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Current policies for promoting neglected and underutilized crop species in Burkina Faso and Niger

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ABSTRACT



Greater use of agrobiodiversity and especially neglected and underutilized species (NUS) like amaranth, Bambara groundnut, cassava, fabirama, okra, moringa, Guinea sorrel, or sweet potato can tackle climate change and food insecurity, and build food sovereignty. The role of NUS in policies and strategies in Burkina Faso and Niger has not been studied earlier. This study uses a mixed method where analysis of current policies, an online survey and workshops with stakeholders were combined. It gives an overview on policies on different sectors and helps to explore options for enhancing the efficiency of incentives aimed at promoting the use of NUS. The contribution of the policies and strategies (44 documents of the 96 identified) to the promotion of NUS and agrobiodiversity was analyzed. They generally recognize the importance of agroecological practices and biodiversity, and thus support the promotion of NUS. However, only 17 mention NUS specifically. Some texts refer to gender as a cross-cutting theme and recognize women's primordial role in a better management of resources. Based on the findings, it is recommended to: (i) include NUS in sectoral policies; (ii) support the marketing and consumption; (iii) consider the best practices implemented in other countries to mainstream NUS in food systems.

ARTICLE HISTORY

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Introduction

Burkina Faso and Niger are landlocked countries in sub-Saharan Africa, both among the least developed countries in the world and suffering from political instability. According to a recent report from the Sahel Predictive Analytics project (von Loeben et al., 2022), the main vulnerability factors in the Sahel are

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climate change, food insecurity, conflicts, migration, and displacement. Policymakers also recognize that climate change causes extreme heat and frequent droughts, and on the other hand, floods, caused by exceptionally heavy rains, can lead to biodiversity loss (Sorgho et al., 2021). High population growth rates (3.7% and 2.7% per year in Niger and Burkina Faso, respectively) (World Bank, 2022), weak infrastructure, a shortage of essential resources, and the negative impacts of climate change hinder economic growth efforts (Adamou et al., 2021). Food and nutrition insecurity has increased in the Sahel region, especially in conflict-affected countries. On the other hand, food system transformations also provide new opportunities for livelihoods in West Africa (SWAC/OECD, 2021).

Agricultural resilience is essential to adapting to climate change. According to the Intergovernmental Panel on Climate Change (IPCC), African agriculture will be strongly affected by global warming, as it reduces food security and contributes to the loss of biodiversity (Trisos et al., 2022). Approximately 20–30% of the plant species will approach extinction if the average rise in global temperature exceeds 1.5–2.5 °C (IPCC, 2007), and thus reduction in the variety of cultivated plants is a threat to resilience. A SWOT analysis (El Bilali et al., 2022a) showed that the lack of availability of seeds and the need of labor and knowledge of crop production are also potential causes for the decline in agrobiodiversity. Other causes are

changes in dietary habits, the misuse of agricultural inputs, vegetation fires, and the lack of conservation (Republique du Niger, 2014). One of the coping strategies for climate change is thus the use of drought-resistant crops and varieties. Mixed cropping systems with landraces are also less prone to pest pressure and diseases (Ficiciyan et al., 2018). The yields of maize, millet, and sorghum are expected to decrease with increasing global temperatures (IPBES, 2018), whereas some climate-smart crops like cassava, cowpea and groundnuts can, on the contrary, benefit from CO₂ fertilization (IPBES, 2018; von Loeben et al., 2022). In this paper, the term ‘neglected and underutilized species’ (NUS) is used for domesticated agricultural plant species that are not used in mainstream agriculture and are sometimes referred to as ‘orphan’ or ‘minor’ crops (Padulosi et al., 2013).

Agrobiodiversity, in particular the valorization of NUS, could potentially help to meet the nutritional needs of rural communities and to provide new income-generating opportunities for young people, farmers, and women, while increasing the resilience of rural communities, improving their livelihoods, and strengthening their socio-economic development. NUS in the context of food systems framework is presented in Figure 1. It shows interactions between drivers, food supply chains, and nutrition and health outcomes, as well as connections to policies. NUS directly contribute to production systems, food availability, and quality and diversity of diets. An in-depth

