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GERMPLASM COLLECTIONS OF NEGLECTED AND UNDERUTILIZED SPECIES AS RESEARCH AND CONSERVATION PLATFORMS FOR THEIR VALORIZATION

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Abstract

Germplasm collections of major crops continue to grow worldwide, while, to date, there is almost no collection of neglected and underutilized species (NUS). Recently, renewed interest has been sparked in NUS because of their great potential to contribute to climate resilience, food and nutritional security and economic development. To support the current dynamic, setting up collections of NUS is the most important step for analysis, conservation and valorisation of their genetic resources. Therefore, this study aims at (i) setting up germplasm collections of some NUS previously identified as of interest in Burkina Faso and (ii) suggesting a set of research activities for their efficient management and promotion. In order to collect a wide diversity of samples, a bibliographic search was first carried out to inventory the potential collection sites. Then, the list was completed through interviews involving custodian farmers, key informants, agricultural extension services, etc. As results, more than 852 accessions of five NUS (viz. Bambara groundnut, roselle, amaranth, moringa and country potato), including rare landraces and their wild relatives, were collected in more than 100 villages from Burkina Faso and eight surrounding countries (viz. Benin, Ghana, Niger, Mali, Côte d'Ivoire, Congo Kinshasa and Chad). Bambara groundnut and roselle were the most represented, with 200 accessions each, followed by country potato (173), amaranth (144) and moringa (135). Agro-morphological characterizations and evaluations of the accessions could contribute to a better knowledge of their diversity and to the identification of some accessions for dissemination in production areas in Burkina Faso. Establishing *core* collections of NUS could contribute to solving the problems related to the conservation of large genetic material and facilitate their use for plant breeding. The collections do not necessarily include the entire diversity of the NUS in Burkina Faso and could be enriched by new collections.

Keywords: *Seed-bank, genetic resources conservation, agrobiodiversity, NUS, SUSTLIVES.*

Introduction

Germplasm collections of major crops, also known as staple crops, continue to grow worldwide (Brown, 1989). For example, wheat, rice and maize add up to nearly one million samples collected and conserved *ex situ* throughout the world (FAO, 2010). However, minor crops, also known as neglected and underutilized species (NUS), are insufficiently represented in existing germplasm collections. NUS are species that have not received sufficient investment in research and development (Ali & Bhattacharjee, 2023; Will, 2008). NUS also refer to species whose agri-food, nutritional, and income-generating potential has not been adequately exploited (Icka

& Damo, 2023). Terms such as orphan, promising, niche and traditional crops are also used to describe them (Will, 2008).

Recently, renewed interest has been sparked in NUS because of their great potential to contribute to climate resilience, food and nutritional security and economic development (Jairu B et al., 2023). NUS are often considered to be more resilient to poor soils, drought, pests and diseases than major crops (Jairu B et al., 2023). They are characterized by rapid growth, high nutritional value and wide availability. They are well integrated into traditional agricultural systems and cultural practices of local communities. They are increasingly seen as smart crops of the future (Jairu B et al., 2023) and an important lever for food and nutritional security and adaptation to climate change (Ali & Bhattacharjee, 2023; Icka & Damo, 2023).

Calls for the promotion of NUS are increasing worldwide (Bogliotti et al., 2021). To facilitate the promotion of NUS, setting up collections is the most important step (Suriya et al., 2023). Indeed, the genetic diversity of certain NUS is threatened in their production areas where ecosystems have been disturbed by human action and climate change, making *in-situ* conservation impossible. *Ex-situ* conservation may be an alternative for the preservation of their genetic resources. Germplasms are strategic reservoirs of genes for plant breeding for present and future needs. But, as important as accession collecting may be, it should not be the ultimate goal. Accessions gathered must be described and documented. Effective use of germplasms relies on a thorough knowledge of existing genetic diversity. So, germplasm collections of NUS should be platforms for scientific investigations for long-term conservation and promotion.

