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NEGLECTED AND UNDERUTILIZED CROP SPECIES (NUS) AND AGROECOLOGY IN WEST AFRICA

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ABSTRACT

There is a widespread agreement that West African food systems need to be transformed. Neglected and underutilised crop species (NUCS/NUS) and agroecology can play a vital role in making these systems more sustainable and resilient. Therefore, this systematic review analyses the multifaceted and multidimensional relationships between NUS and agroecology as well as the potential contribution of NUS to agroecological transition in West Africa. In particular, the article examines whether and which agroecology principles are associated with research on NUS in West Africa. The review draws upon 42 articles dealing with NUS in West Africa selected from 185 publications identified through a search conducted on the Web of Science in March 2025. Generally speaking, there is a lack of studies addressing jointly NUS and agroecology in West Africa. Apart from animal health, all the remaining 12 agroecology principles can be associated with NUS, but in a differentiated way. Biodiversity is by far the principle most associated with NUS, followed by Social values & diets and Co-creation of knowledge. Meanwhile, Recycling, Land and natural resource governance, and Fairness are the principles least associated with NUS. In general, while those dealing with agronomic and environmental aspects (e.g. Biodiversity) are fairly addressed, principles related to socio-economic (Economic diversification, Fairness) and, especially, political (e.g. Land and natural resource governance) aspects are generally overlooked. In terms of the application scale, there is more focus on principles applicable at the field and farm levels, while those more applicable at the agroecosystem level (e.g. Synergy) or the value chain/food system level (e.g. Fairness, Connectivity, Participation) are generally overlooked. There is a need to strengthen research on the nexus between NUS and agroecology in order to foster

the operationalisation of the transition towards sustainable and resilient agri-food systems in West Africa.

Keywords: *agrobiodiversity, agroecology principles, agroecological transition, Sahel, SUSTLIVES.*

INTRODUCTION

Agriculture serves a crucial socio-economic function in West Africa. The contribution of the primary sector, which includes agriculture, forestry, and fishing, to the gross domestic product (GDP) in West African nations varies from 4.8% in Cape Verde to 60.4% in Sierra Leone (World Bank, 2024a). The percentage of employment in agriculture across the region ranges from 11% in Cape Verde to 71% in Niger and 73% in Burkina Faso (World Bank, 2024b). Meanwhile, significant challenges, such as food insecurity and malnutrition, persist throughout West Africa (FAO et al., 2024). Additionally, West Africa and the Sahel face some of the most severe effects of climate change (Baarsch et al., 2020; Lokonon et al., 2019). Agriculture, which is largely dependent on rainfall, is extremely vulnerable to climate fluctuations, and the region lacks sufficient economic and institutional resources to manage these climatic changes and their variability (Sultan & Gaetani, 2016). These identified challenges underscore the pressing need to shift towards sustainable and resilient agri-food systems in the region (El Bilali et al., 2023b).

Neglected and underutilised crop species (NUCS/NUS) (Padulosi, 2017) – also referred to as orphan, minor, abandoned, lost or opportunity crops – encompass a wide variety of plant species that have been primarily ignored, despite their significant potential contributions to sustainable food systems. NUS production is noted to aid in climate change adaptation and mitigation, support agrobiodiversity conservation, enhance food and nutrition security, maintain environmental integrity and health, and promote the sustainability and resilience of food systems (Padulosi et al., 2013). El Bilali et al. (2023a) assert that “*there is a wider recognition of the role and potential of NUS in climate resilience and adaptation, biodiversity conservation, food and nutrition security and rural livelihoods*” (p. 47). In this regard, Mabhaudhi et al. (2016) suggest that advocating for NUS could help meet the Sustainable Development Goals (SDGs).

