

REPUBLIC OF RWANDA



MINISTRY OF LANDS AND FORESTRY

***National Tree Reproductive Materials Strategy
2018 – 2024***

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List of Acronyms

EDPRS	Economic Development and Poverty Reduction Strategy
FSU	Forest Seed Unit
GoR	Government of Rwanda
NFMP	National Forest Management Plan
NFP	National Forest Policy
NGO	Non-Governmental Organisation
NTSC	National Tree Seed Centre
NTSR	National Tree Seed Registry
NTSS	National Tree Seed Strategy
OECD	Organisation for Economic Cooperation and Development
PPP	Public Private Partnership
PTSC	Provincial Tree Seed Centre
RAB	Rwanda Agriculture Board
REMA	Rwanda Environmental Management Authority
RFRI	Rwanda Forest Research Institute
RWFA	Rwanda Water and Forestry Authority
SWOT	Strengths, Weaknesses, Opportunities, Threats
TRM	Tree Reproductive Material (Seed/Seedling/Germplasm)
UR	University of Rwanda

FOREWORD

The National Tree Reproductive Materials Strategy aims at boosting the sustainable production and supply of genetically adapted tree reproductive materials (TRMs) for the establishment of healthy and productive forest and agroforestry plantations that secure goods and services for enhanced socio-economic development and environmental protection in Rwanda. The Strategy recognises the need for adapted high quality tree planting materials and comprehensive quality assurance mechanisms to increase availability of quality planting materials suited to different agro ecological regions of the country. Through the implementation of this Strategy, outstanding regulatory and institutional reforms will be carried out in order to create public-private partnerships in the production, processing, storage, certification and distribution. At the same time, capacity of both public and private actors and stakeholders will be built to ensure efficient and effective fulfilment of functions and mandates in TRM value/supply chain. The public research shall remain an important source of adapted, secure and productive TRMs addressing local needs and a repository of plant genetic resources. As the strategic actions are implemented, the TRMs sector is expected to become an attractive business that is responsive to afforestation, reforestation and forest landscape restoration needs in the country. The Government of Rwanda shall provide an enabling environment to promote private sector investments in TRM production, distribution and research.

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EXECUTIVE SUMMARY

Forests and agroforestry systems in Rwanda play important roles in supporting the livelihood of all Rwandans by providing most of the energy consumed by the majority of the population, controlling soil erosion, protecting water catchments and supplying other goods and ecological services. They also provide ecosystem services that sustain people, communities, and their economies. Yet the unavailability of tree planting materials both in quantity and quality has often been reported as one of the main barriers to tree planting in different agro-ecological regions of the country. To address this problem, farmers, government project managers and development partners need a reliable supply of a diverse range of tree reproductive materials for forestry, agroforestry and restoration activities. In line with Rwanda's strategies and programmes towards afforestation, reforestation, agroforestry and forest landscape restoration, this Strategy has been developed to orient the production, processing, storage, quality control, certification and supply of high quality tree planting materials for creating healthy productive and environmental friendly forest and agroforestry plantations in diverse agro-ecological contexts of the country.

The National Tree Reproductive Materials Strategy is organized around two strategic goals that will be achieved through meeting a set of relevant objectives. These objectives were mainly identified after analysing the strengths, weaknesses, opportunities and threats (SWOT) in the existing tree seeds and seedlings system in Rwanda. The two goals address different components underlying the value/supply chain of tree reproductive materials (TRMs) under legislation, physiologically and genetically adapted TRMs, value creation, human and physical capacity, systems and structures, decentralization and public-private partnerships, TRM security, research, communication and knowledge/awareness creation and sharing.

Strategic goal 1 deals with TRM production, processing, storage systems and quality control that promote availability of sufficient quantities of genetically adapted TRMs to different agro-ecological zones of the country. Actions to achieve this goal are numerous, including revised policy framework for TRM production, distribution and research, enhanced supply of genetically appropriate and adapted TRMs, adopted measures to protect the TRM quality, enhanced public-private partnerships, strengthened communication systems, and established mechanisms for TRM emergencies. Increased human and physical resources of Tree Seed Centre (TSC) and of other public and private actors in TRMs and organizational support for achieving this goal is essential, as are expanded cooperation and partnerships within and among national, regional and international stakeholders in the forestry and agroforestry sectors.

Strategic goal 2 builds upon the role of forestry research programs that should be conducted to ensure the availability of adapted and high quality planting materials to provide long-term sustainability. Research is needed to improve our knowledge of the biology and adaptive genetic variation of priority tree species in the country. Results of this research can be used to develop guidelines for selection of plant materials that are adapted to climatic and other environmental conditions at the planting site and that are resilient to unpredictable environmental disturbances and climate change.

The goal recommends the development of reliable protocols for storage practices for recalcitrant and orthodox tree seeds, with emphasis on indigenous tree species. It also addresses gaps in knowledge of the factors limiting seed germination in tree nurseries and seedlings establishment at planting sites. Further, the strategy recommends specific studies aimed at assessing ecological and economic impacts of using improved TRM as well as determining the internal rate of return to justify investment in using genomic tools in tree improvement research. The Strategy devises innovative techniques to propagate difficult-to-establish species while maintaining the genetic identity and diversity. The application of biotechnology in production of planting materials for some valuable

indigenous species is key in large-scale production of quality planting materials of these species. The domestication of indigenous tree species is also a focus to capture the genetic traits of superior trees and develop a range of cultivars to suit different agro-ecological zones of Rwanda.

The strategy envisages building and strengthening linkages, collaboration and partnerships among actors in the TRM value/supply chain and various stakeholders in forestry and agroforestry as drivers of successful implementation of this strategy. The strategy gives a matrix of expected outcomes, outputs, activities and indicators set under the strategic goals. Furthermore, it gives a budget matrix aligned with pertinent activities that will be implemented to achieve specific outputs. The implementation of the Strategy is expected to last 7 years and to cost nearly 12.7 billion Rwandan francs.

1 INTRODUCTION

Rwanda's forest ecosystems have been vastly overused by the past anthropogenic activities that led to deforestation, land degradation, soil erosion, and loss of biodiversity¹. Since more than 15 years, issues and challenges of degradation have been highlighted in numerous national priorities, policies and strategies such as the Vision 2020, Economic Development and Poverty Reduction Strategies, EDPRS 1 (2008 – 2012), EDPRS 2 (2013 – 2018), the Five Year Strategic Plan for the Environmental and Natural Resources Sector (2014-2018) and Green Growth and Climate Resilience Strategy (2011) towards reversing the degradation process and allied problems. Specifically, Vision 2020 recognizes that the national forest cover must be significantly increased up to 30 % (i.e. a forest area of 714,102 ha) of the national land area (excluding lakes) and the agroforestry systems should cover 85% of the cultivated land. Furthermore, the Government of Rwanda has made restoration pledges to the Bonn Challenge and AFR100 Initiative – totalizing 2 million hectares.

Forests and agroforestry systems in Rwanda play important roles in supporting the livelihood of all Rwandans especially by providing most of the energy consumed by the majority of the population for cooking, controlling soil erosion, protecting water catchments and supplying other goods and ecological services. They also provide ecosystem services that sustain people, communities, and their economies. Yet the unavailability of tree planting materials both in quantity and quality has often been reported as one of the main barriers to tree planting in different agro-ecological regions of the country. To address this problem, farmers, government project managers and development partners need a reliable supply of a diverse range of tree reproductive materials for forestry, agroforestry and restoration activities in their zones.

A long-term vision of productive and environmental friendly forest and agroforestry plantations has been envisaged through availability of quality tree reproductive materials (TRMs) suited to the diverse agro-ecological zones of Rwanda. The matching of tree species to planting sites is of paramount importance as the productivity of tree species is site specific under conditions of management practices imposed on the forest and agroforestry plantations³. Thus, the Forest Sector Strategic Plan 2018-2024 (FSSP) developed in line with the 2018 National Forest Policy (NFP), needs to be supported by a National Tree Reproductive Materials Strategy aiming at a sustainable TRM supply chain.

TRMs are expected to produce trees that are environmentally adapted to various reforestation, agroforestry and restoration sites where they will likely establish and produce goods and services. Hence, TRMs need to be improved both in quality and quantity, and should adapt to sites for meeting the planting objectives (i.e. woody biomass production, ecosystem services and biodiversity conservation). The National Tree Reproductive Materials Strategy 2018-2024 (NTRMs) seeks to develop seeds, seedlings, other vegetative materials and container stocks that will meet long-term goals to enhance economic and ecological functions of forest and agroforestry plantations in different agro-ecological zones of Rwanda. Its Implementation will enhance access and availability of adapted quality tree planting materials for use in reforestation and agroforestry activities that target improved livelihood, economic development and sustainable environmental management.

2 BACKGROUND AND CURRENT STATUS OF TREE REPRODUCTIVE MATERIALS

2.1 Overview of the Tree Seed Centre

In the 1970's, a small forestry seed unit was created within the Silvicultural Research Division of the Rwanda Agricultural Research Institute (ISAR) under the umbrella of the Ministry of Agriculture, Forestry and Animal Resources. This unit collected and supplied seeds mainly of exotic plantation species such as eucalyptus, cypress, and pines as well as multipurpose tree species (e.g. calliandra, leucaena, grevillea) used in agroforestry. In 1985, the unit evolved into the Tree Seed Centre (TSC), known as Centrale des Graines forestières (CGF) with the financial support of the Swiss

Government. Since then, TSC's mission was to centralize tree seed supply activities, such as the development of new seed sources, tree improvement, genetic conservation, seed collection, processing and supply.

During the 80's and 90's, several tree species and provenance trials for indigenous or exotic tree species were established by forestry and agroforestry research programs in different parts of the country (e.g. *Eucalyptus camaldulensis* provenance trials in Bugesera and Gatsibo's districts in 1986, *Pinus kesiya* provenance trial in Kayonza's district in 1991) in order to select adapted tree species to different agroecological zones of the country. Promising tree species and provenances were made available to the TSC for further evaluation in seed stands, provenances and progeny trials. Hence, the TSC's major activities were expanded to cover seed collection and distribution, tree improvement research, tree seed technology research, establishment and management of seed sources, and conservation of tree genetic resources.

Since the 1980's, the centre was able to produce and supply up to 10 tons of tree seeds in Rwanda and in the region. The capacity of TSC to produce, process and supply large quantities of quality tree seeds from species, provenance and progeny trials was recognized by the Organisation for Economic Cooperation and Development (OECD) for the control (certification) of forest reproductive material moving in international trade. In 1993, Rwanda became a member to OECD scheme for the certification of tree reproductive materials, with TSC being the "Designated Authority" for the certification and distribution of forest reproductive materials following the ministerial decree No.1/1993 of 4th January 1993. TSC, therefore, was mandated to produce and distribute quality tree seeds. However, the demand for tree seeds has been increasing rapidly overtime following the rising tree planting and afforestation rates in the country. Hence, TSC had the responsibility to ensure the demand is met by the supply of quality tree seeds. The demand for tree seeds in recent years further increased following the need to meet government targets of increasing the forest cover to 30 % of the national land area and expanding agroforestry to 85 % of agricultural land.

In 2015, following the restructuring of public institutions, TSC was attached to the Department of Forestry and Nature Conservation (DFNC) of Rwanda Natural Resources Authority (RNRA) in the Ministry of Natural Resources (MINIRENA) in order to improve its operational efficiency mainly in the production of quality tree seeds and procurement. Presently, the centre's management falls under Rwanda Water and Forestry Authority (RWFA). The centre is still responsible for establishing and managing tree seed sources, organizing and following up tree seed collections, processing and controlling seed quality before dispatch to end users. This national TSC is officially recognized as the only supplier of tree seeds in the country. TSC has some basic infrastructures, materials and equipment but they are not sufficient for the centre to achieve fully its mandate.

2.2 Current state of tree seed quality

Seed quality refers to the physical and physiological state, but encompasses also the genetic, pathological and entomological attributes that affect seed performance. Seed quality is defined as the measure of characters that will determine the performance of seeds when sown or stored. Seeds being a living biological end-product of genetic and environmental interaction, their behavior cannot be predicted with complete certainty. However, good quality tree seeds are generally collected from mature and healthy trees which fulfill the established relevant standards for their phenotypes depending on species. TSC established seed sources with exotic tree species in provenance trials as well as a number of high value indigenous tree species in domestication plots. Main issues researched in tree seed based activities included adaptability, genetic improvement of tree species, management and evaluation of seed sources, phenological studies, conservation of tree genetic diversity and seed technologies.

Tree improvement perspective included sufficient number of trees per provenance to ensure high genetic variation while establishing progeny trials. At least three different sites within the species' ecological tolerances were chosen for the establishment of the trials. The identity of provenances/progenies was retained at all stages of the trials. For instance *Grevillea robusta*, *Eucalyptus spp.*, *Alnus acuminata* and *Acacia melanoxylon* are some of tree species established in different provenance trials in the country and have led to interesting results for the purpose of tree seeds collection. In cooperation with Forestry and Agroforestry research programs, indigenous species including those under threat of extinction are also included in the experimental trials. Since most interest has been focused on exotic tree species up to now, there is limited knowledge about indigenous tree species, particularly in phenological behavior, seed physiology, extraction, drying, storage and pre-sowing treatments of seeds from these particular tree species which are currently in high demand.

Before the distribution of tree seeds to end users, TSC must guarantee the quality of tree seeds TSC by abiding to internationally agreed rules for seed sampling and testing. Within this context, TSC carries out seed tests to provide information on the quality of seed, seed conservation and pre-treatment methods that will accompany the delivery of seedlots to end-users. The most widely used methods by TSC for assessing seed vigour of every seedlot are measurement of germination rate and seedling growth rate, both in the nursery and laboratory. Physiological and physical qualities of tree seeds are two good criteria to guarantee and good quality TRM. However, the genetic quality is also important because it encompasses adaptability to the planting site, growth performance, tolerance to biological and environmental stresses, and the level of gene diversity within a seedlot. The genetic quality plays a major role in the potential yield, disease and pest resistance, tolerance to drought and other adverse weather. The molecular techniques for determining the genetic quality of seed were not used until now because technically complex and expensive. However, the adoption of the use of molecular markers enables to estimate the extent of pollen contamination in seed orchards, and accordingly, the seed quality depending on genetic diversity.

Clear and complete documentation and record-keeping are made by the TSC. Quality aspects are covered in guidelines which have been elaborated and which cover all stages and processes of seed research, procurement, production and distribution. However, the genetic quality, assessment for insect damage prior to seed extraction and the testing for the presence of pathogens, useful information for nursery growers, must be better documented.

It is noteworthy that the loss of local and external technical capacity during the 1994 genocide against Tutsi has adversely affected the network of tree seed sources (Figure 1). Many provenance trials were damaged and many areas of identified seed stands were clear-felled. In the aftermath of the genocide against Tutsi, the remaining seed stands were rehabilitated and new ones were created. Despite measures taken by the TSC to supply quality tree seeds, an informal tree seed sector that does not consider the quality of tree seeds has rapidly developed. Important quantities of seeds used in tree planting, forestry and agroforestry activities are currently from unknown sources increasing risks of unwanted phenotypes and the inbreeding or the species mix, which could lead to quality reduction in plantations (e.g. increased sensibility to pests and diseases) and therefore a potential reduction in productivity or even an overall danger for the forest plantations.

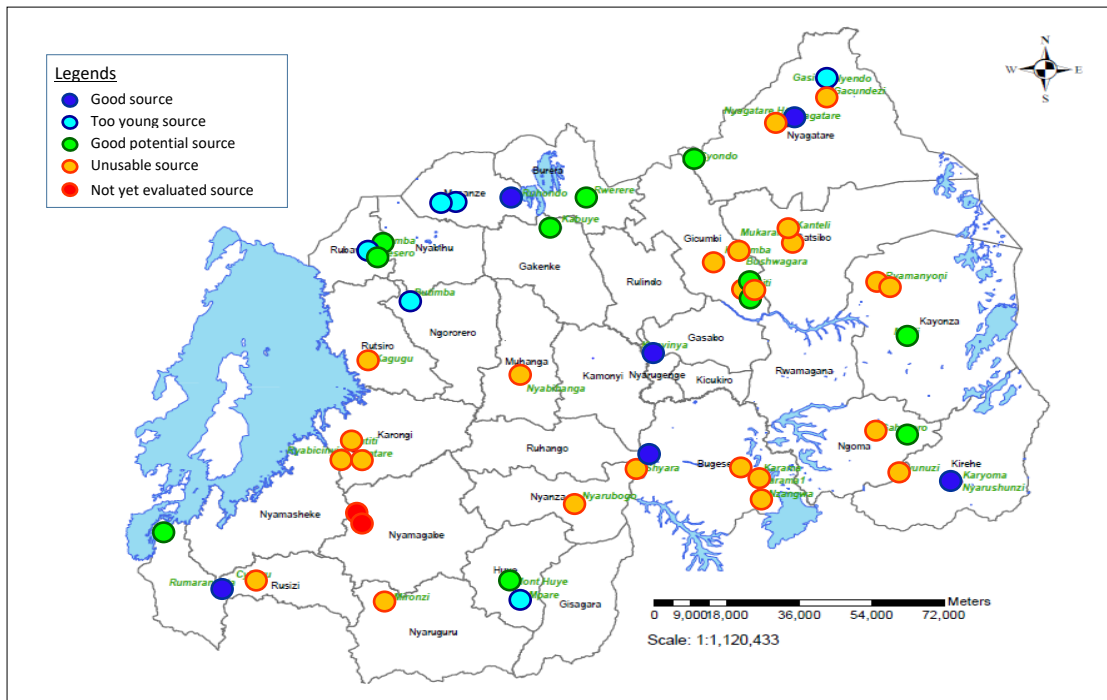


Figure 1: Current state and distribution of tree seed stands in Rwanda

Of the 49 plots (indicated by coloured circles on the map) allocated on 45 stands in 23 districts across the country, only 6 (12.2%) tree seed stands were categorized as good sources of basic seeds (dark-blue circles); 11 (22.5%) stands show good potential to be advanced in the upcoming research programs because of the presence of several plus-trees (green circles), and 6 (12.2%) stands are still too young (light-blue circles). Almost half of the current stands (49%) have to be rehabilitated (orange circles) to enhance their potential for quality seed production. Only 2 stands (4.1%) were not evaluated (red circles).