In Burkina Faso, five species, namely moringa (*Moringa oleifera*), amaranth (*Amaranthus spp.*), Bambara groundnut (*Vigna subterranea*), roselle (*Hibiscus sabdariffa*) and country potato (*Solenostemon rotundifolius*), were previously identified as promising NUS. *Moringa oleifera* is a fast-growing tree of the family of *Moringaceae*. It is native to the Indian subcontinent. It is gaining importance in Africa, especially in sub-Saharan Africa (El Bilali, Dan Guimbo, et al., 2024). All parts of the plant (leaves, seeds, roots, etc.) are used in different ways for human nutrition. Bambara groundnut originates from Africa. It is a legume crop of the *Fabaceae* family. It is considered the third most important legume crop in Africa. Bambara groundnut is recognized to be climate-smart and pest-resistant. It is also known for its ability to enhance soil quality by fixing atmospheric nitrogen (El Bilali, Kiebre, et al., 2024). Amaranth belongs to the *Amaranthaceae* family. *Amaranthus spp.* include wild, semi-domesticated and domesticated species mainly used as leafy vegetables in Africa (Ouedraogo et al., 2024). The origin of amaranth is not clearly established, giving rise to controversy. It is claimed to be highly nutritious and classified as a "crop of the future" (Bhattarai, 2018). Coming to *Hibiscus sabdariffa*, also known as roselle or sorrel, it is believed to be native to West Africa. It is a flowering herb of the family of *Malvaceae*. All parts of the plant are used in human nutrition in different ways (El Bilali, 2024). *Solenostemon rotundifolius* is also known as *fabirama*, *country potato*, *frafra potato*, etc. It is a tuberizing herbaceous species belonging to the family of *Lamiaceae*. It is adapted to marginal soils in dry savannah regions (Tonde et al., 2024). These NUS are of interest for both marginalized communities, struggling with malnutrition, and high-income communities, suffering from hidden hunger. They are locally available, adaptable to various conditions and cost-effective.

To support the current dynamic of promotion of these NUS in Burkina Faso, this study aims at (i) setting up germplasm collections of the five NUS identified as of interest in Burkina Faso and (ii) suggesting a set of research activities for their efficient management and promotion.

Materials and Methods

Because they are neglected, the production areas and geographical distribution of these NUS are not often known. In Burkina Faso, few studies were carried out on moringa, amaranth,

Bambara groundnut, roselle and country potato. In order to collect a wide diversity of samples, two methods were used to identify the potential collection sites such as bibliographic search and individual interviews.

Bibliographic search

A bibliographic search was carried out to inventory the potential collection sites. The bibliographic search was related to works carried out in Burkina Faso on the five identified NUS and published as scientific reports, journal articles and books, theses, etc. This bibliographic search made it possible to list some potential collection sites.

Individual interviews

Then, the list was completed through interviews involving custodian farmers, key informants, agricultural extension services, etc. The custodian farmers and key informants were identified in previous studies (Ba, 2023; Banazaro, 2023; Naino Jika et al., 2023). A pre-established individual survey questionnaire was employed to gather information on the five NUS production areas and their geographical distribution.

Exploration and accession collections

After the identification of potential collection sites, exploration and accession collections of the five NUS were carried out from various sources. The exploration and collections were performed from 2016 to 2025. The method of samples collection varied according to NUS species. For species widely cultivated, such as roselle and Bambara groundnut, the accessions were collected randomly from the producers in their production areas. For country potato, less produced than the other NUS, accessions were collected systematically from producers. For amaranth, cultivated accessions were collected randomly from producers. Their wild relatives and wild forms of cultivated species were collected from spontaneous ecotypes and fallow fields. Coming to Moringa, the accessions were collected systematically from producers and randomly from fallow fields and abandoned plantations. Some accessions of moringa, Bambara groundnut, roselle, amaranth and country potato were obtained from some surrounding countries.

Data analysis

Data analysis was conducted using R (version 4.1.0) statistical software, with descriptive statistics including number of accessions per species, means, frequencies and percentages, etc. Tables and graphs were also designed using Excel.

