Review Article

CASHEW PRODUCTION AND BREEDING IN 5 WEST AFRICAN COUNTRIES

ABSTRACT

Cashew (*anacardiumoccidentale* l.) Is an evergreen perennial tree crop that produce hard greyish nut enclosing a white nutritious kernel. The kernel is one of the major edible nuts or snacks with increasing global demand. The world's largest and most active cashew production region is in west africa; where cote d'ivoire, nigeria, benin, guinea-bissau and ghanatop the list of countries where it thrives best. Since 2014, cashew has become the second-main crop after cocoa in terms of export value, in these countries. It is one of the essential agricultural commodities that have significantly boosted the continent of africa'sgdp, foreign exchange profits, and overall worth due to the rising demand for raw cashew nuts. Cote d'ivoire has profited from a few research and development programs in nut quality control. Efforts are on to enhance the peel-ability of nigeriancashews and to produce improved planting material with the help of private sector investment. Cashew cultivars development of guinea-bissau has not made significant progress, due to few resources available for doing research. In ghana, there are efforts to increase the genetic diversity of cashews, and in benin, numerous farmers have reported inadequate output from their cashew fields. Narrow genetic diversity has been reported in west african cashew gene pools. Low productivity, poor nut quality, infestation of pests and diseases, poor funding, and other factors continue to limit cashew production in west africa. Improvement in nut yield, nut quality, and broadening of cashew genetic base is important to the sustainability of the region's cashew sector. This paper provides an overview of current status of cashew production and breeding in the top five cashew producing countries of west african; the challenges, and opportunities for futureimprovement.

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Keywords: Cashew, Breeding, West Africa, Narrow genetic base

1. INTRODUCTION

The cashew tree (*Anacardiumoccidentale* L.), originate in Brazil andcultivated widely in tropical South and Central America, Asia, and Africa [1]. Cashew in one of the 75 genera and 700 species grouped in the *Anacardiaceae*family. Twenty countries in Western and Eastern Africa, as well as India and Vietnam are cashew havens. The world's largest cashew producer is West Africa, which accounted for 45% of global production in 2015 [2], and 49% in 2018 [3].There are three main regions in West Africa where cashew is grown: the Central region(Côte d'Ivoire, Ghana, Burkina Faso, Guinea, Mali, and Togo); the Eastern region, (Nigeria and Benin); and the Western region(Guinea-Bissau, Senegal, and the Gambia) [4]. The best cashew-growing countries cut across these three regions which includes Cote d'Ivoire, Nigeria, Benin, Guinea-Bissau, and Ghana.

In the 1950s, cashew trees were planted primarily for conservation and rehabilitation purpose. However, since the 1990s, it started to be produced as a necessary crop [5]. It has become one of the most significant agricultural commodities due to its high gross domestic product value, and high foreign exchange gains. It is a substantial source of income for many farmers in Africa. The cashew kernel, which contains a large amount of protein and little cholesterol, is the component of the cashew tree that provides the most nourishment[6].Approximately, it is made up of 21% carbohydrates, 47% macromolecules, and 22% fat; 82% of this fat is unsaturated, which decreases blood cholesterol levels[7]. A healthy diet that includes cashews is linked to a lower risk of mortality and physical disorders, especially stroke [8], as well as lower risk of metabolic syndrome [9] and polygenic abnormalities.

