

# Stalk Sweet Sorghum [*Sorghum bicolor* (L.) Moench] from Burkina Faso: Genetic Diversity, Importance, and Prospects for Variety Improvement

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## Abstract

Sweet stalk sorghum [*Sorghum bicolor* (L.) Moench] is a type of sorghum characterized by the sugary juice in its fresh stalk. It is predominantly cultivated in Burkina Faso for its stalk, which is consumed as a snack. However, sweet stalk sorghum remains underutilized in Burkina Faso due to the lack of awareness of its vast potential. Furthermore, few investigations on sweet stalk sorghum were carried out by research programs in Burkina Faso, except preliminary studies initiated by the Plant Genetics and Breeding Team of the University of Ouagadougou in 2008. This review seeks to consolidate findings from various research efforts on this crop, specifically focusing on indigenous knowledge, genetic diversity, and nutritional value, with the aim of proposing strategies for varietal improvement and broader utilization in Burkina Faso. A critical analysis of the key findings on sweet stalk sorghum was carried out, revealing a significant agro-morphological variability when compared to other sorghum varieties. This analysis also identified potential avenues for the development of forage sorghum, as well as exploration into biofuel production and the possible biotic threats to the crop. Notably, genetic traits such as “stay green” and photoperiod sensitivity in sweet stalk sorghum could contribute to the development of drought-tolerant varieties. Moreover, sweet stalk sorghum could contribute to the diversification of local food resources through the use of both the grains and the juicy, sweet stalks. Furthermore, several prospects,

such as the development of forage sorghum varieties, investigations for biofuel production, and potential biotic threats, have also been identified. This review provides a scientific basis for future breeding programs aimed at enhancing this crop's potential in Burkina Faso.

## Keywords

Sweet Stalk Sorghum, Genetic Diversity, Importance, Valorization, Burkina Faso

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## 1. Introduction

Sorghum [*Sorghum bicolor* (L.) Moench] is grown in several semi-arid regions of the world for human food, animal feed, and various other uses [1] [2]. In Burkina Faso, sorghum is a heritage for farmers, with several types being cultivated [3] [4]. These include grain sorghum, dye sorghum, sweet grain sorghum, and sweet stalk sorghum. Grain sorghum is the most widely cultivated for its grains, which are used in the preparation of local dishes such as “*tô*” and porridge [1] [2]. The sprouted grains are dried and ground to produce a local beer called “*dolo*” [5] [6]. Dye sorghum is grown exclusively for its red pigment, extracted from the anthocyanin-rich leaf sheaths after the stalks are crushed and macerated [7] [8]. As for the sweet sorghums, they are mainly grown for their sugary grains in the doughy stage, hence the name sweet grain sorghum [9], for their juicy, sugary fresh stalk, referred to as sweet stalk sorghum [10] [11]. Sweet stalk sorghum is characterized by a significant accumulation of sugars, with sucrose being the main one [12]. The production of this sorghum contributes to the diversification of food and economic needs for households in Sub-Saharan Africa [13]. It is also used for bioethanol, sugar, syrup, and alcohol production [13] [14]. In Burkina Faso, it is primarily cultivated for its sweet stalk, which is chewed like sugarcane to extract the sweet juice [15]. All of these uses can be achieved while preserving grain and forage production, which are important for human and animal nutrition [16]. Despite the nutritional and socio-economic benefits of sweet stalk sorghum, its production remains marginal in Burkina Faso when compared to other major food and cash crops, especially grain sorghum [17]. It is underutilized by the population, and its cultivation is still limited to small areas, notably in household fields [17]. One of the main constraints to the expansion of sweet stalk sorghum production is its limited use due to the lack of knowledge about its potential, although recent studies have shown genetic diversity [17], indigenous knowledge related to this crop [17] [18], and its relationships with other types of sorghum cultivated in Burkina Faso [17]-[20]. The conservation, maintenance, and valorization of this minor crop could be achieved through a better understanding of its agronomic and socio-economic potential, as well as future opportunities for selection and genetic improvement of this species. Hence, the purpose of this literature review is to (i) highlight the benefits of sweet stalk sorghum, particularly the local knowledge, its

genetic diversity, and its significance and (ii) propose strategies for varietal improvement for its valorization in Burkina Faso.

## 2. Methodology

This review focuses on the exploitation of research work primarily conducted on sweet stalk sorghum in Burkina Faso. The main documents utilized were Master's theses, Advanced Studies Diploma (ASD) theses, Doctoral theses, and scientific articles. These various works were analyzed in order to establish an overview and provide a critical analysis of the main findings on sweet stalk sorghum. In addition, some lines and/or areas of research on this plant genetic resource that have not yet been tackled or have been very little explored were presented in the form of perspectives.

## 3. Results

### 3.1. Genetic and Ethnobotanical Characteristics

#### 3.1.1. Genetic Characteristics

Sweet stalk sorghum, like other cultivated types of sorghum, is an annual monocotyledonous plant belonging to the *Poaceae* family, the genus *Sorghum*, and the species *bicolor* [21]. It is a diploid species with a base chromosome number of  $n = 10$  [22]. Sweet stalk sorghum in Burkina Faso constitutes a pool of important genes [17]. Indeed, various collection expeditions have led to the establishment of a collection of 125 sweet stalk sorghum accessions. Genetic diversity studies using 28 SSR (Simple Sequence Repeat) markers have allowed the structuring of these accessions into six genetic groups. Botanical characterization, however, identified three main races within the germplasm: *Bicolor* (56.8%), *Caudatum* (19.2%) and *Durra* (16%), along with an intermediate race, *Guinea-Bicolor* (5.6%). This indicates significant racial diversity compared to sweet grain sorghum, which belongs to a single main race, *Caudatum*, and two intermediate races, *Caudatum-Guinea* and *Guinea-Bicolor*. Genetic relationship studies between cultivated sorghum types, conducted by [16], revealed no specific relationship between sweet stalk sorghum and botanical races. The comparison between accessions from Burkina Faso, Mali, and Niger showed significantly high values for the genetic differentiation index ( $F_{ST}$ ). It was 0.07 between accessions from Burkina Faso and Niger, 0.13 between those from Burkina Faso and Mali, and 0.25 between accessions from Niger and Mali [17]. Thus, genetic differentiation is twice as high between sweet stalk sorghum accessions from Niger and Mali as between those from Burkina Faso and Mali.

