

STATUS OF SEED SOURCES OF KEY COMMERCIAL TREE SPECIES IN KENYA

**KEFRI - GATSBY AFRICA (KCFP) COMMERCIAL FORESTRY PROJECT
REPORT**

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List of Plates

Plate 1: New <i>Cupressus lusitanica</i> seed orchard in Muguga	4
Plate 2: Ex Zimbabwe <i>Pinus patula</i> seed stand in Kiandogoro Forest Station	5
Plate 3: <i>Pinus patula</i> seed stand at Kamae forest station in Kiambu	5
Plate 4: <i>Eucalyptus urophylla</i> seed stand in Muguga	6
Plate 5: <i>Eucalyptus grandis</i> seed stand in Kabage and Kiandogoro in Nyeri.....	7
Plate 6: Clean and well-maintained <i>M. volkensii</i> clonal seed orchard at Kibwezi.....	9
Plate 7: <i>Melia volkensii</i> tree requiring pruning in Gede seed orchard	9

List of Tables

Table 1: Seed sources within various Eco-regional Research Programmes	3
Table 2a: Geographic location of seed sources in Central Highlands Eco-region Research Programme (CHERP)	10
Table 2b: Description and current status of seed sources in Central Highlands Eco-region Research Programme (CHERP).....	11
Table 3a: Geographic location of seed sources in Drylands Eco-region Research Programme (DERP).....	16
Table 3b: Description and current status of seed sources in Drylands Eco-region Research Programme (DERP).....	16
Table 4a: Seed sources in Coast Eco-region Research Programme (CERP).....	17
Table 4b: Description and current status of seed sources in Coast Eco-region Research Programme (CERP)	18
Table 5a: Geographic location of seed sources in Rift Valley Eco-region Research Programme (RVERP)	19
Table 5b: Description and current status of seed sources in Rift Valley Eco-region Research Programme (RVERP)	21
Table 6a: Geographic location of seed sources in Lake Victoria Eco-region Research Programme (LVERP).....	26
Table 6b: Description and current status of seed sources in Lake Victoria Eco-region Research Programme (LVERP).....	26

Executive summary

The forestry sector in Kenya contributes immensely to the country's socio economic development and has high potential since more than 80 percent of energy in Kenya is from wood. As the population increases, the demand for fuel wood and sawn timber has surpassed the current local production capacity, which has an approximate deficit of 30 percent. Commercial forestry plays an essential role in reducing the wood production gap, employment, generating income for both small scale and large-scale ventures and enhancing forest conservation initiatives.

KEFRI in collaboration with Gatsby Africa identified nine tree species that have a high potential in commercial forestry taking into account the geographical range as well as the potential markets for the various products. The species selection also took into account the species of commercial potential found in the various KEFRI Eco-regions namely; Central highlands Eco-region Programme (CHERP), Drylands Eco-region Programme (DERP), Rift Valley Eco-region programme (RVERP), Coast Eco-region programme (CERP) and Lake Victoria Eco-region programme (LVERP). These species selected were: *Cupressus lusitanica*, *Pinus patula*, *Eucalyptus grandis*, *Eucalyptus camaldulensis*, *Eucalyptus urophylla*, *Grevillea robusta*, *Melia volkensii*, *Casuarina equisetifolia* and *Casuarina junghuhniana*.

The genetic quality of planting material is vital in commercial forestry as it determines the performance of a plantation. In an effort to ensure the supply of high quality planting material, KEFRI has established seed sources of various categories. These include Clonal Seed Orchards (CSO), Seedling Seed orchards (SSO), Established Seed Stands (ESS) and Selected Seed Stands (SSS). Periodic evaluation of these seed sources is of great importance as it advises on the production potential, ensures the integrity of these seed sources and informs the breeding programme. The objectives of this exercise were to: to carry out survey on the current status; assess the productivity; document location, and provide recommendations for each of the seed sources of the selected species. This report therefore, highlights information gathered from desktop review as well as real-time observations from ground truthing exercise conducted on all the seed sources of the selected species. The findings of this report indicate that the seed sources are inadequate to meet the current demand for commercial forestry. It is recommended that various strategies need to be put in place to ensure sufficient supply of high quality planting materials.

TABLE OF CONTENTS

List of Plates	ii
List of Tables	iii
Executive summary	iv
1.0 Introduction	1
1.1 Objectives of the study	1
2.0 Methodology	2
3.0 Findings/Results	2
3.1 Desktop review	2
3.2 Field verification	4
3.2.1 <i>Cupressus lusitanica</i>	4
3.2.2 <i>Pinus patula</i>	4
3.3.3 <i>Eucalyptus urophylla</i>	6
3.3.4 <i>Grevillea robusta</i>	6
3.2.5 <i>Eucalyptus grandis</i>	7
3.2.6 <i>Eucalyptus camaldulensis</i>	7
3.2.7 <i>Casuarina jughuniana</i>	8
3.2.8 <i>Casuarina equisetifolia</i>	8
3.2.9 <i>Melia volkensii</i>	8
4.0 Other institutions involved in seed and seedling production	27
5.0 Recommendations	27

1.0 Introduction

Commercial forestry is one of the most important initiatives in Kenya towards achieving the 10 percent tree cover and contributing to the Government's Big Four Agenda. Nine tree species were identified as priority for consideration in commercial forestry development in Kenya. Identification was done through a consultative process involving stakeholders of the forest sector during the development of the National Tree Improvement Strategy. This exercise took into account the ecological suitability and the existence of current and potential markets for the forest products. The identified species were: *Cupressus lusitanica*, *Pinus patula*, *Eucalyptus grandis*, *Eucalyptus camaldulensis*, *Eucalyptus urophylla*, *Grevillea robusta*, *Melia volkensii*, *Casuarina equisetifolia* and *Casuarina jughuniana*.

All the species have the advantage of being relatively fast growing, their management regimes are known, and their products have extensive markets. The species are grown for one or more of the following uses in Kenya; supply of both domestic and industrial fuelwood, power transmission poles, construction poles; construction timber;, and, specifically in the case of *G. robusta*, use within food production systems by farmers (agroforestry). For these reasons, they are popular amongst farmers and attractive to investors in the forestry sector.

Government agencies namely; Kenya Forestry Research Institute (KEFRI) and Kenya Forest Service (KFS) within the Ministry of Environment and Forestry; and other non-governmental organizations have been involved in programmes that encourage the growing of these species by both small and large-scale investors. A key input in commercial forestry is the genetic quality of seeds or the source of the vegetative propagation material. KEFRI has been involved in implementing programmes targeting the establishment and management of seed sources with the view of yielding high quality seed. Various seed sources have been established on public and private land. However, the status and management regimes of some of the seed sources are not well documented. Full documentation of seed sources is important for planning commercial forestry development programs, addressing the market needs and managing risks of changes in supply and demand of different species.