Large quantities of tree seeds used in Rwanda are still not produced via the formal sector, i.e. by the TSC or private accredited actors. Instead, they are produced informally by individual farmers and farmers' cooperatives themselves and very often from unidentified sources. Incomplete information on the origin of the tree seeds, its quality and availability exists today. The current poor quality of seeds as well for the exotic species as for the indigenous species in most of Rwandan plantations mainly comes from genetic bottlenecks and a bad selection of individuals, resulting in inbreeding and a decrease of genetic diversity. The low production of seeds associated to low germination rates was observed as more significant for indigenous species than for exotic species. Consequently, poor genetic and physiological/physical qualities of tree seeds have limited the growth potential and other required performances of trees, e.g. low flower and fruit productions, vulnerability to pests and diseases and also low drought tolerance.

The countrywide Tree Seed Stand Evaluation⁴, performed at the beginning of 2016 by the National Tree Seed Centre (NTSC) of Rwanda Water and Forestry Authority (RWFA) has supported these observations. There is an urgent need to improve the management of current tree seed stands (, e.g. with adequate forestry practices such as thinning to the required tree density and efficient pest and disease management^{5,6}, to create new tree seed sources of exotic and indigenous tree species, in order to increase the quantity and enhance the genetic quality of the tree seeds. Under the current circumstances, the supply of good quality tree seeds needs to be complemented by imports in the short and medium terms. Awareness campaigns should be conducted for the communities to understand the importance of seed stands and research trials so that they participate in the protection of these resources.

2.3 Current state of the Tree Seed Research

The TSC has actively conducted research into the use of appropriate species and provenances. The research was done in partnership with research programmes in forestry and agroforestry at ISAR in collaboration with ICRAF and Switzerland Government (SWISS INTERCOOPERATION) and later at Rwanda Agriculture Board (RAB). Although TSC has done a good job in conducting tree seed research, only a limited number of species and provenances has been investigated. TSC conducted research on exotic tree species, thus leaving out many indigenous species that are locally important for economic and environmental benefits. A few scattered efforts in the conservation of tree genetic resources are taking place at the Rwanda National Genebank in collaboration with Forestry and Agroforestry Research and Extension at RAB.

Although the TSC was established to support seed source (seed stands) establishment combined with tree improvement, at present, there is no tree breeding programme in Rwanda. A few related activities are conducted such as provenance trials and ex-situ conservation tests. Moreover, the research did not cover seed production and distribution chains for a broader understanding of organizational development and agricultural entrepreneurship in the tree seed subsector. Hence, socio-economic research focusing on improving the capacity of local entrepreneurs to make tree seed and seedling production and distribution a sustainable business and on improving the capacity of farmers to become informed tree seed customers, has not been undertaken since the existence of the TSC in Rwanda.

So far limited technical research has been conducted. Phenological observations were made in order to develop flowering and germination calendars and, in conjunction with research experiments, determine the timing of seed collection which guarantees storability and high germination percentage. This program is vital to TSC in order to ensure the right timing of seed collection from various indigenous tree species. Many of the tree species being observed have seeds that undergo dormancy which needs to be broken before germination. However, the type and nature of dormancy vary from one species to another. Pre-germination treatments were determined for a limited number of tree species in order to ensure proper and uniform germination. Research on the physiological and physical qualities of tree seeds has largely been carried out and supported by access to modest laboratory facilities for testing seeds, cold storage facilities for optimal storage of seeds, and a limited, well trained capacity for seed collection and seed handling.

Despite important achievements in matching tree species to planting sites, identification and establishment of tree seed sources, the protection of experimental sites and diffusion of results proved to be inefficient. The follow-up of the provenance trials previously established in 80's was not performed consistently. As a result, the tree species provenance is currently impossible to identify accurately because many of the experimental protocols are lacking or trees are absent following illegal cutting or destruction by pests and diseases. It turns out to be necessary to characterize existing provenances and to set up new seed provenance trials across Rwanda in collaboration with tree breeding programmes. Particularly, agroforestry species and provenances need to be diversified, focusing on indigenous tree species in order to enhance crop yields, combat erosion and restore degraded land.

Some initiatives have to be developed to provide legal, institutional and technical supports strengthening the capacity of researchers in conducting high quality research in areas of tree improvement and tree seed research that combine species – specific research (technical research focusing on specific tree species) and system-specific research (research that addresses questions how to organize and support decentralized tree seed collection, procurement and distribution). The current situation of the TRM production is not performing well due to the lack of research to inform on appropriate technology and extension. The research and seed production are currently managed in different institution (RAB and RWFA respectively). This has impeded the research on seeds and

forest in general to guide decision makers. The coordination has been difficult and led to the inconsistency in research. Having forest research run by the institution mandated to manage forest would contribute more to the improvement of seeds and forest management. The forest sector strategic plan (FSSP) 2018-2022 proposes to establish a forestry research department within the institution mandated of forest management. This will be one of the solution once implemented.

Current state of Private sector participation in the TRM supply chain

Currently, no accredited tree seed producers or collectors following well-established standards are working for the TSC or for the traders in cooperatives. Since 2007, following the Government's decentralization policy, seed collection was transferred to farmer cooperatives and therefore, TSC does not carry out seed collections any longer. Since then, TSC has involved farmers' cooperatives in tree seeds supply on contract basis. This eases the workload and financial transparency but it comes at a high price of loss of control and hands-on experience on field. The experiences gained from seed collections are not added to the centre and the implication is that field knowledge, field capacity, and skills are being lost.

Most of cooperatives supply a huge quantity of seeds to the NTSC with incomplete information about the origin. Not only can seed be collected from unknown, unregistered provenances, but even if collected from registered sources there is no guarantee that the seed actually is not collected from inferior, exposed trees which in general produce more seed than the desired phenotypes. In addition, as the profit is quantity dependent, the seed supplier cooperatives are increasingly purchasing tree seeds from non-contracted tree seed dealers.

Entrepreneurship in tree seed in Rwanda is emerging but there is a lack of knowledge and skill in this business. The public and private actors are confronted with numerous challenges in the TRM supply financial and technical limitations. Consequently, the current TRM supply system is not adequate for bridging the gaps between demand and supply of high quality TRMs.

There is an urgent need to put in place an appropriate TRM value/supply chain by increasing the interest of private sector, which should have to be considered as a key element in the successful development of a tree seed business. Indeed, a well-established tree seed commercial system is crucial to the development of forestry and agroforestry systems in Rwanda. By implementing the proposed strategy, it is expected that the TSC will attract the private sector involvement in tree seed value chain, while the former will only assume regulatory, research and quality assurance functions.

2.4 Policy and regulatory framework of tree reproductive materials

The present TRMs strategy intends to create enabling conditions for reaching these milestones of Vision 2020 by providing high quality and sufficient quantity tree planting materials. The Rwanda's EDPRS 1 and 2 prioritize forestry as a strategic sector for public intervention to limit natural resources degradation. In order to reach this objective, specific actions in the forestry sector include the design and implementation of a reforestation strategy with diverse species, increase of forest and agroforestry cover and development of a strategy for involving the private sector in forest management. The TRM strategy comes in to draw the road map for the Forestry sector to achieve these objectives of EDPRS.

The National Forestry Policy (2010) responds to the targets of Vision 2020 and EDPRS and recognizes the crucial role of the supply of improved high quality tree seed and other germplasm in order to improve the yield of forests and agroforestry plantations in the country. The forestry policy strategic thrusts on which the tree seed sector development can be directly linked include:

- Determining national tree seed demand and supply;

- Establishing and managing tree seed and other germplasm sources for all agro-ecological zones of Rwanda;
- Producing, marketing and promoting use of high quality tree seed and other germplasm;
- Establishing standards and guidelines for seed collection, handling and distribution for quality control;
- Capacity building within the private sector for tree nursery management;
- Establishing ex-situ stands for conservation and preservation of tree seeds.

The National Forestry Strategy (2009-2012) was built on the National Forestry Policy and included a number of guiding principles that are directly relevant to the TRM value chain. The overall development of the TRM sub sector is anchored in the following principles of the National Forestry Strategy:

- Sustainable forest management, to ensure that all forests are managed to yield sustainable streams of social, economic and ecological goods and services to enable the forestry sector to meet the forestry needs of the current generation without compromising similar rights of future generations;
- Species diversification for reforestation, agroforestry practices and conservation of tree biodiversity in the country;
- Forestry research through which fundamentals of forestry science will inform key decisions on forest management;
- Stakeholder involvement and partnerships, emphasizing involvement of all key stakeholders in forestry at different levels in decision-making that are relevant and affect them;
- Private sector involvement to promote a systematic phasing in of the private sector to play a dominant role in forest management and processing of forest products, leaving the public sector only the regulatory function, research and quality assurance;

The need to produce quality tree reproductive materials was recognized in Rwanda as early as 1973, with the creation of the Tree Seed Centre (TSC) under the former Rwanda Agricultural Research Institute (ISAR). In 2013, the law n° 47bis/2013 of 28/06/2013 has been adopted to cover the Management and Utilization of Forests in Rwanda making reference to forestry and agroforestry planting, conservation and protection of forests, forest management, trade in forestry seeds, forestry research, licenses, and judicial police in respect of forests and administrative sanctions. The other relevant key policies, laws, conventions and strategies in Rwanda which regulate or impact on tree seed reproductive materials at various degrees and the associated value chain are presented in the Annex 1.

These legal instruments need to be reviewed to allow the implementation of the TRM strategy. Indeed, the development of the TRM sector in Rwanda requires a relevant and effective seed legislation including provisions for seed quality control (i.e. publication of minimum quality standards for every forest and agroforestry species), accreditation accessibility (e.g. for tree seed producers, collectors), seed traceability system across the country and intellectual property rights. This way, The Government of Rwanda (GoR) will need assistance to make informed choices concerning the development and the implementation of rules, norms and regulations. For instance, tree seed private operators would have to pass agreements in accordance with Nagoya Protocol and

the new Rwandan regulation about framing the use of genetic resources to be to able participate in the international markets for TRMs.

3 AN ANALYSIS OF STRENGTHS, WEAKNESSES, OPPORTUNITIES AND THREATS OF TRMS SUPPLY CHAIN

The evaluation of the present status of the TRM supply chain revealed major strengths, weaknesses, opportunities and threats. The proposed TRM strategy will look at how the TRM value chain could sustain the continuous supply of sufficient TRMs in good physiological conditions by building on the strengths while minimising the issues and challenges facing the value chain. The key results of the SWOT analysis are presented in Table 1.

The results of the SWOT analysis indicate a variety of strengths and weaknesses of the present TRMs systems, which could be distributed across a range of actors including the existing TSC, the private sector, individual farmers, farmers’ cooperatives, research institutions and end-users such as forestry and agroforestry projects. Combining options from these categories of actors could be the best solution for efficient supply and distribution of TRMs.

Currently, the TRM supply chain is not efficient to cover the short-term and long-term supply of high quality TRM for forestry and agroforestry development in the country. Public and private sectors are insufficiently equipped and organized in the TRM value chain. Moreover, forestry and agroforestry managers and policymakers are faced with incomplete and imprecise information on the origin and physiological qualities of TRMs, particularly the quality and availability of indigenous/exotic species adapted to different environments. Sustainable and productive forestry and agroforestry plantations in the country will depend largely on the degree of success in TRM production and distribution. A well-functioning TRM system is crucial to meet the increasing demands of high quality TRM in a timely and affordable way. It is, however, drawn from a strategy that takes into account the constraints and opportunities of all the actors and their roles in the TRM value chain.

Table 1. Key results of the SWOT analysis of the TRM value chain in Rwanda

Strengths:	Weaknesses:
<ul style="list-style-type: none"> • Existence of TSC having a national mandate of supplying quality tree seeds • Rwanda is a member of OECD Scheme for the Certification of TRM moving in international trade; • Existence of the tree seed laboratory at the Tree Seed Centre • Availability of tree seed sources (identified and established) • Good links with stakeholders at all levels • Engagement of farmers’ cooperatives in seed collection and supply on contract with TSC • Availability of National Genebank at RAB • Existence of tree seedlings producer cooperatives • TSC capacity to deliver large quantities of tree seeds annually • Availability of a list of tree species suited to different agroecological zones of the country • Tree Seed catalogue • Research programmes in forestry and agroforestry 	<ul style="list-style-type: none"> • Poor quality seed sources due to lack of adequate management • Insufficient tree species diversification in tree seed stands • Low genetic diversity and physiological quality of tree seeds • Unavailability of certified tree seeds • Undocumented seeds from farmers cooperatives • Lack of principles for forest pests and diseases management • Weak protection capacity from illegal cutting of trees and damages caused by animals to tree seed stands, provenance and progeny trials • Inadequate capacity to meet increasing demand for tree seeds • Lack of adequate equipment and materials • Unskilled and underequipped stakeholders in nurseries • Inadequate management of planting stocks in private tree nurseries • The prices are not adapted to changing market needs

	<ul style="list-style-type: none"> • Weak enforcement of laws and regulations governing seed certification in the country • Inadequate follow-up, monitoring and funding of previous tree seed research • Lack of a comprehensive database of results in tree improvement and seed research • Inadequate research capacity in tree improvement and breeding • Limited tools to publish and disseminate research results • Small and old infrastructure at TSC • Inadequate seed quality control services • Lack of skilled workers in seed collection, and handling • TSC too centralized and services are not accessible to beneficiaries • Poor communication and marketing system • Weak engagement of the private sector in tree seed production and supply
<p><u>Opportunities:</u></p> <ul style="list-style-type: none"> • Political will, reflected in national policies, strategies and sectorial policies, and Government commitment to international conventions such as UNCCD, UNFCCC, and CBD. • Expected increase in demand for seeds of both exotic and indigenous tree species due to government targets for increasing forest and agroforestry cover • Possible linkages to on-going and planned projects in biodiversity conservation, environmental protection, forest landscape restoration and other forestry related initiatives • Interest and commitment of the private sector in forestry and TRM supply chain • Existence of the National Biotechnology Centre • National, regional and international cooperation and networking in forestry research and extension • Export opportunities of tree seeds in the region • Favourable climate conditions for tree phenology • Membership to OECD scheme for certification of tree reproductive materials • Higher learning institutions providing new forestry professionals • Agricultural land as a potential seed sources of agroforestry trees in the farmland context 	<p><u>Threats:</u></p> <ul style="list-style-type: none"> • Limited financial resources to support the production and distribution of TRMs as well as TRM research • Lack of qualified staff in tree improvement, breeding and TRM research • Insufficient infrastructure for seed quality production • Seed users relying on cheaper, informal markets • Lack of willingness to pay for quality seed originating within the jurisdiction of the user • Lack of access to seed sources in parks and protected areas • Potential slow response to seed orders and inability to conserve and deliver recalcitrant seeds • Lack of trust within the business community • Insufficient technical and scientific information to support the production and distribution of high quality TRMs • Long process for developing high-quality TRMs • Pests and diseases outbreak in forestry and agroforestry • Destruction of TRM sources due to land use change • TRM certification and quality control combined within one organization • Underdeveloped marketing infrastructure • Weak control of TRM movement in the region

Implementation of the National Tree Reproductive Materials Strategy will enhance coordination, strong partnership and collaboration among various public institutions (e.g. RWFA, RAB, UR, etc.), non-governmental organizations as well as with the private seed and nursery entrepreneurs. Collaboration and partnerships are vital to the success of reforestation, agroforestry and forest landscape restoration efforts in the country. Products and collaborations developed through the

Strategy will help forest and agroforestry managers select appropriate TRM to use in different areas. It will also provide guidance for major strategies and initiatives such as the implementation of the New Forest Policy, New Forest Strategic Plan, Forest Management Plans, District Forest Management Plans, Land Restoration Strategic Plan and on-going and future forestry and agroforestry based projects. Although some of the work in TRM production, distribution and research is on-going, full implementation of this strategy will require strong collaboration among actors, an interagency financial support initiative, private sector participation, research and information sharing.

4 THE STRATEGIC FRAMEWORK

The National Tree Reproductive Materials Strategy will support the 2018 National Forestry Policy (NFP), precisely in the policy statement number 3: *"Availability of diverse high-quality Tree Reproductive Material (TRM) adapted to the different agroecological regions is ensured to enhance economic and ecological functions of forest and agroforestry plantations in Rwanda"* (see Forest Sector Strategic Plan 2018-2024). It will aim at a sustainable supply chain of high quality seeds, which does not involve a single model that is appropriate for all species and all actors for the country as a whole, but complementary models that consider the needs of each stakeholder according to agro-bioclimatic planting zones. Multi-stakeholder cooperation will create a unified system capable of meeting national and local seed needs adapted for woody biomass production for fuelwood, timber, pole and service wood, ecosystem restoration and biodiversity conservation across Rwanda.

4.1 Vision

Availability of diverse high quality tree reproductive materials adapted to the different agro-ecological regions for enhanced economic and ecological functions of forest and agroforestry plantations in Rwanda.

4.2 Mission

Create a framework for sustainable production and supply of genetically adapted TRM for the establishment of healthy and productive forest and agroforestry plantations that secure goods and services for enhanced socio-economic development and environmental protection in Rwanda.

4.3 Guiding Principles of the National Tree Reproductive Materials Strategy

The ultimate success of the implementation of the National Tree Reproductive Materials Strategy will be strongly linked to high quality TRM and the promotion of public private partnerships in the TRM supply chain. The strategy presented herein is therefore prepared by giving due regard to these considerations, and also to align efforts of building an efficient and sustainable tree reproductive materials system where the private sector is involved and work collaboratively with public institutions especially the TSC to supply quality tree planting materials for forestry and agroforestry development in the country. Therefore, the guiding principles that will guide the implementation of this Strategy are:

- (1) **Sufficient availability of high genetic quality tree reproductive materials:** healthy and productive forests and agroforestry plantations will be established from a wide range of physiologically and genetically adapted tree reproductive materials that adapt to the planting sites in the different agroecological regions of Rwanda. Quality and sufficient tree reproductive materials will be obtained from locally identified, established and well managed TRM sources or imported from registered and accredited regional and international TRM operators. The procurement of high quality tree reproductive materials will adhere to the frameworks presented in Figure 2 through Figure 5.

