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REVIEW

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Potential of Kersting's groundnut [*Macrotyloma geocarpum* (Harms) Maréchal & Baudet] and prospects for its promotion

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Abstract

Kersting's groundnut is a tropical crop, highly nutritious, adapted to drought-prone areas. The crop is neglected both by researchers and by policy makers. This paper aimed at providing relevant information on the current status of the crop and the prospects to promote its improvement and production. To this end, available papers addressing any of the following aspect: distribution, nutritional value, cropping systems, post-harvest processing, usages, value chains, conservation status, genetic diversity and improvement of Kersting's groundnut were reviewed. In West Africa, the crop provides substantial income for rural population. Kersting's groundnut has several medicinal uses and cultural values as well. However, because of its intensive labor requirement, low yield and non-availability of improved varieties, its cultivation is declining and it is even disappearing gradually in some growing areas. The promotion of the crop's value chains is an option for reversing the declining trend in Kersting's groundnut cultivation. In recent years, some progress has been recorded in the collection, characterization and ex situ conservation of the crop. Thus, there are currently about 100 accessions conserved in various gene banks in Benin, Ghana, France and Belgium. This is still insufficient as compared to the genetic resources available in ex situ for most of the grown legume crops. To cope with this, extensive germplasm collection and their systematic characterization and evaluation coupled with new generation genomic tools need to be undertaken. For this purpose, genomic resources developed for Kersting's groundnut-related species will be valuable assets. The exploitation of genomic resources will enable the development of core and mini-core collections for conservation and breeding purposes. In addition, the use of genomic resources will speed up Kersting's groundnut breeding programs. Furthermore, the genetic base of the crop is extremely narrow and there is a need to broaden it for substantial genetic gain in breeding programs. For this purpose, mutation induction has been proposed as technique to increase variability in the Kersting's groundnut germplasm. Invest in Kersting's groundnut research is key to ensure the conservation and exploit the potential of the crop.

Keywords: Kersting's groundnut, Neglected and underutilized, Mutation induction, Conservation, Value chain

Background

The ever rising of the global population with a slow food production threatens food security, especially in developing countries [1–4]. The number of people suffering from malnutrition is about 795 million, and the developing countries are the most vulnerable regions where most of the population lives in rural areas [5, 6]. The over-reliance of the global agricultural production on very few crop species has led to genetic erosion and the loss of biocultural diversity [7]. Such situation affects the ability of farmers to face challenges of changing climatic conditions and food insecurity [8–10]. In order to ensure more nutritious diets, enhanced livelihoods for farming communities and more resilient and sustainable farming systems, appropriate use of agricultural biodiversity is one of the key pillar identified to achieve the Sustainable Development Goal 2, which is termed "End hunger, achieve food security and improved nutrition and promote sustainable agriculture" [11]. In recent years, there has been

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a growing interest for sustainable agricultural production through crop diversification with an emphasis on the promotion of so-called neglected, minor or underutilized crop species [6, 7, 12–15]. These crops, important in local production systems and diets, have been for long overlooked by research in terms of technology development. In addition, policy makers fail to create favorable conditions for the promotion of the economic potential of underutilized crop species. Neglected crop species are under-represented in conservation efforts both in situ and ex situ, and even the direct stakeholders involved in their production, commercialization and processing have limited knowledge on their economic potential [6, 16, 17]. However, many of these crop species are particularly well adapted to low-input agriculture and they are, as such, important to ensure food and nutritional security in regions where farmers have limited access to agricultural inputs [12, 18, 19]. One of these crop species is Kersting's groundnut.

Kersting's groundnut also known as geocarpa groundnut, Hausa groundnut, is an annual herbaceous and geocarpic legume crop [20, 21]. It belongs to the Fabaceae family and Phaseoleae tribe. It was previously named *Kerstingiella geocarpa* Harms, but following the work of [21], the species was transferred to the genus Macrotyloma, hence its current name *Macrotyloma geocarpum* (Harms) Maréchal & Baudet. Kersting's groundnut seeds have a high protein content and richer in amino acids such as lysine and methionine than most of the other legume crops [22, 23]. In Benin, even though cowpea and bambara groundnut seeds are widely consumed, Kersting's groundnut seeds are preferred to them because of palatable taste [24, 25]. As the other legume crops, Kersting's groundnut is a source of relatively cheap protein for rural populations [26]. Despite its nutritional attributes and its ability to adapt to marginal area, the crop still remains underexploited grain legume [14, 24, 27, 28] and characterized by low yield due to poor agronomic management and lack of improved varieties [29]. It is worth noting that Kersting's groundnut is highly region specific as its cultivation is confined to West Africa [30], an additional fact that may justify its neglected status. This review was initiated in order to provide policy makers with relevant information on the current status of the crop and the prospects to promote its improvement and production. Previous review on Kersting's groundnut [24] has focused on cultivation and commercialization, pests' management, utilization, conservation state of Kersting's groundnut. This paper, without overlooking these aspects, explores market values, potential for yield increase, threats and conservation of the genetic resources, genetic diversity and prospects of the crop genomic dissection.

