TREPA
Transforming Eastern Province through Adaptation

RFA
Rwanda Forestry Authority

GREEN CLIMATE FUND

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Output 3.3: Enhancing tree seed and seedling supply to provide diverse and climate adapted species and varieties within the framework of TREPA 2022-2027

Tree Seed-seedling demand, and certification of seed sources Rwanda; special focus on the Eastern Province.

Interim report

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Contents

Introduction

Purpose of consultancy

Baseline survey on seedling production and seed sources with a view on possible improvements in organisation of the sector.

Background

The Government of Rwanda have pledged to restore 2 million hectares of land under the Bonn Challenge/AFR100 by increasing the forest cover to 30% of national land area, in addition to promoting agroforestry systems to cover 85% of cultivated landscapes (National TRM strategy, 2018). While these are ambitious goals to achieve by the year 2030, access to quality and adequate tree planting materials – as seeds and seedling, represent a significant stumbling block to achieving these goals. Understanding the current national tree sector in Rwanda is key in addressing tree seed/ seedling access, distribution, and management which, in turn, is instrumental to meet the national restoration target.

The first aim of this study is to create an overview of ongoing and planned planting programmes in Rwanda. This is done by estimating the number of seedlings and tree species in nurseries across the country. A second aim is to understand how nursery seedling production is supported by various actors. A third aim is to gain insight into seed sourcing strategies and investigate how genetic quality is estimated.

We utilised three main sources:

I.   Desktop review of projects supporting tree planting in Rwanda - secondary information gathered from published articles, reports, government documents including policies, strategies, development plans etc. and online information on tree planting projects. A total of 191 documents were reviewed to identify any regional, national, provincial, and local programme/ project(s) involved in tree planting in Rwanda. A total of 64 projects/ programs were identified that had a component of tree planting in them. These 64 programmes were spread across the 30 districts in 217 operational sites.

II.   Through the Rwanda Forest Authority (RFA), we sourced data compiled from a 2023 survey which investigated the expected seedling production in nurseries by districts, with information on main supported of nursery production, but without information on tree species. The data lists production by districts, and lumpsum figures of seedling production were given by categories; forests, agroforestry, fruits, bamboo, and ornamentals.

III.   We also obtained data from the One Acre Fund, who kindly provided us with information on the species-wise production of seedlings across districts in the year 2022 and their newly revised approach to support of nursery production in 27 districts.

IV.   We benefitted from previous work carried out by staff and consultants of the National Tree Seed Centre (NTSC) on identified seed sources in the country (compiled by Pedercini et al., 2023).

Current and planned planting programmes in the country

Rwanda Forest Authority survey of seedlings in Nurseries 23-24

The National Forest Authority asked the districts for their expectations on seedling production for the planting season 2023-24. The expectations included targets for the government (district) contribution as well as organisations investing in seedling production in the districts. The expected contributions involve about 44 different organisations (many working in several districts) supporting planting for the purposes of forestry, agroforestry, fruits, bamboo and ornamental. The largest contribution comes from

International NGOs (IGNOs), followed by international projects. Tree planting cooperatives are third (see tables 1, 2 and 3 below). Although the allocation of government budgets for tree planting were still pending at the time of the survey, the figures indicate that most tree planting is funded by earmarked projects. Interestingly, tea companies conduct a considerable planting in specific district (See also appendices 2, 3, and 4).

Table 1. Types of organisations expecting to support nursery production (number of seedlings) in the districts for the planting season 2023-24.

Types of organisations	Count	Forestry	Agroforestry	Fruits	Bamboo	Ornamental	Sum
INGO	36	3,578,495	22,007,122	284,480	30,000		25,900,097
International project	33	1,066,800	16,029,385	893,000	134,000		18,123,185
Cooperative	5	1,347,000	347,000	2,289,000		6,250,000	10,233,000
Tea company	12	1,016,831					1,016,831
Private company	7	552,081	110,000	111,000			773,081
NGO	3		321,000	6,500			327,500
Government budget	3	131,200	100,000	54,000	2,000	1,200	288,400
Unknown	2	14,000	15,000	6,000		80,000	115,000
District not yet budget	8				5,000		5,000
Sum of rows		7,706,407	38,929,507	3,643,980	171,000	6,331,200	56,777,094

Note: Several districts had not yet budgeted for government nursery production. Source: Survey in 2023 by Rwanda Forest Authority

Planting intensity varies among districts, both in the amounts of seedlings and distributed among the purposes (see table 2 and figure 1, a, b, c, d below).

Table 2. Expected nursery production (number of seedlings) in districts for the planting season 2023-24.

District	Forestry	Agroforestry	Fruits	Bamboo	Ornamental	Sum of districts
Musanze	20,000	800,000	52,500	2,000	1,200	875,700
Gicumbi	474,112	1,420,500	417,500	20,000		2,332,112
Rutsiro	56,230					56230
Gakenke		813,000	2,500			815,500
Burera	4,000	869,000	6,000			879,000
Rulindo		2,222,426	2,000			2,224,426
Rubavu		539,000	1,500	5,000		545,500
Nyabihu	118,250	924,000	145,000			1,187,250
Nyamasheke	458,645	1,160,200	13,000	15,000		1,646,845
Karongi	107,885	1,701,500	217,500	8,000		2,034,885
Ngororero		797,000	252,500			1,049,500
Rusizi		2,343,400	2,500	105,000		2,450,900
Rutsiro		399,000				399,000
Kirehe	2,907,440	1,873,625	16,400	16,000		4,813,465
Nyagatare	1,159,600	1,841,056	4,580			3,005,236
Gatsibo		1,196,400	2,000			1,198,400
Kayonza		764,000	12,000			776,000
Ngoma		831,000	13,500			844,500
Rwamagana		771,000	13,500			784,500
Bugesera		1,589,000				1,589,000
Ruhango	15000	5,578,000	1,500			5,594,500
Kamonyi	43000	801,000				844,000
Muhanga		1,329,400				1,329,400
Nyanza	25,000	1,152,000	54,000			1,231,000
Huye	262,081	865,000				1,127,081
Nyamagabe		849,000				849,000
Nyaruguru	591,164	1,004,000				1,595,164
Gisagara	50,000	4,086,000	15,000			4,151,000

District	Forestry	Agroforestry	Fruits	Bamboo	Ornamental	Sum of districts
Kicukiro	350,000	100,000	175,000		800,000	1,425,000
Nyarugenge	50,000	50,000	20,000		1,500,000	1,620,000
Gasabo	1,014,000	260,000	2,204,000		4,030,000	7,508,000
Sum of rows	7,706,407	38,929,507	3,643,980	171,000	6,331,200	56,782,094

Note: Several districts had not yet budgeted for government nursery production. Source: Survey in 2023 by Rwanda Forest Authority

The numbers of seedlings in districts are graphically depicted in In figure 1, a,b,c,d. Some districts have higher overall seedling targets. Seedlings for forestry and fruit trees appear to be targeted to fewer districts than for agroforestry, which is supported in all districts, although at different intensities.
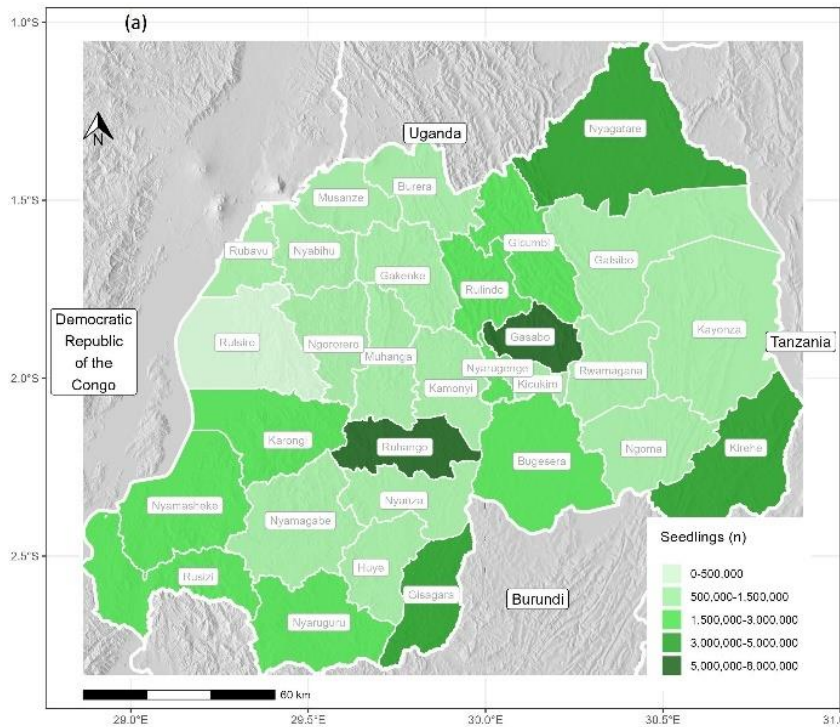

Figure 1a.Relative numbers of seedlings in district nurseries. (a) All seedlings. Note: For some districts, government contributions had not yet been budgeted. Source. Survey in 2023 by Rwanda Forest Authority,
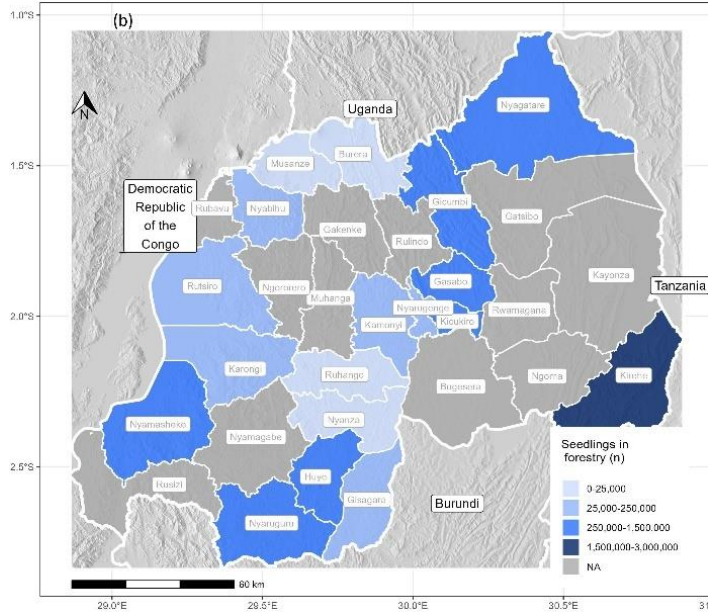
Figure 1b. Relative numbers of seedlings in district nurseries. (b) Forestry seedlings. Note: For some districts, government contributions had not yet been budgeted. Source. Survey in 2023 by Rwanda Forest Authority.