1.1 Objectives of the study

1. To carry out survey on the current status of all the seed sources in KEFRI
2. To assess the productivity status of the seed sources
3. To document location of each seed source
4. To provide recommendations for each seed source

2.0 Methodology

To ascertain the status of the existing seed sources, a desktop review was done followed by a ground truthing exercise. The ground truthing involved field visits to all the seed sources for commercial tree species in Central Highlands Ecoregion Research Programme (CHERP), Coast Ecoregion Research Programme (CERP), Drylands Ecoregion Research Programme (DERP), Rift Valley Ecoregion Research Programme (RVERP) and Lake Victoria Ecoregion Research Programme (LVBERP) located within KEFRI, KFS and private lands. The data collected included information on the tree species, location, source of planting material, year of establishment age, category, area of seed source, land ownership, estimated production capacity of the seed source. In addition, data was also collected on the current status of the seed sources and recommendations made. The seed sources were categorized as; Clonal Seed Orchards (CSO), Seedling Seed Orchards (SSO), Selected Seed Stands (SSS) and Established Seed Stands (ESS).

3.0 Findings/Results

3.1 Desktop review

The desktop review revealed existence of the following seed sources per Eco-region. CHERP: 30 seed sources of *Casuarina jughuniana*, *Cupressus lusitanica*, *Eucalyptus grandis*, *Eucalyptus urophylla*, *Grevillea robusta* and *Pinus patula*; DERP: 5 of *E. camaldulensis* and *M. volkensis*; CERP: 7 of *C. equisetifolia*, *E. camaldulensis* and *M. volkensis*; RVERP 33 of *Cupressus lusitanica*, *Pinus patula*, *Eucalyptus grandis* and *Grevillea robusta* and LVBERP: 4 of *E. camaldulensis*. The details of the seed sources are shown in detail in Table 1. Seed orchards layouts and maps were available for use during the ground truthing exercise.

Table 1: Seed sources within various Eco-regional Research Programmes

No.	Species	CHERP		DERP		RVERP		CERP		LVERP	
		No. of seed sources	Total Area (ha)	No. of seed sources	Total Area (ha)	No. of seed sources	Total Area (ha)	No. of seed sources	Total Area (ha)	No. of seed sources	Total Area (ha)
1	<i>Cupressus lusitanica</i>	8	11.2			14	28.3				
2	<i>Pinus patula</i>	4	40			12	22.5				
3	<i>Eucalyptus grandis</i>	3	5			13	31.5				
4	<i>Eucalyptus urophylla</i>	6	6								
5	<i>Eucalyptus camaldulensis</i>			3	3			3	4.2	3	3.5
6	<i>Melia volkensis</i>			2	22			1	1		
7	<i>Grevillea robusta</i>	6	7			5	16.5				
8	<i>Casuarina equisetifolia</i>							3	4.3		
9	<i>Casuarina junghuhniana</i>	4	7.5								
	Total	30	76.7	5	25	44	98.8	7	9.5	3	3.5

3.2 Field verification

Location maps and layouts were used in the field verification exercise. Results of the exercise are summarized per species and more details are found in Tables 2a &b for CHERP, Tables 3a &b for DERP, Tables 4a &b for CERP, Tables 5a &b for RVERP, Tables 6a &b for LVERP

3.2.1 *Cupressus lusitanica* (Cypress)

All the cypress seed sources are located in Muguga and Londiani, two of them were established in 1968 and 1969. New orchards have been established in Muguga using the genetic materials from the 1968 and 1969 seed orchards and are currently seeding well. Most of the seed sources are healthy although timely maintenance is required to reduce competition by weeds and to maximize seed production. In particular tree topping to facilitate seed collection and rouging to improve the pollen cloud based on results of progeny trials (Plate 1).



Plate 1: New *Cupressus lusitanica* seed orchard in Muguga due for topping and rouging

3.2.2 *Pinus patula*

All *P. patula* seed sources are found in CHERP and RVERP and are located in KFS or KEFRI land (Plate 2 and 3). Some of the orchards in CHERP are old and have low seed production. The only seed stand in Kiambu (Kamae) is diseased as evidenced by yellowing of the trunk (Plate 3). Seed collections from this source were stopped due to the infection. RVERP region has recently established new sources with some already producing seeds.



Plate 2: Ex Zimbabwe *Pinus patula* seed stand in Kiandongoro Forest Station



Plate 3: *Pinus patula* seed stand at Kamae forest station in Kiambu

3.3.3 *Eucalyptus urophylla*

Seed sources of this species are only found in Muguga. The existing stands are currently seeding well and have good seed production potential (Pate 4). However, they are established near other *Eucalyptus* plantations and therefore there is a possibility of contamination through hybridization. These other surrounding *Eucalyptus* species plantations should be removed.



Plate 4: *Eucalyptus urophylla* seed stand in Muguga

3.3.4 *Grevillea robusta*

The mature *G. robusta* seed sources are non-productive since planting which could be attributed to poor siting. Turbo and Muguga seed stands are sources of scions for vegetative multiplication for new seed source establishment. The younger Njoguini seed orchard in Nanyuki and the seed stand in Soin need replanting because of low survival. The Kigetuni seed orchard in Muranga requires urgent maintenance to manage *Lantana camara* invasion. Kigetuni and Nguthuru seed orchards are affected by termites which need to be controlled.

3.2.5 *Eucalyptus grandis*

The seed sources of *E. grandis* are found in CHERP and RVERP. Although most of these seed sources are of good material, the trees are too tall with declining seed productivity (Plate 5). Therefore, establishment of new sources is required from the previously selected material in the seed sources. The new sources should be managed to maintain a reasonable height for seed collection. Many seed sources in RVERP are new establishments with potential for adequate future seed production.



Plate 5: *Eucalyptus grandis* seed stand in Kabage and Kiandogoro in Nyeri

3.2.6 *Eucalyptus camaldulensis*

The seed sources of *E. camaldulensis* are in CERP, DERP and LVERP. However, some of these stands had mixtures of other *Eucalyptus* species and hybrids and exhibited a lot of variation. Seed collected from the affected sources is contaminated and therefore seed collection was terminated. *E. camaldulensis* seed stands in CERP are unproductive and have not produced seed since establishment. Therefore, a survey of appropriate sites for seed production should be undertaken. It is recommended that the purity of material used to establish future seed sources need to be ascertained before establishment.

3.2.7 *Casuarina jughuniana*

Casuarina jughuniana seed sources are found in Meru forest station, Kiandogoro, Uplands and Ontulili. These seed sources are old and elephants have damaged the Ontulili source. Selection of plus trees from these sources for establishment of new seed sources is urgently required.