#### 3.1.2. Ethnobotanical Characteristics

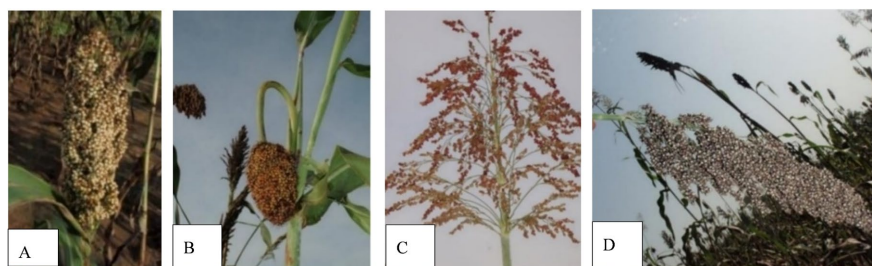
Ethnobotanically, sweet stalk sorghum is primarily cultivated by the Dafing and Bwaba ethnic groups in the Northwest of the country, the Gourmantché in the East, and the Mossi in the Central-North and North regions. According to [17], genetic diversity ( $H_e$ ) and allelic richness ( $R_s$ ) vary significantly between the dif-

ferent ethnic groups. The highest values of genetic diversity ( $He > 0.6$ ) were found among the Mossi and Gourmantché, while the lowest genetic diversity ( $He = 0.46$ ) was observed among the Bwaba. Allelic richness also varies significantly between ethnic groups, except for the Bwaba and Dafing. Furthermore, the significant differences ( $P < 5\%$ ) observed between the Bwaba and Mossi groups, and between the Bwaba and Gourmantché groups, suggest that the accessions cultivated by the Bwaba are genetically distinct from those of the other ethnic groups. In contrast, the Mossi, Gourmantché, and Dafing ethnic groups cultivate genetically similar accessions. Various names for sweet stalk sorghum have been recorded in Burkina Faso during ethnobotanical surveys [15]. The most common names are linked to the sweet taste of the stalk, such as “*kankansiido*” in Mooré language and “*kalat-im*” in Dioula language. The genetic distance between the accessions held by these ethnic groups was low, with a global  $F_{ST}$  differentiation index of 0.069 [17].

## 3.2. Morphology and Physiology

### 3.2.1. Morphology

The sweet stalk sorghum from Burkina Faso contains significant agro-morphological diversity [15]. Agro-morphological characterization studies of sorghum types in Burkina Faso have revealed that sweet stalk sorghum is the most morphologically diverse [20]. Indeed, the panicles of this sorghum exhibit a wide variety of shapes, ranging from loose, semi-loose, semi-compact to compact (Figure 1). The panicle posture [15] [18] can be erect (89.24%) or cross-shaped (10.26%), compared to sweet grain sorghum and dye sorghum, which only have erect panicles [8] [9] [15].

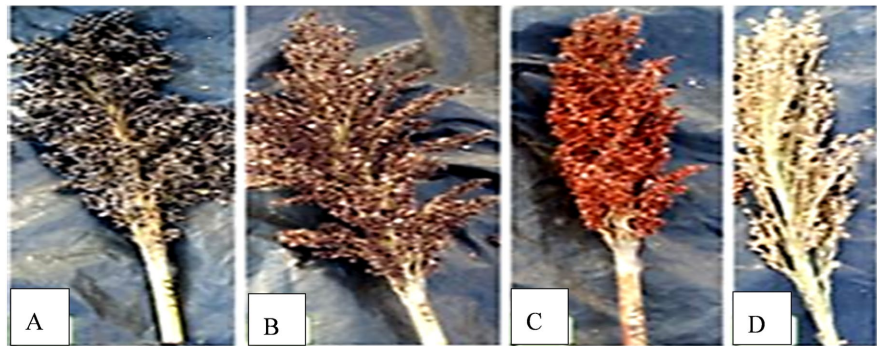


(A) Compact panicle; (B) Compact panicle with cross-shaped peduncle; (C) Loose panicle; (D) Semi-loose panicle.

**Figure 1.** Types of panicles of sweet stalk sorghum [15].

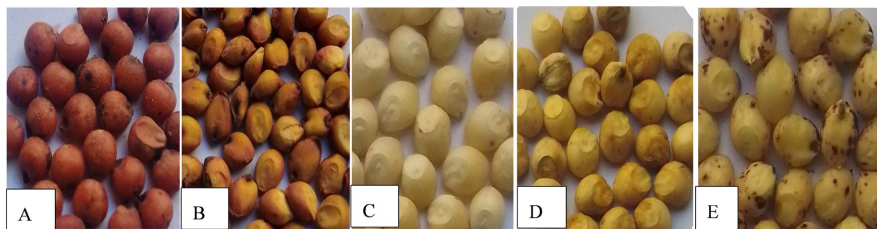
The color of the glumes in sweet stalk sorghum is also varied. According to [20] and [23], the sweet stalk sorghum from Burkina Faso exhibits glumes in various colors, including black, brown, red, and straw (Figure 2).

The characterization of the grains from different genotypes of sweet stalk sorghum also revealed a variability in grain colors [23] [24]. The grains are dark red, light red, white, off-white, and speckled white (Figure 3). However, white, off-white, and speckled white grains are not observed in sweet grain sorghum and dye sorghum, which only have red and gray grains [8] [24].



(A) Black glume; (B) Brown glume; (C) Red glume; (D) Straw glume.

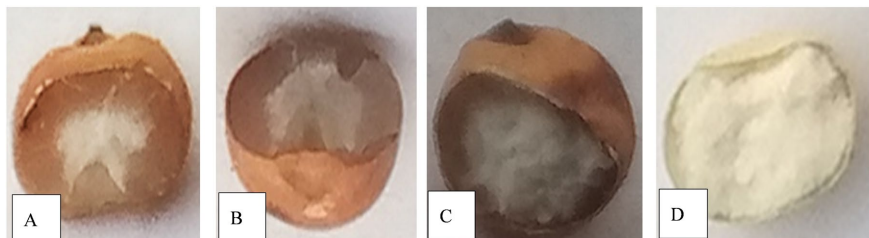
**Figure 2.** Different types of glume colors of sweet stalk sorghum [20].



(A) Dark red grains; (B) Light red grains; (C) White grains; (D) Off-white grains; (E) Speckled white grains.

**Figure 3.** Colors of the grains of sweet stalk sorghum [23] [24].

The evaluation of grain endosperm texture, based on the [25] scale (9 = fully starchy, 7 = predominantly starchy, 5 = intermediate, 3 = predominantly horny, and 1 = fully horny), revealed considerable variability within sweet sorghum. Specifically, [26] found that 36.32% of the genotypes exhibited 50% starchy texture (**Figure 4(B)**), 35.90% displayed 75% starchy texture (**Figure 4(C)**), 17.95% showed 100% starchy texture (**Figure 4(D)**), and 9.83% had 25% starchy texture (**Figure 4(A)**). Unlike sweet grain sorghum, which is composed exclusively of starchy grains, sweet sorghum features genotypes with vitreous endosperm textures, a trait that is distinctive of its use in the preparation of “*tô*”.

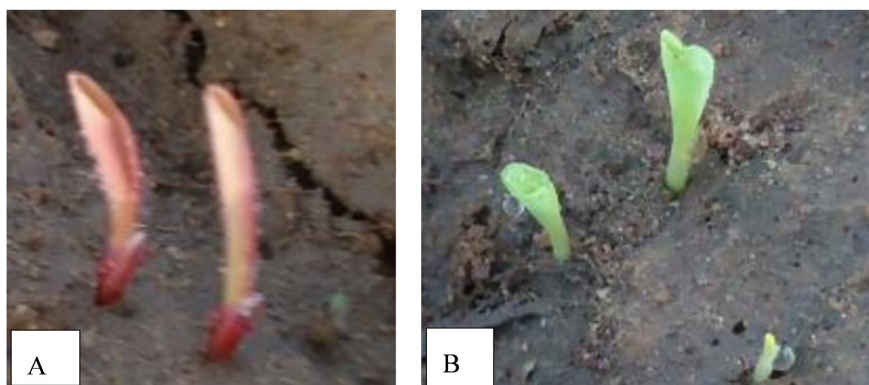


(A) 25% floury; (B) 50% floury; (C) 75% floury; (D) 100% floury.

