Allanblackia meeting Workshop Report

ICRAF headquarters, Nairobi, Kenya

3rd -5th June 2014

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Cover photo: *Allanblackia stuhlmannii* tree bearing fruits, Amani Nature Reserve, Tanzania (Photo by Moses Munjuga)

Acknowledgements

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List of Abbreviations

AB	*Allanblackia*
AFTP	Agroforestry Tree Products
ANOVA	Analysis of Variance
ANR	Amani Natural Reserve
APADER	Association pour la Promotion des Actions de Developpement Endogenes Rurales
ASDP	Agricultural Sector Development Programme
CBD	Convention on Biodiversity
CSIR	Council for Scientific and Industrial Research
CVC	Committee Villageoise de Consultation
DBH	Diameter at Breast Height
DS	Distal Sections
FAO	Food & Agriculture Organization of the United Nations
FAPL	Ferme Agropastorale du Littoral
FORIG	Forest Research Institute of Ghana
FORM	Forest Plantation Management Company, Ghana
H	Height
ICRAF	World Agroforestry Centre
IFAD	International Fund for Agricultural Development
IUCN	International Union for Conservation of Nature
KNUST	Kwame Nkrumah University of Science and Technology, Ghana
LS	Longitudinal Sections
LSBPM	Longitudinal Sections placed in Black Polythene Material
LSD	Longitudinal Sections Placed in Sand
LSPPM	Longitudinal Sections Placed in Plain Polythene
NARS	National Agricultural Systems
NDTL	Novel Development Tanzania Limited
PBPM	Proximal Sections Placed in Black Polythene Material
PES	Payment for Ecosystem Services
PPM	Placed in Plain Polythene
PS	Proximal Sections
PSD	Proximal Sections Placed in Sand

R&D	Research and Development
REDD	Reducing Emissions from Deforestation and Degradation
RRC	Rural Resource Centre
RSSDA	River State Sustainable Development Agency
SD	Science Domain
SUA	Sokoine University of Agriculture
TAFORI	Tanzania Forestry Research Institute
TS	Top Soil
UDSM	University of Dar es Salaam
UEBT	Union for Ethical Bio trade
WSBPM	Whole Seed Placed in Black Polythene
WSPPM	Whole Seed in Plain Polythene
WSSD	Whole Seed in Sand

Background

The conservation and sustainable utilization of agricultural biodiversity constitute one of the most important components of biodiversity within the framework of the convention on biodiversity (CBD). Indigenous fruit trees on farms, home gardens and rangelands contribute to improvement of farmers' livelihoods; health and nutrition, income generation, fodder and environmental services (shade, microclimate, carbon sequestration, soil fertility improvement). During food shortage and pre-harvest periods, indigenous fruit tree products serve as emergency food and can also be used for income generation, mostly by women.

Allanblackia spp. of the family Clusiaceae are high value multipurpose indigenous tree species (spp) in the West, East and Central African regions, notably Ghana, Nigeria, Tanzania and Cameroon. They are being accepted by farmers for use in agroforestry systems with both environmental and economic benefits. The species is not likely to be trapped by climate change due to the observed high genetic diversity within the species and its ability to thrive in different habitats ranging from wet evergreen to dry semi-deciduous forest zones.

Allanblackia spp have even been identified by FAO as a crop of high potential interest in the development of rural communities. It also has the potential to serve as a novel source of household income for rural populations while contributing to forest landscape restoration with the potential of counteracting the impacts of climate change. Benefits derived from *Allanblackia* spp are numerous, including shade, timber, medicine and seed oil (Ofori *et al*., 2006). When dried, the kernel contains about 67-73% of solid white fat (Siaw *et al*., 2003; Sefah, 2006).

Traditionally oil extracted from the seed has been used for cooking and soap making (Ofori *et al*., 2006). The seed oil is of prime importance as a foreign exchange earner and is being developed as a rural-based enterprise for its application in the manufacture of margarine (Shreatha and Akangaamkum, 2008).

The high melting point of the *Allanblackia* seed oil, among other factors, makes it superior to other alternatives like palm oil (Siaw *et al*., 2003; Sefah, 2006; Adubofour *et al*., 2013). Currently, the demand for *Allanblackia* seed oil exceeds 100,000 tonnes annually. However, only 210 tonnes are supplied annually on average from Ghana, Nigeria and Tanzania. The current level of seed production suggests that wild harvesting would not sustain the *Allanblackia* business, hence the need for *Allanblackia* cultivation (Oppong, 2008; Kattah, 2010).

The domestication of *Allanblackia* began through formation of a public-private partnership known as Novella Africa in 2002 to develop a smallholder supply chain of *Allanblackia* nuts and oil. The *Allanblackia* project has therefore been sustained through support from several partners and donors. Unilever also committed to buying sustainably produced *Allanblackia* oil at a guaranteed minimum fair price. The combination of a guaranteed market and high economic return to small-scale producers is attracting smallholder farmers to adopt the species.

The workshop, which was organized by the World Agroforestry Centre from 3rd – 5th June 2014, aimed to bring together key partners and scientists who have been collaborating on the development of best practices to review the current status of *Allanblackia* domestication and the way forward.

Session 1

Welcome remarks: Dr. Jeremias Mowo, Eastern and Southern Africa Regional Coordinator, ICRAF

The *Allanblackia* workshop was officially opened by Dr. Jeremias Mowo, Regional Coordinator for Eastern and Southern Africa. He welcomed the workshop participants and highlighted the fact that *Allanblackia* has great potential for income generation for smallholder farmers in Africa and therefore must be seen as an important species requiring support for domestication. He noted that scientists are expected to improve *Allanblackia* production and consumption, and expressed his gratitude to the partners who have been collaborating on *Allanblackia* domestication in different regions for availing themselves to take part in sharing their experiences and charting the way forward. He also thanked the ICRAF team for organizing the workshop and wished them successful deliberations.

Statement by Dr. Roeland Kindt, Ecologist (SD3), ICRAF

Dr. Roeland Kindt, representing Dr. Ramni Jamnadass, introduced ICRAF Science Domain 3 as the domain that works on three research areas in agroforestry: Tree Diversity, Domestication and Delivery. Dr. Kindt mentioned that each aspect of Science Domain 3 connects very well with work on *Allanblackia* which is a big flagship species. Highlighting the fact that there is a huge demand for *Allanblackia* products, he commended the scientists and partners for their progress on *Allanblackia* research and the strong partnerships formed to drive the domestication of the species. He also mentioned that SD3 was always ready to support up-scaling of *Allanblackia* to enhance the livelihoods of farmers. Dr. Kindt urged the participants to continue working as a team and thanked the participants for attending the workshop.

An overview of the *Allanblackia* project: key components by Dr. Daniel Ofori

Dr. Daniel Ofori, the *Allanblackia* project manager, gave an overview of the *Allanblackia* project, thereby setting the pace for discussions during the meeting. His presentation focused on the following:

i. Importance of *Allanblackia*

Allanblackia spp. are very important as they contain fatty acids which mainly comprise oleic and stearic acids (40-51% and 45-58%, respectively). The oil is used locally for cooking, soap making, ointments; the fruit for making local alcoholic beverages, and wood for timber. At industrial scale, the oil is required for manufacture of food products such as margarine (Figure 1.1).

Figure 1.1. *Allanblackia* margarine

ii Demand for *Allanblackia* oil and production potential for AB trees

There is a huge market for *Allanblackia* oil and it has already received EU certification as safe in food products. Current demand exceeds 100,000 tonnes per year, while only about 210 tonnes of oil per year is obtained from Ghana, Nigeria and Tanzania. The wild harvesting is currently unsustainable and to be able to meet the demands for the *Allanblackia* oil, over 8 million fruiting trees must be available. This is based on the fact that on the average, one *Allanblackia* tree produces 120 fruits, resulting in 40 kilograms of dry seeds, which potentially provide 12 kilograms of oil per tree. The production and income potential for *Allanblackia* are summarised in Table 1.1, and the distribution of *Allanblackia* spp in Africa is given in Figure 1.2.

Table 1.1 Production/income potential from *Allanblackia*

I tree	120 fruits
120 fruits	40 kg dry seeds
1kg dry seeds	$0.40
1 tree/40kg seeds	$16.00
4okg dry seeds	12 kg oil
100,00 tonnes	8,333,333 trees
Farmer income	$133,333,333.33

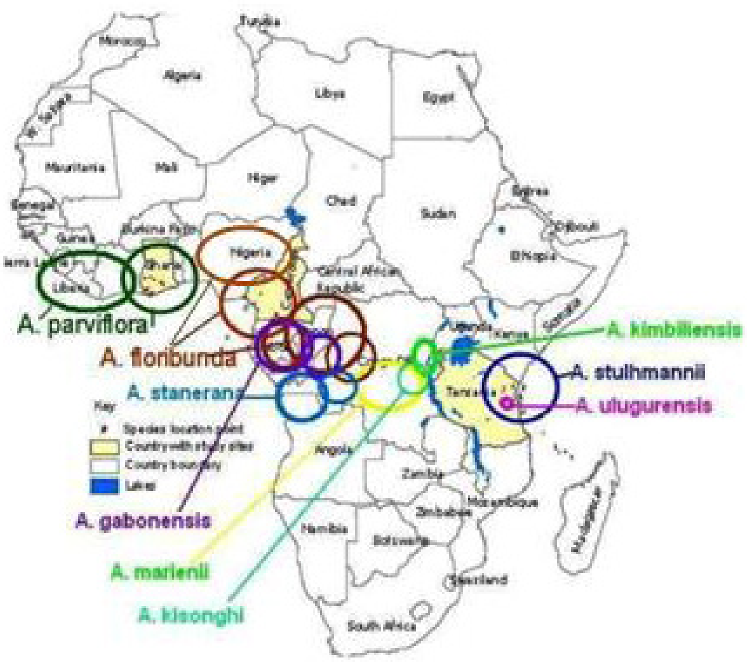

Figure 1.2. A map showing the distribution of *Allanblackia* species in Africa (Source: Bamps, 1996)

iii *Allanblackia* partnership

The domestication of *Allanblackia* is being spearheaded by the *Allanblackia* partnerships, which started in 2002 with the formation of Novella partnerships. Currently, the members of the partneship and their roles are:

i. Unilever: funding, product development and marketing
ii. ICRAF: domestication - selection, propagation, germplasm distribution & conservation & agroforestry development
iii. NARS: CSIR-FORIG, universities, ANR etc. – support R&D
iv. Novel Development Tanzania: supply chain, marketing, multiplication and distribution
v. IUCN: sustainable harvesting & biodiversity conservation
vi. Farmers: smallholder agroforestry systems
vii. FORM: pilot plantations in Ghana
viii. RSSDA: pilot plantations in Nigeria
ix. UEBT: certification of organic and fair trade standards

iv. Supply chain and market development for *Allanblackia* nuts

The objective of the supply chain and market development is to improve the livelihoods of the rural communities through sale of *Allanblackia* nuts. Already, farmers have started benefiting from wild collection and this has boosted their morale. The chart below shows the number of people that participated in *Allanblackia* wild collecting and the money obtained in 2013 in Tanzania (Figure 1.3).

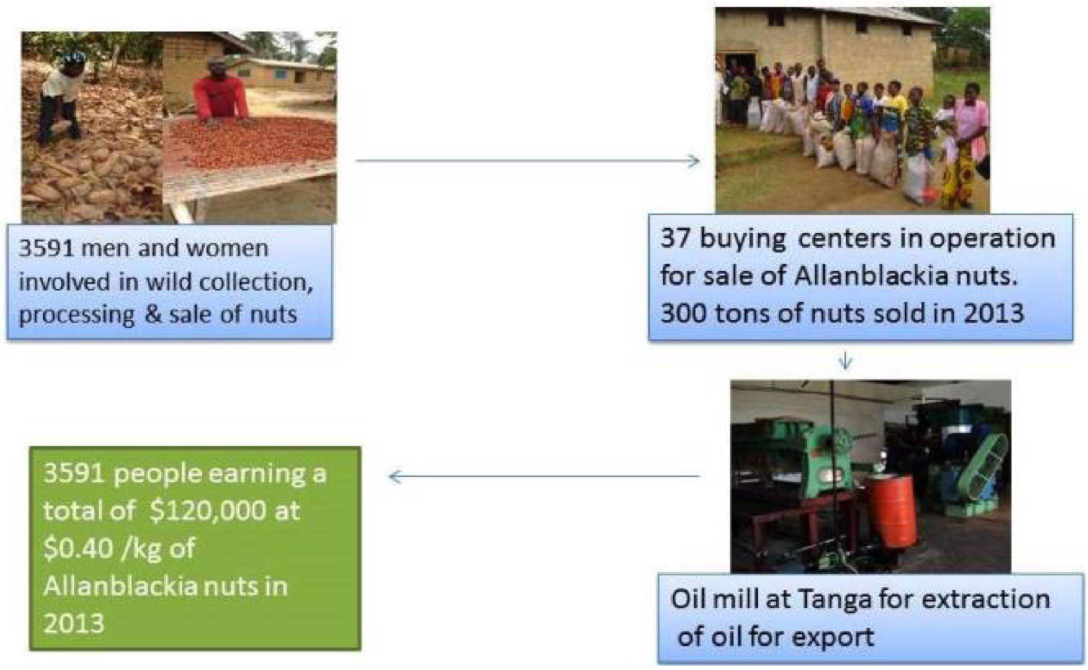

Figure 1.3: A flow chart showing supply chain and market development for *Allanblackia* nuts in Tanzania

Table 1.2 shows the number of farmers participating in the cultivation of *Allanblackia* and the number of seedlings already planted in Tanzania, Ghana, Cameroon and Nigeria.

Table 1.2. The number of farmers involved in planting AB trees and the seedlings already planted in each of the four Countries

Country	Farmers planting AB	Seedlings planted
Tanzania	>500	>100,000
Ghana	>200	>34,000
Cameroon	>100	>3,500
Nigeria	Farmer registration in progress	200,000

Objectives of the meeting

The project manager listed the three main objectives of the workshop as below:

i. Share current status of AB domestication, achievements and constraints of *Allanblackia* component of IFAD fruit tree project

ii. Agree on timeframe: deliverables and responsibilities for phase II

iii. Agree on the content of a publication on *Allanblackia*

Expected outputs

The expected outcomes of the workshop were also listed as follows:

i. Workshop proceedings

ii. Workplans for phase II

iii. Timetable for production of a publication on *Allanblackia*

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Session 2

Since the workshop was an opportunity for collaborators to share progress, results and constraints, component leaders were given the opportunity to make presentations on their respective activities. Seven papers were presented.

