

## Investigating the effects of drought on *Anacardium occidentale* L. (cashew) and adaptation options to climate change in Burkina Faso (West Africa): a review

### ABSTRACT

The objective of this review was to investigate the effects of drought on cashew and to identify options for cashew adaptation to drought in the aim to maintain and/or improve its productivity in plantation and in agroforestry under climate change in Burkina Faso. The methodology used was the review of the scientific literature through the analyse of the findings of 51 studies to explore the effects of drought on the cashew. Drought is a major factor causing land degradation and limiting crop productivity in the Sahel and particularly in Burkina Faso. The cashew contributes in creating jobs and generating revenues mainly for women employed in the cashew nuts processing units established in Burkina Faso. The cashew sensitivity to drought was reported through changes in some physiological parameters under water stress conditions. In order to maintain and/or improve cashew productivity in plantations and in agroforestry systems and the rural households socio-economic conditions under drought with climate change, it is urgent to develop and implement cashew adaptation options. This manuscript recommended adaptation actions to reduce the vulnerability of the effect of cashew to drought under climate change.

Keywords : climate change, cashew adaptation, drought, agroforestry

### INTRODUCTION

The cashew (*Anacardium occidentale* L.) was considered for a long time as forest species used to fight against land degradation [1] but these last years in Burkina Faso it is considered as an important agricultural crop due to its great social and economic potential for farmers and its significant contribution in the country GDP [1]. Drought is a major factor causing land degradation and limiting crop productivity in the Sahel and particularly in Burkina Faso [2]. Therefore, using cashew for a long time to combat land degradation suggests that these species were considered drought tolerant as reported by several authors [3, 4, 5]. However, other relevant research studies reported that cashew productivity was reduced under drought conditions [6, 7, 8, 9, 10]. The cashew production as other agricultural crop largely depends on rainfall in Burkina Faso. Drought which is prevalent, is expected to become more frequent and severe under climate change in Burkina Faso [11] and this calls to understand the potential impacts of drought on cashew and to identify adaptation options. The objective of this

research was to undertake a literature review for investigating the effects of drought on cashew and to identify options for cashew adaptation to drought in the aim to maintain and/or improve its productivity in plantation and in agroforestry under climate change in Burkina Faso.

### **THE METHODOLOGY USED**

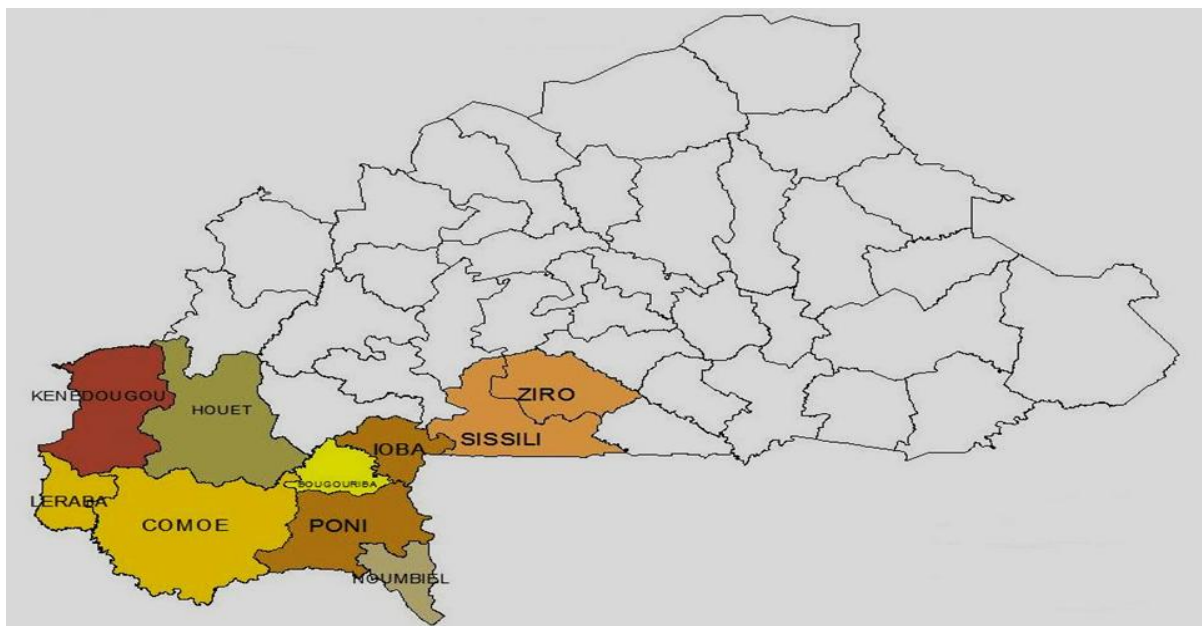
The review of the scientific literature was used through the analysis of the findings of 51 research studies to investigate the effects of drought on the cashew. The details of the literature screening and eligibility criteria can be found in the table 1.