**Figure 4.** Endosperm texture of grains in sweet stalk sorghum [26].

The observation of the coloration of the seedlings color at the juvenile stage by [11] revealed two modalities (**Figure 5**). Indeed, sweet stalk sorghum seedlings are

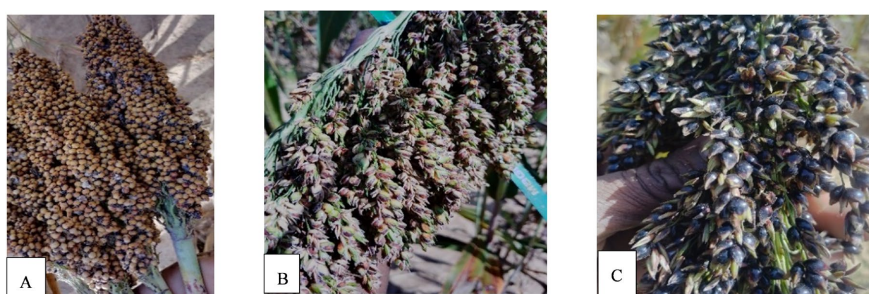
light green (30.77%) and predominantly red-violet (69.23%), in contrast to sweet grain sorghum, where light green seedlings are dominant [9]. Furthermore, observation of the central vein color showed that certain genotypes (82.91%) of sweet stalk sorghum exhibit central veins of a green-matte color, which is characteristic of the digestibility and juiciness of the stalks in these genotypes [15] [24].



(A) Red-violet seedlings; (B) Light green seedlings.

**Figure 5.** Color of sweet stalk sorghum seedlings [11].

The determination of botanical types revealed variability and specificity in the degree of grain coverage in sweet stalk sorghum. In addition to the different degrees of coverage (1/4, 2/4, and 3/4) by the glumes (**Figure 6(A)** and **Figure 6(B)**), observed in other cultivated [3] [9], 22.22% of sweet stalk sorghum genotypes exhibit grains that are fully covered (4/4) by the glumes. Genotypes with closed glumes (**Figure 6(C)**) are commonly referred to as “*blind sorghum*” by local populations [17]. These genotypes belong to the *Bicolor* race and are genetically distinct from other *Bicolor* genotypes, with a genetic differentiation ( $F_{ST} = 0.306$ ). They exhibit low expected heterozygosity ( $H_e = 0.31$ ) and low allelic richness ( $R_s = 3.00$ ) compared to other *Bicolor* genotypes with shorter glumes ( $H_e = 0.58$ ;  $R_s = 5.16$ ).



(A) Fully covered grains; (B) Semi-covered grains; (C) Poorly covered grains.

**Figure 6.** Degrees of grain coverage [23].

### 3.2.2. Physiology

The physiology of a plant represents a series of quantitative and qualitative changes that enable the acquisition of new functions and new organs by the plant

[27]. Like other types of sorghum, the physiological cycle of sweet stalk sorghum includes a vegetative phase, a reproductive phase, and a grain filling and maturation phase [28]. The vegetative phase is characterized by the development and growth of the plant's vegetative structures, namely the roots, main stalk, leaves, and tillers. The reproductive phase of sorghum is the period during which the reproductive structures of the plant (panicles and flowers) are formed. The grain filling and maturation phase corresponds to the development of the grain, which passes through the milky, dough, and finally the physiological maturity stages. During the physiological development cycle, sweet stalk sorghum accumulates significant amounts of sugar in the stalk and becomes juicy starting from flowering [29]. According to [30], the sugar concentration in different genotypes varies depending on the developmental stage and the position of the internodes. [30] showed that Brix is positively correlated with height ( $r = 0.37$ ) and peduncle length ( $r = 0.43$ ). The sugar accumulation process in the stalks, driven by photosynthesis, occurs continuously and continues until harvest as long as the leaves remain green. According to [17], some sweet stalk sorghum genotypes in Burkina Faso stay green until harvest. Furthermore, sweet stalk sorghum genotypes are sensitive to photoperiod, which allows them to adjust the duration of the sowing-to-flowering cycle. In fact, photoperiod sensitivity reduced the sowing-to-flowering cycle by 1 to 21 days in sweet stalk sorghum genotypes [31].

### 3.3. Agronomic Characteristics

The production of sweet stalk sorghum in Burkina Faso remains relatively limited and confined to small areas around households [17]. However, this crop is integrated into the program of the Genetics and Plant Breeding Team at Joseph KI-ZERBO University, convinced of the importance of conserving and promoting underutilized species. The prospecting and collection conducted by [11] revealed that sweet stalk sorghum is predominantly (52.8%) produced in the Sub-Saharan agroecological zone of Burkina Faso. When it is grown for chewing, it is cultivated alongside other cereals such as maize, millet, and ordinary grain sorghum [32] and produced in monoculture when grown for forage [17]. Sowing occurs at the beginning of the season (June-July).

The estimation of sugar content in the genotypes revealed an average sugar concentration of 12.96% at the milky grain stage, 13.70% at the dough stage, and 17.36% at maturity. At the flowering stage, Brix is multiplied by 4 in the first internode and by 7 in the fifth internode [33] at grain maturity. [30] studies revealed that the high Brix values obtained at the hard grain stage are linked to a continuous accumulation of sugar and a reduction in the amount of juice in the stalk during maturity. Furthermore, *Bicolor* genotypes particularly exhibit high Brix values with an average value of 19.27% [15].

Sugar content is positively correlated with grain yield, which shows significant variation, ranging from 5.42 g to 79.61 g per plant [17]. As for forage yield, it ranged from 247.92 g/stalk to 464.69 g/stalk. The genotypes with high biomass

and a semi-late flowering cycle (80.38 days) belong to the *Durra* race, while those with low biomass (14) and higher grain yield (50.25 g/plant) come from the *Caudatum* race [15].

### 3.4. Uses of Sweet Stalk Sorghum

Sweet stalk sorghum is a versatile crop grown for its grain and sugar-rich stalks. In Burkina Faso, its stalk is primarily consumed as a treat (chewing stalk), chewed (Figure 7(A) and Figure 7(B)) like sugarcane to extract the sugar juice [9] [34]. In addition to this specific use, surveys with farmers revealed that the grains of sweet stalk sorghum can be used as a base substrate for the preparation of “*tô*”, local beer “*dolo*”, and porridge, similar to ordinary sorghum. Industrial by-products, such as bagasse (Figure 7(C)), after juice extraction, can be used as organic fertilizer or forage. The stalks and leaves are also used as forage for livestock feed.



(A) Chewing stalk; (B) Juice extraction; (C) Bagasse used as fertilizer or forage.

