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RESEARCH ARTICLE

CEREALS DIVERSITY AND FARMERS' SEED CONSERVATION PRACTICES IN THE SAHELIAN ZONE OF BURKINA FASO

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ABSTRACT

Background: The Sahelian zone of Burkina Faso is characterized by erratic rainfall, high temperatures, and frequent droughts, involving significant challenges to agricultural production. To mitigate these climate risks, farmers cultivate diverse and resilient cereal varieties, which play a crucial role in ensuring food security and sustaining livelihoods. **Objectives**: This study aims to assess the diversity of cereal cultivars and document traditional seed conservation strategies in the communes of Gourcy and Bilanga, located in the Sahelian zone of Burkina Faso. **Methods**: An ethnobotanical survey was conducted among 60 households across four villages. Data were collected through group discussions and individual interviews using a structured questionnaire, supplemented by direct observations of seed conservation practices and field visits. **Results**: The main cereal crops identified in the study area are sorghum, maize, and millet. Sorghum is the most dominant and diversified species, with 23 distinct phenotypes recorded. Additionally, 11 maize phenotypes and 3 pearl millet phenotypes were documented. Local cultivar names are based on phenotypic characteristics or the origin of the variety. Regarding seed conservation, sorghum seeds are typically stored as panicles, whereas maize and millet seeds are preserved as ears. These seeds are kept in distinguishable heaps within traditional granaries or suspended from the roofs of houses and sheds. Seed sampling and analysis indicate that these conservation methods effectively maintain seed physical quality over time. **Conclusion**: The observed diversity of plant genetic resources in the studied villages represents a valuable asset for both conservation efforts and future breeding programs. Preserving and promoting these traditional seed conservation practices could enhance agricultural resilience and contribute to long-term food security in the region.

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INTRODUCTION

Sustainable food and nutritional security in countries where agriculture is the main activity are linked on interspecific and intraspecific crop diversity (Gepts, 2006; Hajjar *et al*., 2008; Renard and Tilman, 2019; Egli *et al*., 2021). While cultivated diversity has declined in developed countries due to monoculture and a seed system unfavorable to traditional seeds, many developing countries still maintain a broad intraspecific and intraspecific diversity of crops. In Burkina Faso, where agriculture is mainly based on rainfed cereals (sorghum, millet, maize), the adoption rate of improved varieties remains low. Many farmers prefer traditional cultivars, which they consider more resilient to climate variability (Mercer and Perales, 2010) and better suited to their living conditions. Some cultivars hold cultural value and are used in ceremonies, giving them an identity-based and cultural heritage significance for local communities. The interspecific and intraspecific diversity found in these communities contributes to the food and nutritional security of local populations. Unfortunately, cultivated diversity is declining due to the shortening of rainy seasons in certain areas, the emergence of new pests and diseases, excessive use of pesticides and herbicides, and deep changes in dietary habits. Since the 1980s, the FAO has highlighted this phenomenon, referring to it as genetic erosion. In response, efforts have been made worldwide to conserve plant genetic resources, resulting in the establishment of approximately 1,750 gene banks globally (Yu *et al*., 2016; Sofi *et al*., 2020; Fernando *et al*., 2023). Numerous collection and characterization studies have been conducted to improve knowledge of plant genetic resources and promote their better management and conservation. In Burkina Faso, several research studies—ranging from ethnobotanical investigations to agro-morphological, biochemical, and genetic characterization—have been conducted (VomBrocke*et al*., 2013; Sawadogo *et al*., 2014; Kondombo *et al*., 2016). However, most of these studies cover only a portion of the country and focus on a

single species. Very few have examined the specific diversity cultivated within Burkina Faso's agroecosystems. A better understanding of cereal crop diversity would allow an assessment of the resilience level of local agro ecosystems to climatic hazards. This aims to determine the intraspecific diversity and seed conservation strategies of three main cereal crops—sorghum, maize, and millet—in the communes of Bilanga (Eastern region) and Gourcy (Northern region) in Burkina Faso.

