Project Title: Indigenous knowledge, genetic diversity and domestication of baobab tree (*Adansonia digitata* L.) in Benin (West Africa).

FINAL TECHNICAL REPORT

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May 2008

1. FORWARD

The present study partially financed by the Rufford Small Grant for Nature Conservation, is a component of a baobab (*Adansonia digitata* L.) conservation and domestication research program being undertaken in Benin and in West Africa. The project is planned to be executed for a period of 18 months (December 2006 – May 2008) and aims at combining molecular analyses (AFLP) and ethnobotanical surveys to develop optimal strategies for conservation and sustainable utilization of baobab genetic resources in Benin. Specifically, it will consist in (i) ethnobotanical survey (first semester), (ii) germplasm collection for molecular analyses (second semester); and (iii) propagation tests (seeds and vegetative) in order to see the potential for domestication of the species (third semester).

A first report (December 2006 – May 2007) focused on the ethnobotanical studies. From the outputs, a scientific article titled *"Folk classification, perception and preferences of baobab products in West Africa: consequences for species conservation and improvement "* is recently published in *Economy Botany* [62(1):74-84], a peer-review scientific journal with impact factor.

The second step of the study consisted in baobab leaves sampling for DNA extraction and fingerprinting using AFLP markers. To this aim, genetic diversity and differentiation within and between baobab populations and locally recognised morphotypes (group of baobabs sharing some linked traits identified by local people) were assessed. Based on the outputs, a scientific article titled *"Genetic fingerprinting using AFLP cannot distinguish traditionally classified baobab morphotypes. Agroforestry Systems*" has been submitted and accepted for publication in *Agroforestry Systems* [DOI: 10.1007/s10457-008-9157-y], also a peer-review scientific journal with impact factor.

The third and final step consisted in the sampling of germplasms for propagation tests and in the organization of workshops with local people. Several propagation (grafting, cutting, layering) and germination techniques have been applied in nursery conditions to assess the easy propagation of the species. Moreover, workshops have been organised among local people to discuss conservation and domestication strategies of baobab in Benin.

2. ACCOMPLISHED ACTIVITIES DURING THE GRANT PERIOD

2.1 Ethnobotanical surveys within local people **(***December 2006 – Mai 2007)*

2.2 DNA extraction and fingerprinting using AFLP markers (June 2007 – November 2007)

2.3 Propagation tests for domestication: seeds germination and vegetative propagation tests: grafting, cutting and layering (December 2007 – May 2008)

2.4 Dissemination of research outputs (throughout the research period)

- *2.4.1 Publications of 2 articles in peer review journals with Impact Factor (see below for the references). The original publications are available at www.springerlink.com.*
    - Assogbadjo A.E, Kyndt T., Chadare F.J., Sinsin B, Gheysen G, Eyog-Matig O. & Van Damme P. (2008). Genetic fingerprinting using AFLP cannot distinguish traditionally classified baobab morphotypes. *Agroforestry Systems:* DOI:10.1007/s10457-008-9157-y
    - Assogbadjo A.E., Glèlè Kakaï R., Chadare F.J., Thomson L, Kyndt T., Sinsin B., Van Damme P. (2008). Folk classification, perception and preferences of baobab products in West Africa: consequences for species conservation and improvement. *Economic Botany* 62(1): 74-84.
- *2.4.2 Workshops with local communities, NGOs and other stakeholders have been organized to discuss conservation and domestication strategies related to the species in Benin.*
- *2.4.3 Participation at two international conferences* (see below for conference details)
    - International Symposium "Underutilized Plant Species for food, nutrition, income and sustainable development" **Arusha, Tanzania**, 3-7 March 2008
    - 5th international conference on new crops and uses; **Southampton, United Kingdom;** 3 - 4 September 2007.

2.5 Submission of 2 interim reports and final reports (technical and financial) to The RSG.

3. INTRODUCTION

The multipurpose baobab (*Adansonia digitata* L.) is a key economic species used daily in the diet of rural communities in West Africa (2005a,b; Codjia *et al*. 2001; 2003; Sidibe and Williams, 2002). The species contributes to rural incomes (Diop *et al.* 2005) and has various important medicinal and food uses (Assogbadjo *et al.* 2005a; Delisle *et al*. 1997; Diop *et al.* 2005; Sena *et al*. 1998; Sidibé *et al.* 1996; Sidibé and Williams 2002; Yazzie *et al*. 1994).