High value of raw cashew nut production in West Africa is attributed to increase in acreage rather than yield [5,10]. This is because poor-yielding trees make up the major part of the cashew tree population in Africa [11,12,13]. Tree yields in farmers' fields are also incredibly variable; some trees may give nothing, while the most prolific may produce over 20kg of nuts [14]. The national cashew nut production of Côte d'Ivoire increased by 31% over three years, from 480,000 tons in 2013 to 703,000 tons in 2015 [2,15] (Table 3). Despite the enormous potential for cashew in Côte d'Ivoire, production is characterized not only by poor yields but also by a less competitive quality of nuts with respect to global standard [16,17].Moisture routinely exceeds the required 10% level, generally regarded as poor or undesirable [18].This may be the cause of decline in quality of Ivorian cashew nuts [19]. In Nigeria, cashew breeding initiatives started with introduction of germplasm, followed by evaluations, selections, and distribution of known superior varieties to farmers [20]. Several areas of research were also identified which included; evaluations of morphological and molecular traits, ploidy determination, studies in reproductive biology, development of improved technology for large-scale production of exotic genotypes, formulation of comprehensive farm management practices, evaluations of soil and mineral nutrients, efficient methods of disease and insect management and breeding for better cashew kernel peel-ability [20,21].Investigative research aimed at improving cashew were carried out in Benin, including cultivar productivity studies and analyses of the genetic diversity of cashew using molecular microsatellite markers [11]. The results concur with those from Nigeria [21], where the cashew cultivars under examination had a high degree of redundancy (low genetic diversity). Despite the importance of cashews as a commodity crop and Ghana's expanded cashew cultivation, the crop has challenges of low and variable nut yields, a low kernel out-turn ratio, and a high frequency of insect pests and diseases.Ghanamade an effort to improve its cashews by importing 30MT of exotic seeds from the dwarf, high-yielding Brazilian cultivars in 1995.Germplasm preservation, experimental trials, production and multiplication of improved cashew planting materials became the focus of the Wenchi Agricultural Research Station [22].The cashew tree was introduced to Guinea-Bissau by the Portuguese in the 19th century, and until the early 20th century, local farmers primarily utilized it in their home gardens, the first deliberate push for cashew farming and its expansion was started by Governor Sarmento Rodrigues (1945–1949)[23]. The cropping system in the country is distinguished by lack of varietal selection for

higher productivity and, by the typical closespacing of 5m, which is not suited for improving production[5]. So far, no genetic characterization of cashew varieties from Guinea-Bissau has been reported. However, two types of cashew are known in the country; "Caju di Mozambique" and "Caju di Terra." Despite having smaller nuts, "Caju di Terra" predominate in Guinea-Bissau cashew plantations because the apples are tastier and used for juice[23].

The yield of West African cashew trees has been significantly reduced as a result of diseases and pests like shoot and twig die-back (*Lasiodiplodiatheobromae)*, fungus, and economically significant pests like Cashew stem girdler (*Analeptestrifasciata*), The tea mosquito (*Helopeltisantonii*), and Stem and root borer (*Plocaederusferrugineus L*)[20, 24). Effective management and breeding for resistance to these diseases and pests are required to boost the yield potential of African cashew germplasm. World cashew production has continued to increase steadily over the years, the Africa's share however, must be sustained[25]. This review seeks to elucidate some key aspects of cashew and the present state of production, breeding or improvement strategies in the top five West African producers.

1.1 Botanical Description

The cashew tree (*Anacardiumoccidentale* L.), a member of the *Anacardiaceae*, is a pitchy-barked tree and shrub that are most abundant in the tropics of the eastern and western hemispheres. Only the cashew *occidentale* is economically significant among the eight recognized *Anacardium* species because of its nutritious kernel and edible hypocarp (apple). The stem is upright, and the shoot cover is mostly symmetrical and umbrella-shaped.The tree's leaves, which can reach a height of 15 meters or more, are leathery, glabrous, and thick, measuring 10 to 20 cm long by 5 to 10 cm wide, with petioles that are roughly 0.5 to 1 cm long. It has a deep and extensive root system[26]and thrives in sandy soils with low fertility. Cashew is andromonoecious; having hermaphrodite and male blooms growing on the same panicle[27]. The quantity of flowers on each panicle varies according to region [28]and the surrounding environment due to changes in altitude, humidity, temperature, and rainfall.

1.2 Classification and Cultivars

Two types of cashew trees are identified in the species *Anacardiumoccidentale* L.; the giant and the dwarf cultivars [29]. The giant type is the most commonly cultivated in the cashew growing countries in West Africa. It grows to a height of 5 to 15 m or more with a crown diameter of 12 – 14 m, or as much as 20m under favorable conditions of wide spacing and high soil fertility. When it is sexually propagated (grown from nut/seed), it starts flowering between 24 to 36 months after planting. Dwarf cashew have smaller stem and trunk diameter compared to giant types and a prolonged seasonal period of fruit production [30]. The dwarf cashew is common only in Brazil with an average height of 4 m, and a crown diameter of 6 to 8 m wide. For sexually propagated dwarf cashew tree, flower production begins between 6 to

