in the authors' keywords. Furthermore, agroecosystems or practices and biodiversity conservation (species diversity) appeared to be among the important practices in land restoration, biodiversity, and food systems in Africa.

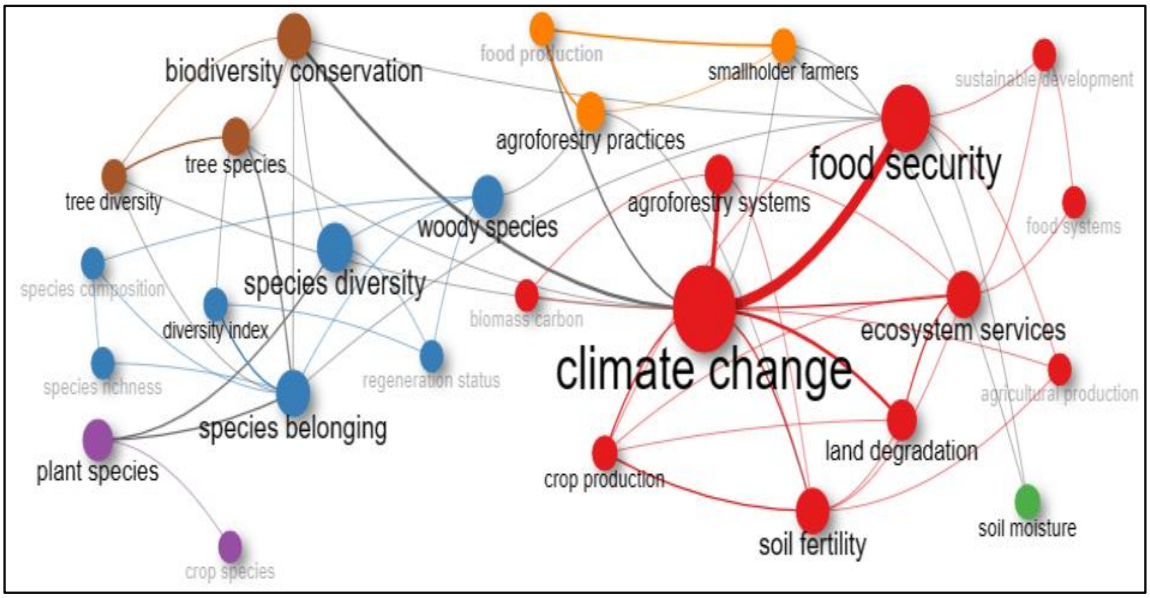

Figure 6. Author's keywords co-occurrence network on land restoration and biodiversity in food systems of Africa: various colors indicate word clusters; label size indicates how frequently each keyword occurs. The same cluster of keywords is frequently listed together.

4.4. Research Themes, Trends, and Hot Topics

4.4.1. Research Themes Analysis

Figure 7 illustrates a thematic map constructed based on keywords, categorizing them into four distinct themes: niche (left top), motor (top right), emerging or declining (left bottom), and basic themes (right bottom). The niche themes, such as provisioning services, soil health, adaption, and conservation, represent highly specialized and well-established topics within the field. The motor themes, which encompass adaptation, conservation, livelihoods, sustainability, and agrobiodiversity, are pertinent research areas that have witnessed substantial growth. The emerging and declining themes encompassed newly introduced research areas and those that are gradually fading into obscurity. Finally, the basic themes, including food security and climate change, are fundamental subjects that are relevant to research but still require further development. The prevalence of specialized topics such as soil health, adaptation, and conservation indicates a concerted effort by authors to address pressing issues of land degradation and food insecurity in Africa. Moreover, the growth of research areas like livelihoods, sustainability, and agrobiodiversity reflects an increasing recognition of the impact of climate change on these critical challenges. These findings underscore the alignment of research efforts with global challenges, highlighting the importance of adopting agro-ecofriendly approaches to sustain livelihoods and mitigate the impacts of climate change on agricultural systems.

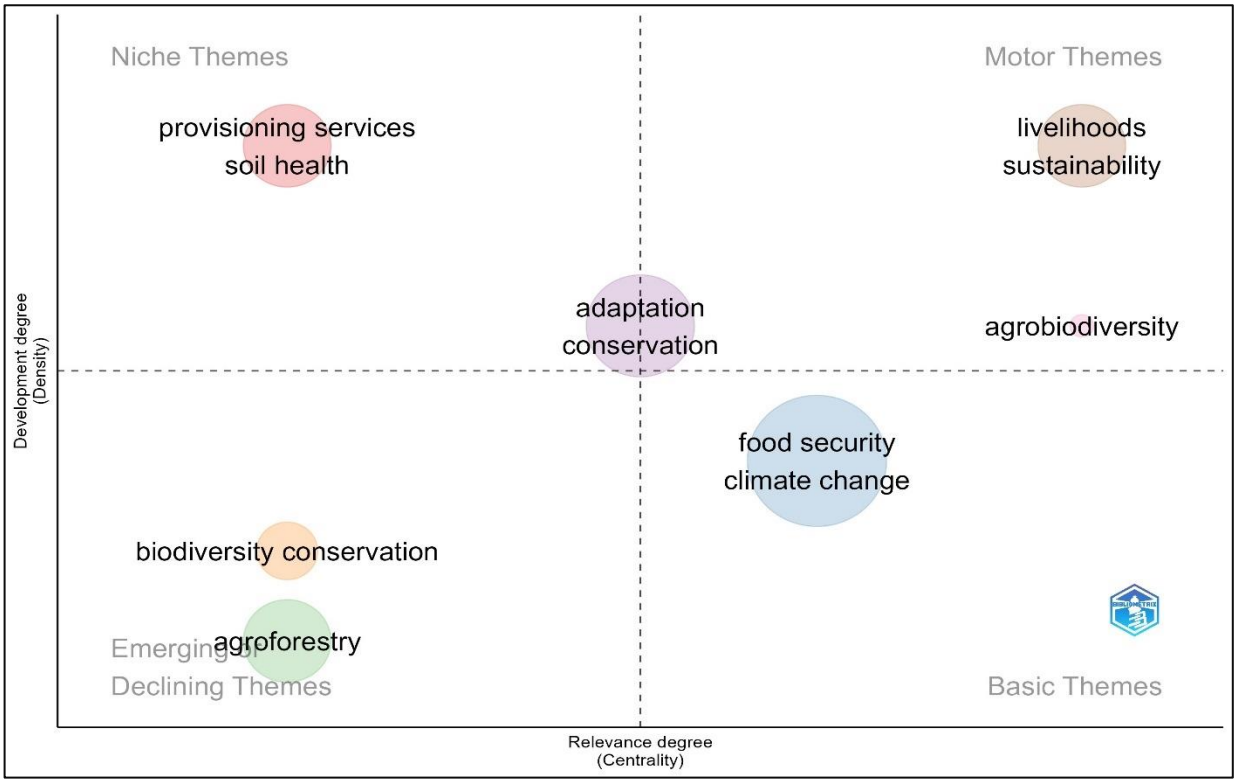

Figure 7. Thematic map representation of keywords in publications on land restoration, biodiversity, and food systems in Africa.

