NATIONAL FORESTRY RESOURCES RESEARCH INSTITUTE
(NaFORRI)

TREE IMPROVEMENT AND GERMPLASM RESEARCH PROGRAMME

Strategic Plan
2016/17 – 2025/26

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TABLE OF CONTENTS

List of Tables

List of Figures

LIST OF ACRONYMS

ASSP	Agricultural Sector Support Programme
ATAAS	Agriculture Technology Advisory and Agribusiness Services
CBD	Convention on Biological Diversity
COP	Conference of the Parties
Dev	Development
EAC	East African Community
EU	European Union
FAO	Food and Agriculture Organization
GoU	Government of Uganda
HR	Human Resources
ICRAF	International Centre for Research in Agroforestry
ICT	Information Communication Technology
ISO	International Standards Organization
IT PGRFA	International Treaty for Plant Genetic Resources for Food and Agriculture
Lab	Laboratory
MSc	Master of Science
NaFORRI	National Forestry Resources Research Institute
NARI	National Agricultural Research Institute
NARO	National Agriculture Research Organization
NAROSec	National Agricultural Research Organization Secretariat
NDP	National Development Programme
NFP	National Forest Plan
NFTPA	National Forestry and Tree Planting Act
NTR	Non-Tax Revenue
PARI	Public Agricultural Research Institute
PhD	Doctor of Philosophy
PIC	Prior Informed Consent
R & D	Research and Development
SLM	Sustainable Land Management
TBP	Tree Biotechnology Programme
TIGRP	Tree Improvement and Germplasm Research Programme
ToR	Terms of Reference
UGX	Uganda Shillings
UNCCD	United Nations Convention to Combat Desertification
UNDP	United Nations Development Programme
USAID	United States Agency for International Development
ZARDI	Zonal Agricultural Research and Development Institute

FOREWORD

Uganda's development strategy is premised on realizing the vision of "*a transformed Ugandan society from a peasant to a modern and prosperous country*" by 2040. The Uganda Vision 2040 has set a target to increase forest cover in the country from 14% in 2013 to 24% in 2040. The national strategy is arched in the second National Development Plan (NDPII) (2015/16 – 2019/20) whose overriding theme is *"Strengthening Uganda's competitiveness for sustainable wealth creation, employment and inclusive growth"* and focuses, among others, on "*increasing national forest cover and economic productivity of forests*" in the next 10 years by increasing "*afforestation, reforestation, adaptation and mitigating deforestation for sustainable forestry*". One of the avenues to achieve this has been identified in NDPII as the promotion of "*forestry research and development*".

The Tree Improvement and Germplasm Research Programme (TIGRP) is the only research unit that is evolving as the lead agency in conducting tree improvement research for development, and is thus playing a key role in implementation of relevant aspects of Uganda's development strategies. The TIGRP is therefore poised to be a central focus of forestry research in the country through the development of various appropriate improved trees for diverse needs. This will, no doubt, contribute to the increase in forest cover, enhance resilience of local communities as well as provide avenues for livelihood diversification.

The Management of the National Forestry Resources Research Institute (NaFORRI) is therefore committed to the full implementation of this Strategic Plan. The Institute management will work very closely with the Advisory Committee, TIGRP management, and all stakeholders to ensure that proper management frameworks are in place for successful implementation of the TIGRP Strategic Plan. The institute management will also ensure that the Strategic Plan is implemented through timely preparation of annual work plans and performance contracts derived from the Plan, as well as regular monitoring and evaluation.

On behalf of the management of NaFORRI, I wish to thank all those who were involved in the preparation of this Strategic Plan, particularly the leadership and staff of the TIGR Programme for their relentless commitment. I have no doubt that, with the core values enunciated in the plan i.e. Creativity and innovation, Professionalism, Gender responsiveness, Integrity, Team work, Clean and healthy environment and adequate Partnership, this strategic plan will be successfully implemented.

Hillary Agaba (PhD)
Director of Research
National Forestry Resources Research Institute

PREFACE

This Strategic Plan outlines the approaches that the Tree Improvement and Germplasm Research Programme will employ in undertaking tree improvement research and development in the next ten years, in line with the Programme's mandate and functions. The Plan will guide and steer the Programme towards contributing to the realization of Uganda's vision of "*a transformed Ugandan society from a peasant to a modern and prosperous country*" by 2040. This Strategic Plan has identified strategic focus areas, strategic objectives and outputs to guide the Programme in contributing to the actualization of Uganda's national development goals.