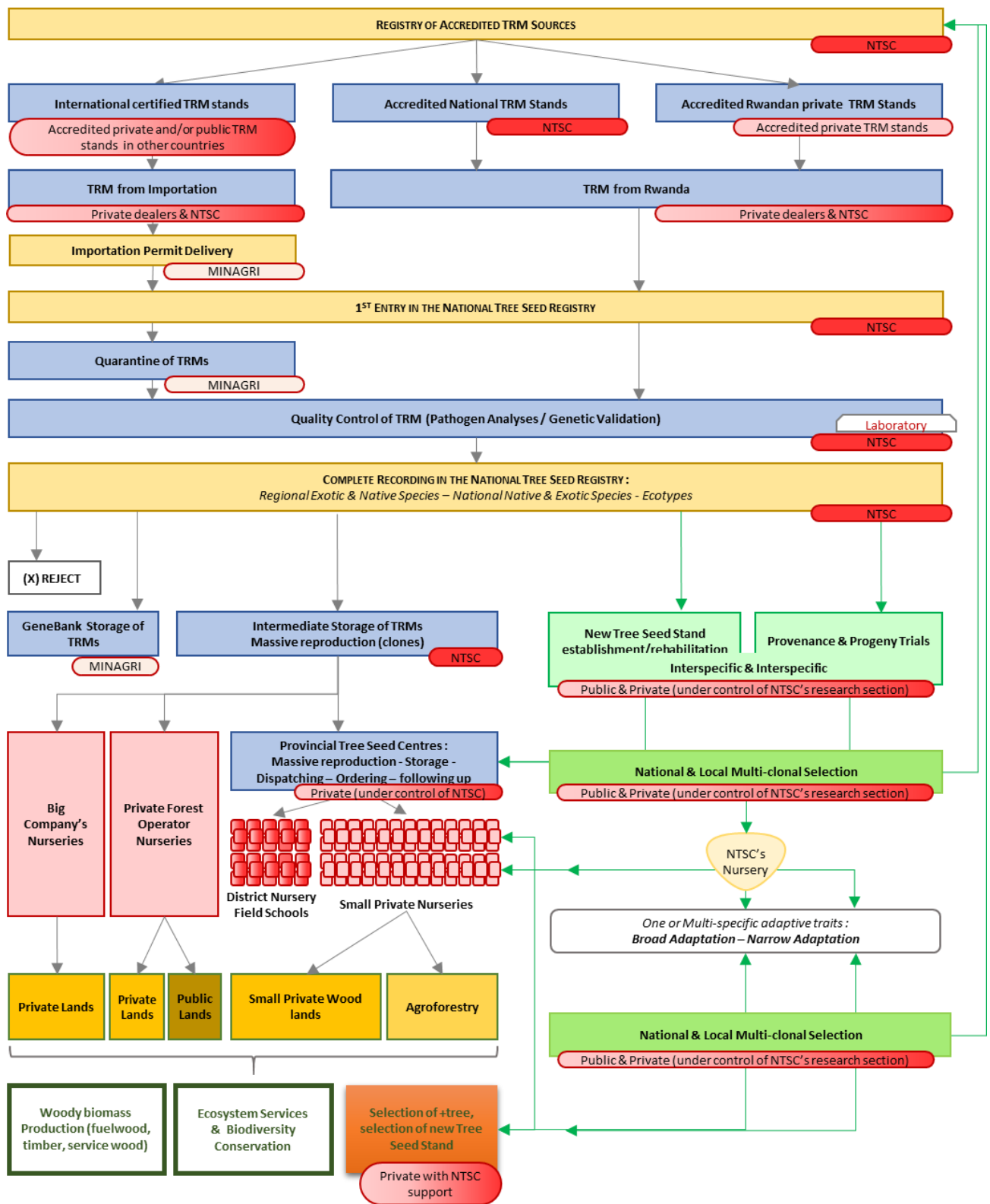


Figure 2: Framework for accredited entities for the supply of high quality tree reproductive materials for use in forestry and agroforestry systems on public and private lands

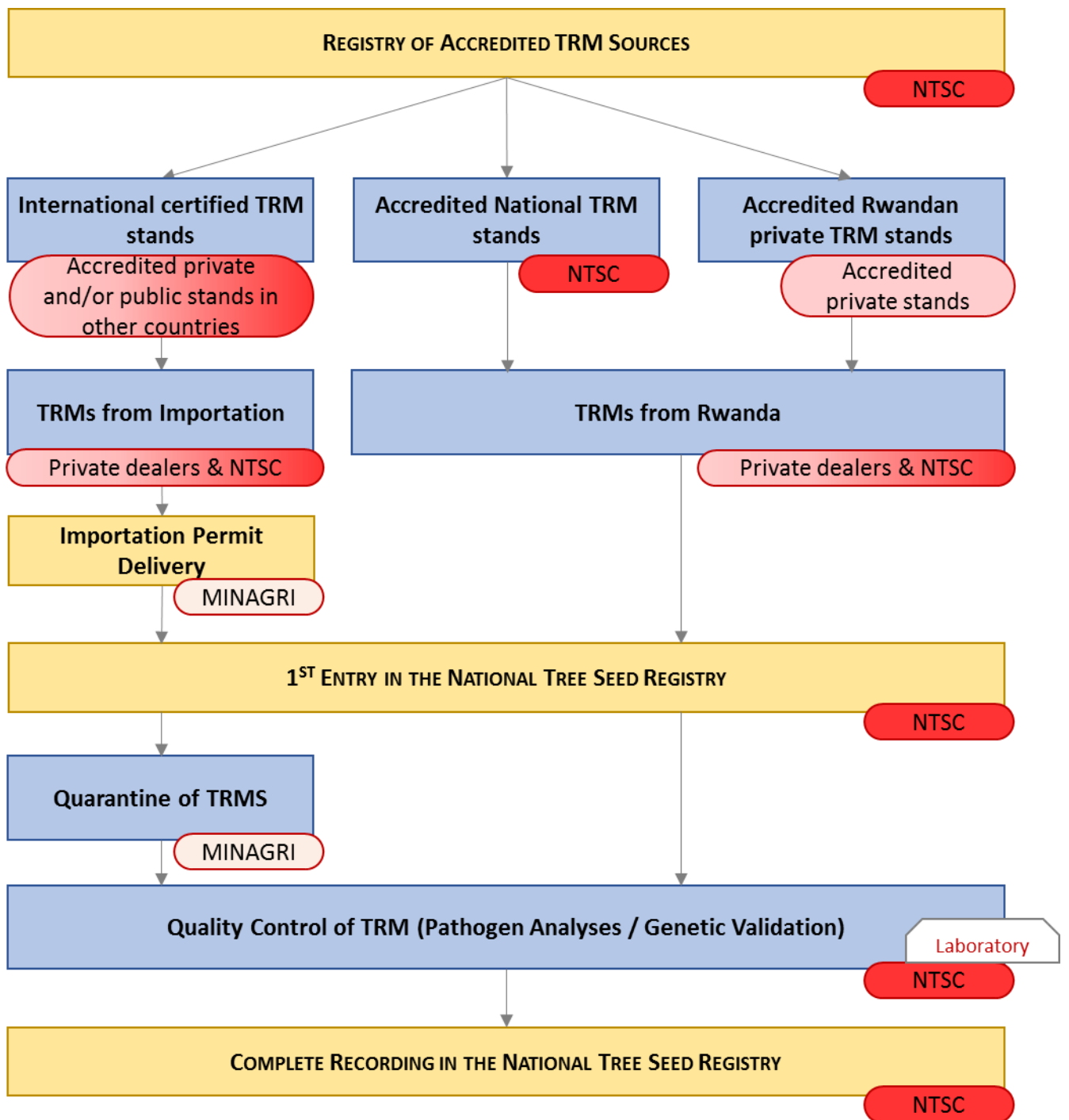


Figure 3: A framework for local supply, importation and quality control processes of TRMs

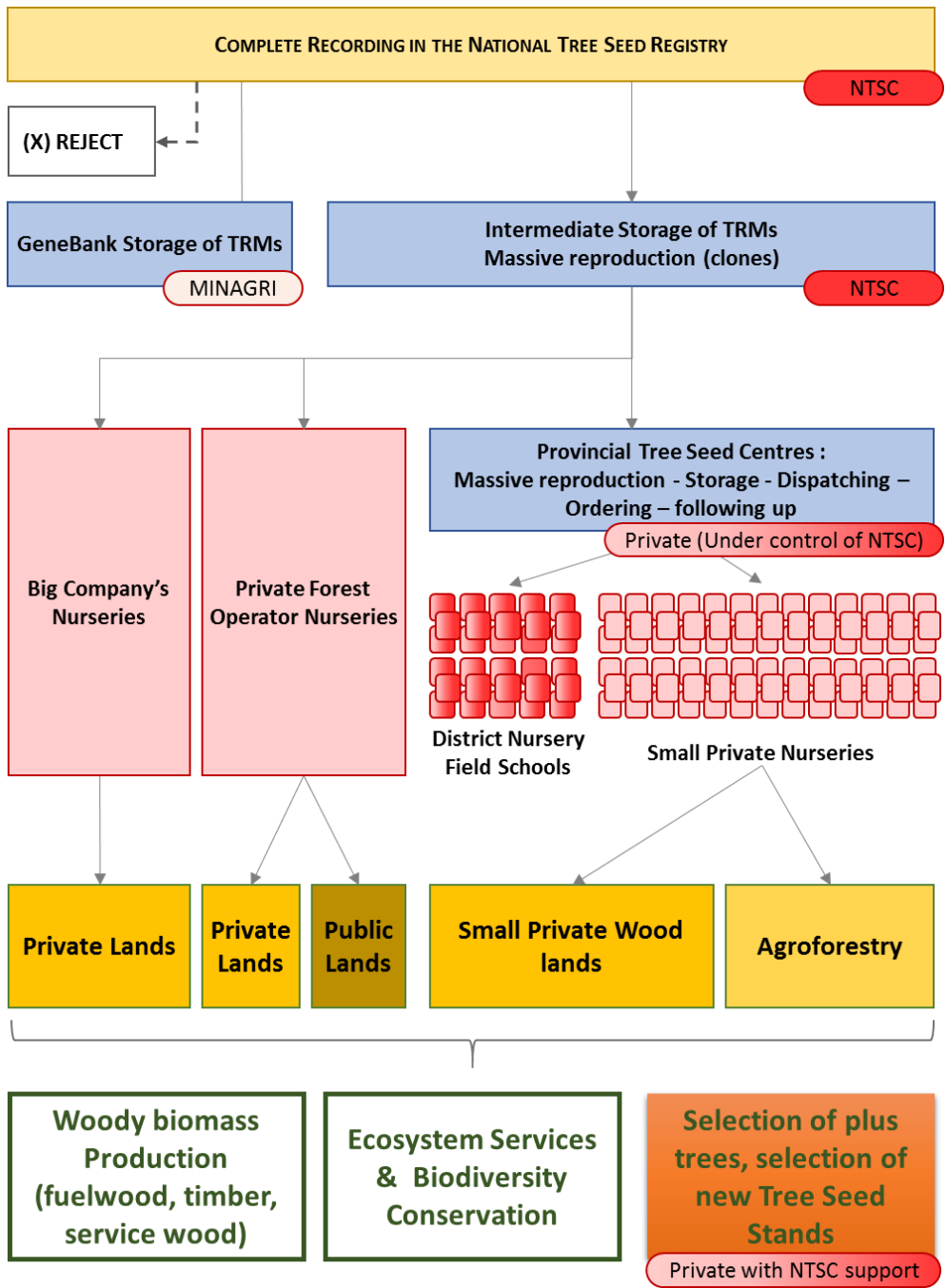


Figure 4: Management process of TRM production, storage and procurement to end-users

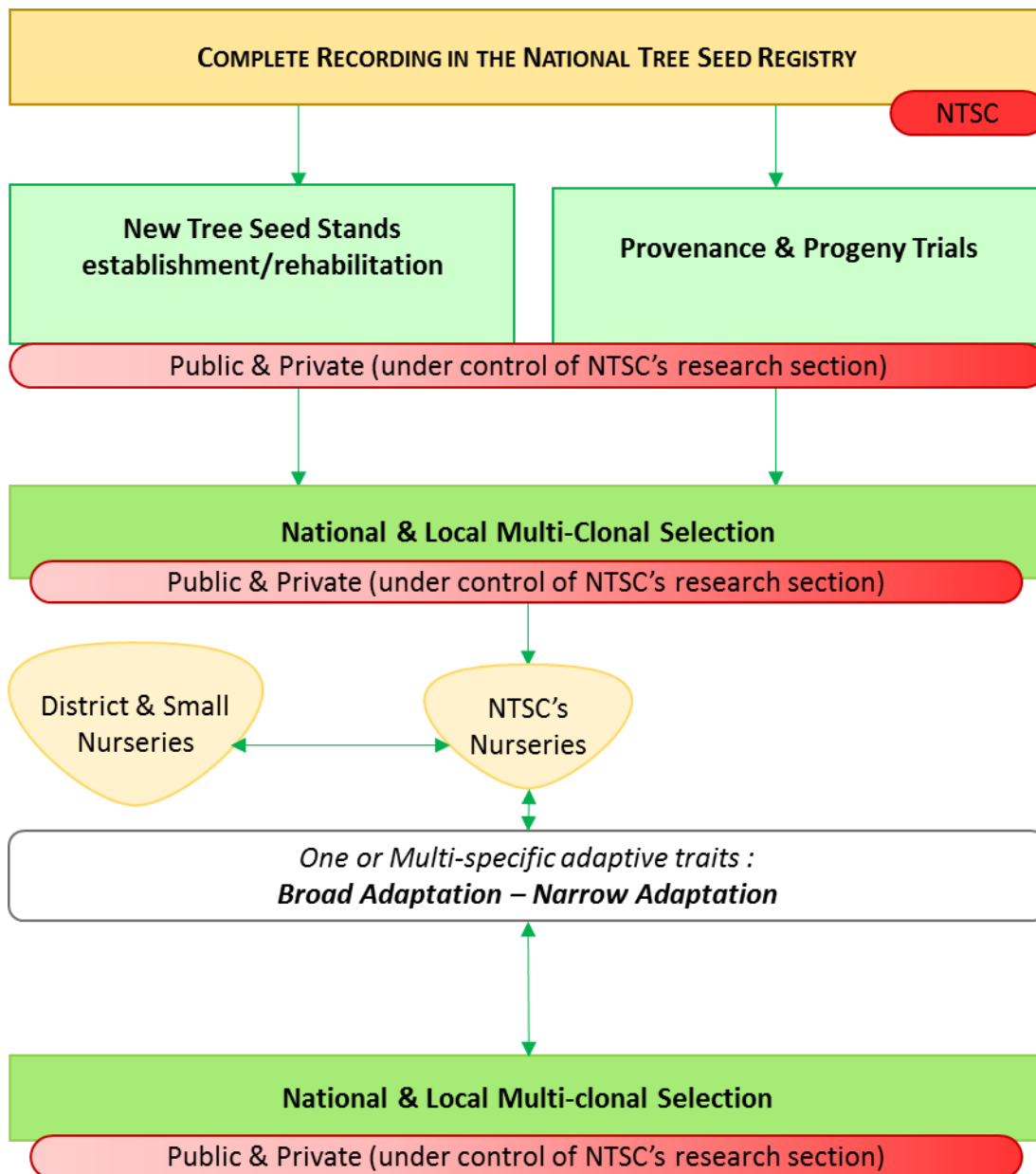


Figure 5: A framework for TRM registry, research and partnerships between NTSC and other public and private actors in TRM value/supply chain

- (2) **Quality assurance in TRM supply chain:** The highest standards of quality TRMs shall be included in various guidelines/ protocols aimed at assisting TRM actors in producing quality TRMs. These tools shall contain practical information on seed standards for a range of tree species.
- (3) **Research in TRM value/supply chain:** the production of high genetic quality TRMs shall be supported by research conducted on suitable high quality TRMs, seed sources, seed collection, seed processing, seed testing and seed storage. Research shall also be carried out in the TRMs systems to provide a broader understanding of organizational development and entrepreneurship in TRM sub-sector.

- (4) **Conservation of tree biodiversity:** The focus shall be on ex-situ and in-situ conservation to be able to conserve high value exotic and indigenous tree genetic resources for the supply of high quality reproductive materials for use in forestry and agroforestry programmes in the future.
- (5) **Private sector involvement:** There will be a progressive involvement of the private sector in the TRM system which creates a lucrative business in the production and distribution of high quality TRMs. The TSU will develop strategic partnerships with the private sector for mobilizing the required resources, strengthening the technical capacity, sharing information, facilitating access to inputs and markets and policy advocacy for the development of enabling policies for the private sector to engage in TRM supply chain.
- (6) **Win-Win system in TRM production and distribution:** The sustainability of the TRM supply chain shall be assured within a win-win, public-private partnership approach to produce and distribute high quality TRMs. A high level of cooperation among the stakeholders and a long-term commitment will promote a common improvement of the value/supply chain, through exchange of information and mutual learning. The collaboration and complementarity of the skills of the various national and local actors shall contribute to a better response to the short and long term needs of TRMs. Actions that shall characterize the win-win system include the development of a fair and attractive TRM markets, participatory genetic improvement of tree species, and decentralized TRM production and distribution at district and provincial levels.
- (7) **Secure value-based system of TRMs:** Sustainable TRM production systems shall be developed without compromising the physiological and genetic quality. Strategies for seed production and ways of introducing sustainability in seed production and distribution systems shall be put in place jointly with the different actors in the value chain. Strategic actions shall cover the award of operational licence, set up of a traceability system, certification and development of quality standards and physical protection of TRM.
- (8) **Transparency:** Transparency shall be required around the roles that the stakeholders play in the TRM supply chain by identifying good practices that enhance the development of specific quality TRMs and successful partnerships. The TRM systems shall allow informed opinion on the role of the private sector, which is essential for a meaningful dialogue about the improvement of the TRM value/supply chain. A series of policies, regulations, and other monitoring tools to protect all stakeholders shall be adopted. Tools for information sharing such as the National TRM Register and various databases shall be created, maintained and made accessible to different stakeholders and actors in the TRM supply chain.
- (9) **Effective communication system:** This shall consist of using various tools to transmit information on the tree seed system to every stakeholder and thus better coordinate efforts to improve and supply TRMs to end-users. Appropriate communication tools shall be developed and used to suit TRM actors at different levels of the value chain with the purpose of developing their skills and empowering them to solve their own problems in the production and distribution of TRMs.
- (10) **Capacity Development:** The aim is to build human and physical resources in the public and private actors in TRM production, processing, storage, quality control and research. The nature of human capacity development activities shall range from academic trainings, teaching and supervision of graduate and postgraduate research students and other types of young scholars through mentoring and on-the-job training, seminars, workshops and conferences. The development of physical resources shall be done through government earmarked funding, resource mobilization from donors, competitive grant systems as well as linking actors in TRM supply chain to financial institutions such as Commercial Banks and Saving and Credit Cooperatives.