4.4.2. Research Trends Analysis

Analyzing the keywords employed by authors in publications is an indispensable tool for exploring current trends and the focal points of scholars within a given field [89]. This approach is particularly valuable as publication keywords swiftly elucidate the core theme and emphasis of a given research work. It is noteworthy that the font size in our analysis exhibited a positive correlation with word frequency. Consequently, words appearing more frequently were visually represented in larger font sizes within the word cloud.

The most recurrent keywords underscored the collective effort to enhance and sustain food systems through the implementation of intelligent agricultural practices, notably, smart agriculture systems such as agroecosystem practices (Figure 8). These endeavors were concurrently aimed at the restoration and conservation of species biodiversity and agricultural resources. Moreover, South Africa and Ethiopia emerged as leading nations in the adoption of smart agriculture systems. This strategic adoption was directed towards promoting sustainability in food systems while simultaneously addressing the imperative of restoring and conserving biodiversity. The prominence of these keywords in the literature reflects the global scholarly emphasis on leveraging innovative agricultural practices for sustainable food systems and ecological conservation. These insights underscore the global scholarly commitment to leveraging innovative agricultural strategies to achieve both ecological conservation and food security goals.

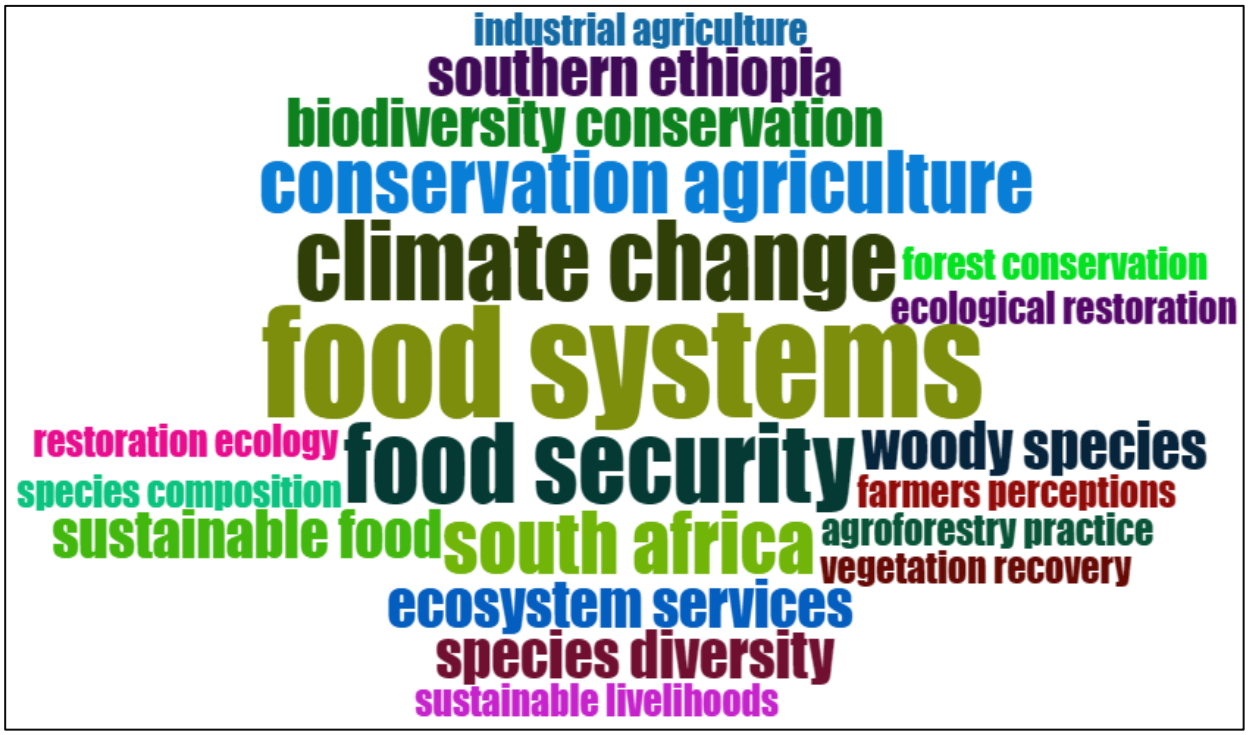

Figure 8. A word cloud of the 20 most frequently used research keywords.

4.4.3. Hot Topics

Figure 9 illustrates the dynamic evolution of key terms in the research landscape, visually depicting the emergence and growth of various keywords. The data indicates that a significant number of these keywords first appeared in research discussions around 2013 and have since experienced continuous growth. Notably, "climate change" and "food security" have consistently been the focal points of discussions since 2013. Additionally, keywords such as "biodiversity conservation" and "land degradation" have maintained enduring relevance. Conversely, certain terms, such as "plant species" and "agroforestry systems and practices", have witnessed a rapid surge in prominence after 2018. This observation suggests that authors in the field of land restoration and biodiversity conservation practices were actively engaging in addressing climate change and food insecurity in Africa. Their focus involves leveraging agroecosystems and enhancing natural vegetation in the African context, emphasizing a commitment to ecological solutions.