This is the first strategic plan of the Tree Improvement and Germplasm Research Programme and has been prepared in conformity with Uganda's Vision 2040. This plan has been informed by the UN Sustainable Development Goals (2015), Uganda Agriculture Policy (2013), Uganda Forest Policy (2001), the National Forest Plan (2002), the National Forestry and Tree Planting Act (2003), NARO Strategic Plan (2010 – 2019) and the National Agricultural Research Act (2005). The National Forest Plan (2002) places emphasis on the introduction of a tree improvement programme in Uganda and this provides the spirit of this strategic plan. To conform to international standards of research management and sustainability, the Programme aims at getting ISO certification and also enhance resource mobilization from the government, development partners, private public partnerships and internal sources through Non-Tax Revenue.

In developing this strategic plan, ideas were obtained from a stakeholder workshop conducted as an annual review and planning meeting. In addition, an analysis of the strengths, weaknesses, opportunities and threats was also used as an approach to setting and implementing strategic objectives and initiatives to enhance performance. This Strategic Plan has laid emphasized on critical focus areas, multi-sectoral as well as multidisciplinary approaches to research. Moreover, the Strategic Plan has included necessary measures that will ensure that robust monitoring and evaluation is carried out to achieve the intended objectives and outputs. The budget projections in this Strategic Plan are only indicative and will be subject to annual revision based on evolving realities.

The Programme Management will ensure effective implementation of this Plan and calls upon our internal and external stakeholders to support us towards being '*An internationally recognized centre of excellence in tree improvement research, development and technology transfer*'.

Samson Gwali (PhD)
Programme Leader
Tree Improvement and Germplasm Research Programme, NaFORRI

ACKNOWLEDGEMENTS

We appreciate the support given by the National Agricultural Research Organization (NARO) to the Tree Improvement and Germplasm Research Programme and NaFORRI in general during the preparation of this Strategic Plan. The writing of this plan has benefited from the contribution of many individuals and stakeholders who were consulted. All the participants who attended the Annual Review and Planning meeting that was held at NaFORRI on 7th October 2015 are recognized. This Strategic Plan was prepared by TIGRP with logistical support from NaFORRI management. Appreciation goes to all those organizations that sent representatives to the review and planning meeting which recommended the preparation of this Management Plan. It is not possible to list all their names here for practical purposes. Please accept our sincere appreciations.

The following persons have been very crucial for the development and initial review of this Strategic Plan and deserve mention. These include Dr. Hillary Agaba (Director, NaFORRI), Dr. Samson Gwali (Programme Leader, TIGRP), all programme leaders and staff of NaFORRI. Special mention goes to the following staff of TIGRP for developing and writing specific sections of the Strategic Plan i.e. Grace Abigaba, Juventine Boaz Odoi, Judith Nantongo Ssali, Aggrey Ntakimanye, Moses Basoga, Richard Oluk, Emilly Kamusiime and Sarah Nalumansi.

The overall product as realized in this Plan is therefore truly a concerted effort of all those who participated, in big and small ways. To all these, and many more that are out there, TIGRP sincerely says, THANK YOU. However, while it is true that a diversity of persons and institutions contributed in the development of ideas which have finally been incorporated in this Strategic Plan, the TIGRP bears responsibility for whatever is presented in this Plan.

EXECUTIVE SUMMARY

The Tree Improvement and Germplasm Research Programme (TIGRP) embarked on the process of strategic planning as a result of an organizational shift in research delivery mode from themes to programmes in the National Agriculture Research Organization (NARO). The need for strategic thinking has therefore been emphasized in recent times and this has been implemented through Annual Research Reviews and Planning meetings, during which key stakeholders assess progress and set targets for research outputs. Research programmes have therefore been urged to develop strategic plans in order for their activities and outputs to fit better into institute and organizational aspirations. At a workshop held at Mukono Zonal Agricultural Research and Development Institute (ZARDI) from 9th to 11th September 2015, it was agreed that all activities of NARO research programmes be guided by strategic plans. This strategic plan has therefore been developed to guide the research agenda of the Tree Improvement and Germplasm Research Programme for the next 10 years.