**Figure 7.** Various uses of sweet stalk sorghum [9].

### 3.5. Perspectives for Selection and Varietal Improvement

#### 3.5.1. Sustainable Management of Genetic diversity

In-situ conservation plays a crucial role in protecting local varieties of crops [35]. Indeed, varieties in their environment develop characteristics that allow them to adapt to changing climatic conditions. [36] reported that the outcrossing rate ranges from 3% to 31% in sorghum. This phenomenon, which results in gene flow and genetic introgression between different sorghum variants cultivated in agroecosystems [37], contributes to evolutionary adaptation. Furthermore, gene flow may lead to the regression of certain traits of interest. This is the case for the sweet taste, governed by a biallelic gene with a dominance effect. The recessive allele “su” codes for a sweet flavor, while the dominant allele “Su” codes for a non-sweet flavor [38]. Thus, gene flow between a sweet-stalk genotype and a non-sweet-stalk genotype, as seen in grain sorghum, could lead to the loss of the sweet flavor. However, there is no data on the relationship between genetic diversity and the outcrossing rate in sweet stalk sorghum in Burkina Faso. It is therefore necessary to assess the factors that jointly influence the maintenance of the variability of agro-morphological traits and their genetic diversity, particularly the outcrossing rate of the species. This will provide a foundation for variety creation and in-situ conservation of sweet stalk sorghum.

### 3.5.2. Source of Forage Production

The reduction of natural pastures has led livestock farmers to adopt semi-intensive farming systems, relying on forage crops to feed the cattle. This requires the intensification of forage crop production and the management of water during the dry season [39]. In this context, the leaves and stalks of sweet-stalk sorghum could contribute significantly. Indeed, the good protein content and high digestibility of sweet-stalk sorghum promote the growth and productivity of livestock [40]. Moreover, the work of [41] revealed that some sweet-stalk sorghum genotypes have a biomass yield 25.8% higher than the forage sorghums used in Sudan. In Burkina Faso, characterization studies allowed [17] to identify nine high-biomass sweet-stalk sorghum accessions (464.59 g/plant) and 14 high-grain-yielding sweet-stalk sorghum accessions (50.25 g/panicle). These accessions of sweet-stalk sorghum therefore represent a reservoir of promising genotypes for the development of forage varieties.

### 3.5.3. Source of Biofuel Production

The growing demand for energy has led to a drastic reduction in fossil resources and accelerated climate change due to greenhouse gas emissions [42]. Energy security has therefore become a major concern, prompting research to explore alternative energy sources [43]. In this context, it is imperative to adopt policies aimed at reducing the use of fossil fuels [44]. In this regard, ethanol production from lignocellulosic materials emerges as an effective strategy to mitigate global warming while enhancing energy security [14]. Due to its high biomass production potential and sugar accumulation, sweet stalk sorghum stands out as a promising bioenergy crop [45]. Biofuel is produced from the juice or biomass of sweet stalk sorghum [29] in developed countries such as the United States and Canada. According to [33], between 342 and 1,210 liters of ethanol per hectare of sweet stalk sorghum can be obtained. Thus, the high Brix content of certain sweet stalk sorghum genotypes from Burkina Faso could represent a feasible opportunity for biofuel production, reducing Burkina Faso's dependence on fossil fuels.

### 3.5.4. Source of Drought Tolerance Genes

Sorghum is one of the cereal crops that adapts well to marginal soils and low rainfall conditions. However, drought caused by progressive global climate change affects crop performance due to insufficient moisture to support plant growth until maturity. Drought tolerance is the plant's ability to maintain its physiological activities despite water deficit. To achieve this, it develops physiological, morphological, and biochemical mechanisms. The ability to maintain leaf greenness or "stay green" is a trait that enhances photosynthesis for energy and nutrient production in sorghum grown in semi-arid areas. According to [46], this trait is positively correlated with grain yield and varies between varieties. The work of [17] revealed that sweet stalk sorghum retains its green leaves at maturity. Thus, the "stay-green" trait in sweet sorghum constitutes a potential for valorizing this crop in contrasting areas and can even be introgressed into other types of sorghum to

develop genotypes suited for the arid regions of Burkina Faso. Therefore, the collection of sweet sorghum from Burkina Faso represents a valuable genetic resource for sorghum improvement.

### 3.5.5. Crop Production Systems

[47] defined the cropping system as the set of technical routes and cultural practices implemented to achieve production objectives. Most agronomic research on sorghum has focused on the development of agricultural techniques and practices for grain production. However, forage production and dual-purpose use (grain and forage) are increasingly being addressed [3] [48] [49]. Nevertheless, research on sweet sorghum is scarce, if not nonexistent. Very little information is available to date on the productivity and cultural techniques associated with sweet sorghum cultivation. However, it is well established that variations in cultural techniques and practices, particularly fertilizer application rates, can influence grain and/or forage (straw) yield of cereals [49] [50]. Indeed, fertilization is a critical aspect in the production and valorization of plant resources. Furthermore, soils in most tropical regions of Africa exhibit low fertility levels [51], while the food needs of the population continue to grow [52] [53]. Thus, in addition to diversifying its uses, better valorization of this minor crop could be achieved through proper identification and management of fertilization.

### 3.5.6. Management of Biotic Threats Related to Brix Quality in Burkina Faso

40 genera of fungi, with the most important being *Aspergillus*, *Fusarium*, *Curvularia*, *Phoma*, *Penicillium*, and *Colletotrichum* [54]-[56]. Studies conducted by [57] have shown that sweet grain sorghum is attacked by *Bipolaris sp.*, *Curvularia lunata*, *Fusarium moniliforme*, *Phoma sorghina*, *Colletotrichum graminicola*, *Nigrospora oryzae*, and *Exserohilum sp.* However, these studies did not address the various biotic threats to sweet stalk sorghum in Burkina Faso. Nonetheless, pests associated with grain sorghum and sweet grain sorghum would represent a threat to the quality of sweet stalk sorghum. One such example is the anthracnose caused by *Colletotrichum sublineola*, which causes reddish internal lesions observed on mature stalks [58] [59]. This could compromise the quality of both forage and especially the Brix content in sweet stem sorghum. Therefore, investigations into anthracnose in sweet stalk sorghum are necessary to ensure the quality of the Brix.

### 3.5.7. Development of Molecular Marker

The genetic diversity of plants is a key component in selection, conservation, and evolution [60]. Selection based on agromorphological traits has greatly contributed to the improvement of sorghum to withstand various abiotic stresses, such as droughts [61]. Although morphological markers provide opportunities for direct observation of the phenotype, they have limitations as they are influenced by environmental factors [62]. The discovery of molecular markers in nuclear DNA, which are less affected by environmental variations, has thus opened a new era for selection. By enabling the tagging of specific genes, molecular markers enhance

the management and manipulation of genetic variability to select genotypes with an increasing number of favorable genes or gene associations. As a result, several molecular tests have been developed to complement conventional selection approaches. These range from protein-based markers to DNA-based markers, including isozymes [1] [63]. SSR markers have already been used in diversity studies of sweet sorghum [16] [17]. However, analyses based on SNP markers allow for the precise characterization and description of an entire species' genome, enabling the detection of genes responsible for agronomically important traits [64]. The development of SNP markers could contribute to the study of genetic determinism and a better understanding of the quantitative traits of agronomic interest in sweet sorghum, such as Brix.