18months after planting. Cashew is also classified based on the size and quality of the nuts and kernel. Six nut sizes are identified in Nigeria, these are madras, small, medium, large, extra-large and jumbo; with the extra-large nuts possessing the largest kernel size rather than the jumbo [31]. Kernel quality is classified from W150 to W500 based on the number of kernels in one-pound weight. Seven common grades are available: W150, W180, W210, W240, W320, W450 and W500. W150 is biggest in size but very rare and hardly available commercially. W180 is the best commercially available referred to as the king of cashew while W210 is popularly referred to as Jumbo. W240 is known internationally as the premium large nut and W320 is identified as the standard large. Basically, the bigger the kernel, the more the nutrient, the tastier, and the more value placed on it.

1.3 Nutritional Importance

Cashew kernel is rich in many nutrients (Table 1). It contains a large amount of unsaturated fatty acids, mono and unsaturated carboxylic acid, a large variety of amino acids, vitamins, minerals, phytosterols, and fiber [32]. Consumption of cashew nut had been linked with several health benefits. It is associated with a reduced risk of metabolic syndrome[9], polygenic disease, mortality and stroke[8]. Some studies have also shown that consumption of cashew nut boosts psychological wellbeing [33], increase bone mineral density [34], and reduce the danger of depression[35]. Cashew long term consumption is associated with a reduced risk of weight gain and fleshiness [36].

Table 1: Cashew nut nutrient value per 100 g

Content	Nutrient Value	Recommended Dietary Allowance %
Energy	553 Kcal	28%
Carbohydrates	30.19 g	23%
Protein	18.22 g	32.50%
Total Fat	43.85 g	146%
Cholesterol	0 mg	0
Dietary Fiber	3.3 g	8.50%
Vitamins		
Folates	25 µg	6%
Niacin	1.062 mg	6.50%
Pantothenic acid	0.864 mg	17%
Pyridoxine	0.417 mg	32%
Riboflavin	0.058 mg	4.50%
Thiamin	0.423 mg	35%
Vitamin A	0 IU	0%
Vitamin C	0.5 mg	1%
Vitamin E	5.31 mg	35%
Vitamin K	4.1 µg	3%
Electrolytes		
Sodium	12 mg	1%
Potassium	660 mg	14%
Minerals		
Calcium	37 mg	4%
Copper	2.195 mg	244%

Iron	6.68 mg	83.50%
Magnesium	292 mg	73%
Manganese	1.655 mg	72%
Phosphorus	593 mg	85%
Selenium	19.9 µg	36%
Zinc	5.78 mg	52.50%

Source: USDA National Nutrient data base [37]

2. CASHEW PRODUCTION IN WEST AFRICA

West Africa is the most important cashew production region of the world; where Cashew has become the second largest export crop after Cocoa [4]. The region produced 1,795,000 metric tons of raw cashew nut in 2018, which is about half (49%) of the world production [3]. Although 90% of nuts traded in the global market comes from Western and Eastern African nations; West Africa's total cashew exceeds that of east Africa which accounts for 13% of world production; mainly from Tanzania, Mozambique and Kenya. Cashew cultivation is spread widely within the West African region, having three main producing areas; the Central area (Côte d'Ivoire, Ghana, Burkina Faso, Guinea, Mali and Togo), the Eastern Area (Nigeria and Benin), and the Western area (Guinea Bissau, Senegal and The Gambia), [4]. Cote D'Ivoire, Nigeria, Benin, Guinea-Bissau and Ghana top the list of countries in West Africa where cashew thrives best [38].

Cote d' Ivoire is presently the leading cashew producing country of the world with an estimateof 900,000 tons [39]. Theproduction resulted from increased land cultivation rather than a rise in yield. New acreage planted each year contributed largely to the observed production growth rate of 20.67% [40].Cashew nut yield of 400 - 500 kg/ha obtained on farmers' field in Cote d'Ivoireis lessthan the world average yield of 1t/ha[41,42]. The plantations are very densely planted (>100 trees/ha), and average production per tree is approximately 2 to 3kg [43]