Results and Discussion

More than 113 villages were identified as collection sites and explored for sampling. Eight different countries were covered for the collections (Table 1). Burkina Faso and Ghana were the most represented in terms of the number of villages covered and the number of accessions collected. In Burkina Faso, all 45 provinces of the 13 administrative regions were explored and more than 700 accessions were collected in 100 villages. In Ghana, 116 collections were collected in 13 villages. Accessions collected in Burkina Faso represent more than 82% of the entire collection, while those collected in Ghana represent approximately 14%. The number of accessions collected in the other countries ranged from one to 12. A total of 852 accessions of NUS, including rare landraces, cultivated accessions and their wild relatives, and wild forms of cultivated species, were collected. Bambara groundnut and roselle were the most represented, with 200 landraces each (23.47%), followed by country potato (173 accessions), amaranth (144 accessions) and moringa (135 landraces). The 144 accessions of *Amaranthus spp.* collected

include three species, namely *Amaranthus cruentus* (112 accessions), *Amaranthus dubius* (6 accessions) and *Amaranthus hypochondriacus* (26 accessions). Among the three species, *A. cruentus* is the most cultivated in Burkina Faso, although wild forms of the species still exist. *A. dubius* and *A. hypochondriacus* are considered to be wild, but some morphotypes are in the domestication process.

This study made it possible to gather NUS accessions that can be used to set up a seed bank for *ex-situ* conservation. In the climate change context, the conservation of NUS accessions away from their natural habitats has an advantage. It is an effective way of preserving threatened NUS genetic diversity from genetic erosion. The introduced accessions from the other countries will increase the genetic diversity in Burkina Faso. But inspections have to be done for the presence of pests and diseases before using them in Burkina Faso. Indeed, the introduction of plant material from other countries could cause the introduction and the spreading of new pathogens (Engels & Visser, 2003).

Table 1. Number of collected accessions and information related to their collection sites

NUS species	Countries	Acc. num.	Regions	Prov.	Dept.	Villages	Total of accessions
Moringa oleifera	Burkina Faso	113	13	21	31	38	135
	Benin	2	-	-	-	-	
	Niger	12	2	-	-	-	
	Chad	6	3	-	-	-	
	Congo Kinshasa	1	1	1	1	1	
	Côte d'Ivoire	1	1	1	1	1	
Vigna subterranea	Burkina Faso	193	8	11	19	21	200
	Benin	3	-	-	-	-	
	Niger	4	-	-	-	-	
Hibiscus sabdariffa	Burkina Faso	200	9	14	24	35	200
Amaranthus spp.	Burkina Faso	137	9	15	21	26	144
	Mali	7	-	-	-	-	
Solenostemon rotundifolius	Burkina Faso	57	8	9	11	16	173
	Ghana	116	-	-	13	13	
Total	**8 countries**	**852**	**20**	**47**	**70**	**113**	

Acc. num.: Accession number; Prov.: Province; Dept.: Department.

After accession collections, the management of germplasm includes conservation, characterization, documentation, multiplication, distribution and utilisation (Kiran Sagar et al., 2023).

Germplasm conservation

The entire collection is conserved in a seed bank in Burkina Faso for future uses. Conservation of entire collection is particularly important to ensure continued availability of NUS seeds. This seed bank will be used as platforms for conservation and research activities. NUS are particularly threatened by climate change and the continuous destruction of natural ecosystems of wild crops, leading to genetic erosion. The impacts of climate change are expected to be higher in Sub-Saharan Africa developing countries (El Bilali, 2021). The agricultural sector will be severely affected, requiring the development of strategies to preserve and conserve genetic resources.

The ultimate goal of setting up collections could be to encourage the use of accessions to promote food security and sustainable agricultural production (Engels & Visser, 2003). This

collection is being used for community's immediate and future needs. In some production areas, communities had already lost certain landraces of NUS. This germplasm made it possible to reintroduce some rare landraces in production areas, contributing to maintaining the genetic diversity of the NUS. In addition, the germplasm will serve as a strategic reservoir of genes for future plant breeding programs. A subset of the collection will be used as a working sample for research activities.