In their analysis of research on sustainability transitions in West African agri-food systems, El Bilali et al. (2023b) found that agroecology is one of the most prominent niches. According to FAO (2018), agroecological innovations incorporate ecological principles—such as recycling, efficient resource use, minimizing external inputs, diversification, integration, soil health, and synergies—when designing farming systems to promote food security and nutrition. FAO (2018) identified ten elements of agroecology to steer the shift toward sustainable agriculture and food systems: Diversity, co-creation and sharing of knowledge, synergies, efficiency, recycling, resilience, human and social values, culture and food traditions, responsible governance, and circular and solidarity economy. HLPE (2019) elaborated a consolidated list of 13 principles of agroecology related to improving resource

efficiency (1. recycling, 2. input reduction), strengthening resilience (3. soil health, 4. animal health, 5. biodiversity, 6. synergy, 7. economic diversification) and securing social equity/responsibility (8. co-creation of knowledge, 9. social values and diets, 10. fairness, 11. connectivity, 12. land and natural resource governance, 13. participation). As stated by HLPE (2019), the 13 principles of agroecology connect and operationalize the 10 FAO elements. However, the 13 principles are somewhat more distinct and formulated as actionable statements that include normative and causative aspects (Wezel et al., 2020).

Some previous reviews dealt with NUS in West Africa [e.g. El Bilali et al. (2024), Maranz et al. (2002)], but they are not recent and/or address only partially or marginally the topic in the whole region (they either focus on one or a few NUS and/or on one or a few countries). Furthermore, no review covers agroecology in the whole region. In this context, the present paper analyses the multifaceted and multidimensional relationships between NUS and agroecology as well as the potential contribution of NUS to agroecological transition in West Africa. In particular, the article examines whether and which agroecology principles are associated with research on NUS in West Africa.

METHODS

The initial idea was to search for articles that simultaneously address NUS and agroecology in West Africa. However, a search performed on the Web of Science (WoS) on 17 March 2024 returned only 2 results. Considering this negative outcome, it was necessary to change the approach used. Indeed, it was decided to first search for all articles that address NUS in the West Africa region, then to see whether and how they deal with agroecology.

The second search conducted on WoS yielded 185 documents. After evaluating their titles, abstracts, and full texts, a total of 143 documents were excluded for not meeting the eligibility criteria. Out of these, 18 documents were rejected based solely on their titles since they refer to countries outside West Africa. Additionally, 109 documents were discarded due to their abstracts; for example, since this study is focused on crop NUS (viz. NUCS), documents pertaining to forests and forestry, major commercial crops, or animals, livestock, fish and insects, were excluded. Finally, 16 documents were omitted after a thorough review of the full articles, as they did not satisfy at least one of the eligibility criteria; among these were 15 review articles. Therefore, 42 articles – including 38 articles and 4 proceeding papers – were considered in the systematic review.

Then, the articles dealing with NUS in West Africa were checked to see whether they also address agroecology. Indeed, the topical/content analysis of the eligible documents was informed by the principles of agroecology (HLPE, 2019). For each principle, a series of themes was identified, drawing upon HLPE (2019) and the Agroecology Coalition (Agroecology Coalition, 2024).

Some limitations of this systematic review need to be noted. Firstly, the decision to use the Web of Science (WoS) database for the search made sure that only high-quality scholarly literature was evaluated; consequently, grey literature (such as

reports) and research on NUS published in journals not included in WoS were omitted. Secondly, the specific search terms chosen could have influenced the findings, even though various terms were used to expand the initial screening regarding NUS in West Africa. In particular, certain articles mentioning specific species of NUS, without incorporating general terms like NUS, may have been missed. A further limitation is that the article does not consider the “red flags” (Agroecology Coalition, 2024) specifying practices against agroecological values. In other words, some of the considered articles might include red tags such as genetically modified organisms (GMOs), synthetic fertilisers and pesticides, monoculture, productivism, seed systems, women and marginalized groups, processed food, and human rights.

RESULTS AND DISCUSSION

The scholarly literature on NUS in West Africa is still limited. The studies reviewed encompass various geographical scopes, from global to local levels, including both regional and national contexts. The West African nations highlighted in the studies consist of Benin, Burkina Faso, Côte d'Ivoire/Ivory Coast, Ghana, Guinea, Mali, Mauritania, Niger, Nigeria, Senegal and Togo. Notably, the majority of the articles focus on a few countries such as Benin, Mali, Nigeria and Senegal. The literature examined both NUS and staple crops. While certain studies address NUS broadly, others are centred on specific families or categories of plants, such as cereals, fruits and vegetables. Additionally, some research concentrates on particular NUS or crops, including African aubergine, amaranth, Bambara groundnut, baobab, black benniseed, cassava, cowpea, desert date (*Balanites aegyptiaca*), fonio, Kersting's groundnut (*Macrotyloma geocarpum*), millet, miracle plant (*Synsepalum dulcificum*), moringa, African basil (*Ocimum gratissimum*), pigeon pea, sesame, sorghum and yam.