Nigeria grow cashew in almost all regions of the country. About 60 to 70% of the local production is commercialized of which 90% is exported in the form of raw nuts. From the year 2000-2017, Nigeria ranked first in raw cashew nut production with over 450,000 metric tons harvested from about 262,000 ha. Cote D'Ivoire ranked second with about 345,000 metric tons harvested from over 853,000 ha. Thus, Cote D'Ivoire and Nigeria were the top producers of cashew in West Africa region, with individual yields exceeding 340,000 metric tons per *annum* in the period between 2000 and 2017 [44]. Although, Cote D'Ivoire, had the largest area harvested under cashew, average yield was generally lower compared to Nigeria (Table 2 & 3). Nigeria's increased nut production from year 2000 to 2010 is attributed to improvement in seed varieties [44]. After 2010, Cote D'Ivoire surpassed Nigeria in nut production due to increased investment from the private sector, area put to cultivation, investment in seed technology and genetic improvement [45,46]. FAO statistics shows declined in Nigeria raw nut production to 97,146 tons in 2015, increased to 98,291 in 2016, and 100,000 tons in 2017 where it stabilized (Table 3). Pests and disease, unimproved planting materials,fewer private sector investment compared with Cote d'Ivoire, lack of government support, and difficulty in land acquisition are part of the problems limiting cashew production in Nigeria [47].

Guinea Bissau and Benin maintained the top two countries with average production above 100,000 metric tons after Cote D'Ivoire and Nigeria despite the fact that the cashew sectors of the two were affected by pest and disease incidences, as well as low support from both public and private sectors [44]. In the two countries, production was observed to increase from 4 and 3.1% to 7.64 and 7%, respectively, from 2007 to 2014. The trend in the two countries was similar to that in Cote D'Ivoire where there was a significant increase in production due to an increase in acreage of the crop with huge support from the governments and many non-governmental organizations [5].

Republic of Benin is known for high standard raw cashew nut [20], extremely well priced for its quality in the international market. Cashew production is within the central and northern regions of the country. Collines, Zou, Borgu, Donga, Atacora are the major cashew producing areas in Republic of Benin. [48] reported that Benin ranked seventh in the world in terms of cashew nut production with 90,000 metric tons in 2011 [49]. In 2015, the average nut yield was estimated at 325kg per ha (Cashew nut overview index box, 2021). Benin produced an estimated 140,000 tons in 2018 [4].

Guinea-Bissau accounts for 15% of the raw cashew exports worldwide in 2015, which is only surpassed by Ivory Coast [2]. Cashew represents more than 90% of the country's exports [50] and at the same time is responsible for poverty alleviation at the smallholder level. Cashew nut overview index box (2021) revealed that in 2015, approximately 225,000 tons of cashew nut were produced in Guinea-Bissau. The cashew nut harvested area rose slightly to 302,000 ha in 2015 while the average yield of nut in Guinea-Bissau slightly reduced to 320kg per ha in 2015 (Table 3).

Ghana is one of the vital contributors of cashew in African, they produce smaller amount of cashew nut, but, with greater exports over her national production, which indicates the cross-border commercialism of raw cashew nut between Ghana and neighboring countries like Cote d'Ivoire, Burkina Faso, Togo and Republic of Mali. Major areas of Ghana that produce cashew are Coastal Savanna, Brong-Ahafo/Afram Plains, Upper East Region, Northern Region and Upper West Region. Farmers were incentivized through the liberalization of export markets to re-establish abandoned cashew farms and establish new ones[23]. Through these supports for market and production, Ghana exported 15 metric tons of cashew nuts in 1991, marking the beginning of cashew export from Ghana. By 1997, the quantity of export had increased to 3,571 metric tons. As reported by Cashew nut overview index box (2021), in 2015 [51], the amount of Cashew nut produced in Ghana was estimated at 276tons. Cashew nut output in Ghana indicated a moderate increase, which was largely conditioned by a tangible expansion of the harvested area and a mild downturn in the yield figure. In 2015, the cashew nut harvested area in Ghana amount to 85 tons per ha, approximately equating the year before. The average yield of Cashew nut in Ghana rose to 3.2 tons per ha in 2015. However, African Cashew Alliance expects significant growth in cashew production in Ghana and for the country to have a fair share of the cashew market in the coming years. This is due to concerted efforts by the government and stakeholders in recent years towards reorganizing and regulating the cashew sector including the establishment of the Tree Crops Development Authority (TCDA) and the Cashew Council Ghana (CCG) [39].