3.2.8 *Casuarina equisetifolia*

The seed sources are all located in CERP. All stands visited were heavily infected with *Casuarina* bark blister disease and most trees had died. However, some of the trees appeared healthy. Changes in climatic factors could possibly be responsible for this. However, proper site matching, soil tests and treatment are recommended before establishment of *Casuarina* seed sources. Since there are no healthy seed sources of *C. equisetifolia*, their establishment should be prioritized in sites that are more suitable. In addition, trees that appeared healthy within the infected stands are most likely tolerant of the disease and should be selected for establishment of new tolerant seed sources.

3.2.9 *Melia volkensii*

Melia volkensii seed sources are located in Kitui, Kibwezi and Gede. The orchards were generally well maintained, properly fenced and adequately isolated from neighbouring plantations (Plate 6). This is recommended for other species. However, regular weeding and pruning are important to minimize disease incidences and improve productivity. The seed orchard at Gede has heavy vegetative growth compared to seed- productivity (Plate 7), and needs timely pruning. Future orchards should be established in more suitable sites for seed production.

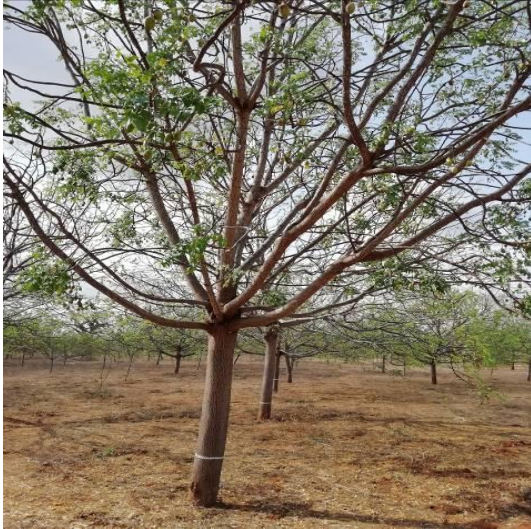


Plate 6: Clean and well-maintained *M. volkensii* clonal seed orchard at Kibwezi



Plate 7: *Melia volkensii* tree requiring pruning in Gede seed orchard

Table 2a: Geographic location of seed sources in Central Highlands Eco-region Research Programme (CHERP)

NO.	SITE	GPS LOCATION			SPECIES	AREA (ha)
		LAT	LONG	ALT(M)		
1	Muguga (Kioni residence)	1° 12.45' S	36° 38.49' E	2090	<i>C. lusitanica</i>	1.2
2	Muguga (Borehole)	1° 12.35' S	36° 38.36' E	2060	<i>C. lusitanica</i>	1
3	Muguga (Malale)	1° 13.41' S	36° 38.41' E	2050	<i>C. lusitanica</i>	1
4	Kari Gate	1° 13.16' S	36° 38.45' E	2050	<i>C. lusitanica</i>	1
5	Kari Gene Bank	1° 13.0' S	36° 37.44' E	2100	<i>C. lusitanica</i>	1.5
6	Kari Gene Bank	1° 12.59' S	36° 37.49' E	2100	<i>C. lusitanica</i>	1.5
7	Ketri Malale	1° 13.38' S	36° 38.36' E	2060	<i>C. lusitanica</i>	2
8	KARI Kikuyu Boys	1° 13.33' S	36° 37.57' E	2090	<i>C. lusitanica</i>	2
9	KARI GATE	1° 13.35' S	36° 38.44' E	2050	<i>E. urophylla</i>	1
10	Muguga Pine view	1° 12.29' S	36° 38.45' E	2070	<i>E. urophylla</i>	1
11	Muguga Pine view	1° 12.27' S	36° 38.47' E	2080	<i>E. urophylla</i>	1
12	KARI MALALE	1° 13.38' S	36° 38.35' E	2060	<i>E. urophylla</i>	1
13	Muguga Pine view	1° 12.19 'S	36° 38.46' E	2080	<i>E. urophylla</i>	1
14	Muguga Pine view	1° 12.34'S	36° 38.46' E	2070	<i>E. urophylla</i>	1
15	Kigetuiini	0°39'45"S	37°9.0'13"E	1510	<i>G. robusta</i>	1
16	Nanyuki	0°0'26"N	36°58'58"E	1840	<i>G. robusta</i>	1
17	Nguthuru(kenol)	0°56'55"S	37°5.0'1"E	1490	<i>G. robusta</i>	1
18	Marania 1(T)	0°5'1"N	37°29'12"E	2450	<i>P. patula</i>	17
19	Kiandongoro	0°27'25"S	36°50'28"E	2370	<i>P. patula</i>	1
20	Kabage	0°23'30"S	36°49'27"E	2280	<i>P. patula</i>	1
21	Nguthuru(Kenol)	0°56'54"S	37°5.0'4"E	1560	<i>G. robusta</i>	1
22	Kiandongoro	0°27'26"S	36°51'30"E	2250	<i>E. grandis</i>	1
23	Kabage	0°24'27"S	36°51'10"E	2220	<i>E. grandis</i>	2
24	Kabage	0°23'29"S	36°49'23"E	2310	<i>E. grandis</i>	2
25	Meru KEFRI Station	0°3'43"N	37°37'49"E	2490	<i>C. jughuniana</i>	2
26	Meru, Ontulili	0°1'18"N	37°9'40"E	2120	<i>C. jughuniana</i>	3

NO.	SITE	GPS LOCATION			SPECIES	AREA (ha)
27	Kiandogoro, 1(k)	0°27'25"S	36°50'28"E	2370	<i>C. jughuniana</i>	1.5
28	Njukiini 1 N(a)	0°29'46"S	37°45'18"E	1490	<i>G. robusta</i>	2
29	Kamae	0°50'57"S	36°38'23"E	2620	<i>P. patula</i>	21
30	Uplands	1°3'40"S	36°40'56"E	2430	<i>C. jughuniana</i>	1

Table 2b: Description and current status of seed sources in Central Highlands Eco-region Research Programme (CHERP)

No.	Site	Species	Category	Source of material	Ownership	YOE	Stand density	Espacement	Current production level	General observation	Recommendations	Remarks
1	Muguga (Kioni residence)	<i>C. lusitanica</i>	SO	Kenya, Uganda & Tanzania	KEFRI	1969	60-80	4x4	Low	-Orchard is old -Some trees are dying -Several broken tops - Poor seeding	Clear fell and establish a new seed source on the site	-Material is good -Selected material have been replicated in a younger orchard
2	Muguga (Borehole)	<i>C. lusitanica</i>	SO	Kenya, Uganda & Tanzania	KEFRI	1968	60-80	4x4	Medium	-Orchard is old	Clear fell and establish a new seed source on the site	-File is missing -same material as in Muguga Kioni residence orchard
3	Muguga (Malale)	<i>C. lusitanica</i>	SO	Muguga (Kioni residence) RE 262/68-69	KEFRI	2007-2008	80	4x4	Low	-Trees are too closely planted -low seeding -Healthy trees	-Maintenance required -Topping and thinning to open the crown	
4	KARI gate	<i>C. lusitanica</i>	SO	Muguga (Kioni residence) RE 262/68-69	KEFRI	2012	80	6x6	Low	-Canopy closing -few seeds but many flower buds -Healthy trees	-Conduct literature search on topping of cypress for proper management	
5	KARI Gene Bank	<i>C. lusitanica</i>	SO	Muguga (Kioni residence) RE 262/68-69	KEFRI	2013	80	6x6	Low	-Moderate flowering -Medium seeding -Healthy trees	-Prune lower branches up to 1m for accessibility -General maintenance	
6	KARI Gene Bank	<i>C. lusitanica</i>	SO	Muguga (Kioni residence) RE 262/68-69	KEFRI	2014	80	6x6	Low	-Low flowering -Healthy trees -Low seeding	-Clear bushes -Introduce corner trenches	