Figure 1c. Relative numbers of seedlings in district nurseries. (c) Agroforestry seedlings. Note: For some districts, government contributions had not yet been budgeted. Source. Survey in 2023 by Rwanda Forest Authority.

Figure 1d. Relative numbers of seedlings in district nurseries. (d) Fruit tree seedlings. Note: For some districts, government contributions had not yet been budgeted. Source. Survey in 2023 by Rwanda Forest Authority.

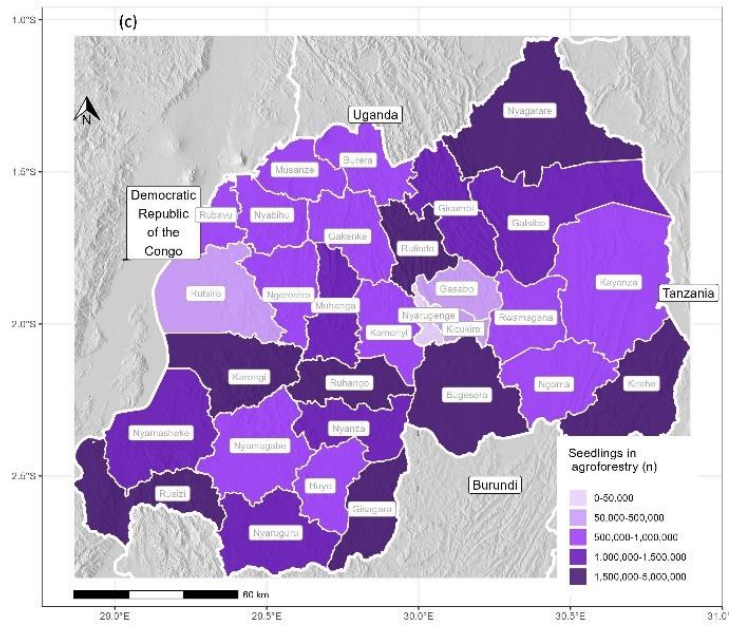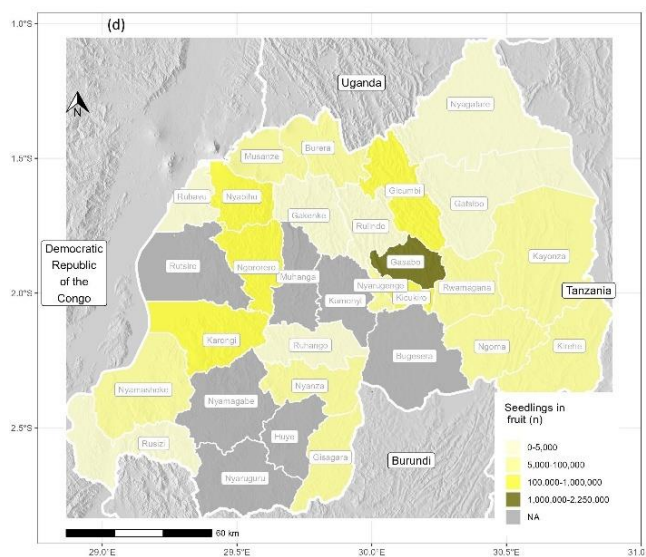## Desktop review of support to tree planting in Rwanda

All programmes from the RFA survey were identified in the desktop review. The desktop review indicates that there are many small projects which are not included in the RFA survey information.

For each of the 64 identified projects, we collected information relating to the lead organisation, source of funding, implementing partners, project timelines, expected targets to be achieved, tree species and quantities distributed, and areas of operation in Rwanda (see table 3 and appendix 4).

It is however noted that not all information was available for all projects identified and it was not always possible to translate their targets into number of seedlings to be produced. Importantly, it was possible to document the location (district) of operation for almost all projects.

Table 3. Number (#) of projects/programmes in districts

No	District	#	No	District	#
1	Musanze	9	16	Kayonza	13
2	Gicumbi	8	17	Ngoma	3
3	Gakenke	6	18	Rwamagana	8
4	Burera	4	19	Bugesera	13
5	Rulindo	7	20	Ruhango	8
6	Rubavu	6	21	Kamonyi	4
7	Nyabihu	10	22	Muhanga	5
8	Nyamasheke	8	23	Nyanza	7
9	Karongi	4	24	Huye	7
10	Ngororero	10	25	Nyamagabe	3
11	Rusizi	3	26	Nyaruguru	4
12	Rutsiro	11	27	Gisagara	8
13	Kirehe	14	28	Kicukiro	4
14	Nyagatare	11	29	Nyarugenge	2

No	District	#	No	District	#
15	Gatsibo	10	30	Gasabo	7

Source: Compilation by authors, see also appendix 4.

One Acre Fund provided information on their seedling production for 2022, which totalled 20,153,522 seedlings. This corresponds to more than a third of the expected total seedling production for 2023 in Rwanda. Almost 16 million seedlings (80 percent of total) were of Grevillea robusta (see figure 2 for distribution in districts). Eucalypts were not produced in One Acre Fund nurseries, but several indigenous as well as exotic fodder species were produced. For some species listed (see appendix 5) there were no seedlings produced, reflecting that One Acre Fund had the intention to produce, but could not obtain seeds from the NTSC.
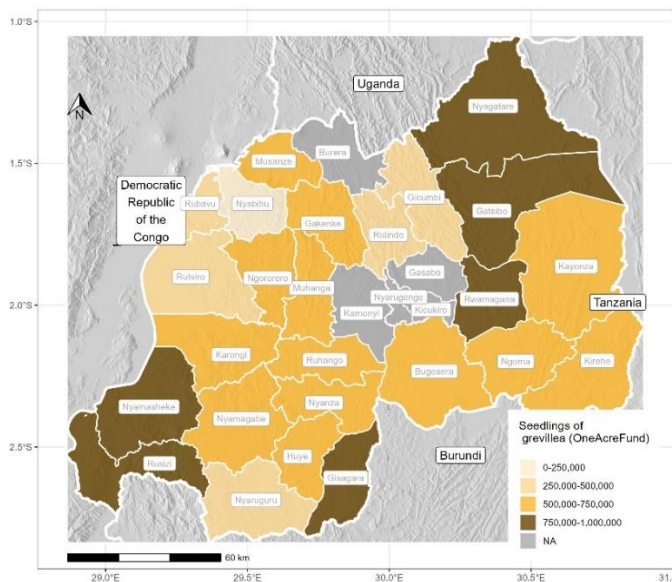

Figure 2. One Acre Fund. Grevillea robusta in nurseries, 2022. See table in appendix 5. Source: Excel Sheet sent to authors by One Acre Fund in August, 2023.

Sales of seed from the National Tree Seed Centre (NTSC)

Pedersen (2019, appendix D, Table 12) provided a summary of sales by the NTSC for the period 2016-19. The NTSC sold seed of 55 species. The 10 most important species in terms of **kg sold x number of seed per kg** are all exotics (see table 4 and Appendix 1 for the full list). In principle the NTSC has at least one seed source for each of these 55 species (but see below in next section).

Table 4 below, shows that the ten species sold in the largest quantities are all exotics. When calculated in number of seedlings, the numbers are very high. For example, with a planting density of 1,000 seedling/hectare, and a seed and seedling mortality factor of ¼, the number of seed for the 10 most planted species (820,906,727seeds) corresponds to about 200,000 hectares of plantations. The most sold species are typically exotic species with small orthodox seeds, which is like what was found in a similar review for the Forest Landscape Restoration in Ethiopia (Lillesø and Derero, 2018).

Table 4. Ten most sold species. Sales of seed from NTSC – average of period 2016-2019 seasons.

