

Enhancing livelihoods and resilience of smallholder farmers to climate change through the scaling up of value chains of indigenous fruit species: the case study of Baobab in Benin

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Abstract

The project “Scaling up African baobab food products valuation through enhancement of their safety and value chains for food and nutritional security in Benin” implemented from March 2018 to March 2023, aimed at combining both participatory research and capacity building activities to establish a long-lasting valorisation scheme for the African baobab at a national scale in Benin. It helped to enhance the livelihoods and resilience of smallholder farmers to climate change by (i) developing sustainable plant propagation techniques for leaves and fruit production within farmer fields, making it possible to expand access to this nutritious plant while reducing pressure on wild populations of the species and conserving biodiversity, and (ii) improving processing techniques of derived food from the species plant parts to ensure micronutrients availability and increase the safety of baobab-related products for the communities. It was a business-oriented project with the dual aim to reduce pressure on the wild population of baobab while benefiting from the development of the baobab value chains. Its implementation highlighted the importance of the species regarding climate change mitigation and adaptation to its impacts.

Keywords: African baobab, biodiversity conservation, climate change resilience, nature-based solution, wild edible plant species

Résumé

Le projet "Valorisation des produits alimentaires du baobab africain par l'amélioration de leur sécurité et des chaînes de valeur pour la sécurité alimentaire et nutritionnelle au Bénin", mis en œuvre de mars 2018 à mars 2023, visait à combiner à la fois la recherche participative et les activités de renforcement des capacités pour établir un schéma de valorisation durable du baobab africain à l'échelle nationale au Bénin. Il a permis d'améliorer les moyens de subsistance et la résilience des petits agriculteurs face au changement climatique en

(i) développant des techniques de propagation végétale durables pour la production de feuilles et de fruits dans les champs des agriculteurs, rendant possible l'accès élargi à cette plante nutritive tout en réduisant la pression sur les populations sauvages de l'espèce et en conservant la biodiversité, et (ii) en améliorant les techniques de transformation des aliments dérivés des parties de la plante pour assurer la disponibilité des micronutriments et augmenter la sécurité des produits liés au baobab pour les communautés. Il s'agissait d'un projet orienté vers les affaires avec le double objectif de réduire la pression sur la population sauvage de baobab tout en bénéficiant du développement des chaînes de valeur du baobab. Sa mise en œuvre a mis en évidence l'importance de l'espèce en ce qui concerne l'atténuation du changement climatique et l'adaptation à ses impacts.

Mots-clés: baobab africain, conservation de la biodiversité, résilience au changement climatique, solution fondée sur la nature, espèces de plantes sauvages comestibles

Introduction

The impacts of climate change are increasingly irreversible on all components of nature (IPCC, 2023). Although emissions from developing countries, particularly in Sub-Saharan Africa, are quite low, this region is expected not only to be the most affected but also the least capable to face the projected negative impacts of climate change (IPCC, 2023). Several promising approaches including ecosystem-based adaptation (EBA) are being considered to ensure local adaptation to climate change (Fandohan *et al.*, 2015). These ecosystem-based approaches for adaptation to climate change imply the use of local biodiversity and ecosystem services as adaptive strategies to help people face the adverse impacts of climate change (Convention on Biological Diversity, 2009). Within this EBA framework, indigenous wild edible plant species are seen as key components because of their potential role in buffering climate change's sociocultural and economic impacts, and their strong ability for environment stabilization and ecological restoration (Bayala *et al.*, 2014). These resources are often rich in micronutrients and can be used in food-to-food fortification. If well structured, their value chains can strategically contribute to improving farmers' revenues and hence improve their livelihoods. These resources are also hands-on and local people use them raw, or partially processed. Among them, is the African baobab (*Adansonia digitata* L.), one of the most remarkable trees in the world (Gebauer *et al.*, 2016). Several studies in different African countries have highlighted this indigenous fruit tree as a priority species for domestication and expanded use (Gebauer *et al.*, 2016). In many countries in West Africa including Benin, the leaves, and fruit pulp are the important ingredients in sauces, porridges and beverages (Chadare *et al.*, 2009). Its importance in human nutrition is well established and this is driving the development of a growing local and increasingly global market. Despite the huge nutritious and economic importance of the species' pulp, leaves and derived products, its Value Chains in Sub-Saharan Africa are still underdeveloped. At the same time, the over-utilization of wild baobab saplings has been affecting its natural regeneration. Indeed, the big challenge the species is facing is a high risk of extinction in the wild where it is threatened because of high pruning by bush fire (seedlings), grazing and lack of natural regeneration. The BAOCHAIN project, implemented from March 2018 to March 2023, was established to enhance the potential for baobab to address food security in the relatively arid regions it occurs. This project addressed issues across the baobab value chain by (i) developing sustainable plant propagation techniques for leaves and fruit production within farmer fields,

making it possible to expand access to this nutritious plant while reducing pressure on wild supplies and conserving biodiversity, and (ii) improving food processing techniques to ensure micronutrients availability and increasing safe baobab-related products for the communities.

Overview of the project. Promoting value chains of multipurpose indigenous fruit species that are well adapted to local conditions is key to enhance the livelihoods and resilience of smallholder farmers to climate change, especially in semi-arid and arid regions. This is the focus of the project “*Scaling up African baobab food products valuation through enhancement of their safety and value chains for food and nutritional security in Benin*”. The project BAOCHAIN developed sustainable plant propagation techniques for leaves and fruit production within farmer fields, making it possible to expand access to this nutritious plant while reducing pressure on wild populations of the species and conserving biodiversity. It also improves processing techniques of derived food from the species plant parts to ensure micronutrients availability and increase the safety of baobab-related products for the communities. It is a business-oriented approach with the dual aim to reduce pressure on the wild population of baobab while benefiting from the development of the baobab value chains.