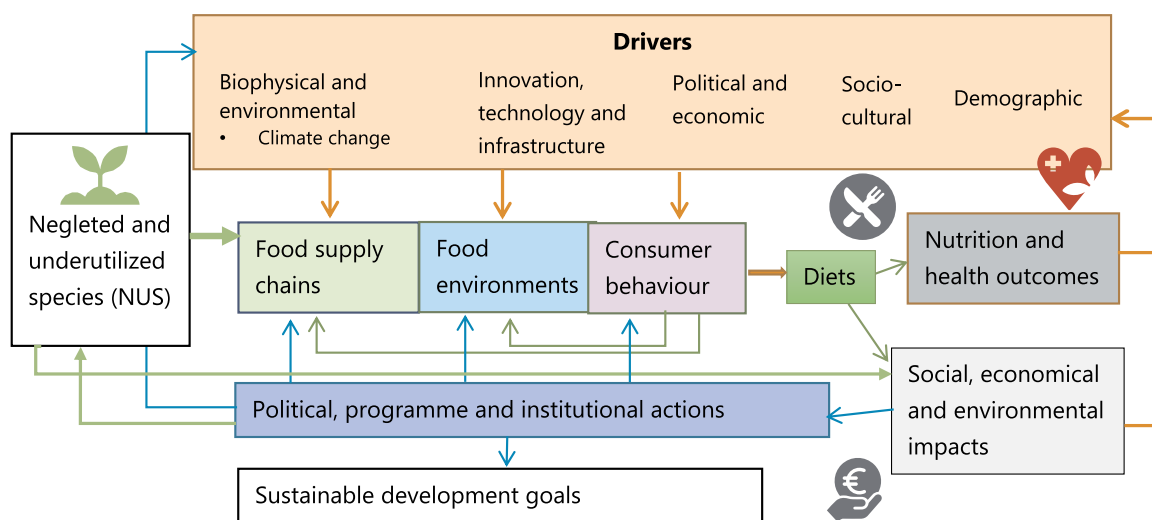


Figure 1. Neglected and underutilized species (NUS) in the conceptual framework of food systems for diets and nutrition. The framework is adapted from HLPE (2017).

literature review (El Bilali et al., 2022a) and a series of articles (El Bilali, 2020; El Bilali et al., 2022b; Mabhaudhi et al., 2019) confirmed that NUS can prevent agrobiodiversity loss and tackle the effects of climate change due to their adaptability to difficult and marginal conditions and tolerance to biotic and abiotic stresses. In addition, NUS often reduce soil and agro-ecosystem degradation because they are adapted to marginal areas (El Bilali et al., 2022a).

In the recent past, growing NUS was not seen as a rewarding commercial choice for farmers because of the lack of seeds, and because these species were not considered to be sufficiently productive compared to the commercialized species and varieties, which can benefit from concerted fertilization plans designed to maximize production. Climate change is imposing severe limits on the ability to maintain stable production despite farmers having access to improved varieties and agricultural inputs. This has led to reassessing the use of NUS in agriculture to provide stable, albeit lower yields (El Bilali et al., 2022a). The increasing attention to sustainability and resilience across the agri-food system and using agroecological approaches to agroecosystem management represent an opportunity to promote NUS to address challenges such as food and nutrition insecurity and poverty (El Bilali et al., 2022b), especially in West Africa where there is an urgent need to transform agri-food systems (Staatz & Hollinger, 2016). The adaptation potential of NUS to drought and other environmental stresses likely to impact food production in Niger and Burkina Faso could also be assessed by combining ecological climate data with evolutionary genomics by using trans-disciplinary genome–environment associations (Cortés et al., 2022; Cortés & Blair, 2018). However, the mainstreaming of NUS requires, inter alia, an enabling policy environment in which to operate (Taylor et al., 2011; El Bilali et al., 2023).

The role of the promotion of the production and use of NUS in international, regional, and national policies and strategies in Burkina Faso and Niger has not been studied earlier. In this context, the objectives of this study were (1) to identify and analyze the role of NUS and agrobiodiversity in policies and strategies related to food production, food systems and rural development, (2) to study whether the gender aspect is addressed in these policies and strategies, (3) to consider the views of experts and stakeholders to explore whether NUS related policies and strategies support a change throughout the NUS value chains, and (4) to validate the results by key stakeholders

Table 1. The main objectives and methodology used.

Objective	Method
To analyze the role of neglected and underutilized species (NUS) or agrobiodiversity in policies and strategies	Desk review of documents
To study the gender aspect in NUS related policies and strategies	Desk review of documents
To consider the views of experts and stakeholders on NUS related policies and strategies and their implementation	Online survey
To validate the results by key stakeholders in Burkina Faso and Niger	Workshop

in Burkina Faso and Niger (Table 1). The results are expected to support policy efforts and implementation of strategies and provide some recommendations for policy makers but also other stakeholders to support promoting the production and use of NUS.

Methods

This study draws upon a mixed method where document analysis, an online survey and an interactive workshop with stakeholders were combined (Table 1). This study used a systematic review of strategies and policies as well as reviews and other publications that focus on agricultural diversity and livelihoods in Burkina Faso and Niger and at global and African levels to assess the current enabling policy environment to promote NUS. Initially, 96 potentially relevant documents were identified by authors and stakeholders of the project SUSTLIVES – Sustaining and improving local crop patrimony in Burkina Faso and Niger for better lives and ecosystems (SUSTLIVES, 2024). The analysis consisted of searching for specific mentions of issues related to NUS or agrobiodiversity. Documents that were not available online or were no longer current or valid were excluded. Therefore, 44 policy and strategic documents (15 global or continental, 16 dealing with Burkina Faso, 13 dealing with Niger) were studied in more detail (Table 2).

Then, the views of experts and stakeholders in Burkina Faso and Niger were considered through an online survey undertaken between November 2022 and January 2023. The online survey was conducted using the Webropol survey system (Webropol Ltd. Helsinki, Finland, webropol.com). Stakeholders representing the Afrika Evolve, Bioprotect, *Confédération Paysanne du Faso*, Institute of the Environment and Agricultural Research of Burkina Faso (INERA),

Table 2. Strategies and policies analyzed.**International and regional**

UN Convention on Biological Diversity 1992 (CBD)
 International Treaty for Plant Genetic Resources for Food and Agriculture (ITPGRFA) 2001-
 The Comprehensive African Agricultural Development Programme (CAADP) 2003-
 Maputo Declaration 2003
 Strategic action plan for biodiversity 2011–2020
 Malabo Declaration on Accelerated Agricultural Growth 2014
 The Paris Agreement on Climate Change 2015
 Agenda 2030 & Sustainable development goals (SDG) 2015
 Global Action Plan for Agricultural Diversification (GAPAD) 2015
 Delhi declaration on agro-biodiversity management 2016
 FAO's 10 elements of agroecology 2018
 The Global Manifesto on Forgotten Foods 2021
 The, 2021 Rome Manifesto: using agrobiodiversity to transform food systems ('The Rome Manifesto')
 Framework for action on biodiversity for food and agriculture 2022
 The African Union Climate Change and Resilient Development Strategy and Action Plan 2022–2032