(11)**Emergency TRM:** In order to ensure the stability and quality standards of TRMs, an emergency TRM supply strategy shall be jointly planned by all stakeholders to avoid the dissemination of poorly adapted and low value TRMs during emergency situations.

4.4 Strategic Goals, Objectives and Activities

Considering the weaknesses and challenges in the national TRM production and distribution chain, the present strengths and emerging opportunities in the forestry and agroforestry sectors, as well as the National Tree Seed Centre comparative advantages and roles, two integrating strategic goals upon which the TRM system should rely are developed. These goals also help to channel efforts into the production and distribution of high quality tree reproductive materials with participation of various actors in the value chain. Both strategic goals complement each other in terms of impact pathways but each presents complex strategic objectives and multiple activities.

Strategic Goal 1. Strengthen the production and supply capacity in genetically appropriate TRM

Objective 1.1. Review the legal framework in TRM production and supply and provide suggestions for policy reform.

Current policy opportunities and constraints in TRM will be documented and disseminated. An exhaustive review of the national legal framework in TRMs production, supply and research will be done. The review will be done to identify policy instruments that will support the decentralization of tree seed production and distribution in order to enable the private sector to play a significant role in the TRM value/supply chain. The analysis of opportunities and constraints of policy instruments on trade in TRM will also be conducted in the region to assess the possibilities for Rwanda to position itself into East African networks of operators and dealers in TRMs. The review of the national and regional legal frameworks for TRMs will lead to the Development of policy guidelines and recommendations for TRM production, distribution and trade. Hence the main activities involved in the review of legal framework are:

- Review of the policy instruments governing TRM production and distribution by the diverse governmental institutions involved directly and indirectly in the implementation of the strategy;
- Formulation of policy guidelines and recommendations for TRM production, distribution and trade;
- Facilitating policy dialogue fora;
- Dissemination of the updated legal instruments to all stakeholders.

Objective 1.2. Enhance the supply of genetically appropriate and adapted TRMs for reforestation, agroforestry and forest landscape restoration practices

Healthy and productive forest and agroforestry plantations can only be established from genetically appropriate and adapted TRMs. A comprehensive and integrated TRM planning, production and storage systems promotes the availability of sufficient quantities of suitable TRMs when and where they are needed for reforestation, agroforestry and forest landscape restoration programmes. The main actions to achieve these objectives are: (1) Needs and capacity assessment of high quality TRMs production and distribution, and (2) Improvement and expansion the production capacity of TRMs sources

For achieving these, expanded cooperation and partnership within and among public and private sectors are essential.

(1) Needs and capacity assessment of high quality TRMs production and distribution

Current and future forest and agroforestry TRM will be selected based on the concerns of the populations and on strong economic and ecological criteria that lead to higher woody biomass production, enhanced land restoration and genetic conservation in the short, medium and long terms. The assessment will also extend to identifying infrastructure assets, staffing and training needs, and evaluating databases and reporting systems. Based on the results of need and capacity assessment, the TSC will include potential and accredited TRM dealers, researchers, and other relevant stakeholders comprising both national and international accredited service providers. The National Tree Seed Registry will be designed to provide information on these stakeholders including their TRMs provision capacity, the expected quality, the indicative costs and the delivery time. A computer based system will be developed and operationalized to provide this information as an alternative to the National Tree Seed Registry. Based on the assessment of the needs in TRM, imports will be organized. Only high-quality TRM, not available locally, will be imported from international TRM providers by accredited private dealers and public sector in order to satisfy the national TRM needs.

(2) Improvement and expansion of the production capacity of TRMs sources

Ensuring adequate supply of high quality TRMs will require the establishment of their sources. The best TRMs will be selected based on the desired traits and adaptability to the different agroecological zones. TRM sources will be established in a way that ensures sufficient genetic diversity, adaptation to planting sites, and resistance to pests and diseases occurrence and to climate changes hazard^{3,7}.

All current tree seed stands on private or public land will be rehabilitated and managed to enhance the production of high-quality TRM. The rehabilitation will be done by TSC from the first year of the implementation of the strategy. Silvicultural operations will be carried out to improve the current tree seed stands in order to have sufficient plus-trees of the same species for the collection of quality tree seeds.

The supply and sustainable availability of genetically appropriate TRM will also be enhanced through the establishment of a network of additional tree seed stands across the agroecological zones of the country. Specific sites will be selected for setting up new tree stands, provenance or progeny trials as well as seed orchards. The design of new tree seed stands, clonal and seedling seed orchards, provenance and progeny trials will be done by the NTSC and research partners (RAB, UR) in collaboration with District Forest Officers, private partners and local cooperatives.

Tree seed stands producing high-quality interspecific hybrid seeds and having complementary adaptive traits will be set up from imported high-quality seeds. The main activities will include the selection of plus-trees in national interspecific tree seed stands to perform controlled crosses and establish progeny trials, the design and set up of assisted migration trials from best clones.

Monitoring and follow up of these sources of TRMs will be performed regularly and silvicultural operations will be carried out to increase the yields and quality of TRMs. Several decentralized selection programs for forest and agroforestry species will be put in place to focus on certain ecotypes. Thus, the selection, diversity and sustainable production of good quality ecotypes will be achieved through a local participatory approach. The development, implementation, coordination and evaluation of these programs will be carried out by local private actors in collaboration with

non-governmental organizations (NGOs) under the supervision of local and national authorities. The key activities that will be carried out in establishing high quality ecotypes include:

- Selection of high-quality ecotypes with a high genetic diversity within local populations, targeting specific adaptive traits for every species;
- Establishment of local intraspecific tree seed stands from large number of ecotypes selected for a narrow adaptation to more specific areas and imported tree seeds targeting specific adaptive traits to start tree seed improvement programs locally;
- Putting in place local comparative tests between unselected, selected ecotypes and high-quality imported seeds to demonstrate the importance of the high-quality TRM selection to the smallholders;
- Selecting plus-trees in local intraspecific tree seed stands to perform controlled/uncontrolled crosses and establish progeny trials;
- Putting in place different types of provenance trials to support assisted migration programs from best clones or families selected from first provenance and progeny trials.

Objective 1.3. Protect the Value of TRMs

The NTSC is the most important source of tree seeds for forestry and agroforestry practices legally recognized by laws and regulations in the country. This is why it may appear attractive for government and donor funded projects and NGOs to make their tree seed orders. However, informal system of tree seeds exists in the country and tree seed dealers supply the seeds of which the quality is generally lower compared to the seeds derived from the formal system. The use of such low-quality tree seeds impedes the quality and productivity of forests and agroforestry systems. In order to create an environment that encourages the establishment of quality and productive forest and agroforestry plantations, it is essential that TRMs be protected against inappropriate production and distribution of TRM in the country. This protection will be ensured through quality assurance, a well-established TRM traceability system, accreditation of service providers, validation of the genetic identity enhancing the physiological and physical qualities, massive production by clonal reproduction of high-quality seedlings from imported high-quality TRM, quality conservation of improved parental individuals and their progeny, certification and protection of TRM sources against biotic and abiotic factors. The NTSC will be empowered to perform regular field controls to ascertain the TRM identity and quality and whether the production was done in accordance with relevant standards.

Objective 1.4. Strengthen the capacity of the National Tree Seed Centre

In a view of the weaknesses in the present TRMs value/supply chain, specific actions are required for improving proactive planning capabilities and capacity of the NTSC infrastructure, materials and technical capacities to respond to on-going and future reforestation, agroforestry and forest landscape restoration needs. The ability of the NTSC to effectively respond to these needs will highly depend on the reliable availability of genetically appropriate TRMs. This requires comprehensive and integrated TRM planning and production and storage systems that promote availability of sufficient quantities of suitable TRMs. Activities to achieve this goal will be to identify infrastructure, staffing and training needs, expanding and improving facilities and TRM production capacity for processing, testing, storage and research, developing a capacity building plan that will involve the recruitment of new staff and staff training based on well-defined required skills, expanding TRM sources,

production and conservation for use now and into the future, setting up mechanisms to work collaboratively with the private sector to increase seed production capacity in the country.

Objective 1.5. Develop and strengthen the capacity of other public and private actors in the TRM value chain

There are a number of issues in the enabling environment that are hampering the efficiency of the TRMs system in the country. One of the major challenges identified through the SWOT analysis is the dominance of the public sector in the production and distribution of TRMs. The TRM strategy proposes a transition reducing the monopoly role of the public sector to the provision of services and facilitation. Actions to achieve this objective are described below, including Enhanced public-private partnership in the production and distribution of quality TRMs, increased end-users' access to high quality TRMs, and enhanced capacity for TRMs research.

(1) Enhanced public – private partnership in TRMs production and distribution

A greater collaboration between the public sector and the private sector is envisaged for attracting private investment and strengthening the production of high-quality TRMs while respecting the regulations and standards. This is expected to lead to more participation of private operators, some of which have shown interest due to the market prospects. Mechanisms for enhancing public-private partnership shall be developed for production of good quality TRM, encompassing the informal and formal TRMs sectors in the development of sustainable TRMs system. To this end, activities required for strengthening the capacity of the private sector will be to increase its interest and capacity in producing and distributing good quality TRM through training, awareness campaigns, various communication tools and networking in the TRM sector. An area of focus will also be on organizing private TRM actors and training on business practices and awareness rising on TRM quality assurance through certification and standardization. The TSC will also support resources mobilization in the private sector by linking TRM actors to financial institutions so that the required infrastructure for collection, processing, conservation and quality assurance is established and operational.

(2) Increased end-users' access to high quality TRMs

The end-users are important stakeholders in the TRM supply chain. Their access to TRMs will be facilitated by decentralising the functions of the NTSC. To this end, four satellite TRM centres, corresponding to the four provinces of the country will initially be established as decentralized units of the TSC that will ensure the storage and distribution of high-quality TRMs in specific localities. These Provincial TRM centres will be developed and jointly managed by the public sector and private partners under the supervision of the NTSC. Moreover, a network of 30 accredited District nursery field schools (one per district) managed by private local partners under the supervision of the NTSC will be established and equipped to serve as learning sites on massive propagation techniques, TRM processing, conservation and quality control. Additional farmer field schools will be formed in all the districts to facilitate the local learning process and ease the transfer of information and knowledge in TRMs production and use.

(3) Enhanced capacity for TRMs research

Research partners in TRM supply chain are important since tree improvement, breeding and improved TRMs are both crucial to establishing sustainable productive forests and agroforestry systems in different agroecological contexts of the country. These research areas are of overriding importance, but to make investment in it worthwhile, research partners should have the necessary skills and expertise. Specialized training and academic training of research partner staff will be organized and supported by the Ministries in charge of forestry and education in collaboration with other stakeholders including MINAGRI/RAB, NTSC, and the University of Rwanda through the Biotechnology Centre. National and international collaboration agreements will be developed

among different stakeholders to increase the capacity for research through enquiry and mobilize the necessary financial resources for successful research that underpin the production of high quality TRM.

In the long term, enhanced scientific innovations, skills, information and policy advice for increased productivity of forest and agroforestry resources will require an improved institutional setting. To this end, the forestry research department will be created within the institution mandated of forest management to facilitate the coordination of forest research activities with other institutions in Rwanda. This department will be designed to strengthen forest research in Rwanda as to boost better management of the NTSC for sustainable production and supply of forest seeds, forest productivity and improved livelihood.

Objective 1.6. Strengthen management, extension and communication services for public and private actors in TRM value/supply chain

Poor management, inefficient extension system, limited communication and collaboration among stakeholders in TRM supply chain could lead to inefficiencies in the performance of the TRM chain and quality assurance system. In turn, this could reduce the amount of quality TRMs of in-demand tree species reaching the end-users and the overall TRM quality. This TRM strategy acknowledges these challenges and proposes the solutions presented below.

(1) Development and management of a National TRM Register, other registries and databases

The National TRM Register will consist of a computerized system providing regularly up-dated information on TRM across the country. The system will provide a diversity of information in TRMs including but not limited to the needs in forest and agroforestry TRM, adapted tree species and their suitability to different agroecological zones, an inventory of seed lots available on the market. The registry will also be designed to provide physiological and genetic characteristics of TRMs as determined from provenance trials, progeny testing and assessments of potential ecological and economic risks associated with agroecological contexts. In addition, specific guidelines about the use of the National TRM catalogue will be developed and disseminated among TRM actors in the supply chain. The National TRM Registry will be connected to other databases and registries including: National Association of TRM professionals' web-site, Accreditation Registry of TRM professionals, Tree Pest & Disease Registry and Registry of Tree Species under Moratorium.

These Registries/Databases will be developed and managed by the NTSC in collaboration with other competent authorities and other actors from private and NGO sectors involved in TRM value /supply chain. Some of these databases will be designed to provide biological features, phenotypic, genetic and physiological characteristics of every forest and agroforestry species in Rwanda. A careful inventory of the biology of the forest and agroforestry tree species will be carried out to identify (i) insect-pollinated species or wind-pollinated species, (ii) monoecious or dioecious species, (iii) vegetative propagated species, (iv) resistance threshold to drought, frost, pests and diseases, and (v) phenology of species. Detailed information and results from public and private provenance and progeny trials will also be gathered and included in the databases. Additional linked registries that will be designed will consist as mentioned above of Tree Pests and Diseases Registry and Registry of Tree Species under Moratorium.

(2) Development and implementation of different types of efficient and interconnected communication systems

Effective communication throughout the TRM supply chain is essential for TRM system efficiency. The development of efficient communication will create transparency and trust among and within TRM actors and clients, and will contribute to sustainable TRM business. The TRM strategy has to

contribute to value creation with innovative and sustainable solutions for actors in the value chain. The commitment of TRM actors to ethical and sustainable business practices, with consideration for TRM production, processing, certification, quality assurance, protection and delivery are expected throughout the implementation of the strategy. Various centralized or decentralized communication tools will be developed and used among the various actors in order to disseminate information and to establish competence hubs both of which will facilitate decision-making.

Standardized tools for efficient communication will be developed in close cooperation with all actors in the TRM supply chain. For instance, technical guidelines/manuals describing procedures, modalities, technical specification and necessary templates to organize importation of TRM, ensure proper seedling production and planting based on new TRM will be developed to ensure massive reproduction of these new TRM. Besides technical guidelines, information will be regularly posted on NTSC website and published in brochures that will be distributed at the district level. As an example, these communication tools will include pertinent information such as TRM market regulations, benefits of participatory approach and benefits of breeding. Mass communication including media and broadcasted information through TVs and Radio will be developed to promote the participation of the private sector in high-quality seed importations or to raise awareness among the stakeholders and TRM end-users of the importance of protecting the seed stands, seed orchards and experimental sites set up for the seed market and research. Awareness campaigns will be conducted to disseminate information during the first two years of the strategy. Scientific results from research will be published in national and international journals for the benefit of the scientific community, educational purposes and applications.

Communication services will be decentralized within each district and actors in the value chain. This will allow specific reinforcement of skills and better feedback for further refinement. Regular monitoring and feedback mechanisms will be put in place to ensure that the information disseminated by means of various communication tools is understood and used by all actors.

1.7. Promote multidisciplinary participation of stakeholders who can develop collaborative partnerships, based on the respective comparative advantage in TRM value chain.

A sustainable TRM value chain should be pluralistic in nature or allow for the participation of a multiplicity of actors who can develop collaborative partnerships, based on their respective comparative advantage, between the private sector, NGOs, public institutions including policy, service providers, research, educational and extension institutions. Mapping of actors in the TRM value/supply chain will be done and TRM value/supply chain analysis will be conducted to identify opportunities to improve the performance of the chain that will have to produce and deliver high quality TRM to end users. As actors in the value/supply chain do not work in isolation, their capabilities to share information, ideas, opportunities, problems and even business systems will be built by developing approaches that enhance strategic collaboration for a shared vision of producing quality TRMs. Such approaches will include building trust and commitment, open communication, information sharing, networking, cooperation, partnership and opportunities for mutual benefits as well as continuous improvement in production, processing and delivery of TRMs. Partnership agreements between the NTSC and other public/private actors will be developed with the aim of producing high-quality TRM through such activities as production, protection, processing, storage, propagation, tree breeding, fair trade arrangement and research activities. An effective mechanism for coordination, networking, partnership and information/knowledge sharing will be developed. The main activities will be to create a steering committee, associations or networks of enterprises/cooperatives, and engage the private sector in securing funds for some extension services and research.

Particularly, private actors will be mobilized to participate actively in the TRM business as main national accredited providers. Partnership arrangements in the management of TRM sources, certification and protection will be established, emphasising the benefits that will accrue to them. Incentive mechanisms will be developed to support their investment in a sustainable TRM value/supply chain. Mechanisms for financial and technical support will be put in place so that accredited actors are facilitated to access credits from existing financial institutions in the country, subsidies and seed vouchers from the Government. A secure investment system will be put in place for all TRM operators to provide appropriate TRMs in a fair and attractive TRM markets. Training programmes in the value/supply chain will be designed and conducted to enhance the skills and knowledge of TRM in planning, establishment and management of new TRM, tree breeding and massive propagation of high-quality TRMs.

In the value/supply chain, TRM research will be decentralized in order to combine the scientific approach of the formal sector and responsiveness to the needs of smallholders in the informal sector, which will bring the informal TRM dealers into the formal system. Therefore, research will be designed and implemented to address local constraints in producing adapted TRMs having the desired traits.

Objective 1.8. Develop mechanisms for creation of TRM reserves for use in emergency situations.

With increase in the effects of climate change, the possibility of TRM emergencies is real. Depending on the type and severity, an outbreak could cause significant damage to TRM resources which affect the production and distribution of high quality TRMs. It is therefore important that emergency TRMs be available to improve end-users' access to good quality TRMs through distribution, without having to rely on imported TRMs which, if no care is taken, can bring many problems, including pests, diseases and unsuitable TRMs. The provision of quality TRMs in emergency situations will constitute one of the interventions in the implementation of this Strategy. The intervention strategy will be established on the basis of a diagnostic phase in order to avoid any inappropriate introduction of germplasm during the emergency. An emergency supply in TRM will be developed by establishing formal partnerships with accredited private/public national partners, local partners and NGOs to help acquire sufficient quantities of high quality TRMs that adapt to local agro-ecological conditions. Moreover, this partnership will be extended to TRM research stakeholders to ensure that emergency operations comply with TRM quality standards. Measures will be put in place so that the right TRMs are available and to ensure quality TRM are offered for reforestation, agroforestry, forest landscape restoration and any other tree planting activity. The development of an efficient emergency supply in TRM will involve the following activities:

- Identification of circumstances under which emergency interventions will be needed;
- Determination of the types of interventions needed to support the rehabilitation and restoration of the TRM system;
- Mapping sources of good-quality TRMs to assist in the supply of appropriate diverse genotypes per species from within the country and outside the country;
- Designing cost-effective and focused emergency interventions;
- Identifying and assigning specific roles to TRM stakeholders during the diagnostic, emergency and subsequent rehabilitation phases;
- Developing conservation measures of remaining indigenous and exotic improved TRM storages;

- Developing and dissemination tools for monitoring and evaluation of emergency TRM interventions.