Within baobab species, there is evidence indicating the existence of a number of local forms differing in habit, vigor, size, quality of the fruits and foliar vitamin content (Assogbadjo et al. 2005a; Gebauer et al. 2002; Sidibé and Williams 2002). However, information about the ecology, the morphological and genetic variation within and between populations of both species and the productivity of their various organs is lacking (Sidibé & Williams, 2002).

The participatory domestication of indigenous fruits has been proposed as an appropriate means to alleviate poverty (Poulton & Poole 2001), and could also have positive benefits on the environment since new plantings of baobab would help to restore the declining resources of this important tree.

The main objective of the present study is to combine modern molecular tools and ethnobotanical surveys as well as propagation techniques to define and analyse a better conservation and domestication strategies for the species in Benin. To this aim, an ethnobotanical survey was conducted to assess local recognised morphotypes of these species in rural area of Benin. Also, Amplified Fragment Length Polymorphism (AFLP) analysis (Vos *et al*. 1995) was applied to find the intra-specific genetic diversity of those locally recognised morphotypes and on the whole populations in order to assess the genetic diversity and differentiation within and between baobabs in Benin. Because AFLPs are known to map throughout the genome of any particular species analyzed so far, this high-volume DNA fingerprinting techniques gives fast and efficient measurements of genome-wide diversity (Powell *et al*., 1996). We used this technique to investigate not only if the traditional classifications of *A. digitata* are confirmed by genome-level genetic differentiation but also if there is within the species some genetic variations which should be conserved for the benefit of local people.

Finally, baobab germplasm have been collected for propagation tests.

4. MATERIALS AND METHODS

4.1 Study areas

The study was conducted in the three climatic zones of Benin (112 622 km^2 and 6.752.569 inhabitants in 2002), located between 6° and 12°50 N and 1° and 3°40 E in West Africa. The zones studied are: the Sudanian zone located between 9°45' - 12°25' N, the Sudano-Guinean zone located between 7°30' - 9°45' N and the sub-humid Guinean zone (Dahomey Gap) located between 6°25' - 7°30' N.

- ***Sudanian zone***

The annual mean rainfall in the Sudanian zone is often less than 1000 mm and the relative humidity varies from 18% during the harmattan period (December – February) to 99% in August. The temperature varies from 24°C to 31°C. The Sudanian zone has hydromorphic soils, well-drained soils, and lithosols. The vegetation of this zone is composed of savannas and gallery forests with trees of smaller size. The main activities of local people in this zone, like the rest of Benin, are agriculture, extensive animal husbandry, and the illegal and heavy logging of woodland and gallery forests.

- ***Sudano-Guinean zone***

The mean rainfall in Sudano-Guinean zone is unimodal, from May to October, and lasts for about 113 days with total mean annual varying between 900 mm and 1110 mm. The annual temperature ranges from 25°C to 29°C, and the relative humidity from 31% to 98%. The soils in this zone are infertile mineral soils and ferruginous soils of variable fertility. The vegetation of the Sudano-Guinean transition zone is characterized by a mosaic of woodland, dry dense forests, tree and shrub savannas and forest galleries.

- ***Guinean zone***

The rainfall regime in the Guinean zone is bimodal from April to June and from September to November, with a mean annual rainfall of 1200 mm. The mean temperature varies between 25°C and 29°C and the relative humidity between 69% and 97%. The soils are either deep ferrallitic , and of low fertility or alluvial and heavy clay soils. The vegetation in this zone has been strongly affected by various agricultural activities and now forms a mosaic of cultivated lands and small relic forest patches. The original vegetation was dense semi-deciduous forests and Guinean savannas. This zone represents about 10 % of Benin and supports 60 % of the country’s inhabitants.

4.2 Studied ethnic groups

In each zone, the following ethnic groups were considered: (i) in Southern-Benin: Adja, Fon, Mina and Goun; (ii) in Central-Benin: Datcha, Nago and Lokpa; and (iii) in Northern-Benin: Dendi, Otamari (Somba), Djerma, Haoussa and Peulh (Figure 1).