Burkina Faso

Programme d'action national d'adaptation à la variabilité et aux changements climatiques (NAPA), 2007
 Politique nationale de sécurisation foncière en milieu rural (PNSFMR) 2007
 Le Programme national d'investissement agricole 2009 (PNIA)
 Droit Foncier Rural, 2009
 La Politique nationale de développement de l'élevage (PNDEL) 2010–2025
 Plan d'action national 2011–2015 du Burkina Faso pour la mise en œuvre de la Convention sur la diversité biologique (NBSAP)
 Code l'environnement, 2013
 Politique nationale de développement durable au Burkina Faso (PNDD) 2013
 Loi n° 070/2015/cnt portant loi d'orientation agro-sylvo-pastorale, halieutique et faunique au Burkina Faso
 Plan national d'adaptation aux changements climatiques (PNA) 2015
 Politique nationale de nutrition 2016 (PAN)
 Plan national de développement économique et social (PNDES) 2016–2020
 Plan national de développement économique et social (PNDES II) 2021–2025
 Stratégie de développement rural (SDR) 2016–2025
 Politique sectorielle pour la production agro-sylvo-pastorale (PS PASP) 2018–2027
 Contribution déterminée au niveau national du Burkina Faso (CDN) 2021–2025

Niger

Politique Semencière Nationale (PSN), 2012
 « Les Nigériens nourrissent les Nigériens », Cadre Stratégique (3N) 2012
 Plan d'action 2016–2020 de l'initiative 3N
 Plan d'action 2021–2025 de l'initiative 3N
 Plan forestier national (PFN) – Niger 2012–2021
 Stratégie nationale et plan d'actions sur la diversité biologique (SNPA/DB), 2014
 Stratégie et Plan d'Actions de Promotion des Produits Forestiers Non Ligneux (PFNL) au Niger, 2016
 Plan national de développement économique et social 2017–2021 (PDES)
 Politique nationale de sécurité nutritionnelle au Niger 2017–2025
 Sustainable development and inclusive growth strategy (SDIGS) Niger 2035, 2017
 Stratégie et Plan National d'Adaptation face aux changements climatiques dans le secteur Agricole (SPN2A) 2020–2035
 Contribution Déterminée au Niveau National (CDN) 2021
 Feuille de Route Nationale Semencière du Niger (FdRNS) 2022

PRECIS Dosso project, Joseph Ki-Zerbo University, and NGOs *Associazione Amici dello Stato Spirito Santo – Centro di Collaborazione Comunitaria*, *Afrique Verte Niger*, *COSPE Niger*, *MANITSESE*, *LVIA*, and *SWISSAID* were invited to participate in the survey. The questions focused on strategies and policies favorable to the promotion of agrobiodiversity and/or the use of NUS, the line ministries involved, how strategies and policies have been implemented in recent years to support the use of NUS, and effective measures to foster the use of NUS in Burkina Faso and Niger. A large share of responses were from Burkina Faso (71%), and 28% from Niger.

With reference to the gender aspect, the work consisted exclusively of reviewing the analyzed policies of both Burkina Faso and Niger, seeking and extrapolating any instance linking NUS to a gender dimension.

Finally, the results from the documentary analysis and the online survey were submitted for validation by key stakeholders working in agricultural, rural, and related sectors in Burkina Faso and Niger. In Niger, a workshop was held on 15 May 2023 at the Abdou Moumouni University of Niamey (UAM) with 21 representatives from different institutions including the Ministry of Agriculture, the National Institute of Agricultural Research of Niger, UAM, *Plateforme Paysanne du Niger* and the NGO *Afrique Verte Niger*. In Burkina Faso, the draft report was shared with 44 stakeholders, including the Ministry of Agriculture. The contributions and inputs received from stakeholders in both countries were used to finalize the analysis and validate the results (SUSTLIVES, 2023).

Results and discussion

NUS like amaranth, Bambara groundnut, cassava, fabirama, okra, moringa, Guinea sorrel, or sweet potato are rarely mentioned in policies and strategies in Burkina Faso and Niger. There were 17 hits on NUS in the most potential documents reviewed in detail (Table 2). However, the idea of increasing agrobiodiversity is frequently recognized in these selected documents. This section first provides an overview of the main policies and strategies at the international and African levels that deal with agrobiodiversity. It then explores the relationships between agrobiodiversity and/or NUS and some specific topics such as the governance and regulation of the seed system, nutritional aspects, agricultural production and value chain management in national policies and strategies

in Burkina Faso and Niger. The results of the online survey and stakeholder workshops were used to give some examples of good practices and formulate some recommendations. As part of the online survey, respondents were asked to identify strategies or policies to be integrated into this analysis.