MATERIALS AND METHODS

Study area: The study covered the villages of Niéssega and Boogo in the commune of Gourcy, as well as the villages of Diankoudougou and Koulmasga in the commune of Bilanga. Bilanga, located in the administrative Eastern region, is situated at 12° 33' 00" N and 0° 02' 00" W, while Gourcy, in the Northern region, is at 13°13' 00" N and 2° 21' 00" W. Both communes lie within the Sahelian zone, receiving between 500 mm and 600 mm of annual rainfall (Kambire *et al*., 2015). The rainy season lasts from June to September, with a progressive decline in rainfall compared to the 1960s (Ouedraogo, 2012). Temperatures in these villages can reach up to 45°C in April. The soils are nutrient-poor, shallow, and have low water retention capacity. Sorghum and maize are the primary staple cereals, accounting for approximately 90% of production. However, their yields remain low, averaging less than 1.5 tons per hectare (MAAH, 2019).

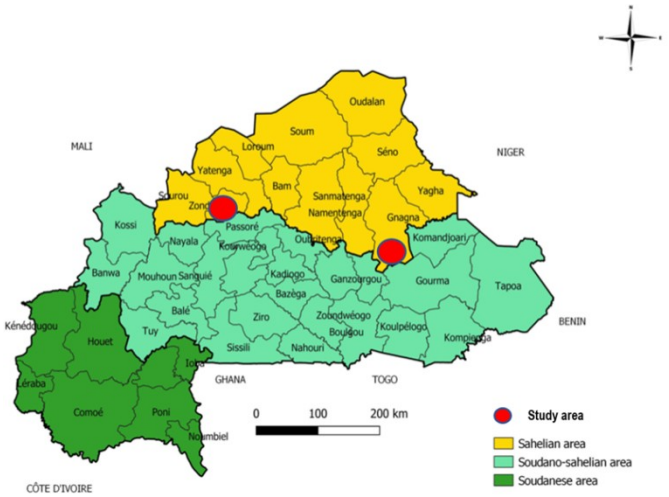

Figure 1. Study area, climate zones and administrative provinces of Burkina Faso (adapted from Sangaré *et al*., 2021)

Data Collection: The methodology involved an ethnobotanical survey among farmers in Niéssega, Boogo, Diankoudougou, and Koulmasga. Individual household interviews and focus group discussions were conducted with members of Agricultural Equipment Cooperatives (CUMA) in the two communes. A questionnaire was used to collect data on farming systems, crop species diversity, cultivar origins, and seed conservation methods.In each commune, interviews were conducted with the heads of 30 households. The interviews were administered in the local language with the assistance of an interpreter. Field observationswere carried out with the help of CUMA representatives. The study focused on sorghum (Sorghum bicolor), maize (Zea mays), and millet (Pennisetum glaucum), which are the main crops in the study areas. To assess the effectiveness of conservation tools, samples were collected from farmers according to their conservation methods. Samples were collected and transported to the laboratory at Fada N'Gourma University and the seeds have been sorted. The weight percentage of grains with a good physical appearance was determined for each sample

Data Analysis: Survey data were entered and processed using Microsoft Excel. Descriptive statistical methods were applied to summarize the data and generate tables.

RESULTS

Farming Systems: The main cereals grown in the study areas are sorghum (*Sorghum bicolor* (L.) Moench), which occupies the largest cultivated area, maize (*Zea mays* L.) and millet (*Pennisetum glaucum* (L.) R. Br.). Farmers commonly practice mixed sorghum cultivation, sowing multiple sorghum cultivars in the same field. Additionally, sorghum is often intercropped with cowpea. In contrast, maize and millet are usually grown as monocultivars or single-variety crops. Fields contain scattered trees and shrubs, shaping the agricultural landscape. The most common tree species include *Vitellaria paradoxa, Parkia biglobosa, Tamarindus indica, Faidherbia albida, and Azadirachta indica*. However, the presence of old trees dominates, with little natural regeneration. Production systems remain low-intensity farming, with most fieldwork done manually. At the beginning of the season, animal traction is used for plowing. The use of organic fertilizer depends on household availability, with priority given to severely degraded soils. Less than 30% of farmers use mineral fertilizers, and when they do, it is at low doses. Weeding is typically performed manually with a traditional hoe ("daba").

Cultivar Diversity: A total of 23 sorghum phenotypes have been identified. The local naming of cultivars is mainly based on phenotypic characteristics, agronomic traits and the origin. For example, a cultivar could be named to highlight a specific agronomic trait, such as drought tolerance or resistance to Striga sp. Some cultivars bear the name of the first producer who introduced them to the community (Table 1). It is common for different cultivars to have the same name due to phenotypic similarity. According to producers, the growth cycle of cultivars varies from 70 to 120 days, depending on the cultivar.