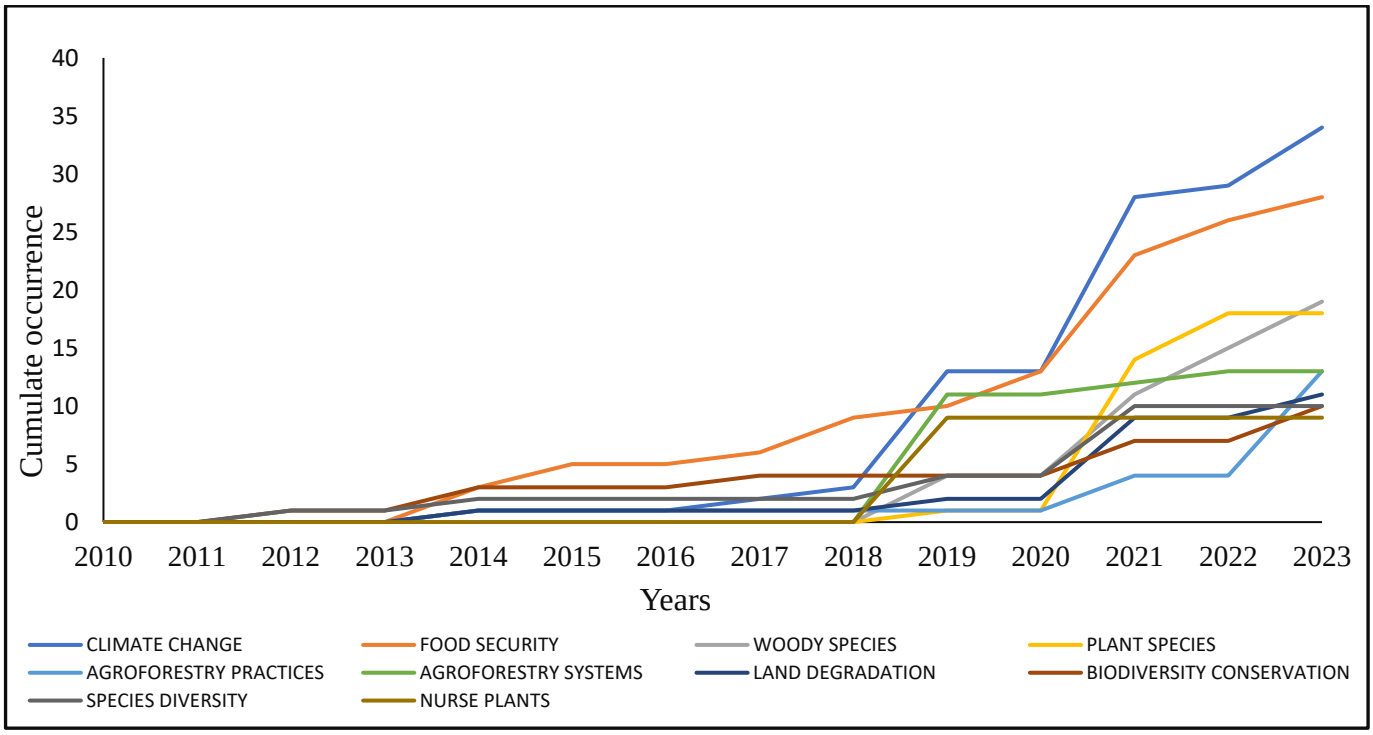

Figure 9. Dynamic view of authors' keywords over time.

5. Discussion

Bibliometric studies have emerged as indispensable tools for assessing scientific activity, providing valuable insights into the expansion, extent, and dispersion of scholarly literature within specific fields of study. These methods serve as reliable and universally applicable measures to gauge the productivity of a given sector [90]. Consequently, countries with advanced scientific development will increasingly recognize the necessity of employing these tools to gain a comprehensive understanding of their scientific landscape [91]. This study highlights the research trends on the contribution of land restoration and biodiversity in African food systems over the 13 years. The analysis included an assessment the outputs of productive nations, active authors, keyword co-occurrence networks, research themes, trends, and hot topics.

On the other hand, among the most productive countries, only three nations have Multiple Country Publications (MCP): Kenya, Mozambique, and Burkina Faso. This indicates a high need of collaboration among the African nation in this field. This can help more in increasing the research productivity and also lead to innovative solutions, as researchers can tackle complex problems from multiple angles, as noted by Marris et al. [92], Edmondson and Harvey [93], and Van Biljon and Mwapwele [94]. Additionally, the majority of productive authors engaged in this subject area originate from Ethiopia, followed by South Africa. However, it is noteworthy that the most productive author in this study is from outside Africa. This underscores the fact that a significant portion of research in this field is conducted by authors from developed countries, such as the USA. This observation can be linked to the financial resources and support that authors from these nations receive from their respective governments. Consequently, African countries must strategically invest in research on land restoration, biodiversity, and food systems to fight food insecurity on the continent.

Consequently, these studies explore key suggestions and recommendations from research documents on land restoration, biodiversity, and food systems in Africa. A first pivotal study by Gliessman [11] suggested a five-level approach for transforming the global and African food systems, emphasizing agroecology's role. The analysis of Muluneh [77] reveals climate change-induced shifts impacting biodiversity and food security, stressing

the need for conservation over resource-intensive strategies. In Ethiopia, Endale et al. [78] link tree species biodiversity with food security, proposing interventions for resilience in the face of climate change. Kiptot et al. [79], highlight agroforestry's gender-specific impact on food security, stressing the need for policy interventions. Building on this, Kapari et al. [95] highlighted a gender-sensitive approach that considers the roles of both men and women in sustainable agriculture practices and their contributions to sustainable livelihoods. The study further emphasizes that women's empowerment plays a critical role in the adoption of Climate-Smart Agriculture (CSA) practices. The authors suggest that empowering women can enhance the uptake of CSA, aligning with findings that the gender of a household head significantly impacts the adoption of these practices. Furthermore, Carsan et al. [80], explores agroforestry's potential in bolstering agricultural resilience, while Amare and Simane [81] assess climate change adaptation options in Ethiopia for enhancing household food security.

In another study in South Africa, Chimonyo et al. [82], advocate for increased knowledge on intercropping systems for improved resilience of food production. Kouassi et al. [83] analyzes land use changes in Cote d'Ivoire, recommending participatory planning and reforestation initiatives. In Ghana, Mensaha and Enu-Kwesi [84] reveal significant impact on coastal livelihoods, urging behavioral change communication. An ecological study in Ethiopia by Kidane and Kejela [85] emphasizes collaborative efforts for sustainable utilization of wild and semi-wild edible plants. These studies collectively underscore the multifaceted challenges and opportunities for enhancing food security and biodiversity conservation in the African context.