Climate change is the main driver in the global context. The Paris Agreement on Climate Change (United Nations, 2015) provides the basis for most international strategies for sustainable development. Agenda 2030 with the 17 Sustainable Development Goals (SDGs) and Nationally Determined Contributions (NDCs) list concrete actions to implement the Paris Agreement targets. Both Burkina Faso and Niger have published NDCs that are in line with international policies and strategies. The High-Level Panel of Experts on Food Security and Nutrition (HLPE) is the science-policy interface of the United Nations Committee on World Food Security (CFS). It is at the global level the most important inclusive and evidence-based international and intergovernmental platform for food security and nutrition. HLPE highlights that food systems actors need to design adapted and context-specific transition pathways to sustainable food systems combining technical interventions, investments, and enabling policies and instruments (HLPE, 2019). HLPE report (2019) aims to help decision-makers design and implement concrete transition pathways to more sustainable food systems at different scales, from the local level (farm, community, landscape) to the national, regional, and global levels. HLPE recommends that states and intergovernmental organizations support diverse and resilient production systems by adapting international agreements and national regulations on genetic resources and intellectual property to better consider farmers' access to genetic resources adapted to local conditions, as well as farmer-to-farmer seed exchanges.

Food sovereignty means that people have right to define and control their own food and agricultural systems. African Union has set an ambitious agenda of food sovereignty and creating a more just and sustainable agri-food system (Trautman et al., 2023). However, transforming the agri-food systems will require more financial resources. In Africa, the Comprehensive Programme for Agricultural Development in Africa (CAADP) (African Union & New Partnership for Africa's Development, 2003), the Maputo Declaration (African Union, 2003) and Malabo Declaration (African Union Commission, 2014) were based on the premise that increased public agricultural

expenditure would increase productivity, leading to reduction of hunger and poverty (African Union, 2014). The Malabo Declaration on Accelerating Agricultural Growth and Transformation for Shared Prosperity and Improved Livelihoods is an agreement by African Union members to address food security by allocating 10 percent of the national budget to the agricultural sector (African Union Commission, 2014), to improve agricultural productivity, reduce poverty, and strengthen resilience. The Malabo Declaration encourages the consumption of locally produced food, including school feeding programs, and resilience of systems to reduce the vulnerability of livelihoods. Niger and Burkina Faso are among those countries that reached the 10 percent sector expenditure target in at least one year between 2000 and 2016 (Kamenya et al., 2022), but the African continent has not been able to achieve the target of 6% annual growth in agriculture, and the government expenditure in agriculture for Africa has rather declined (Diallo & Wouterse, 2023).

There are several frameworks contributing to position sustainable agriculture and the role of NUS or agrobiodiversity in general as an essential component of sustainable development. The SDG target 2.5 calls for the maintenance of genetic diversity of seeds through seed and plant banks at national, regional, and international levels. In accordance with the UN Convention on Biological Diversity (CBD) for sustainable agriculture and food security (1992), the International Treaty for Plant Genetic Resources for Food and Agriculture (ITPGRFA) recognizes the fair and equitable sharing of benefits arising from the conservation and sustainable use of plant genetic resources for food and agriculture. The Strategic Plan for Biodiversity 2011–2020 adopted in Nagoya, Japan, represented an essential advance for the conservation of biodiversity and aimed to develop national action plans for biodiversity conservation. McCouch et al. (2020) emphasize that the benefit-sharing requirements of ITPGRFA should not limit the open access for information related to plant genetic resources. Further, rapid technological developments based on data rather than physical germplasm create new opportunities for breeding and might challenge existing agreements. There are policy opportunities for germplasm mobilization of NUS on investing on systematic pre-breeding or use of genome editing to generate recombinant populations (McCouch et al., 2020). Genome editing, however, has regulatory requirements and needs international agreements.

Currently, for instance European Union does not allow genome editing in plant breeding. Cortés and Barnaby (2023) also suggest harnessing gene banks for phenotyping and genotyping crop wild relatives and landraces. This kind of advanced schemes could enable bridging the gap among local agrobiodiversity, technical developments, and policy deployments.

The Delhi Declaration on Agrobiodiversity Management (2016) provides a roadmap for the sustainable use and management of agrobiodiversity. It recognizes the importance of traditional agrobiodiversity knowledge available from farmers, pastoralists, tribal and rural communities, and its central role in conservation and use for a safer and climate-resilient world. The Global Manifesto on Forgotten Foods (The Association of Agricultural Research Institutions in the Near East and North Africa et al., 2021) calls for collective actions to valorize NUS and support smallholder farmers, especially women and youth who have a key role in maintaining the NUS production. The manifesto also calls for investments and policy support for forgotten foods. Meanwhile, the Global Action Plan for Agricultural Diversification (GAPAD) puts forward the environmental, social and economic benefits of agricultural diversification through a major use of underutilized crop species (cf. NUS); it stresses that ‘Crops that are currently underutilised can contribute to agricultural diversification, support more environmentally sustainable agricultural systems and provide new livelihood options for smallholders and the poor’ (Crops for the Future, 2016). The African Union Climate Change and Resilient Development Strategy and Action Plan 2022–2032 provides a continental framework for collective action and strengthened cooperation to address climate change issues to improve livelihoods and well-being, promote adaptive capacity, and achieve sustainable, low-emission economic growth. It encourages zero loss of biodiversity in product supply chains. In the CBD COP15 (2022), new objectives were set by the Kunming-Montreal Global Biodiversity Framework providing a possibility to use new knowledge to update national biodiversity strategies and to highlight the adoption of NUS as a strategy for adaptation to climate change and to food and nutrition security. A note by African Ministerial Conference on the Environment (2023) proposes the way forward for Africa in implementing the Kunming-Montreal global biodiversity framework. It requires African countries to revise their national biodiversity strategies and action plans to align with the framework.