Distribution and production

Kersting's groundnut was suggested to be originated from West Africa where it is grown [31]. Later on, this was confirmed by [21] with an emphasis on a sudano-zambezian distribution. Hepper [32] purported having identified the wild types of *M. geocarpum*. However, [33] suggested that the cultivated taxon and the one collected by Hepper in Cameroon and Central Africa Republic should be considered as two different species. Until now, the wild type of Kersting's groundnut is unknown. Prospection should be undertaken in the attempt to collect and identify the wild type that can be conserved in gene banks and used in breeding programs for its yield improvement and other potential characters.

Northern Togo and Central Benin were supposed to be the center of origin of the species [24]. This suggests that the center of origin of Kersting's groundnut is not known yet. Further research and collection missions should be undertaken to identify the centers of origin and diversity of the species as this will have implications on the definition of conservation strategies of its genetic resources for current and future exploitation. Actually, identification of the centers of origin and diversity of crop species is of great importance for crop improvement efforts as these centers harbor a wealth of genetic diversity [34, 35]. Kersting's groundnut is particularly adapted to drought areas as it can still thrive for rainfall as low as 500–600 mm, well distributed over 4–5 months [30]. The crop can grow and fix N_2 in drought-prone environments where any other crops can barely survive [22]. Kersting's groundnut is less susceptible to diseases and pest attack in the field [25, 28]. With current climate variability and the occurrence of intra-season drought in West African region [36, 37], it may be a viable crop option for vulnerable ecosystem.

Although cultivated on relatively small areas, Kersting's groundnut is well established in the production systems in West Africa and it has long been grown by local population [20, 21, 30]. The cultivation belt covers the West African savanna zone, Cameroon and Tchad [21, 30]. Kersting's groundnut cultivation was also reported in Mauritius, Tanzania and Fiji [24]. There is no available statistic on the global harvested area, yield and production of the crop.

Cultivation practices

Kersting's groundnut is integrated in cropping systems in West Africa. Both male and female farmers are involved in its cultivation [25, 38]. Conversely to Benin where most of the growers were <50 years old [25, 38], in Ghana [28] and Nigeria [27], Kersting's groundnut cultivation is reserved to elderly people [27, 28]. To plant Kersting's groundnut, farmers use saved seeds from previous

harvest or buy seeds on the markets because there is no formal seed production system supplying certified seeds of the crop in any of the growing countries in West Africa [25, 27, 28]. Actually, both public and private sectors are reluctant to invest in formal seed production system of underutilized crops [39]. To cope with this challenge, a community-based seed system can be established in growing areas. Thus, in each growing village, a farmer can be identified and monitored by extension agents to produce and supply seeds for his fellow farmers in the village and the vicinities.

Depending on cropping systems adopted in growing areas, seeds are directly sown on mound, flat or ridge [24]. The type of tillage (ridge or flat) was reported to affect the yield of the crop depending on the soil type [40]. Weeding two or three times is recommended [41], but it is rarely respected by farmers [25, 28]. Kersting's groundnut is very sensitive to long-lasting rainfall during the cropping season because of grains deterioration due to high soil moisture which can lead to total crop loss [42]. Thus, drained soils, mainly ferruginous and ferralitic soils, are well appropriate for growing Kersting's groundnut. The crop is generally grown in pure stand on small area (0.25 ha) or in association with cereals or roots (cassava) (*Pennisetum* spp., *Sorghum vulgar*, *Zea mays*) [24, 25, 27, 28, 42]. Adazebra [43] found that the yield of the shoot dry matter can average 35.09 t ha^{-1}. In addition, when inoculated with rhizobium, Kersting's groundnut can fix up to 16.5–57.8 kg ha^{-1} of atmospheric N_2 [44]. The shoot dry matter and the amount of fixed atmospheric nitrogen point out the potential of the crop to contribute to improve soil fertility.