#### 4. Discussion

A critical analysis of the results from previous studies and the challenges faced by the breeding program for neglected crops such as sweet sorghum in Burkina Faso is essential for their valorization. Supported by the scientific community and international policies, initiatives have been set up to collect and preserve the genetic resources of sweet sorghum in local germplasm banks. Indeed, most breeding programs begin with the prospection and establishment of germplasm collections, which are crucial steps for the conservation of species at risk of extinction [65]. In Burkina Faso, the Plant Genetics and Breeding Team is conducting studies to promote and preserve underutilized species from the threat of genetic erosion. In fact, sustainable management of genetic resources is essential to ensuring food security, particularly in arid and semi-arid areas. The large number of accessions collected and the cultivation area [17] demonstrate that sweet sorghum is an important crop for the predominantly rural population. It is a heritage for Burkinabe farmers, cultivated for centuries by various ethnic groups [17]. This raises the question of its efficient use in selection. Indeed, food security depends on the sustainable management of genetic resources of available species, particularly those on which populations in arid and semi-arid areas rely. This requires an understanding of the genetic structure and variation between individuals from different collections [66]. Various morphological and molecular markers have been used to determine the genetic diversity and structure of sweet sorghum populations. Morphological markers, which refer to phenotypic traits visible to the naked eye [65] [67], are traditionally used in germplasm management. The use of these markers has revealed significant genetic diversity and a large reservoir of agronomically important traits observed within the sweet sorghum collection [17]. The various characterizations have highlighted the potential for Brix production in sweet sorghum from Burkina Faso. The high Brix levels observed in certain genotypes could be exploited for the production of industrial products such as sugar, starch, fiber, biofuel, syrup, and ethanol [13] [68]. Furthermore, the bagasse left after juice extraction could serve as an energy source [69]-[71]. Additionally, the leaves and stalks of sweet sorghum provide high-quality forage. According to [40] and

[72], silage derived from sweet sorghum biomass is particularly palatable due to its high sugar and protein content. Thus, high-yielding forage genotypes identified by [17] could meet the needs of intensive livestock farming. However, sorghum is still primarily used for human consumption through the preparation of local dishes in Burkina Faso. Studies by [3] and [73] justified the large-scale production of grain sorghum, mostly of the Guinea race, due to its high vitreousness and white grain color, qualities required in culinary traditions. The variation in grain appearance observed makes sweet sorghum one of the most promising species for achieving food security and balance in developing countries. White grain varieties are particularly suited for common dishes, while red grain varieties are better for brewing and local beer. The variability in panicles, especially among different races of sweet sorghum, could also be an asset. This is exemplified in grain sorghum, where inter-racial crosses have recombined favorable traits for adaptation, productivity, and grain quality in the progeny [74]. Thus, crosses between *Guinea* and *Caudatum* lines in sweet sorghum are preferred for achieving productivity and grain quality objectives, leading to better valorization of this sorghum. However, genotypes from the *Bicolor* race with closed glumes are not ideal in terms of culinary quality. Indeed, a good variety should have grains that are easy to mill by women, not easily crushed to minimize losses with the husk, and provide white flour [74]. These genotypes, however, serve as ideotypes for selecting varieties resistant to grain diseases and pests [75]. Given the many advantages of this crop, efficient management of the genetic reservoir and the conservation of a broad gene diversity are crucial for selecting favorable traits. In the face of growing agricultural challenges such as drought, many countries, particularly in Africa and India, have recognized the need to create new lines and exploit heterosis through hybridization. Thus, the creation of new adapted varieties requires integrating local cultivars into breeding programs. The resilience of sweet sorghum to harsh climatic conditions makes it a promising crop in drought-prone regions [76], particularly in Burkina Faso, where this species represents a potential solution to food security challenges related to climate change. The photoperiod sensitivity of sweet sorghum would allow it to adapt to climatic variations by synchronizing its flowering period with the end of the rainy season [20]. This is not the case for photoperiod-insensitive varieties, which require fixed sowing dates [77] [78]. This adaptability of sweet sorghum to the climate could increase the resilience of farmers to the recurring climatic changes in recent years. The work of [49] revealed a 60% monomorphism rate between regular grain sorghum, sweet grain sorghum, and sweet stalk sorghum, suggesting a strong maternal relationship among the different types of sorghum and opening up the possibility of hybridization to recombine traits of interest. This is the case with the SOUMBATIMI variety, which results from the cross between Malian grain sorghum and sweet stalk sorghum [79] and Sarioso 15, a dual-purpose variety [80]. Crosses have demonstrated that high Brix and sucrose levels are dominant traits in sweet sorghum. The distribution of genotypes in the F<sub>2</sub> generation and backcrosses sug-

gests a case of polygeny with epistatic interactions [81]. Although advances have been made in agricultural research, they do not guarantee long-term food security in the face of ongoing environmental changes. Sustainable management of genetic resources and adaptation to climatic variations remain ongoing challenges to ensure long-term food security.

## 5. Conclusion

The sweet stalk sorghum is a versatile cultivar, produced not only for its use in human and animal nutrition, but also as a significant source of biofuel, sugar, and syrup. In addition to its multiple applications, it is particularly valued for its drought tolerance, making it a key crop for food security and the resilience of farming communities facing climatic challenges. Burkina Faso boasts a rich genetic diversity of sweet stalk sorghum, a valuable phylogenetic resource for varietal improvement. This diversity could facilitate the development of varieties better adapted to climatic variations, thereby strengthening the strategic role of sorghum in sustainable agriculture and food security in Burkina Faso.

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## Conflicts of Interest

The authors declare no conflict of interest.

## References

- [1] Zongo, J.D. (1991) Ressources génétiques des sorghos [*Sorghum bicolor* (L.) Moench] du Burkina Faso: Evaluation agro-morphologique et génétique. Université d'Abidjan, 175 p.
- [2] Chantreau, J., Cruz, J.-F., Ratnadass, A., Trouche, G. and Fliedel, G. (2013) Le sorgho. Editions Quae, 245 p. <https://doi.org/10.35690/978-2-7592-2062-5>
- [3] Barro-Kondombo, C.P. (2010) Diversités agro-morphologique et génétique de variétés locales de sorgho (*Sorghum bicolor* [L.] Moench) du Burkina Faso. Eléments pour la valorisation des ressources génétiques locales. Thèse d'état, Université de Ouagadougou, 136 p.
- [4] Tondé, W.H., Sawadogo, N., Sawadogo, P. and Sawadogo, M. (2023) Genetic Diversity, Importance and Prospects for Varietal Improvement of Sweet Grain Sorghum in Burkina Faso. *International Journal of Zoology and Applied Biosciences*, **8**, 44-52. <https://doi.org/10.55126/ijzab.2023.v08.i01.007>
- [5] Lyumugabe, F., Gros, J., Nzungize, J., Bajyana, E. and Thonart, P. (2012) Characteristics of African Traditional Beers Brewed with Sorghum Malt: A Review. *Biotechnologie, Agronomie, Société et Environnement*, **16**, 509-530.
- [6] Songre-Ouattara, L.T., Kabore, R., Kam, J.M., Konkobo-Yameogo, C., Ouedraogo, J. and Trouche, G. (2016) Quelles variétés de sorgho pour satisfaire les exigences des productrices de malt et de dolo au Burkina Faso? *Journal of Applied Biosciences*, **106**, 10286-10299. <https://doi.org/10.4314/jab.v106i1.9>