**Table 1** : The key definitions used for the identification of the relevant studies

<b>Key definitions for the identification of the relevant studies</b>	
<i>Drought.</i>	Water stress or limitation effect on the cashew growth, yield and physiological parameters
<i>Climate change.</i>	The effect of the temperature increase and the rainfall decrease and variability
<i>Vulnerability.</i>	The sensitivity of the cashew to drought and the adaptive capacity of the cashew to drought
<i>Adaptation.</i>	The actions implemented to cope with the negative effects of drought on cashew
<i>Cashew.</i>	The trees of cashew

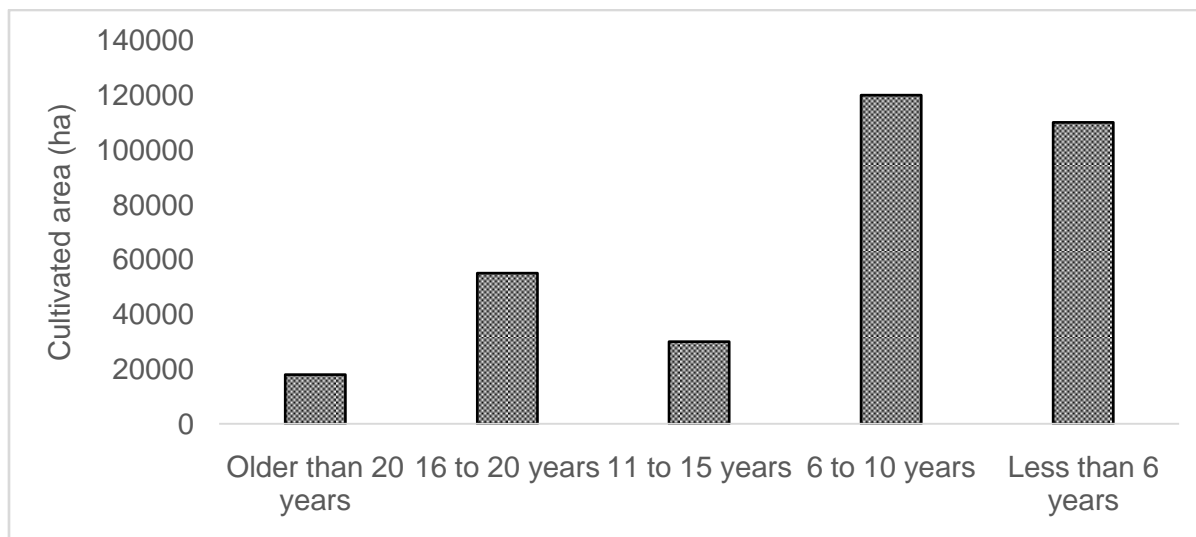
### **THE SOCIO-ECONOMIC CONTRIBUTION OF CASHEW IN BURKINA FASO**

The cashew is widely expanded in the agricultural systems in Burkina Faso due to the economic opportunities provided by these tree species [1, 12, 13]. In Burkina Faso, the cashew is mainly cultivated in 04 administrative regions including Cascades, Hauts-Bassins, South-West and Centre-West regions. The maximum of cashew farmers are in the South-West region due to the fact that its production requires a rainfall amount higher to 800 mm/an [14]. The Cascades region is composed of Comoé and Leraba districts. The Hauts-Bassins region is composed of Houet and Kenedougou districts. The South-West region is composed of Poni, Ioba and Bougouriba districts and the Centre-West region is composed of Ziro and Sissili districts. The figure 1 below presents these different districts in the 04 administrative regions of cashew production in Burkina Faso.