Strategic Goal 2. Develop and implement research programs that improve the availability of genetically appropriate and adapted TRM to support the value chain

Objective 2.1: To diversify the tree species and provenances adapted to different agro-ecological zones of the country and improve the physiological and genetic quality of TRMs to be provided for reforestation, agroforestry and land restoration

The use of a diversity of both indigenous and exotic species in afforestation, agroforestry and forest landscape restoration could be a good strategy to improve their health and productivity while also enhancing resistance to pests and diseases and adaptation to climate change risks. The development of genetically appropriate TRMs relies heavily on research on tree species conducted to ensure the availability of adapted TRMs to provide long-term sustainability. Research is needed in the selection of genetically appropriate tree species and improvement of knowledge of adaptive genetic variation of current tree species in forestry and agroforestry systems. Results of this research can be used to develop the guidelines for selection of TRMs that are adapted to different agroecological zones and other environmental conditions at the planting sites and that are resilient to unpredictable environmental disturbances and climate change. Within these zones and specific sites, investigations are needed to identify traits that enhance establishment and yields at the planting sites. In this respect, the TRMs Strategy envisages three complementary actions below to develop genetically appropriate TRMs and to improve technology for TRM production and distribution.

(1) Development of tree species specific TRMs and seedling production practices that maintain genetic diversity.

The selection of genetically appropriate tree species will be strongly encouraged in order to develop tree species and varieties that match the planting sites in the different agroecological zones of the country and withstand the rapid rate of environmental change. Assisted migration will be envisaged for conservation objectives and for maintaining healthy and productive forests and agroforestry systems. To support the assisted migration programs, provenance and progeny trial zones will be designed over space and time under future climate-change scenarios for both indigenous and exotic key tree species. Research programs based on several indigenous and exotic species will be developed, focusing on needs, interests and tree species preferred by local communities, NGOs and government stakeholders.

Planting strategies for exotic and indigenous species will be improved based on innovative research programs that will address local and national needs. To achieve this, exotic genotypes will be selected based on their adaptability to different agro-bioclimatic zones of Rwanda. An environmental migration range for several exotic species will be established to guide the transfer of TRM depending on their best adaptability in climate change context. The components of tree breeding programs for both exotic and indigenous species will be developed, implemented and evaluated to quantify and qualify the genetic diversity. An exhaustive scientific follow up of the tree seed stands established based on promising tree species and provenances, and the different types of provenance/progeny trials will be maintained and monitored regularly.

Many studies will be developed to improve understanding of factors limiting the establishment of exotic tree seed stands and orchards, evaluate the performance of seed/seedlings in nurseries and investigate the reproductive biology of forest and agroforestry tree species and provenances. Moreover, studies aimed at assessing the ecological and economic impacts of using improved exotic

tree species and provenances in some agro-bioclimatic zones will be conducted to weigh the pros and cons of using these improved materials in forestry and agroforestry.

(2) *Accelerating the improvement process of adapted tree species*

The greatest impact will be achieved if efforts are concentrated on a limited number of woody species. Genomic selection tools will be introduced and used to accelerate the improvement process in tree breeding programs for few key tree species including *Pinus* and *Eucalyptus* genera, for which large genomic studies have already been performed and are now well-documented. Initially, genetic markers will be used to identify and characterize tree genetic resources, i.e. to analyse genetic diversity and to identify tree collections for conserving biodiversity. The internal rate of return on the investment of using genomic tools in tree improvement research will be determined, to measure the profitability of investing in the use of these tools.

(3) *Enhanced conservation of tree diversity and better functioning of TRMs supply system*

The domestication of indigenous tree species will enable to capture the genetic traits of superior trees and develop a range of cultivars to suit the different agroecological zones of Rwanda. An environmental migration range for several indigenous species will be established to guide the transfer of TRM depending of their best adaptability in climate change context. Research proposals will be developed and implemented to study the physiology, genetics and phenology of key indigenous species in the country. In agroforestry participatory domestication strategies will be developed with the farmers. To this end, farmers will be trained in various vegetative propagation techniques, such as air layering or marcotting and basic nursery skills. Participatory domestication will empower the farmers and maintain their right to indigenous knowledge and germplasm, as proposed by the Convention on Biological Diversity.

Objective 2.2. To improve the seed storage conditions of recalcitrant and orthodox tree seeds

Tree seeds are stored as important genetic resources for afforestation, agroforestry, ecosystem restoration, conservation and domestication. However, there has been little research on seed germination and storage behaviour of many tree species, especially indigenous tree species of the country. It is envisaged that reliable but cheap seed storage technologies could enhance germination and reduce forest genetic resource erosion or extinction. This review takes stock of the knowledge gaps on seed germination and storage behaviour of some important tree species in order to develop technologies that will enhance seed standard storage conditions and very-long term storage of tree seeds. Improvements in tree seed conservation will be achieved by developing adapted pre-treatment methods of various trees under a controlled moisture environment and by identifying and developing processes to control pest and diseases in storage rooms.

While orthodox seeds tolerate relatively long storage periods, many recalcitrant tree seeds have a short storage period and are hence much more likely to be lost during storage. Emphasis will be put in enhancing the germination capacity of the latter through improved long-term term storage conditions. Under this focus, the research activities to be implemented include adapting pre-treatments before cryopreservation of some high-quality clones of key species and validating regularly the genetic/quality of cryopreserved clones.

Objective 2.3. Develop and promote the large-scale propagation of high-value trees species for mass production of high-quality reproductive materials

Currently, lack of good quality tree reproductive materials is a major limitation to tree growing. Tree planting programmes rely on small tree nurseries with very limited resources for mass production of

planting materials. More recently, the government has resorted to seedling production through small scale contractors. However, due to lack of sufficient resources and technical know-how, the few seedlings currently produced under these contracts are of poor quality. At the moment, the target individual and community lands for tree growing are so seriously degraded that they require very good planting material for successful tree growing. There is a clear need for quantum increase in nursery seedling production of good quality seedlings of appropriate tree species for planting in the country. There have only been a few methods developed for raising seedlings of some valuable tree species, especially indigenous ones and tree species which are difficult to raise from seed. Furthermore, these methods have not been applied for large-scale production of planting materials. In the implementation of this strategy, appropriate methods for mass production of high quality tree planting materials will be developed. Under this objective, the activities to be performed will include investigations on the application of biotechnology (in-vitro propagation) in production of planting materials for some valuable indigenous species, developing vegetative propagation methods for some tree species (mainly indigenous tree species), development of methods that improve the germination capacity of seeds in the tree nurseries and adaptability of tree seedlings to planting sites.

Objective 2.4. To develop capacity and mobilize resources for tree breeding and tree seed research

In Rwanda, forestry research does not provide all the information and responses to the challenges of producing high quality tree planting materials that will result into healthy and productive forest and agroforestry plantations in the current state of rapidly changing climates. The main constraints to more effective and responsive forestry research include the institutional organization and coordination, insufficient financial support and lack of adequate research capacities. In efforts to conduct quality research in TRM, a resource mobilization strategy will be developed to attract resources from a larger range of partners. Priority areas for research and resource partnerships will be established with a focus on increasing pooled resources from donors and government earmarked funding. Competitive funding, through writing TRM research proposals, will be one the tools to be used in attracting research funds.

Strategies for bridging the gaps in research capacity will be developed through academic and specialized trainings in specific areas such as biotechnology, tree breeding and molecular biology. Furthermore, partnerships between TSC and diverse research centres of excellence, universities and technical schools will be established to develop co-supervision programs, manage experiments, transfer knowledge, skills and practices to stakeholders, develop and promote technical and academic programs related to TRM research, etc. Partnerships will also be extended to the provision of research infrastructure, services and technical support to strengthen the capacity of scientists and technicians in order to conduct high-quality research in TRM related fields.

Objective 2.5. To develop strategies for dissemination of research results

The dissemination of key research findings is a crucial step in community-based research. TRM researchers will have the ethical obligation to ensure that research results are disseminated to the TRM actors, clients (end-users), other stakeholders and the general communities at national, regional and international levels. In efforts to increase ease and efficiency, a strategic dissemination approach will be developed and implemented to distribute salient research results to various end-users. An efficient dissemination plan will be developed initially to address the needs of the targeted audience, using appropriate language, and adapted dissemination methods (e.g. written text including illustrations, graphs and figures; electronic and web-based tools; and oral presentations at community meetings and scientific conferences). Stakeholder meetings will be organized to present research findings. These results will be also presented by researchers in national and/or international congresses. Policy briefs will be developed to disseminate evidence-based information

for decision-making in Rwanda. Key research results will be published in national and international peer reviewed journals.

5 IMPLEMENTATION, MONITORING AND EVALUATION

The NTSS will be implemented over a period of 10 years by MINILAF through Rwanda Water and Forestry Authority (RWFA), and the various stakeholders implicated in different activities. A clear assignment of responsibilities and roles of public and private stakeholders is necessary to allow for better coordination of the activities (Annexes 3 & 4). However, to successfully achieve the objectives, implementation will be done under the supervision of an effective management unit that must, at all times, have a reliable and comprehensive overview of the implementation progress, arising issues, necessary adjustments and important considerations for the forthcoming review. For the effective implementation of the strategy, it is recommended to bring together both forestry research and forest planting materials unit into one department at the authority in charge of forestry.

A Monitoring and Evaluation Framework will be created in order to harmonize the actions of every stakeholder and give a strategic direction to the process. An adequate sequencing, from short term to medium term interventions, will have to be put in place considering the relatedness of actions under each section of the value/supply chain intra & inter-goals. To this end, the coordinating unit will also be in charge to review and update the strategy by:

- measuring the effectiveness of the activity (mechanisms and procedures) carried out under the plan of action to attain the strategy objectives;
- Implementing an iterative and cyclical process in which successive actions will be upgradable. During implementation, the number of stakeholders, including ones not so far identified or engaged, is likely to change (some stakeholders will fall out while others will get involved).

The sustainable production and distribution of high quality TRM should include regular monitoring and evaluation, supported by research results in the supply chain. To facilitate monitoring, the following activities will be undertaken: development of annual action plans including milestones and indicators; development and implementation of district, provincial and national monitoring programmes to assess the impacts of TRMs production, distribution and quality assurance; reporting on progress and information sharing; building the capacity and drawing on the knowledge of actors in TRM supply chain with respect to undertaking monitoring exercises.

The director of the TSC will be a full time employee who will oversee the implementation of the strategy. The execution of the strategic plan will be evaluated against appropriate performance indicators (e.g. technical, financial indicators) specified in the logical framework. The director of the TSC will be supported by an implementation and evaluation committee. An advisory board from independent national and international experts will be hired for the evaluation of large research projects.

Assessment of outcomes will have to be systematized and validated to have a reliable basis on which to conduct the process for reviewing and updating the strategy and therefore make it more effective. Annual reports on the progress and the recognized achievement will be published to provide feedback mechanisms for all partners to report progress and achievements. The actions to adapt action plan will be evaluated, reviewed and finally endorsed.

A database will be developed to accommodate all indicators by which progress will be measured. It will include an annual schedule of actions within the TRM Strategy period (2018-2024) and clearly stated responsibilities of stakeholders (i.e. detailed roles and functions of actors in each link of the

value/supply chain), tools and infrastructure used to implement, limitations and feasibilities, priorities and deadlines.

During the first year, an annual plan as well as quarterly plans will be developed to adjust the monitoring and evaluation tools. All departments will organize, under the supervision of their heads, a quarterly meeting to evaluate activities achieved in the previous quarter as compared to what had been planned.

The tables below consist of activity matrices and budget matrices for the 2018-2024 National Tree Reproductive Materials Strategy's Goals.

5.1 Log frame for the National Tree Reproductive Materials Strategy for Rwanda for 2018-2024

Expected outcomes	Outputs	Activities	Indicators	Time-frame
Goal 1. Strengthen the production and supply capacity in genetically appropriate TRM				
1.1. Legal framework for forest and agroforestry TRM reviewed	1.1.1. Current policy opportunities and constraints in TRM identified, documented and disseminated	1.1.1.1. Review of the policy instruments governing TRM production and distribution	List of policy issues identified	2018
		1.1.1.2. Facilitating policy dialogue fora	<ul style="list-style-type: none"> Number and type of fora for policy dialogue Number and type of coalitions built for shared policy objectives 	2018 - 2019
		1.1.1.3. Development of policy guidelines and recommendations for TRM production, distribution and trade	<ul style="list-style-type: none"> Policy briefs developed List of recommendations formulated 	2018-2019
		1.1.1.4. Dissemination the updated legal instruments	<ul style="list-style-type: none"> Number and types of awareness campaigns conducted Types and number of materials disseminated 	2019-2021
1.2. Enhanced supply of genetically appropriate and adapted TRMs	1.2.1. Needs and preferences of TRM identified	1.2.1.1. Need assessment	TRMs needs are identified and agreed with stakeholders	2018-2019
		1.2.1.2. Publish this list of needs in a sub-section of the National Tree Seed Registry	Priority needs in TRMs included in and regularly updated in the National Tree Seed Registry	2018-2024
	1.2.2. High quality TRM sources diversified	1.2.2.1. Identify national and international high-quality TRM sources from diverse locations and accredited service providers	High quality TRM sources are identified	2018-2024
		1.2.2.2. Organize importation of high-quality seeds based on need assessment of TRMs	Sufficient quantities of high quality TRM are available for afforestation and agroforestry practices	2018-2024
	1.2.3. Existing tree seed stands rehabilitated	1.2.3.1. Carry out silvicultural works to improve the current sites identified as good seed sources	At least 25 ha of tree seed stands rehabilitated	2018-2019
		1.2.3.2. Carry out silvicultural works to improve high production potential of young seed sources	About 120 ha of tree seed stands rehabilitated	2019-2022
		1.2.3.3. Carry out silvicultural works and replace species on current sites identified as unusable seed sources	At least 70 ha of tree seed stands converted into healthy and productive seed stands	2020-2024
	1.2.4. New tree seed sources established across Rwanda	1.2.4.1. Carry out a national inventory of public and private land for establishment of new tree seed stands	Area (ha) for tree seed sources establishment and their locations	2018-2019
	1.2.5. New national intraspecific orchards established from high-quality intraspecific seeds to target a broad adaptation	1.2.5.1. Establish intraspecific tree seed stands from high-quality imported TRM and selected for multiple adaptive traits	25 New intraspecific tree seed stands established	2018-2020
		1.2.5.2. Select plus-trees in national intraspecific tree seed stands to perform controlled/uncontrolled crosses and establish progeny trials	30 progeny trials established	2023-2024
		1.2.5.3. Establish three different types of provenance trials for support assisted migration programs from best clones or families selected from first provenance and progeny trials	Four new local intraspecific orchards are established	2024
		1.2.5.4. Perform a regular follow of each trial site to apply adequate silvicultural techniques	59 well-managed TRM sites	2018-2024
	1.2.6. New local intraspecific orchards established from high-quality intraspecific seeds/ecotypes to target a narrow adaptation to specific agro-bioclimatic zones	1.2.6.1. Assess and select from the first year of the strategy high-quality ecotypes with a high genetic diversity within local populations and targeting specific adaptive traits for every species	Number of ecotypes selected per tree species and local population	2018-2021
		1.2.6.2. Establish local intraspecific tree seed stands from large number of ecotypes selected for a narrow adaptation to more specific areas	16 local intraspecific TRM stands established	2019-2023

		1.2.6.3. Establish local comparative tests between unselected, selected ecotypes and high-quality imported seeds to convince visually the smallholders	16 comparative trials set up	2019-2023
		1.2.6.4. Select plus-trees in local intraspecific tree seed stands to perform controlled/uncontrolled crosses and establish progeny trials	Number of plus-trees selected per species; 24 established progeny trials	2025-2024
		1.2.6.5. Set up different types of provenance trials for support assisted migration programs from best clones or families selected from first provenance and progeny trials	First 8 new local intraspecific orchards established	2024
		1.2.6.6. Perform a regular follow of each trial site to apply adequate silvicultural techniques	64 well-managed TRM sites	2020-2024
	1.2.7. New tree seed stands delivering high-quality interspecific hybrid seeds with complementary adaptive traits established and managed regularly	1.2.7.1. Establish interspecific tree seed stands from imported high-quality seeds of pure species	28 interspecific tree seed stands established	2018-2020
		1.2.7.2. Select plus-trees in national interspecific tree seed stands (see 1.2.8.1) to perform controlled crosses and establish progeny trials	Number of plus-trees selected for each species; At least 32 progeny trials established	2023-2024
		1.2.7.3. Establish assisted migration trials from best clones and families selected	First 8 established assisted migration trials from selected hybrid TRMs	2024
		1.2.7.4. Perform a regular follow of each trial site to apply adequate silvicultural techniques	68 well-managed TRM sites	2019-2024
1.3. Measures to protect TRM quality developed and implemented	1.3.1. A TRM Traceability system allowing the tracking of all TRM across the Rwanda to respond to the needs of a validation and quality control program for each stage established	1.3.1.1. Develop and operationalize a computerized TRM monitoring data system	Types of information put in the Traceability system	2018-2019
		1.3.1.2. Conduct training sessions and disseminate tools associated to the TRM traceability system	<ul style="list-style-type: none"> Number and types of training conducted Types and number of tools delivered Number of trained people trained on the use of the traceability system 	2018-2024
	1.3.2. Accredited service providers identified	1.3.2.1. Develop an open-access governmental web platform linked to the NTSR, quality standards to identify capacities of TRM	Web platform developed;	2018-2024
		1.3.2.2. Carry out a competency assessment of applicants for TRM accreditation		2019-2024
	1.3.3. Genetic Identity of all TRM validated	1.3.3.1. Develop protocols of genetic identity control, through genetic tests based on intraspecific or interspecific molecular markers allowing to characterize pure or hybrid seed lots	Protocols of genetic quality control available	2018-2024
		1.3.3.2. Perform regularly field controls by randomly seed samplings to verify the seed identity		2018-2024
	1.3.4. Good physiological and physical qualities of TRMs determined	1.3.4.1. Develop protocols for testing and maintaining physiological and physical qualities of tree seed during all handling stages of TRMs	Protocols established for physiology & physical quality control	2018-2024
	1.3.5. Massive production by clonal reproduction of high-quality seedlings from imported high-quality TRM developed	1.3.5.1. Develop protocols for massive reproduction of imported high-quality TRM by cutting after selection of best clones	Protocols developed for imported high-quality clones	2018-2024
	1.3.6. Quality conservation of improved parental individuals and their progeny initiated	1.3.6.1. Develop protocols of conservation for each species to conserve improved parental individuals and progeny	Protocols established for conservation of improved populations	2018-2024
		1.3.6.2. Perform a massive propagation by cuttings of all clones and families selected for their best adaptive traits	Number of clones and families propagated by cutting; Number of trees in each clone and family	2018-2024