Agroecology is an approach to apply ecological and social principles to the management of sustainable agriculture and food systems. FAO’s 10 elements of agroecology (FAO, 2018; Wezel et al., 2020) constitute a conceptual framework that provides guidance for achieving the transformation towards environmentally, socially, and economically sustainable agricultural and food systems to achieve Zero Hunger (SDG 2) and numerous other SDGs. Agroecology through the element of diversity and the principle of biodiversity (Wezel et al., 2020) connects the transition to a sustainable food system to the sustainable use of genetic resources. The Rome Manifesto: using agrobiodiversity to transform food systems (Anonymous, 2021), an output of the 2nd International Agrobiodiversity Congress, aims at combating climate change, malnutrition, loss of biodiversity and environmental degradation by consuming a variety of foods as part of a diet that is nutritious, sustainable, affordable, acceptable, safe and accessible to all; producing food as part of diverse, resilient, and sustainable food systems; and preserving agrobiodiversity to give people the options they need to sustainably and inclusively transform food systems and improve lives. The Rome manifesto values the role of NUS and traditional foods that maintain ancient links with territories and that are adapted to local climates and cultures. The framework for action on biodiversity for food and agriculture (FAO, 2022) promotes coordinated action across all food and agriculture sectors to improve the sustainable use and conservation of biodiversity for food and agriculture at the genetic, species and ecosystem levels. Improved seed systems are needed to increase production of NUS. The availability of good quality seeds is crucial for increasing the production of NUS. In general, seed systems can be distinguished into an informal seed system, a formal or certified seed system where seed companies manage seed production and sell their seed varieties, and an intermediate system of seed producers who select, multiply and exchange varieties according to locally defined rules of use (Louwaars & de Boef, 2012; Westengen et al., 2023). Informal seed systems and local seed networks preserved by farmers have been a pillar of the agricultural system for centuries and are the only seed source for some local genotypes. In all African countries, informal systems cover most of the available and affordable seeds from local food crop selection (Croft et al., 2018). They have provided resilience to local biotic and abiotic stresses (Westengen et al.,

2023). For example, in Niger, over 60% of farmers select their own seeds and save them for later planting, distribute or market them with communities, and ensure that it is passed from one generation to the next (Swissaid, 2019).

In 2008, the Economic Community of West African States (ECOWAS) established that all seeds marketed must be certified and appear on a list of approved varieties in an official catalogue, based on three main parameters: distinction, uniformity, and stability (DUS). The existing local production system that gives rise to different types of seeds improved and made available by the national 'governmental' systems means that some types of traditional seeds might not meet the DUS characteristics required for registration in national variety catalogs. Thus, farmers' seeds cannot necessarily be sold on the market because they do not meet the certification parameters. For vegetable seeds, the ECOWAS standard is even stricter than international standards for certification (Kuhlmann et al., 2023). However, according to Westengen et al. (2023), the new agenda for seed system development is based on the view that formal and farmers' seed systems are complementary. For a resilient system, a variety of pathways are needed to ensure farmers' seed security. Community-based agrobiodiversity initiatives have aimed at integrating informal seed systems into food security initiatives (de Boef et al., 2013). Most of these projects work with farmers and other stakeholders to provide communities with lost traditional varieties or new open-pollinated varieties created through participatory breeding (Ricciardi, 2015). They are working to register community seed banks that would allow them to manage funds, market, and gain support from local governments (Mushita et al., 2015). Community seed banks collect information needed to trace the history of genetic resources and help bridging the gap that still exists between the informal and formal seed systems. However, the minimum technical support for producers, the lack of responsiveness of seed companies to develop on the sub-Saharan African market and the limited public investments still tend to keep the formal and informal seed systems apart (Croft et al., 2018, Kuhlmann et al., 2023). Africa's vegetable seed sector is not as well developed, and seed companies mostly trade imported vegetable seeds (Kuhlmann et al., 2023). On the other hand, many commercial varieties come from genetic material selected and improved by public research institutions beside private companies.

The governance of the seed system in Burkina Faso and Niger since the 1990s has highlighted an increasing evolution of the national and regional regulatory framework of the seed system and a return to the creation, production, and use of improved seeds, aligning it with the structuring of the seed system in the Organisation for Economic Co-operation and Development (OECD) countries to produce DUS seeds and guarantee farmers access to registered seeds that have passed an evaluation process.

The Government of Niger considers the diversity of seeds of traditional varieties maintained by farmers to be a national asset (Swissaid, 2019), but this mainly concerns the main crops (millet, sorghum, cowpea, and onion), which cover more than 95% of Niger's agricultural land. The aim of the National seed policy in Niger is to create an environment conducive to the development of a genuine seed industry with traceability to better secure rural producers, to improve agricultural productivity and thereby increase farmers' production and incomes, and finally, to conserve national agro-biodiversity. Niger's National Seed Roadmap (Ministère de l'Agriculture et d'Élevage, Association des Producteurs Privés de Semences du Niger, 2022) is a product of a multi-stakeholder, interactive and iterative process involving the main actors in the seed sector in Niger with a holistic approach to the seed sector transformation framework (Borman et al., 2022). This roadmap aims to integrate the informal seed system into the national action framework, making it possible to activate NUS production chains that derive from local seed systems.