Table 2: West Africa Cashew Nut Profile in 2018

	COTE D'LVOIRE	NIGERIA	GUINEA BISSAU	BENIN	GHANA
Official Production (MT)	700 000	250,000	175,000	140,000	80,000
Estimate Production (MT)	875 000	240,000	185,000	140,000	115,000
% of World Production	23.8	6.5	5	3.8	3.1
Planted Acreage	2,850,000	755,000	495,000	425,000	325,000
Productive Acreage	2,475,000	660,000	470,000	370,000	280,000
Average nut yield (KG/HA)	350	363	394	377	400
Average nut count (NT/KG)	190	180	210	170	190
Average production growth during last 5yrs (MT/YR)	65,000	15,000	1,000	12,500	9,000

[4]

Table 3: Cashew Nuts Production from 2015-2020

		Cote D'Ivoire	Nigeria	Guinea-Bissau	Benin	Ghana
2015	**Production(T)**	703000	97149	169137	225230	50000
	Area H.(ha)	1675000	131529	302362	693016	85000
	Yield (kg/ha)	419.7	738.6	559.4	325	588.2
2016	**Production(T)**	650000	98291	155021	125728	78268
	Area H.(ha)	1530804	132544	283071	386857	142275
	Yield (kg/ha)	424.6	741.6	547.6	325	550.1
2017	**Production(T)**	711000	100000	160958	133965	90000
	Area H.(ha)	1682504	140000	290659	402530	166159
	Yield (kg/ha)	422.6	714.3	553.8	332.8	541.6
2018	**Production(T)**	761317	100000	161705	115590	102531
	Area H.(ha)	1839217	140000	289720	330934	192458
	Yield (kg/ha)	413.9	714.3	558.1	349.3	532.7
2019	**Production(T)**	634631	100000	159228	130276	85962
	Area H.(ha)	1526995	140000	29371	366662	161400
	Yield (kg/ha)	415.6	714.3	542.1	355.3	532.6
2020	**Production(T)**	848700	98809	160630	190000	82420
	Area H.(ha)	2033886	142553	291365	524250	155572
	Yield (kg/ha)	417.3	693.1	551.3	362.4	529.8

Source: Food and Agricultural Organization (2015-2020)[15]

3. PRESENT BREEDING STATUS

The goals of most breeding program in cashew includespest and disease resistance, nutrient quality, high shelling percentages, high yield with bold nuts, high sex ratio, short flowering phase, dwarf tree and compact canopy. In many of the leading cashew-producing nations of West Africa, the aforementioned breeding aims continue to receive attention.

The Cocoa Research Institute of Nigeria (CRIN) started growing cashews in Nigeria in 1973 using landraces that were descended from the Portuguese's initial importation in the sixteenth century [20,52]. The collections were later found to have a narrow genetic base[53,54].Additional efforts were made to increase the gene pool of the materials byintroducing genetic material from India, Tanzania, and the Republic of Mozambique between 1978 and 1980. A third collection of germplasm, which consisted ofmaterial with characteristic bold nuts and premium kernels, was brought in from Brazil in 1980(By a non-public Company). The Cocoa Research Institute of Nigeria collected germplasm accessions from these introductions in cooperation with these farmers to broaden the National Cashew germplasm base [21]. Later, about 59 accessions (11 from previous landraces, 23 from Indian supply, and 25 from Brazilian introductions) were used in recurrent breeding to increase yield of jumbovarieties[52].These Brazilian resources helped CRIN select the "Brazilian Jumbo," a better kind of cashew that bears earlier than local varieties, which take five years to mature. The Nigerian cashew, however, still has poor peelability, and efforts are currently being made to enhance it.