	1.3.7. Tree seed sites and nurseries protected against damages caused by biotic and abiotic factors.	1.3.7.1. Identify, list and regularly up-date pests and diseases, that may affect TRMs	Listing of identified pests & diseases	2018-2024
		1.3.7.2. Develop firewall zone around all tree seed sources and tree seed trials	Put in place firewall zone for every tree seed stands, seed orchards, TRM trials	2018-2024
		1.3.7.3. Put wire fencing around the more vulnerable sites: begin by the more accessible sites by animals, human activities.	Put in place wire fencing in relevant sites	2018-2024
		1.3.7.4. Put advertising boards including the description and goal of the site, but also the fine amount for degradations	Put in place advertising boards on all tree seed stands, seed orchards, TRM trials	2018-2024
		1.3.7.5. Put in place a reliable and recorded warning system involving all stakeholders from local to national levels and vice versa	Operational warning system	2018-2024
	1.3.8. Certification of tree seeds improved after selection	1.3.8.1. Perform a careful monitoring of, by pre-testing, the quality of TRM at each stage of the supply chain	Performed quality control pre-tests before certification	2022-2024
		1.3.8.2. Submit the improved seeds for certification by transparent and independent bodies	Certified improved TRM	2023-2024
1.4. Capacity of the National Tree Seed Centre strengthened	1.4.1. A new institutional structure, including reorganization of staff among DFNC, FSU and NTSC set up	1.4.1.1. Oversight of FSU administration, staff recruitment and information dissemination about TRMs	Number of new staff recruited	2018-2024
		1.4.2. Adequate Infrastructural capacities for processing, conservation and research at NTSC established	1.4.2.1. Feasibility study for infrastructure needs of the NTSC	One detailed feasibility study report
	1.4.3. Facilities for collection, processing, testing, storage, security and propagation of TRM at the NTSC set up and maintained	1.4.2.2. Building and Rehabilitation of infrastructures of the NTSC	Number and types of NTSC's infrastructures rehabilitated New infrastructures developed	2018-2019
		1.4.3.1. Put in place adequate equipment and materials in the NTSC	List of equipment and materials secured for tree seed stand management, collection, processing, testing, storage, NTSC management, security	2018-2019
	1.4.4. Human resources for support TRM for development in FSU strengthened	1.4.3.2. Maintenance of equipment in the NTSC	Types and number of equipment maintained	2018-2024
		1.4.4.1. Organize national and international trainings of FSU/NTSC's staff	Number (and type) of training given to TSU/NTSC staff Number of FSU/NTSC staff trained	2018-2024
		1.4.4.2. Implement specific training sessions in function of roles/task of each actor in the FSU/NTSC via detailed action plan	Training plan produced Number (and type) of training given to actors Number of actors trained	2018-2024
		1.4.4.3. Produce training and extension materials for the establishment and management of tree seed stands	Number and types of training and extension materials produced in the management of tree seed stands	2018-2024
1.5. Capacity of other public and private actors in TRMs value chain developed and strengthened	1.5.1. Adequate infrastructure capacity for processing, conservation, massive production and research at provincial and district level put in place	1.5.1.1. Building four private decentralized centres (Provincial Tree Seed Centres (PTSC)) managed by private partners under NTSC's supervision	4 Provincial Tree Seed Centres available	2018-2019
		1.5.1.2. Create a network of 30 accredited District field school nursery (one per district) managed by private local partners under the supervision of the NTSC	30 accredited District Field School Nurseries (one per District) available	2018-2020

		1.5.1.3. Equip the forestry research department with appropriate equipment to meet the need of TRM	Department fully equipped	2018
	1.5.2. Facilities for ordering, storage, dispatching, massive reproduction, and following up of TRM put in place and maintained regularly	1.5.2.1. Facilitate financial accessibility to private partners for putting in place adequate equipment and materials in the PTSCs	4 full-equipped PTSCs available	2018-2019
		1.5.2.2. Facilitate financial accessibility to private partners for the maintenance of facilities in the PTSCs	4 operational PTSCs available	2019-2024
		1.5.2.3. Avail adequate equipment and materials in the 30 District nursery field schools	30 full-equipped District Field School Nurseries	2018-2021
		1.5.2.4. Maintenance of equipment in District nursery field schools	30 operational District Field School Nurseries	2018-2024
	1.5.3. Capacities and skills of TRM private dealers acting at national level developed	1.5.3.1. Develop a training program for key private actors in charge of TRM importation and seed collection	Training plan developed Training manuals developed List of private actors to be trained	2018-2024
		1.5.3.2. Publish and disseminate regularly recommendations and comments from private dealers to public partners and vice versa	List of relevant recommendations and comments annually published	2018-2024
	1.5.4. Local partners' skills in TRM production, management and distribution enhanced	1.5.4.1. Develop additional Farmer's Field Schools in specific districts to support the transfer of information and knowledge on agroforestry seeds from the national to the local level and vice versa	Number of FFS groups in agroforestry established, disaggregated by district Number of training organized, Training reports Number of agroforestry FFs facilitators trained	2020-2024
		1.5.4.2. Develop Forest Farmer's field schools in every district to support the transfer of information and knowledge on Forestry seeds from the national to the local level and vice versa	Number of FFS groups in forestry established, disaggregated by district Number of training organized, Training reports Number of FFFs facilitators trained	2018-2024
		1.5.4.3. Publish and disseminate regularly recommendations and comments via pertinent IT in order to make adjustments in real-time and improve the overall system	List of relevant recommendations and comments made annually by local partners to RWFA and vice versa	2019-2024
	1.5.5. Academic and research partners in TRM enhanced	1.5.5.1. Develop national and international collaboration agreements with University of Rwanda, NTSC, RAB, RFRI	At least 6 agreements developed between NTSC and RAB (Genebank), UR (Biotechnology Centre), 3 international universities (Kenya, South Africa, Brazil), research institutes (KEFRI), etc.	2018-2024
1.5.5.2. Develop programs to strengthen the learning process in forest and agroforestry TRM sectors		Enhanced academic programs in forestry, agroforestry, tree genetic & genomic, etc.	2018-2024	
1.5.5.3. Publish and disseminate regularly recommendations and comments of academic partners via pertinent IT in order to make adjustments in real-time and improve the overall system		List of relevant recommendations and comments made annually by academic and research partners to RWFA and vice versa	2019-2024	
1.6. Management, Extension and Communication Services for Public and Private Actors in TRM Supply Chain strengthened	1.6.1. A National Tree Seed Register developed	1.6.1.1. Design a network database for multiple TRM stakeholders' records and linked to other relevant databases/registries	1 network database model developed and regularly updated	2018-2024
		1.6.1.2. Publish and disseminate specific guidelines about the use of this NTSR.	Guidelines produced and disseminated; List of the beneficiaries of the guidelines.	2019-2024
	1.6.2. Other registries/databases in synergy with the NTSR developed	1.6.2.1. Develop a database of biological features, phenotypic, genetic and physiological characteristics of every forest and agroforestry species in Rwanda	4 databases available for biology, physiology, phenology and phenotypic features of forest and agroforestry tree species	2019-2023
		1.6.2.2. Compile all information and results about public and private provenance and progeny trials in a database	Database developed	2018-2024

		1.6.2.3. Design a Tree Pest & Disease Registry	1 computerized registry of Pests and Diseases, always up to date and associated to NTSR	2018
		1.6.2.4. Registry of Tree Species under Moratorium	Availability of the Registry	2018
	1.6.3. Efficient and interconnected communication systems developed	1.6.3.1. Organize Interpersonal and group communications meetings between FSU/NTSC and all stakeholders in forest and agroforestry seed sector	Number of meeting organized; Attendance list, minutes of meetings held	2018-2024
		1.6.3.2. Develop awareness campaigns to disseminate regularly information with a particularly emphasis during the first two years of the strategy.	10 awareness campaigns across country	2018-2024
		1.6.3.3. Design and Integrate in the diverse developed websites/registries a FAQs and discussion page of information aimed at a large audience	FAQs page developed	
		1.6.3.4. Develop decentralized communication services within each district, each private company and each entity involved in research and education	Types of communication services provided	2018-2024
		1.6.3.5. Publish scientific findings in local, national and international journals	List of Journal articles published	
		1.6.3.6. Elaborate technical guidelines/manuals describing procedures, modalities, technical specification and necessary templates to organize importation of TRM	Types and number of produced guidelines and manuals	2018-2024
		1.6.3.7. Publish seed market regulations, benefits of participatory approach, benefits of breeding, etc. on the FSU / NTSC website and brochures distributed at the district level.	Up-to-dated TRM trade data published online in the NTSR; Number of brochures distributed at district level and list of beneficiaries	2018-2024
1.7. Multidisciplinary participation of stakeholders in TRM value chain promoted	1.7.1. Private partners mobilized at national and local level in multidisciplinary management of forest and agroforestry TRM	1.7.1.1. Carry out mobilization campaigns to attract the private sector in TRM business.	Mobilization meetings organized	2018-2023
		1.7.1.2. Carry out mobilization campaigns to attract local actors, cooperatives and smallholders to become local partners in the formal TRM supply.	Mobilization meetings organized for local private partners	2018-2023
	1.7.2. Incentive mechanisms developed to support private sector	1.7.2.1. Put in place financial and technical supports to assist the large private seed sector	Number of supported big private companies	2018-2022
		1.7.2.2. Put in place financial and technical supports to assist the local private seed sector	Number of supported local private companies	2018-2024
	1.7.3. A fair and attractive Tree Seed market developed	1.7.3.1. Make a cost-benefit analysis of each seed source to determine how costs and benefits can be shared within the community and between the local community and the forest local and national administration.	Cost-Benefit Analysis Report	2018-2021
		1.7.3.2. Regulate seed prices to prevent fluctuations due to over or under production.	TRM trade supported (see output 1.1.1)	2018
		1.7.3.3. Develop fair and attractive trade agreements based on realistic royalties between communities and government or communities and private operators	Signed and implemented agreements/MoUs	2018-2022
		1.7.3.4. Establish specific targets between growers and customers through dealers based on actual needs, costs and seed categories, while maintaining a fair price/ quality ratio for all	Annual plans available	2018-2024

		1.7.3.5. Establish a direct or indirect remuneration system for small farmers devoting the necessary time to monitoring and maintenance of provenance sites or progeny tests, from which they will not derive any direct benefit	Developed remuneration guidelines	2018-2024
	1.7.4. Strong partnerships created between the NTSC and other public/private actors	1.7.4.1. Elaborate diverse partnership agreements: The development of MoU between the NTSC and other public/private actors	Developed and signed agreements between NTSC, other public institutions and private sector	2018-2019
	1.7.5. An effective mechanism for coordination, networking, partnership and information/knowledge sharing developed	1.7.5.1. Create and operationalize a steering committee	Steering committee (SC) meetings organized; Minutes of SC meetings	2018-2024
		1.7.5.2. Creation of associations or networks of enterprises/cooperatives	Statutes of the Associations and Networks of enterprises and cooperatives	2018-2019
		1.7.5.3. Decentralize extension services	Types of extension services provided by private actors	2019-2022
1.8. Mechanisms for TRM emergencies developed	1.8.1. An efficient TRM emergency supply developed	1.8.1.1. Identify under what circumstances emergency interventions will be needed	A listing of specific circumstances before starting the emergency protocols	2018-2019
		1.8.1.2. Determine what types of interventions can be used to support the rehabilitation and restoration of the seed system	Report defining intervention in emergency situations Built scenarios to be used in emergency situations	2018-2019
		1.8.1.3. Mapping sources of good-quality seeds to assist in the supply of appropriate diverse genotypes per species from local sources and outside Rwanda but within the region	Seed source maps	2019-2024
		1.8.1.4. Make a diagnosis of the situation so that the assistance is cost-effective and focused on the critical problems	Report defining the required assistance	During emergency situation
		1.8.1.5. Respond to the emergency through sustainable scenarios based on the principles of in-depth knowledge acquired over time	Applied scenarios in emergency situations	During emergency situation
		1.8.1.6. Encourage conservation of remaining indigenous and exotic improved seed storages	TRM storage sites developed across Rwanda	2023-2024
		1.8.1.7. Provide to practitioners' advices for evaluating seed systems and seed security, design, monitoring and evaluating seed assistance interventions	Specific guidelines and checklists developed and disseminated to practitioners	2020-2024
Goal 2. Develop and implement research programs that improve the availability of genetically appropriate and adapted TRM to support the value chain				
2.1. Planting strategies improved for exotic and indigenous species, based on innovative research programs that result on local and national needs	2.1.1. Selected exotic genotypes adapted to different agro-ecological zones of Rwanda	2.1.1.1. Develop components of Tree Breeding Programs for exotic species	Well-defined components to perform several tree breeding programs for exotic species	2018-2024
		2.1.1.2. Perform an exhaustive scientific follow up of the tree seed stands and the different types of provenance/progeny trials put in place for intraspecific and interspecific exotic species	Several tree traditional breeding research programs in progress for key exotic species	2018-2024
		2.1.1.3. Determine ecological and economic impacts of using improved exotic tree species and provenances in some agro-bioclimatic zones	Several research projects in progress to better weight up the pros and cons about the use of improved populations for exotic species	2023-2024
		2.1.1.4. Design studies to enhance understanding of factors limiting the establishment of exotic tree seed stands and orchards evaluate the performance of seed/seedlings in nurseries and investigate the reproductive biology of forest and agroforestry tree species and provenances.	Several research projects in progress about factors limiting the establishment of exotic species and their performance in nurseries Developed research protocols available	2019-2024
		2.1.2. indigenous tree species domesticated for genetic resources conservation	2.1.2.1. Develop research projects to study physiology, genetic & phenology of indigenous tree species	On-going research projects; List of indigenous tree species under observation Database on physiology and phenology of indigenous tree species

		2.1.2.2. Establish components of Tree Breeding Programs for exotic and indigenous trees species	Well-defined components to perform several tree breeding programs for indigenous species	2018-2024
		2.1.2.3. Perform an exhaustive scientific follow up of the tree seed stands and the different types of provenance/progeny trials	Several tree traditional breeding research programs in progress for key indigenous species	2018-2021
		2.1.2.4. Determine ecological and economic impacts of using improved tree varieties in some agro-ecological zones s	Several research projects in progress to better weight up the pros and cons about the use of improved populations for indigenous species	2023-2024
		2.1.2.5. Develop research protocols for understanding the factors limiting the establishment of indigenous tree seed stand/seed and the performance of their seed/seedlings in nurseries	Several research projects in progress about factors limiting the establishment of indigenous species and their performance in nurseries	2019-2024
	2.1.3. Improved clones selected by means of genomic selection tools	2.1.3.1. Determine the internal rate of return on the investment of using genomic tools in research on the improvement of some <i>Pinus</i> and <i>Eucalyptus</i> species	Economical study in progress about the use of genomic tools in tree breeding programs in Rwanda	2020-2024
		2.1.3.2. Introduce genomic tools in breeding programs for one or two <i>Pinus</i> species	Underway advanced breeding by genomic selection for 1 or 2 <i>Pine</i> species	2020-2024
		2.1.3.3. Introduce genomic tools in breeding programs for one <i>Eucalyptus</i> species	Underway advanced breeding by genomic selection for at least one <i>Eucalyptus sp.</i>	2020-2024
2.2. Improved seed conservation	2.2.1. Seed standard storage conditions improved	2.2.1.1. Identify pre-treatment methods for a controlled storage moisture condition per each species	Protocols for conservation on short, medium and long term storage of indigenous and exotic species seeds;	2019-2024
		2.2.1.2. Identify methods to control pest and diseases in storage rooms	Best pre-treatment methods identified for each species	2019-2024
	2.2.2. Very-long term storage conditions of tree seeds enhanced	2.2.2.1. identify pre-treatment methods before cryopreservation for some high-quality clones of key species	Optimized protocols developed for cryopreservation	2019-2024
		2.2.2.2. Validating regularly the genetic/quality of cryopreserved clones		2019-2024
2.3. Improved large-scale propagation of high-value trees species for mass production of high-quality seedlings	2.3.1. species adapted to cutting or grafting techniques identified	2.3.1.1. Determine vegetative propagation method of some key tree species	Number of species adapted to different vegetative propagation techniques (ex. cutting, grafting)	2020-2024
	2.3.2. Specific clones adapted to in vitro propagation identified	2.3.2.1. Developing in vitro culture technology for key species	In-vitro protocols developed Number of lines per species propagated by in vitro culture	2022-2024
	2.3.3. Improved adaptability of tree seedlings	2.3.3.1. Enhancing the establishment capacities in nursery and field	Optimized conditions for each species	2019-2024
2.4. Capacity for TRM research increased	2.4.1. Research funds mobilized and skills to support research programs increased	2.4.1.1. Mobilize research funds from competitive grants' proposals	Research concept notes and project documents developed and submitted for funding Resources mobilized per project	2018-2024
		2.4.1.2. Develop local, national, regional and international partnerships	Meetings and visits organized	2018-2024
2.5. National & International Scientific Visibility enhanced	2.5.1. TRM research results disseminated	2.5.1.1. Publishing results in national or international reviews	Publications, workshops, reports, etc.	2019-2024
		2.5.1.2. Organizing stakeholder meetings to present research results	Meetings organized, Minutes of meetings	2019-2024
		2.5.1.3. Presenting results in national and/or international congress	Congress participation and reports	2019-2024