Post-harvest techniques

Kersting's groundnut's seeds are orthodox, and they can be stored dry (relative humidity ranging 15–20 %) at −20 °C or as cool as possible [45]. In post-harvest, pods are directly stored or shelled and grains are mixed with sands or wood ash before storing in sacks and granaries. Saved seeds for sowing next season are stored in closed containers such as gourds and calabash for better and longer conservation [24]. Branches of *Hyptis sepicigera* Lam, leaves of *Azadirachata indica* A. Juss and fruits of *Capsicum frutescens* L. are mixed with grains and serve as insect repellent to conserve the seeds [38, 42]. Farmers also used chemical insecticides [25]. However, in Kersting's groundnut, the use of these products is not always sufficient to avoid pests attack especially when the seeds are infested during harvest [25]. In fact, the major constraint faced by farmers in post-harvest is pest attack during storage. Bruchid, especially *Callosobruchus maculatus* Fabricius, infestation can cause severe grains loss [25, 46]. Pest attack prevents farmers from storing their products over a long period. As such, they cannot benefit from the rise of price during periods of shortage. In fact, they sell out their products right away after harvesting. *C. maculatus* infestation in stored Kersting's groundnut could be controlled by applying diatomaceous earth formulations Probe-A or Damol-D1 at 1.50 or 2.00 g kg^{-1} at 50 % relative humidity [47]. In addition, pest attack during post-harvest can be mitigated by the exploitation of the crop genetic resources to breed cultivars which can prevent or delay bruchids infestation [46, 48]. In fact, [46] revealed that accessions with brown and black seed color were less susceptible to infestation of *C. maculatus* Fabricius. Legume seed contains anti-nutritional compounds, for instance lectins, which serve as defense mechanism against bruchids [48]. These compounds can be genetically determined. For instance, in common bean, the production of lectin and lectin-like seed proteins, responsible for resistance to bruchids, was successfully transferred to susceptible cultivars through interspecific hybridization [48]. Similarly, in Kersting's groundnut, the genetic determinism of resistance to *C. maculatus* in brown and black seed color cultivars should be investigated. And then, the possibility for introgression of bruchids-resistant locus from brown and black seed color cultivars into white seed cultivars, which are most preferred by consumers, should be explored.

Nutritional values of Kersting's groundnut seeds

Kersting's groundnut seeds contain 21.3 % of crude protein, 6.2 % of crude fiber, 61.53–73.3 % of carbohydrate and 3.2 % of ash [49, 50]. Vitamin content of Kersting's groundnut seeds is yet to be determined. The crude protein of the seed shows good profile of amino acids and contains a higher level of arginine (9.3/100 g), phenylalanine (3.2/100 g) and histidine (2.1/100 g) [23]. Arginine, the most abundant amino acid in Kersting's groundnut seeds, is well known for its role in children growth [23, 51, 52]. Including Kersting's groundnut seeds in infantile food formulation, mainly in areas where there is severe undernourishment, can be of great importance to ensure nutritional security [23, 50]. The seeds have low fat content (1.0 %) and low sodium (5.67 mg g^{-1}). This is particularly interesting in diet formulations for people suffering from high blood pressure and those eager to lose weight [23]. The low atherogenic index of the seeds reveals its potential to be used as hypocholesterolemic. Owing to these potentialities, consumption of Kersting's groundnut seeds is good for anemic patients and may limit the occurrence of atherosclerosis and coronary heart disease [23]. The seeds are good source of essential mineral (K, Mg, Ca, P, Na, Fe) [53]. Tannin, hemagglutinins and phytate are anti-nutritional factors contained in the seeds. However, this should not be a reason to avoid

its consumption since presoaking and boiling in water almost eliminate all the anti-nutritional factors [54]. Even without this treatment, the anti-nutritional composition of the seeds could not reduce their overall nutritional quality [49, 55].

Usages of Kersting's groundnut

Kersting's groundnut is primarily grown for its edible seeds. Several diets are made from the seeds. In Benin, the seeds are boiled, seasoned with salt and vegetable oil and served as special meal for guests of honor. During celebrations or special occasions, boiled seeds can be eaten alone or accompanied with bread, yam, rice or *gari* (cassava-derived product) [24, 25, 30]. Kersting's groundnut seeds can be processed into flour and use to make porridge. Seeds flour is also processed into different local cakes (ata, akara, Yoyouè), bean cakes ("Koose" its local name) and steamed pastes ("Tubani," the local name of the cake) or boiled [24, 27, 38, 41]. In Ghana, Nankanis boil the seeds with baobab seeds for food [56].