No.	Site	Species	Category	Source of material	Ownership	YOE	Stand density	Espacement	Current production level	General observation	Recommendations	Remarks
7	KETRI Malale	<i>C. lusitanica</i>	SO	Muguga (Kioni residence) RE 262/68-69	KEFRI	2017-2019(beating up)	80	6x6	Low (young)	-On PELIS site -Beaten up twice since 2016	Abolish PELIS for SO establishment	
8	KARI Kikuyu boys	<i>C. lusitanica</i>	SO	Muguga (Kioni residence) RE 262/68-69	KEFRI	2018-2019	80	6x6	Low (young)	-On PELIS site	-Spot weeding 1 m of each side of the trees -Abolish PELIS	
9	KARI Gate	<i>E. urophylla</i>	ESS	Malale SSO	KEFRI	2013	80	4x4	Low	- Human and animal damage at younger age - trees generally healthy but a few with cankers >70% forked -Good growth	Clear fell and plant a new seed source	New material has been imported from Camcore
10	Muguga Pine view	<i>E. urophylla</i>	SS	Malale SSS	KEFRI	2014	80	4x4	Medium	-Human disturbance -Mixed with other Eucalyptus species -Heavy seeding	-Clear fell and plant afresh	
11	Muguga Pine view	<i>E. urophylla</i>	SS	Malale SSS	KEFRI	2015	80	5x5	Medium	-Heavy seeding -Trees very tall -Canopy closing -Healthy trees	Topping, slashing and general maintenance required	
12	KARI MALALE	<i>E. urophylla</i>	SS	Malale SSS	KEFRI	2016	80	5x5	Low	-Too close to other Eucalyptus species -Heavy seeding	-Clear other Eucalyptus plantations within 100 m of the stand -Needs topping, branch brushing, thinning and maintenance -No seed collection until after clearing neighboring plantations	
13	Muguga Pine view	<i>E. urophylla</i>	SS	Malale SSS	KEFRI	2017	80	6x6	(Low)Young	- Initial survival was low -Beating up done in 2019 -Under PELIS -very near <i>E. saligna</i> plantation -Low seed set -Low flowering	-Brushing and pruning of lower branches -Topping Abolish PELIS	

No.	Site	Species	Category	Source of material	Ownership	YOE	Stand density	Espacement	Current production level	General observation	Recommendations	Remarks
14	Muguga Pine view	<i>E. urophylla</i>	SS	Malale SSS	KEFRI	2018	80	6 x6	Low (young)	Initial survival not good (<20%) -Replanted in 2019	Urgent maintenance required	Seed collection should not be done until the younger trees start seeding
15	Kigetuiini	<i>G. robusta</i>	CSO	Muguga tree bank	Kigetuiini primary school	2018	80	6x6	Low (Young)	- very bushy and inaccessible -some seedlings eaten by termites, -some scions are being overtaken by root stocks	- Requires urgent maintenance - assess the survival and the status of the grafts	consider replanting if graft survival is low
16	Nanyuki(Njoguini)	<i>G. robusta</i>	CSO	Muguga tree bank	Njoguini primary	2017	20	6x6	Low (dead)	-less than 5% survival due to prolonged drought, -watering of the seedlings stopped due to insufficient water in the school.	-Replant the orchard, water storage currently being installed by the school.	
17	Nguthuru (kenol)	<i>G. robusta</i>	GSO	Muguga tree bank	Nguthuru primary	2014	40	6x6	Low	-The orchard is under PELIS - high termite attack - trees are being pruned by the farmers	-Advice the farmers to stop pruning the trees - top the trees to encourage lateral branches and ease collection of seeds -control termites	-Beating up was done late hence non uniformity of the trees -Seed collection to commence when most of the trees are seeding
18	Marania 1 (T)	<i>P. patula</i>	SSS		KFS	1982	40-60	3x3	High	-Most trees are of good form, healthy and seeding well	Collect scions from the selected plus trees and include them in the establishment of a seed orchard	Selection of plus trees has been done (Leonida insert the number)
19	Kiandongoro	<i>P. patula</i>	ESS	Ex-Zimbabwe	KFS	1999-2000	80	3x3	Medium	-Trees are tall and healthy -Most trees are of good form	Collect scions from the selected plus trees and include them in the establishment of a seed orchard	Selection has been done (Leonida insert the number)
20	Kabage	<i>P. patula</i>	ESS	Ex-Zimbabwe	KFS	2000	80	3x3	Medium	-Thinning has been done, -no pruning done,	-Select plus trees and collect scions for establishing seed orchard	-Potential stand for plus trees selection

No.	Site	Species	Category	Source of material	Ownership	YOE	Stand density	Espacement	Current production level	General observation	Recommendations	Remarks
21	Nguthuru (Kenol)	<i>G. robusta</i>	CSO	Muguga tree bank	Nguthuru primary	2015	60-80	6x6	Low	-over 80 percent survival -termite attack reduced after application of termiticides in 2016 - it is under agroforestry -the trees are over-pruned by the school	-Advice the school management to stop pruning the trees, -top the trees to encourage lateral branches and ease collection of seeds -control termites	
22	Kiandongoro	<i>E. grandis</i>	ESS	Ex-South Africa	KFS	2000	80	3x3	Low	-Trees are very tall and healthy, -plus trees have been selected -good stocking	Clear fell the stand and allow coppicing	-Pus tree selection done (insert numbers). -Grafted seedling of the selected plus tree to be included in seed orchard establishment
23	Kabage	<i>E. grandis</i>	ESS	Ex-Zimbabwe	KFS	2002	80	3x3	Low	-Trees are too tall and healthy, - Plus trees have been selected -Good stocking -seed collection stopped	Clear fell the stand and allow coppicing	-Pus tree selection done (insert numbers). -Grafted seedling of the selected plus tree to be included in seed orchard establishment
24	Kabage	<i>E. grandis</i>	ESS	Ex- Zimbabwe	KFS	2000	80	3x3	Low	Trees are very tall and healthy, good stocking	Clear fell the stand and allow coppicing	-Pus tree selection done (insert numbers). -Grafted seedling of the selected plus tree to be included in seed orchard establishment
25	Meru forest Station	<i>C. jughuniana</i>	SSS	unknown	KFS	1974	40-60	3x3	High	-Most trees died because of damage by elephants. -Trees are of good form, tall and healthy, -termite attack though no effect on performance, - most remaining trees are male	Select good parent trees and pool with the other three stands for use to establish new stands	Consider that the species dioecious