There are initiatives that support NUS seed systems like 'Consumption of Resilient Orphan Crops & Products for Healthier Diets' (CROPS4HD, <https://crops4hd.org/>) which aim to make NUS more attractive in four countries, including Niger. 'Local production of safe vegetables for West African consumers' (SafeVeg, <https://avrdc.org/safeveg-local-production-of-safe-vegetables-for-west-african-consumers/>) aims to improve vegetable production and seed availability of African eggplant, amaranth, okra, pepper and roselle (hibiscus) in three countries including Burkina Faso. For example, amaranth has a high genetic diversity and is well adapted to drought and marginal land (Alemayehu et al., 2015). To conclude, the organization and governance of the seed system is one of the key aspects to consider in improving the recognition of NUS and the availability and access to quality seeds that meet the DUS requirements.

NUS are part of a healthy and sustainable diet. The national nutrition policies in Burkina Faso (e.g. Politique nationale de nutrition 2016) and Niger (Niger's Politique nationale de sécurité nutritionnelle 2017–2025) aim to tackle SDG 2 (eliminate hunger, ensure food security, improve nutrition, and promote sustainable agriculture) through a multisectoral mobilization of institutional, human, and financial resources. In Burkina Faso, the National Nutrition Consultative Council will ensure the coordination and monitoring of nutrition policy through a broad participation. The mechanism and indicators for monitoring and evaluation and the frequency of collecting the necessary data will be recorded in the strategic nutrition plan that will emerge from this policy.

In general, plant-based diets are highly recommended, and NUS can provide nutritious alternatives to major common crops (El Bilali, 2020). Recent evidence supports the role of consuming vegetables, fruits, and berries in the prevention of chronic diseases like type 2 diabetes or cardiovascular diseases (Rosell & Fadnes, 2024). Starchy vegetables like sweet potato or cassava are also an important source of energy in the diet. Amaranth is known to be an excellent combination of starch and good quality protein, and rich in micronutrients and bioactive components (Alemayehu et al., 2015). Rosell and Fadnes (2024) also recommended consuming a variety of vegetables to ensure a wide range of nutrients and phytochemicals, supporting the advantages of NUS consumption.

Globally, plant-based diet is also recommended due to its environmental sustainability. In developed countries this means transition in consumption habits. The diet in West Africa is, however, essentially based on cereals (e.g. millet, sorghum, rice). In Niger, the remaining 40% of energy requirements are covered by seed legumes (cowpeas), root crops and tubers (cassava, sweet potato, potato), vegetable oils, animal by-products and fish, and fruits and vegetables. The cuisine of Burkina Faso is very similar, consisting of porridge, fonio, peanuts, potatoes, beans, yams and okra (Lykke et al., 2002). Lykke et al. (2002) recommend that development projects should work to secure the supply of nutritionally important traditional products and to diversify the food base by promoting the use of NUS within existing land use systems. NUS would allow a rebalancing of diets nutritionally, which is why also health ministries should be interested to take measures to promote their adoption. For example, vitamin A

deficiency could be decreased by promoting the consumption of orange fleshed sweet potatoes (Shiratori et al., 2023). Moreover, an important aspect that could change and guide farmers' choices lies in consumer trends. In the first report on The State of Biodiversity for Food and Agriculture in the World (FAO, 2019), Burkina Faso provides examples of how biodiversity for food and agriculture contributes to providing more balanced diets. For example, nutritional and therapeutic products from various crops are used as dietary supplements, including red and white sorghum seeds, moringa leaf powder, soybeans, and spirulina (MAAH, 2016). However, precise data on cultivated areas (irrigated and rainfed crops), estimated productions and their contributions to the national economy are lacking. Also, as there are regional differences in culture and customs, local contexts must be considered for effective nutritional improvement (Shiratori et al., 2023).

The Nigeriens Nourishing Nigeriens Initiative, 3N Initiative (Haut-Commissariat à l'Initiative 3N, 2012), is the Niger's framework for sustainable agricultural development and food and nutrition security. The initiative aims to expand proven adaptation and mitigation technologies, expand sustainable land management practices with associated adaptation and mitigation benefits, and implement a range of resilience-building strategies. It aims to strengthen national capacities for food production, supply and resilience to food crises and disasters. Production of Moringa (*Moringa oleifera*) is an excellent opportunity to contribute to achieving the objectives of the 3N Initiative. The Action Plan 2021–2025 (Haut-Commissariat à l'Initiative 3N, 2021) aims to develop crops such as moringa, cowpea, sugarcane, onion, and pepper. The target is to increase moringa production and the number of processing units. Policies and strategies in Burkina Faso and Niger reflect the global goals. The national policies and strategies related to NUS are mostly based on global and regional policies, strategies, and processes that promote the sustainable use, management, and conservation of NUS, contributing to food security and food diversity. In recent years, national and international projects and programs have promoted NUS, for example, projects to develop moringa production and processing. According to the results of the online survey, there are plans to include NUS more in national strategies and policy frameworks. Some measures have already been taken to improve the participation of local populations in conservation actions, paying particular attention to

women as the main users of biological resources. A good example are the promotion days for local products. Other actions mentioned include the creation of the National Commission on Plant Genetic Resources in Burkina Faso, which encourages the preservation and use of all types of plant genetic resources, and the implementation of the National Agricultural Advisory Support and Extension Programme, which is part of the 2018–2027 agro-sylvo-pastoral sectoral production policy. Smale and Jamora (2020) reviewed the economical valuing of genetic resources and gene bank accessions. They conclude that gene bank valuation is fundamentally multidisciplinary and provide value in numerous ways in a changing agricultural landscape. However, even though the conservation of genetic resources is frequently mentioned in the national policies or strategies in Burkina Faso and Niger, they do not specifically identify modern technologies like hybrid breeding or genome–environment associations which will in coming years bring new opportunities for NUS genomic resources also in developing countries.