**Figure 1** : The different districts in the 04 administrative regions of cashew production in Burkina Faso [15].

The total production of the cashew nuts is estimated at 11124 tons with about 45000 households involved in the cashew production in Burkina Faso [1,15]. The cashew nuts are the 3<sup>rd</sup> agricultural export products after the cotton and the sesame in Burkina Faso [15]. The volume of cashew nuts exported was 13747 tons in 2008 and 10337 tons in 2009 for an amount of 2318627 and 2062091 USD collected, respectively [16]. The figure 2 indicates that a large proportion of cashew cultivation are very young suggesting that cashew production in Burkina Faso is expected to increase very rapidly around 200000 tons/year in 2025 due to the double effect of increased yields because of the young cashews coming up at the maximum of their potential production and the increase in planted areas [17].



**Figure 2** : Distribution of the cashew age in planted areas of Burkina Faso [17]

The cashew contributes in creating jobs and generating revenues mainly for women employed in the cashew nuts processing units established in Burkina Faso. The women's association in the Comoe district of the Cascades administrative region established cashew nuts processing units that are employing about 2500 people among this 70% are women receiving a monthly salary of about 48000 FCFA which is above to the guaranteed inter-professional minimum salary in Burkina Faso of 30,000 FCFA [18]. The revenues provided to the farmers through selling the cashew nuts is also very important. For example with a market price of cashew nuts in the farms of about 700 FCFA/kg in 2016, the mean net benefits for farmers and per hectare were estimated to be 424000 FCFA and 77000 FCFA, respectively [17]. Also, the cashew farmers that have a large area of cashew-based agroforestry systems or cashew plantations recruit occasional workers for pay in rural areas to help them in the maintenance of the farms or in the collection of cashew nuts [18]. Due to the socio-economic importance of the cashew sector, the government of Burkina Faso in 2019 established the Burkina Faso Cashew Council (CBA) with the mandate to regulate, monitor and develop activities in the cashew sector.

### THE DROUGHT AND CLIMATE CHANGE

The drought is defined as a lack of water compared to the needs of the plants [19] and according to Chopart [20] there are two types of drought, the soil and climatic. The soil drought can be explained by the fact that the useful water fraction defined by the difference between the field capacity and the permanent wilting point in the soils is relatively low due to the high soil infiltration. The climatic drought is due to the fact that the water requirements of the plants are generally poorly covered due to the low

rainfall and high evaporation during the rainy season. The climatic drought is expected to become more frequent and severe in Burkina Faso due to climate change [11]. According to the IPCC report, a temperature increase is expected ranging from 1.2 up to 3.0°C by 2050 depending on the different greenhouse gas emission pathways with a multiplication of extreme events such as floods and droughts with droughts more frequent in the Sahel region and particularly in Burkina Faso [21]. It is reported that climate change in the tropics will create warmer and drier environments, increasingly variable rainfall regimes and more frequent climate extremes [22, 23].

## **THE VULNERABILITY OF CASHEW TO DROUGHT IN BURKINA FASO**

The ecosystem based approach considering the vulnerability as a function of exposure, sensitivity and adaptive capacity [24] was used for the vulnerability analysis of the cashew to drought. The climate change exposure factor considered in this analysis was drought.