Rank (kg)	Rank 2 (seeds)	Seeds/kg	Origin	Current name	Kg-Avg-2016-18-19	Seeds-Avg-2016-18-19	Potential seedlings*
16	1	3,267,974	Exotic	*Eucalyptus grandis*	46.8	152,832,251	38,208,063
6	2	719,424	Exotic	*Eucalyptus microcorys*	207.1	148,968,825	37,242,206
11	3	1,887,507	Exotic	*Eucalyptus camaldulensis*	74.6	140,823,751	35,205,938
15	4	2,325,581	Exotic	*Alnus acuminata*	47.8	111,085,271	27,771,318
1	5	78,751	Exotic	*Grevillea robusta*	1,242.3	97,832,367	24,458,092
18	6	1,850,000	Exotic	*Eucalyptus saligna*	39.4	72,828,333	18,207,083
19	7	1,176,470	Exotic	*Casuarina equisetifolia*	36.3	42,666,645	10,666,661
12	8	393,701	Exotic	*Eucalyptus globulus subsp. maidenii*	74.1	29,160,105	7,290,026
8	9	177,305	Exotic	*Solanum betaceum*	100.4	17,807,329	4,451,832
7	10	47,037	Exotic	*Senna spectabilis*	146.7	6,901,850	1,725,463

Source: Pedersen (2019, Appendix D, table 12). See appendix 1 for full list. Note*: Ratio of expected seedlings from seed is 4:1.
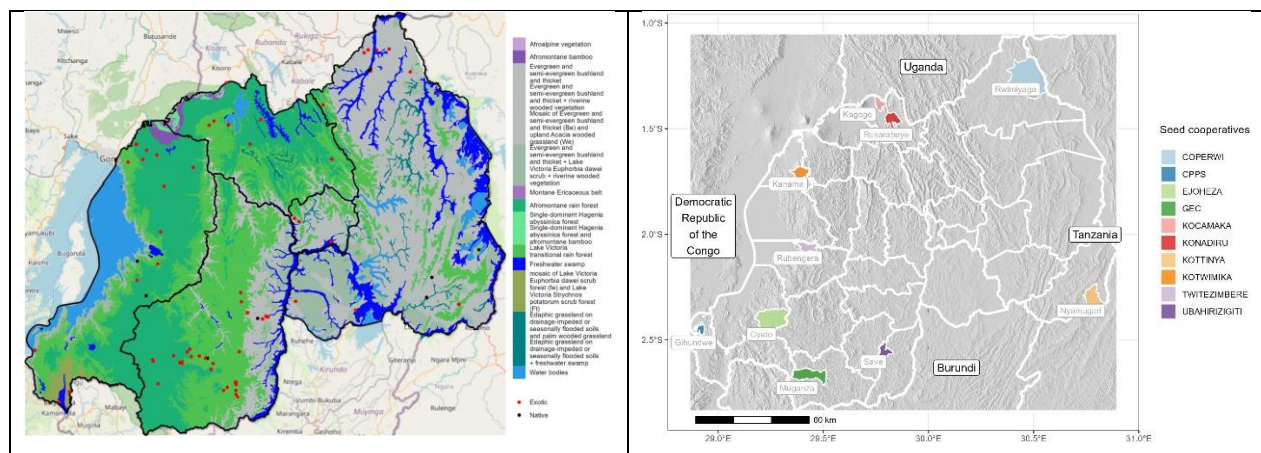
Seed sources

Pedercini et al. (2023) discuss a species prioritisation for Rwanda and summarise the previous work done by the staff and consultants to the Rwanda NTSC.

Pedercini et al. (2023) lists 183 seed sources registered by the NTSC. From the descriptions (remarks and notes collated in the database of seed sources) of the tree seed sources, they deem that around 79 seed sources may be suitable and in use.

We would probably be more stringent and suggest that 15 could be considered suitable for immediate use and a somewhat larger number could possibly be taken into use after suitable management (thinning, etc.). However, the 183 tree seed sources should be described in a way that enables evaluation of their genetical quality, such that they can be included in a public certification system of seed sources (see appendix 6).

The NTSC identifies seed sources; however, ten cooperatives are contracted by Rwanda Forest Authority (RFA) to collect seed for the NTSC (IUCN/REMA/RWFA, 2019). The distribution of seed source sites can be seen in figure 3a and the distribution (to sectors) of the seed collection cooperatives are shown in figure 3b. We cannot say for sure that the seed cooperatives collect from the identified seed sources or if they collect from undescribed seed sources in farmland, plantations, and natural vegetation.

Figure 3a. Distribution of seed sources sites in potential vegetation types and regions. Source: Pedercini, Kindt, Graudal, 2023, Figure 5.1.	Figure 3b. Locations (sectors) for the 10 contracted seed cooperatives. Source: Pedercini, for this report, based on IUCN/REMA/RWFA, 2019.

The strategy for reproductive material, seed cooperatives, and the National tree seed centre (NTSC)

The National Tree Reproductive Materials Strategy (Anon, 2018) lists many strengths and weaknesses in the seed and seedling systems in Rwanda, among which we find the availability and quality of seed sources and the potential production and distribution channels particularly important and insufficiently implemented (table 5).

Table 5. Extract from SWOT analysis. Source: IUCN/REMA/RWFA, 2019, table 1

Strengths	Weaknesses
• Availability of tree seed sources (identified and established)	• Poor quality seed sources due to lack of adequate management
	• Insufficient tree species diversification in tree seed stands
• Existence of tree seedlings producer cooperatives	• Undocumented seeds from farmers cooperatives

Source: Anon (2018)

 We suggest that defining quality should be the starting point for a strategy (quality is only vaguely described in the strategy document) and central to the strategy will be to envisage how the current tree seed and seedling distribution system can be tweaked with the aim to facilitate decentralised producers and distributors to utilise quality as an important parameter in their choice of seeds and seedlings.

Tree seed quality is first and foremost genetic quality of seed sources - while the commonly used "germination capacity" is only a measure of how much seed can be expected from a given seed lot. Genetic quality of seed sources must be described according to the type of seed sources. For **immediate production** of seed there are (i) farmland seed sources (existing trees growing on farms); (ii) Plantation seed sources (mostly exotic species growing in plantations and woodlots); and (iii) Natural forest (or in Woodland or Bushland) seed sources (natural vegetation that contain indigenous species adapted to the current environment) (Lillesø *et al.*, 2011). The genetic quality is evaluated by different criteria for each of the three types of seed sources. Generally, it can be said that Natural Forest seed sources in intact forest contains the highest genetic quality, and they are also the most difficult to efficiently organise seed production and distribution from. Farmland and Plantation seed sources are easy to collect from but require special considerations to minimise inbreeding and fragmentation. The National Tree Reproductive Materials Strategy puts much emphasis on seed orchards, which are sources for **future production**, such seed orchards may indeed produce superior planting material, however, it should be considered that it takes several years before such orchards become productive and that the seed orchards would cover only part of the demand for species. See appendix 6 for how this classification complies with the OECD classification.

There is therefore an urgent need to develop production and distribution chains for **immediate production** that can meet the demands for seeds across the landscapes in Rwanda (Lillesø *et al.* 2018). This will require creation of networks for production and distribution of seed and seedlings – by identifying and facilitating quality seed sources for immediate production and their seed source custodians – and linking them with production and distribution of seedlings in the thousands of nurseries across the landscapes of Rwanda.

Twagirayezu (2015) investigated a sample of 53 nurseries in three districts - Bugesera, Nyabihu, Rubavu – grouped into Government, Group, and Private nurseries - the nurseries received from 41 to 48% of the seed from the NTSC. Private seed dealers delivered from 0-18% of the seed and the remaining seed were collected by the nurseries themselves. The NTSC thus seem to deliver a higher proportion of seed to nurseries than most other such centres in Africa (Lillesø, 2020), but currently it cannot be verified that the seed delivered by the NTSC provides seeds of higher quality than locally collected seed.

It is commonly observed in Africa that governments and NGOs favour centralised nurseries at the expense of small private nurseries (Holtne, 2012; Lillesø and Derero, 2019; Lillesø, 2020). We did not have access to statistics on the size distribution (in terms of seedling capacity) across the districts for Government, Group, and Private nurseries. However, information from One Acre Fund on their current nursery production strategy is pertinent – as One Acre Fund supports about one third of nursery production in Rwanda – One Acre Fund has four central nurseries with a production capacity of around two million seedlings, but for the current season the intention is to centrally produce 300,000 fruit tree seedlings. The expected production of 20.8 million tree seedlings will be from 1,847 decentralised nurseries in the 27 supported districts – around 11,000 seedlings per nursery (One Acre Fund, Email September 12, 2023). This seems to be a model that could be integrated with the development of a decentralised network of seed sources.