Land tenure positively influences the number of sustainable agricultural practices adopted by households in Burkina Faso (Mare et al., 2022). The National Policy for Securing Land Tenure in Rural Areas (PNSFMR – 2007) aims to ensure that all rural actors have equitable access to land, the guarantee of their investments and the effective management of land disputes. The Rural Land Governance Act (2009) recognizes customary land rights and provides legal mechanisms to formalize user rights and equitable access to rural land. The law also aims to promote the sustainable management of natural resources and investments in the agro-silvo-pastoral sector, reduce poverty in rural areas, and resolve land conflicts (Ashley, 2020). However, Parrot et al. (2022) report that even though land tenure rules have the potential to secure land rights the institutions needed to implement these regulations hardly exist. Poor rights of access to land are barriers to entry especially for women farmers.

The National Adaptation Programme of Action (NAPA – 2007) of Burkina Faso highlights that climate change will result in the disappearance of some plant species and the migration of other species from the Sahelian regions (north) to the Sudanian ones (south). The Rural Development Strategy (SDR) for the years 2016–2025 targets sustainable food and nutrition security, strong economic

growth, and poverty reduction. In the study by Sorgho et al. (2021) stakeholders, decision-makers, and policymakers in Burkina Faso agreed that adaptation to climate change like cultivation of early or drought-resistant crop varieties is essential for continued agricultural productivity in the country. The National Economic and Social Development Plan (PNDES) focuses on agriculture as a key driver of economic growth, with a focus on more productive, sustainable, and market-oriented production (Ashley, 2020). PNDES II for 2021–2025 aims to implement innovative projects to develop agro-sylvo-pastoral sectors with high productivity.

According to Diallo and Wouterse (2023), Niger is not going to meet SDG2. However, implementing the agriculture investment plan would meet CAADP's target of a 6% agricultural growth rate. Since the droughts of the 1970s, the government of Niger has created numerous strategies to reduce the impacts of rain shortages on agricultural production and food security through irrigation, increasing crop yields, recovering degraded land, and preventing desertification (Adamou et al., 2021). Niger's NDC is in line with national policies and strategies, including 3N Initiative, SDDCI-Niger 2035, Economic and social development plan (PDES) 2022–2026 as well as programs/projects for the sustainable management of natural resources and access to modern energy services for all by 2030.

The Sustainable Development and Inclusive Growth Strategy, Niger 2035 (Republic of Niger, 2017), a national strategy for sustainable land and ecosystem management, aims to provide a framework for all government strategies and actions and considers the development of productive agriculture that is less dependent on climatic hazards to help the country meet the food challenge and provide employment opportunities including for young people and women. The strategy is implemented through the five-year PDES (Ashley, 2020). In Niger, the National Strategy and Action Plan on Biological Diversity (SNPA/DB – 2014) aims, inter alia, to conserve and sustainably use ecosystems, species, and genetic resources integrating biodiversity into policies and strategies. The Strategy provides a table with species that are extinct or threatened and that are demanded by the population. Among these are sweet potatoes, cassava, and Roselle (*Hibiscus sabdariffa*).

In the regions of Maradi, Tahoua and Zinder in Niger, the Family Agriculture Development Programme (ProDAF), coordinated by the International Fund for

Agricultural Development (IFAD), contributes to ensuring sustainable food and nutritional security, and resilience capacities to crises of rural households. The development objective is to sustainably increase the incomes of 240,000 family farms, their resilience to external shocks, including climate change, and their access to local, urban, and regional markets. It is expected to increase the yield of the main vegetable crops by 40%, improve the quality of products marketed, and the development of winter vegetables. The ProDAF Programme will set up 90 new women's granaries and 4500 home gardens and support 5500 households with agricultural kits (seeds and fertilizers) so that they improve their level of agricultural production and access foods with high nutritional value crops like *Moringa oleifera* and *Cassia tora*.

The National Climate Change Adaptation Strategy and Plan in the Agricultural Sector (SPN2A) 2020–2035 aims to group together measures issued in response to the adaptation needs of producers to climate change over the medium term and the need to increase their resilience to various types of shocks. Crop diversification is among the main climate-change mitigation strategies adopted by households in Niger. According to Zakari et al. (2022), female-headed households are more likely to select climate-resilient crop varieties than male-headed households. On the other hand, male-headed households more often adopt improved agronomic practices. Institutional factors such as access to credit and market, climate information and extension services would promote adopting climate-resilient crop varieties and increase agricultural production and food security in the Sahelian region (Zakari et al., 2022). According to online survey of our study, seasonal participatory seed exchange events, local fairs, field and demonstration days, community meetings, and educational events are examples of useful activities to share information and promote awareness and dissemination of NUS.