- [7] Balole, T.V. and Legwaila, G.M. (2006) *Sorghum bicolor* (L.) Moench. In: PROTA, Éd., *Ressources végétales de l'Afrique tropicale 1: Céréales et légumes secs*, Wageningen, 187-197.
- [8] Nandkangré, H. (2009) Caractérisation agro-morphologique et biochimique de quelques écotypes de sorgho teinturier [*Sorghum bicolor* (L.) Moench] de la région du Centre-Nord du Burkina Faso. Mémoire de DEA, Université de Ouagadougou, 50 p.
- [9] Sawadogo, N. (2015) Diversité génétique des sorghos à grains sucrés [*Sorghum bicolor* (L.) Moench] du Burkina Faso. Ph.D. Thesis, Université de Ouagadougou, 182 p.
- [10] Anglani, C. (1998) Sorghum for Human Food—A Review. *Plant Foods for Human Nutrition*, **52**, 85-95. <https://doi.org/10.1023/a:1008065519820>
- [11] Nebié, B. (2009) Étude de la variabilité agromorphologique de quelques écotypes de sorghos sucrés [*Sorghum bicolor* (L.) Moench] du Burkina Faso. Mémoire de DEA, Université de Ouagadougou.
- [12] Shukla, S., Felderhoff, T.J., Saballos, A. and Vermerris, W. (2017) The Relationship between Plant Height and Sugar Accumulation in the Stems of Sweet Sorghum (*Sorghum bicolor* (L.) Moench). *Field Crops Research*, **203**, 181-191. <https://doi.org/10.1016/j.fcr.2016.12.004>
- [13] Dube, F. and Maphosa, M. (2022) Significance of Sweet Sorghum as a Multi-Purpose Crop for Sub-Saharan Africa. *African Crop Science Journal*, **30**, 235-243. <https://doi.org/10.4314/acsj.v30i2.9>
- [14] El-Zawawy, W.K., Ibrahim, M.M., Abdel-Fattah, Y.R., Soliman, N.A. and Mahmoud, M.M. (2011) Acid and Enzyme Hydrolysis to Convert Pretreated Lignocellulosic Materials into Glucose for Ethanol Production. *Carbohydrate Polymers*, **84**, 865-871. <https://doi.org/10.1016/j.carbpol.2010.12.022>
- [15] Nebie, B., Nanema, R., Bationo-Kando, P., Traore, E., Labeyrie, V., Sawadogo, N., et al. (2013) Variation de caractères agromorphologiques et du Brix d'une collection de sorghos à tige sucrée du Burkina Faso. *International Journal of Biological and Chemical Sciences*, **7**, 1919-1928. <https://doi.org/10.4314/ijbcs.v7i5.12>
- [16] Tiendrebéogo, J. (2020) Performances agronomiques, potentialités fourragères du sorgho grains sucrés [*Sorghum bicolor* (L.) Moench] et relation génétique avec les autres types de sorgho cultivés au Burkina Faso. Joseph KI-ZERBO, 162p.
- [17] Nebié, B. (2014) Diversité génétique des sorghos à tige sucrée [*Sorghum bicolor* (L.) Moench] du Burkina Faso. Thèse de Doctorat, Université de Ouagadougou, 118 p.
- [18] Tuina, S., Tiendrebéogo, J., Kiébré, M., Sawadogo, N. and Nanema, R.K. (2023) Farmers' Perception of Phenotypic Variation of Different Types of Sorghum Cultivated in Burkina Faso. *American Journal of Plant Sciences*, **14**, 1085-1100. <https://doi.org/10.4236/ajps.2023.1410074>
- [19] Tiendrebéogo, J., Sawadogo, N., Kiendrebéogo, T., Kiébré, Z., Sawadogo, B., Kiébré, M., et al. (2020) Réponse agro-morphologique de 14 génotypes de sorgho grains sucrés du Burkina Faso à la fertilisation minérale. *Journal of Applied Biosciences*, **145**, 14880-14881. <https://doi.org/10.35759/jabs.v145.4>
- [20] Sawadogo, N., Tiendrebéogo, J., Naoura, G., Béré, T.L.K., Tondé, W.H., Sawadogo, B., et al. (2022) Photoperiod Sensitivity and Variability of Agromorphological Traits and Brix Content of Sweet Sorghum Cultivated in Burkina Faso under Two Sowing Dates. *Advances in Agriculture*, **2022**, Article ID: 9504150. <https://doi.org/10.1155/2022/9504150>
- [21] Mathews, S., Spangler, R.E., Mason-Gamer, R.J. and Kellogg, E.A. (2002) Phylogeny of Andropogoneae Inferred from Phytochrome B, GBSSI, and *ndhF*. *International*

*Journal of Plant Sciences*, **163**, 441-450. <https://doi.org/10.1086/339155>

- [22] Doggett, H. (1988) Sorghum. 2nd Edition, Wiley, 512 p.
- [23] Yaméogo, N. (2021) Evaluation comparative de la variabilité agro-morphologique et du brix de trois types (ou variants) de sorghos [*Sorghum bicolor* (L.) Moench] cultivés au Burkina Faso. Mémoire de Master, Université Joseph KI-ZERBO, 60 p.
- [24] Sévérin, T., Josiane, T., Romaric, K.N. and Nerbéwendé, S. (2024) Phenotypical Variability of Four Types of Sorghum Cultivated in Intercropping Conditions in Two Agroclimatic Areas of Burkina Faso Based on Qualitative Traits. *African Journal of Agricultural Research*, **20**, 588-606. <https://doi.org/10.5897/ajar2024.16657>
- [25] IBPGR and ICRISAT (1993) Descriptors for Sorghum [*Sorghum bicolor* (L.) Moench]. International Crops Research Institute for the Semi-Arid Tropics.
- [26] Berthé, S., Tiendrébéogo, J., Tonde, W.H. and Sawadogo, N. (2024) Variabilité morphologique du sorgho à tige sucrée au Burkina Faso: Perspective d'amélioration et de valorisation. *Colloque de la Société Africaine de Génétique section Burkina Faso*, Ouagadougou, 13-15 Novembre 2024, 222.
- [27] Heller, R., Esnault, R. and Lance, C. (1985) Physiologie végétale. 2: Développement. Masson, 215 p.
- [28] Chantereau, J. and Nicou, R. (1991) Le sorgho. Maisonneuve et Larose, 159 p.
- [29] Ratnavathi, C.V. and Chavan, U.D. (2016) Sorghum Syrup and Other by Products. In: Ratnavathi, C.V., Patil, J.V. and Chavan, U.D., Eds., *Sorghum Biochemistry*, Elsevier, 253-310. <https://doi.org/10.1016/b978-0-12-803157-5.00005-8>
- [30] Sawadogo, B. (2013) Étude de la variabilité morphologique et biochimique de sorghos à tiges sucrées [*Sorghum bicolor* (L.) Moench] de la zone soudanienne du Burkina Faso. Mémoire de DEA, Université de Ouagadougou, 49p.
- [31] Sawadogo, N., Drabo, I., Ouédraogo, N., Tondé, W.H., Béré, T.L.K., Tiendrébéogo, J., *et al.* (2023) Heritability, Genetic Advance, and Correlation Studies of Morpho-Agronomic Traits and Brix in Burkina Faso Sweet Stalk Sorghum Genotypes. *Journal of Applied Biology & Biotechnology*, **11**, 50-57. <https://doi.org/10.7324/jabb.2023.110325>
- [32] Barnaud, A. (2007) Savoirs, pratique et dynamique de la diversité génétique : le sorgho (*Sorghum bicolor* ssp. *bicolor*) chez les Duupa du Nord Cameroun. Thèse de Doctorat, Université de Montpellier II, 320 p.
- [33] Chavan, U.D., Patil, J.V. and Shinde, M.S. (2009) An Assessment of Sweet Sorghum Cultivars for Ethanol Production. *Sugar Tech*, **11**, 319-323. <https://doi.org/10.1007/s12355-009-0056-y>
- [34] Naoura, G., Emendack, Y., Baloua, N., vom Brocke, K., Hassan, M.A., Sawadogo, N., *et al.* (2020) Characterization of Semi-Arid Chadian Sweet Sorghum Accessions as Potential Sources for Sugar and Ethanol Production. *Scientific Reports*, **10**, Article No. 14947. <https://doi.org/10.1038/s41598-020-71506-9>
- [35] Juliana, S. (2012) L'agrobiodiversité, vers des instruments de protection innovants. *Apprendre à innover dans un monde incertain: Concevoir les futurs de l'agriculture et de l'alimentation*, Éditions Quæ, 155.
- [36] Ollitrault, P. (1987) Evaluation génétique des sorghos cultivés (*Sorghum bicolor* L. Moench) par l'analyse conjointe des diversités enzymatique et morphophysologique. Relations avec les sorghos sauvages. Thèse de Doctorat, Université Paris XI, 187p.
- [37] Sagnard, F., Deu, M., Dembélé, D., Leblois, R., Touré, L., Diakité, M., *et al.* (2011) Genetic Diversity, Structure, Gene Flow and Evolutionary Relationships within the Sorghum Bicolor Wild-Weedy-Crop Complex in a Western African Region. *Theoreti-*