The Strategic Plan is aligned to Uganda Vision 2040, the second National Development Plan (2015/2016 – 2019/2020), the 1995 Uganda Constitution as well as relevant international and national development plans, policies and legal frameworks, and to NARO and NaFORRI Vision and Mission. The Strategic Plan was developed using recommendations from stakeholder views as well as an analysis of the strengths, weaknesses, opportunities and threats that are envisaged by the TIGRP. Consultations with relevant stakeholders and refinement of the research focus areas resulted into the formulation of the TIGRP Mandate, Goal, Vision and Mission statements as well as core values that will guide the implementation of this strategic plan. The statements and core values are:

Mandate:
The mandate of the Tree Improvement and Germplasm Research Programme can be categorized into four specific areas:

1) **Breeding** for genetically improved and well adapted trees, including research involving basic genetics, natural variation, hybridization, heritability, open pollination, controlled crosses, collection and handling of pollen, plus tree selection (including marker – assisted and juvenile selection),
2) **Propagation**, progeny and provenance testing, including research involving seed and vegetative propagation (cuttings, layering, budding, grafting, cell and tissue culture), progeny and provenance trials.
3) **Tree seed research** for improved germination, quality and tree productivity: seed handling (collection, processing, storage, seed testing and control), pest management, tree phenology, seed sources (establishment and maintenance), seed orchards (design and establishment, maintenance as well as special techniques for enhancing seed production).
4) **Gene conservation**, including research in and establishment of seed and germplasm banks, clone banks, horticulture, mother gardens, nurseries

Goal: To identify, develop and conserve superior genotypes of economically important and well adapted tree/plant species in Uganda.

Mission: To conduct tree improvement research, provide information and technologies for enhanced productivity of forestry and allied natural resources for socio-economic development.

Vision: To be an internationally recognized centre of excellence in tree improvement research, development and technology transfer.

Core Values: Creativity and innovation, Professionalism, Gender responsiveness, Integrity, Team work, Clean and healthy environment and Partnership.

In order to achieve its mission, the Tree Improvement and Germplasm Research Programme has identified strategic focus areas and strategic objectives to meet the needs of clients and stakeholders by delivering value through its products and services. Research in the TIGRP during the period of the Strategic Plan will address three research focus areas namely: Improvement of trees for health, food security and nutrition; Improvement of trees for timber and energy; and Development of a robust tree seed sector. Four strategic objectives were formulated based on a stakeholder and SWOT analysis as well as organizational capacity.

The total estimated budget to finance implementation of this Plan for the ten year period is estimated at UGX 16.215 billion. The Programme intends to finance this budget through the annual Government of Uganda allocation, development partners, Public-Private Sector Partnerships, and internal revenue generation (Non-Tax Revenue). Detailed work plans will act as tools for monitoring the implementation progress of the Strategic Plan. This will be done by linking planning, budgeting and reporting through annual work plans as well as periodic reporting. The Programme will employ a Risk Management Strategy in mitigating risks associated with implementation of the strategic objectives.

1.0 Introduction

1.1 Background

Forests and trees outside forests are of immense importance to Uganda. In 2004, the contribution of forests to GDP was equivalent to 5.2% (Bush et al. 2004), 2.75% from wood and non-wood products and 1.45% from environmental services including carbon sequestration (Obua et al; 2010). Contribution to annual incomes of the households in Uganda was estimated at Uganda shillings 332.3 billion (US$173 million) (Obua et al; 2010). It is also indicated that over 90% of household energy in Uganda is derived from biomass (firewood and charcoal) (Bizarri, 2009). Despite the above, the most critical trend in forestry is the progressive reduction of tree cover and hence the productive and regulatory functions (Obua, 2010). Research in tree improvement and germplasm development is a strategy that can provide robust pathways and knowledge for addressing the problems facing the forestry sector through use of seed and seedlings of high genetic quality. Areas of research include genetic improvement of superior tree species, provenance testing, seed production, progeny testing and seed orchard, clone bank/clonal seed orchard establishment. These include techniques for plus tree selection of important commercial tree species, the protection of genetic diversity and genetic quality of trees and forests, cultural and management techniques and the use of clones and seedling seed for tree or forest establishment.