### ***The cashew sensitivity to drought***

The literature review revealed controversial results about the effects of drought on cashew. Some research studies reported that cashews are drought tolerant [25] due to the deep root system allowing the plant to better access water in the soil. The cashew competitiveness to access water and nutrients in the soil under high soil evaporation was reported as a factor that explained its drought tolerance and ability to grow in adverse environments [5, 26]. The cashew drought tolerance was explained by [3] because it grows well under dry farming conditions, its cultivation is concentrated in intertropical regions that normally present low soil fertility and sometimes high salinity and these regions are characterized by high temperatures with low and irregular precipitation. It was reported that the cashew is drought tolerant due to the fact that only nearly 1% of the 3.4 millions of hectares cultivated with cashews in the world are under irrigation [27]. Though, cashew drought tolerance was reported in the literature, very few research supported this cashew drought tolerance with scientific evidences. The major research studies that have been reviewed based their arguments about cashew tolerance to drought on the fact that it can grow in adverse environments. Even if cashew can grow in adverse environments, it was reported that the cashew that have grown in adverse environments did not develop the same aboveground structure compared to those that have grown in favourable environments [28] and this result suggests that cashew is drought sensitive. The cashew sensitivity to drought was reported through its negative effect on productivity [29]. The long dry seasons was reported as one of the major factor limiting current and future cashew climate suitability in West

Africa[10].Oliveira et al.[30]reported that Brazilian farmers though able to grow cashew for a long time in poor soils that is a drought tolerant crop with little management, as a result, a decline in cashew average nut yields to as low as 200 kg/ha was observed.Oliveira et al.[30]also reported that low nut yields of cashew are commonly associated with years of low rainfall. According to the table 2,the irregular precipitation was reported as the factor explaining the low and fluctuating cashew nut yields obtained over the years since 2009in Burkina Faso [15].

**Table 2** : Variation of the cashew nuts yields in Burkina Faso between 2009 and 2014 [15]

Years	2009	2010	2011	2012	2013	2014
Yield (tons)	320	129	170	199	262	221

The cashew sensitivity to drought was reported through changes in some physiological parameters under water stress conditions. The cashew stomata closure under dry conditions to maintain a favourable leaf water potential was reported by [31]. The difference of gas exchange rates between irrigated and unirrigated cashew 03 or 04 months after the end of the rainy season was reported with a better gas exchange rate observed for irrigated cashew [31].The drought has negatively affected the cashew relative water content and its ability to maintain high relative water content at plant level in the conditions of water stress[32, 33,34, 9].The cashew growth parameters were reported to be negatively affected by drought. Drought was reported as one of the main constraints limiting the cashew growth in Benin[35, 36, 8], in Senegal[6] and in Burkina Faso[7].The cashew survival rate and growth were negatively affected and differently by the application of water stress according to the provenance of the seeds [9]. The cashew biomass and height were reduced and responded differently by the application of water stress according to the provenance of the seeds and the root system development decreased for all the provenance of the seeds with the application of water stress[9].The literature review revealed that the cashew as the others cereal crops have their physiological, growth and yield parameters negatively affected by drought.

***The socio-economic implications of cashew sensitivity to drought in Burkina Faso***

The cashew productivity decline due to the negative effects of drought could lead to a reduction of cashew nuts production and consequently the export volumes leading to a decrease of the rural households incomes and the national economy. The few cashew processing units as a result of

reduced cashew nuts production may lack sufficient cashew nuts to process which could result to the unemployment of several women working in these processing units or to the reduction of the employees revenues. This reduction or loss of incomes will negatively affect the households living standards such as housing and cooking fuel [37], children access to education [38, 39] and consequently exacerbating the children labour [40, 41] and rural households health [42]. The CBA is getting funding from the government through the taxes collected during the cashew nuts exportation for the implementation of its activities to support the cashew sector. The volumes reduction of export cashew nuts will lead to a decrease of the taxes collected and consequently the CBA will receive less funding from the government which could negatively affect the investments for the development of the cashew sector. The cashew cultivation by the farmers allows them to diversify their source of revenue increasing their resilience to climate shocks like drought as reported by [43]. The reduction of cashew production due to drought will consequently reduce the farmers resilience to climate change. The adaptive capacity analysis to address the drought effect on cashew in Burkina Faso showed the existence of relevant institutional and technical capacities. Indeed, the institutions such as the Institute of Environment and Agricultural Research (INERA) and the National Centre of Forest Seeds (CNSF) are recognized and leading research centres conducting research on cashew. However, the current research topics on cashew in these research centres are mainly focused on identifying more productive cashew varieties and cashew good agricultural practices that **certainly** improve productivity. These institutions have researchers with the relevant profile to address the issue of the effects of drought on cashew but the lack of appropriate equipments for cashew physiological parameters under drought was reported. In terms of awareness and capacity building the major activities carried out by the different partners working in the cashew sector are focused on the cashew good agricultural production practices vulgarisation with few or any activities regarding the effects and adaptation of cashew to drought. However, we noted a strong political will to strengthen the development of the cashew sector by the government of Burkina Faso through the establishment of CBA. In terms of financial resources, we noted that several partners as well as the government of Burkina Faso have mobilised important financial resources to implement a large number of projects in the cashew sector but any project is currently addressing the effects of drought on cashew for adaptation. The combined effects of cashew sensitivity to drought and the relative low country adaptive capacity to address the effect of drought on cashew reveal that the cashew is vulnerable to drought under climate change as