Characterization of the germplasm

Germplasm collections should contain materials that offer both short-term and long-term benefits to users. Characterizations for agronomic and morphological traits are necessary to facilitate the use of germplasm (Upadhyaya et al., 2008). Agro-morphological characterizations of the accessions could contribute to a better knowledge of their diversity. Characterization is the identification of the distinctive heritable traits of accessions. Agro-morphological characterizations were carried out in three experimental sites (Gampela and pella in the Sudano-Sahelian zone and Farako-Ba in the Sudanian zone) according to the climatic zones of Burkina Faso. This research activity made it possible to describe all the collected accessions and to determine the level of their genetic diversity.

These characterizations showed a great genetic diversity for all the NUS. This is not surprising because most of the collected accessions are landraces and their wild relatives, which are considered to be very diverse (Tan et al., 2020). For moringa, leaf blade length, petiole length, leaf blade width, plant height and stem diameter were the most discriminant traits between collected accessions. Regarding country potato, the discriminant traits are related to vegetative development, cycle, and tuber yield (Kiebre et al., 2025). Coming to roselle, the discriminant traits are related to calyx, seed, leaf and yield, but the most discriminant traits are calyx colour, calyx shape and seed and calyx yield (Kiebre et al., 2025). The characterizations also showed that Bambara groundnut is one of the most diverse crop species. Traits related to seeds were the most diverse. Seed colour, seed size, seed shape and seed yield were the most discriminant traits. Considering amaranth, inflorescence and leaf colour, plant height and biomass were the most discriminant variables (Kiebre et al., 2025). The characterizations made it possible to define a set of discriminating traits for each species that could be suggested as descriptors to researchers. The proposal of descriptors will constitute a major step forward for research on NUS, providing a valuable tool for standardized characterization of NUS. Although molecular markers are increasingly used for germplasm characterizations, phenotypic markers are still essential because they are easy to perform and less expensive.

Participatory evaluations and selection of accessions of interest

Generally, there is no research program on NUS, leading to a lack of quality varieties (Ali & Bhattacharjee, 2023). After characterizations and while waiting for varieties to be formally developed, best-performing accessions can be identified and released in production areas for immediate use. Thus, participatory evaluations and selections of accessions of interest involving local communities were carried out in eleven villages in Burkina Faso. Evaluation is an agronomic description of the germplasm using traits of interest to communities and breeders. The agronomic performances of accessions were assessed and traits of interest for communities and breeders were determined. Thus, the high-yielding accessions were identified according to the communities' preferences. In each village, the three most suitable and preferred accessions were identified. Then, the selected accessions were multiplied and disseminated in the species production areas in Burkina Faso. The accessions' dissemination will ensure the introduction of new varieties in some production areas and the reintroduction of the lost and rare landraces in areas where they had been lost. For example, formerly widely cultivated in Oubritenga and Bazéga provinces (central Burkina Faso), country potato has been gradually abandoned over

the years. Thus, the selected accessions were reintroduced in some villages such as Kolguinguéssé and Goundrin. The selected accessions were also disseminated throughout individual farmers, farmers' associations and development NGOs in Burkina Faso.

Core collections establishment

Maintaining entire collections is very important, but poses many challenges to managers. It may require more investment than conserving a subset of the collection. In addition, using a large number of accessions for varietal improvement is not technically practical. Establishing *core* collections of NUS should contribute to solving the problems related to the conservation of large genetic material and facilitate their use for plant breeding. A *core* collection is a subset of the entire collection that ideally represents all the genetic diversity of the entire collection (Brown, 1989). Generally, 10% of the whole collection can be expected to contain over 70% of the variation in a species (Brown, 1989).

On the basis of the agro-morphological traits, a *core* collection of 20 accessions (approximately 10% of the entire collection) was defined for Bambara groundnut, roselle and amaranth. These *core* collections could be used by researchers in plant breeding programs. The *core* collections could be duplicated and conserved in some local seed banks in Burkina Faso.

Very few publications exist on morphological characterization and evaluation of NUS in Western Africa. If some data are published, they either contain many gaps or are published locally with limited access to a wide audience. Data from these characterizations and evaluations will be published as articles in peer-reviewed journals for wide use.