The growth of tree improvement in Uganda has, however, been so slow. There has been little tree improvement since the 1970s, which has resulted in the planting of untested, insecure and genetically poor trees in the forest estate, both by government and private investors/individuals. This has left the forest sector dependent upon importation of seed from abroad. In addition, the lack of tree improvement research in Uganda has resulted in poor plantation stands, many of which have been salvaged. Moreover, environmental pressures have exerted an undesirable influence over genotypic expression thereby compromising the potential to carry out meaningful plus tree selection. In other words, it has become increasingly difficult to determine whether the growth habit of trees is due to their genetic potential or environmental influences. This therefore calls for a focused tree improvement programme to ensure that the tree planting stock provides the desired products.

1.2 Rationale

The difference between tree improvement and other forestry sectors is that the consequences of utilizing germplasm of poor genetic constitution are not always immediately obvious. The fact that the genetic make-up of a tree cannot be seen means that failure to achieve the objective of tree management may be attributed to other factors rather than tree improvement. Many forestry programmes therefore fail to recognize the importance of tree improvement and hence suffer the consequences of poor growth and form in their growing stock. A strategy for tree improvement is required in order to carry out a coherent range of activities to support the forestry sector. Tree improvement therefore relies on a series of interlinked activities to take place in order to fulfill its potential.

1.3 Mandate

The mandate of the Tree Improvement and Germplasm Research Programme can be categorized into four specific focal areas i.e.

1) **Breeding** for genetically improved and well adapted trees: basic genetics, natural variation, hybridization, heritability, open pollination, controlled crosses, collection and handling of pollen, plus tree selection (including marker – assisted and juvenile selection).

2) **Propagation**, progeny and provenance testing: seed and vegetative propagation (including cuttings, layering, budding, grafting, cell and tissue culture), progeny and provenance trials.

3) **Tree seed research** for improved germination, quality and tree productivity: seed handling (collection, processing, storage, seed testing and control), pest management, tree phenology, seed sources (establishment and maintenance), seed orchards (design and establishment, maintenance as well as special techniques for enhancing seed production).

4) **Gene conservation**: seed and germplasm banks, clone banks, horticulture, mother gardens, nurseries

2.0 Role of Tree Improvement and Germplasm Research in National Development

2.1 Linkages with Inter-governmental arrangements at the international level

2.1.1 UN Sustainable Development Goals

The member states of the United Nations Organization have recently (2015) passed the international development agenda for the next 30 years. All member states have an obligation to contribute to the attainment of the 17 sustainable development goals. In the next 10 years, the Tree Improvement and Germplasm Research Programme will provide Access to quality tree germplasm for commercial forestry thereby contributing to Goal 1 (ending poverty); and conduct research, multiply and provide knowledge, technologies and tree products including trees for food security, nutrition and health while being fully gender responsive, thus contributing to Goal 2 on ending hunger and achieving food security and improved nutrition. Generation and multiplication of research products and knowledge will specifically contribute to sub-goals 2.2 (malnutrition), 2.3 (doubling agricultural productivity and incomes), 2.4 (sustainable food production and resiliency), 2.5 (maintaining genetic diversity of seeds and cultivated plants).

2.1.2 The United Nations Convention to Combat Desertification (UNCCD)

In its 10-year Strategic Plan (2008-2018), the UNCCD Parties provided for the strengthening of Sustainable Forest Management … to prevent soil erosion and flooding, to increase the

size of atmospheric carbon sinks, and to conserve and sustainably use biodiversity. The Global Financing Mechanism that was established by the UNCCD was aimed at … promoting the rehabilitation of degraded forests. In this 10 year strategic plan implementation period, the TIGRP will contribute by producing a variety of tree seed, seedlings and other planting materials for improvement of local economies, livelihoods and carbon sequestration.

2.1.3 The United Nations Convention on Biological Diversity (CBD) (1992)

The CBD addresses forestry in its expanded Programme of Work on Forest Biological Diversity (COP6, April 2002 - annex to decision VI/22). The Programme constitutes a broad set of goals, objectives and activities aimed at the conservation of forest biodiversity. During the 10 year period of this strategic plan, the TIGRP will be actively involved in gene discovery, characterization of genetic diversity as well as marker assisted selection of desirable traits for tree growing in Uganda. This will be a direct contribution to sustainable use of tree/forest biological diversity. This will also directly increase public education, participation, and awareness of forest/tree genetic diversity in Uganda.