2.1 Rural Resource Centres and Sustainable Supply System of *Allanblackia* Planting Materials: An Appraisal from Ghana

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Abstract

The Participatory Tree Domestication Programme modelled after the Rural Resource Centre (RRC) approach was used to disseminate knowledge and skills on *Allanblackia* (AB) propagation and cultivation as well as to distribute AB planting materials to farmers. This paper assessed the role and effectiveness of RRCs in AB propagation and cultivation. Generally, RRCs have been instrumental in training and capacity building of farmers on AB propagation and cultivation. However its effectiveness in supply of AB planting materials for cultivation in farms and establishment of satellite nurseries has been less than desirable. The main constraint responsible for this is the limited financial capacity to produce adequate planting stock to meet the huge demand of farmers. To address this challenge, RRCs in Ghana should diversify planting material production in order to generate funds to support its operation.

Introduction

Rural communities have used *Allanblackia* (AB) trees for decades as a source of cooking oil, medicine and timber. A few years ago, the food processing industry discovered *Allanblackia* oil as a new ingredient ideally suited for the manufacturing of spreads like margarine; thereby creating a huge market demand and business potential of this tree species (Ochieng, 2007). Currently, the potential market demand for AB oil is estimated at over 100,000 tons/year with the potential to exceed 200,000 tonnes a year (Pye-Smith, 2009). Harvesting fruits of wild *Allanblackia* species in countries with natural home range such as Nigeria, Ghana and Tanzania cannot meet this demand. These countries together supply a paltry total of 210 tons/year (Kattah, 2010). To address the challenges of over-exploitation and decreasing *Allanblackia* abundance in the forests, World Agroforestry Centre and its partners from the public and private sector have been domesticating the species since 2002 using a participatory tree domestication approach. The program includes community sensitization, exploration, participatory selection of superior mother trees, conservation in field gene banks, development of agroforestry systems with AB and market development, with the main objective of providing an alternative income support for rural communities.

For this programme to be successful, RRCs were established to serve as diffusion hubs for new technologies and good quality germplasm to support cultivation of *Allanblackia*.

In Ghana, RRCs were established in 2008 in two political districts namely, New Edubiase and Wassa Akropong, all in the Western region. About 200 farmers were trained at the RRCs on *Allanblackia* propagation and cultivation. About 34,000 planting stocks were also produced at the RRCs and distributed to farmers for planting (Ofori, 2014). After six years of piloting the RRC concept, it is necessary to assess the performance of the model in meeting the intended objectives. For instance, answers to the following questions are imperative:

- What is the level of knowledge on AB planting material production?
- Is the current mode of planting material distribution efficient?
- What is the role of gender in AB planting material production and distribution?
- What are the challenges encountered in the use of RRCs as a hub of AB planting material dissemination?

The objective of this study was to assess the performance of RRCs and challenges in the dissemination of good quality planting stocks in Ghana, and recommendations made to improve the supply efficiency.

Methodology

Study site

The study was conducted in ten communities in Ghana namely, Dikoto, Samang, Wassa-Kumasi, Konkoso, Krofofrom, Awona, Gyedua, Dikoto-Junction, Amoakokrom, Adjeikrom. The communities are located in New Edubiase and Wassa Akropong political districts where the RRC methodology was piloted.

Data collection and analysis

Participatory research approach namely; key informant interviews, focus group discussions and administration of questionnaires was used in data collection. The key informant interviews explored the information on the role of RRCs in AB planting materials supply system, training of farmers, gender involvement in the production and supply of AB planting materials, and challenges to the implementation of the RRC model. The questionnaires together with the focus group discussions sought information on the knowledge of AB planting materials production, effectiveness of the RRCs, challenges faced, and benefits or otherwise of the role of RRCs. In all, 84 respondents took part in the study (Table 2.1.1).

In assessing the effectiveness of the role of RRCs in sustainable AB planting material supply the following indicators were used: number of AB planting materials produced, distributed and planted; number of farmers trained and skills acquired in AB propagation and cultivation; and number of satellite nurseries established. The indicators were used in assessing the actual output against the target achieved and the objectives of RRC.

Table 2.1.1. Respondents and data collection approach

Respondents	Approach	Number of respondents
RRCs Manager	Interview	2
Focal Persons*	Interview	5
Farmers	Questionnaire	77

*Focal persons are designated persons or agents trained in collection and purchasing of AB seeds.

Results and Discussion

Role of RRC in dissemination of AB planting materials

The role of RRCs in dissemination of AB planting stocks was prominent in training farmers in AB propagation and cultivation and building their capacity to establish satellite nurseries

Level of knowledge of farmers in AB propagation and cultivation

As many as five different knowledge-based and practical skills were acquired by about 200 farmers during several training and capacity building workshops conducted at the RRCs in New Edubiase and Wassa Akropong. The skills acquired included

AB cultivation techniques, seedling management techniques, seed processing, selection of quality planting materials and nursery management practices (Figure 2.1.1).

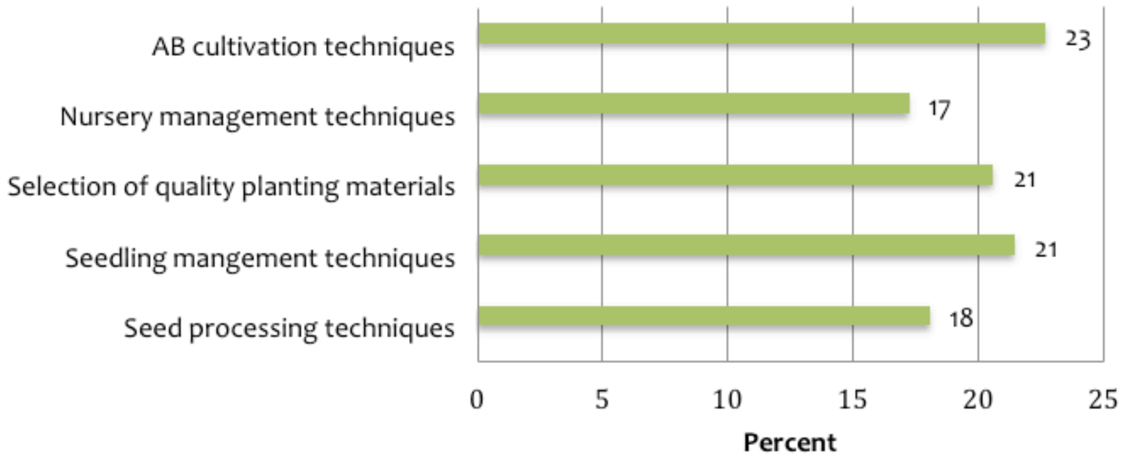

Figure 2.1.1. Knowledge and skills acquired by farmers in AB propagation and cultivation

From farmers' perspective, RRC was effective in training and skill development of farmers in AB production and cultivation. Seventy-four percent (74%) of the farmers interviewed indicated the effectiveness of the RRC in training and capacity building (Figure 2.1.2). Some factors that contributed to its effectiveness were the participatory nature of the training and subsequent farm visits by RRC managers to provide technical backstopping in AB cultivation on farms.

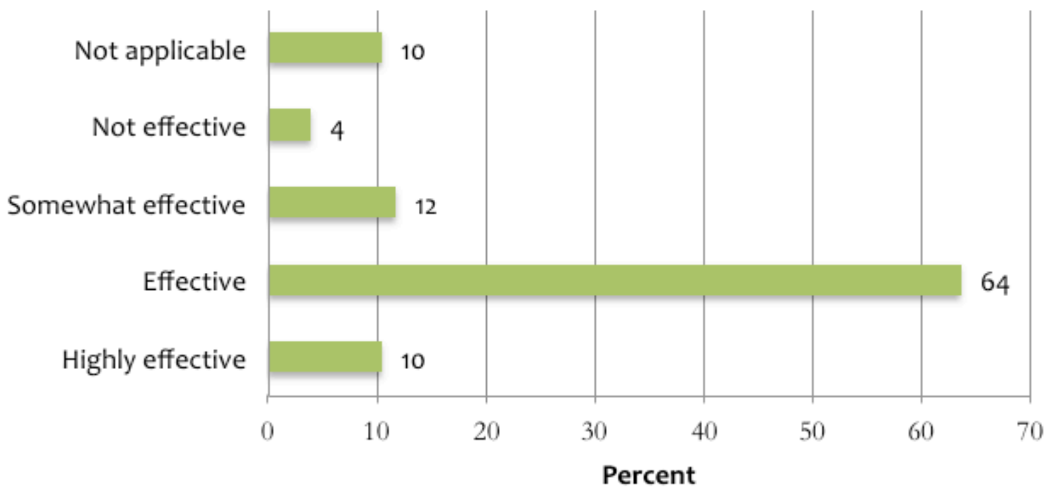

Figure 2.1.2. Farmers' perceptions on the effectiveness of RRC in capacity development on AB cultivation

Establishment of satellite nurseries

Results from the interview with RRC managers and focal persons pointed out that 10 satellite nurseries were established within New Edubiase (3) and Wassa Akropong (7) districts (Table 2.1.2). In total the satellite nurseries contributed 16.2% of the planting stocks required within the two districts. The low number of satellites nurseries and planting stocks produced may be a reflection of the close proximity of participating farmers to the RRCs. RRCs also produced planting stocks that were distributed to farmers for free. Hence farmers did not see the

need to establish nurseries and produce planting stocks on their own. Another possibility for the low number of satellite nurseries may be due to difficulty in the propagation of the species which the training and capacity building programs in the RRCs tried to address.

Table 2.1.2. Number of satellite nurseries established

District /Project Area	Number of satellite nurseries
New Edubiase	3
Wassa Akropong	7
Total	**10**

Table 2.1.3. Demand/Supply of AB planting materials

District / Project Area	Demand	Quantity Supplied
New Edubiase	2000	9000
Wassa Akropong	2000-60000	800-1000
Total	**62000**	**10000**

Efficiency of RRC in supply of AB planting materials

RRCs were inefficient in supply of adequate planting materials to farmers. In terms of supply of AB planting materials, only 16% (10,000 planting materials) of the demand for planting materials by farmer groups in participating communities was met by the RRCs (Table 2.1.3). This figure falls within the range reported by Jamnadass et al, 2010 (7000 planting materials) and Ofori et al, 2013 (18,000 planting materials). In general, the supply was unable to meet the targeted quantity and demand by farmers. Existing RRCs were not well maintained and at the time of the survey, there was no on-going activity on production of planting stocks in the two RRCs.

Table 2.1.3. Demand/Supply of AB planting materials

District / Project Area	Demand	Quantity Supplied
New Edubiase	2000	9000
Wassa Akropong	2000-60000	800-1000
Total	**62000**	**10000**

Gender involvement in the production of AB planting stocks and cultivation

In terms of gender involvement in AB propagation and cultivation, respondents were of the view that there were more men involved than women (Figure 2.1.3). The main reason limiting women participation is the land tenure system. Ownership of farmlands influences access to farmlands as well as the decision of what to cultivate on the land. In the AB project areas, majority of men owned land, hence had access to farmlands and decided what kind of crops to cultivate. As a result, women's limited position in relation to land ownership constrains them from engaging in AB cultivation, particularly when the male authority in the household did not consent to it.

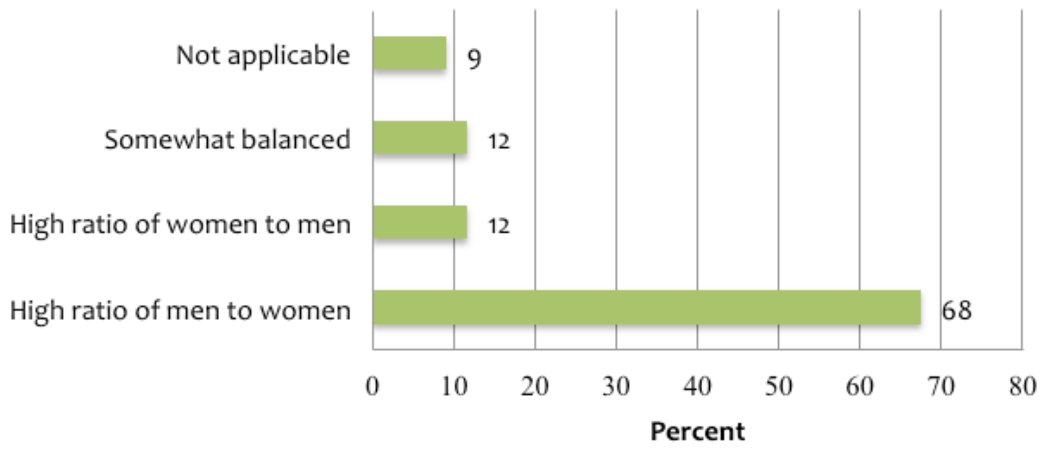

Figure 2.1.3 Gender involvement in AB propagation and cultivation in Ghana

Challenges encountered in supply of AB planting materials

The most frequently mentioned challenges encountered in sustainable supply of AB planting materials were inadequate production of planting material by RRCs (30%), lack of incentives (23%), limited financial assistance (20%) and limited communication (17%) – Figure 2.1.4.

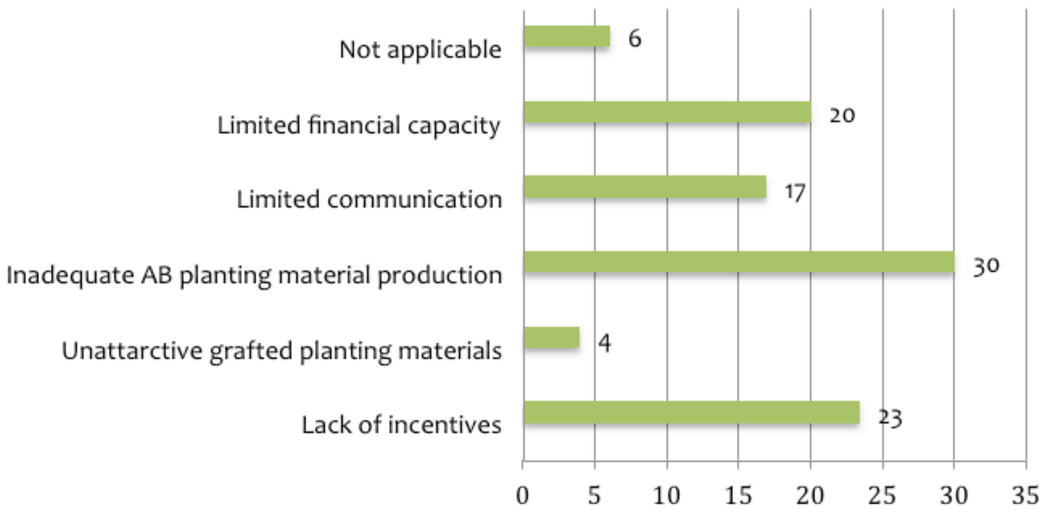

Figure 2.1.4. Challenges encountered in supply of AB planting materials in Ghana

Conclusion and recommendations

Overall, RRCs have been instrumental in training and capacity building of framers in AB propagation and cultivation. However, the effectiveness in supply of AB planting materials for cultivation in farms and establishment of satellite nurseries has been less than desirable. Limited financial capacity, inadequate planting materials production to meet farmer demand and limited communication with farmers were factors that influenced the ineffectiveness of RRCs. The establishment and operation of RRC are capital intensive. Farmers are supposed to run RRCs after initial investment by funding organizations or project implementers using the model. Smallholder farmers do not have the financial ability to operate RRC. To address this challenge, RRCs in Ghana

should diversify planting material production. Propagation of planting materials of other species and subsequent sale can generate funds to support their operation. Franzel *et al.* 1996 alluding to this point further mentioned that the choice of the other species incorporated into RRC should be based on market demand, farmer interest and the ability to increase productivity by cultivation. Regular communication between farmers, RRC managers and project implementers particularly at the initial stages is critical to sustain interest of farmers in AB propagation and cultivation.