The study further identifies key thematic areas, including "climate change", "food security", "biodiversity conservation", and "agroecosystems", within the realm of land restoration, biodiversity, and food systems research in Africa. This underscores the practical application of solutions, such as agroforestry systems and smart agriculture, aimed at mitigating food insecurity amidst climate change challenges. Notably, these solutions, as highlighted by Mbow et al. [13], play a pivotal role in simultaneously addressing climate change and food security issues in Africa. In line with the findings, these practical solutions are designed to enhance food security while also minimizing land degradation by improving soil fertility [96,97] and enhancing crop production [98]. Additionally, these solutions promote the ecosystem services contributing to overall environmental sustainability [64]. The study aligns with the observation of Mbow et al. [13] that diverse agroecosystems are crucial in tackling climate change and food insecurity challenges in Africa. Importantly, Mbow et al. [13] noted the diversity in the forms and procedures of agroecosystems used in Africa. They emphasized that this diversity reflects their adaptability, which is influenced by various factors, including agro-ecological zones.

Furthermore, the examination of research hot topics and predictions of future trends through themes analysis, trends analysis, and hot topics analysis revealed the focal points of investigations in this subject area in Africa over time. Notably, themes included "food security/systems", "agroecosystems or practices", "agricultural land", "biodiversity conservation", "adaptation", and "livelihoods". This trend analysis indicates that from 2010 to 2023, researchers actively engaged in practical initiatives, adopting agroecosystems or practices with a focus on agricultural conservation. These efforts are aimed at enhancing food systems and security in Africa, particularly in response to the challenges posed by climate change. This ecological approach underscores the importance of sustainable agricultural practices and biodiversity conservation in addressing the complex interplay between land and food production. Additionally, it emphasizes the need for adaptive strategies to enhance environmental resilience on the African continent [13]. It has been highlighted by some studies that Africa is highly vulnerable to climate changes, as it has a severe influence on arable land, which consequently affects food security [99–101]. Furthermore, disturbingly, projections suggest that by 2025, a substantial portion of two thirds of arable land in Africa is anticipated to become arid due to insufficient rainfall [99]. This threatening trend is reported to result in a substantial decline in agricultural productivity,

with estimates indicating a potential decrease of up to 9% by the year 2050 [100]. Based on the analysis of themes, trends, and hot topics, this study predicts that researchers will persistently adopt and enhance agroecosystems and practices over the next five years. These efforts aim to improve food systems in Africa and ensure sustainable livelihoods in the face of climate change. The ongoing practical implementation of these systems, coupled with the utilization of innovative technologies like smart agriculture, will not only increase food production, but also promote sustainability in arable land across the continent.

6. Conclusions

In conclusion, this study has provided valuable insights into the research trends and contributions in land restoration, biodiversity, and food systems in Africa. It has identified key countries, authors, and research themes, emphasizing the need for collaboration among African nations and increased investment in research to tackle food insecurity and promote sustainability. However, a significant portion of research is conducted by authors from developed countries, highlighting the necessity for African countries to strategically invest in local research capacity. To translate these insights into action, policymakers should prioritize funding and infrastructure development for local research institutions, enhancing the capacity of African researchers to address region-specific challenges. Collaborative research initiatives should be established, fostering partnerships that pool resources and expertise to effectively tackle food security and climate change issues. Policymakers must promote policies that support agroecological practices and biodiversity conservation, providing incentives for farmers to adopt sustainable practices that enhance ecosystem services. Integrating indigenous knowledge systems and traditional agricultural practices is crucial for enhancing resilience and sustainability. Future research should examine socio-economic factors influencing food insecurity and develop customized region-specific adaptation strategies. Additionally, the adoption of and investment in innovative technologies, such as smart agriculture, should be encouraged to improve productivity while minimizing environmental impacts. Finally, establishing frameworks for monitoring and evaluating the impacts of implemented policies and practices will help assess progress and inform future actions. Overall, this study underscores the importance of collaborative efforts, innovative technologies, and practical solutions in achieving food security, promoting sustainability, and addressing climate change impacts in Africa. By focusing on these actionable recommendations, stakeholders can work together to create a more resilient and sustainable future for the region.