Kersting's groundnut seed flour combined with maize in a ratio 70:30 contains higher nutrient (high amino acid and mineral content as compared to maize alone) and can be used as weaning food for infants [49, 50]. The seeds flour has potential industrial uses, and it could be used in the formulation of viscous food including baked goods and soups notably because of their water absorption and oil emulsion capacities [57].

The fresh leaves are used as vegetables or added to soup [30], while the stover is used to feed animals. Medicinal and emetic properties of the seeds were also reported [20, 30, 42]. Actually, people drink water in which the seeds are boiled as a remedy for diarrhea and the mixture of dry seed powder and water or "pito" (local beer in northern Ghana) is said to be used as an emetic in cases of poisoning [20]. Leaf decoction is used as a vermifuge, and the plant is used in the treatment of dysentery, venereal diseases, fever and diabetes [24, 25]. Despite the various usages of Kersting's groundnut in folk medicine, little is known about the biological active ingredients responsible for these properties. There is then a need for further studies on the identification and isolation of these bioactive substances which would be used in drug industries.

Kersting's groundnut has also cultural and symbolical value. The dry boiled seeds had cultural and traditional values for Sisalas people in northern Ghana. Actually, the dry boiled seeds were served to children during the final funeral rites of their mother [20]. In Togo, the seeds are used by Kabyès and Maubas people in rituals and in funeral ceremonies and have then a symbolical and cultural value [30]. Use of Kersting's groundnut seeds in rituals was also reported in Burkina Faso [42]. In Benin, the cultivars with black seed color are used in folk medicine for treating diarrhea, stomach troubles, ulcer and cough [25]. The black seeds were also used in ritual and mystical [38].

Market values and opportunities to upgrade the Kersting's groundnut value chains

The main purpose for growing the crop depends on the regions. In Benin, the crop is primarily grown for sale because of its high economic value (2–5 times the price of rice) [14]. Kersting's groundnut is an important source of income for rural population since gross revenue earned from growing the crop averages \$1200 ha^{-1} [25, 38, 58]. However, in Ghana, Burkina Faso, Togo and Nigeria, farmers produced the crop mainly for home consumption [28, 30, 42]. In Nigeria, the market value of Kersting's groundnut seeds is still low [27]. Thus, beyond the reported constraints hampering the cultivation of Kersting's groundnut, the relatively low economic value and poor market access in many of the growing areas are the key reasons for its abandonment [27]. This status may be explained by the lack of added value to the product which is sold as dry seeds. In order to reverse this trend, a strategy for *on-farm* conservation and promotion of the crop will rely on the increase of market value and the development of the crop-based value chains [17]. For this purpose, seeds processing into flour and incorporation into industrial and infantile food formulations will contribute to add more value to Kersting's groundnut seeds and to gain market share. The success in increase market value and market share depends on a partnership among stakeholders (inputs' suppliers, farmers, researchers, private sector, government agencies, donors, etc.) along the value chains [18]. The partnership should foster synergistic actions among the stakeholders in order to cope with various challenges. Because of the complexity in promoting value chains for neglected crops such as Kersting's groundnut, the right entry point or driver should be identified [17] (Table 1). Each driver may be considered as opportunities or challenges depending on the conditions. Thus, promoting Kersting's groundnut value chains should focus on transforming challenges into opportunities [17]. The choice of drivers should be based on prevailing social, cultural and economic context related to Kersting's groundnut in each region. Using Kersting's groundnut as an alternative source of income for smallholder farmers may foster its value chain in Benin. In countries where the crop has low economic value, emphasis on improved nutrition should be considered as driving factor to promote the value of Kersting's groundnut.