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2.2 Propagation of *Allanblackia parviflora* through seed sectioning

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Abstract

Whole seeds and seed sections (distal end, proximal end and longitudinal sections) of *Allanblackia parviflora* were germinated in sand, plain and black polythene bags. At 90 days after sowing, germination of proximal sections ranged from 0% to 54 % with proximal sections placed in sand (PSD) being the lowest and proximal sections placed in plain polythene material (PPM) being the highest, ($p < 0.0001$). Germination of longitudinal sections, ranged from 0 to 44 % with longitudinal sections placed in sand (LSD) being the lowest and longitudinal sections placed in plain polythene (LSPPM) being the highest, ($p < 0.0001$). For whole seed, germination ranged from 13 to 31 % with whole seed in sand (WSSD) being the lowest and whole seed in plain polythene (WSPPM) being the highest, ($p < 0.0001$).

Introduction

Allanblackia species (Clusiaceae family) are indigenous to West, East and Central African regions; with the potential to provide an alternative source of income for the rural populations. Uses of the species include shade, timber, medicine and seed oil. The seed oil is the most important economic product of the species. Pressed crude oil from the dry seeds is about one-third of seed dry weight (Attipoe *et al*., 2006). Traditionally, oil extracted from the seed has been used locally for cooking and soap making (Ofori *et al*. 2006). On the international market, over 100,000 tonnes of *Allanblackia* oil is required annually but, on average, only about 210 tonnes are supplied from Ghana (*A. parviflora* = 40 tons), Nigeria (*A. floribunda* = 20 tons) and Tanzania (*A. stuhlmannii* = 150 tons). There is therefore a need to domesticate *Allanblackia* to sustain the supply of *Allanblackia* seeds to feed both the local and foreign markets.

In an effort to domesticate a new tree crop like *A. parviflora* and promote its cultivation on a large scale, there is a need to develop methods for propagation of the species for sustainable supply of adequate quality planting stock. *A. parviflora* seed germination is however slow, and intact seeds usually take a long period of time (over 3 years) to germinate (Ofori *et al*. 2008). Seeds with seed coat removed and kept in polythene bags started germinating from 2 weeks and within 10 months, 75 and 68% germination were obtained for plane and black polythene bags, respectively.

Methodology

Seed segments namely: distal sections (DS), proximal sections (PS), longitudinal sections (LS) were cut from freshly extracted whole seeds of *A. parviflora,* using a sharp knife. Two hundred seeds each in four replicates (50 seed sections/seeds x 4) of the named sections or whole seeds were placed in plain polythene, black polythene or plain polythene bags further enclosed in black polythene bags without adding any germination media. Seed sections/seeds were sparingly sprayed with fine mist of tap water and the open end of the polythene bags sealed. All samples were placed in a plant house at the Forestry Research Institute of Ghana, Kumasi. An ambient temperature of 27-30°C was maintained. Treatments were arranged in randomized complete block design with four replications in the plant house. Samples were opened and sparingly sprayed with water at two-week intervals during the period of observation.

Data per replicate were presented in percentages. The percentage data were arcsine transformed to conform to normal distribution before subjecting them to analysis of variance (ANOVA) using SAS 9.2 edition.

Results

Seed germination pattern observed

Generally, germination of whole seed of *A. parviflora* began with the emergence of the seed root at the distal end of the seed followed by the appearance of the epicotyl from the proximal end and then hypocotyl at the base of the epicotyl. This type of germination pattern was also observed in longitudinal sections of the seed. Proximal sections also produced both epicotyl and hypocotyl at the proximal end but without seed root. In the case of distal sections however, only seed roots grew from the distal extremities without further production of shoots and therefore could not develop into seedlings.

All seed sections sown in sand rotted and did not produce either root or shoots.

Germination percentages of seed/seed sections

Proximal sections placed in plain polythene material (PPM) recorded the highest germination percentage of 53.9 %. This was significantly different ($p < 0.0001$) from germination percentage of 42.6% recorded for proximal sections placed in black polythene material (PBPM) and proximal sections placed in black and plain polythene materials (PBPM), $p < 0.0001$. Sections placed in black and plain polythene materials (PBPM), Proximal Sections placed in sand (PSD) recorded zero germination (Figure 2.2.1).

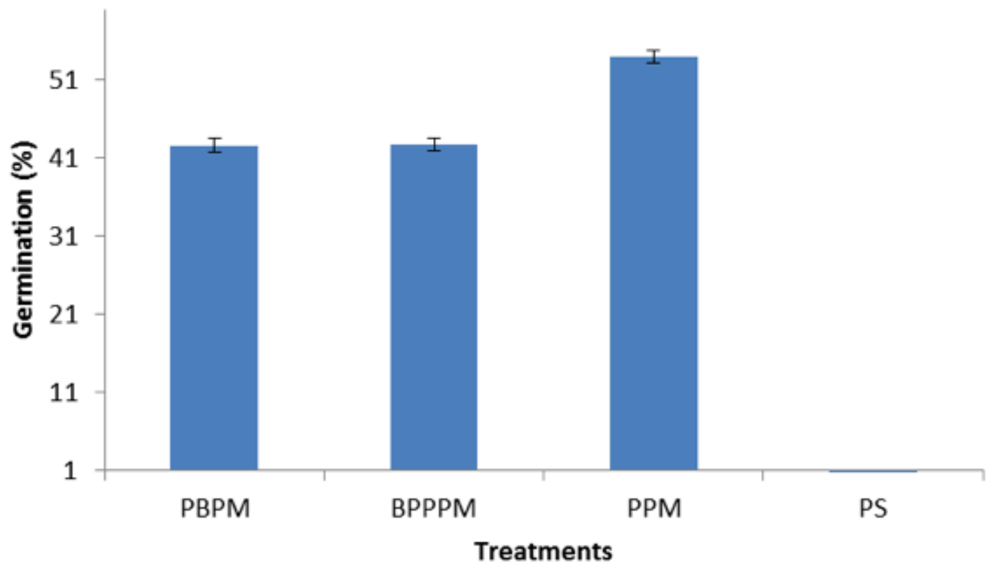

Figure 2.2.1. Effects of incubating *A. parviflora* seeds in different polythene bags on germination of proximal sections of *A. parviflora* seeds

Longitudinal Sections

Germination percentages (%) recorded for longitudinal sections placed in plain polythene material (LSPPM), black polythene material (LSBPM) and in sand (LSD) are presented in Figure 2.2.2. Longitudinal sections placed in plain polythene material gave a significantly ($p< 0.0001$) higher germination percentage of 43.9 % than 38.1 % recorded for longitudinal sections placed in black polythene material (LSBPM). Longitudinal sections placed in sand (LSD) did not germinate.

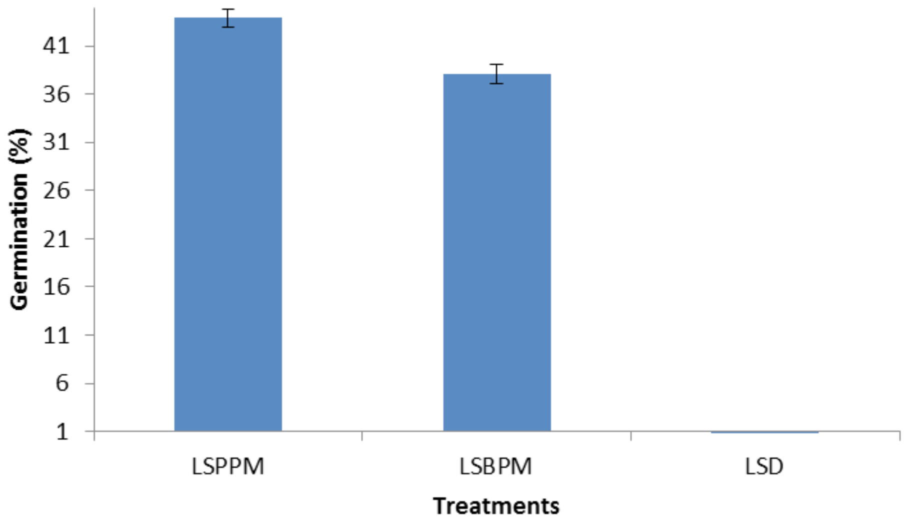

Figure 2.2.2. Effects of incubating *A. parviflora* seeds in different polythene bags on germination of longitudinal sections of *A. parviflora seeds*

Whole Seed

Significant ($p < 0.001$) differences in seed germination were recorded. Germination percentages of whole seed placed in plain polythene (WSPPM = 30.6 %) and whole seed placed in black polythene (WSBPM = 29.3 %) were significantly higher than whole seed placed in black polythene plus plain polythene material (WSBPPM = 24.4%). Germination percentage of whole seed placed in sand (WSSD = 12.8%) was significantly low compared to the other treatments (Figure 2.2.3).

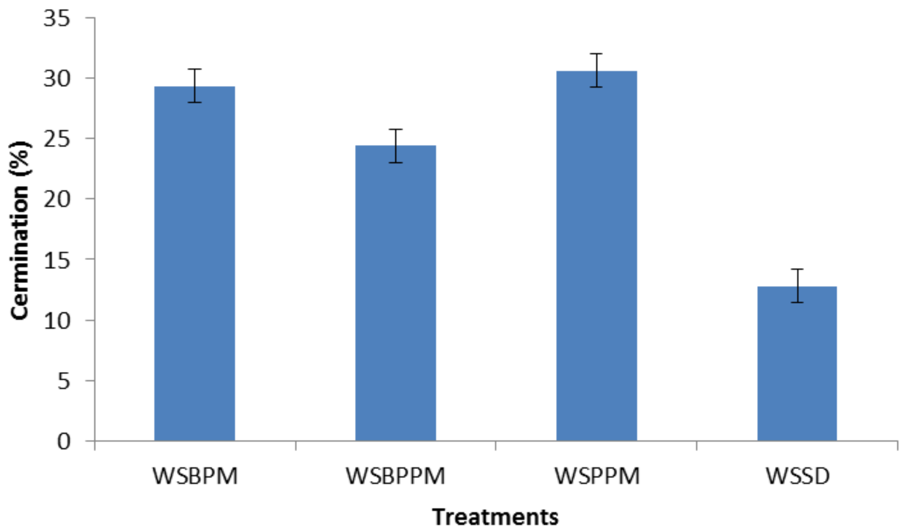

Figure 2.2.3. Effects of incubating whole seeds of *A. parviflora* in different materials on seed germination

Discussion

The pattern of germination described as '*Garcinia* -type' of seed germination by de Vogel (1980) in *Garcinia indica* (Malik *et al*., 2005; Asomaning et. al., 2011) was observed in *A. palviflora* which is also in the family, Clusiaceae. The authors observed that proximal and half proximal sections of *Garcinia kola* seed produced complete seedlings, but distal sections from the species produced only roots and

failed to develop into seedlings. The middle section of the seed produced neither roots nor shoots. In *Garcinia gummi-gutta*, on the other hand, Geeta *et al*. (2006) reported on the development of the middle sections of the seed to complete seedlings in addition to distal and proximal end sections. This was ascertained to that fact that mature embryo in *Garcinia gummi-gutta seed* is a swollen hypocotyl, completely filling the space within the seed, while the embryo of *A. parviflora* seed is located at the proximal section only.

The observation that germination percentages recorded from seed and seed sections placed in plain polythene bag were relatively higher than those placed in black polythene bags and plain polythene further enclosed in black polythene bag, could be due to the presence of an optimum temperature generated in the plain polythene bag compared to the black bag. An earlier study done in Ghana indicated that, the temperatures generated in plain polythene bag in the morning and mid-day were 23°C and 27°C respectively. While morning and mid-day temperatures in black polythene bag were 27°C and 30 °C respectively (Ofori et al. 2011). The fact that all seed sections sown in sand got rotten may be due to excessive fungal attack observed at the cut surfaces (sand media used was not sterilized).

Conclusion

In conclusion, the removal of thick and hard seed coat and seed sectioning are forms of mechanical scarification and have a great potential for breaking A. *parviflora* seed dormancy. The germination of proximal end sections in plain polythene bags may be recommended for raising seedlings of *A. parviflora*, since this was the best in terms of percentage as well as speed of germination. Germination of longitudinal seed sections also requires further development as it has the potential for producing two seedlings from a single seed.

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2.3 Effect of coarse sand as a pre-potting medium on the growth of *Allanblackia parviflora* seedlings at the nursery

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Abstract

The experiment was carried out for a period of three months. Different soil media were used namely: Top soil+ AB soil, AB soil + top soil + humus, Top soil + humus, AB soil only, Humus only and Humus + AB soil; all in the ratio of 1:1. Two hundred and forty (240) germinated seeds of *Allanblackia parviflora* of approximately 2cm and 3.5cm shoot length and seed root lengths respectively were used. One hundred and twenty (120) germinated seeds were potted directly in the formulated media, and the other half were placed in coarse sand. The sand-nurtured germinated seeds were transferred to the formulated media after four weeks. Subsequent measurements were made every fortnight. A t-test ($p<0.05$) for seedling height and diameter showed that coarse sand significantly affected the growth of *A. parviflora.* The period of observation after potting looks too short for any effects on the different medias on seedling growth to be apparent. However, sand nurturing significantly enhanced growth of seedlings.

Introduction

Indigenous fruit trees are progressively being recognized for the remarkable role they play in rural poverty reduction, food security, income generation, health and environmental benefits, among others, especially in tropical Africa. This has stimulated a lot of research; and studies on their domestication for increased production. The cultivation of many fruit tree species is faced by a number of challenges, mostly driven by their inherent characteristics associated with growth (Asaah *et al.*, 2012). Exploring methods that can enhance the growth of these high valued indigenous fruit trees could lead to sustained productivity.