Observations specifically for Eastern Province

Much of the natural vegetation in the Eastern Province has been converted to agriculture and small-scale plantations of exotic tree species. In figure 4, the districts covering the Eastern Province are overlaid over the potential natural vegetation map of Rwanda.
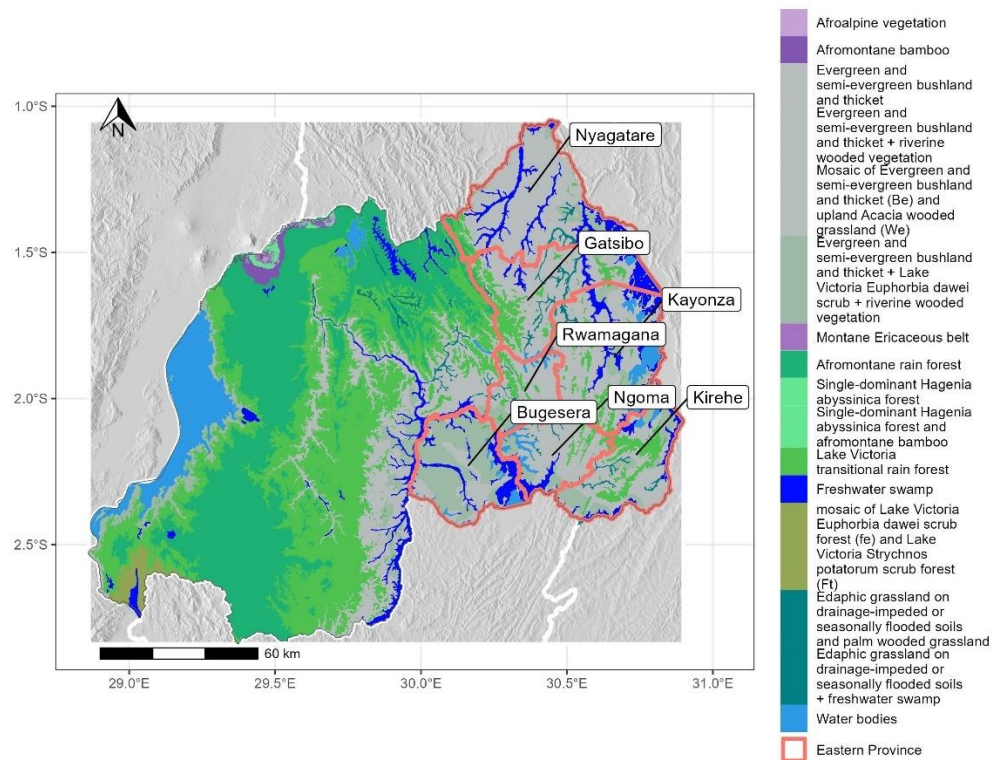

Figure 4. Districts in Eastern Province overlaid on the potential vegetationmap of Rwanda

Figure 4 shows that most of the region is mainly covered by three potential vegetation types – Evergreen and semievergreen bushland and thicket (Be) at lower altitudes, and in the south-western part interspersed with Lake Victoria Euphorbia dawei scrub forest (fe) based on topography and edaphic conditions. Lake Victoria transitional rain forest (Ff) occur on ridges stretching into the landscape. Further west in Rwanda this forest type (Ff) potentially occurs in larger contiguous areas. Afromontane rain forest (Fa) occurs in small areas at high altitudes in the northern part of the Eastern Region. The national park, Akagera along the border with Tanzania, possibly contains higher proportions of relatively intact vegetation of (Be) and (Ff).

In table 6 below, we analyse which of the top-31 priority species (of priority level "AA"; see Kindt, Pedercini, Graudal (2023)) are native to the potential natural vegetation types found in the Eastern Province and for the exotic species, which species are suitable the region.

Table 6. Indigenous and exotic species in Evergreen and semievergreen bushland and thicket (Be)/Lake Victoria Euphorbia dawei scrub forest (fe), Lake Victoria transitional rain forest (Ff), and Afromontane forest (Fa)

Ff	Fa	Be (/fe)	Indigenous species – priority species from natural forest and woodland
N	N	P	*Erythrina abyssinica, Pterygota mildbraedii, Faurea saligna*
N	P	N	*Myrianthus holstii*
P	N	N	*Maesopsis eminii, Markhamia lutea*
P	P	N	*Afrocarpus falcatus, Croton megalocarpus, Dombeya torrida, Entandrophragma excelsum, Hagenia abyssinica, Maesa lanceolata, Neoboutonia macrocalyx, Parinari excelsa, Polyscias fulva, Prunus africana, Symphonia globulifera, Syzygium guineense*
P	P	P	*Bersama abyssinica*
			Exotic species – priority, but not native to the province
N	N	N	*Acacia mearnsii, Acacia melanoxylon, Calliandra houstoniana var. calothyrsus, Carapa grandiflora, Casuarina equisetifolia, Cupressus lusitanica, Eucalyptus globulus subsp. maidenii, Eucalyptus saligna, Grevillea robusta, Persea americana, Pinus patula, Syzygium parvifolium*

N= Not present, P= present

For the indigenous species, an identification of remnant intact or relatively intact vegetation is required, with visits to the most promising areas to determine their species content and thus potential as seed sources for the priority species. It is likely that Akagera National Park could contain candidate sources in vegetation type Be and Ff. Utilising such seed sources in natural vegetation with tall trees requires to identify, train and equip seed source custodians and to organise efficient distribution of seed. These activities should be facilitated by the National Tree Seed Centre (see also appendix 6 for seed source definitions).

For the exotic species, seed sources will most likely consist of trees growing in farmland. An inventory needs to be carried out to identify the most promising areas for each priority species. An inventory could utilise the latest remote sensing tools for identifying species in farmland (Mugabowindekwe *et al.*, 2023). The seed sources need to be evaluated for genetic quality for each species. For several exotic priority species, it may be advisable to identify seed sources in farmland for immediate production and to start planting seed orchards for future production (see also appendix 6 for seed source definitions).

Participatory forest management is practiced in Rwanda for community-based conservation (Umuziranenge, 2019). This approach has the potential to be utilised for seed sourcing in natural vegetation. Seed collection from tall trees requires skilled tree climbers and safe climbing equipment. Furthermore, there are three conditions for a successful enterprise: (i) Identification and documentation of the seed source for each species to define the genetic quality of the source; (ii) collection of seed lots from a minimum of 30 unrelated trees is needed to ensure genetic diversity (see appendix 6); and (iii) successful sales of all the seed collected is needed to make seed collection economically viable.

A successful enterprise thus require efficient distribution networks to customers in the districts in the Eastern Region. These networks would include other seed source custodians and networks of private nurseries as well as the National Tree Seed Centre. With proper management of the seed sources, seed collection will have a minimal impact on the ecology of the forest (Schmidt, 2016a and b).

Summary of observations and recommendations

Observations

The national programme on Forest Landscape Restoration in Rwanda is supported by many different organisations. More than 56 million seedlings are planted every year. This is a very impressive investment in improving the livelihoods of the rural and urban populations in the country.

In Rwanda, genetic quality is not utilised as a concept for ensuring quality of tree seed and seedlings. Consequently, the potential benefits of forest landscape restoration are not fully achieved.

Sourcing quality tree seed is generally only a very small fraction of the overall cost of any tree establishment activity. However, planting good quality seed enables to grow superior products and to enhance the provision of tree environmental services. These benefits are generally much larger than any initial extra cost incurred in sourcing better quality seed (Lillesø et al, 2021).

Recommendations

Genetic quality for tree seed should be introduced as a concept in Rwanda. The concept will only be relevant if good quality seed sources are identified and made available to the customers.

Breeding Seed Orchards should be established for the future production of improved seed of priority exotic and indigenous species.

For the immediate production, the NTSC should supervise the identification of quality seed sources that can produce seed of good genetic quality. At the same time, RFA should create an enabling environment for the collection, production, and distribution of seeds based on the quality sources which are widely distributed across the country. The custodians of seed sources in farmland, plantations and in natural forest will need support in terms of information, and skills in protection, collection, and sales. Furthermore, users of seed – the many organisations and nurseries in the landscapes of Rwanda - must have access to information on suitable sources for the species that they require.

The remaining natural forest in national parks in Rwanda contains many indigenous priority species for planting. Seed sources should be identified and documented for these species and the national Tree Seed Centre has a key role in supporting the development of an economically viable production and distribution of tree seed from these seed sources.

The goal for the tree seed-seedling sector should be that the NTSC guides the producers and distributors rather than acting as the sole producer of seed. This goal is the norm for agricultural seed in most countries and could be the goal for the tree seed and seedling sector in Rwanda (Lillesø et al, 2021).