No.	Site	Species	Category	Source of material	Ownership	YOE	Stand density	Espacement	Current production level	General observation	Recommendations	Remarks
26	Meru, Ontulili	<i>C. jughuniana</i>	SSS	unknown	KFS	1985	20	3x3	Low	-Few trees remaining -Severe elephant damage, -replanting was done by KFS in 2015 by seedlings raised from seeds collected from the stand -its is under PELIS	select good trees from the 1985 planting and pool with the other three stands for use to establish new stands	
27	Kiandogoro 1(k)	<i>C. jughuniana</i>	ESS	Best performing <i>C. jughuniana</i> provenance from international provenance trial	KFS	2006	40-60	3x3	Medium	- very bushy with a lot of creeper plants -High percentage of male trees -currently flowering and seeding Over 50 percent survival	-Requires urgent maintenance -Explore possibility of topping to ease seed collection and encourage production of more lateral branches -select good parent trees and use for establishing a seed stand	Most seedlings were destroyed by termites during earlier establishment
28	Njukiini 1 N(a)	<i>G. robusta</i>	GSO	Muguga tree bank	KFS	2011	60-80	6x6	Low	-Under PELIS, KFS currently filled the empty spaces with materials of unknown origin.	Write off due to contamination with other materials	
29	Kamae	<i>P. patula</i>	SSS	KEFRI seed Centre	KFS	1983	80	3x3	Medium	-Most trees show discolouration on the stem(orange),trees are very tall and forking and some have fallen -pruning not done well	-Stop collecting seeds	
30	Uplands	<i>C. jughuniana</i>	SSS	Not known	KFS	Not known	40-60	3x3	Low	-Selective harvesting and thinning has been done (big trees removed), poor quality trees left, -last seed collection was done in 2015	-Seed collection should be stopped completely.	

Table 3a: Geographic location of seed sources in Drylands Eco-region Research Programme (DERP)

No	Site	GPS Location			Species	Area (Ha)
		LAT	LONG	ALT		
1	Chuluni Secondary school	1° 24.7'11''S	38° 2.1'88''E	1117 m	<i>E. camaldulensis</i>	1
2	Matinyani secondary school	1° 18.7'92''S	37° 58.4'97''E	1197 m	<i>E. camaldulensis</i>	1
3	St. Charles Lwanga boys' high school	1° 22'29.94''S	37° 58' 50.23''E	1138 m	<i>E. camaldulensis</i>	1
4	Tiva	1° 22'14.93''S	37° 50' 15.27''E	1130 m	<i>M. volkensii</i>	11
5	Kibwezi	2° 18.044' S	38° 1.8'82' E	840 m	<i>M. volkensii</i>	11

Table 3b: Description and current status of seed sources in Drylands Eco-region Research Programme (DERP)

NO	Site	Species	Category	Source of material	Ownership	*YoE	Current stand density (%)	Espacement	Current production level	General observation	Recommendations	Remarks
1	Chuluni secondary school	<i>E. camaldulensis</i>	ESS	Ramogi	Chuluni secondary school	2013	60-80	4x4	Low	-Stand mixed with other tree species e. g <i>E. tereticonis</i> Terminalia, Vitex payos -Site variation in tree size -Low seeding (out of season) -no seed collection going on	Write off	Contaminated seed source
2	Matinyani secondary school	<i>E. camaldulensis</i>	ESS	Not known	Matinyani secondary school	2007	40-60	3x3	Low	-A lot of variation (mixed with other Eucalyptus species and hybrids) -Some trees of good form -No flowers, scanty seeds -Never thinned	write off	Contaminated sources
3	St. Charles Lwanga boys' high school	<i>E. camaldulensis</i>	ESS		St. Charles Lwanga boys' high school	2008	60-80	4x4	Low	-Mixed species and hybrids, a lot of variation in age, coppice -Pests on leaves (galls) -No flowering or seeding -Never thinned	write off	Contaminated sources

4	Tiva	<i>M. volkensii</i>	CSO	Various plus trees	KEFRI	2012 - 2013	>80	6x6	High	-Well maintained -Low seed set (out of season) -Canker observed -Canopy closing	-Lop to open up the canopy for improved seed production -Establishment of 2 nd generation orchard -Increase spacing for future orchards -remove diseased trees	-In good condition -It is fenced
5	Kibwezi	<i>M. volkensii</i>	CSO	Various plus trees	University of Nairobi	2012 - 2013	>80	6x6	High	Heavy seeding	Continue with management	Well maintained

*YoE – Year of establishment

Table 4a: Seed sources in Coast Eco-region Research Programme (CERP)

NO.	SITE	GPS LOCATION			SPECIES	AREA (ha)
		Latitude	Longitude	Altitude		
1	Gede	3° 17.687' S	39° 59.803' E	32 m	<i>C. equisetifolia</i>	1.3
2	Gede	3° 17.799' S	39° 59.460' E	37 m	<i>C. equisetifolia</i>	1
3	Mr. Bawaly farm	3° 13.463' S	40° 5.713' E	25 m	<i>C. equisetifolia</i>	-
4	Gede	3° 17.975' S	39° 59.277' E	33 m	<i>C. equisetifolia</i>	2
5	Gede	3° 17.753' S	39° 59.347' E	50 m	<i>E. camaldulensis</i>	1
6	Gede	3° 17.681' S	39° 59.877' E	32 m	<i>E. camaldulensis</i>	1
7	Gede	3° 18.081' S	39° 59.446' E	35 m	<i>E. camaldulensis</i>	2.2
8	Gede	3° 18.013' S	39° 59.460' E	23 m	<i>M. volkensii</i>	1

Table 4b: Description and current status of seed sources in Coast Eco-region Research Programme (CERP)