There is no article specifically addressing the relationships between NUS and agroecology or the contribution of NUS to the agroecological transition in West Africa. Apart from animal health, all agroecology principles are associated with NUS. Indeed, the remaining 12 agroecology principles are addressed in a differentiated way (Table 1). Biodiversity is by far the principle most associated with NUS.

Table 1. Agroecology principles associated with the selected documents.

Agroecology principle	Articles associated with the principle*
1. Recycling	Traore et al. (2004)
2. Input reduction	Dansi et al. (2012a); Diop et al. (2023); Ibrahim et al. (2018); Jabbar (1993); Mbosso et al. (2020); Traore et al. (2004)
3. Soil health	Asadu et al. (1998); Ibrahim et al. (2018); Jabbar (1993); Mbosso et al. (2020); Traore et al. (2004)
5. Biodiversity	Ahmad et al. (2023); Ahoyo et al. (2024); Aly et al. (2011); Assima et al. (2022); Assogba et al. (2016); Bernholt et al. (2009); Condé et al. (2024); Dansi et al. (2012a); Dansi et al. (2012b); de Bon et al.

Agroecology principle	Articles associated with the principle*
	(2015); Dingkuhn et al. (2006); Diop et al. (2023); Faye et al. (2019); Gandji et al. (2020); Ibrahim Bio Yerima et al. (2020); Idowu (2009); Kaczmarek et al. (2023); Kafoutchoni et al. (2021); Manda et al. (2022); Maranz et al. (2008); Metry et al. (2023); Mint Abdelaziz et al. (2020); Nyadanu and Lowor (2015); Nyadanu et al. (2016); Quain et al. (2018)
6. Synergy	Bernholt et al. (2009); de Bon et al. (2015); Jabbar (1993); Maranz et al. (2008); Ndoye et al. (2024); Traore et al. (2004)
7. Economic diversification	Condé et al. (2024); Falola et al. (2022); Guira et al. (2017); Ibrahim et al. (2018); Idowu (2009); Mbosso et al. (2020)
8. Co-creation of knowledge	Ahoyo et al. (2024); Assogba et al. (2016); Blench (2016); Condé et al. (2024); Dansi et al. (2012a); Diop et al. (2023); Kaczmarek et al. (2023); Rudebjer et al. (2013); Tchokponhoué et al. (2021)
9. Social values & diets	Ahoyo et al. (2024); Assogba et al. (2016); Bankole et al. (2024a); Bankole et al. (2024b); Bernholt et al. (2009); Diop et al. (2023); Guira et al. (2017); Idowu (2009); Maranz et al. (2008); Nyadanu and Lowor (2015); Tchokponhoué et al. (2021)
10. Fairness	Dansi et al. (2012b); Falola et al. (2022); Idowu (2009); Mbosso et al. (2020)
11. Connectivity	Bernholt et al. (2009); Condé et al. (2024); de Bon et al. (2015); Falola et al. (2022); Ibrahim et al. (2018); Mbosso et al. (2020); Nyadanu et al. (2016)
12. Land and natural resource governance	Ahmad et al. (2023); Assima et al. (2022)
13. Participation	Assogba et al. (2016); Dansi et al. (2012a); Ibrahim et al. (2018); Mbosso et al. (2020); Nyadanu et al. (2016); Rudebjer et al. (2013)

* Some articles are associated with different agroecology principles.

No article specifically addresses *recycling* in relation to NUS. However, the adoption of agroforestry systems (Traore et al., 2004) allows having more closed nutrient cycles with the decomposition of organic matter (especially leaves) from tree species, providing nutrients to crops.