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Appendices

Appendix 1. Average seed sales (2016-2019) from National Seed Centres, Huye

Rank (kg)	Rank 2 (seeds)	Seeds/ kg	Current name	Kg-Avg-2016-18-19	Seeds-Avg-2016-18-19	Potential seedlings*
16	1	3,267,974	*Eucalyptus grandis*	46.8	152,832,251	38,208,063
6	2	719,424	*Eucalyptus microcorys*	207.1	148,968,825	37,242,206
11	3	1,887,507	*Eucalyptus camaldulensis*	74.6	140,823,751	35,205,938
15	4	2,325,581	*Alnus acuminata*	47.8	111,085,271	27,771,318
1	5	78,751	*Grevillea robusta*	1,242.30	97,832,367	24,458,092
18	6	1,850,000	*Eucalyptus saligna*	39.4	72,828,333	18,207,083
19	7	1,176,470	*Casuarina equisetifolia*	36.3	42,666,645	10,666,661
12	8	393,701	*Eucalyptus globulus subsp. maidenii*	74.1	29,160,105	7,290,026
8	9	177,305	*Solanum betaceum*	100.4	17,807,329	4,451,832
7	10	47,037	*Senna spectabilis*	146.7	6,901,850	1,725,463
20	11	188,679	*Toona sinensis*	35.6	6,716,981	1,679,245
30	12	625,000	*Eucalyptus tereticornis*	9.3	5,833,333	1,458,333
5	13	19,000	*Calliandra houstoniana var. calothyrsus*	299.3	5,687,333	1,421,833
25	14	205,939	*Spathodea campanulata*	16.8	3,452,911	863,228
10	15	39,510	*Leucaena diversifolia*	86.8	3,428,158	857,040
21	16	98,058	*Jacaranda mimosifolia*	33.4	3,275,137	818,784
14	17	50,000	*Carica papaya*	56.7	2,833,333	708,333
31	18	310,000	*Polyscias fulva*	8.6	2,666,000	666,500
26	19	149,700	*Pinus patula*	16.5	2,475,040	618,760
24	20	83,056	*Callitris preissii*	27	2,242,525	560,631
22	21	64,683	*Passiflora edulis*	29.7	1,918,931	479,733
23	22	48,662	*Markhamia lutea*	29.6	1,440,389	360,097
17	23	24,201	*Tephrosia vogelii*	39.9	965,634	241,409
27	24	67,500	*Acacia mearnsii*	14	945,000	236,250
42	25	257,069	*Desmodium uncinatum*	3.3	856,898	214,225
32	26	86,207	*Acacia angustissima*	8.5	729,885	182,471
13	27	11,545	*Cajanus cajan*	57.4	663,049	165,762
4	28	1,603	*Afrocarpus falcatus*	330.3	529,524	132,381
35	29	84,592	*Acacia melanoxylon*	5.3	445,518	111,380
3	30	1,000	*Croton megalocarpus*	396	396,033	99,008
40	31	102,249	*Mimosa scabrella*	3.8	385,140	96,285
2	32	785	*Maesopsis eminii*	427.3	335,553	83,888
39	33	72,643	*Sesbania sesban*	3.9	283,308	70,827
33	34	39,000	*Senna siamea*	6.7	260,000	65,000
38	35	50,454	*Sesbania macrantha*	4.2	211,907	52,977
43	36	57,372	*Pinus caribaea*	3.3	191,241	47,810
34	37	29,002	*Eucalyptus urophylla*	5.4	155,646	38,912
46	38	31,348	*Acrocarpus fraxinifolius*	2	62,696	15,674
36	39	10,576	*Terminalia superba*	5	52,882	13,221
28	40	3,571	*Vachellia sieberiana*	12.2	43,452	10,863
50	41	55,000	*Leucaena trichandra*	0.5	27,500	6,875
44	42	9,641	*Gliricidia sepium*	2.7	25,710	6,428
41	43	3,577	*Araucaria cunninghamii*	3.7	13,115	3,279
55	44	184,162	*Mimosa invisa*	0.1	12,277	3,069
49	45	13,722	*Senegalia polyacantha*	0.7	9,148	2,287
48	46	11,001	*Acacia koa*	0.7	7,701	1,925

Rank (kg)	Rank 2 (seeds)	Seeds/ kg	Current name	Kg-Avg-2016-18-19	Seeds-Avg-2016-18-19	Potential seedlings*
51	47	11,447	*Faidherbia albida*	0.4	4,960	1,240
54	48	21,437	*Leucaena leucocephala*	0.2	3,573	893
9	49	15	*Persea americana*	100	1,500	375
47	50	1,533	*Entandrophragma excelsum*	0.8	1,277	319
29	51	99	*Artocarpus heterophyllus*	11.7	1,159	290
45	52	384	*Terminalia microcarpa subsp. microcarpa*	2.7	1,023	256
52	53	1,262	*Mucuna pruriens*	0.3	421	105
53	54	803	*Biancaea decapetala*	0.3	268	67
37	55	29	*Carapa grandiflora*	4.3	126	32

Source: Pedersen (2019, Appendix D, table 12). Note*: Ratio of expected seedlings from seed is 4:1

Appendix 2. RFA survey – organisations expecting to support nursery production in districts of Rwanda

Institution type	Institution	# of districts
Cooperative	KAREMUCO Cooperative	1
Cooperative	KOANDU Cooperative	1
Cooperative	OPPC RABAGIRANA Cooperative	1
Cooperative	UMUKINDO Cooperative	1
Cooperative	URURABO NIBOYE Cooperative	1
District not yet budget	District has not yet budgeted for nurseries	8
GVMNT	Government project	2
GVMNT	VUP-Pw – road project	1
INGO	Action Aid	1
INGO	ARCOS (Albertine Rift Conservation Society)	2
INGO	AREECA (The Alliance for Restoration of Forest Ecosystems in Africa)	5
INGO	One Acre Fund	27
INGO	RDB/African parks (Rwanda Development Board/African Parks)	1
Int_project	CDAT PROJECT	12
Int_project	COMBIO (Reducing vulnerability to climate change through enhanced community-based biodiversity conservation in the Eastern Province of Rwanda)	3
Int_project	ETI/MINAGRI (Export Targeted Modern Irrigation)	1
Int_project	Green Gicumbi (Strengthening climate resilience of rural communities in Northern Rwanda)	1
Int_project	ICRAF (World Agroforestry's projects)	1
Int_project	SAIP Project (Sustainable Agricultural Intensification and Food security Project, SAIP)	8
Int_project	SAPMP Project (Sustainable Agricultural Productivity And Market Linkage Project, SAPMP))	2
Int_project	TREPA (Transforming Eastern Province through adaptation)	2
Int_project	UNHCR – Refugee camps	3
NGO	KAGENO – local NGO	1
NGO	NATURE RWANDA - local NGO	1
NGO	REDIRE - local NGO	1
Private company	ABISHYIZEHAMWE	3
Private company	DALILA FAMILY Co – fruit seedlings	1
Private company	KME Ltd - Forest Concession owner	1
Private company	Private nurseries established in district, seedlings produced may be planted in another district	1
Private company	Ultimate Company - Private wood company	1
Tea company	Ekaterra	1
Tea company	GATARE Tea Company Ltd	1
Tea company	Gisakura Tea Company	1
Tea company	Karongi Tea Company	1
Tea company	Mata Tea Company	1
Tea company	Muganza Kivu Tea Company Ltd	1
Tea company	Mulindi Tea Factory Ltd	1
Tea company	Nshili - Kivu Tea Company Ltd	1
Tea company	Rugabano Tea Company/Silverback	1
Tea company	Rwanda Mountain Tea (RMT) 2	1
Tea company	Rwanda Mountain Tea (RMT) /Rutsiro	1
Tea company	SHAGASHA Tea Company Ltd	1
Unknown	NDAHAYO Viateur Tel: 0788620975	1
Unknown	UWIMANA Salomon Tel: 0785723194	1

Appendix 3. Types of organisations expecting to support nursery production in the districts for the planting season 2023-24

District	Org_Type	Forestry	Agroforestry	Fruits	Bamboo	Ornamental	Total
Bugesera	INGO	0	839,000	0	0	0	839,000
	Int_project	0	750,000	0	0	0	750,000
Burera	INGO	0	854,000	0	0	0	854,000
	Unknown	4,000	15,000	6,000	0	0	25,000
Gakenke	INGO	0	813,000	2,500	0	0	815,500
Gasabo	Cooperative	1,004,000	260,000	2,204,000	0	3,950,000	7,418,000
	Unknown	10,000	0	0	0	80,000	90,000
Gatsibo	INGO	0	859,000	0	0	0	859,000
	Int_project	0	337,400	2,000	0	0	339,400
Gicumbi	INGO	0	585,500	2,500	0	0	588,000
	Int_project	411,000	835,000	415,000	20,000	0	1,681,000
	Tea company	63,112	0	0	0	0	63,112
Gisagara	INGO	0	752,000	0	0	0	752,000
	Int_project	50,000	3,334,000	15,000	0	0	3,399,000
Huye	INGO	0	715,000	0	0	0	715,000
	Int_project	0	150,000	0	0	0	150,000
	Private company	262,081	0	0	0	0	262,081
Kamonyi	Cooperative	43,000	37,000	0	0	0	80,000
	INGO	0	764,000	0	0	0	764,000
	Private company	0	0	0	0	0	0
Karongi	INGO	0	781,500	2,500	0	0	784,000
	Int_project	0	920,000	215,000	8,000	0	1,143,000
	Tea company	107,885	0	0	0	0	107,885
Kayonza	INGO	0	644,000	0	0	0	644,000
	Int_project	0	120,000	12,000	0	0	132,000
Kicukiro	Cooperative	250,000	0	65,000	0	800,000	1,115,000
	Int_project	100,000	100,000	110,000	0	0	310,000
Kirehe	Cooperative	10,000	10,000	1,000	0	0	21,000
	GVMNT	83,200	0	0	0	0	83,200
	INGO	2,233,440	1,010,000	5,400	0	0	3,248,840
	Int_project	580,800	853,625	10,000	16,000	0	1,460,425
Muhanga	INGO	0	697,000	0	0	0	697,000
	Int_project	0	632,400	0	0	0	632,400
Musanze	GVMNT	20,000	100,000	50,000	2,000	1,200	173,200
	INGO	0	700,000	2,500	0	0	702,500
Ngoma	INGO	0	781,000	2,500	0	0	783,500
	Int_project	0	50,000	11,000	0	0	61,000