- cal and Applied Genetics*, **123**, 1231-1246.  
<https://doi.org/10.1007/s00122-011-1662-0>
- [38] House, L.R. (1987) Manuel pour la selection du sorgho (2ème édit.). ICRISAT-Patancheru, 229 p.
- [39] Leclerc, E., Pressoir, G. and Braconnier S. (2014) L'avenir prometteur du sorgho sucré. *Field Actions Science Reports*, 9 p.
- [40] Whitfield, M.B., Chinn, M.S. and Veal, M.W. (2012) Processing of Materials Derived from Sweet Sorghum for Biobased Products. *Industrial Crops and Products*, **37**, 362-375. <https://doi.org/10.1016/j.indcrop.2011.12.011>
- [41] Mohammed, M.I. and Mohamed, M.A. (2009) Evaluation of Newly Developed Sweet Sorghum (*Sorghum bicolor*) Genotypes for Some Forage Attributes. *American-Eurasian Journal of Agricultural & Environmental Sciences*, **6**, 434-440.
- [42] Belle, E.M.S., Burgess, N.D., Misrachi, M., Arnell, A., Masumbuko, B., Somda, J., et al. (2016) Impacts du changement climatique sur la biodiversité et les aires protégées en Afrique de l'Ouest, Résumé des résultats du projet PARCC, Aires protégées résilientes au changement climatique en Afrique de l'Ouest. UNEP-WCMC, 52 p.
- [43] Phoon, B.L., Lai, C.W., Juan, J.C., Show, P. and Pan, G. (2019) Recent Developments of Strontium Titanate for Photocatalytic Water Splitting Application. *International Journal of Hydrogen Energy*, **44**, 14316-14340.  
<https://doi.org/10.1016/j.ijhydene.2019.01.166>
- [44] Phwan, C.K., Ong, H.C., Chen, W., Ling, T.C., Ng, E.P. and Show, P.L. (2018) Overview: Comparison of Pretreatment Technologies and Fermentation Processes of Bioethanol from Microalgae. *Energy Conversion and Management*, **173**, 81-94.  
<https://doi.org/10.1016/j.enconman.2018.07.054>
- [45] Wortmann, C.S., Liska, A.J., Ferguson, R.B., Lyon, D.J., Klein, R.N. and Dweikat, I. (2010) Dryland Performance of Sweet Sorghum and Grain Crops for Biofuel in Nebraska. *Agronomy Journal*, **102**, 319-326.  
<https://doi.org/10.2134/agronj2009.0271>
- [46] Borrell, A.K., Mullet, J.E., George-Jaeggli, B., van Oosterom, E.J., Hammer, G.L., Klein, P.E., et al. (2014) Drought Adaptation of Stay-Green Sorghum Is Associated with Canopy Development, Leaf Anatomy, Root Growth, and Water Uptake. *Journal of Experimental Botany*, **65**, 6251-6263. <https://doi.org/10.1093/jxb/eru232>
- [47] Sebillotte, M. (1993) L'agronome face à la notion de fertilité. *Natures Sciences Sociétés*, **1**, 128-141. <https://doi.org/10.1051/nss/19930102128>
- [48] Thera, K. (2017) Analyse des déterminants génétiques contrôlant la production et la composition de la tige chez le sorgho (*Sorghum bicolor* [L.] Moench). Intégration des approches bi-et multi-parentales. These de doctoratn, Université Montpellier, 186 p.
- [49] Tiendrebéogo, J., Sawadogo, N., Kiébré, M., Kaboré, B., Bationo/Kando, P., Kiendrebéogo, T., Ouédraogo, M.H. and Sawadogo M. (2018) Evaluation comparative de la production de grains et du fourrage de sorgho à grains sucrés du Burkina Faso. *SPECIAL SIST2017 SNA2\_agrono27i*, **11**, 261-271.
- [50] Thivierge, M., Chantigny, M.H., Seguin, P. and Vanasse, A. (2015) Sweet Pearl Millet and Sweet Sorghum Have High Nitrogen Uptake Efficiency under Cool and Wet Climate. *Nutrient Cycling in Agroecosystems*, **102**, 195-208.  
<https://doi.org/10.1007/s10705-015-9689-2>
- [51] Vanlauwe, B., Bationo, A., Chianu, J., Giller, K.E., Merckx, R., Mokwunye, U., et al. (2010) Integrated Soil Fertility Management. *Outlook on Agriculture*, **39**, 17-24.  
<https://doi.org/10.5367/000000010791169998>