4.3 Methods

4.3.1 Ethnobotanical surveys

Investigations have been done in the three climatic zones of Benin. In the country, sampling of localities has been done in the areas where local ethnic groups have been shown to have an outstanding and important knowledge on the baobab and where the latter is used for their daily needs. In total, structured interviews have been conducted among 112 women and 151 men of different ages in 9 ethnic groups. Interviews included questions on perception and human/cultural meaning of morphological variation, use forms, preferences (desirables/undesirable traits) and links between traits. Statistical analyses included descriptive statistics and principal component analyses (PCA).

4.3.2. Sampling for DNA fingerprinting

Six baobab populations with 30 individuals per population (180 individuals in total) have been sampled from the three climatic zone of Benin, specifically in the areas where local ethnic groups have an outstanding and important knowledge on the species. From the ethnobotanical survey, eight morphotypes of baobab were identified by local people within the sampled baobab populations, a morphotype being defined as a group of baobabs sharing some linked traits identified by the ethnic groups. For each sampled baobab, four or five leaves were harvested and dried in silica gel for DNA extraction and AFLP analysis.

4.3.3 Genetic data analysis

DNA were isollated following the MATAB protocol (Kelly *et al*., 2004) whereas AFLP analysis were performed as described by Vos *et al* (1995) with minor modifications. For each individual, the DNA fingerprints were scored by visual inspection for presence (1) or absence (0) of specific AFLP-bands. Only distinct, major bands were scored. For statistical analyses, allele-frequency based analyses of genetic diversity and structure were performed using AFLPsurv version 1.0. (Vekemans 2002) which is based on the methods described by Lynch & Milligan (1994). Nei's (1973) gene diversity (also known as expected heterozygosity) as well as global and pairwise genetic differentiation (F_{ST}) values were computed. Significance of the genetic differentiation between groups was tested by comparison of the observed F_{ST} with a distribution of F_{ST} under a hypothesis of no genetic structure, obtained by means of 1000 random permutations of individuals among groups. Moreover, a model-based (Bayesian) clustering method was applied on the presence/absence matrix to infer genetic structure in the dataset, using the software Structure version 2.0. (Pritchard et al. 2000).

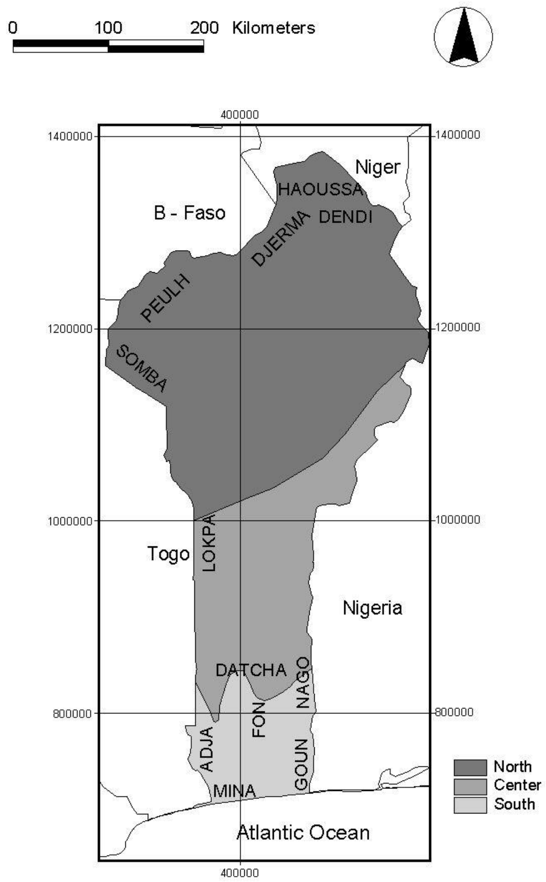


Figure 1: studied ethnic groups

4.3.3 Propagation tests for baobab

- ✓ *Seeds sampling for germination tests*

Seeds has been sampled within the three climatic zones of Benin. Within each climatic zone, 10 individuals of baobab have been randomly selected. For each sampled tree, 10 capsules have been randomly sampled for seeds collection.