5.2 Budget matrix of the 2018-2024 Rwanda National Tree Reproductive Materials Strategy (in millions FRW)

GOALS	Expected outcomes	Outputs	2018	2019	2020	2021	2022	2023	2024	Total	
Goal 1. Strengthen the production and supply capacity in genetically appropriate TRM											
	1.1. Legal framework for forest and agroforestry TRM reviewed	1.1.1. Current policy opportunities and constraints in TRM identified, documented and disseminated	81	31	16	16	1	1	1	147	
	1.2. Enhanced supply genetically appropriate and adapted TRMs	1.2.1. Needs and preferences of TRM identified	26	16	11	11	11	11	11	97	
		1.2.2. High quality TRM sources diversified	82	62	54	54	54	54	52	412	
		1.2.3. Existing tree seed stands rehabilitated	25	85	102	102	102	42	42	500	
		1.2.4. New tree seed sources established across Rwanda	20	15						35	
		1.2.5. New national intraspecific orchards established from high-quality intraspecific seeds to target a broad adaptation	75	383	180	38	38	203	263	1,180	
		1.2.6. New local intraspecific orchards established from high-quality intraspecific seeds/ecotypes to target a narrow adaptation to specific agro-bioclimatic zones	20	140	145	150	135	230	240	1,060	
		1.2.7. New tree seed stands delivering high-quality interspecific hybrid seeds with complementary adaptive traits established and managed regularly.	100	410	235	50	50	260	265	1,370	
	1.3. Measures to protect TRM quality developed and implemented	1.3.1. A TRM Traceability system allowing the tracking of all TRM across the Rwanda to respond to the needs of a validation and quality control program for each stage established	113	5	5	5	5	5	5	143	
		1.3.2. Accredited service providers identified	15	11	11	5	5	5	5	57	
		1.3.3. Genetic Identity of all TRM validated	25	110	110	110	65	65	65	550	
		1.3.4. Good physiological and physical qualities of TRMs determined	5	10	10	10	10	5	5	55	
		1.3.5. Massive production by clonal reproduction of high-quality seedlings from imported high-quality TRM developed	40	40	40	40	40	40	40	280	
		1.3.6. Quality conservation of improved parental individuals and their progeny initiated	25	25	25	25	25	25	25	175	
		1.3.7. Tree seed sites and nurseries protected against damages caused by biotic and abiotic factors.	15	15	12	4	4	4	4	58	
		1.3.8. Certification of tree seeds after selection improved					20	20	30	50	
	1.4. Capacity of the National Tree Seed Centre strengthened	1.4.1. A new institutional structure, including reorganization of staff among DFNC, FSU and NTSC set up									
		1.4.2. Adequate Infrastructural capacities for processing, conservation and research at NTSC established	162	100							262
		1.4.3. Facilities for collection, processing, testing, storage, security and propagation of TRM at the NTSC set up and maintained	150	32.5	32.5	7.5	7.5	7.5	7.5	245	
		1.4.4. Human resources for support TRM for development in FSU strengthened	12.5	12.5	12.5	12.5	12.5	12.5	12.5	87.5	
1.5. Capacity of other public and private actors in TRMs value chain developed and strengthened	1.5.1. Adequate infrastructure capacity for processing, conservation, massive production and research at provincial and district level put in place	80	142	204	102					528	
	1.5.2. Facilities for ordering, storage, dispatching, massive reproduction, and following up of TRM put in place and maintained regularly	16.5	35.2	48	27	4.5	4.5	4.5	140.2		
	1.5.3. Capacities and skills of TRM private dealers acting at national level developed	10	10	10	10	10	10	10	70		

		1.5.4. Local partners' skills in TRM production, management and distribution enhanced	4.5	7.5	12	12	12	12	12	72
		1.5.5. Academic and research partners in TRM enhanced	15	38	38	38	38	38	38	243
	1.6. Management, Extension and Communication Services for Public and Private Actors in TRM Supply Chain strengthened	1.6.1. A National Tree Seed Register developed	20	4	4	4	4	4	4	44
		1.6.2. Other registries/databases in synergy with the NTSR developed	17.5	22.5	22.5	22.5	12.5	2.5	2.5	102.5
		1.6.3. Efficient and interconnected communication systems developed	38	22	15.4	15.4	15.4	15.4	15.4	137
	1.7. Multidisciplinary participation of stakeholders in TRM value chain promoted	1.7.1. Private partners mobilized at national and local level in multidisciplinary management of forest and agroforestry TRM	20	20	9	7	4	4		64
		1.7.2. Incentive mechanisms developed to support private sector	20	20	15	10	10	5	4	84
		1.7.3. A fair and attractive Tree Seed market developed	37	30	28	8	8	5	5	121
		1.7.4. Strong partnerships created between the NTSC and other public/private actors	5	5						10
		1.7.5. An effective mechanism for coordination, networking, partnership and information/knowledge sharing developed	12	7	5	5	5	3	3	40
	1.8. Mechanisms for TRM emergencies developed	1.8.1. An efficient TRM emergency supply developed	25	55	3	3	8	8	13	115
	Total Budget for Goal 1		1,312	1,921.2	1,414.9	903.9	696.4	1,101.4	1,184.4	8,534.2
Goal 2. Develop and implement research programs that improve the availability of genetically appropriate and adapted TRM to support the value chain										
	2.1. Planting strategies improved for exotic and indigenous species, based on innovative research programs that result on local and national needs	2.1.1. Selected exotic genotypes adapted to different agro-ecological zones of Rwanda	51.5	71.5	71.5	71.5	71.5	101.5	101.5	540.5
		2.1.2. indigenous tree species domesticated for genetic resources conservation	51.5	131.5	131.5	131.5	131.5	161.5	101.5	840.5
		2.1.3. Improved clones selected by means of genomic selection tools				215	215	515	1,015	1,015
	2.2. Improved seed conservation	2.2.1. Seed standard storage conditions improved		29.75	29.75	29.75	29.75	29.75	29.75	178.5
		2.2.2. Very-long term storage conditions of tree seeds enhanced		27	27	27	27	27	27	162
	2.3. Improved large-scale propagation of high-value trees species for mass production of high-quality seedlings	2.3.1. species adapted to cutting or grafting techniques identified			18	18	18	18	18	90
		2.3.2. Specific clones adapted to in vitro propagation identified					135	135	135	405
		2.3.3. Improved adaptability of tree seedlings		18	18	18	18	18	18	108
	2.4. Capacity for TRM research increased	2.4.1. Research funds mobilized and skills to support research programs increased	4	4	4	4	4	4	4	28
	2.5. National & International Scientific Visibility enhanced	2.5.1. TRM research results disseminated		17	34	44	54	64	74	287
	Total Budget for Goal 2		107	298.5	333.75	343.75	488.75	558.75	1,523.75	3,654.5
Total Budget for the Strategy (Budget Goal 1 + Budget Goal 2)			1,419	2,220	1,749	1,248	1,185	1,660	2,708	12,188.70

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GLOSSARY

Agro-bioclimate zone: A geographic area having similar patterns of energy flow, vegetation, and soils as a result of a broadly homogeneous macroclimate;

Basic seed: A seed necessary for producing certified seed

Biological control: The use of biotic agents such as insects, nematodes, fungi, and viruses for the control of weeds and other forest pests;

Breeding orchard: (breeding seed orchard) A planting of selected trees, usually clonally propagated, designed to ease tree breeding work;

Breeding population: A group of individuals selected from a wild population for use in a breeding program. Usually phenotypically selected for desirable traits. In species with large natural ranges, there are usually several to many, more-or-less separate breeding populations, each designed to provide progeny suited to a specific geographic region;

Candidate tree: A tree that has been tentatively selected for inclusion in a breeding program, but has not yet been measured or compared with surrounding trees;

Certified seed: A seed from the multiplication of basic seed whose quality has been approved through a legally recognized certification process;

Character (trait): A distinctive but not necessarily invariable feature exhibited by all individuals of a group and capable of being described or measured; e.g. height growth, bud flush. A character of a given individual will have a certain phenotype as determined by the individual's genotype and environment;

Clone:

(1) To propagate a plant asexually usually by grafting, rooting cuttings, tissue culture, or apomictic seed. Except for an extremely low level of mutation, all plants from a clone are genetically identical. (This is the usage most common in agronomy, horticulture and forestry),

(2) A group of plants produced from cuttings, stump or root sprouts, tissue culture, or some other method that produces offspring genetically identical to the original plant. Most commonly used in forestry to establish grafted seed orchards, but becoming more common for commercial plantations;

Ecotype: A sub-population of a species that occurs in a well-defined environment, usually showing better adaptation to that environment than the species as a whole;

Elite tree: A tree that has been shown by progeny testing to produce superior offspring;

Exotic:

(1) Broad definition: A non-indigenous population introduced into a new area;

(2) Narrow definition: a species introduced from another country;

Forest tree breeding: (Forest tree genetic improvement) The application of knowledge of genetics to developing improved trees;

Forest tree improvement: The application of genetic principles to produce trees or a source of seed to create trees with specific desirable traits based on their phenotypic and genotypic characteristics; the improvement or enhancement of wood quality, volume, and growth rates using a combination of genetic improvement and forestry activities, such as fertilization and pruning;

Genecology: Relationships between patterns of adaptive genetic variation and ecological variation;

Genetically improved seed: Seed that originate from a tree breeding program and that have been specifically designed to improve some attribute of seeds, seedlings, or vegetative propagules selection;

Genetic diversity: Variation among and within species that is attributable to differences in hereditary material

(1) General concept: the amount of genotypic variability in a population,

(2) Quantitative definition: the number of different alleles per loci and the proportion of loci with more than one allele in a species or population;

Genetic gain: The change achieved by artificial selection in a specific trait. Gain is usually expressed as the change per generation or the change per year. Gain is influenced by selection intensity, parental variation, and heritability;

Genetics: Genetics is the basic science dealing with causes of resemblances and differences among organisms related by descent. It considers the effects of genes and the environment;

Genomics: the study of the full genetic complement of an organism (the genome). It employs recombinant DNA, DNA sequencing methods, and bioinformatics to sequence, assemble, and analyse the structure and function of genomes.

Genotype: The specific set of genes possessed by an individual, both expressed and recessive;

Germplasm conservation: Maintaining the genetic variability of a population in:

(1) *ex situ*: a different environment or geographic location than where it evolved, i.e., plantations of exotic species, breeding orchards, cold storage of seed or pollen;

(2) *in situ*: approximately the same geographic and ecological conditions under which it evolved (This should always be the first choice);

Phenology: The study of the timing of life cycle events at the population level, most often focusing on how they respond to climate change. It often makes use of long-term records and includes events such as flowering, leaf fall, hatching and annual migration.

Phenotype: The visible characteristics of a tree. The phenotype is determined by the genotype interacting with the environment in which it is grown.

Plus-Tree: A phenotypically superior but untested tree

Population: A group of individual trees having some characteristics in common, either location, family ancestry, or intended use.

Progeny test: A test to compare the offspring of different parents.

Provenance test: A test comparing trees grown from seed or cuttings collected in many parts of a species range.

Quality declared seed: Seed produced from basic or certified seed, declared by the producer as being in conformity with technical, identity and quality standards governing seed production and approved by the competent authority after the verification of the quality;

Quality seed: Seed inspected by a competent person, processed and which is in conformity with quality standards prescribed by this Law;

Seed: plant or part of a plant which is or is intended to be used for propagation of a plant including, a grain, scions, seedling, corm, cutting, shoot, root, runner, node, stem, stock, banana pup or tubers which were used for propagation of a plant or are intended to be used as such;

Seed certification agency: recognised agency in a country responsible for the certification of seed according to the relevant laws;

Seed conditioner: a person authorized to deal with the business of cleaning, treating or otherwise conditioning seeds intended for use or sale.

Seed dealer: a person licenced to engage in the business of seed production, conditioning or marketing and selling as well as testing seeds in laboratories in accordance with relevant laws;

Seed establishment: farm, field, warehouse, factory or any building where seed is produced, processed or sold;

Seed inspection: official belonging to a quality control department responsible for performing field control and sampling of seeds in accordance with relevant laws;

Seedling: A young tree having a diameter at breast height equal to or less than 1 cm

Seed orchard: Plantation of clones or sowing of trees selected, isolated to prevent the pollination by not desirable individuals and fitted out for a fast and plentiful production of seeds improved with the aim of reforestations. Orchards with seeds are often established before the genetic quality of clones was estimated by progeny tests. When the results of progeny tests are known, individuals of lower quality are removed by orchards;

Seed planning unit: (SPU) An organizational unit that forms the basis for breeding and seed production planning. SPUs are organized per species, seed planning zone (SPZ), and elevation band and are designed to facilitate program development and strategic planning for tree improvement;

Seed planning zone: (SPZ) Geographic area defined on a map or by a bio-geoclimatic variant to control the movement of seed or to delineate an area within which parent trees are selected for propagation or breeding.

Seed processing: Cleaning, sorting or grading of seed to improve the quality;

Seed production area: A stand or plantation not originally planned to produce seed, but rogued of inferior trees and treated in such a manner as to produce large quantities of seed. Usually the stand or plantation is from a known origin or selected seed lot;

Seed producer: Any person approved by the relevant authority to produce seeds according to the standards set by relevant law;

Seed source: The location where a seed lot was collected. If different seed lots of an exotic species are collected and tested, the test is called a seed-source test to distinguish it from a provenance test;

Seed trees: Trees selected to be left standing to provide seed sources for natural regeneration. Selection is usually based on good form and vigour, the absence of serious damage by disease, evidence of the ability to produce seed, and wind-firmness;

Seed lot: A designation of a group of seeds with some factor in common, i.e., year of collection, stand or seed orchard, individual "+" trees, point of origin in a provenance test, a half- or full-sib family;

Species: A group of individuals that have their major characteristics in common and (usually) can only breed with each other;

Stakeholder: The range of groups and individuals who have a formal or informal stake in resource planning and management decisions, including tenure holders, local resource user and community groups, non-governmental organizations, and research institutions;

Stand: A group of trees that are sufficiently the same in species composition and arrangement of age classes and condition so that they can be managed as a unit;

Tree: Any perennial plant of at least six (6) meters tall at maturity in situ, having a stem and an upper part consisting of branches and leaves;

Tree selection: Choosing individual trees or populations with desirable characters to obtain genetic improvement.

Annex 1 Relevant tree seed, reproductive, genetic material regulatory instruments

Law	Policy (governing)	Main relationship with the Forestry/Agroforestry TRM Sector
N° 53/2010 of 25/01/2011	RWANDA NATURAL RESOURCES AUTHORITY (RWFA, Mission, organization and functioning), after the development of National Forestry Policy in 2010.	
N° 47bis/2013 of 28/06/2013	THE MANAGEMENT AND UTILISATION OF FORESTS In Rwanda	<p>making reference to forestry/Agroforestry planting, conservation and protection of forests, forest management, forestry research, licenses, judicial Police in respect of forests and administrative sanctions and mentioning:</p> <ul style="list-style-type: none"> i) State forests in Art. 5 “Categories of State forests (1° protected forests; 2° production forests; 3° forests reserved for research) ”; ii) Art. 17 “Planting Agroforestry trees” / Art. 18 “Planting trees in urban areas and on roadsides”; iii) Art. 20 “Role of the population in the conservation and protection of forests” / Art. 21 “Collaboration of institutions to protect forests” / Art. 22 “Responsibilities of local authorities”; iv) Art. 29 “Forest fire prevention” / Art. 30 “Fires control towers in forests”; v) Art. 33 “Inventory of forests”; vi) Art. 36 “Management of forests reserved for research / Art. 37 “Management of District forests” / Art. 38 “Management of private forests / Art. 39 “Harvesting of private forests” / Art. 45 “Fundamental research” / Art. 46 “Applied research” / Art. 47 “Publication of research results”; vii) Art. 57 “Bringing into the country a forest planting material” / Art. 58 “Introducing a forest planting material into the country for the first time” / Art. 59 “Taking a forest planting material out of the country” / Art. 60 “Trade in forest products” / Art. 61 “Special sale certificate” / Art. 62 “Trade in forestry seeds” / Art. 63 “Sale of forestry services”;
N° 43/2013 of 16/06/2013	LANDS in Rwanda	<ul style="list-style-type: none"> i) “Land use management and its protection” including: Art. 27 “Land use and development planning” (section 6) / Art. 25-26 “Land sub-lease for agricultural, forestry and livestock production” (section 5); ii) “Land rights and obligations” including: Art. 37 “Special conditions for conservation and exploitation of Land” / Art. 40 “Land considered to be properly exploited” / Art. 41 “Land considered not to be properly exploited (i.e. If the land is not protected from soil erosion; If the land meant for agriculture is not covered by crops or other plants at least up to a half (1/2) of its area, etc.) / Art. 43 “Land tax and lease fee”;