Ngororero	INGO	0	797,000	252,500	0	0	1,049,500
	INGO	0	724,000	0	0	0	724,000
Nyabihu	Int_project	0	200,000	145,000	0	0	345,000
	Tea company	118,250	0	0	0	0	118,250
Nyagatare	INGO	1,159,600	1,115,696	4,580	0	0	2,279,876
	Int_project	0	725,360	0	0	0	725,360
Nyamagabe	INGO	0	849,000	0	0	0	849,000
Nyamasheke	GVMNT	28,000	0	4,000	0	0	32,000
	INGO	170,455	898,000	2,500	0	0	1,070,955
	Int_project	0	241,200	0	15,000	0	256,200
	NGO	0	21,000	6,500	0	0	27,500
	Tea company	260,190	0	0	0	0	260,190
Nyanza	INGO	0	662,000	0	0	0	662,000
	Int_project	25,000	490,000	54,000	0	0	569,000
Nyarugenge	Cooperative	50,000	50,000	20,000	0	1,500,000	1,620,000
Nyaruguru	INGO	0	704,000	0	0	0	704,000
	Int_project	0	300,000	0	0	0	300,000
	Private company	180,000	0	0	0	0	180,000
	Tea company	411,164	0	0	0	0	411,164
Rubavu	INGO	0	539,000	1,500	0	0	540,500
Ruhango	INGO	15,000	754,000	1,500	0	0	770,500
	Int_project	0	4,824,000	0	0	0	4,824,000
Rulindo	INGO	0	2,172,426	0	0	0	2,172,426
	Int_project	0	50,000	2,000	0	0	52,000
Rusizi	INGO	0	862,000	2,500	30,000	0	894,500
	Int_project	0	1,181,400	0	75,000	0	1,256,400
	NGO	0	300,000	0	0	0	300,000
Rutsiro	INGO	0	399,000	0	0	0	399,000
	Tea company	56,230	0	0	0	0	56,230
Rwamagana	INGO	0	736,000	1,500	0	0	737,500
	Int_project	0	35,000	12,000	0	0	47,000

Appendix 4. Projects/programmes in districts

No	District	#	List of projects/ programmes	Category type
1	Musanze	9	Climate Justice programme	INGO/NGO
			Green Amagaya I; LDCF-II Project titled "Building resilience of communities living in degraded forests, savannahs and wetlands through an Ecosystem-based Adaptation (EbA) approach"	Government
			Poverty-Environment Action for the Sustainable Development Goals (PEA)	Government
			Reducing Vulnerability to Climate Change in North West Rwanda through Community based adaptation	Government
			Project for Inclusive Small Livestock Markets	Government
			Rwanda Dairy Development Project – RDDP	Government
			Virunga Transboundary Initiative	INGO/NGO
			Kitchen gardens and Tree planting programme	INGO/NGO
			Tubura - OAF	INGO/NGO
2	Gicumbi	8	Commercialisation and de-risking for agricultural tranformation project (CDAT)	Government
			Rural Community Support Project (RCSP)	Government
			Strengthening climate resilience of rural communities in Northern Rwanda	INGO/NGO
			Forest Management and Woody Biomass Energy Support Project	Government
			Project for Inclusive Small Livestock Markets	Government
			Rwanda Dairy Development Project – RDDP	Government
			Kitchen gardens and Tree planting programme	INGO/NGO
			Tubura – OAF	INGO/NGO
3	Gakenke	6	Landscape Approach to Climate Proof the Rural Settlements Project	Government
			Rural Community Support Project (RCSP)	Government
			Forest Management and Woody Biomass Energy Support Project	Government
			Project for Inclusive Small Livestock Markets	Government
			Tubura – OAF	INGO/NGO
			Forest Investment Program: Development of agroforestry for sustainable agriculture in Rwanda	Government
4	Burera	4	Project for Inclusive Small Livestock Markets	Government
			Rwanda Dairy Development Project – RDDP	Government
			Virunga Transboundary Initiative	INGO/NGO
			Tubura - OAF	INGO/NGO
5	Rulindo	7	Building Resilience to Climate Change and Sustainable Livelihoods in Rwanda's Agrosystems	INGO/NGO
			Sustainable Agricultural Intensification and Food security Project (SAIP)	Government
			Forest Management and Woody Biomass Energy Support Project	Government
			Rwandan Youth Development and Voluntary Organization	NGO - local
			Project for Inclusive Small Livestock Markets	Government
			Kitchen gardens and Tree planting programme	INGO/NGO
			Tubura - OAF	INGO/NGO
6	Rubavu	6	Landscape Restoration and Integrated Water Resources Management in Sebeya Catchment and other catchments project	Government

No	District	#	List of projects/ programmes	Category type
			Sebeya Project - Embedding Water Resources Management in Rwanda	INGO/NGO
			Trees on Farm project - I & II	INGO/NGO
			Rwanda Dairy Development Project – RDDP	Government
			Virunga Transboundary Initiative	INGO/NGO
			Tubura - OAF	INGO/NGO
7	Nyabihu	10	Feed the Future Hinga Waze	INGO/NGO
			Landscape Restoration and Integrated Water Resources Management in Sebeya Catchment and other catchments project	Government
			Sebeya Project - Embedding Water Resources Management in Rwanda	INGO/NGO
			Trees on Farm project - I & II	INGO/NGO
			Sustainable Agricultural Intensification and Food security Project (SAIP)	Government
			Reducing Vulnerability to Climate Change in North West Rwanda through Community based adaptation	Government
			Project for Inclusive Small Livestock Markets	Government
			Rwanda Dairy Development Project – RDDP	Government
			Virunga Transboundary Initiative	INGO/NGO
			Tubura - OAF	INGO/NGO
8	Nyamasheke	8	Community gardens and Kitchens	INGO/NGO
			Building the capacity of Rwanda's government to advance the National Adaptation Planning process	Government
			Feed the Future Hinga Waze	INGO/NGO
			REinforcement of Developing Initiatives in Rural Environment (REDIRE)	INGO/NGO
			Commercialisation and de-risking for agricultural tranformation project (CDAT)	Government
			Coffee agroforestry project	INGO/NGO
			Project for Inclusive Small Livestock Markets	Government
			Tubura - OAF	INGO/NGO
9	Karongi	4	Feed the Future Hinga Waze	INGO/NGO
			Sustainable Agricultural Intensification and Food security Project (SAIP)	Government
			Project for Inclusive Small Livestock Markets	Government
			Tubura - OAF	INGO/NGO
10	Ngororero	10	Feed the Future Hinga Waze	INGO/NGO
			Building resilience to climate change and sustainable agriculture value chains in agro-systems around Mukura Forest and Lake Kivu Catchment Landscape	INGO/NGO
			Landscape Restoration and Integrated Water Resources Management in Sebeya Catchment and other catchments project	INGO/NGO
			Sebeya Project - Embedding Water Resources Management in Rwanda	INGO/NGO
			Green Amagaya I; LDCF-II Project titled "Building resilience of communities living in degraded forests, savannahs and wetlands through an Ecosystem-based Adaptation (EbA) approach"	Government
			Landscape Approach to Forest Restoration and Conservation (LAFREC)	Government
			Project for Inclusive Small Livestock Markets	Government
			Kitchen gardens and Tree planting programme	INGO/NGO
			Food for the Hungry - Child support and tree planting	INGO/NGO

No	District	#	List of projects/ programmes	Category type
			Tubura - OAF	INGO/NGO
11	Rusizi	3	Building the capacity of Rwanda's government to advance the National Adaptation Planning process	Government
			Commercialisation and de-risking for agricultural tranformation project (CDAT)	Government
			Tubura - OAF	INGO/NGO
12	Rutsiro	11	Feed the Future Hinga Waze	INGO/NGO
			Building resilience to climate change and sustainable agriculture value chains in agro-systems around Mukura Forest and Lake Kivu Catchment Landscape	INGO/NGO
			Landscape Restoration and Integrated Water Resources Management in Sebeya Catchment and other catchments project	INGO/NGO
			Sebeya Project - Embedding Water Resources Management in Rwanda	INGO/NGO
			Sustainable Agricultural Intensification and Food security Project (SAIP)	Government
			Community partners interventions through Nature based villages	INGO/NGO
			Landscape Approach to Forest Restoration and Conservation (LAFREC)	Government
			Project for Inclusive Small Livestock Markets	Government
			Rwanda Dairy Development Project – RDDP	Government
			Kitchen gardens and Tree planting programme	Government
			Tubura - OAF	INGO/NGO
13	Kirehe	14	Commercialisation and de-risking for agricultural tranformation project (CDAT)	Government
			Green Amagaya I; LDCF-II Project titled "Building resilience of communities living in degraded forests, savannahs and wetlands through an Ecosystem-based Adaptation (EbA) approach"0	Government
			Building Capacity of Rwanda's Government to advance the national adaptation planning Process (NAP)	Government
			Transforming Eastern Province through Adaptation	INGO/NGO
			Green Amayaga Project II	Government
			Community partners interventions through Nature based villages	INGO/NGO
			Alliance for Restoration of Forest Landscapes and Ecosystems in Africa	INGO/NGO
			Landscape Approach to Climate Proof the Rural Settlements Project	Government
			ARCOS Tree planting	INGO/NGO
			Reducing climate change vulnerability through increased community-based biodiversity conservation in the Eastern Province of Rwanda	Government
			Anchor Farm Project: Rwanda	INGO/NGO
			ETI (Export Targeted Modern Irrigation)	Government
			Management For Climate Change Mitigation And Adaptation Around Mahama Refugee Camp	NGO - local
			Tubura - OAF	INGO/NGO
14	Nyagatare	11	Alliance for Restoration of Forest Landscapes and Ecosystems in Africa	INGO/NGO
			Building the capacity of Rwanda's government to advance the National Adaptation Planning process	Government
			ARCOS Tree planting	INGO/NGO
			Reducing climate change vulnerability through increased community-based biodiversity conservation in the Eastern Province of Rwanda	Government
			Anchor Farm Project: Rwanda	INGO/NGO