No.	Site	Species	Category	Source of material	Ownership	YoE	Espacement	Current stand density (%)	Current production level	General observation	Recommendations	Remarks
1	Gede	<i>C. equisetifolia</i>	SS	Good mother trees	KFS	2011	4x4	<20	Low	<10 trees remaining and site planted with <i>Milicia excelsa</i>	Write off and remove sign post	
2	Gede	<i>C. equisetifolia</i>	ESS	Robinson Island	KFS	2006	3x3, thinned to 6x6 in some sections	60-80	Low	Some trees dead from bark blister disease Not seeding	write off	the stand might have been poorly sited
3	Mr. Bawaly farm	<i>C. equisetifolia</i>	SSS	Not known	Mr. Bawaly	1979		<20	Low	Only boundary trees remaining trees were cut down and replaced with mangoes	Write off	
4	Gede	<i>C. equisetifolia</i>	ESS	50 clean and healthy mother trees	KFS	2014	5x5	<20	Low	-95% trees dead and dying from bark blister disease and poor maintenance	Write off	No seed collected
5	Gede	<i>E. camaldulensis</i>	ESS	Regionally selected mother trees	KFS	2009	6x6	60-80	Low	Bushy	Requires maintenance	No seed collected yet
6	Gede	<i>E. camaldulensis</i>	ESS	Various plus trees within the county	KFS	2011	4x4	>80	Low	Mixed with Eucalyptus and other species	Write off	

7	Gede	<i>E. camaldulensis</i>	ESS	Plus trees	KFS	2014	4x4	>80	Low	Mixed with Eucalyptus and other species	Write off	
8	Gede	<i>M. volkensii</i>	CSO	Various plus trees	KFS	2014	6x6	>80	Low	-high vegetative growth -Healthy trees Scanty seeding	-Requires pruning/pollarding and general management	Not well established High potential for seed production

Table 5a: Geographic location of seed sources in Rift Valley Eco-region Research Programme (RVERP)

No	SITE	GPS LOCATION			Species	CATEGORY	AREA(ha)
		LATITUDE	LONGITUDE	ALTITUDE (m)			
1	Masaita 1U	S 00.14648	E 035.62162	2444	<i>C. lusitanica</i>	SO	1.3
2	Masaita 1Q	S 00.14508	E 035.62335	2436	<i>C. lusitanica</i>	SO	2
3	Kamara 6E	S 00.12897	E 035.67197	2510	<i>C. lusitanica</i>	GSO	2
4	Masaita 1C	S 00.14351	E 035.62292	2440	<i>C. lusitanica</i>	GSO	2
5	Kamara 7D	S 00.12151	E 035.67493	2544	<i>C. lusitanica</i>	GSO	2
6	Kamara 6F	S 00.12712	E 035.66714	2493	<i>C. lusitanica</i>	GSO	1
7	Masaita 7D	S 00.12321	E 035.67445	2531	<i>C. lusitanica</i>	GSO	2
8	Kamara 7D	S 00.12214	E 035.67283	2515	<i>C. lusitanica</i>	GSO	2
9	Kamara 7D	S 00.12052	E 035.67081	2499	<i>C. lusitanica</i>	GSO	4
10	Masaita 2T	S 00.14745	E 035.64816	2484	<i>C. lusitanica</i>	GSO	2
11	Masaita 2T	S 00.14842	E 035.65004	2458	<i>C. lusitanica</i>	GSO	2
12	Turbo Compt 2K	N 00.63614	E 035.06310	1837	<i>G. robusta</i>	GSO	7.5

13	Soin-Kipsitet Agricultural Training College	S 00.18864	E 035.16074	1306	<i>G. robusta</i>	SS	3
14	Muhoroni Sugar	To be collected			<i>G. robusta</i>	SS	3
15	Homalime -Koru	S 00.14483	E 035.25373	1466	<i>G. robusta</i>	SS	3
16	Turbo 2J	N 00.64551	E 035.06783	1844	<i>E. grandis</i>	SO	3
17	Turbo- Nzoia 3A (EP 164)	N 00.72546	E 035.05432	1884	<i>E. grandis</i>	SSO	3
18	Turbo 2 K	N 00.63960	E 035.06470	1838	<i>E. grandis</i>	SS	3
19	Turbo 2K	N 00.63886	E 035.06437	1842	<i>E. grandis</i>	SO	3
20	Turbo 1G	N 00.67060	E 035.02813	1872	<i>E. grandis</i>	SO	3
21	Turbo 1G	N 00.67150	E 035.02519	1848	<i>E. grandis</i>	SO	2
22	Turbo, Nzoia, 3 D (a)	N 00.70616	E 035.04646	1863	<i>E. grandis</i>	SO	4.5
23	Masaita 1C	S 00.14565	E 035.62344	2424	<i>P. patula</i>	SO	3
24	Kamara 6E	S 00.12714	E 035.67212	2523	<i>P. patula</i>	SO	3
25	Kamara 7D	S 00.12350	E 035.67081	2558	<i>P. patula</i>	ESS	1
26	Kamara 7D	S 00.12000	E 035.67694	2531	<i>P. patula</i>	SO	1
27	Kamara 5I	S00.13053	E 035.67762	2545	<i>P. patula</i>	SO	2
28	Kamara 7D	S 00.11830	E 035.67570	2535	<i>P. patula</i>	GSO	1
29	Kamara 7D	S 00.12194	E 035.66949	2498	<i>P. patula</i>	GSO	2.5

30	Kamara 7E	S 00.12116	E 035.66866	2483	<i>P. patula</i>	GSO	2
31	Masaita 2T	S 00.14600	E 035.64533	2465	<i>P. patula</i>	GSO	1
32	Masaita 2T	S 00.1479	E 035.64736	2479	<i>P. patula</i>	GSO	3
33	Molo North	S 00.17567	E 035.73180	2519	<i>P. Patula</i>	GSO	1

Table 5b: Description and current status of seed sources in Rift Valley Eco-region Research Programme (RVERP)

No	Site	Species	Category	Source of material	YoE	Ownership	Espacement	Current stand density	Current production level	General observation	Recommendations
1	Masaita 1U	<i>C. lusitanica</i>	CSO	Locally selected Plus Trees in 1960s in East Africa	1970	KFS	6 x 6	70%	Low	-An old S.O. with big trees -low seed production	Replicate the material into a new seed orchard
2	Masaita 1Q	<i>C. lusitanica</i>	CSO	Various Plus Trees selected from plantations in Rift Valley	2007 to 2009	KFS	6X6	60%	Low	-Trees showing vigorous growth -Light seed crop	Top- prune to check height growth
3	Kamara 6E	<i>C. lusitanica</i>	CSO	Grafts from Plus trees in the Rift Valley,	2005 to 2007	KFS	6X6	>80%	High	-Tree canopy closed - Heavy seeding by most of the trees in the orchard	-Continue seed collection -Rogue using progeny trial data
4	Masaita 1C	<i>C. lusitanica</i>	CSO	Grafts from Various Plus Trees in Rift Valley	2004-2006	KFS	6x6	60-80%	Medium	- Tree canopy closed -Good seeding	-Continue seed collection, -consider roguing suing progeny trial data
5	Kamara 7D	<i>C. lusitanica</i>	CSO	Grafts from Plus trees in the Rift Valley	2010, 2011	KFS	6x6	60-80%	High	-Trees in a state of vigorous growth - Orchard has significant quantities of seed	-De-top the trees, -Start collecting seed from this orchard