reported by [44, 45]. There is then an urgent need to develop and implement cashew adaptation options to drought in Burkina Faso.

### **THE CASHEW ADAPTATION TO DROUGHT**

The literature review reported that selecting cashew drought tolerant varieties helps to improve its productivity under climate change [9, 10]. The literature review did not allow to identify research projects currently implemented in Burkina Faso for selecting cashew drought tolerant varieties suggesting future research for identifying cashew drought tolerant varieties in Burkina Faso. The high trees transpiration rate in dry conditions increase their sensitivity to drought and tree pruning was reported to reduce transpiration [46] and then it could contribute to increase adaptation to drought but such research was not yet conducted on cashew in Burkina Faso. Undertaking research to identify cashew pruning fraction that allows to maintain optimal cashew nuts production while reducing transpiration is crucial to adapt cashew to drought in Burkina Faso. The research results reported that the cashew polyclonal seeds have greater adaptability and productivity [47, 48] but the literature review did not show the development of such seeds in Burkina Faso suggesting future research to explore the development of cashew polyclonal seeds and to test their adaptation capacity to drought in Burkina Faso. It was reported in the literature by the farmers in Benin that practicing thinning contributes to adapt cashew to drought because it reduces trees density and therefore competition for access to soil water [49]. The literature review did not reveal research studies addressing the effect of cashew density on transpiration in Burkina Faso suggesting to undertake future research to investigate the effects of different cashew densities on transpiration rate for determining the optimal cashew density that reduces transpiration rate while maintaining optimal cashew production. [8] showed that irrigation improved cashew productivity in the conditions of water stress and [30] reported a different positive response of irrigation on cashew nuts yield according to the genotypes used. [31] also reported a positive effect of irrigation on cashew during the period from flowering to the beginning of the fruits harvesting corresponding to the dry season. The literature review did not reveal research studies on the effect of irrigation on cashew in Burkina Faso suggesting future research to assess the effect of different irrigation schemes on cashew growth and productivity. Some soil management techniques that reduce soil evaporation and mitigating the adverse effects of drought were reported by several authors [8, 47, 50]. Future research to test the effect of some of these soil management techniques on cashew performance in the conditions of water stress could help to formulate adaptation options of

cashew to drought in Burkina Faso. [51] reported that the application of endogenous cashew adaptation strategy depends on the farmers knowledge about the effects of drought on cashew. It is then required to increase awareness and to build capacity of farmers, policy makers, technical and financial partners about the effects of drought on cashew and the adaptation options for their support to increase cashew adaptation to drought.

## CONCLUSION

The cashew is a very important socio-economic crop in Burkina Faso used in plantation or in agroforestry systems. The literature search revealed that the multiplication of the occurrence and the increase in the magnitude of drought under climate change could undermine several years of investments to improve cashew productivity and rural households socio-economic conditions in Burkina Faso. In order to maintain and/or improve cashew productivity in plantations and in agroforestry systems and the rural households socio-economic conditions under drought with climate change, it is urgent to develop and implement cashew adaptation options.

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