No	District	#	List of projects/ programmes	Category type
			Transforming Eastern Province through Adaptation	INGO/NGO
			Regreening Africa	INGO/NGO
			Commercialisation and de-risking for agricultural tranformation project (CDAT)	Government
			Rwanda Dairy Development Project – RDDP	Government
			Food for the Hungry - Child support and tree planting	INGO/NGO
			Tubura - OAF	INGO/NGO
15	Gatsibo	10	Feed the Future Hinga Waze	INGO/NGO
			Reducing climate change vulnerability through increased community-based biodiversity conservation in the Eastern Province of Rwanda	Government
			Anchor Farm Project: Rwanda	INGO/NGO
			Transforming Eastern Province through Adaptation	INGO/NGO
			Regreening Africa	INGO/NGO
			Commercialisation and de-risking for agricultural tranformation project (CDAT)	Government
			Sustainable Agricultural Intensification and Food security Project (SAIP)	Government
			Rural Community Support Project (RCSP)	Government
			Food for the Hungry - Child support and tree planting	INGO/NGO
			Tubura - OAF	INGO/NGO
16	Kayonza	13	Kayonya Irrigation and Integrated Water Management project - I & II	Government
			Feed the Future Hinga Waze	INGO/NGO
			Reducing climate change vulnerability through increased community-based biodiversity conservation in the Eastern Province of Rwanda	Government
			Anchor Farm Project: Rwanda	INGO/NGO
			Transforming Eastern Province through Adaptation	INGO/NGO
			Regreening Africa	INGO/NGO
			Commercialisation and de-risking for agricultural tranformation project (CDAT)	Government
			Coffee agroforestry project	INGO/NGO
			Sustainable Agricultural Intensification and Food security Project (SAIP)	Government
			Rural Community Support Project (RCSP)	Government
			Green Amagaya I; LDCF-II Project titled "Building resilience of communities living in degraded forests, savannahs and wetlands through an Ecosystem-based Adaptation (EbA) approach"0	Government
			Rwanda Dairy Development Project – RDDP	Government
			Tubura - OAF	INGO/NGO
17	Ngoma	3	Feed the Future Hinga Waze	INGO/NGO
			Transforming Eastern Province through Adaptation	INGO/NGO
			Tubura - OAF	INGO/NGO
18	Rwamagana	8	Rwanda Wildlife Conservation Society	NGO - local
			Reducing climate change vulnerability through increased community-based biodiversity conservation in the Eastern Province of Rwanda	Government
			Anchor Farm Project: Rwanda	INGO/NGO
			Transforming Eastern Province through Adaptation	INGO/NGO
			Sustainable Agricultural Intensification and Food security Project (SAIP)	Government

No	District	#	List of projects/ programmes	Category type
			Forest Management and Woody Biomass Energy Support Project	Government
			Rwanda Dairy Development Project – RDDP	Government
			Tubura - OAF	INGO/NGO
19	Bugesera	13	Feed the Future Hinga Waze	INGO/NGO
			Rwanda Environmental Conservation Organization (RECOR)	NGO - local
			Reducing climate change vulnerability through increased community-based biodiversity conservation in the Eastern Province of Rwanda	Government
			Transforming Eastern Province through Adaptation	INGO/NGO
			Regreening Africa	INGO/NGO
			Building Resilience to Climate Change and Sustainable Livelihoods in Rwanda's Agrosystems	Government
			Trees on Farm project - I & II	INGO/NGO
			Commercialisation and de-risking for agricultural tranformation project (CDAT)	Government
			Green Amagaya I; LDCF-II Project titled "Building resilience of communities living in degraded forests, savannahs and wetlands through an Ecosystem-based Adaptation (EbA) approach"0	Government
			Poverty-Environment Action for the Sustainable Development Goals (PEA)	Government
			Community partners interventions through Nature based villages	INGO/NGO
			Kitchen gardens and Tree planting programme	INGO/NGO
			Tubura - OAF	INGO/NGO
20	Ruhango	8	FLR Green Mayaga project - I & II	Government
			Commercialisation and de-risking for agricultural tranformation project (CDAT)	Government
			Green Amayaga Project II	Government
			Project for Inclusive Small Livestock Markets	Government
			Rwanda Dairy Development Project – RDDP	Government
			Food for the Hungry - Child support and tree planting	INGO/NGO
			Tubura - OAF	INGO/NGO
			Forest Investment Program: DEVELOPMENT OF AGROFORESTRY FOR SUSTAINABLE AGRICULTURE IN RWANDA	Government
21	Kamonyi	4	FLR Green Mayaga project - I & II	Government
			Food for the Hungry - Child support and tree planting	INGO/NGO
			Tubura - OAF	INGO/NGO
			Forest Investment Program: DEVELOPMENT OF AGROFORESTRY FOR SUSTAINABLE AGRICULTURE IN RWANDA	Government
22	Muhanga	5	Commercialisation and de-risking for agricultural tranformation project (CDAT)	Government
			Rural Community Support Project (RCSP)	Government
			Food for the Hungry - Child support and tree planting	INGO/NGO
			Tubura - OAF	INGO/NGO
			Forest Investment Program: DEVELOPMENT OF AGROFORESTRY FOR SUSTAINABLE AGRICULTURE IN RWANDA	Government
23	Nyanza	7	FLR Green Mayaga project - I & II	Government
			Commercialisation and de-risking for agricultural tranformation project (CDAT)	Government

No	District	#	List of projects/ programmes	Category type
			Sustainable Agricultural Productivity And Market Linkage Project (SAPMP)	Government
			Sustainable Agricultural Intensification and Food security Project (SAIP)	Government
			Rwanda Dairy Development Project – RDDP	Government
			Tubura - OAF	INGO/NGO
			Forest Investment Program: DEVELOPMENT OF AGROFORESTRY FOR SUSTAINABLE AGRICULTURE IN RWANDA	Government
24	Huye	7	Commercialisation and de-risking for agricultural tranformation project (CDAT)	Government
			Project for Inclusive Small Livestock Markets	Government
			Rwanda Dairy Development Project – RDDP	Government
			Rwanda National Tree Seed Centre - Huye	Government
			Kitchen gardens and Tree planting programme	INGO/NGO
			Tubura - OAF	INGO/NGO
			Forest Investment Program: DEVELOPMENT OF AGROFORESTRY FOR SUSTAINABLE AGRICULTURE IN RWANDA	Government
25	Nyamagabe	3	Feed the Future Hinga Waze	INGO/NGO
			Project for Inclusive Small Livestock Markets	Government
			Tubura - OAF	INGO/NGO
26	Nyaruguru	4	Commercialisation and de-risking for agricultural tranformation project (CDAT)	Government
			Project for Inclusive Small Livestock Markets	Government
			Tubura - OAF	INGO/NGO
			Forest Investment Program: DEVELOPMENT OF AGROFORESTRY FOR SUSTAINABLE AGRICULTURE IN RWANDA	Government
27	Gisagara	8	FLR Green Mayaga project - I & II	Government
			Commercialisation and de-risking for agricultural tranformation project (CDAT)	Government
			Coffee agroforestry project	INGO/NGO
			Sustainable Agricultural Productivity And Market Linkage Project (SAPMP)	Government
			Project for Inclusive Small Livestock Markets	Government
			Kitchen gardens and Tree planting programme	Government
			Tubura - OAF	INGO/NGO
			Forest Investment Program: DEVELOPMENT OF AGROFORESTRY FOR SUSTAINABLE AGRICULTURE IN RWANDA	Government
28	Kicukiro	4	Building the capacity of Rwanda's government to advance the National Adaptation Planning process	Government
			Commercialisation and de-risking for agricultural tranformation project (CDAT)	Government
			Second Rwanda Urban Development Project (RUDP II)	Government
			Forest Management and Woody Biomass Energy Support Project	Government
29	Nyarugenge	2	Second Rwanda Urban Development Project (RUDP II)	Government
			Forest Management and Woody Biomass Energy Support Project	Government
30	Gasabo	7	Building the capacity of Rwanda's government to advance the National Adaptation Planning process	Government
			Commercialisation and de-risking for agricultural tranformation project (CDAT)	Government

No	District	#	List of projects/ programmes	Category type
			Rural Community Support Project (RCSP)	Government
			Green Amagaya I; LDCF-II Project titled "Building resilience of communities living in degraded forests, savannahs and wetlands through an Ecosystem-based Adaptation (EbA) approach"	Government
			Second Rwanda Urban Development Project (RUDP II)	Government
			Forest Management and Woody Biomass Energy Support Project	Government

Appendix 5. One Acre Fund - Seedlings in districts in 2022

District	Grevillea robusta	Calliandra houstoniana var. calothyrsus	Prunus africana	Jacaranda mimosifolia	Acrocarpus sp.	Polyscias fulva	Leucaena sp.	Toona sinensis	Senna sp.	Maesopsis eminii	Croton sp.	Markhamia lutea	Alnus acuminata
Bugesera	629,250							83,900				125,850	
Burera	555,100						128,100						170,800
Gakenke	731,700												81,300
Gatsibo	757,680								86,100	17,220			
Gicumbi	470,400						58,800		58,800				
Gisagara	752,000												
Huye	715,000												
Kamonyi	496,600										24,679	242,723	
Karongi	609,800	139,400											34,800
Kayonza	515,200											128,800	
Kirehe	723,360						82,200			16,440			
Muhanga	561,600							70,200	70,200				
Musanze	630,400			157,600									
Ngoma	709,200											78,800	
Ngororero	663,700												153,300
Nyabihu	244,000										143,400		329,600
Nyagatare	920,550							108,300				54,150	
Nyamagabe	509,400											339,600	
Nyamasheke	763,200			76,320									
Nyanza	529,600							66,200				66,200	
Nyaruguru	352,000							70,400				281,600	
Rubavu	262,080												283,920
Ruhango	583,200											145,800	
Rulindo	310,800						88,800		44,400				
Rusizi	775,800	86,200											
Rutsiro	343,300										16,700		39,000
Rwamagana	788,000												
Grand Total	**15,902,920**	**225,600**	**0**	**233,920**	**0**	**0**	**357,900**	**399,000**	**259,500**	**33,660**	**184,779**	**1,463,523**	**1,092,720**