Input reduction is a further principle that has received little attention in the literature on NUS in West Africa. However, some studies underline that NUS can be grown without synthetic inputs, thus reducing external inputs. For instance, referring to the black benniseed, a crop cultivated as a leafy vegetable in Benin, Dansi et al. (2012a) stress that the production is still traditional and organic with no use of mineral fertilizers or pesticides. Furthermore, the production of nitrogen-fixing legumes (e.g. Bambara groundnut) (Ibrahim et al., 2018; Mbosso et al., 2020) allows reducing the use of mineral fertilizers. Many NUS, especially cereals (e.g. fonio) and legumes (e.g. Bambara groundnut) are cultivated under a rainfed regime, thus not requiring any irrigation water. Agroforestry (Traore et al., 2004) and mixed crop-livestock systems (Jabbar, 1993) reduce reliance on off-farm manure. Similarly, practices such

as seed exchange among farmers (Diop et al., 2023) reduce reliance on purchased seeds. Ibrahim et al. (2018) found that Bambara groundnut is mostly produced without any external inputs in Western Niger. Furthermore, farmers mainly use their own seeds (Ibrahim et al., 2018).

Soil health is only marginally addressed in the analysed literature. What is even more alarming is that the few articles that seem to address soil health are rather old (Asadu et al., 1998; Traore et al., 2004), which might denote a loss of interest in this topic, which is instead becoming central given the widespread land degradation. However, the production of nitrogen-fixing legumes, such as Bambara groundnut (Ibrahim et al., 2018; Mbosso et al., 2020), allows improving soil fertility and health. Agroforestry (Traore et al., 2004) and crop-livestock system (Jabbar, 1993), which ensure a constant supply of organic matter and nutrients, contribute to soil fertility and health (including soil biological activity).

As stated above, *biodiversity* is largely addressed in the selected articles. While some articles study directly the diversity of some NUS, others cover diverse accessions/varieties of NUS and analyse their agronomic, nutritional and, even, medicinal features and properties. However, the focus is generally on species diversity while land use diversity and agroecosystem diversity have received little attention in the literature. The only exceptions are those studies addressing diversity in some territories in Burkina Faso (Ahmad et al., 2023), Mali (Assima et al., 2022), Ghana (Nyadanu et al., 2016), Senegal (de Bon et al., 2015), Benin (Dansi et al., 2012b) and Niger (Bernholt et al., 2009). These mainly refer to polyculture systems in rural (de Bon et al., 2015) and urban/peri-urban (Bernholt et al., 2009) areas.

It is hard to find articles addressing the *synergy* principle. There are only a few studies that focus on agroforestry (Traore et al., 2004), so crop-tree integration, and mixed crop-livestock systems (Jabbar, 1993). Furthermore, as stated above, some articles deal with polyculture systems (Bernholt et al., 2009; de Bon et al., 2015). Ndoye et al. (2024) analyze the diversity and enzymatic activity of arbuscular mycorrhizal fungi (AMF), developing on roots, in different fonio agroecosystems in Senegal.

Economic diversification seems addressed only in relation to value chains, marketing and processing. Indeed, marketing/commercialization (Falola et al., 2022; Idowu, 2009; Mbosso et al., 2020) and processing (Guira et al., 2017; Mbosso et al., 2020) represent two important income-generation and value-addition activities.

Co-creation of knowledge is fairly addressed in the analysed literature. Some articles refer to participatory approaches and methods for data collection and analysis, involving actively local communities, such as Participatory Research Appraisal (Dansi et al., 2012a). Ethnobotanical research allows the documentation, conservation and valorisation of traditional and indigenous knowledge on NUS (Ahoyo et al., 2024; Condé et al., 2024; Diop et al., 2023). Interestingly, some studies assess the relationship between knowledge diversity and biodiversity/agrobiodiversity (Ahoyo et al., 2024; Diop et al., 2023; Tchokponhoué et al., 2021). Co-creation and dissemination of knowledge also imply strengthening the capacities on NUS of young African researchers (Rudebjer et al., 2013).