Allanblackia parviflora, normally referred to as vegetable tallow tree, is an indigenous fruit tree species belonging to the family Clusiaceae (Orwa and Oyen, 2007). It is one of the nine species of the genus *Allanblackia,* and has been identified as a tree crop of high potential interest for the development of rural communities. It is an evergreen tree species which is mainly found in forest stands and farmlands in the rainforest region of Ghana. The tree is medium sized and can grow to a height of about 40m, with straight stem, characterized by horizontal branches and simple opposite leaves with shiny surfaces. The bark is reddish-brown with small rectangular or circular scales over small red pits and also produces either pink- red or white flowers (Hawthorne and Gyakari, 2006).

A. parviflora tree is valued for its seed oil. The seeds yield a solid edible fat used for cooking and for the manufacture of oil-based products such as soaps, spreads, cosmetics etc. (Irvine, 1961). The high melting point, and stearic acid composition of the seed oil places a high premium on *Allanblackia* oil relative to others like palm oil (Adubofour *et al.,* 2013). The seed oil is thus being developed as a rural-based enterprise in Ghana to increase livelihood opportunities for farmers and to ensure retention of trees on farms for environmental sustainability (Peprah *et al.*, 2009).

Cultivation of the species is constrained by its slow growth, partly due to factors such as the potting medium, germinant potted and time of potting (Ofori *et al*., 2011). Hence methods for improving seedling growth performance of the species are essential to enhance its cultivation. According to Ofori *et al.,* (2011), *A. parviflora* seedlings grow best when seeds that have developed either shoot only or both shoot

and root are potted. Again, potting germinated seeds directly in different soil media i.e. *Allanblackia* (AB) soil only; Top soil only; sterilized *Allanblackia* (AB) soil showed differences in growth of *A. parviflora* seedlings (Yeboah *et al*., In Prep). However, there is no evidence on how a pre-potting treatment affects the growth of *A. parviflora* seedlings. The objective of the study was therefore to investigate the effect of pre-potting media on the growth of *A. parviflora* seedlings at the nursery.

Methodology

Six soil media used were, Top soil (TS) only, *Allanblackia* (AB) soil only (soil under *Allanblackia* tree), Humus (H) (decomposing leaves and branches of *Leucenna leucocephala*) only, AB+TS+H, TS+H and H+AB; all in the ratio of 1:1.

The experiment was carried out for three months, using 240 germinated seeds of *A. parviflora*. The germinants were approximately 2cm and 3.5cm shoot length and seed root length. Polythene bags of size (12cmx18cm) were filled with the formulated media as mentioned above. Each media (treatment) was made up of 40 pots (20 for direct potting of germinated seeds and 20 for potting of sand-nurtured germinated seeds). The germinated seeds were divided into two, with one set of 120 germinated seeds potted directly into the media (i.e. 20 pots per each medium directly potted with germinated seeds). The rest of the germinated seeds (120 germinated seeds), were placed in coarse sand for 4 weeks and then transferred into the formulated media. Watering of the seedlings was done every morning to field capacity.

Assessment on height and stem diameter was done every two weeks in all the treatments. In the case of sand–nurtured germinants, initial measurements were taken immediately after potting in the formulated media. Red indelible ink was used to mark each seedling at 1cm above the soil surface, where diameter readings were taken to ensure consistency of point measurement. Diameter readings were taken using digital calliper, while a tape measure was used to record the total height of the seedlings.

Results

The sand nurtured *Allanblackia parviflora* seedlings showed a higher mean seedling height growth (8.06375 cm) than the directly potted seedlings (5.09375 cm), a significant increase of 2.970 cm (95% CI), t (23)=12.22 $p<0.0001$ (Figure 2.3.1). Soil with the combination of AB soil also gave the highest height growth in both sand-nurtured germinants and the direct-sowing germinants. However these were not statistically different ($p > 0.05$).

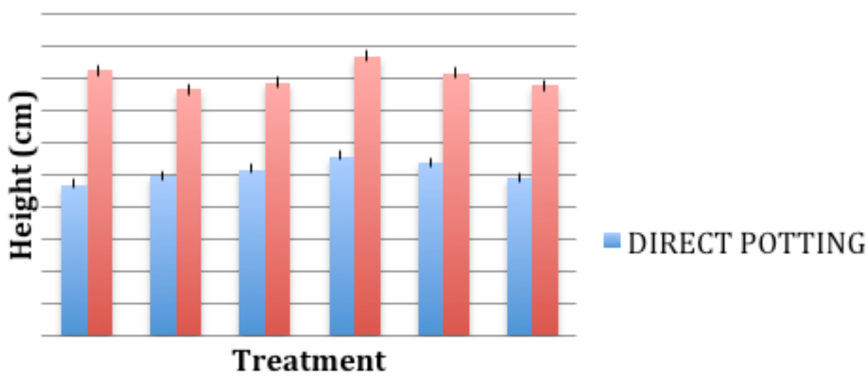

Figure 2.3.1. The mean height growth of sand-nurtured and directly potted AB seedlings seedlings in different potting media (TS=Top soil, AB *Allanblackia* soil, H= Humus soil).

Diameter growth (Figure 2.3.2) also showed the same trend as in Figure 2.3.1. Sand nurtured *A. parviflora* seedlings showed a higher mean seedling diameter growth (3.70208 mm); than the directly potted seedlings (3.24375 mm). A significant increase of 0.458 mm (95 % CI; 0.2817 to 0.6350), t (23) =5.368, p<0.0001. Likewise the height growth, AB soil/media in combination of AB soil also gave the highest diameter growth but the differences were not significant (p > 0.05).

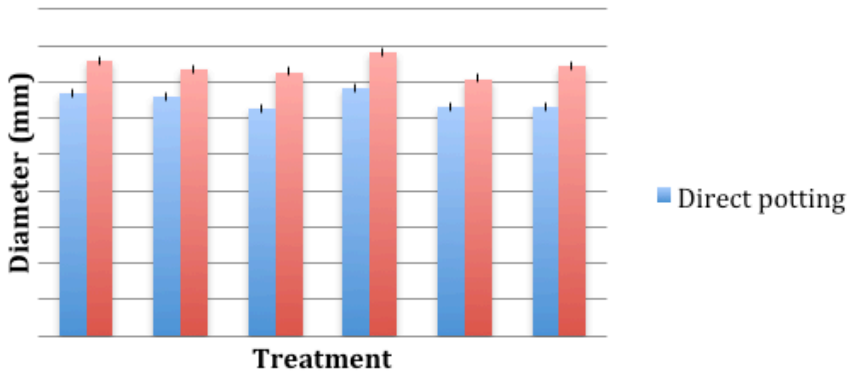

Figure 2.3.2. The mean diameter growth of sand-nurtured and directly potted AB seedlings in different potting media (TS=Top soil, AB *Allanblackia soil*, H= Humus soil).

Discussion and Conclusion

According to Hartman *et al.,* (2000), root systems develop over a greater area and depth in sandy, well-drained soils which however gives rise to increase in growth. The significant increase in growth of sand nurtured *Allanblackia* seedlings could be due to the fact that roots became well developed when seedlings were on coarse sand. In addition to root development, plant-microorganism symbiotic associations have been found to be an important function in plant productivity (Van der Heijden *et al.,* 2008). Strom (2013), studying *Allanblackia* mycorrhiza association, reported that a large number of potential Arbuscular Mycorrhizal symbionts were found both on young and older roots of *Allanblackia.* The high growth of seedlings in media containing AB soil might be due to a positive interaction between *Allanblackia* and mycorrhiza.

Therefore, results obtained show that raising *A. parviflora* seedlings on coarse sand before transplanting onto potting media significantly increased early growth. Moreover, soil media in combination of AB soil was found to be the best for *A. parviflora* seedling growth compared to the other potting media.

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2.4 Progress on domestication of *Allanblackia floribunda* Oliver (Clusiaceae) in Cameroon

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Abstract

Factors affecting domestication of *Allanblackia floribunda* in Cameroon were reviewed and are presented in this paper. This include factors affecting rooting ability and growth performance of leafy stem cuttings, growth and development of different propagules, effect of mycorrhiza on growth of *Allanblackia*, flowering and fruiting cycle of *Allanblackia* and performance of RRCs in the dissemination of *Allanblackia* planting stock in Cameroon. All studies are still in progress but preliminary results show that; irradiance affected the height growth of coppiced shoots on stockplants ($P < 0.001$) with 1428.6 µmol M^2 S^{-1} being the best. Percentage rooting of cuttings was highest (85.71 ± 4.12%; $P = 0.04$) when cuttings were treated to NPK 20-20-20 foliar fertilizer during callus initiation stage. The number of roots per rooted cutting was not affected by fertilizer application. Arbuscular mycorrhiza was found to be associated with *Allanblackia*. The strain and the beneficial effects are yet to be identified. Plants grown from seeds were found to grow better than those grown from cuttings, grafts and marcotts. However, grafts fruited earlier. Nonetheless, seedlings produced 7 times more fruits than grafted plants. Currently, with the contribution of the RRC, about 198 farmers have been trained on domestication of *A. floribunda* and this number is expected to increase with time due to the enthusiasm of beneficiaries.

Introduction

In the early 2000s, Unilever after developing a supply chain for *Allanblackia* in Ghana and Tanzania, approached the World Agroforestry Centre (ICRAF) to propose a strategy that could bring *Allanblackia* into cultivation. In response to this, ICRAF recommended the participatory tree domestication approach that had been successful in the domestication of other indigenous species of the humid tropics of Africa. A participatory tree domestication programme was therefore initiated in Cameroon, Ghana and Tanzania through a formation of public-private partnerships known as the Novella Africa partnerships. The domestication programme in Cameroon was targeted on *A. floribunda* and focused *on* ethnobotanical studies, development of different options for propagation, development of germplasm distribution system for supply of quality planting stocks as well as models for integration in farming systems.

Methodology

- **Factors controlling the stockplant growth, rooting ability and performance of leafy stem cuttings**

The experiments were conducted in two sites. The *A. floribunda* stockplant management experiment was established at ICRAF's experimental site in Mbalmayo, while the propagation experiment was conducted in Nkolbisson, Yaoundé. Parameters evaluated were stockplant irradiance (2008.1 µmol M^2 S^{-1}, 1428.6 µmol M^2 S^{-1}, 542.2 µmol M^2 S^{-1}, 283.2 µmol M^2 S^{-1} and 160.4 µmol M^2 S^{-1}), effect of NPK fertilizer 20-10-10 applied to stockplants (25 and 50 g/stump and control), application of NPK fertilizer (15-15-30, 20-20-20 and 30-10-10) to cuttings in propagator and the period of their application (at setting, at Callus initiation and both (setting and callus)). Data was analyzed using Log Linear Regression model for shoot growth of stockplants, percentage rooting of cuttings and mean number of roots per cutting.

- **Relationship between Mycorrhiza and growth of *A. floribunda***

One hundred and forty-two (142) trees of *A. floribunda,* consisting of mature trees (>50 cm dbh) and young trees (< 50 cm dbh) were sampled from disturbed (fallow and agricultural field) and un-disturbed (intact forest) sites for the study. Soil and roots were sampled from the selected trees. Trap cultures were set for spore density assessment, while roots were stained to determine the type of mycorrhiza present and the percentage of the root colonization (Brundrett, 1996). Data was analyzed using Log linear regression model

- **Growth and development of different propagule types of *A. floribunda***

A study is ongoing to assess growth, flowering and fruiting of *A. floribunda* trees; 48 seedlings, 38 grafts, 48 cuttings and 18 marcots. The seedlings and graft were planted in 2006 (7 years), cuttings and marcotts were planted in 2007 (6 years) and 2010 (3 years) respectively. Tree growth parameters (height, collar and crown diameters), flowering and fruiting are recorded each year.

- **Assessment of efficacy of RRCs in the dissemination of *A. floribunda* germplasm in Cameroon**

Partners were selected using two criteria: those who are currently implementing an income generating activity based on *Allanblackia,* such as UGAO (Union des GIC Agroforestiers de l'Ocean), FAPL (Ferme Agropastorale du Littoral) and Elat Meyong . CVC (Comite Villageoise de Consultation) and APADER (Association pour la Promotion des Actions de Development Endogène Rural) formed a second group that constituted of existing RRCs with *Allanblackia* as one of their priority species under domestication. Fourteen members of these groups where invited for a training workshop to build their capacity on propagation and planting of *Allanblackia*. Each central nursery received a sprayer, watering can, secateur, scissor, 250 polythene potting bags, one rooting propagator, and pesticides as backstopping material. A strategy for monitoring and evaluation was set-up. This strategy consisted of agreeing with farmers on the reporting period as well as the frequency of the back stopping visit. In addition, developing and sharing results from all data collected with the farmers.

Results and discussion

The effects of irradiance and fertilization on height of shoots on stockplants were significant ($P < 0.001$ and $P = 0.023$ respectively). Shoots on stockplants that received 1428.6 µmol M^2 S^{-1} (3/4 of incident sunlight) (79 ± 2.09 cm) grew significantly higher than shoots on stockplants that received other irradiance levels (Figure 2.4.1). Related to fertilization, the highest height growth was observed on stumps which received 50 g (73.56 ± 2.04 cm after 8 months) whilst the lowest was observed on the control (65.95 ± 1.94 cm). In terms of rooting of cuttings, shoots that were grown under 542.23 µmol M^2 S^{-1} irradiance, had the highest rooting ability (78.22%) (Figure 2.4.2). Furthermore, cuttings that received NPK 20-20-20 fertilizer at callus initiation stage had the highest rooting ability (85.71 ± 4.12 %) (Figure 2.4.3). No significant differences were observed in the number of roots per rooted cutting. Nonetheless, it varied from 1 to 3, with very few cuttings developing 2 or 3 roots. The number of roots per rooted cutting could be associated with the carbohydrate contents in cuttings (Leakey, 2004) as they are needed as energy source for rooting of cuttings. And hence there is a need for further investigation into this observation.