Source: Based on table of seedling production provided directly to the consultant by One Acre Fund in August, 2023 in Kigali. Note. Empty columNs - for species intended to be planted, but seed unavailable for the NGO. Source: One Acre Fund

26

Appendix 6. Definitions of tree seed sources and compliance with the OECD Scheme for the Certification of Forest Reproductive Material

Introduction

Forest landscape restoration (FLR) has become an increasingly important concern in recent years, with ambitious commitments made in the last two decades. An example is the current Bonn Challenge which aims to restore 350 million hectares of degraded and deforested landscapes by the year 2030 of which 100 million is under the African chapter, AFR100. Rwanda has pledged 2 million hectares for the for AFR100.

FLR consists of restoring natural forests and woodlands through natural regeneration and planting, establishment of plantations, and of agroforestry tree planting on smallholder farms.

Definitions of tree seed sources have been developed and applied in many countries, and standardised (slightly differently) by OECD, EU, FAO, DFSC, GTZ[1] and others (for convenience we call it the OECD system). These guidelines generally rank seed sources into identified, selected, qualified sources and for selected sources, into tested and untested reproductive material (e.g., OECD, 2023).

The OECD Scheme for the Certification of Forest Reproductive Material seeks to encourage the production and use of forest tree seeds or plants that have been collected, processed, raised, labelled, and distributed in a manner that ensures their trueness to name.

The shortcoming of the OECD system is that it does not explain how the different types of seed sources need to be evaluated differently to determine how seed collection will ensure genetic quality. This shortcoming can quite easily be remedied by classifying seed sources into five types that can then be classified according to the OECD system.

Most seed for smallholder plantings is from trees that are scattered on farmland or from natural forests and common-sense criteria of quality can be applied to such sources. These criteria will enable collaboration between public and private (*incl.* NGOs) organisations and the entrepreneurial sector (small-scale nurseries and small-scale seed vendors) where the public sector actively supports entrepreneurial development (see also Lillesø *et al.*, 2021, Graudal et al, 2021).

The support to tree planting for restoration in Rwanda is very much a decentralised process, where the decisions on species and source selection are taken at district. Most of the seeds are procured from private seed dealers and own collection by tree nurseries as part of the decentralised process of tree planting and most of the seeds are collected from trees in farmland, plantations, and natural forest (Lillesø and Derero, 2018). PATSPO II in Ethiopia establishes Breeding Seed Orchards and Seedling Seed Orchards for priority species, which in the longer term will provide tested reproductive material. A similar approach is planned for the Eastern Province of Rwanda under TREPA.

Region of provenance

OECD requires that Regions of Provenance are delineated for untested (identified, selected, qualified) sources of a species. The reason for this requirement is that for untested material, the Region of Provenance provides information on the assumed adaptation of the source – "For a species or sub-species, the Region of Provenance is the area or group of areas subject to sufficiently uniform ecological

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[1] OECD (Organisation for Economic Co-operation and Development), EU (European Union), FAO (Food and Agriculture Organisation of United Nationa), DFSC (Danida Forest Seed Centre), GTZ (German Agency for Technical Cooperation)

conditions in which stands or seed sources showing similar phenotypic or genetic characters are found." (OECD Forest, 2022).

For Rwanda, ICRAF utilises the the atlas of Potential Vegetation of Rwanda, as a planting zone system <a shinyapps tool is under development for Rwanda>, which corresponds to Regions of Provenance. Many Rwanda tree species occur across planting zones and the same species can thus have seed sources that are adapted to different planting zones.

Categories of seed sources

OECD Forest Scheme

OECD Forest (2022) categorises reproductive material into (i) Identified; (ii) Selected; (iii) Qualified; and (iv) Tested.

(i) Identified - this is the minimum standard permitted in which the location and altitude of the place(s) from which reproductive material is collected must be recorded; little or no phenotypic selection has taken place.

(ii) Selected - the basic material must be phenotypically selected at the population level.

(iii) Qualified - The components of the basic material have been selected at the individual level; however, evaluation may not have been undertaken or completed.

(iv) Tested - The superiority of the reproductive material must have been demonstrated by comparative testing or an estimate of its superiority calculated from the genetic evaluation of the components of the basic material.

The purpose of this categorisation is to enable a decentralised registration of seed sources. The description of seed sources therefore aims to produce a phenotypical description of the seed source at a population level, and to include an evaluation of a sample of individual trees in a source. The sources for *immediate production* therefore correspond to the OECD category of *Qualified*. The seed sources for *future production*, Breeding seed Orchards and Seedling Seed Orchards correspond to the OECD category of *Tested*.

Seed sources

ICRAF differentiates between sources for:

Immediate production: (i) Natural vegetation, (ii) Farmland; (iii) Plantation; - These three types of sources are untested, but they can still be documented with respect to phenotypical condition, number of potential seed trees, and vegetation type (Region of Provenance). Each of the three types has a unique distribution of genetic variation among individual trees and the evaluation of genetic quality must be made separately for each type. The minimum number of trees to be collected from is different for each type, but they should all have healthy seed trees, and the number of seeds collected from each seed tree should be equal.

(i) Natural vegetation contain the largest diversity of species and genetic variability within species and pollination is good in intact forest. In most cases, mature trees are large and difficult to collect from. Collection is best done by skilled tree climbers, favouring actors that can specialise on natural forest. - Minimum number of selected, sexually mature good trees to be included in a genetically qualified natural forest seed source: preferably 50 trees or more – all of which are further than 100 m from another tree of same species. - Minimum number of trees that must have contributed equally to a given seed lot: preferably 40 trees more - that should all grow in the same planting zone. - All trees are healthy

and of acceptable quality (in traits as relevant). - Trees should not be remnants left over after severe logging of superior trees

(ii) <u>Farmland.</u> Trees are either remnants of natural vegetation or planted trees. Easy access makes farmland a favourite for seed collection. Origin is often unknown, genetic variability may be low, possibly suffering from inbreeding, pollination is not ensured. - The minimum number of selected, good trees to be included in a genetically qualified farmland seed source: 50 trees – all of which are further than 100 m from another seed tree of same species. - A seed tree must at the same time be within pollination distance of other trees of the same species. - Minimum number of trees that must have contributed to a given seed lot: 30 trees. - Minimum number of farms on which seed trees grow (when origin is unknown): 5 farms.

(iii) <u>Plantation</u> (of unknown origin). There is a grey zone between 'plantations' and 'planted farmland seed sources'. For the purpose of classification, we suggest that trees planted in shelterbelts, farm borders, and permanently intercropped are considered to be farmland seed sources, whereas trees planted as even-aged blocks (most often in monoculture) are considered plantations. A minimum area of one hectare where seeds can be collected may be sufficient - provided it is known that the plantation was established from well-mixed seeds of a good representative collection. This size of area will ensure possibilities of collecting from 50-100 seed trees at a sufficient spacing (14-10 m) even after thinning. Many of the smaller AFTS have a small size at reproductive maturity so spacing might only need to be 5-10 m depending on species. In such cases 0.5 ha should be adequate. - The plantation shall exhibit good growth and performance indicating that the genetic origin is suitable for the site (in terms of health and other characters as relevant for the given species) - Minimum size of the plantation of unknown origin**: 75 trees,** preferable larger. - Seed should be collected from at least **40 trees**, preferably more. - Previous thinning(s) should not have removed the best trees to any severe extent (in characters as relevant), and future thinning(s) should be selective leaving superior trees.

Future production: (iv) Planted Seed Orchard - Breeding seed Orchards (BSOs) and Seedling Seed Orchards (SSOs) – both sub-types are established from seed collection across the area of natural distribution of the species and with seeds from selected unrelated trees. The relative contribution of seedlings from mother trees is controlled and equal, and with a minimum number of families contributing to the seed orchard.

(iv) <u>Planted Seed Orchard, BSOs</u> maintain family identity, which enables analysis of genetic variation and selection of the best families for final seed production.

(iv) <u>Planted Seed Orchard, SSOs</u> are established from bulked seed lots (family identity is not controlled), which makes them easier to establish, the layout is simpler and there is no workload of analysing the genetic variation. SSOs are phenotypically thinned, which will increase the genetic potential in the final seed production.

A fifth type is (v) **Vegetative propagation**. Propagation by vegetative means is an important way to maintain selected genotypes of trees. In the tropics this is particularly relevant for well-known varieties of fruit trees like mango, avocado, and papaya. Vegetative propagation can also be considered if seedling production is very complicated, however, considering the many disadvantages to vegetative propagation (in particular high costs of production), it is usually easier and more sustainable to handle the seed problem rather than developing vegetative propagation.