- ✓ *Germination tests*

For each provenance (climatic zones), several types of substrates have been compared: sand (100 %); sand (1/3) + organic matter (2/3); sand (1/4) + organic matter (3/4). More over, in order to test the hypothesis that germination is inhibited by the seed coat, the experiment has been designed to compare the germination capacity of intact seeds with that of seeds from which a 5–10mm² fragment of coat has been removed with pruning shears. The whole design has been replicated three times and arranged in split plot within homogenous randomised blocks. For data analyses, the percentage of germination of seeds has been recorded. Moreover, growth rate (height, diameter at basal area) has been recorded for each treatment.

Baobab seeds germination tests in nursery condition

- ✓ *Vegetative propagation*

Three major vegetative propagation tests have been assessed: grafting, cutting and layering. The main advantage of these techniques is to avoid a great deal of heterogeneity which results from seed propagation.

- *Grafting*

The rootstocks and scions were selected on the basis of good physical and sanitary characteristics (vigorous growth and absence of parasites) of baobab seedlings already established before the beginning of the project. Their height ranged between 50 and 150 cm and diameter between 3 and 6 cm. The used rootstocks were 24 months old seedlings. Two methods of grafting were investigated: side cleft and side veneer grafting. In all cases, a plastic film was used to control transpiration. Scions were collected in the same area like the rootstocks. A success rate was assessed in order to assess the easy propagation of baobab using the two grafting methods.

Baobab grafting in nursery condition

- *Cutting*

Stem cutting has been taken from pruned branches of seedling (24 months old) and rooted in nursery condition to test the easy propagation of baobab by this technique. The experiment has been designed within a randomized blocks. The used substrates (sterilized or not) was composed by sand (½) + organic matter (½). To stimulate the rooting, Indole Acetic Acid (IAA 1%) as well as Alpha Naphtalen Acetic Acid (ANA 1%) was used. The survival of scions has been assessed each day for a 4 months duration experiment.

Cutting of baobab in nursery condition

- *Layering*

The used substrates for layering techniques were composed only by sterilized organic matter. Two types of hormones have been used (Indole Acetic Acid (IAA) and Alpha Naphtalen Acetic Acid (ANA)) to stimulate the rooting process.

Baobab layering (air and soil) in nursery condition

5. RESULTS

5.1 Indigenous knowledge on baobab: Folk classification and local perception

Local people used 13 criteria to differentiate baobab individuals in traditional agroforestry systems. These criteria are related to the characteristics of leaves, fruits, bark and the whole tree. Based one the variants, several types of baobab were distinguished in the traditional agroforestry systems of Benin. Using colour and structure of bark as criteria, 3 types of baobab can be distinguished by local people of Benin: baobab with pink and smooth bark, baobab with rough and gray bark and baobab with smooth and gray bark.

Using the shape and size of the fruits, 4 types of baobab can be distinguished: baobab with small size capsules, fruit with middle size and long shape, baobab with middle size and round shape, baobab with big size capsules. Using the taste of the leaves, two types of baobab can be distinguished: baobab with bitter leaves and baobab with delicious leaves. Using the taste of the pulp, local populations distinguish the baobab with sweet pulp and the baobab with acid and slightly acidic taste. Using the tree fertility as criteria, local people distinguished two types of baobab tree: female tree producing fruits and male tree, which never produce fruits.

Concerning the preferences, baobab trees having delicious leaves, sweet or slightly acid pulp, non slimy pulp, yellowish pulp, capsules producing high yield of pulp, bark easy to harvest, and which are considered as female are the desirable ones in rural areas of Benin. In contrast, the undesirable baobabs are the male trees (never produce) or the ones producing acid pulp, slimy pulp, tasteless kernel, bitter leaves, hard seed coat, low yield of pulp and/or having bark difficult to harvest are the ones which are undesirable in rural areas of Benin. Moreover, Ditamari people from Benin have outstanding knowledge to link specific traits. For the latters, hairy leaves are always tasteless, male baobabs always give tasteless leaves, fruits with middle size and long shape always gives sweet pulp; baobab tree with precocious or tardy maturity of the fruits always produce sweet pulp.