Table 1. Main local names of sorghum cultivars

Local names	Characteristics
Kazinga	Red seed sorghum
Kène pèlga	White seed sorghum
Kamiougou	Red sorghum (cited as resistant to striga)
Fib miougou	Red glume sorghum
Zonobougo	sorghum with small seeds (prepared like rice)
Maka	Sweet sorghum
Belko	Sorghum cultivar introduced by Belko

Sorghum cultivars are primarily of the Guinea race, with only two Durra varieties identified, which are used for therapeutic purposes. Eleven (11) maize cultivars have been identified. Some maize cultivars share the same name due to similar phenotypic traits. In general, producers distinguish two main types of maize: yellow maize and white maize. These cultivars mainly originate from two sources: ancestral cultivars known as "Kaman moaga" and research-derived cultivars often referred to as "griture" in reference to agricultural research services. Although "griture" is originate from research, they

are considered cultivars because they have been adopted by producers for many years and their seeds are regularly saved from harvests (Table 2).

Table 2. Local names of some corn cultivars

Local names	Characteristics
Kamanemiougou	yellow corn
Kamanepelga	white corn
Kaman-moaga	Ancestral corn cultivars
Griture	Corn cultivar originated from research

Based on their growth cycle duration, producers classify maize cultivars into early-maturing (50-70 days), intermediate-maturing (70-90 days), and long-cycle cultivars (more than 90 days). Long-cycle cultivars (over 90 days) represent less than 30% of all cultivars and are at risk of disappearing due to shorter rainy seasons. Maize cultivation has gained importance over the past decade in the northern region, where its cultivated areas are increasing. Primarily, early-maturing maize cultivars are sown in household plots to cover the lean season. These are small plots of about half a hectare, fertilized with manure when available. Pearl millet is the least diversified cereal among the three crops. Only three cultivars have been identified: one with awned spikes of the "sanio" type (Bamba *et al*., 2019), one with gray-colored seeds, and one with white-colored seeds. Millet is minimally cultivated in the studied villages. For cereal crops (sorghum, maize, millet), the seed system is informal. Most producers produce their own seeds or obtain them through exchanges with other producers.

Seed Conservation Strategies: In the North, mud granaries covered with thatched roofs are the most commonly used storage structures for seeds. In the East, harvests are also stored in granaries. Unlike the granaries in the North, those in the East are often entirely made in straw. Cereal seeds (sorghum, maize, millet) are generally stored in the form of ears or panicles, which are grouped into small piles. These piles may be kept in granaries along with the rest of the harvest or suspended from a tree, a shed, or the roof of a house (Figure 2). New storage tools like 20 Liter jerrycans plastic and "pics", polypropylene bags have emerged in the investigated areas. In northern region, attempts are made to modernize straw granaries into metal sheet granaries (Figure 3).

Effectiveness of Seed Conservation Strategies: When panicles and ears are well dried and stored away from pests and humidity, sorghum seeds stored in granaries for 1 to 2 years maintain good physical quality. More than 90% of the seeds remain undamaged. However, beyond two years, a significant portion of the seeds suffer physical damage or are attacked by mold and termite.

DISCUSSION

The dominance of sorghum, maize, and millet in the surveyed villages aligns with the statistics of the Ministry of Agriculture, which classifies these crops as traditional cereals (MARAH, 2022). These crops have always been present in Burkina Faso's agroecosystems and form the basis of the population's diet (VomBrocke *et al*., 2013). According to Barro-Kondombo *et al*. (2010), citing the Ministry of Agriculture, Burkina Faso's agriculture is dominated by cereal crops (sorghum, millet, maize), which occupy 83% of the total cultivated areas. The polyvarietal sowing practiced by farmers promotes cultivar evolution within agroecosystems by facilitating gene flow. This practice has also been reported among the Duupa people of northern Cameroon (Barnaud *et al*., 2008). The intercropping of sorghum and cowpea is widespread in family farming in Burkina Faso. Cowpea, a leguminous plant, contributes to better soil fertility management through its ability to fix atmospheric nitrogen (Voisin *et al*., 2015; Guinet *et al*., 2019).