Threats and conservation status

Kersting's groundnut is threatened of disappearance in many growing areas. The gradual disappearance of the crop from production systems was observed in Ghana

Table 1 Drivers for the promotion of Kersting's value chains Adapted from [17]

Drivers	Opportunities	Why this driver?
Globalization culture	Exposure to global diet diversity (e.g., tourism, international cuisine)	Diet based on the seeds is preferred by Europeans and Africans [89]
Consumer trends (local, global)	Changing consumer attitudes toward health and environment	The different medicinal uses and popularization of its consumption in Benin [14, 25]
Sustained use of natural resources	Increasing awareness on the need for diversified cropping systems	Potential to improve soil fertility [44] and to thrive in drought-prone environment [30]
Climate change	Rising need for climate-tolerant species/adaptability to locations	Thrive in drought-prone environment [30]
Commoditization of NUS	Growing shares of NUS in local, regional and international markets	Formerly reserved to *Vaudoun* priest and headman but now consumed by any member of family [24]
Commodity avoidance	Research on commodity substitutes (e.g., NUS) in food formulations	Potential of use in manufactured products (soup, bakery) [57]
Poverty alleviation	Alternative source of income for smallholder farmers	It contributes significantly to income earned by growers in Benin [25]
Food security/improved nutrition	Access to food and enriched food basket for rural and urban people	Protein and mineral content and possibility to be combined with maize and used as weaning food for infant [50, 53]

[20, 28]; in Togo [30], in Burkina Faso [42]; and more recently in Nigeria [27] and Benin [25]. Several factors were identified to be responsible for the abandonment of the crop. Low yield, small grain size, low market value, production destined only for home consumption, high labor requirement, non-availability of improved varieties are the main underlying reasons associated with the decline in the production of Kersting's groundnut [27, 42]. Thus, Kersting's groundnut is facing serious genetic erosion [27]. This information should be taken into account in defining the species status in the International Union for Conservation of Nature (IUCN) red list. As a matter of fact, the species is currently rated as Less Concern ("the taxon is not considered to be specifically threatened or in decline at present") [59]. This report does not seem to reflect the current status of the species.

The use of the crop in rituals and ceremonies by some ethnic groups can be an opportunity for the conservation and as a mean to avoid its total abandonment in growing areas. However, the decline in traditional knowledge over generations [60] preventing youth from recognizing the cultural value of the crop can be a serious threat for its in situ conservation. Moreover, the abandonment of rituals involving the use of Kersting's groundnut is a threat for the conservation and the cultivation of the crop [42]. Henceforth, cultural changes can reduce crop diversity maintained on farm [61, 62].

Unlike most of the grown crop legumes with thousands of accessions collected and conserved in gene bank [1, 63], extensive collection and evaluation of accessions of Kersting's groundnut as regards to their performance have not been undertaken yet. Currently, only about 100 accessions have been collected and conserved by various organizations, namely Laboratory of Biotechnology, Genetic Resources, Animal and Plant Breeding (Dassa-Zoumè, Benin), University of Development Studies (Tamale, Ghana), Gembloux Agricultural University (Belgium) and [Institut de Recherche pour le Développement (IRD)] (Montpellier, France) [25, 33, 43]. This is a great limiting factor for the promotion, improvement of the crop productivity and its conservation since its cultivation is even threatened of extinction in some areas [24, 27, 33, 64]. Investing in the discovery or the development of genetically superior varieties is a viable and important option for increasing productivity [65, 66]. Thus, in order to improve Kersting's productivity and limit the extent of genetic loss, there is a need to undertake an extensive collection, characterization and evaluation of the available Kersting's groundnut germplasm. In so doing, varieties meeting both farmers and consumers' preferences or varieties with important traits to be exploited in breeding programs can be identified [67–70]. This will also be important to get useful information for the definition of core collection for conservation and materials sharing purposes among scientists.

Diversity and genomic dissection of Kersting's groundnut

Few studies have addressed the assessment of genetic diversity of Kersting's groundnut. Assogba et al. [25] and Bayorbor et al. [71] collected and characterized 12 and 32 Kersting's groundnut landraces in Ghana and in Benin, respectively, using agro-morphological traits and obtained three groups of accessions. These studies are limited to specific areas, which may limit the extent of diversity covered and the discovery of useful traits from