5.2 Genetic variation within and between baobab populations and morphotypes

5.2.1 Genetic variation within baobab species in Benin

When bands from all 180 sampled individuals were considered, levels of polymorphism within populations varied between 89.4 % and 98.2 %, reflecting a high level of polymorphism and variation within populations. The highest estimate of the likelihood of the data, conditional on a given number of clusters, was obtained when clustering all genotypes into six gene pools. Results indicated that the genetic structuring of the sampled individuals was correlated with their geographic origin. Nei's gene diversity (expected heterozygosity) within populations ranged between 0.26 and 0.37. A three level AMOVA partitioned 14.70% among the three regions of Benin and 5% of genetic variation among populations within regions. Analysis of population structure with allele-frequency based *F*-statistics revealed a global F_{ST} of 0.127 ± 0.072 (P = 0.001). The total gene diversity (Ht) was estimated to be 0.355 ± 0.02 while the mean gene diversity within populations (Hw) and the average gene diversity among populations (Hb) were estimated at 0.309 and 0.045 ± 0.072, respectively. Pairwise genetic distances between populations (F_{ST}), calculated using AFLPsurv 1.0, were statistically significant (P < 0.001). Within the same climatic region, the genetic distance is generally lower than 0.05, whilst genetic distance between populations located in the different climatic zones were larger than 0.05. Mantel tests comparing genetic differentiation and geographic distance per population showed a significant correlation of 0.758 (P < 0.001), indicating isolation by distance.

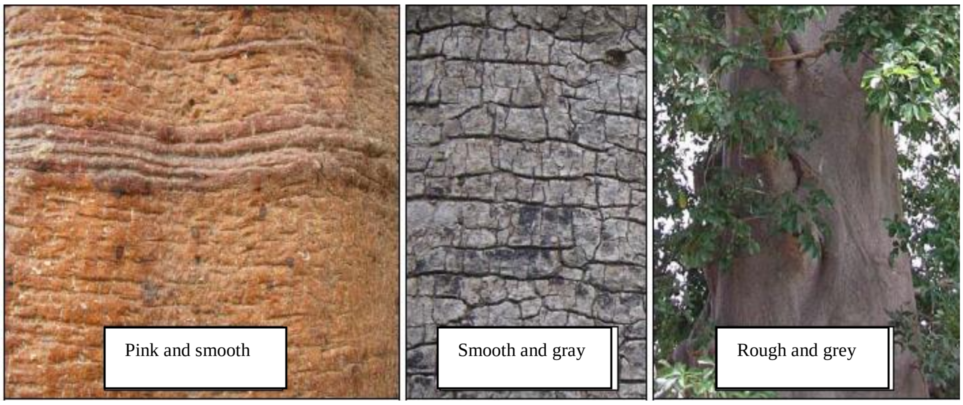
5.2.2 Genetic variation within morphotypes

Nei's gene diversity within morphotype ranged between 0.29 and 0.37 indicating a substantial amount of variation within locally recognised morphotype. Analysis of population structure with allele-frequency based *F*-statistics revealed that morphotypes are not significantly differentiated from each other at genetic level. A non-significant F_{ST} value was observed within the country. Pairwise F_{ST}-values confirmed that none of the analysed morphotypes are genetically differentiated. As such genetic fingerprinting with AFLPs did not correlate with the traditional morphological classification of the identified morphotypes of baobab in rural areas of Benin.

Capsules variability

Pulp color variability

Seeds variability in baobab



Bark color variability in baobab

5.3 Propagation test for baobab

5.3.1 Germination

- ✓ ***Percentage of germination according to treatments***

Percentage of seed germination is generally low and varied according to the treatments (table 1). Based on seeds provenance, the mean percentage of germination varied from 18.70% (Seeds from Sudanian zone) to 21.48 % (seeds from Sudano-Guinean zone) and 37.22 % (seeds from Guinean zone). Moreover, the number of days between seedlings and first rising varied from 5 to 6 days whereas the number of days for the maximal rising varied 20 days (Guinean) to 23 days (Sudanian and Sudano-Guinean).

Based on the used substrates, sand (ferralitic soil) has given the best mean rate for seed germination (32.04 %) compared to the substrates S2 (23.30 %) and S3 (22.06 %).