Conclusion

Collections of five NUS and some research activities for their efficient management and promotion were carried out. Up to 852 accessions of Bambara groundnut, roselle, amaranth, moringa and country potato were collected from Burkina Faso and eight surrounding countries. The collections include rare landraces, cultivated accessions and their wild relatives, and wild forms of cultivated species of the five NUS. Agro-morphological characterizations revealed a great diversity of the collections, while the participatory evaluations made it possible to identify some accessions of interest, which were disseminated in the production areas for immediate use.

The collections constitute a decisive step towards the conservation and promotion of NUS in West Africa. They could be used as a multi-actor platform for research programs. It can also serve as a training framework for students. The collections do not necessarily include the entire diversity of the NUS in Burkina Faso and could be enriched by new collections.

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References

Ali, A., & Bhattacharjee, B. (2023). Nutrition security, constraints, and agro-diversification strategies of neglected and underutilized crops to fight global hidden hunger. *Frontiers in Nutrition*, *10*(June), 1–12. https://doi.org/10.3389/fnut.2023.1144439

Ba, M. (2023). Caractérisation des agriculteurs gardiens de semences traditionnelles de voandzou [*Vigna subterranea* (L.) Verdc.] et d'oseille de Guinée [*Hibiscus sabdariffa* (L.)] pour des initiatives locales de conservation dans quatre provinces du Burkina. *Univ. Joseph KI-ZERBO, Master Thesis*, 176 p.

Banazaro, P. (2023). Profilage des agriculteurs gardiens de variétés traditionnelles de céréales [*So*rghum bicolor (L.) et *Pennisetum glaucum* (L.)] et légumineuses [*Vigna unguiculata* (L.)], diversité variétale et initiatives locales de conservation dans quatre provinces. *Univ. Joseh KI-ZERBO, Master Thesis*, 62 p.

Bhattarai, G. (2018). Amaranth: A Golden Crop for Future. *Himalayan Journal of Science and Technology*, *2*(July), 108–116. https://doi.org/10.3126/hijost.v2i0.25854

Bogliotti, C., Calabrese, G., El Bilali, H., Rae, I., Platzer, M., Marino, M., Ramos de la Cruz, M. J., Wagsta, P., Pipi, P., Mathur, S., Oenema, S., & Kiene, T. (2021). Voices from the agencies: research for development (R4D) agencies supporting efforts to conserve and promote the sustainable use of NUS. In Padulosi S., King E.D. I. O., Hunter D., Swaminathan M.S. (Ed.), *Orphan crops for sustainable food and nutrition security* (pp. 365–384). https://doi.org/DOI: 10.4324/9781003044802-36

Brown, A. H. D. (1989). Core collections: A practical approach to genetic resources management. *Genome*, *31*(2), 818–824. https://doi.org/10.1139/g89-144

El Bilali, H. (2021). Climate change and agriculture in Burkina Faso. *Journal of Aridland Agriculture*, *7*, 22–47. https://doi.org/10.25081/jaa.2021.v7.6596

El Bilali, H. (2024). State and contours of research on roselle (Hibiscus sabdariffa L.) in Africa. *Open Agriculture*, *9*(1). https://doi.org/10.1515/opag-2022-0336

El Bilali, H., Dan Guimbo, I., Nanema, R. K., Falalou, H., Kiebre, Z., Rokka, V. M., Tietiambou, S. R. F., Nanema, J., Dambo, L., Grazioli, F., Naino Jika, A. K., Gonnella, M., & Acasto, F. (2024). Research on Moringa (*Moringa oleifera* Lam.) in Africa. *Plants*, *13*(12), 1–44. https://doi.org/10.3390/plants13121613

El Bilali, H., Kiebre, Z., Nanema, R. K., Dan Guimbo, I., Rokka, V.-M., Gonnella, M., Tietiambou, S. R. F., Dambo, L., Nanema, J., Grazioli, F., & Acasto, F. (2024). Mapping Research on Bambara Groundnut (*Vigna subterranea* (L.) Verdc.) in Africa: Bibliometric, Geographical, and Topical Perspectives. *Agriculture*, *14*(9), 1541. https://doi.org/10.3390/agriculture14091541

Engels, J. M. M., & Visser, L. (2003). *A guide to effective management of germplasm collections.* IPGRI Handbooks for Genebanks, No. 6. IPGRI, Rome, Italy.