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References

1. Hossain, A.; Krupnik, T.J.; Timsina, J.; Mahboob, M.G.; Chaki, A.K.; Farooq, M.; Bhatt, R.; Fahad, S.; Hasanuzzaman, M. Agricultural land degradation: Processes and problems undermining future food security. In *Environment, Climate, Plant and Vegetation Growth*; Springer International Publishing: Cham, Switzerland, 2020; pp. 17–61. [CrossRef]
2. Gomiero, T. Soil degradation, land scarcity and food security: Reviewing a complex challenge. *Sustainability* **2016**, *8*, 281. [CrossRef]
3. Blanco-Canqui, H.; Lal, R. *Principles of Soil Conservation and Management*; Springer Science & Business Media: Berlin/Heidelberg, Germany, 2008.
4. Challinor, A.J.; Watson, J.; Lobell, D.B.; Howden, S.M.; Smith, D.R.; Chhetri, N. A meta-analysis of crop yield under climate change and adaptation. *Nat. Clim. Change* **2014**, *4*, 287–291. [CrossRef]
5. ISC-UNDRR-IRDR. A Framework for Global Science in Support of Risk Informed Sustainable Development and Planetary Health. 2020. Available online: https://council.science/wp-content/uploads/2020/06/DRR_GlobalScience-Framework-FINAL.pdf (accessed on 10 January 2024).
6. Lott, J.E.; Ong, C.K.; Black, C.R. Understorey microclimate and crop performance in a Grevillea robusta-based agroforestry system in semi-arid Kenya. *Agric. For. Meteorol.* **2009**, *149*, 1140–1151. [CrossRef]
7. Garnett, T. Three perspectives on sustainable food security: Efficiency, demand restraint, food system transformation. What role for life cycle assessment? *J. Clean. Prod.* **2014**, *73*, 10–18. [CrossRef]
8. Ponisio, L.C.; M'Gonigle, L.K.; Mace, K.C.; Palomino, J.; De Valpine, P.; Kremen, C. Diversification practices reduce organic to conventional yield gap. *Proc. R. Soc. B Biol. Sci.* **2015**, *282*, 20141396. [CrossRef]
9. Djurfeldt, G.; Holmen, H.; Jirström, M.; Larsson, R. *The African Food Crisis Lessons from the Asian Green Revolution*; Cabi: Wallingford, UK, 2005.
10. Altieri, M.A.; Funes-Monzote, F.R.; Petersen, P. Agroecologically efficient agricultural systems for smallholder farmers: Contributions to food sovereignty. *Agron. Sustain. Dev.* **2012**, *32*, 1–13. [CrossRef]
11. Gliessman, S. Transforming food systems with agroecology. *Agroecol. Sustain. Food Syst.* **2016**, *40*, 187–189. [CrossRef]
12. Nyantakyi-Frimpong, H.; Kangmennaang, J.; Kerr, R.B.; Luginaah, I.; Dakishoni, L.; Lupafya, E.; Shumba, L.; Katundu, M. Agroecology and healthy food systems in semi-humid tropical Africa: Participatory research with vulnerable farming households in Malawi. *Acta Trop.* **2017**, *175*, 42–49. [CrossRef]
13. Mbow, C.; Van Noordwijk, M.; Luedeling, E.; Neufeldt, H.; Minang, P.A.; Kowero, G. Agroforestry solutions to address food security and climate change challenges in Africa. *Curr. Opin. Environ. Sustain.* **2014**, *6*, 61–67. [CrossRef]
14. Muhie, S.H. Novel approaches and practices to sustainable agriculture. *J. Agric. Food Res.* **2022**, *10*, 100446. [CrossRef]
15. Kerr, R.B.; Madsen, S.; Stüber, M.; Liebert, J.; Enloe, S.; Borghino, N.; Parros, P.; Mutyambai, D.M.; Prudhon, M.; Wezel, A. Can agroecology improve food security and nutrition? A review. *Glob. Food Secur.* **2021**, *29*, 100540. [CrossRef]
16. DeClerck, F.A.; Koziell, I.; Benton, T.; Garibaldi, L.A.; Kremen, C.; Maron, M.; Del Rio, C.R.; Sidhu, A.; Wirths, J.; Clark, M.; et al. A whole earth approach to nature-positive food: Biodiversity and agriculture. In *Science and Innovations for Food Systems Transformation*; Springer International Publishing: Cham, Switzerland, 2023; pp. 469–496. [CrossRef]
17. Smith, P.; Gregory, P.J. Climate change and sustainable food production. *Proc. Nutr. Soc.* **2013**, *72*, 21–28. [CrossRef] [PubMed]
18. Rejeb, A.; Abdollahi, A.; Rejeb, K.; Treiblmaier, H. Drones in agriculture: A review and bibliometric analysis. *Comput. Electron. Agric.* **2022**, *198*, 107017. [CrossRef]
19. Singh, A.P.; Yerudkar, A.; Mariani, V.; Iannelli, L.; Glielmo, L. A Bibliometric Review of the Use of Unmanned Aerial Vehicles in Precision Agriculture and Precision Viticulture for Sensing Applications. *Remote Sens.* **2022**, *14*, 1604. [CrossRef]
20. WWF. *Towards Nature Positive–The Role of Restoration for Land Degradation Neutrality*; WWF: Gland, Switzerland, 2022.
21. Chan, F.K.S.; Chen, J.; Li, P.; Wang, J.; Wang, J.; Zhu, Y. The cross-boundary of land degradation in Mongolia and China and achieving its neutrality-challenges and opportunities. *Ecol. Indic.* **2023**, *151*, 110311. [CrossRef]
22. Kang, Y.; Khan, S.; Ma, X. Climate change impacts on crop yield, crop water productivity and food security–A review. *Prog. Nat. Sci.* **2009**, *19*, 1665–1674. [CrossRef]
23. King-Okumu, C.; Tsegai, D.; Sanogo, D.; Kiprop, J.; Cheboiwo, J.; Sarr, M.S.; da Cunha, M.I.; Salman, M. How can we stop the slow-burning systemic fuse of loss and damage due to land degradation and drought in Africa? *Curr. Opin. Environ. Sustain.* **2021**, *50*, 289–302. [CrossRef]
24. Du Preez, C.C.; Van Huyssteen, C.W.; Kotzé, E.; Van Tol, J.J. Ecosystem services in sustainable food systems: Operational definition, concepts, and applications. In *The Role of Ecosystem Services in Sustainable Food Systems*; Academic Press: Cambridge, MA, USA, 2020; pp. 17–42. [CrossRef]
25. Cao, S.; Zhong, B.; Yue, H.; Zeng, H.; Zeng, J. Development and testing of a sustainable environmental restoration policy on eradicating the poverty trap in China's Changting County. *Proc. Natl. Acad. Sci. USA* **2009**, *106*, 10712–10716. [CrossRef]
26. Blignaut, J.; Mander, M.; Schulze, R.; Horan, M.; Dickens, C.; Pringle, C.; Mavundla, K.; Mahlangu, I.; Wilson, A.; McKenzie, M.; et al. Restoring and managing natural capital towards fostering economic development: Evidence from the Drakensberg, South Africa. *Ecol. Econ.* **2010**, *69*, 1313–1323. [CrossRef]
27. Aronson, J.; Alexander, S. Ecosystem restoration is now a global priority: Time to roll up our sleeves. *Restor. Ecol.* **2013**, *21*, 293–296. [CrossRef]