2.1.4 The International Treaty on Plant Genetic Resources for Food and Agriculture (IT-PGRFA)

The International Treaty on Plant Genetic Resources for Food and Agriculture (IT PGRFA) aims at guaranteeing food security through the conservation, exchange and sustainable use of the world's plant genetic resources for food and agriculture (PGRFA), as well as the fair and equitable benefit sharing arising from its use. The work of TIGRP on management of priority species like *Vitellaria paradoxa* and *Carissa edulis* among others contributes directly to the conservation and use of tree genetic resources with implications for food security.

2.1.5 The East African Community Treaty

The EAC treaty provided for the sustainable management of natural resources and the EAC parliament subsequently adopted a Protocol on Environment and Natural Resources Management. This protocol provides, inter alia, for the "*protection and promotion of the use of indigenous knowledge that is compatible with conservation or sustainable use of biological resources"*. In conducting research, especially for food security, nutrition and health (medicinal plants research), the TIGRP will contribute by documenting all relevant traditional knowledge and practices (contributing to the provisions of Article 11 (2h and j) of the EAC Protocol), while ensuring that Prior Informed Consent (PIC) as required by the Nagoya Protocol as well as the National Guidelines for Access to Genetic Resources and Benefit Sharing are followed.

2.2 Uganda Constitution 1995

The 1995 Uganda Constitution aims at "*sustainable national development that takes into account environmental conservation, social development and economic growth*". This strategic plan lays ground for the Tree Improvement and Germplasm Research Programme to contribute technologies and public awareness as enshrined in National Objective XXVII sections (i) and (iv) i.e. "promote sustainable development and public awareness" and

"ensure conservation and promote rational use and protect Uganda's biodiversity". These objectives are further enunciated in Chapter 15 that deals with Land and the Environment and Article 245 (Protection and preservation of the environment from degradation).

2.3 Uganda's Vision 2040

Uganda's Vision 2040 presents the country's development strategy that is premised on realizing the vision of "*a transformed Ugandan society from a peasant to a modern and prosperous country*" by 2040. The Uganda Vision 2040 has set a target to increase forest cover in the country from 14% in 2013 to 24% in 2040. This strategic plan is therefore anchored in the Uganda Vision 2040 and will see the Tree Improvement and Germplasm Research Programme contribute to the country's strategic agenda by:

i). Enhancing private investment in forestry through production and promotion of commercial tree planting of clonal eucalyptus and other plantation tree species, thereby helping to restore and add value to ecosystems, including forests.

ii). Promoting the development, adoption and equitable transfer of environmentally sound technologies in tree improvement through training, both on station and on-farm and by encouraging student internships.

iii). Coherently and effectively responding to current and future challenges in forests including climate change, yield, pests and diseases as well as tree growth constraints.

2.4 National Development Plan (NDP) II (2016-2021)

The NDP is a national strategy that aims at directing Uganda's development based on the overriding theme of ***"Strengthening Uganda's competitiveness for sustainable wealth creation, employment and inclusive growth"***. The NDP emphasizes *"…sustainable development through preservation of natural resources such as forests and wetlands …*".

In paragraph 522, the NDP points out that the environment and natural resources sub-sector targets, in the short run, to increase forest cover in the country from 14% in 2013/2014 to 18% in 2019/2020. The Plan also notes that the focus of the country for the next 10 years is "*increasing national forest cover and economic productivity of forests*" by increasing "*afforestation, reforestation, adaptation and mitigate deforestation for sustainable forestry*". One of the avenues to achieve this has been identified in NDPII as the promotion of "*forestry research and development*". The Tree Improvement and Germplasm Research Programme will contribute to this target by enhancing responsiveness to tree planting requirements of the environment and natural resources sub-sector, especially through the production of quality seed, seedlings and plantlets. In addition, the TIGRP will actively enhance the research capacity of staff through re-tooling and long term training in order to be able to more effectively address the tree growing needs of Uganda.

2.5 Agricultural Sector Support Programme (ASSP) 2016/2017 – 2020/2021

Environment is treated as a cross-cutting issue within the Agriculture Sector Support Programme. Loss of forests and land degradation are specific environmental issues mentioned as having significant implications on the performance of the agriculture sector. The TIGRP will contribute to this through development of research products including clonal eucalyptus and tree seed/seedlings for plantation/farm forestry. This will address the issue of sustainable land management (SLM) and loss of biodiversity in agricultural landscapes.