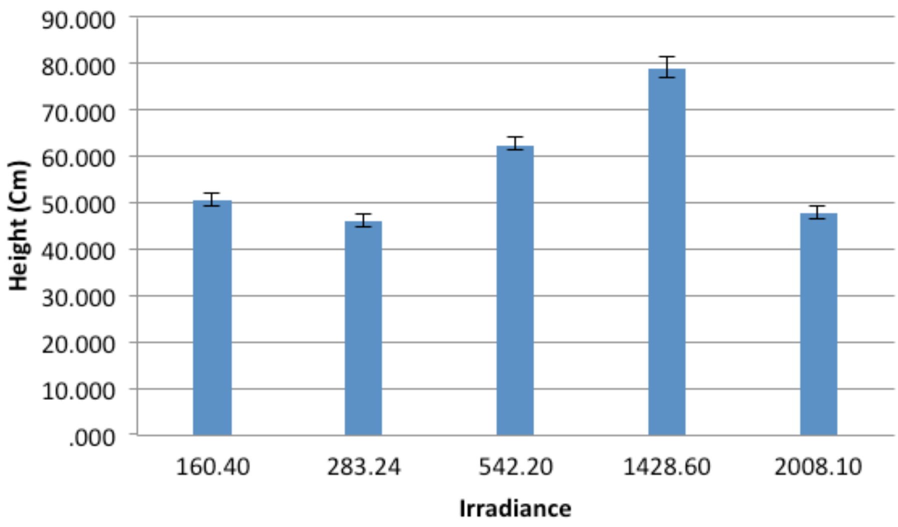

Figure 2.4.1: The influence of shade level on height of *A. floribunda* stump

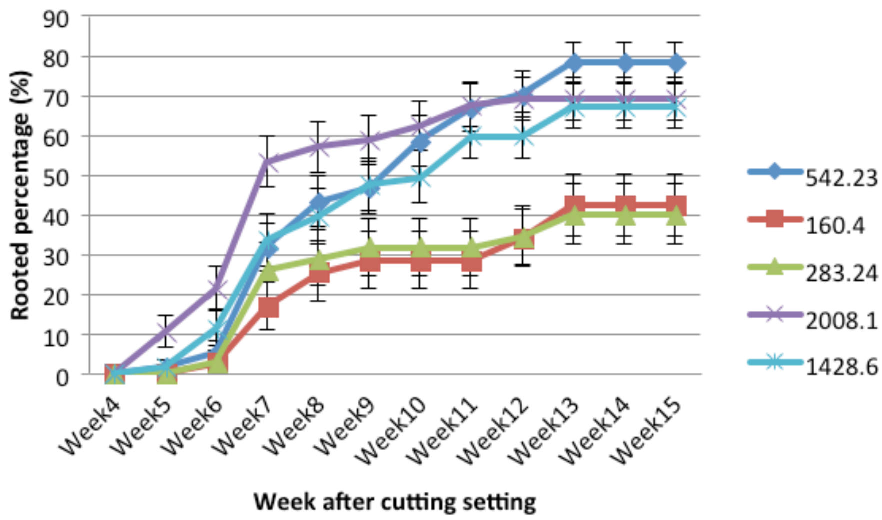

Figure 2.4.2: Cumulative rooting percentage of cutting after treatment with different levels of irradiance

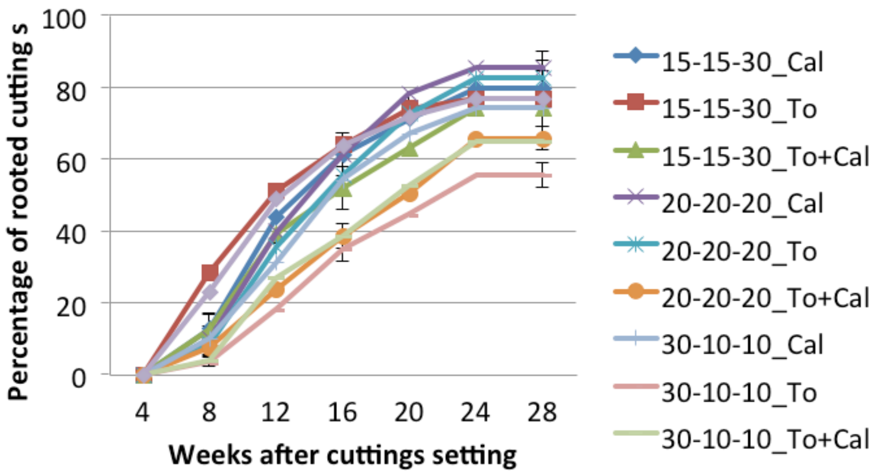

Figure 2.4.3: Combined effect of NPK foliar fertilizer and period of application on the rooting of cuttings

On *Allanblackia* x mycorrhiza interactions, it was found that *A. floribunda* roots were colonized by arbuscular mycorrhizas. The extent of root colonization of *A. floribunda roots by mycorrhiza* was significantly ($P<0.01$) different between the populations sampled. Roots from undisturbed sites had the highest root colonization (35.29 ± 0.70%) compared to roots from disturbed sites (29.96 ± 0.77%). Age classes had significant ($P < 0.001$) influence on root colonization of the species. The adult or old trees with circumferences of 50cm and above had the highest root colonization percentage (35.45 ± 0.72%) compared to saplings and seedlings with circumferences of less than 50 cm (30.05 ± 0.75%). Assessment of the effects of this relationship between *A. floribunda* and Arbuscular mycorrhizal on the growth and development of *A. floribunda* is in progress. Given the fact that most of the trees (about 80%) maintain arbuscular mycorrhizal association depending on the quality of the soil (Smith and Read, 1997), suggest that this *Allanblackia* x mycorrhiza association might have positive effects on the growth of *Allanblackia*. In order to maximize this putative beneficial effect of mycorrhiza, soil disturbances should be very minimal since they have been found to have negative effects on root colonization by mycorrhiza (Onguene, 2000) probably due to the destruction of inoculum through land preparation, chemical products like pesticides or bushfire. The high colonization of mycorrhiza on mature trees should be due to abundant production and availability of carbohydrates (Brundrett *et al.*, 1996).

In terms of growth performance among different propagules types, significant differences were observed on tree height ($p<0.001$) within two years. Seedlings were observed to have the highest rate of growth (166.66 ± 1.88 cm), followed by cuttings (72.56 ± 1.42 cm), marcots (42.86 ± 1.75 cm) and grafts (29.32 ± 0.92 cm). A similar trend was again observed at 6 years after planting. Flowering started three years after planting for grafts, and four years for seedlings. In the 6th year, grafts had the highest percentage of flowering (47.92) and fruiting (20.8%), followed by seedlings (flowering = 14.58% and fruiting = 0.21 %), while none of cuttings and marcots flowered nor fruited. However, seedlings had higher mean number of fruits (3) compared to grafts (2.6). Furthermore, fruits from seedlings are about seven times bigger than fruits from grafts.

Now that best propagules are known, the question is how to disseminate planting stocks. In 2013, five central nurseries with off-shoot of five satellite nurseries were established, with a total number of farmers involved in *Allanblackia* domestication being 198. In addition to *A. floribunda,* farmers produced other plant species, for instance, *Dacryodes edulis, Irvingia gabonensis, Ricinodendron heudelotii, Garcinia lucida and Theobroma cocoa that* have high socio-economic and nutritional value. In APADER, FAPL and CVC, at total of 2500 seedlings, 350 cuttings and 33 marcots were produced.

Conclusion

In conclusion, a wealth of information on propagation and growth performance of different propagules has been generated in support of upscaling of *Allanblackia* cultivation. More work is being done on the strengthening of the RRCs and networking with satellite nurseries for upscaling of production of planting stocks. The beneficial effect of *Allanblackia* x mycorrhiza association is being evaluated. Once positive, production of the beneficial strains of mycorrhiza will be undertaken.

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2.5 *Allanblackia stuhulmanii*: achievements and constraints in Tanzania

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Introduction

Agriculture is the foundation of the Tanzanian economy and is dominated by smallholder farmers. It accounts for about half of the national income, three-quarters of merchandise exports and is source of food and provides employment opportunities to about 80% of Tanzanians. It has linkages with the non-farm sector through forward linkages to agro-processing, consumption and export; provides raw materials to industries and a market for manufactured goods (Government of Tanzania, 2012).

The agricultural sector in Tanzania therefore needs to be managed sustainably to increase agricultural production and incomes while managing the biological resources by linking biodiversity and sustainable development. New indigenous tree crops can supply products for domestic use and for sale to supply farmers with significant extra income while providing ecological services such as enhanced micro-climate and improved soil fertility. *Allanblackia* is a tree species that has recently received considerable interest of scientists, development agencies and private sector food manufactures because *Allanblackia* cultivation on farms can combine environmental and economic benefits along the whole value chain of oil production.

Allanblackia stuhlmannii is a new crop with a high potential of bringing new income to rural communities and hence improving livelihood while adding to the list of exported crops for Tanzania (ICRAF, 2011). Benefits derived from *Allanblackia* spp. are numerous, including shade, timber, medicine and seed oil (Ofori *at al*., 2006). The kernel when dried contains about 67-73% of solid white fat (Siaw *et al*., 2003, Sefah, 2006). The oil has unique characteristics with a melting point above 34°C, thus, remaining solid at room temperature. The high melting point of the *Allanblackia* seed oil, among other things, makes it superior to other alternatives like palm oil (Siaw *et al*., 2003). Collection of *Allanblackia* seeds from the forest is currently the dominant harvesting method as very few trees are found on farmlands. The current level of seed production suggests that wild harvesting would not sustain the *Allanblackia* business, hence the need for large-scale cultivation of *Allanblackia* spp. (Oppong, 2008; Kattah, 2010) as a strategy to develop a sustainable source for the *Allanblackia* seed oil value chain.

The Tanzanian government has even developed interest in *Allanblackia* and asked ICRAF to conduct a sensitization workshop in the country in November 2011 (ICRAF, 2011), based on the fact that, *Allanblackia* is an indigenous African tree that is endangered in many of its natural habitats, replanting *Allanblackia* trees will contribute to reduction in the pressure on natural stands, biodiversity improvement and ecosystem services including carbon sequestering (possible source for additional income through 'Payment for Ecological Services' (PES) and/or carbon credits).

Studies on *Allanblackia* (AB) in Tanzania, are concentrated on *Allanblackia stuhlmannii* in the East Usambara (Amani), West Usambara (Korogwe) and South Nguru (Turiani). The work is being undertaken through a team of organizations, comprising Amani Nature Reserve (ANR)/Tanzania Forest Service (TFS), University of Dar es Salaam (UDSM), Sokoine University of Agriculture (SUA), Novel Development Tanzania Limited (NDTL), Tanzania Forestry Research Institute (TAFORI), World Agroforestry Centre (ICRAF)

and farmers, all gearing towards improvement of the livelihoods of poor rural small-scale farming households in Tanzania by sustainable development of *Allanblackia* as a new African tree cash crop .

Methodology

Effects of scion source, position and season on grafting success of *Allanblackia stulhmannii* under nursery conditions in Tanzania

Experiments were set up at different times of the year: November 2011 (short rains), April 2012 and 2013 (long rains), July 2012 and 2013 (cold season), September 2012 and 2013 (dry season) at Kwamkoro nursery, East Usambara, in a randomized complete block design. Scions prepared were labelled as coming from two different positions (position 1 = scion from apex and 2 = scion below position one i.e. not from apical portion of shoot). For each season, 40 scions per each of the two positions (1 and 2) were prepared from each tree and grafted on two-year old seedlings using top cleft grafting method, in completely randomized design (4 replicates with 10 grafts per replicate) under 50% shade provided with shade net. Grafting success was assessed two weeks after grafting; and thereafter, every week until either all had sprouted or dead.

Effect of seed post-harvesting maturation on *A. stuhlmannii* seed germination in Tanzania

The fallen fruits were collected from the ground and transported to the nursery, then covered with polythene sheet to undergo maturation. The experiments were conducted in the nursery located at Kwamkoro in Tanzania with altitude of 950m above sea level and temperature regimes of 16.3-24.1^{0}C. Low tunnelling beds were prepared and each filled with soil, sand and sawdust under 50% shading. The media was treated with fungicide and insecticides and left for three days. The media were then flushed with water to drain the excess chemicals and left for 24 hours before setting the experiments. Five fruits were sampled weekly and seeds extracted. Twenty-four (24) factorial treatment combinations, each having 100 seeds were used, thus 12 sample periods (0 to 12 weeks after collection) by 3 different media (soil, sand and sawdust), replicated under shade (dry grass shade with 580 µmol $m^{-2}s^{-1}$), all laid in randomized complete blocks with 4 replications of 25 seeds each. The germination beds were mulched with dry grass and then covered with polythene sheet to prevent water loss from the germination bed. The trend of seed germination was monitored, as well as growth seedlings for the next 12 weeks.

Assessment of *Allanblackia stuhlmannii* flowering, fruiting dynamics, seed yield, oil quantity and quality in East Usambara Mountains, Tanzania

A total of 135 trees (90 female and 45 male) have been marked from three ecological zones (30 from each zone) in and around Amani Nature Reserve. Coordinates for each tree was taken using a hand held GPS (Garmin 62S). Diameter at breast height was measured and recorded. The height was estimated and crown cover was measured by laying the tape in two directions (perpendicular to each other) under the canopy.

For each tree, a careful search for flower buds and/or open flowers was carried out using binoculars. Standardization of field observers was conducted three times to ensure that all observers maintained the same level of accuracy. The number of flower buds/open flowers was scored on a 1-4 scale independently by two observers (that is 1= 0-25%; 2= 26-50%, 3= 51-75%, and 4=76-100%).

Similarly, each tree was inspected for fruits and the total number of fruits on the tree was recorded. Those on the ground were also counted, recorded and then collected to avoid double counting during the next round of assessment. Whenever possible, fallen fruits were categorized into mature or immature (abortive).

Effects of fertilizer application on rooting of cuttings

The cuttings were prepared from coppiced shoots grown on stumps. The study was conducted plastic bowls filled with rooting media and placed in a low tunnelling propagator. The media was treated with fungicides and insecticides; and left standing overnight, before draining the excess chemical. The set up was provided with irradiance of 850 µmol M^{-2} S^{-1} using banana leaves and grasses as shading

materials. Two factors were tested namely: fertilizer (Control, NPK (25-25-25) and foliar) and period of application (at setting, at callus initiation and at rooting initiation). The application was done only once with all precautions to avoid contamination. The number of cuttings per treatment was 10 with two replications. The evaluation started two weeks after the cuttings were set and extended until the 20th week. The parameters assessed were percentage rooting, mean number of roots per rooted cutting and mortality of cuttings.

Results and discussions

The trends in the rate of grafting successes showed a significant influence of season on grafting success ($P < 0.05$). The lowest (16.7%) success rate was recorded in April, that coincides with long rainy seasons, but was increased to 73.8% in July and then reached a peak in September (89.2%) and decreased to 66.7% in November (Figure 2.5.1). This trend suggests that grafting should be done in the dry season, preceded by cold season, during which the trees are dormant and getting ready to grow as was also reported by Vanaja et al. (2007). Apical scions gave the highest success rate compared to basal scions (Figure 2.5.2) suggesting that the presence of apical buds enhances production of endogenous auxin (Morris *et al*., 2005; Ferguson and Beveridge, 2009) in support of the healing process and formation of successful union between scion and rootstock.