Trees and shrubs conserved in fields are often useful species. For example, *Parkia biglobosa* seeds are used to make "soumbala," a popular condiment. *Tamarindus indica* fruits are used in juice production and the preparation of traditional dishes such as tô (a maize or sorghum flour porridge) and gruel. The butter from *Vitellaria paradoxa* is used in food preparation, skincare, and various local ceremonies. The farming system is not highly intensified. The daba, though rudimentary, remains the predominant tool in Sahelian agroecosystems due to its affordability, community-wide availability, and ease of use, requiring no special technical skills. The use of agricultural inputs (chemical fertilizers, pesticides, herbicides) is low due to high costs, limited accessibility, and the promotion of agroecology in the study area. The Association for Research and Training in Agroecology (ARFA), which operates in the region, supports farmers in producing their own inputs by valorizing local waste materials instead of relying on imported inputs. The local naming of a cultivar is often based on a specific phenotypic trait that distinguishes it from others. For instance, the names Kazinga and Kamiougou refer to the white or red coloration of the grains, respectively. However, within white-grained cultivars, two cultivars may differ in at least one other characteristic, leading to different cultivars sharing the same name due to phenotypic resemblance. Barro-Kondombo *et al*. (2010) also reported that certain varieties bearing the same name differed in at least one trait, such as growth cycle duration, glume color, or grain color. The diversity of growth cycle durations meets specific needs. Early-maturing varieties, aside from their phenotypic characteristics, are primarily used to quickly address food shortages. Long-cycle cultivars (over 90 days) have often been cultivated for generations and inherited from ancestors. Although they hold cultural significance, the shortening of rainy seasons is causing their gradual disappearance. Some cultivars, due to their social value (medicinal and ritual use), are renewed every two or three years on small, more favorable plots (Barro-Kondombo *et al*., 2010). According to Vaksmann *et al*. (1996), the diversity in growth cycles and sensitivity to photoperiodism enable traditional sorghum cultivars to adapt remarkably well to Sahelian environments and climate conditions. Sorghum tends to flower more quickly towards the end of the rainy season.

The dominance of the Guinea race among cultivated sorghum varieties has been reported by several authors (Barro-Kondombo *et al*., 2010; Sawadogo *et al*., 2014). In Burkina Faso, 93% of local cultivars belong to the Guinea race, 4% to the Caudatum race, 2% to the Bicolor race, and 1% to the Durra race (Zongo, 1991). In Mali, 70% of local varieties are Guinea, 16% Durra, 1% Caudatum, and 13% intermediate types. Guinea sorghums are characterized by their tall height, photoperiod sensitivity, and high outcrossing rates (Chantereau *et al*., 1998). Farmer-managed varietal diversity helps mitigate climatic risks and address various constraints and uses (Trouche, 2005). The strong genetic diversity of local varieties

Figure 2. Forms and storage locations of cereal seeds.a) Bundle of sorghum panicles (*Sorghum bicolor*), b) Maize ears (*Zea mays*), c) Mud granary, d) Straw granary

Figure 3. Metal sheet granaries

results from farmer seed management practices (selection, exchanges, introductions, and seed multiplication methods) and a relatively high outcrossing rate (3-31%) (Ollitrault *et al*., 1997). The traditional tools used for seed conservation date back several centuries. If producers continue to use these tools, it is certainly because they offer a certain level of effectiveness in preserving seeds. The evaluation of the physical quality of seeds stored in these traditional granaries has shown that these practices help maintain the physical integrity of the seeds. The emergence of metal sheet granaries could be explained by the scarcity of straw. The use of "pics" bags and 20-liter plastic jerrycans may be justified by their effectiveness in preservation and, above all, their ease of use.

Key points

- Sorghum, maize, and millet are the dominant cereal crops in the Sahelian zone of Burkina Faso, serving as staple foods and forming the foundation of the local diet.
- Farmers practice polyvarietal sowing and intercropping to promote genetic diversity and improve soil fertility management.
- Tree species such as *Parkia biglobosa, Tamarindus indica, and Vitellaria paradoxa* are preserved in

agricultural fields for their nutritional, medicinal, and cultural significance.

- Traditional seed storage techniques, including granaries and hanging structures, play a crucial role in preserving seed quality and viability.
- The selection of diverse sorghum cultivars based on growth cycle duration and photoperiod sensitivity enables farmers to adapt to climatic variability and enhance food security.

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