Mean percentage of germination varied from 16.34 % for the scarified seeds to 35.50 % for the non-scarified one. The ANOVA showed a high significantly difference for the percentage of germination according to the seeds provenance ($P < 0.0001$), the used substrates ($P = 0.0003$) and the seeds scarification ($P < 0.0001$).

Table 1: Percentage of seed germination per treatment after 30 days

PROV	SUB	SCAR	Mean	SD
S	S1	NS	36.47	24.73
S	S1	GS	5.26	14.67
S	S2	NS	32.63	23.30
S	S2	GS	6.66	11.88
S	S3	NS	25.88	18.39
S	S3	GS	6.66	9.70
SG	S1	NS	23.33	21.96
SG	S1	GS	41.11	24.22
SG	S2	NS	15.55	18.85
SG	S2	GS	13.33	16.80
SG	S3	NS	10.00	12.37
SG	S3	GS	25.55	24.55
G	S1	NS	67.06	18.63
G	S1	GS	23.16	19.16
G	S2	NS	58.88	14.51
G	S2	GS	12.22	18.33
G	S3	NS	51.11	27.63
G	S3	GS	13.33	18.15

Legend: PROV : provenance ; S: Sudanian zone ; SG : Sudano-guinean zone : G : Guinean zone ; SUB : Substrate ;S1 : sand (100 %) ; S2 : sand (2/3) + Organic matter (1/3) ; S3 : sand (1/4) + Organic matter (3/4) ; SCAR : Scarification ; ; GS : Scarified seed ; NS: Non scarified seeds ; Sd: standard of deviation.

- ✓ ***Growth of baobab seedlings***

The seedlings height assessment revealed a significance difference according to the used substrates ($Pr < 0.0001$) and scarification ($P = 0.0084$). Moreover, provenance has not significantly influence the height growth of seedlings. The seedlings basal diameter growth varied significantly according to the substrates ($P = 0.0178$).

5.3.2 Vegetative Propagation Tests

- ***Grafting***

The grafting test resulted in 100 % success. Consequently baobab can be grafted easily for propagation of desired trees.

- ***Cutting***

Success of cutting rate of baobab varied significantly according to the used substrates. The sterilised substrate yielded more success than the non-sterilised substrate. The combination S1&HO has yielded the highest rate of success (33.33 %) whereas combination S2&HO and S2&H1 has yielded the lowest rate (20 %). However, no statistical difference is observed for the used hormones.

- ***Air Layering***

No observation till now and the experiment is still ongoing.

- ***Layering***

No observation till now and the experiment is still ongoing.

6. DISCUSSION & CONCLUSIONS

6.1 Local perception and genetic diversity in baobab species

The analysis, involving a comparison between an ethnobotanical survey and a genetic analysis of baobab individuals, shows that AFLP fingerprinting cannot distinguish the traditionally classified forms of *A. digitata*. These morphotypes seem to include a substantial amount of genetic variation and are not differentiated from each other on genome-wide scale. An explanation for the lack of observed genetic differences between morphotypes may be a result of phenotypic plasticity in the species so that phenotypic differences observed between locally recognized morphotypes are plastic responses to differences in habitat. This phenomenon was found in several species of tropical and temperate trees for many traits, usually in response to the changes in climate (Kramer, 1995; Kitajima et al., 1997; Heaton *et al*., 1999). It is possible that strong non-genetic effects underlie the traditional classifications. Baobab characteristics such as, pulp and leave taste, fertility of the tree which were the traits used for the traditional classification in this study, might be to a large extent dependent on environmental factors. Indeeed, for African baobab, Assogbadjo *et al.* (2005) observed in some phenotypic studied characters of the species, significant correlations with abiotic factors of environment (temperature, rainfall, humidity and soil conditions). Also, Soloviev *et al.* (2004) showed for *Balanites aegyptiaca* and *Tamarindus indica* (savanna trees) the significant influence of different climatic zones of Senegal on fruit pulp production.

Since no genetic differentiation is found between the locally recognized morphotypes, a morphotype-based approach in the collection of genetic variation for conservation programs is not advisable. However, farmers are able to guide breeders in collecting germplasm from trees since they have knowledge to distinguish types of baobab. This can allow selecting the “plus tree“for propagation, and planning a domestication programme, combining indigenous knowledge and genetic findings.