28. IPBES. *Summary for Policymakers of the Assessment Report on land Degradation and Restoration of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services*; Scholes, R., Montanarella, L., Brainich, A., Barger, N., Brink, B., Cantele, M., Erasmus, B., Fisher, J., Gardner, T., Holland, T.G., et al., Eds.; IPBES secretariat: Bonn, Germany, 2018.
29. International Resource Panel-IRP. *Land Restoration for Achieving the Sustainable Development Goals: An International Resource Panel Think Piece*; Herrick, J.E., Abrahamse, T., Abhilash, P.C., Ali, S.H., Alvarez-Torres, P., Barau, A.S., Branquinho, C., Chhatre, A., Chotte, J.L., Cowie, A.L., et al., Eds.; A Think Piece of the International Resource Panel; United Nations Environment Programme: Nairobi, Kenya, 2019.
30. Sawadogo, H. Using soil and water conservation techniques to rehabilitate degraded lands in northwestern Burkina Faso. In *Sustainable Intensification*; Routledge: London, UK, 2012; pp. 120–128.
31. Woolf, D.; Solomon, D.; Lehmann, J. Land restoration in food security programmes: Synergies with climate change mitigation. *Clim. Policy* **2018**, *18*, 1260–1270. [CrossRef]
32. Paul, B.K.; Mutegi, J.K.; Wironen, M.B.; Wood, S.A.; Peters, M.; Nyawira, S.S.; Misiko, M.T.; Dutta, S.K.; Zingore, S.; Oberthür, T.; et al. Livestock solutions to regenerate soils and landscapes for sustainable agri-food systems transformation in Africa. *Outlook Agric.* **2023**, *52*, 103–115. [CrossRef]
33. Chidumayo, E.N.; Gumbo, D.J. (Eds.) *The Dry Forests and Woodlands of Africa: Managing for Products and Services*; Earthscan: London, UK, 2010.
34. Sendzimir, J.; Reij, C.P.; Magnuszewski, P. Rebuilding Resilience in the Sahel: Regreening in the Maradi and Zinder Regions of Niger. *Ecol. Soc.* **2011**, *16*, 1. Available online: https://www.jstor.org/stable/26268916 (accessed on 2 June 2024). [CrossRef]
35. Sop, T.; Oldeland, J. Local perceptions of woody vegetation dynamics in the context of a 'greening Sahel'. A case study from Burkina Faso. *Land Degrad. Dev.* **2013**, *24*, 511–527. [CrossRef]
36. Schweizer, D.; van Kuijk, M.; Ghazoul, J. Perceptions from non-governmental actors on forest and landscape restoration, challenges and strategies for successful implementation across Asia, Africa and Latin America. *J. Environ. Manag.* **2021**, *286*, 112251. [CrossRef]
37. Millennium Ecosystem Assessment. *Ecosystems and Human Well-Being*; Island Press: Washington, DC, USA, 2005; Volume 5, p. 563.
38. Potts, S.G.; Imperatriz Fonseca, V.; Ngo, H.T.; Biesmeijer, J.C.; Breeze, T.D.; Dicks, L.; Garibaldi, L.A.; Hill, R.; Settele, J.; Vanbergen, A.J.; et al. Summary for Policymakers of the Assessment Report of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services on Pollinators, Pollination and Food Production. 2016. Available online: https://hdl.handle.net/11336/130568 (accessed on 2 June 2024).
39. García-Martín, M.; Huntsinger, L.; Ibarrola-Rivas, M.J.; Penker, M.; D'Ambrosio, U.; Dimopoulos, T.; Fernández-Giménez, M.E.; Kizos, T.; Muñoz-Rojas, J.; Saito, O.; et al. Landscape products for sustainable agricultural landscapes. *Nat. Food* **2022**, *3*, 814–821. [CrossRef]
40. Frąc, M.; Hannula, S.E.; Bełka, M.; Jędryczka, M. Fungal biodiversity and their role in soil health. *Front. Microbiol.* **2018**, *9*, 707. [CrossRef]
41. Hanson, H.C. Ecology in agriculture. *Ecology* **1939**, *20*, 111–117. [CrossRef]
42. Félix, G.F.; Scholberg, J.M.; Clermont-Dauphin, C.; Cournac, L.; Tittonell, P. Enhancing agroecosystem productivity with woody perennials in semi-arid West Africa. A meta-analysis. *Agron. Sustain. Dev.* **2018**, *38*, 57. [CrossRef]
43. IPBES. *Global Assessment Report on Biodiversity and Ecosystem Services of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services*; Brondizio, E.S., Settele, J., Díaz, S., Ngo, H.T., Eds.; IPBES Secretariat: Bonn, Germany, 2019; 1148p. [CrossRef]
44. Roe, D.; Seddon, N.; Elliott, J. Biodiversity Loss Is a Development Issue. International Institute for Environment and Development. Available online: https://pubs.iied.org/pdfs/17636IIED.2019 (accessed on 20 February 2024).
45. Krausmann, F.; Erb, K.H.; Gingrich, S.; Haberl, H.; Bondeau, A.; Gaube, V.; Lauk, C.; Plutzar, C.; Searchinger, T.D. Global human appropriation of net primary production doubled in the 20th century. *Proc. Natl. Acad. Sci. USA* **2013**, *110*, 10324–10329. [CrossRef]
46. Baarsch, F.; Granadillos, J.R.; Hare, W.; Knaus, M.; Krapp, M.; Schaeffer, M.; Lotze-Campen, H. The impact of climate change on incomes and convergence in Africa. *World Dev.* **2020**, *126*, 104699. [CrossRef]
47. Fischer, J.; Bergsten, A.; Dorresteijn, I.; Hanspach, J.; Hylander, K.; Jiren, T.S.; Manlosa, A.O.; Rodrigues, P.; Schultner, J.; Senbeta, F.; et al. A social-ecological assessment of food security and biodiversity conservation in Ethiopia. *Ecosyst. People* **2021**, *17*, 400–410. [CrossRef] [PubMed]
48. Chivenge, P.; Mabhaudhi, T.; Modi, A.T.; Mafongoya, P. The potential role of neglected and underutilised crop species as future crops under water scarce conditions in Sub-Saharan Africa. *Int. J. Environ. Res. Public Health* **2015**, *12*, 5685–5711. [CrossRef] [PubMed]
49. Krause, T.; Tilker, A. How the loss of forest fauna undermines the achievement of the SDGs. *Ambio* **2022**, *51*, 103–113. [CrossRef] [PubMed]
50. Crist, E.; Mora, C.; Engelman, R. The interaction of human population, food production, and biodiversity protection. *Science* **2017**, *356*, 260–264. [CrossRef]
51. Pawera, L.; Khomsan, A.; Zuhud, E.A.M.; Hunter, D.; Ickowitz, A.; Polesny, Z. Wild food plants and trends in their use: From knowledge and perceptions to drivers of change in West Sumatra, Indonesia. *Foods* **2020**, *9*, 1240. [CrossRef]