FAO. (2010). The Second Report on the State of the World's Animal Genetic Resources for Food and Agriculture. Rome. https://doi.org/10.4060/i4787e

Icka, P., & Damo, R. (2023). Neglected and underutilized crop species a path to improving nutritional security and diversification of agriculture. Proceedings of the VIII International Scientific Conference "High Technologies. Business. Society 2023", 06-09 March 2023, Borovets, Bulgaria, 82–86.

Jairu, D., Wasaful Quader, S., Pratiksha, Khalkho, R. (2023). Neglected and Underutilized Species (NUS): The Smart Crop of the Future. *Food and Scientific Reports*, *4*(12), 0–9. https://www.researchgate.net/publication/376886505

Kiebre, Z., De Muro, P., Vanga, A. F., Nanema, J., Dambo, L., Kiebre, M., Nanema, R. K., Dan Guimbo, I., Pulchérie, T. S., El Bilali, H., & Acasto, F. (2025). Actes du Colloque régional sur le rôle de la biodiversité agricole et des espèces négligées et sous-utilisées (NUS) pour le développement durable et la sécurité alimentaire et nutritionnelle. *CIHEAM*, 156.

Kiran Sagar, D., Shrishail, M. V., Sathish, B., Mallappa, Basavaraj, T., & Nagajyothi, G. (2023). Germplasm conservation, evaluation, characterization and improvement of genetic resources of fruit crops in India: Preserving of future fruit crops for the future.

International Journal of Advanced Biochemistry Research, *8*(1S), 271–276. https://doi.org/10.33545/26174693.2024.v8.i1se.346

Naino Jika, A. K., Kiebre, Z., Ba, M., Banazaro, P., Grazioli, F., & El Bilali, H. (2023). Custodian farmers of Bambara groundnut and sorrel seeds in Mossi area of Burkina Faso: profile, diversity and conservation methods. *AGROFOR International Journal*, *8*(2), 77–85.

Ouedraogo, J., Kiebre, Z., Nanema, R. K., Kiebre, M., Bationo/Kando P. (2024). Genetic Diversity of Amaranth in Burkina Faso. *Journal of Plant Biotechnology*, *2818*(51), 387–394.

Suriya, J., Saravanan, S., Dinkar, D., & Dwivedi, N. (2023). Exploration and Collection of Germplasm. *Elite Publishing House*, *February*, 90–104.

Tan, X. L., Azam-Ali, S., Goh, E. Von, Mustafa, M., Chai, H. H., Ho, W. K., Mayes, S., Mabhaudhi, T., Azam-Ali, S., & Massawe, F. (2020). Bambara Groundnut: An Underutilized Leguminous Crop for Global Food Security and Nutrition. *Frontiers in Nutrition*, *7*(December), 1–16. https://doi.org/10.3389/fnut.2020.601496

Tonde, I., Kiebre, Z., & Nanema, R. K. (2024). Effect of planting dates on the quantitative traits of *Solenostemon rotundifolius* [(Poir.) J. K. Morton]. *African Journal of Biotechnology*, *23*(July), 245–254. https://doi.org/10.5897/AJB2024.17667

Upadhyaya, H., Gowda, C., & Sastry, D. (2008). Plant genetic resources management: collection, characterization, conservation and utilization. *Journal of SAT Agricultural Research*, *6*, 1–16.

Will, M. (2008). *Promoting value chains of neglected and underutilized species for pro-poor growth and biodiversity conservation. Global Facilitation Unit for Underutilized Species, Rome, Italy*. http://www.cffresearch.org/FutureCrop-@-Publications_.aspx#sthash.4Ll4zPtg.dpbs