6.2 Traditional knowledge and genetic improvement of baobab

From the outputs of this study, we observed that there are some specific traits, which are desired only in some ethnic groups. For instance, baobabs producing small capsules are only desired in Ditamari area while those producing big capsules are preferred in Dendi area. As such, selection and breeding programmes yielding on the propagation of baobabs producing big capsules will probably be more applicable in Otamarilands, where local people desire the small capsules. Consequently, it will be more relevant to define for each area specific selection and improvement programme of baobab taking into account the most important and desired traits for local people in the considered area.

The practical approach is to seek trees, which have particular, market-oriented, trait combinations such as big capsules with sweet pulp for pulp market, easily extractable kernels for the kernel market, easily extracted bark for the art market, acid pulp for the drink market, et cetera. This approach to genetic selection can result in substantial improvement in crop quality and productivity for a relatively small level of investment, especially when implemented in participatory mode with farmers, rather than undertaken in isolation by research institutions. Having identified the superior trees with the desired traits, the capture of tree-to-tree variation using techniques of vegetative propagation is relatively simple as mentioned in the present study for baobab and also well understood for many tree species (Leakey 2004, 2005), although the numbers of people with the appropriate skills may be a constraint to its widespread application in the future.

6.3 Conservation of baobab genetic diversity in Benin

As African baobab seeds exhibited orthodox behaviour (Razanameharizaka *et al*., 2006), they can be conserved *ex situ* in seed banks and also *in situ* or *in circa* as living trees. Strategies for prioritizing the conservation of genetic diversity need to consider not only the level of diversity in an area but also the identified morphotypes, and condition of, a particular region. The best option should be to conserve seeds from non desirable baobab in *ex situ* in gene banks and the living desired trees *in situ* as seeds and service suppliers. The high levels of genetic variation present within populations suggested that large numbers of samples from a few populations would capture a sufficient amount of the species' genetic variability. However, such a practice would increase the chance of missing rare alleles, particularly in disjunct populations, which also expresses extreme phenotypes for phenological traits related to climatic adaptation. We suggested in these cases to sample for *ex situ* gene conservation, populations from different geographic areas and individuals from all morphotypes to maximize genetic diversity for *ex situ* collections thereby increasing probability of conserving rare alleles. We have also recommended to sample seeds deployed for *ex situ* conservation in gene banks from a high number of individuals and within all climatic zones and morphotypes, thereby avoiding low genetic diversity within seedlots and consequently low risk of inbreeding depression and high adaptive capacity to environmental variation in trees to be planted within the parklands agroforestry systems. This is also important since it can allow the sampling of different classes of alleles (widespread, localized, and rare).

6.4 Propagation of baobab

The results indicated that baobab can be successfully grafted using the side cleft grafting and side veneer grafting methods. According to Sidibe & Williams (2002), three years after grafting small baobab tree can be flowered. This demonstrates the ability of grafting to promote flowering/fruiting in small trees by using ontogenetically old scions. This can facilitate improvements in fruit harvesting.

Moreover, cutting of baobab can be optimised since lower rate is observed for the moment. Based on our results, we suggest for the cutting optimisation, to use sterilise organic matter substrate without hormone. This will be very useful for the species propagation since it can allow propagation of clone in a relatively low period. Optimisation of cutting technique can also help to solve bottleneck that limit wider domestication of the desired morphotypes according to local people. For the moment, our result showed that no hormone is needed to improve the success of the cutting rate of baobab.

For *A. digitata*, the removal of a fragment of seed coat not always significantly increased the capacity to germinate contrary to the findings of Razanameharizaka *et al.* (2006) who observed a significant difference of germination rate between the scarified and non-scarified seeds. Indeed, our results showed that baobab seed can germinate without any scarification of its seed coat. The low germination rate observed for the scarified seeds could be due to the damages caused on the embryo when performing the scarification. Another explanation may be that the seed coat was not well removed and no water or oxygen can be entered to stimulate germination process. The experiment should then be replicated to confirm or not our findings.

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This work is supported by Rufford Small Grant for Nature Conservation and Bioversity International (ex IPGRI). We also thank the International Foundation for Science (IFS) and CTA which provided travel grants for attending conferences. We thank these institutions and their donors. Our acknowledgement also goes through local people of Benin and West Africa.