As for *social values & diets*, while some articles deal with the nutritional composition of some NUS and their contribution to food and nutrition security (Bankole et al., 2024a; Bankole et al., 2024; Guira et al., 2017; Idowu, 2009; Maranz et al., 2008, 2008; Nyadanu & Lowor, 2015), so can be associated with consumption patterns and “diets”, studies dealing with “social values” are lacking. There are only a very few exceptions; indeed, apart from knowledge-related issues already mentioned above, some articles address social and cultural issues related to the conservation and valorization of NUS. For instance, Ahoyo et al. (2024) argue that social dynamics (e.g. ethnicity) and traditional knowledge affect the selection of plants for medicinal uses in Benin. Similarly, referring to the ethnolinguistic and genetic diversity of fonio in Senegal, Diop et al. (2023) conclude that “*Social factors are pivotal in structuring diversity and should be taken into greater consideration in research and conservation projects to dovetail local and regional scales*”. Furthermore, some studies address gender questions (Assogba et al., 2016; Bernholt et al., 2009), but generally in a marginal way.

Fairness is another agroecology principle that seems largely overlooked in the existing literature on NUS in West Africa. Indeed, no article specifically and explicitly addresses fairness in relation to NUS in West Africa. However, this principle is explicitly addressed in studies about the value chains of NUS, especially marketing and commercialization (Falola et al., 2022; Mbosso et al., 2020). Furthermore, NUS contribute to the livelihoods of many rural communities (Dansi et al., 2012b; Idowu, 2009) and, consequently, the reduction of poverty and vulnerability.

Connectivity principle can be associated with a few studies dealing with the marketing and commercialisation of NUS (Falola et al., 2022; Mbosso et al., 2020). Furthermore, it should be underlined that often an important portion of NUS production is self-consumed (Bernholt et al., 2009; Ibrahim et al., 2018), which means that the producer and consumer are the same (cf. prosumer), thus ensuring the highest level of connectivity with the shortest possible supply chain. This is particularly the case with home gardens (Bernholt et al., 2009).

Generally speaking, there is no article that specifically addresses *land and natural resource governance* in relation to NUS. However, a few articles address policies and their effects on biodiversity and NUS. For instance, Ahmad et al. (2023) and Assima et al. (2022) suggest that input subsidies tend to decrease crop species diversity at the farm level.

Participation is specifically addressed only in a few articles. These, in general, refer to participatory research and appraisal approaches and methods (Assogba et al., 2016; Dansi et al., 2012a; Nyadanu et al., 2016). Furthermore, other studies address the participation of small-scale producers and smallholders in NUS value chains (Ibrahim et al., 2018; Mbosso et al., 2020). Participation also concerns the involvement of African organizations and institutions, especially those representing farmers/producers, in international partnerships on NUS (Rudebjer et al., 2013).

CONCLUSIONS

West African food systems need to be transformed. NUS and agroecology can play a vital role in making these systems more sustainable and resilient. To the best of our knowledge, this is the first Web of Science-based systematic review that analyses comprehensively the scholarly literature on NUS and examines its association with the 13 principles of agroecology.

In general, there is a scarcity of research that examines both NUS and agroecology in West Africa. Additionally, there is a lack of articles that specifically explore the connections between NUS and agroecology or the role of NUS in facilitating the agroecological transition in the region. Aside from animal health, all principles of agroecology can be linked to NUS. In fact, the other 12 agroecology principles are discussed in various ways within studies focused on NUS in West Africa. The principle of Biodiversity is the one most strongly associated with NUS, followed closely by Social values & diets and Co-creation of knowledge. Conversely, the principles of Recycling, Land and natural resource governance, and Fairness are the ones least connected to NUS. Overall, while agronomic and environmental aspects (e.g. Biodiversity) receive adequate attention, socio-economic principles (e.g. Economic diversification and Fairness), and particularly political aspects (e.g. Land and natural resource governance), are frequently neglected. Regarding the scale of application, there is a stronger emphasis on principles relevant at the field and farm levels, while those that are more applicable at the agroecosystem level (for instance, Synergy) or the value chain/food system level (like Fairness, Connectivity, and Participation) are generally ignored.

There is a need to strengthen research on the nexus between NUS and agroecology in order to foster the operationalisation of the transition towards sustainable and resilient agri-food systems in West Africa. In that regard, regional initiatives such as the project “Enhancing value chains and markets of Neglected and Underutilized crop Species to contribute to Agroecological transition in Africa” can be instrumental in filling the existing knowledge and research gaps. Moreover, integrated and multidisciplinary research addressing the different dimensions of agroecology (environmental/agronomic, social/cultural, economic, political/governance) and at different scales (viz. field, farm, agroecosystem, food system) should be encouraged.

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