52. Springmann, M.; Clark, M.; Mason-D'Croz, D.; Wiebe, K.; Bodirsky, B.L.; Lassaletta, L.; De Vries, W.; Vermeulen, S.J.; Herrero, M.; Carlson, K.M.; et al. Options for keeping the food system within environmental limits. *Nature* **2018**, *562*, 519–525. [CrossRef]
53. Leclère, D.; Obersteiner, M.; Barrett, M. Bending the curve of terrestrial biodiversity needs an integrated strategy. *Nature* **2020**, *585*, 551–556. [CrossRef]
54. Fanzo, J.; Hunter, D.; Borelli, T.; Mattei, F. (Eds.) *Diversifying Food and Diets: Using Agricultural Biodiversity to Improve Nutrition and Health*; Routledge: London, UK, 2013.
55. Crippa, M.; Solazzo, E.; Guizzardi, D.; Monforti-Ferrario, F.; Tubiello, F.N.; Leip, A.J.N.F. Food systems are responsible for a third of global anthropogenic GHG emissions. *Nat. Food* **2021**, *2*, 198–209. [CrossRef]
56. Egbebiyi, T.S.; Lennard, C.; Crespo, O.; Mukwenha, P.; Lawal, S.; Quagraine, K. Assessing Future Spatio-Temporal Changes in Crop Suitability and Planting Season over West Africa: Using the Concept of Crop-Climate Departure. *Climate* **2019**, *7*, 102. [CrossRef]
57. Toledo, A.; Burlingame, B. Biodiversity and nutrition; a common path toward global food security and sustainable development. *J. Food Compos. Anal.* **2006**, *19*, 477–483. [CrossRef]
58. Wezel, A.; Brives, H.; Casagrande, M.; Clement, C.; Dufour, A.; Vandenbroucke, P. Agroecology territories: Places for sustainable agricultural and food systems and biodiversity conservation. *Agroecol. Sustain. Food Syst.* **2016**, *40*, 132–144. [CrossRef]
59. Mburu, S.W.; Koskey, G.; Kimiti, J.M.; Ombori, O.; Maingi, J.M.; Njeru, E.M. Agrobiodiversity conservation enhances food security in subsistence-based farming systems of Eastern Kenya. *Agric. Food Secur.* **2016**, *5*, 19. [CrossRef]
60. Bilali, H.; Cardone, G.; Naino Jika, A.; De Falcis, E.; Rokka, S.; Diawara, A.B.; Nouhou, B.; Ghione, A. Agro-Biodiversity in National Pathways for Food System Transformation: Case of West Africa. 2022. Available online: https://urn.fi/URN:NBN:fi-fe2022121672185 (accessed on 2 June 2024).
61. Cowie, A.L.; Penman, T.D.; Gorissen, L.; Winslow, M.D.; Lehmann, J.; Tyrrell, T.D.; Twomlow, S.; Wilkes, A.; Lal, R.; Jones, J.W.; et al. Towards sustainable land management in the drylands: Scientific connections in monitoring and assessing dryland degradation, climate change and biodiversity. *Land Degrad. Dev.* **2011**, *22*, 248–260. [CrossRef]
62. Telo da Gama, J. The Role of Soils in Sustainability, Climate Change, and Ecosystem Services: Challenges and Opportunities. *Ecologies* **2023**, *4*, 552–567. [CrossRef]
63. Rey Benayas, J.M.; Bullock, J.M. Restoration of biodiversity and ecosystem services on agricultural land. *Ecosystems* **2012**, *15*, 883–899. [CrossRef]
64. Duru, M.; Therond, O.; Martin, G.; Martin-Clouaire, R.; Magne, M.A.; Justes, E.; Journet, E.P.; Aubertot, J.N.; Savary, S.; Bergez, J.E.; et al. How to implement biodiversity-based agriculture to enhance ecosystem services: A review. *Agron. Sustain. Dev.* **2015**, *35*, 1259–1281. [CrossRef]
65. Allen-Wardell, G.; Bernhardt, P.; Bitner, R.; Burquez, A.; Buchmann, S.; Cane, J.; Cox, P.A.; Dalton, V.; Feinsinger, P.; Ingram, M.; et al. The potential consequences of pollinator declines on the conservation of biodiversity and stability of food crop yields. *Conserv. Biol.* **1998**, *12*, 8–17. Available online: https://www.jstor.org/stable/2387457 (accessed on 2 June 2024).
66. Brussaard, L.; Caron, P.; Campbell, B.; Lipper, L.; Mainka, S.; Rabbinge, R.; Babin, D.; Pulleman, M. Reconciling biodiversity conservation and food security: Scientific challenges for a new agriculture. *Curr. Opin. Environ. Sustain.* **2010**, *2*, 34–42. [CrossRef]
67. Matocha, J.; Schroth, G.; Hills, T.; Hole, D. Integrating climate change adaptation and mitigation through agroforestry and ecosystem conservation. In *Agroforestry—The Future of Global Land Use*; Springer: Dordrecht, The Netherlands, 2012; pp. 105–126. [CrossRef]
68. Tscharntke, T.; Clough, Y.; Wanger, T.C.; Jackson, L.; Motzke, I.; Perfecto, I.; Vandermeer, J.; Whitbread, A. Global food security, biodiversity conservation and the future of agricultural intensification. *Biol. Conserv.* **2012**, *151*, 53–59. [CrossRef]
69. Kremen, C. Ecological intensification and diversification approaches to maintain biodiversity, ecosystem services and food production in a changing world. *Emerg. Top. Life Sci.* **2020**, *4*, 229–240. [CrossRef] [PubMed]
70. Leakey, R.R. The role of trees in agroecology and sustainable agriculture in the tropics. *Annu. Rev. Phytopathol.* **2014**, *52*, 113–133. [CrossRef] [PubMed]
71. Gordon, L.J.; Finlayson, C.M.; Falkenmark, M. Managing water in agriculture for food production and other ecosystem services. *Agric. Water Manag.* **2010**, *97*, 512–519. [CrossRef]
72. Montagnini, F. The contribution of agroforestry to restoration and conservation: Biodiversity islands in degraded landscapes. In *Agroforestry for Degraded Landscapes: Recent Advances and Emerging Challenges*; Springer: Singapore, 2020; Volume 1, pp. 445–479. [CrossRef]
73. Benton, T.G.; Bieg, C.; Harwatt, H.; Pudasaini, R.; Wellesley, L. Food system impacts on biodiversity loss. In *Three Levers for Food System Transformation in Support of Nature*; Chatham House: London, UK, 2021; pp. 2–3.
74. Gnacadja, L.; Wiese, L. Land degradation neutrality: Will Africa achieve it? Institutional solutions to land degradation and restoration in Africa. In *Climate Change and Multi-Dimensional Sustainability in African Agriculture: Climate Change and Sustainability in Agriculture*; Springer: Cham, Switzerland, 2016; pp. 61–95. [CrossRef]
75. Cuccurullo, C.; Aria, M.; Sarto, F. Foundations and trends in performance management. A twenty-five years bibliometric analysis in business and public administration domains. *Scientometrics* **2016**, *108*, 595–611. [CrossRef]
76. Aria, M.; Cuccurullo, C. Bibliometrix: An R-tool for comprehensive science mapping analysis. *J. Informetr.* **2017**, *11*, 959–975. [CrossRef]