Indeed, the baobab value chain (VC) has been so far disregarded in many government agendas. In this context and based on outcomes of earlier projects/initiatives on baobab (DADOBAT, 2006-2010; CORAF/WECARD, 2014-2016; RU-GRG 135, 2015-2017; RU-GRG 125, 2015-2017), a more comprehensive innovation platform was established to consider the full value chain. This project was implemented from March 2018 to March 2023. It was a multi-actors participatory research for actions initiative, that developed a platform to support a sustainable and operative baobab value chain in Benin for its most valued products (leaves and pulp) focusing on human nutrition. The project was built around six work packages to facilitate university-Technical and Vocational Education and Training institutions (TVET) and community linkages to upgrade baobab products’ Value Chains while improving farmers’ livelihoods and baobab conservation. In this frame, the activities of the project were implemented with regard to climate change adaptation and mitigation following a nature-based approach.

Baobab tree: an asset for local communities to adapt to climate change. From the adaptation point of view, this project has highlighted the importance of the baobab tree, in particular the products derived from its pulp and leaves, for the survival of communities during periods of lack of food resources. Indeed, communities have been living on baobab resources (pulp and leaves) for ages without structuring the value chains around them. Through this project, the economic potential of the species has been demonstrated. For instance, the upgrading of baobab pulp processing generated between 3.12 USD and 12.81 USD per kg of baobab pulp, and the processing of fresh leaves created about 0.41 USD per kg of dry weight of baobab leaves. This species was therefore seen as a great alternative to revenue generation for local communities, and this is an interesting asset which could be used in adaptation mechanism. Moreover, the nutritional value of the pulp and young leaves of the species was assessed and improvement of the processing techniques were developed in order to help communities and consumers of baobab derived products to have access to healthy products to satisfy their daily requirement in nutrients (iron, calcium, magnesium and vitamins A and C). In this context, the research activities of the project, specifically in food sciences and technology, enabled the development of five key technologies: seasoned baobab leaf powder;

complementary food supplement (CFSs); *mutchayan*, a fermented cereal dough enriched with baobab pulp; maize flour enriched with baobab pulp; pasteurized baobab nectar drink. All these technologies have widely been up taking by the communities. There was a positive impact on consumers who now have access to more healthy foods and drinks. For instance, the baobab fortified complementary foods are reaching many households with porridge, drinks and baby-food and contributing to malnutrition reduction. The dried baobab leaves have increased access of urban areas as well as rural areas to these nutritious vegetables.

Furthermore, the research activities on propagation of baobab enabled the development of three technologies: baobab leaves production within 45 days, final slot grafting and side veneer grafting to support earlier fruiting. These technologies were developed as low-risk activities for agroforestry purpose in order to particularly reduce harvest pressures on the wild populations of the species. In fact, activities of the project showed that planting baobab from seeds for the production of leaves in permanent gardens is promising. For instance, young leaves of the species can be sustainably available as vegetable for consumption from 45 days onwards after sowing the seeds (41.62 ± 1.16 kg of dried matter of leaves per 100 m²). From the grafting experimentations, grafted seedlings have the advantage of having identical characteristics as the mother tree and show a shortened period to fruit production as they may start flowering less than five years after grafting instead of 8-12 years after plantation from seeds. These results provided a solid basis for further domestication of African baobab with positive consequences for food security and nutrition and biodiversity as well. Indeed, with these technologies, farmers could improve the availability of young leaves since growing them in farm gardens will reduce the frequency of accidents due to the dangers of climbing baobab trees to harvest leaves from the wild. Also, impacts of climatic risks (rain scarcity, high temperature) could be perceived as less affecting the availability of young leaves from wild populations of the species since the young leaves can now be horticulturally produced by farmers. Approximately, 400 out of the 700 farmers and food processors exposed to the opportunities have taken up the developed technologies. These farmers and food processors have improved their production capacity and their marketing of baobab products, refining their livelihoods and their food security.

Baobab for mitigation action toward climate change. *Adansonia digitata* is a long living (up to 1200 years) tree species occurring in arid and semi-arid regions of Africa. Promoting its value chain is a way to strengthen its domestication through plantation and sustainable valorisation. In the frame of the BAOCHAIN project, demonstration gardens have been installed in the two TVET institutions (1 ha at LTA Natitingou and 4.5 ha at LAMS). This initiative aims at demonstrating the feasibility of the plantation of the species. From a mitigation point of view, *A. digitata* is one of the strategic tree species with important carbon sequestration potential. For instance, it has been estimated that a single baobab tree can sequester about 0.72 tons of carbon from seedling to the age of 18 years. Thus, a plantation of 1 ha of baobab (100 trees) can sequester 72 tons of carbon from seedlings to the age of 18 years. The domestication of such species by local communities and its plantation through Government initiatives could highly contribute to climate change mitigation by removing important amounts of carbon from the atmosphere. The BAOCHAIN project has trained 6 university students (BSc and Master) and 11 TVET students and strengthened the capacities of 500 farmers of the vegetative propagation and plantation of baobab trees. These human resources could be useful for such an initiative.

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