landraces in other growing countries. Pasquet et al. [33] used biochemical markers (allozyme) to characterize 18 domesticated accessions from Togo and Burkina Faso and two wild accessions of Kersting's groundnut. These authors found total absence of diversity within and among domesticated accessions as well as within and between both wild accessions. This revealed an extremely narrow genetic base of Kersting's groundnut, which results from a very strong genetic bottleneck [33]. The narrow genetic base of the crop is not likely to favor genetic gain in breeding programs [72]. Therefore, measures should be taken up in order to broaden its genetic base through intensive collection. The self-pollinated nature of the chasmogamous flowers of the crop prevents hybridization and constitutes a breeding barrier, limiting the extent of genetic diversity [33]. Severe limitation is then put on genetic improvement since "plant breeding is based, ipso facto, on genetic variation" [73]. Hence, the need is to increase genetic diversity in Kersting's groundnut germplasm [74]. Thus, mutation induction in the cultivated accessions of Kersting's groundnut may be an important tool to broaden the genetic base of this species and offer valuable materials for genetic improvement. This technique has been used in legume crops such as chickpea [75], lentil [76] and other crop species [77]. Incorporation and wide hybridization are also used in broadening crop genetic base [75, 78, 79], but as there is currently no known wild relative of Kersting's groundnut and the diversity is extremely low, their application will be limited.

There is no available genomic information for Kersting's groundnut. Therefore, knowledge on genetic variation within the cultivated Kersting's groundnut germplasm and the capacity to trace its divergence from the wild type have not benefited from the recent development of DNA-based markers yet. However, owing to the conservation of genome structure and function between legumes species, developed tools as molecular markers in well-researched and related species can be transferred and used in Kersting's groundnut [63, 80, 81]. Thus, molecular characterization of germplasm collections using genomic tools will speed up the discovery of important agronomic traits by construction of linkage and association map.

Improvement of Kersting's groundnut productivity: potential for yield increase

The low yield of Kersting's groundnut as for many other crops in sub-Saharan Africa is due to poor agronomic management and lack of improved varieties [29]. The use of Bradyrhizobium CB 756, a rhizobium strain, was proven to be able to induce nodulation in Kersting's groundnut [82]. This finding opened the door for further investigation in the use of inoculant to improve the productivity of the crop. Thus, [44] showed that the application of rhizobium resulted in yield increase to up to 1556 kg ha^{-1}. However, the success of inoculation can be locality dependent and further on-farm researches involving farmers in the various growing areas should be undertaken [44, 83, 84]. To increase the chances of getting efficient strains, the structure and the symbiotic capabilities of indigenous rhizobium populations and their competitiveness should be assessed [83–86]. This lies in the fact that local strains can be more efficient than exogenous strains that were previously proven to be highly efficient on other legume crops [84, 87].

Kersting's groundnut responded well to inorganic nitrogen application. In fact, oppositely to other symbiotic legumes, nodule functioning in Kersting's groundnut is tolerant to nitrate in the root medium [88]. As a consequence, inorganic fertilizer can be applied without affecting the nodule function [88]. Thus, in Benin, [40] suggested that the application of 100 kg ha^{-1} of the complex mineral fertilizer (16–16–16) can improve Kersting's groundnut yield up to 967 kg ha^{-1} as compared with the average nationwide yield of about 600 kg ha^{-1} [58]. This technology needs, however, to be disseminated to farmers.

So far, there has been no breeding program aiming at improving Kersting's groundnut. This limits the development of improved varieties and hinders actions seeking the promotion of the crop. Coping with this challenge will require state funding more than market-driving breeding programs which is oriented to major crops [7].

Conclusion

This paper shed light on the potential of Kersting's groundnut and ways to promote its cultivation in the growing areas. Increasing the production of such crop is likely to contribute to food security and constitute an option to improve the resilience of rural population to drought. The seeds are highly nutritious, rich in amino acid and show interesting features to be incorporated in infant food formulation and other industrial products. The use of the seeds to treat several ailments was pointed out. Kersting's groundnut is of cultural importance in some of the growing areas, and it contributes to enhance soil fertility. However, the crop is still suffering from a lack of support from both decision makers and researchers. Therefore, there is a lack of innovation to promote its cultivation and farmers faced several constraints leading to its abandonment. In order to bring the crop from its current status of neglected and underutilized species, its value chains should be promoted based on appropriate choice of drivers. Thus, awareness needs to be raised on the crop by calling attention to its potentials mainly

in ensuring nutritional security. The different potential of the crop should be given research priority. Genetic resources of Kersting's groundnut should be properly collected, characterized and conserved. Furthermore, public support to breeding program targeting the crop should be encouraged in order to contribute to the development of improved varieties.

Abbreviations
IRD: Institut de Recherche pour le Développement; IUCN: International Union for Conservation of Nature.

Authors' contributions
MATA conceived and carried out the review. VAE participated in drafting and revising the manuscript. Both authors read and approved the final manuscript.

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Competing interests
The authors declare that they have no competing interests.

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