No	Site	Species	Category	Source of material	YoE	Ownership	Espacement	Current stand density	Current production level	General observation	Recommendations
6	Kamara 6F	<i>C. lusitanica</i>	CSO	Grafts from Plus trees in the Rift Valley	2012	KFS	6x6	60-80%	Low	-Stand in a vigorous state of growth -Stand has started seeding	-Needs to be de-topped -Consider seed collection
7	Masaita 7D	<i>C. lusitanica</i>	CSO	Grafts from Plus trees in the Rift Valley	2014	KFS	6X6	>80%	Low (Young)	-trees getting tall - Many Trees are flowering	Needs tending, de-topping, and protection
8	Kamara 7D	<i>C. lusitanica</i>	CSO	Grafts from Plus trees in the Rift Valley	2015	KFS	6x6	>80%	Low (Young)	-trees in a state of vigorous growth - No seed yet but signs of flowering	Needs tending and protection
9	Kamara 7D	<i>C. lusitanica</i>	CSO	Various Plus Trees (in Rift Valley)	2019	KFS	8 x 8	>80%	Low (Young)	-Just establishing after planting it out this season	Keep monitoring and carryout maintenance
10	Masaita 2T	<i>C. lusitanica</i>	CSO	Grafts from Plus trees in the Rift Valley	2015, 2017, 2018	KFS	6x6	40-60%	Low (Young)	-Trees growing well within shamba system - Some trees show early flowering	-Needs tending and protection -Get the survival rates per clone
11	Masaita 2T	<i>C. lusitanica</i>	CSO	Grafts from Plus trees in the Rift Valley	2016, 2017, 2018	KFS	6x6	40-60%	Low (Young)	-Trees newly established - Those that survived are growing well	- Get the survival rates per clone -Survival count, tending, and in-filling
12	Turbo Compt 2K	<i>G. robusta</i>	CSO	Grafts from various plus trees across the country	2003-2004	KFS	6X6	60-80%	low (Mature)	-Poor seeding -Trees occasionally flower but no successful seed formation	replicate in a suitable site
13	Soin-Kipsitet Agricultural Training College	<i>G. robusta</i>	SS	Seed from seed orchard in Turbo	2017	Soin ATC	3x3	<40%	Low (poor survival)	-Extremely poor survival -Less than 10% surviving and half the plot is occupied by thick weedy grasses	-Write off -Use the same land to establish a new orchard

No	Site	Species	Category	Source of material	YoE	Ownership	Espacement	Current stand density	Current production level	General observation	Recommendations
14	Muhoroni Sugar	<i>G. robusta</i>	SS	From Seed orchard in Turbo	2018	Muhoroni sugar	3x3	40-60%	Low (Young)	-Require maintenance	maintenance by slashing and spot weeding
15	Homalime -Koru	<i>G. robusta</i>	SS	Maseno	2015	Homalime	3x3	60-80%	Low (Young)	-Trees seem to have had a struggle growing through grass -Trees unhealthy, poor growth The plot is weedy with grass	-urgent need of maintenance An MOU should be drawn between KEFRI and Homalime
16	Turbo 2J	<i>E. grandis</i>	SSO	Plus trees from Turbo 2K, Brookebond, Sotik, James Finlay, Williamson Tea	2012-15	KFS	4 x 4	>80%	Medium	-Good growth but variable seeding from tree to tree -Stand is well maintained by cultivation	-Rogue -De-top
17	Turbo-Nzoia 3A (EP 164)	<i>E. grandis</i>	SSO	Australian progenies	Original crop planted in 1989 and coppiced in 2013	KFS	3 x 3	40-60%	Medium	-This is a second coppice crop, -Seeding Stand bushy with lantana weed average seed crop	-Require singling to retain 1 stem per stump -Maintain by clearing bushes
18	Turbo 2 K	<i>E. grandis</i>	SS	Ex-Zimbabwe	Original crop planted in 2000-2002 coppiced in 2014	KFS	3x3	>80%	Low (Too tall)	- Tall trees with average seed production but difficult to harvest due to tree height	-Write off -Clear fell and collect material for establishing a new seed source
19	Turbo 2K	<i>E. grandis</i>	SSO	Ex-S .Africa	Original planting in 2002 coppiced in 2014	KFS	3 x 3	>80%	Low (Too tall)	-Tall trees with average seed production but difficult to harvest due to tree height	-Write off -Clear fell and collect material for establishing a new seed source

No	Site	Species	Category	Source of material	YoE	Ownership	Espacement	Current stand density	Current production level	General observation	Recommendations
20	Turbo 1G	<i>E. grandis</i>	SSO	Various plus tree selection from various sites	2016	KFS	4X4	>80%	Low (young)	-Few trees are seeding -Trees healthy with vigorous growth	Trees should be de-topped to check on excessive height growth
21	Turbo 1G	<i>E. grandis</i>	SSO	Various plus tree selection from various sites	2017	KFS	4X4	60-80%	Low (young)	-Trees have been raised under shamba system and show vigorous growth -No seeding yet	De-top to check excessive height growth
22	Turbo, Nzoia, 3 D (a)	<i>E. grandis</i>	SSO	Various plus tree selection from various sites	2018	KFS	5 x 5	70%	Low (young)	-trees that were planted on the section previously under trees are growing faster than the ones on previously grassland portion -Uneven growth due to different fertility status of the farm	Maintenance required
23	Masaita 1C	<i>P. patula</i>	CSO	Various Plus Trees from Rift Valley	2008-2010	KFS	6X6	60-80%	Low (young)	some trees are seeding, though light seed crop	top prune to check height growth
24	Kamara 6E	<i>P. patula</i>	CSO	Various plus trees from Rift Valley	2005 to 2007	KFS	6X6	>80%	Medium	-Trees seeding but looking crowded -Trees growing well	-Top-prune to check height growth, -use progeny data to rogue this stand
25	Kamara 7D	<i>P. patula</i>	ESS	EX-Zimbabwe	2002	KFS	3X3	60-80%	Low(Mature)	-Most trees of good form but may be overgrowing for the purpose of seed collection	- Plus Trees selected to be used to establish seed orchards -Thin stand to improve seed production
26	Kamara 7D	<i>P. patula</i>	CSO	Various plus trees in Rift Valley	2011-2012	KFS	6x6	60-80%	Low(young)	-Trees healthy -Signs of flowering	-Trees require to be de-topped to check excessive height growth