- [52] Dufumier, M. (2004). *Agricultures et paysanneries des Tiers mondes*. Karthala, 598 p. <https://doi.org/10.3917/kart.dufu.2004.01>
- [53] OCDE and FAO (2016) *Perspectives agricoles de l'OCDE et de la FAO 2016-2025*. OECD. [https://doi.org/10.1787/agr\\_outlook-2016-fr](https://doi.org/10.1787/agr_outlook-2016-fr)
- [54] Zida, P.E., Somda, I., Sérémé, P., Néya, A., Néya, J.B., Leth, V., Torp Ole, J. and Lunds, S. (2010) Les maladies fongiques transmises par les semences de sorgho au Burkina Faso: Importance, Méthodes de détection et moyens de lutte. *Bulletins Techniques, CNRST*, 39 p.
- [55] Sombda, I., Konaté, S., Ouédraogo, M.R., Kaboré, Y.E., Lankoandé, D.O., Coulibaly, T.O., Ouédraogo, K.A., Takahasi, J., Sato, M. and Kato, R. (2012) *Manuel Pathologie des semences*. PDSA, MAHRH, 77 p.
- [56] Bonzi, S. (2013) *Evaluation de la mycoflore des semences de sorgho et de Poaceae sauvages. Analyse de la variabilité des isolats de Phoma sorghina (Sacc.) Boerema Dorenbosch et Van Kest. et recherche de méthodes de lutte alternatives*. Thèse de doctorat unique, Université Polytechnique de Bobo-Dioulasso, 160 p.
- [57] Sanon, E., Dabiré, K., Bakiono, B., Boua, D., Tonde, W.H., Sawadogo, N. and Sankara, P. (2023) Parasitic Fungi of Sweet Grain Sorghum in Burkina Faso: Risks of Its Consumption in the Absence of Hygienic Rules. *Mycopath*, **20**, 57-64.
- [58] TAAT Clearinghouse (2022) *Catalogue de la Boîte à Outils des Technologies sur le Mil et Sorgho. Série de Rapports Techniques 014, Technologies pour la Transformation de l'Agriculture en Afrique*. Bureau de Coordination Technique, IITA, Vol. 6, 139 p.
- [59] Mekonen, M., Tesfaye, K., Mengiste, T., Chala, A., Nida, H., Mekonnen, T., et al. (2024) Pathotype Determination of Sorghum Anthracnose (*Colletotrichum sublineola*) Isolates from Ethiopia Using Sorghum Differentials. *Frontiers in Microbiology*, **15**, Article 1458450. <https://doi.org/10.3389/fmicb.2024.1458450>
- [60] Peterson, G., Dong, Y., Horbach, C. and Fu, Y. (2014) Genotyping-by-Sequencing for Plant Genetic Diversity Analysis: A Lab Guide for SNP Genotyping. *Diversity*, **6**, 665-680. <https://doi.org/10.3390/d6040665>
- [61] Anderson, J.A., Churchill, G.A., Autrique, J.E., Tanksley, S.D. and Sorrells, M.E. (1993) Optimizing Parental Selection for Genetic Linkage Maps. *Genome*, **36**, 181-186. <https://doi.org/10.1139/g93-024>
- [62] Tonde, W.H. (2023) *Caractérisation génétique et identification de sources de tolérance à la sécheresse du sorgho grains sucrés [Sorghum bicolor (L.) Moench] au Burkina Faso*. Thèse de Doctorat, Université Joseph KI-ZERBO.
- [63] Ollitrault, P., Arnaud, M. and Chantereau J. (1989) Polymorphisme enzymatique des sorghos 2-organisation génétique et évolutive des sorghos cultivés. *Agronomie Tropicale*, **44**, 211-222.
- [64] Santoni, S., Faivre-Rampant, P., Prado, E. and Prat, D. (2000) Marqueurs moléculaires pour l'analyse des ressources génétiques et l'amélioration des plantes. *Cahiers Agricoles*, **9**, 311-327.
- [65] Pernès, J. (1984) *Gestion des ressources génétiques des plantes*. Technique et documentation Lavoisier, 517 p.
- [66] Menz, M.A., Klein, R.R., Unruh, N.C., Rooney, W.L., Klein, P.E. and Mullet, J.E. (2004) Genetic Diversity of Public Inbreds of Sorghum Determined by Mapped AFLP and SSR Markers. *Crop Science*, **44**, 1236-1244. <https://doi.org/10.2135/cropsci2004.1236>
- [67] Maesen, L.J.G.V. (1990) *Pigeonpea: Origin, History, Evolution, and Taxonomy*. CAB International, 490 p.

- [68] Yucel, C. and Erkan M.E. (2020) Evaluation of Forage Yield and Silage Quality of Sweet Sorghum in the Eastern Mediterranean Region. *The Journal of Animal and Plant Sciences*, **30**, 923-930. <https://doi.org/10.36899/JAPS.2020.4.0108>.
- [69] Belayachi, L. and Delmas, M. (1995) Sweet Sorghum: A Quality Raw Material for the Manufacturing of Chemical Paper Pulp. *Biomass and Bioenergy*, **8**, 411-417. [https://doi.org/10.1016/0961-9534\(95\)00046-1](https://doi.org/10.1016/0961-9534(95)00046-1)
- [70] Jacques, P., Girault, E., Catlin, T., Geerlofs, N., Kop, T., van der Zwaag, S., et al. (1999) Bainite Transformation of Low Carbon Mn-Si TRIP-Assisted Multiphase Steels: Influence of Silicon Content on Cementite Precipitation and Austenite Retention. *Materials Science and Engineering: A*, **273**, 475-479. [https://doi.org/10.1016/s0921-5093\(99\)00331-7](https://doi.org/10.1016/s0921-5093(99)00331-7)
- [71] Sipos, B., Réczey, J., Somorai, Z., Kádár, Z., Dienes, D. and Réczey, K. (2008) Sweet Sorghum as Feedstock for Ethanol Production: Enzymatic Hydrolysis of Steam-Pre-treated Bagasse. *Applied Biochemistry and Biotechnology*, **153**, 151-162. <https://doi.org/10.1007/s12010-008-8423-9>
- [72] Eggleston, G., Cole, M. and Andrzejewski, B. (2013) New Commercially Viable Processing Technologies for the Production of Sugar Feedstocks from Sweet Sorghum (*Sorghum bicolor* L. Moench) for Manufacture of Biofuels and Bioproducts. *Sugar Tech*, **15**, 232-249. <https://doi.org/10.1007/s12355-013-0229-6>
- [73] Gapili, N. (2016) Étude de la diversité génétique et du photopériodisme d'accessions de sorgho grains [*Sorghum bicolor* (L.) Moench] du Burkina Faso. Thèse Unique de Doctorat, Université Ouaga 1.
- [74] Trouche, G., Da, S., Pale, G., Adama, S., Ouedraogo, O. and Gosso, G. (2001) Evaluation participative de nouvelles variétés de sorgho au Burkina. *Actes de l'atelier de restitution du programme conjoint sur le sorgho LCRISAT-Cirad*, Bamako, 5-6 Septembre 2001, 36-55.
- [75] Gian, N., Noah, A., Irene, K., Benjamin, G. and Beate, H. (2021) Stratégie Afrique du FiBL 2021-2025. Institut de recherche en agriculture biologique FiBL, CH-Frick. <https://orgprints.org/id/eprint/43798/>
- [76] Muluneh, M.G. (2021) Impact of Climate Change on Biodiversity and Food Security: A Global Perspective—A Review Article. *Agriculture & Food Security*, **10**, Article No. 36. <https://doi.org/10.1186/s40066-021-00318-5>
- [77] Etasse, C. (1977) Synthèse des travaux sur le sorgho. *Agronome Tropicale*, **32**, 311-328.
- [78] Vaksman, M., Traoré, S.B. and Niangado O. (1996) Le photopériodisme des sorghos africains. *Agriculture et Développement*, **9**, 13-18.
- [79] ICRISAT (2016) Highlights-First Multipurpose Sweet Sorghum Varieties Released in West Africa for Crop and Livestock Integration.
- [80] Trouche, G., Brocke, K.V., Temple, L. and Guillet, M. (2016) Analyse de l'impact des programmes de sélection participative du sorgho conduits au Burkina Faso de 1995 à 2015. Rapport final validé par le chantier Impress, 197 p.
- [81] Audilakshmi, S., Mall, A.K., Swarnalatha, M. and Seetharama, N. (2010) Inheritance of Sugar Concentration in Stalk (Brix), Sucrose Content, Stalk and Juice Yield in Sorghum. *Biomass and Bioenergy*, **34**, 813-820. <https://doi.org/10.1016/j.biombioe.2010.01.025>