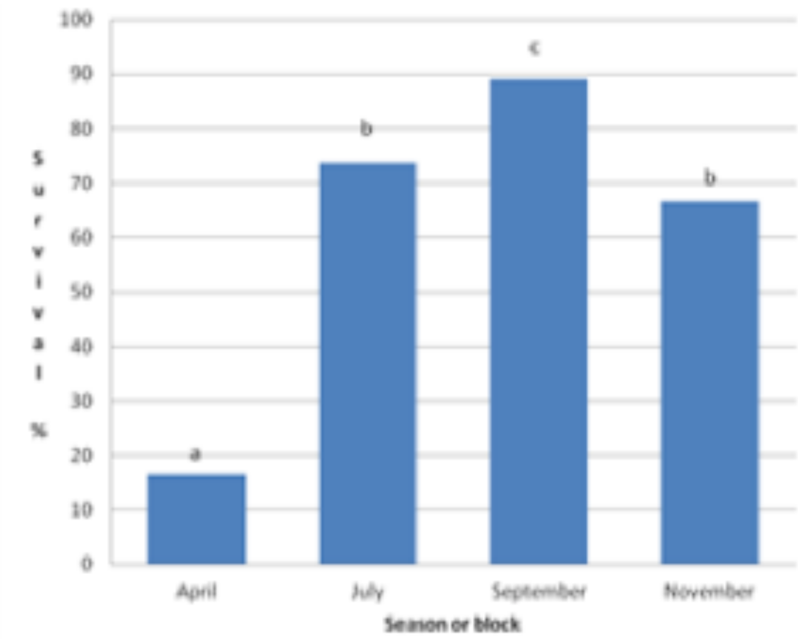

Figure 2.5.1: Effect of season on grafting success of *A. stuhlmannii* in Tanzania

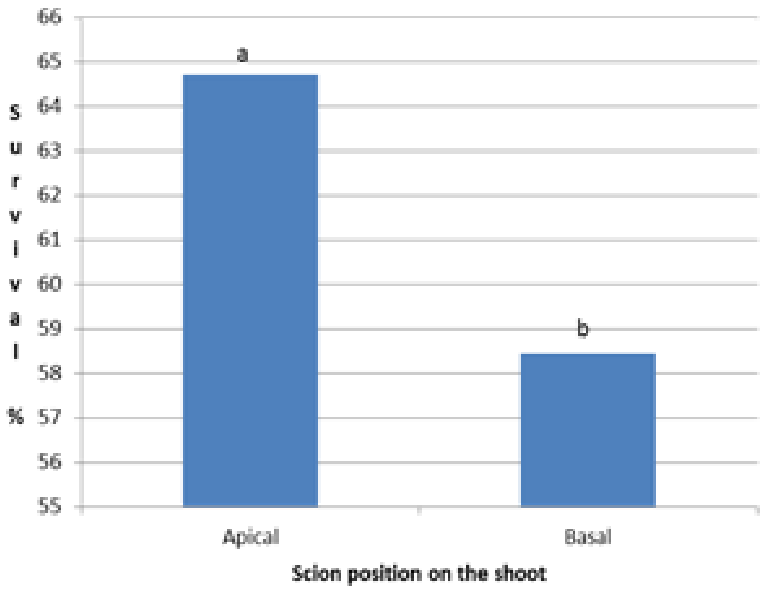

Figure 2.5.2: Comparison of grafting success (%) of scions taken from apical and basal portions

For all the media, seeds stored for four weeks before sowing had the highest germination ability. Sawdust was the best (67%), followed by sand (59%) and then red soil (54%). The results suggest that, the four-week storage of seeds coincides with the physiological maturity of the embryo as has been found in *Gacinia kola* of the same family (Anegbeh et al., 2006). Temperature was found to be an important factor in the germination of *Allanblackia* seeds. Temperature below 25°C was inhibitory to seed germination. This is supported by the fast rate of seed germination when placed in incubation area that maintains adequate warmth for seed germination even during cold seasons.

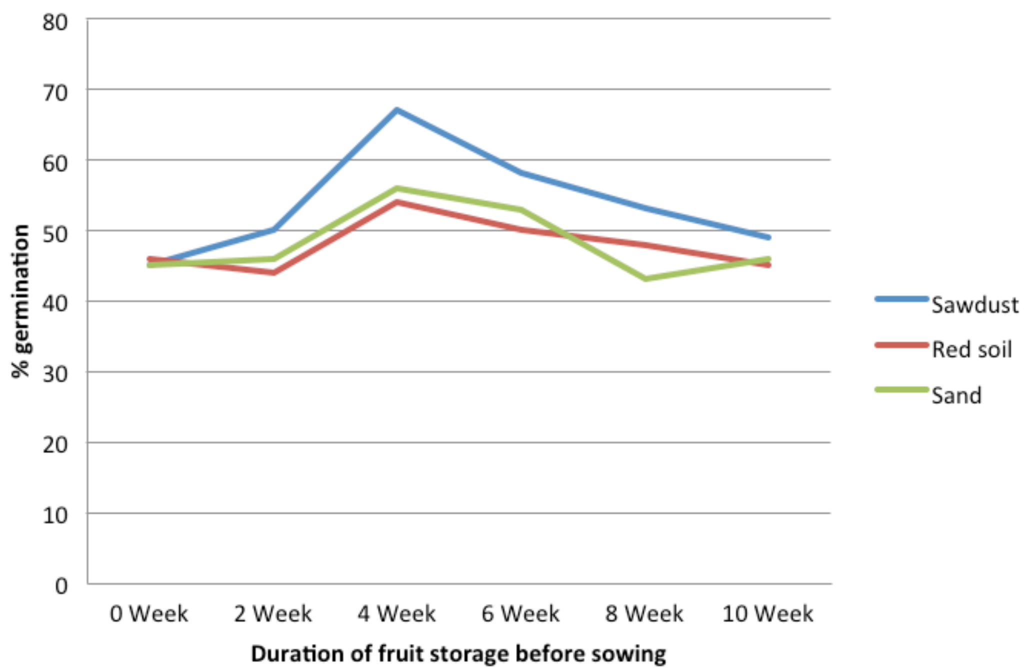

Figure 2.5.3: Effects of fruit storage on germination success

On monitoring for flowering and fruiting, none of the 135 trees monitored in September 2013 flowered. Flowering was however observed between November 2013 and January 2014, which kept increasing with time.

Studies on effect of fertilizer on rooting of cuttings are ongoing. Preliminary results have showed significant differences, with application of foliar fertilizer at the time of setting cuttings having the highest rooting percentage (27%). This was followed by NPK (22:22:22), applied at rooting (20%), with application of NPK (22:22:22) applied at callus stage being the lowest (Figure 2.5.4). Data collection is still in progress.

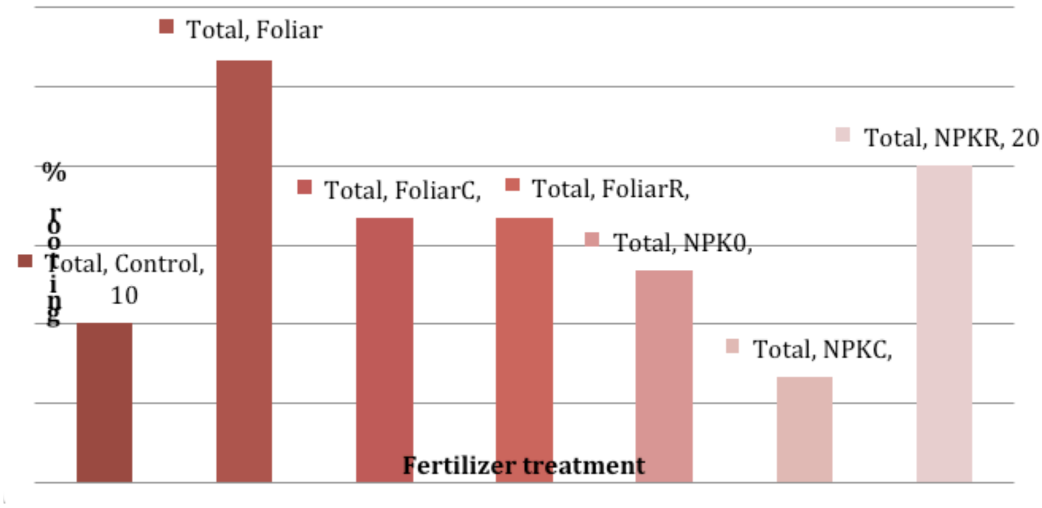

Figure 2.5.4: Fertilizer application at different rooting stage in a cutting

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2.6 Novel Developments in Tanzania: Supply Chain and Domestication

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Novel Developments in Tanzania

Novel Developments Tanzania Ltd is a locally owned private company that spun off from a Unilever Project, Novella. The company manages the *Allanblackia* supply chain in Tanzania where more than 4000 collectors, 50% of whom are women are involved in wild collection. NDTL has also supported over 500 farmers/collectors to plant over 100,000 *Allanblackia* seedlings. The company has been a member of Union for Ethical Bio trade (UEBT) since 2012, audited twice, and has been confirmed as a trading member. NDTL has been awarded with AB Oil – Novel Food Certification.

The supply chain

The *Allanblackia* supply chain in Tanzania described in Figure 2.6.1 shows processes and resources required for the supply chain. NDTL also builds the capacity of collectors and farmers on fruit collection, and handling of AB nuts as well as on some aspects of AB propagation and cultivation (Figure 2.6.2). NDTL manages the 40 collection centres through centre clerks who live in the villages. Clerks are responsible for receiving nuts from farmers, check quality, weigh, pay farmers and keep records. Purchased nuts are stored temporarily at collection centres before being transported by NDTL to the oil mill where the nuts are crushed to extract the crude oil for export (Figure 2.6.3).

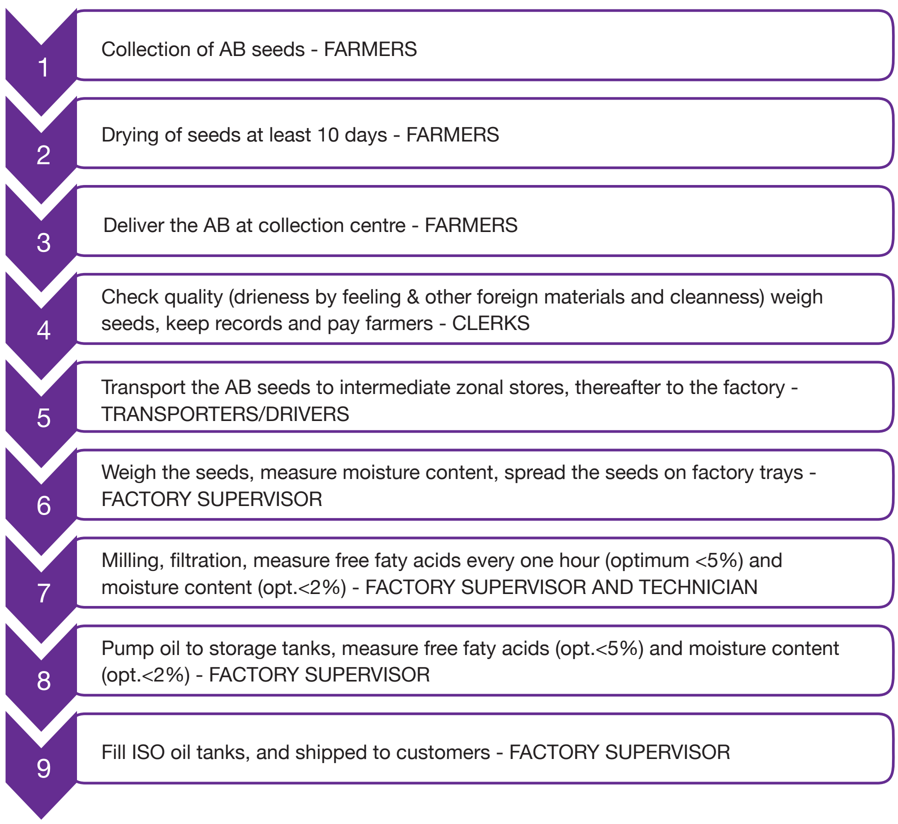

Figure 2.6.1: The supply chain in Tanzania; processes and inputs required

Figure 2.6.2: Farmers during a training session

Figure 2.6.3: AB oil crushing and transportation

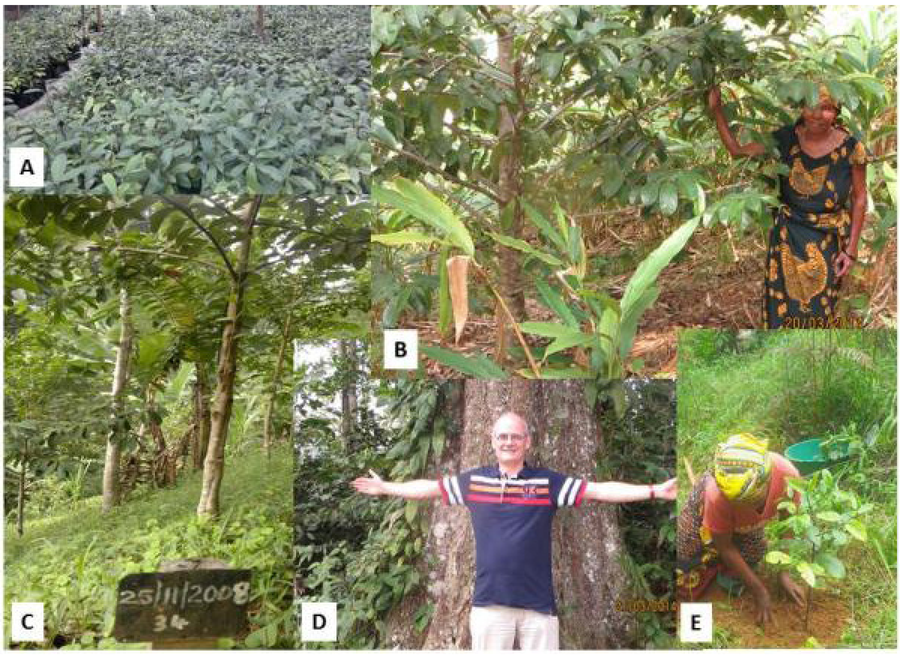

Figure 2.6.4: A: AB nursery, B: Famer inspecting AB tree on farm, C: Demonstration plot established in 2008 D: Size AB tree can grow and E: A farmer planting AB seedling (domestication)

Domestication

NDTL is supporting domestication in Tanzania (Figure 2.6.4) through establishment and management of nurseries for supply of planting materials, provide support to field planting, extension services and monitoring and evaluation of trees planted since 2006. In 2013 and 2014, the biggest planting program was implemented in Tanzania; where 1700 farmers were mobilized and trained (thanks to UEBT/Unilever/ICRAF), and more than 50,000 seedlings will be distributed and planted in 2014 and 2015. Currently, Novel is working with ICRAF to improve nursery production, management of satellite nurseries and distribution of seedling to farmers.