Governance of food systems is still in silos. According to online survey responses, the ministries of agriculture and the environment in both countries are the most important in the field of NUS. Also, ministries responsible of research and innovations, health, and livestock were mentioned, which shows the cross-sectional role of NUS as part of the food system and the fight against climate change. However, based on the results of online survey, there are still silos between disciplines. Promoting the use of NUS requires a systemic approach that considers the whole food system. The value chains of NUS are often either

disorganized or non-existent in Burkina Faso and Niger because of low production levels. This makes it difficult for NUS to benefit from economies in a large scale (El Bilali et al., 2022a). The creation of value chains based on NUS is a complex process that depends on income market opportunities for farmers, who must also derive economic benefits from their crops and not just grow them for their own consumption. The loss of knowledge and the heritage of traditional knowledge is at present one of the major obstacles to the adoption of NUS. It limits the possibility of reintegrating NUS into the consumption habits of populations, which would recreate demand on markets. To this end, it is necessary to recreate demand by stably reintroducing NUS into local consumption habits. School meal programs provide a good opportunity for that (Hunter et al., 2020; FAO et al., 2021). The promotion of NUS demands joint action at several levels by the ministries of agriculture, the environment, health, research, and education.

Demand for NUS-based foods by consumers and food service providers should regenerate demand in local and national markets, and, in turn, recreating the conditions for farmers and agricultural entrepreneurs to appreciate NUS convenience. However, value chains are not separate lines but part of complex food systems with numerous actors and their interconnections (see Figure 1). In Sub-Saharan Africa, the poor infrastructure, such as transport and storage facilities, makes it difficult for smallholders to sell their products on markets at fair prices. Governance arrangements in food systems are needed in connecting sustainable, resilient production with healthy diets for consumers (Chen et al., 2021). The food system approach helps stakeholders for guiding activities within the agricultural sector, which complements the decision-making potential and helps to fulfil UN commitments like SDGs (Borman et al., 2022). The systems thinking also supports taking NUS supporting strategies and policies to increase the resilience of food systems.

Gender is a cross-cutting issue. Women's empowerment and their involvement in decision-making improves household well-being (Sell & Minot, 2018). Gender is a cross-cutting issue in many initiatives. Also, Global Manifesto on Forgotten Foods (The Association of Agricultural Research Institutions in the Near East and North Africa et al., 2021) and many other documents recognize that women play a key role in the valorization of NUS. The analysis of

the policy documents in Burkina Faso, showed a recurrent recognition of the importance of empowering women through specific actions and reported the access and control of land, animal and pastoral resources as an important issue to be tackled for women role in agriculture. However, no connection or link between women and NUS was found in the documents analyzed. On the other hand, an ongoing project EWA-BELT connects the NUS to women empowerment (<https://www.ewabelt.eu/>). Niger developed its National Gender Policy (NGP) in 2008 and a ten-year implementation plan (2009–2018) to which most action plans and national strategies refer and report the importance and consideration gender account. Still, more actions are needed to link gender in practice with NUS, or agricultural value chains.

Recommendations. This analysis provided insight into how policies impact the use of crop diversity by value chain actors and organizations. It also explored policy options to improve the effectiveness of incentives to promote the use of crop diversity for climate change adaptation strategies and nutritional benefits. Indeed, some recommendations can be made based on this analysis:

- include NUS in sectoral policies;
- support the intermediate sector as well as NUS marketing and consumption;
- consider good practices from other countries in NUS-related policies in future strategies in Burkina Faso and Niger.

Online survey for stakeholders in this study rise the need for more research on NUS. It is obvious that the new breeding technologies will impact the potential of the utilization of NUS also in Burkina Faso and Niger in future. Using next-generation genomic tools like a genome marker system and genome-wide association studies for analyzing trait variation would improve the understanding of genetic control of the nutritional properties of NUS (Wu et al., 2020). Participatory pre-breeding with farmers could be the next step to identify traits and leverage nutrient content of NUS (Peláez et al., 2022).

Conclusions

The global goals have been well taken into account in national policies in Burkina Faso and Niger. We identified 94 strategies and policies whereof only a few mention NUS as such. However, the production and

sustainable use of traditional plant species is part of agrobiodiversity strategies, agroecology, and other concepts and conceptual frameworks that promote diversity and local production to increase resilience and improve nutritional security by diversifying diets. It has been recognized at AU level that more investments to implement policies is needed. The analyzed policies and strategies show a growing awareness that the adoption of NUS can play a central role in solving various sustainable development problems. The documents call for greater resilience of the food system and improvement of the livelihood of local people as an important step in the process of adapting to climate change, and eradicating poverty and food insecurity. In addition, the analysis highlighted gaps in the current policies that should be addressed in order to allow the promotion of NUS in Burkina Faso, Niger and beyond (cf. Sahel). Most of the documents analyzed in Burkina Faso and few in Niger recognized gender as one of the cross-cutting themes and the importance of women role in a better management of resources, but none linked them to NUS. Regarding seed systems, the most urgent need is to support the integration of the informal and formal seed systems. For this to happen, it is necessary to strengthen the role of community seed banks in guaranteeing and promoting the quality of NUS seeds and ensuring the continuity of the participatory selection processes necessary to promote the commercialization of NUS and reward the entrepreneurship of small seed companies. Finally, creating sustainable and inclusive NUS-based value chains is a complex process that depends also on market opportunities and income generation for farmers. Therefore, it is necessary to recreate stable domestic demand by reintroducing NUS into local consumption habits and diets. This endeavor requires joint, concerted action at multiple levels (regional, national, local) and by different ministries (e.g. agriculture, environment, health, research and education, etc.) and stakeholders from the public, civil society and private sectors.

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Declaration of competing interest

The authors report there are no competing interests to declare.

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