Due to the aging of cashew trees, and the lack of improved cultivars, low productivity (0 to 5kg/tree/year) has been documented in various farmers' fields in the Central, Southern, and North-Western sections of Benin [12]. The local cashew trees that are currently growing in farmers' fields are progeny of previous genotypes, that are quite old and need to be improved. Although, there are some young trees that are flourishing; most of them are allegedly still of the older, unimproved varieties [12]. In terms of cashew breeding goals,results from a study by Sika[11] aimed at evaluating the genetic diversity of cashew cultivars grown in the Benin Republic by molecular microsatellite markers (SSR) were in agreement with those from a study by Aliyu[21] in Nigeria, where the cashew cultivars studied had a high level of redundancy. The study used 60 cultivars of cashew selected from entirely different geographical locations in Benin.A general study on the morphological characterization of cashew tree accessions was also conducted [11] however, this study focused on the agro-morphological characterization of preselected cashew mother trees in Benin rather than on trees that had been chosen based on their agronomic performances. It evaluated the agronomic and phenotypic variation of the farmer's plantations' preselected cashew mother trees. The results revealed significant differences between the cashew mother trees.The Central Agricultural Research Center (CRA-Centre) of the National Agricultural Research Institute of Benin (INRAB) initiated and launched a cashew breeding program in 2011, to address the low plantation yield of 3 to 6 kg/tree compared to 10 to 15 kg/tree in major cashew-producing countries like India, Brazil, Viet-Nam, and Tanzania [48].As in other African nations like Tanzania and Ghana, Benin is developing a cashew breeding program [55].

In 1995, the Ghanaian government purchased 30MT of Brazilian high-yielding dwarf kinds of seed and sold it to the nation's cashew producers.

Compared to cocoa and coffee, there has not been much research on cashew in Ghana.As of 2000–2001, the types of cashews grown by farmers were unknown because the acquisition and distribution were done between farmers' exchange [56].Yield per tree in farmer fields in Northern Ghana is often poor and very variable, with some trees yielding nothing and the best producing between 2-3 kg per tree. A 10-year yield data was reported to have been obtained from over 200 native accessions evaluated at Wenchi within the Guinea-Savanna transformation belt; the data provided insight for the selection of 10 prime-yielding trees that met criteria like anthracnose resistance, early flowering, and bearing for additional evaluation. This was to serveas a temporary solution, to deliver scions from the most promising genotypes in Northern Ghana's dry savannah vegetationto address the issue of the cashew farmers' poor and unpredictable yields[55]. The Cocoa Research Institute of Ghana gathered a good variety of cashew germplasm materials from cashew seeds in Ghana (local collections) and other countries (Benin, Tanzania, Brazil, and Mozambique) to address the issues of low yields and yield variability at the agricultural research stations in Wenchi and Bole[13]. Four cashew-growing settlements in the areas (Wenchi, Kintampo, Amponsahkrom, and Nyakoma)were the sites of fieldwork[22]. The fieldwork was done for six months (June to November 2016).The Wenchi Agricultural Research Station is currentlyproducing and multiplying improved cashew planting materials. The requirements of the work include the preservation of germplasm as well as the testing and multiplication of enhanced planting materials for farmers. The station also serves as a resource center for farmers and scholars [22]. The Cocoa Research Institute of Ghana has undertaken attempts to increase the genetic diversity of the cropin order to promote the creation of superior, high-yielding cashew cultivars with huge nuts and high yield percentages for farmers in Ghana[13]. Additionally, germplasm materials from Benin, Tanzania, Mozambique, Nigeria, and Brazil were brought as seed sources and established for field testing in two significant ecosystems, the transitional savanna (Wenchi) and Guinea savanna (Bole). Except for the exception of the Brazilian germplasm accessions, significant volumes of information were allegedly gathered from the remainder of the materials reviewed [13].

Research was conducted within Guinea-Bissau on the feasibility of developing cashew in the colony, taking into account prior experience in Mozambique, a major cashew producer at the time.Several tens of hectares of orchards were planted, and nurseries were created in Bafatá, Bissau, Bolama Island, Canchungo, and Prábis as part of its extension work[23].There is no varietal selection at the small farmer level and no thought is given to the development of orchards as a means of boosting productivity. Due to the lack of advancement in cashew cultivars, [5]study brought attention to the detrimental potential of diseases impacting cashew farms in Guinea-Bissau.In the second half of the 1980s, two European Union-funded projects that included a progeny check and the introduction of new genotype material in representative production areas of the country attempted to improve the production material. Sadly, after

the trial was complete, this field of study was abandoned. 45 locally selected varieties and 6 novel foreign genotypes were reported to have been properly planted[23]. Tissue culture and orchard establishment, maintenance, and vegetative propagation techniques were also carried out, but the results could not be put to practical use due to a lack of agricultural extension resources [23]. No dwarf type cashew trees have been discovered; instead, the country primarily cultivates common or giant cashew cultivars [57]. There have been no genetic or morphological characterizations of cashew cultivars grown in Guinea-Bissau[5].