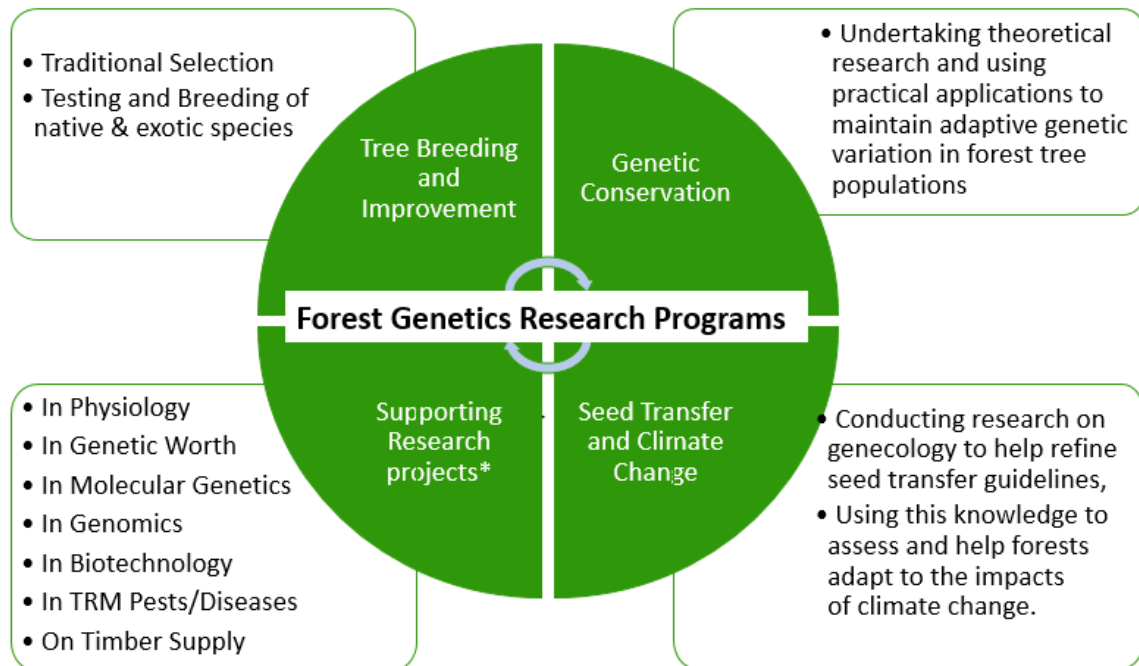
Law	Policy (governing)	Main relationship with the Forestry/Agroforestry TRM Sector
<p>N° 005/2016 of 05/04/2016 Repealing the Law N° 14/2003 of 23/05/2003 (on Production, Quality Control and Marketing of plant quality seeds) & associated to few Ministerial Orders</p>	SEEDS AND PLANT VARIETIES in Rwanda	<p>iii) <i>“Criminal penalties, administrative decisions and sanctions”</i> including: Art. 51 <i>“Organ in charge of land use inspection”</i> (Sector administration in charge of inspecting whether the land is properly exploited and in a productive way) / Art. 55 <i>“Degraded or unexploited land in private domain of the state or its organs”</i>;</p>
<p>N°001/11.30 of 18/08/2010</p>		<p>i) Plant variety Evaluation, Certification and Registration,</p> <p>ii) Quality Seed Production processing and Marketing,</p> <p>iii) Importation and Exportation of Seeds,</p> <p>iv) Seed Certification,</p> <p>v) Protection of a new Plant variety</p> <p>Art. 1 <i>“Establishment of Variety Release Committee (VRC)”</i> by the Minister in charge of Agriculture,</p> <p>Art. 2 via the VRC</p> <p>i) <i>“Conditions and modalities for testing every variety submitted for release” / “ Receiving and processing applications submitted by variety owners for their variety to be released”</i>;</p> <p>ii) <i>“Supervision of tests for DUS (distinctness, Uniformity, Stability) and VCU (Value For Cultivation and Use) for new varieties submitted for release and the NVPT (National Variety Performance trial) for varieties released in other Countries to be registered on the National Plant variety List” / “Releasing seed varieties for production of quality seeds”</i>;</p>
<p>N°002/11.30 of 18/08/2010</p>		<p>iii) The submission to the Minister in charge of agriculture, for approval, a list of varieties to be registered or withdrawn from the National Plant Variety List (NPVL)</p>
<p>N°003/11.30 of 18/08/2010</p>		<p>The determination of Regulations on Quality Seed Production and Control of Seed produced and marketed</p>
<p>N°004/11.30 of</p>		<p>The setting Forth Conditions required for Marketing Quality Seeds</p> <p>The determination of Prices for Services rendered in Seed Quality Control</p>

Law	Policy (governing)	Main relationship with the Forestry/Agroforestry TRM Sector
18/08/2010	N°005/11.30 of 18/08/2010	The setting Forth Standards for processing Quality seeds
N° 16/2016 of 10/05/2016	PLANT HEALTH PROTECTION in Rwanda	<p>GoR via MINAGRI demands that imported seeds are accompanied by an official certificate from the country of origin, indicating their purity, moisture content, germination rate and testifying that they are free from any diseases that can be transmitted</p> <p>Art. 10 "Phytosanitary inspection of a Plant and Plant Product"</p> <p>Art. 20 "Importation of Pest, Plant or Plant Product for scientific and research purposes"</p> <p>Art. 31 "Phytosanitary Certificate"</p>
N° 70/2013 of 02/09/2013	BIODIVERSITY In Rwanda	<p>By signing the Convention on Biological Diversity (CBD) in 1996, by adopting in 2011 a Biodiversity Policy followed by this Biodiversity Law in 2013 (LAW N° 70/2013), and by ratifying Cartagena and Nagoya Protocols from 12/10/2004 and 12/10/2014, respectively, GoR commits to conserve:</p> <ul style="list-style-type: none"> i) the biological diversity; ii) the sustainable use of its components; iii) the fair and equitable sharing of benefits arising from the use of genetic resources; <p>GoR is working currently to develop an enabling legal and institutional framework for implementation of protocols</p> <p>The Centre of Excellence in Biodiversity and Natural Resources Management (CoE) is currently in charge of coordinating, overseeing and monitoring all activities relevant to biodiversity conservation and management, and reviewing the implementation of the National Biodiversity Strategic Action Plan.</p>
2013	<p>PROTECTED AREAS in Rwanda</p> <p>after the establishment of the Rwanda Protected Areas Concessions Management Policy (2013)</p>	Promoting the conservation of Natural Resources & Wildlife habitat and the sustainable use of biological Resources.

Law	Policy (governing)	Main relationship with the Forestry/Agroforestry TRM Sector
Decentralized policy adopted in May 2000, and revised in 2012, sfd	Decentralized Policy	<p>recognizing three decentralized systems from the headquarter to the lower levels depending on the transfer of responsibilities, authority, functions, as well as power and appropriate resources:</p> <ul style="list-style-type: none"> i) Deconcentration basing on the transfer of functions while power and authority are conserved by central government; ii) Devolution: allowing transfer of some power, authority, functions and resources; iii) Delegation basing on the transfer of functions and resources and allowing to local authority acting on the behalf of the superior authority without a formal transfer of authority in the same structure (i.e. lower office will have still responsibility to consult the higher office on matters that require decision-making);
N° 54 bis/2011 of 14/12/2011	establishing Rwanda Meteorological Agency (Meteo Rwanda) and determining its mission, organization and functioning and operating under the Minister of Infrastructure (Mifotra)	<p>providing weather and climate information:</p> <ul style="list-style-type: none"> i) getting climatological data, records and information, ii) Acquiring training and maintenance of instruments and equipment related to meteorology, iii) getting access Rwanda Meteorological Agency's Library
N° 45/2013 of 16/06/2013	on the organization of statistical activities	makes reference to data accessibility for e.g. land maps, agriculture data, livestock and environment data.
N° 14/2016 of 02/05/2016	governing PPP, after the establishment of The Decentralization Implementation Policy, adopted in 2012, defining PPPs as a mechanism for developing rural areas and key sectors.	<p>In 2009 Rwanda's government has shown support for PPPs through its National Public Investment Policy, which sets out broad guiding principles for the implementation of PPPs, relating to eligibility criteria, competitive selection, risk-sharing, budgeting and accounting.</p> <p>The Rwanda Development Board (RDB) is currently the leading public institution playing a role in PPP (Art. 10), in association with a steering committee (Art. 7 & 8) and Contracting Authority (Art. 9).</p> <p>In article 5, forests are considered as potential sector for PPPs</p>

Law	Policy (governing)	Main relationship with the Forestry/Agroforestry TRM Sector
N° 44/2013 of 16/06/2013	establishing THE RWANDA LAW REFORM COMMISSION (RLRC) and determining its mission, organization and functioning	<p>should be applied in case it's necessary to revise, update or develop laws during the implementation of the NTSS, knowing that RLRC is responsible in other things for:</p> <ul style="list-style-type: none"> i) Analyzing Rwandan laws and providing recommendations to relevant authorities for their improvement, modernization and reform; ii) Conducting studies designed to assess laws applicable in the country in order to identify those that are not implemented and the new ones that may be necessary and advise relevant authorities accordingly; iii) Ensuring proper codification and revision of Rwandan laws;
N° 20/2016 of 20/05/2016	modifying and complementing the Law N°80/2013 of 11/09/2013	
N° 80/2013 of 11/09/2013	establishing the National Commission of Science and Technology (NCST) and determining its mission, organization and functioning.	NCST is directly supervised by the Office of the President of the Republic.
No 50/2007 of 18/09/2007	determining the Establishment, organization and functioning of cooperative organizations in Rwanda:	<p>Art. 5: "Cooperative Organizations may carry out activities in all sectors of economic and social life, and they are divided into the following categories: 1° Production and marketing Cooperative Organizations; 2° Commercial and Consumer Cooperative Organizations; 3° Services Cooperative Organizations; 4° Multipurpose Cooperative Organizations."</p> <p>Art. 6 : " The Cooperative Organizations may constitute among themselves Unions, Federations and Confederation for the better management of their property and the defense of their common interests. (Rwanda Cooperative Agency)</p> <p>Cooperative Organization (min. 7 persons) → Cooperatives in Unions (min. 3 Coop. Org.) → Cooperative Federation (min. 3 Coop. in Unions/ at National Level) → Confederation of Cooperatives (min. 3 Coop. Fed.)</p> <p>Art. 18: "A cooperative federation shall carry out economic and service activities only to support the initiatives of its member unions. The federation shall operate without prejudicing but rather complementing the activities of the cooperative unions or primary Cooperative Organizations."</p> <p>Cooperatives are under District level's Authorities in delivering legal registration.</p>

Annex 2 Some research programs supporting Forest and Agroforestry TRM improvement



* Projects assisting to the delivery and most effective use of selected material derived from the tree breeding programs

Annex 3 Stakeholder responsibilities

<u>Main actor</u>	<u>Related actors</u>	<u>In charge to</u>	<u>for</u>
MINILAF	<p>& MINAGRI, MININFRA, MINADEF, MINICOFIN</p> <p>& MINAGRI, MINALOC, MINICOM</p> <p>& MINAGRI, MINICOM</p> <p>& MINAGRI, MINICOM</p> <p>& MINAGRI, MINEDUC</p> <p>& private security operators</p>	<ul style="list-style-type: none"> • Participate in reviewing of policies in relation to the Forest/Agroforestry TRM and ensure their implementation. • Upkeep strong linkage among national and local actors (cell, sector and district) via the councils (Decentralized government). • Prepare and provide a national program in matters of Forest/Agroforestry TRM management to every stakeholder. • Attribute to each actor their responsibilities for seed procurement activities. • Advise, assist and encourage private sector stakeholders in participating in activities of TRM supply and improvement. • Encourage constant collaborative work between governmental actors and private seed producers, nursery operators and other private partners. • Support research program development on forest/Agroforestry TRM improvement and its socio-economical impact. • Establish agreements 	<ul style="list-style-type: none"> • Providing institutional support to the TRM sector to obtain adequate and functional linkages and ensured collaborations between local government (e.g. councils, District Forest officers, agronomists) and line of the ministries/authorities (for planning, financing, implementing in a timely and accurate manner). • Supporting capacity-building. • Informing each stakeholder about the detailed strategy. • A strong support to TRM value chain actors. • A boosted seed production/supply in the private sector by the enhanced accessibility to knowledges, skills, loans, micro-credits. • A strengthening of participative approach • The leadership development of MINILAF for forest TRM research and strengthening links between MINILAF & MINAGRI in Agroforestry TRM research sector. • The guaranteed protection of public tree seed stands, seed orchards and research sites.

<u>Main actor</u>	<u>Related actors</u>	<u>In charge to</u>	<u>for</u>
RWFA (FSU)	<ul style="list-style-type: none"> & NTSC, MININFRA & NTSC, RDB, RAB, districts, private sector, NGOs, smallholders & NTSC, RDB, RAB & NTSC & NTSC & NTSC, RAB & NTSC, RDB, RAB, MINADEF, NGO & NTSC & NTSC 	<ul style="list-style-type: none"> • Support for the rehabilitation of the National Tree Seed Centre (NTSC). • Ensure a management and an exploitation of private and public Forest/Agroforestry TRM production sites based on standards. • Supervise and/or provide advices about the management and exploitation of seed resources for private and public sectors. • Manage the National Tree Seed Registry. • Ensure the smooth running of the TRM value chain • Control the forest/Agroforestry TRM lots for public and private actors. • Coordinate seed procurement activities on their own tree seed stands, on the tree seed stands established on Natural Forests (after RDB authorization), and on Lands managed by MINADEF (after Defense agency authorization). • Guarantee seed quality dispatching through Rwanda, managing the TRM traceability and certification processes. • Develop and implement across the country the traceability system of TRM. 	<ul style="list-style-type: none"> • The strengthening public infrastructures and equipment related to activities given by a National Tree Seed Centre. • The maintenance of the identity, adaptability, diversity and productivity of forest/Agroforestry seed resources. <p>idem</p> <ul style="list-style-type: none"> • A better decision-making in real time as for the procurement and the allocation of TRM. • The correction of problems in TRM value chain and the control of national seed market. • The tracking of genetic material flow. • The security of TRM. • The NTSC would be the main seed trader, but also the primary provider of TRM seed services for the Forest/Agroforestry seed industry. • A better TRM follow up.

<u>Main actor</u>	<u>Related actors</u>	<u>In charge to</u>	<u>for</u>
	& RAB	<ul style="list-style-type: none"> • Deliver seed certification. 	<ul style="list-style-type: none"> • A better TRM follow up of improved seeds.
	& NTSC, RAB	<ul style="list-style-type: none"> • Develop different computational registries and databases. 	<ul style="list-style-type: none"> • A better synergy of the information diffusion.
	& RAB, private sector	<ul style="list-style-type: none"> • Delivery to private companies accreditations to produce, collect and putatively storage TRM. 	<ul style="list-style-type: none"> • The strengthening of the private sector implication.
	& RAB, private sector	<ul style="list-style-type: none"> • Sub-contract via agreements with private licenced contractors, some activities (e.g. seed collection by professional climbers, silvicultural operations, seed delivery...). 	<ul style="list-style-type: none"> • The delegation of some activities to private sector in order to reduce the NTSC workload and support the economical private sector.
	& NTSC, PTSC, Districts	<ul style="list-style-type: none"> • Begin the decentralization of some activities managed by the NTCS to PTCS and District officers. 	<ul style="list-style-type: none"> • The involvement strengthening of provincial, district and local actors to sustain several activities of the TRM value chain.
	& RAB, RDB, private sector and all other actors	<ul style="list-style-type: none"> • Prevent and control the pests & diseases targeting forest/Agroforestry TRM. 	<ul style="list-style-type: none"> • The implementation of appropriate strategies in order to control and prevent damages caused by the pests & diseases from the seed production sites to the seed planting via the storage stage.
	& NTSC, RAB, RDB, MINADEF and UR	<ul style="list-style-type: none"> • Monitor and coordinate Forest/Agroforestry TRM Research activities. 	<ul style="list-style-type: none"> • The supplying of pertinent products, information and technologies to every actor.
	& NTSC	<ul style="list-style-type: none"> • Prepare technical norms for activities in relation to the seed improvement. 	<ul style="list-style-type: none"> • A better quality of TRM.
	& NTSC, UR, RAB	<ul style="list-style-type: none"> • Provide training modules, guidelines, from central government to provincial, district, sub-district offices. 	<ul style="list-style-type: none"> • The transfer of all pertinent information to each actor.
	& Districts, private sector, NGO	<ul style="list-style-type: none"> • Coaching personal without driving. 	<ul style="list-style-type: none"> • The strengthening of the leadership.

<u>Main actor</u>	<u>Related actors</u>	<u>In charge to</u>	<u>for</u>
	& UR, RAB	<ul style="list-style-type: none"> • Develop relationships and collaborations with other institutions, international organizations related to activities of TRM management and breeding. 	<ul style="list-style-type: none"> • The strengthening of the skills in Forest/Agroforestry TRM sector.
Private sector, NGO	& NGOs	<ul style="list-style-type: none"> • Manage their own private lands on the base of governmental directives for the TRM management. 	<ul style="list-style-type: none"> • A better production and quality of TRM.
Private sector, NGO	& NGOs	<ul style="list-style-type: none"> • NGOs will be in charge to support introduction of seed/seedling on farmlands and manage their own nurseries. 	<ul style="list-style-type: none"> • A better management of TRM.
Private sector, NGO	& NGOs	<ul style="list-style-type: none"> • NGOs will have responsibility to guarantee that seed quality will always up to standard. 	<ul style="list-style-type: none"> • A better quality of TRM.
	& private sector	<ul style="list-style-type: none"> • Private nurseries will have to continually looking for and developing best conditions adapted to each species and transfer information to FSU (and vice-versa). 	<ul style="list-style-type: none"> • The significant reduction of the seedling loss from germination stage to field plantation.
RWFA	& all actors	<ul style="list-style-type: none"> • Exchange all pertinent information via the National association of Tree Reproductive Material professionals. 	<ul style="list-style-type: none"> • A permanent enhancement of the TRM chain supply

Annex 4 Stakeholder relevance

In Rwanda	Implications
- Ministry of Lands and Forestry (MINILAF)	- Forestry, Agroforestry advice, Land, Funds, Policy, Infrastructure, data, Forest expertise, Biodiversity, biosecurity, Forest seeds (genetic resources)
<i>Rwanda Natural Resources Authority (RWFA)</i>	
<i>Rwanda Environment Management Authority (REMA)</i>	
- Ministry of Agriculture (MINAGRI)	- Agroforestry, Seeds, Control of Pathogens, Agroforestry expertise, Seeds, Funds, Policy
<i>Rwanda Agriculture Board (RAB)</i>	
- Ministry of Commerce (MINICOM)	- Private sector, Investment, Cooperatives
<i>Rwanda Development Board (RDB)</i>	
- National Institute of Statistics of Rwanda (NISR)	- GeoData, Statistics
- Ministry of Local Government (MINILOC)	- Local Policy, sustainable development, economic development
- Ministry of Infrastructure (MININFRA)	- Forest protection, wood supply
- Ministry of Justice (MINIJUST)	- Law revision
<i>Rwanda Law Reform Commission (RLRC)</i>	
- Ministry of Education (MINEDUC)	- Science and technology skills, Forestry, Agroforestry, Infrastructure (research centres)
<i>University of Rwanda (UR)</i>	
- Ministry of Disaster Management and Refugee Affairs (MIDIMAR)	- Policy, Disaster reduction (Fire security)
- Ministry of Public Service and Labour (MPSL, MIFOTRA)	- Skills and Competences, Training, Coordination and Collaboration
- Ministry of Finance, Planning and Economic Development (MINECOFIN)	- Budget allocation
- Rwanda Meteorological Agency (Meteo Rwanda)	- Climate data
- National Funds for environment in Rwanda (FONERWA)	- Budget allocation
Internationally	
- IGAD Climate Prediction and Application Center (ICPAC)	- Climate Change, Prediction, sustainable management
- International Centre for Research in Agroforestry (ICRAF)	- Agroforestry, Research
- African Development Bank (ADB)	- Funds
- Centre de Coopération Internationale en Recherche Agronomique pour le Développement (CIRAD)	- Research expertise, Training
- International Union of Conservation of Nature (IUCN)	- Funds, expertise
- Belgian Development Cooperation (BTC)	- Funds, expertise
- Dutch Cooperative Agency (DCA)	- Funds, expertise
- Rwanda Local Development Support Fund (RLDSF)	- Funds
- National Geographic (East Africa Fund)	- Funds for Research and Conservation
- International Union of Forest Research Organizations (IUFRO)	- Non-governmental network of international forest scientists