Major challenges faced by AB supply chain include: Annual fluctuations in AB tree fruiting can cause expected quantity of seeds collected to fall far below expected volume. Yield from wild harvesting does not look sustainable but very important in keeping the wild harvesting surviving to maintain farmers and market interest while a lot of efforts are being made in support on domestication. The short-term difficulty is high investment requirement, hence production costs are high. To address these, there is a need to upscale AB cultivation but best farming practices for up-scaling of AB cultivation is yet to be optimized. Nonetheless, the species also takes a long time (over 8 years) to reach reproductive maturity age.

2.7 *In vitro* propagation of *Allanblackia*

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Abstract

Allanblackia is conventionally propagated by seed and vegetatively through cuttings, marcotting and grafting. These methods have low multiplication rates and there is therefore need to develop alternative propagation methods to supplement the production of planting materials. Propagation by tissue culture technique provides a viable option and could permit the production of relatively uniform plants on a massive scale in a shorter period of time. The objective of this study was to develop an efficient, rapid tissue culture protocol for mass propagating *Allanblackia*. Leaf explants harvested from *Allanblackia* seedlings growing in the greenhouse were used. Sterilization of the explants was evaluated using different concentrations of calcium hypochlorite (1, 1.5 and 2%) and varying time intervals (15, 20, 25, 30, 35 and 40 minutes). The explants were then cultured on Murashige and Skoog (MS) media supplemented with different concentrations of Benzyl amino purine (BAP) Kinetin each at 5, 10, 20, 19 and 40 µM and thidiazuron (TDZ) at 0.1, 0.5, 1.5 and 2 µM as well as 100 mg/l myo-inositol 3% sucrose and gelled with 0.3% gelrite. The highest number (100%) of clean explants was obtained when 2% $CaOCl_2$ was used for 25 minutes. The highest (91%) percent of explants with callus was obtained on media supplemented with 0.5 µM TDZ.

Introduction

Allanblackia is conventionally propagated by seed and vegetatively through cuttings and grafting (Munjuga *et al.,* 2008; Ofori *et al.,* 2008). Propagation by seed is difficult as the seeds are recalcitrant and the germination rates are low (Ofori *et al.,* 2011). The vegetative methods have several advantages, including production of ramets that are genetically identical to the mother plant and mature faster and flower earlier than when propagated through the seed route. Propagation by tissue culture technique provides a viable option and could permit the production of relatively uniform plants on a massive scale in a shorter period of time. The only available information on tissue culture of *Allanblackia* is the preliminary work of Neondo *et al.* (2011). Therefore, it is of paramount importance to optimize the various factors influencing the *in vitro* regeneration.

The success in tissue culture depends on the effectiveness of the explant sterilization methods prior to culture initiation. Although Neondo *et al.* (2011) reported successful establishment of a sterilization procedure for *Allanblackia* explants, it was not possible to adopt the protocol in the current work for various reasons. Firstly, formaldehyde is rarely used to sterilize leaf explant and it is known to be extremely phytotoxic and secondly, the concentrations of sodium hypochlorite were expressed in uncommon manner (ml %). Consequently, there was a need to develop an alternative sterilization procedure.

Materials and methods

Plant materials

Leaf explants were excised using sterile surgical blade from mother plants grown in the greenhouse in Abidjan. They were taken to the lab in a beaker containing tap water. Cleaning of the explants was carried out using cotton wool and liquid soap. The explants were then kept under running tap water for two hours. They were later transferred to the lamina flow cabinet, immersed in 70% (v/v) ethanol for 30 seconds and rinsed twice with sterile distilled water. This was followed by surface sterilization using

various concentrations of calcium hypochlorite (1, 1.5 and 2%) and varying time intervals (15, 20, 25, 30, 35 and 40 minutes) and finally rinsing four times in sterile distilled water.

Media preparation

Media was prepared by dissolving the Murashige and Skoog (MS) media (1962) organic and inorganic components in distilled water. For the sterilization of experiment, MS media without growth regulators was used. On the other hand, for induction of somatic embryos MS supplemented with each cytokinin: Kinetin and Benzyl adenine (BAP) (evaluated at 5, 10, 20 and 40μM), and Thidiazuron (TDZ 0.1, 0.5, 1 and 1.5 and 2 μM) 100mg/l Inositol, 2% sucrose and gelled with 3% gelling agent was used. The Murashige and Skoog medium without growth regulators was used as control. The media pH was adjusted between 5.7 and 5.8 by using either 1N HCL or 1N NaOH before the gelling agent was added. Media was then heated on a hot plate with continuous stirring using a magnetic stirrer until agar was dissolved and media was then dispensed in test tubes for autoclaving. Sterilization of the media was achieved in an autoclave set at a temperature of 121oC and a pressure of 1.1kg/cm^2 for 20 minutes.

Results

Effects of calcium hypochlorite on sterilization of AB leaf explants

The results of the effect of different calcium hypochlorite ($CaOCl_2$) concentrations on clean explants 14 days after culturing are presented in Table 2.7.1. The highest percentage (100%) of clean explants was obtained when 2% $CaOCl_2$ was used for 25 and 30 minutes. In subsequent experiments, leaf explants were sterilized in 2% $CaOCl_2$ for 25 minutes.

Table 2.7.1: Effects of different calcium hypochlorite concentration on elimination of surface contamination from *Allanblackia* leaf explants

CaOCl2 Concentration (%)(w/v)	Duration (min)	Initial number of explants	Clean explants	Contaminated explants	% of clean explants
1	25	10	3	7	30
	30	10	5	5	50
	35	10	9	1	90
	40	15	3	7	30
1.5	20	15	4	6	40
	25	10	4	6	40
	30	10	3	7	30
	35	10	5	5	50
2	15	10	5	5	50
	20	10	8	2	80
	25	10	10	0	100
	30	10	10	0	100

Effect of growth regulators on induction of callus from AB leaf explants

The effect of BAP, Kinetin and TDZ on callus induction is presented in Table 2.7.2. The highest percent (91%) of explants with callus was obtained on media supplemented with TDZ 0.5µM. The highest (40 µM) concentration of BAP and Kinetin and the control did not support callus induction.

Table 2.7.2: Effect of BAP, Kin and TDZ on induction of callus

Callus formation (%)			
Cytokinin conc (µM)	**TDZ**	**BAP**	**Kin**
Control	0	0	0
0.1	0	-	-
0.5	91	-	-
1	50	-	-
2	50	-	-
5	-	0	50
10	-	25	0
20	-	17	0
40	-	0	0

Discussion

Plant growth regulators play a key role in process potentials and dedifferentiation. Cytokinins are known to stimulate cells and, as such, they are also suitable candidates for induction of somatic embryogenesis and callus induction. It has been suggested that TDZ is more effective than other cytokinins used for somatic embryogenesis (Thorpe *et al*., 1991; Lin *et al.,* 2004). The effects of TDZ occur at lower concentrations than other cytokinins and it has been suggested that it either directly promotes growth due to its own biological activity or through inducing the synthesis and/or accumulation of endogenous cytokinins or auxins. During the current study TDZ was more effective than all the other cytokinins evaluated. This work is still in progress and factors that influence induction and regeneration of somatic embryos are currently being evaluated.

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Session 3

Best practices in AB domestication

The group brainstormed extensively on issues pertaining to AB domestication and summarized some of the best practices developed and research needs.

Seed propagation

Allanblackia Stuhlmannii

- Mature fruits are collected from the ground.
- Fruit storage for > 4 weeks in hygienic conditions, and then covered with a clear polythene sheets to avoid desiccation and also maintain a temperature between 25 °C and 30°C.
- The seeds are extracted; testa removed and then soaked in water for 2-4 hours.
- The seeds are then sowed in decomposed, moistened sawdust, and covered in poly sheets. Germination should start after 3 weeks.
- Select germinants that have roots and shoots and pot them directly.

A. parviflora and *A. floribunda*

- Mature fruits are collected from the ground.
- Fruit storage for > 4 weeks in hygienic conditions, at ambient temperatures
- Seeds are extracted, testa removed, and then soaked in water for 2-4 hours, then incubated in a polythene bag to germinate (black or clear).
- Maintenance of high humidity (>75%) and temperature of 23 °C to 30°C are essential to promote seed germination at 3 weeks.
- Germinants with shoot(s) and/or root(s) are then placed in moist coarse sand for 4 weeks before potting in sandy loam soil.

Seed sectioning: *A. parviflora* and *A. floribunda*

- Cut clean seeds in proximal/longitudinal sections.
- Place sections in clear polythene bags that maintain high humidity (>75%), and kept at 23 °C to 30°C.
- Germination should start at 3 weeks.
- Inspect at intervals of two weeks to remove germinants; the germinants should have at least 2 leaves for transplanting.

Nursery management

- Seedlings are potted after 3-4 leaves have been developed.
- Composition of potting medium**:** forest soil, AB soil, compost at 2:1:1 ratio
- Seedlings should be placed in 50% shade
- Water daily to field capacity

Vegetative propagation

Grafting

- Top wedge technique is best and easiest method.

Scion source

- Scions from branches of mature fruiting trees result in early fruiting but plagiotropic growth.
- Scions from orthotropic coppiced shoots result in longer fruiting time but orthotropic growth
- Scions from orthoptropic pollarded shoots result in moderate fruiting time and mostly orthotropic growth

Research needs

- Research to be done on the above three options to get best practice for fruiting time and growth.
- Research to be done on material less than 15 years with different DBH classes as factors.

Cutting propagation

Stock plant management

- Using stumps of mature trees as stockplants require no fertilization. Maintain stump height at 0.5m–1m high.
- Stumps of seedlings are maintained at 30cm and fertilized with 30g of NPK (20-10-10). 50% shading is required.

Preparation of cuttings

- Harvest orthotropic shoots for cutting preparation
- Leaf area: 50cm^2
- Cutting length: 6cm on average
- Cutting diameter: mean of 5mm
- Rooting hormone not needed
- NPK 20:20:20, applied to *A. floribunda* cuttings during callus initiation stage has positive effects.

Research gap

- Relationship between fertilizer quantity and carbohydrate content
- Relationship between plagiotropy and rooting/ growth of rooted cutting
- Relationship between age of shoots and rooting
- Relationship between growth of rooted cuttings and mycorrhizal inoculation

Weaning

Removed cuttings from the propagation chamber when one root reaches at least 1cm long. Initially put in weaning chamber for acclimatization (>75% humidity) until new shoot development. Then remove from chamber and move to 50% shade for 2 weeks before moving to normal nursery conditions for at least 6 weeks before field planting

Marcotting

- Stem/pollarded height: 1.5-2m
- Position of canopy: upper part
- Branch size: 3-5cm diameter
- Media: deposed moist sawdust or decomposed palm stem
- Potting mixture: Same as seedlings above
- Length of marcots: 50-75cm
- Weaning: same as cuttings above
- Fertilizer: foliar fertilizer seems to boost rooting

Field management

They should be planted immediately after the new shoot reaches 5 cm, i.e. about 2-3 months after harvesting.

Tissue culture (*In vitro* propagation)

- Media prepared using Murashige and Skoog basal salts and supplemented with cytokinins
- Disease-free young leaves (2nd pair) are harvested
- Cleaned with liquid soap and kept in running tap water for two hours
- Disinfect explants using 2% calcium hypochlorite for 25 minutes
- Leaf explants sub-divided into small 1cm2 segments
- Explants cultured on a cytokinin enriched media and incubated in the dark at 25°C
- Callus induced from the cut edges of the leaf explants

Research needs (next steps)

- Optimize the factors and conditions for regeneration of AB somatic embryos
- Germination of somatic embryos
- Weaning of plantlets

Field Planting

What to plant

Seedlings preferred for all the three species (*A. parviflora, A. stuhlmannii* and *A. floribunda*). Seedlings grow faster and are able to produce many fruits compared to the other propagules. The only problem with seedlings is that the sex of the tree cannot be determined at juvenile stage.

Cuttings seem to be the next preferred after seedlings as they normally have bushy crown morphology. This may mean large surface area for flowering and fruiting, but needs management to support the stems.

Marcots and grafts have plagiotropic growth and their growth architecture is not encouraging.

In which system?

Monoculture is less applicable due to land shortage. Secondly its silviculture, pests and diseases are not well known.

Agroforestry is most preferred to maximise use of available land to allow farmers to grow other crops. Due to its conical crown structure, it occupies less space and has less competition with other crops or trees. It is a good candidate tree for inter-cropping to provide shade for under-storey crops i.e. spices, cocoa, etc., or used for boundary planting.

What layout options are feasible?

a. As a boundary

b. In contour planting to check soil erosion

c. Intercropping with other trees or crops. Here reasonable spacing should be considered

What spacing (density) is feasible?

For an agroforestry system, there is a limitation with land available and the spacing however, may depend on the farm set-up.

In monoculture, initial spacing may be 6x6m, giving 256 trees/ha. Trees could be thinned to 128 trees per ha when flowering begins, assuming sex ratio is 1:1. Where plot is isolated from other *Allanblackia* trees, it would be advisable to maintain 85% females and 15% males to enhance pollination. Thinned trees could also be sold as poles or fuel wood to provide short-term income to defray part on the investment. A typical design in agroforestry system could follow the planting model below.

Proposed *Allanblackia* planting model

The spacing for the AB trees shall be as follows: spacing for *Allanblackia* trees set at 6x6m between trees for two rows, followed by a space of 10-15m (for crops/other plants), and then another two rows of the *Allanblackia* trees (of the same spacing as the first rows). The indigenous timber trees may be planted on the periphery to add value to the land use for the farmer. Thinning for *Allanblackia* should begin at 7th-10th year, where most males and unhealthy trees are removed. Usually 85% of those remaining shall be females; with the rest (15%) being males. *Allanblackia* trees usually produce many fruits when sparsely planted (farmers should bear this in mind when planting). In addition, the exposure of *Allanblackia* trees to irradiance and careful pruning may significantly increase the fruit production per tree.

What level of management?

Weeding is very critical at initial stages after planting. About 50% shading is also required and could benefit from other crops like plantain, banana, cassava etc. planted a year earlier. The nurse crops could also provide short-term financial returns on investments.

Up-scaling AB cultivation: challenges & recommendations

Agroforestry has been used in the up-scaling of AB cultivation in Tanzania, Cameroon and Ghana. Germplasm supply system has been through a central nursery in Tanzania and RRC approach in Ghana and Cameroon.

The RRC model has faced a lot of challenges in Ghana because:

- It is capital-intensive and farmers do not have the capacity/financial ability to support it. Most farmers do not have the resources to set up RRCs.