No	Site	Species	Category	Source of material	YoE	Ownership	Espacement	Current stand density	Current production level	General observation	Recommendations
27	Kamara 5I	<i>P. patula</i>	CSO	Various plus trees in Rift Valley	2013	KFS	6X6	60-80%	Low(young)	-Trees tall and in good health -Moderate flowering and light seeding observed	Trees require to be de-topped to check excessive height growth
28	Kamara 7D	<i>P. patula</i>	CSO	Various plus trees in Rift Valley	2014	KFS	6X6	60-80%	Low (Young)	-Trees showing good growth, -Moderate flowering but no seeding	de-top to check excessive height growth
29	Kamara 7D	<i>P. patula</i>	CSO	Grafts collected from various Plus Trees in Rift Valley	2019	KFS	8 x 8	>80%	Low (young)	Just planted	To be keen on maintenance to ensure high survival
30	Kamara 7E	<i>P. patula</i>	CSO	Various plus trees in Rift Valley	2015	KFS	6X6	60-80%	Low (young)	-Good growth, -Flowering observed	de-top to check excessive height growth
31	Masaita 2T	<i>P. patula</i>	CSO	Various plus trees in Rift Valley	2017	KFS	6 x 6	>80%	Low (young)	-Trees showing good growth, -No flowering -not seeding -2017 planting, 2018 infill	To be keen on maintenance to ensure high survival
32	Masaita 2T	<i>P. patula</i>	CSO	Various plus trees in Rift Valley	2015-16	KFS	6x6	60-80%	Low (young)	-trees show uneven growth due to infilling -few flowers, no seeds	De-top the tall ones
33	Molo North	<i>P. Patula</i>	CSO	Old selections in East Africa	1970	KFS	5 x 5	60-80%	Low(Mature)	-Decline in seed production due to age - Contains First Generation selections of Plus Tree	Collect the material and use to establish new clonal seed orchard

Table 6a: Geographic location of seed sources in Lake Victoria Eco-region Research Programme (LVERP)

SITE	GPS LOCATION			Species	AREA(ha)
	LATITUDE	LONGITUDE	ALTITUDE (m)		
Ramogi, Compt. Dudi 21B	S 0.01564	E 34.06202	1220	<i>E. camaldulensis</i>	1
Sidindi- Rambo village	N 0.14900	E 34.37575	1844	<i>E. camaldulensis</i>	2
Siaya- Nyandiwa area	N 0.05675	E 34.25058	1243	<i>E. camaldulensis</i>	0.5
Sangalo Inst. Of Agriculture- Bungoma	N 0.59575	E 34.58953	1380	<i>E. grandis</i>	2

Table 6b: Description and current status of seed sources in Lake Victoria Eco-region Research Programme (LVERP)

SITE	Species	Category	Source of material	Land ownership	Yoe	Espacement (m)	Current stand density	current production level	General observation	Recommendations
Ramogi, Compt. Dudi 21B	<i>E. camaldulensis</i>	Provenance trial/Seed stand	Seed from Australia	KFS	1981	3 x 3	60-80%	Medium	-Good form -Stand is bushy with a lot of undergrowth	Continue collecting Clear bushes in the stand to ease accessibility
Sidindi- Rambo village	<i>E. camaldulensis</i>	Seed Stand	Seed from KEFRI seed centre	Farmer-George Opendo Olayo	2014	3 x 3	60-80%	Medium	a lot of variability in tree size very bushy stand	-Carryout thinning to remove the small/deformed trees and retain only the good trees for seed production -Maintain by clearing bushes
Siaya- Nyandiwa area	<i>E. camaldulensis</i>	Seed stand	Seeds from KEFRI seed centre	Farmer-Margaret Apondi Muga	2012	3 x 3	40-60%	Medium	-The surviving trees show robust growth -Stand is bushy	Carryout thinning to remove the small/deformed trees and retain only the good trees for seed production -Maintain by clearing bushes
Sangalo Inst. Of Agriculture- Bungoma	<i>E. grandis</i>	Seedling seed Orchard	Masaita forest Londiani	Sangalo Institute	2016	3 x 3	60-80	Low (Young)	-Trees in good condition -Stand is bushy	Carryout thinning to remove the small/deformed trees and retain only the good trees for seed production -Maintain by clearing bushes

4.0 Seed sources owned by other institutions involved in seed and seedling production of commercial tree species

The private firms visited were James Finlays, George Williamson, Unilever Tea in Rift Valley, Kakuzi and Aberdare Technologies in Central Kenya. The firms in Rift Valley are multinational companies involved in tea business. They have also invested in large acreage of forests especially growing of Eucalyptus for fuelwood to supply bioenergy used in tea processing.

None of the firms have designated seed sources but collect seeds from their own mature plantations during felling operation. They operate some basic quality practices by collecting seeds only from big dominant trees. James Finlay also imports improved seeds from Zimbabwe. The company also practices clonal forestry and produces 60% of their planting materials vegetatively. James Finlays, George Williamson, Unilever Tea produce seedlings for their own internal use and do not supply to external parties.

Kakuzi Limited exclusively imports *E. grandis* seeds from South Africa and raises them in their tree nursery for their own commercial planting. They establish 50 ha of plantation every year and the surplus seedlings are sold to interested farmers. The firm buys *E. camaldulensis* seeds from KEFRI for boundary planting.

Aberdare Technologies is a private commercial tree nursery that deals with production of seedlings of different tree species that are propagated vegetatively and through seed. They have a clonal hedge for Eucalyptus hybrids initially obtained from Tree Biotechnology Program Trust in Karura. They have also established new hedges of *E. grandis* x *E. urophylla* (GU) hybrids from South Africa.

5.0 Recommendations

1. Reference the breeding strategy for maintenance of seed sources
2. Develop SOPs for establishment of provenance trials and testing of gains and wood properties (This can be referenced with TaFoRRI. KEFRI can adopt and adapt SOPs from Tanzania for Kenya)
3. Existing seed sources of some species particularly *C. jughuniana* and *C. equisetifolia* are not productive as they are old or diseased. New seed sources of these species in reference to the Kenya National Tree Improvement strategy as well as the seed supply and demand strategy.
4. There is need to prepare management protocols for all established seed sources to ensure that proper management such as rouging, thinning, topping and pruning are carried out timely and accordingly.

5. All the seed sources should be branded, well maintained and managed to ensure their maximum potential.
6. Seed sources with low seed production, poor genetic quality or contaminated with species from the same genus should be written-off. This includes *P. patula* seed stand in Kamae and *E. camaldulensis* seed stands in Kitui. Emphasis should be given to using/ obtaining the best genetic resources and removing poorer genetic resources. This can entail the use of progeny test data.
7. There is need to identify suitable sites for establishing *G. robusta* and *C. equisetifolia* as both species were found not to be productive in their present sites.
8. Documentation of seed sources should be well-maintained to ensure availability of information and guide on their management.
9. Seed sources should be well isolated from other plantations of the same species to avoid pollen contamination and hybridization.
10. Establish fewer and larger seed orchards in good seed production areas since they are more economical and easier to manage.
11. Consider revising future spacing to between 8x8 and 10x10 meters for *C. lusitanica* and *P. patula* seed orchards
12. Conduct soil tests for pathogens before planting Casuarina on a site