77. Muluneh, M.G. Impact of climate change on biodiversity and food security: A global perspective—A review article. *Agric. Food Secur.* **2021**, *10*, 1–25. [CrossRef]
78. Endale, Y.; Derero, A.; Argaw, M.; Muthuri, C. Farmland tree species diversity and spatial distribution pattern in semi-arid East Shewa, Ethiopia. *For. Trees Livelihoods* **2017**, *26*, 199–214. [CrossRef]
79. Kiptot, E.; Franzel, S.; Degrande, A. Gender, agroforestry and food security in Africa. *Curr. Opin. Environ. Sustain.* **2014**, *6*, 104–109. [CrossRef]
80. Carsan, S.; Stroebel, A.; Dawson, I.; Kindt, R.; Mbow, C.; Mowo, J.; Jamnadass, R. Can agroforestry option values improve the functioning of drivers of agricultural intensification in Africa? *Curr. Opin. Environ. Sustain.* **2014**, *6*, 35–40. [CrossRef]
81. Amare, A.; Simane, B. Does adaptation to climate change and variability provide household food security? Evidence from Muger sub-basin of the upper Blue-Nile, Ethiopia. *Ecol. Process.* **2018**, *7*, 13. [CrossRef]
82. Chimonyo, V.G.P.; Modi, A.T.; Mabhaudhi, T. Perspective on crop modelling in the management of intercropping systems. *Arch. Agron. Soil Sci.* **2015**, *61*, 1511–1529. [CrossRef]
83. Kouassi, J.L.; Gyau, A.; Diby, L.; Bene, Y.; Kouamé, C. Assessing land use and land cover change and farmers' perceptions of deforestation and land degradation in South-West Côte d'Ivoire, West Africa. *Land* **2021**, *10*, 429. [CrossRef]
84. Mensaha, J.; Enu-Kwesi, F. Implications of environmental sanitation management for sustainable livelihoods in the catchment area of Benya Lagoon in Ghana. *J. Integr. Environ. Sci.* **2019**, *16*, 23–43. [CrossRef]
85. Kidane, L.; Kejela, A. Food security and environment conservation through sustainable use of wild and semi-wild edible plants: A case study in Berek Natural Forest, Oromia special zone, Ethiopia. *Agric. Food Secur.* **2021**, *10*, 29. [CrossRef]
86. Djenontin, I.N.S.; Foli, S.; Zulu, L.C. Revisiting the factors shaping outcomes for forest and landscape restoration in Sub-Saharan Africa: A way forward for policy, practice and research. *Sustainability* **2018**, *10*, 906. [CrossRef]
87. Ziadat, F.M.; Zdruli, P.; Christiansen, S.; Caon, L.; Monem, M.A.; Fetsi, T. An overview of land degradation and sustainable land management in the near East and North Africa. *Sustain. Agric. Res.* **2022**, *11*, 11–24. [CrossRef]
88. Esfahani, H.; Tavasoli, K.; Jabbarzadeh, A. Big data and social media: A scientometrics analysis. *Int. J. Data Netw. Sci.* **2019**, *3*, 145–164. [CrossRef]
89. Song, Y.; Chen, X.; Hao, T.; Liu, Z.; Lan, Z. Computers & Education exploring two decades of research on classroom dialogue by using bibliometric analysis. *Comput. Educ.* **2019**, *137*, 12–31. [CrossRef]
90. King, D.A. The scientific impact of nations. *Nature* **2004**, *430*, 311–316. [CrossRef]
91. Bordons, M.; Zulueta, M.A. Evaluation of the scientific activity through bibliometric indices. *Rev. Esp. Cardiol.* **1999**, *52*, 790–800. [CrossRef]
92. Marris, E.; Pearson, H.; Waldrop, M.; Hayden, E.C.; Schiermeier, Q.; Baker, M. Language: Disputed definitions [News Feature]. *Nature* **2008**, *455*, 1023–1028.
93. Edmondson, A.C.; Harvey, J.F. Cross-boundary teaming for innovation: Integrating research on teams and knowledge in organizations. *Hum. Resour. Manag. Rev.* **2018**, *28*, 347–360. [CrossRef]
94. Van Biljon, J.; Mwapwele, S. Research collaboration in asymmetric power relations: A study of postgraduate students' views. *J. Transdiscipl. Res. S. Afr.* **2023**, *19*, 1288. [CrossRef]
95. Kapari, M.; Hlophe-Ginindza, S.; Nhamo, L.; Mpandeli, S. Contribution of smallholder farmers to food security and opportunities for resilient farming systems. *Front. Sustain. Food Syst.* **2023**, *7*, 1149854. [CrossRef]
96. King, K.F.S.; Chandler, M.T. *The Wasted Lands. The Programme of Work of ICRAF*; International Council for Research in Agroforestry: Nairobi, Kenya, 1978.
97. Thangata, P.H.; Hildebrand, P.E. Carbon stock and sequestration potential of agroforestry systems in smallholder agroecosystems of sub-Saharan Africa: Mechanisms for 'reducing emissions from deforestation and forest degradation'(REDD+). *Agric. Ecosyst. Environ.* **2012**, *158*, 172–183. [CrossRef]
98. Nair, P.R.; Kumar, B.M.; Nair, V.D.; Nair, P.R.; Kumar, B.M.; Nair, V.D. Definition and concepts of agroforestry. In *An Introduction to Agroforestry: Four Decades of Scientific Developments*; Springer: Cham, Switzerland, 2021; pp. 21–28. [CrossRef]
99. Liliana, H. *The Food Gaps: The Impacts of Climate Change on Food Production: A 2020 Perspective*; Universal Ecological Fund: Alexandria, VA, USA, 2005.
100. Intergovernmental Panel on Climate Change (IPCC). *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*; Parry, M.L., Canziani, O.F., Palutikof, J.P., van der Linden, P.J., Hanson, C.E., Eds.; Cambridge University Press: Cambridge, UK, 2007; 976p.
101. World Bank. Arable Land (Hectares per Person), World Bank. 2016. Available online: http://data.worldbank.org/indicator/AG.LND.ARBL.HA.PC (accessed on 10 December 2023).