- The set-up was project-based/donor-driven with little ownership by farmers/communities.
- RRCs were limited to the production of *Allanblackia* planting stocks and lacked species diversification. AB is a new crop, and is therefore still not very attractive to many people compared to other crops e.g. cocoa.

Recommendations for improvement

- Move away from the central nusery concept and support farmers to produce their own seedlings in their satellite nurseries.
- Need for diversification of seedling production in the nurseries.
- The issue of funding needs to be addressed by linking up with REDD initiatives/carbon credit market eg. *Plan Vivo International.*
- Need for government support in the form of extension services.

Enrichment planting

Enrichment planting is an up-scaling strategy of AB cultivation which involves inter-planting of AB in the forest for restoration purposes. The system was introduced in Ghana through FORM Ghana and approximately 60 hectares has been planted using seedlings from their own nursery.

Session 4

Presentation of IFAD *Allanblackia* component Tranche II, by Dr. Daniel Ofori

Overall Objective

The goal of the project is to reduce rural poverty in Cameroon, Ghana and Tanzania through enhanced cultivation, processing, marketing and use of *Allanblackia.*

Specific Objectives

- Provide farmers with improved AB planting material that is most suitable for a given environment and farming system by characterising available AB planting material and identifying the most suitable AB propagation techniques in a participatory 'bottom-up' approach.
- Develop the most efficient way for up-scaling AB planting material production and dissemination by evaluating the potential of the 'Rural Resource Centre' model.
- Identify morphological markers linked with AB oil quantity and quality and used for selection of 'plus trees'.
- Provide information on sex ratio in AB to provide informed decision on AB plantation establishment.
- Increase and disseminate knowledge on improved AB propagation and multiplication methods and tree management techniques.
- Build capacity of farmers, nursery managers and institutions on sustainable AB propagation, multiplication, management and marketing.

Work package 1: Participatory characterisation of superior AB germplasm and selection of most suitable AB propagation methods (Ghana, Tanzania and Cameroon)

Research questions

i. What are the different propagation methods for AB?

ii Which of the different propagule types has shortest gestation period?

iii Which of the propagules has high productivity?

Key activities

- Fine tuning of propagation techniques for AB.
- Seed germination: Germinate seeds under different temperatures, soaking of seeds before germination and seed sectioning before sowing.
- Improve quality of roots on rooted cuttings: application of different shade levels and fertilizer to stock plants and also explore on the effect of fertilizer application to cuttings under propagation at different stages of development.
- Marcoting: Use of different substrates (soil, mixture of soils and sawdust, coir dust) and pollarding heights of the mother trees (at 1.5, 2, 4 & 6m).
- Best protocols to be developed will be employed in the production of 3000 propagules from different techniques (seedlings, cuttings, grafts & marcots.

- Establish trial plots with different propagule types (cuttings, grafts, seedlings and marcots).
- Develop a database on existing knowledge about AB characterization and propagation.

Work package 2: Establishing sustainable AB planting material supply systems by using the 'Rural Resource Centre' approach (Tanzania, Ghana and Cameroon)

Research questions

- What is the level of knowledge on quality AB germplasm production?Is the current mode of AB germplasm distribution efficient?
- What is the role of gender in AB germplasm production and distribution?

Key activities

- Assessment of mode of germplasm flow (RRCs and satellite nurseries).
- Collect information on knowledge on AB production levels, propagation, cultivation, and sources of germplasm and how easy to obtain AB germplasm.
- Farmers' perceptions on the availability and quality of AB germplasm.
- Increase the AB seedling production capacity of the existing RRCs and evaluate how they enhance AB germplasm dissemination.
- Identify bottleneck in this chain.

Work package 3: Identification of morphological markers linked with AB oil quantity and quality and used for selection of 'plus trees' (Tanzania and Ghana)

Research questions

- Is AB fruit shape related to oil quality and quantity?
- Is AB flower colour related to oil quality and quantity?
- Is the AB oil quality and quantity influenced by the environment?

Key activities

- Determine the relationship between AB fruit shape and oil quality and quantity: identify AB trees with different shapes of fruits and analyse of the quality and quantity of seed oil.
- Determine the relationship between AB flower colour and oil quality and quantity: analyse oil from AB trees with pink and white/cream floral colours. Observe differences and use as markers for seletion of desirable res for mass production.
- Determine provenance effect on AB oil: different AB provenances will be identified and oil extracted and analysed from seeds of trees growing in different provenances and environments.

Work package 4: Determination of the sex ratio in AB to provide informed decision on AB plantation establishment

Research questions

- What is the sex ratio in AB populations?
- Does the AB sex ratio differ on different land use systems?

Key activities

- Determine sex ratio in AB populations: assess sex ratio in three different land use systems; planted gene bank from seedlings with no thinning, on-farm and in the natural forest.
- Marking of AB trees on farm (three agro-ecological zones).
- Marking of AB trees in the natural forest in (three agro-ecological zones).
- Inspection of AB flowers from the marked trees to determine sex ratios.
- Estimate of AB sex ratios in the un-thinned AB gene banks.

Work package 5: Development of knowledge and information sharing products about sustainable AB selection, propagation and on-farm management (all partners)

Research questions

- What is the level and kind of information available on sustainable production of AB?
- What is the mode of information flow among stakeholders on AB domestication?

Key activities

- Develop and disseminate extension and training materials adapted to different target groups: will be achieved by translating research outputs into simple language and self-explanatory form for various target groups such as farmers and extension workers.
- Publish results in international journals, conference presentations/proceedings as well as in other electronic and print media.

Work package 6: Building capacity of smallholder farmers and other key stakeholders along the AB value chain for effective adoption of AB propagation and cultivation practices (Ghana and Cameroon)

Research questions

- What is the level of knowledge on sustainable AB production within the different stakeholder groups?
- What is the level of willingness of farmers to integrate AB trees into their farming systems?

Key activities

- Assess the needs for capacity building in the AB growing zones.
- Organize and perform a workshop including important key stakeholders along the AB value chain in Ghana and Cameroon.
- Train 20 nursery managers of RRCs, satellite and private nurseries in AB propagation techniques.
- Select and organize 500 female and male farmers in Ghana and Cameroon (250 per location). Provide the 500 selected farmers with training on AB propagation, on-farm cultivation and marketing, and with 10 young AB trees each.
- Produce and disseminate 10,000 AB seedlings per country for field planting.

Expected Outputs

- Assess the needs for capacity building in the AB growing zones.
- Organize and perform a workshop including important key stakeholders along the AB value chain in Ghana and Cameroon.
- Train 20 nursery managers of RRCs, satellite and private nurseries in AB propagation techniques.
- Select and organize 500 female and male farmers in Ghana and Cameroon (250 per location). Provide the 500 selected farmers with training on AB propagation, on-farm cultivation and marketing, and with 10 young AB trees each.
- Produce and disseminate 10,000 AB seedlings per country for field planting.

Session 5

Production of a publication on *Allanblackia*

It was noted that a lot of work has been done on *Allanblackia* and the information needed to be documented. It was recommended that a publication on *Allanblackia* be produced. The chapters were discussed and agreed upon. Leaders and members for each chapter were selected and roles assigned (see Table 5.1). The timetable for completion of tasks was also discussed and agreed upon.

Table 5.1: Structure of the publication

Chapter description	Leaders and the word limits
1. Background 1.1 Introduction 1.2 Economic importance 1.2.1 Agroforestry and land use 1.2.2 Food products 1.2.3 Industrial uses 1.2.4 Medicinal uses 1.3 Taxonomy and nomenclature 1.3.1 Botanical description 1.3.2 Description of genus 1.3.3 Description of species 1.4 Origin and distribution	*Henry/Lars/Ebenezer/Paul/Mathew 5000 words
2. Ecological requirements 2.1 Climate (water, temperature, light, altitude etc.) 2.2 Soil	*Moses/Ebenezer 3500 words
3. Reproductive biology 3.1 Phenology 3.2 Flowers 3.3 Fruits and seeds 3.4 Breeding system	*Lars /Henry /Mathew/Daniel 3500 words

Chapter description	Leaders and the word limits
4. Agronomy 4.1 Propagation 4.1.1 Seed propagation 4.1.2 Vegetative propagation 4.2 Field establishment 4.2.1 Site selection 4.2.2 Land preparation 4.2.3 Time of planting 4.2.4 Transplanting and spacing 4.3 Pest and diseases 4.4 Mycorrhiza	*Ebenezer/Theresa/Joseph/Moses/Alain/Rik/Jane 5000 words
5. Seed and seedling distribution 5.1 Models 5.2 Actors 5.3 Outreach 5.4 Quality of planting stocks 5.5 Constraints	*William/Ezekiel/Ebenezer/Alain 3500 words
6. Genetic resources 6.1 Working collections 6.2 Genetic variation 6.3 Genetic conservation (in different countries) 6.4 Constraints (threats)	Mwanaidi/*Theresa/Moses/Sesiwa/Alain 3500 words
7. Harvesting, post-harvest handling and processing 7.1 Harvesting 7.1.1 Maturity stage 7.1.2 Nut extraction 7.1.3 Nut extraction and handling 7.2 Storage for processing 7.3 Transportation 7.4 Processing 7.5 Constraints	*Fidelis/Ezekiel 4000 words

Chapter description	Leaders and the word limits
8. Marketing and commercialization 8.1 Production cost, price and income 8.2 Potential market 8.3 Employment/social improvement	*Amos/Fidelis/Jeroen 3500 words
9. General conclusions and future research needs	*Parveen/Daniel + all 2000 words

*Leader for each group

Parveen Anjarwalla, Daniel Ofori, Lars Graudal, Ramni Jamnadass, Roger Leakey and Ian Dawson were proposed as reviewers of the AB book. The deadline for the drafts from respective groups was set for 15th October 2014. The first draft of the AB book was expected to be ready by 30th October 2014. Each chapter shall consist of the following topics: Introduction, Main issues, Conclusions and References. To ensure flow of information, the following country contact persons were nominated: Tanzania – Mathew, Ghana – Theresa, Cameroon – Alain, and Nigeria – Daniel.

Updates on database development

Dr. Ofori took the participants through various aspects of the database and how to access information regarding the project. Participants were informed that accessibility of data is limited to organizations that contribute data and encouraged partners to submit their data.

Participants suggested that:

- Protocol for data collection should be standardized.
- The measurement should be done at the same time in all regions to avoid inconsistences.
- The database should have digital photos.

Recommendations

On the authenticity and consistency in generation of data, it was decided that there was need for data standardization. This was due to the fact that, such data come from different countries and there may be differences in actual data generated. The standardized protocol was therefore considered critical. The protocol shall clearly indicate: what phenological aspects shall be considered, what exactly should be measured (scored) and when, what exactly is **dbh**, among others.

- Once a protocol has been developed, there should be a training workshop for standardization of data collection, including.
- Experimental design: This should be standardized to allow for comparison of results from different countries and/or species.
- **Soil sampling protocols:** Paul Musili and Alain Tsobeng were asked to send the soil sampling protocols they have for consideration. Mathew was also asked to obtain generic protocols as well. Such protocols could be improved where necessary.
- **Grafting protocol:** It was agreed that, the existing protocol for grafting be improved or 'perfected' during the training workshops proposed, when actual experimentation is done. Find a possible grafting protocol online here: http://www.ehow.com/how_5158997_graft-scions.html
- **Seed count protocol**: Joseph Asomaning was asked to circulate the protocol on the seed count based on ISTA standards. This was prompted by the fact that, the participants were not able to agree on the best protocol to do seed count.

Annexes

Annex I: List of participants

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Annex II: Workshop programme

Time	Activity	Responsible person
	Monday 2nd June 2014	
	Arrival of participants	Sallyannie Muhoro
	Tuesday 3rd June 2014	
	Meeting begins at ICRAF	
0745 - 0830	Pick up from hotel	Sallyannie Muhoro
0830 - 0900	Registration	Sallyannie Muhoro
Session 1 - Opening session		**Chair – Daniel Ofori**
0900 - 0910	Welcome remarks by Regional Coordinator ESA	Jeremias Mowo
0910 - 0920	Statement by SD3 Co-Leader	Ramni Jamnadass
0920 - 0930	Greetings from Unilever	Jeroen Oostenenk
0930 - 0950	Objectives of the meeting	Daniel Ofori
0950 -1030	Participants self-introduction and expectations	Ebenezer Asaah
1030 - 1100	Group photo, coffee, tea etc.	Sallyannie Muhoro
Session 2 – Update on *Allanblackia* project		**Chair - Jeroen Oostenenk**
1100 - 1110	Review and amendment of agenda	Parveen Anjarwalla
1110 - 1140	Brief on IFAD *Allanblackia* project and expected outputs	Daniel Ofori
1140 - 1240	Ghana	Theresa/Joseph/ William
1240 - 1340	Lunch break	Sallyannie Muhoro
1340 - 1440	Cameroon	Alain/Ebenezer
1440 - 1540	Tanzania	Moses/Sesiwa/Henry/ Fidelis
1540 - 1550	Cote D'Ivoire	Jane Kahia
1550 -1605	Health break	Sallyannie Muhoro
1605 - 1620	Nigeria	Nemi
1620 - 1720	**Session 3: General discussion**	**Chair - Lars**
1720 - 1730	Closing /departure to hotels	Sallyannie Muhoro

Time	Activity	Responsible person
Wednesday 4th June 2014		
0745 - 0815	Pick up from hotel	Sallyannie Muhoro
0815 - 0830	Registration	Sallyannie Muhoro
Session 4: Best practices -		**Chair - Ebenezer**
0830 - 1000	Group work on best practices: (vegetative propagation, seed germination, field planting and management)	
1000 – 1015	Tea Break	Sallyannie Muhoro
1015 - 1100	Presentation of reports	
Session 5: IFAD II/AB book		**Chair: Henry**
1100 - 1230	Presentation of IFAD AB phase II	Daniel Ofori
1230 - 1330	Lunch break	Sallyannie Muhoro
1330 - 1345	Book on *Allanblackia*	Daniel Ofori
1345 - 1500	Group work	
1500 - 1600	Presentation of report	
1600 - 1700	General discussion and way forward	Theresa Peprah
1700 - 1730	Closing	Daniel/Ramni
Thursday, 5th June 2014		
0745 - 0815	Pick up from hotel	Sallyannie Muhoro
0815 - 1115	Group work on AB book. Groups meet, select leader, discuss content, draft outline and share responsibilities	Parveen Anjarwalla
	Tea Break	
1115 - 1400	Write-up of presentations for workshop proceedings. Produce about 4-page summary of presentation following normal style of paper writing: title, abstract, introduction, methodology, results, discussion and conclusion	Parveen Anjarwalla
1400 - 1500	Closing /Lunch	

The World Agroforestry Centre is a member of the CGIAR Consortium

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