The first cashew trees in Côte d'Ivoire were planted in the entire Northern and Centralregion around 1951[10]. The notable increase in cashew production in Cote D'Ivoire was attributed to major advancements made due to increase in the amount of land set aside for cashew farming as well as a significant increase in private sector investment [46].Orchard yields in the Ivory Coast average only 448 kg of nuts per hectare, which is a result of the use of common nuts as plant material and inadequate rural cropping practices such as extremely high planting densities of 625 to 1,111 plants per hectare[58]. The National Center for Agronomic Research (CNRA) team conducted the first survey in the ex-Denguélé, Savanes, Bandama Valley, and Zanzan regions in 2010 to identify potentially high-yielding trees, characterize them, and enrich the CNRA collection. 72 high-producing trees were found, geo-referenced, and agro-morphologically classified as a result of the survey.After receiving training on the varietal selection of cashew trees from a Tanzanian expert, a second survey was rigorously conducted. The second study took place in the Poro (Waraniéné, Karakoro, Koni, Fapaha, and Sinématiali) and Bagoué (Boundiali) regions between February and March 2014, 48 high-yielding trees were found [10].Apart from work done by the national agricultural research center (CNRA) on genotypic screening of high-yielding cashew nuts [18], and cashew nut pests [59], cashew nut industry has also benefited from few research and development projects in nut quality management. No scientific research has yet been done on the characterization of the physical and sanitary features of raw cashew nuts, which would enable the development of the map of nut quality according to the production regions in Côte d'Ivoire[16].

3.1 Challenges facing cashew breeding and production

Pest and disease infestations continue to limit cashew production in West Africa, resulting in low yield and poor nut quality [11, 23,20,13, 16]. Most cashew-producing nations in West Africa have genetic pools with relatively narrow genetic variation. In addition, open-pollinated seeds from the wild and primitive landraces were used to establish the majority of the existing farms. At the moment, West Africa has no published records of improved hybrid cashew as found in other producing regions.This research brought to light the issue of the lack of sufficient funding for research and development in the majority of the cashew-producing countries in West Africa. In Guinea-Bissau for example, fund scarcity led to the abandonment of compelling research projects that could have been extremely beneficial for cashew production and improvement[23]. Also in Nigeria, cashew production was projected to decrease by 18.9% or more from 2017 upwards, due to decrease in genetic improvement efforts as a result of limited

investment in genetic research and development [44, 21]. Even though countries such as Ghana, Guinea, and Mali are actively funding research to improve the species' genotype, Nigeria appears to be lagging in this endeavor.

3.2 Opportunities for future improvement

Adoption of polyploid breeding in cashew has been claimed to likely open potential for the generation of superior varieties and expansion of the crop's genetic base to surpass the documented narrow genetic base [20]. The identification of strong parental lines is also crucial for improving the efficacy of the hybridization procedure. It is necessary to conduct a thorough assessment of cashew-growing regions, record existing genetic resources, and evaluate (characterize) these materials for practical agronomic and yield qualities across the region using a set of uniform descriptors [21].

With the assistance of helpful nongovernmental organizations like the African Cashew Alliance (ACA), Sustainable Tree Crops Programme (STCP), Bill and Melinda Gates Foundation, Common Funds for Commodities (CFC), TechnoServe - Business Solutions to Economic Condition, United Nations agency, and various relevant stakeholders in the trade, the aforementioned projects can be implemented smoothly and have a significant impact on the cashew sector in Africa. A similar initiative is said to have recently been successful in the trade of cashews throughout Eastern Africa.

4. CONCLUSION

West Africa was the world's greatest cashew producer in 2018, harvesting 1,795,000 metric tons of raw cashew nuts, or 49% of the global supply[3]. To ensure sustainable production of cashew in this region, high-yielding selection with quality profiles should be used to supply planting materialsto farmers.To develop better planting materials, supplement or broaden the gene pool, develop hybrid cashew that may outperform the current cultivars, and build capacity of all stakeholders to increase the production of cashew, which can in turnimprove the sustenance of the population, timely financial support is necessary from both the government and external donors.

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