2.6 NARO Strategic Plan (2010 – 2019)

Environmental sustainability is one of NARO's key social responsibilities. Natural resource management is one of the five themes in the organization's research and development continuum. A number of projects in forestry, soil and water and plant biodiversity have been developed for implementation in the short and medium-term. The Tree Improvement and Germplasm Research Programme will therefore actively contribute to NARO's strategic plan through the implementation of projects

2.7 The Uganda Forestry Policy (2001)

The Uganda Forestry Policy (2001) will continue to provide political guidance to forestry developments. The Tree Improvement and Germplasm Research Programme will actively contribute to the forestry policy environment in Uganda by:

i). Promoting profitable and productive forestry plantation businesses (in fulfillment of ***Policy Statement 3***) through the production of quality clonal plantlets and seedlings.

ii). Supporting sustainable forest sector development through both basic and applied research to enhance the quality and traits of tree products through research (in fulfillment of ***Policy Statement 10***). In addition, training of forestry sector stakeholders will be supported through appropriate on-station and field demonstration plots, and by developing and delivering both on farm, regional and on-station stakeholder training courses to enhance the ability of farmers to grow high quality trees.

iii). Conducting high quality research and providing high quality tree seed and planting stock for tree growing needs of Uganda (in fulfillment of ***Policy Statement 11***).

2.8 National Forest Plan (2011/12 – 2021/22)

The National Forest Plan (NFP) is a sector-wide national instrument for managing and utilizing forestry resources in Uganda. The NFP aims at contributing to the forest sector vision and goal enshrined in the Forestry Policy, and putting into action the policy statements contained therein. During the period of this strategic plan, the Tree Improvement and Germplasm Research Programme will contribute directly to program 8 (Forestry Research) and program 9 (Supply of quality tree seed and planting materials) of the NFP. The TIGRP will do this by implementing tree improvement programmes for

selected trees (e.g. *Vitellaria paradoxa, Carissa edulis, Warburgia ugandensis and Zanthozylum chalybeum*) as well as undertaking specific studies to generate knowledge about information gaps and transfer knowledge to stakeholders on relevant tree species in the country. During the period of this strategic plan, the TIGRP will also strive to supply quality tree seed and planting materials by innovating improved seed testing and storage procedures; producing quality seed, tree seedlings and other planting materials as well as multiplying and disseminating desired indigenous tree species.

2.9 The National Forestry and Tree Planting Act (NFTPA) (2003)

The NFTPA is the legislative framework for the forestry sub-sector. The NFTPA was enacted, to among other things, guide and cause the people of Uganda to plant trees to meet the needs of the present generation without compromising the rights of future generations. The TIGRP in the current period of the strategic plan will contribute to this by multiplying and disseminating various tree seed, seedlings and other tree germplasm for on farm growing.

2.10 The National Agriculture Policy (2013)

The National Agriculture Policy (NAP) was specifically designed to actualize an agricultural revolution in Uganda and the tree improvement and germplasm research programme will contribute to this through the improvement of tree species like clonal eucalyptus that will reduce pressure on indigenous tree species for fuel wood and shade for animals. Through diverse techniques, improved trees will be disseminated to farmers to increase food and nutrition security in the country. This will contribute the National Agriculture Policy's first objective of ensuring household and national food and nutrition security for all Ugandans.

3.0 Situational Analysis

The TIGRP aims at developing its research capacity in tree improvement. However, to progressively move on, it has considered its strengths, weaknesses, opportunities and threats as indicated below:

3.1 Strengths

- Presence of committed multidisciplinary staff
- Availability of research infrastructure e.g. greenhouses and land.
- National mandate of NaFORRI to handle forestry research in the country
- Existing partnerships with local, national, regional and international bodies

3.2 Weaknesses

- Limited staffing levels to address the strategy and respond to rapidly emerging opportunities
- Insufficient infrastructure e.g. Lack of laboratories, stores etc.
- Financial insufficiency to operate and expand the activities of the programme

3.3 Opportunities

- The positive perception of tree improvement as a novel area that has the potential of improving trees for their products and services

- A diversity of stakeholders who can participate in shaping the programme
- Accelerated interest in investment in forestry plantations (Demand for innovative solutions to forestry investment issues-rotation, pest and disease control, etc.).

3.4 Threats

- Uncertain funding bottlenecks.
- Pests and diseases out breaks
- The changing environmental conditions
- The long term nature of the tree rotation hence affecting funding/ payback duration

4.0 Strategy for Implementation

4.1 Aspirations of the Tree Improvement and Germplasm Research Programme

The TIGRP desires to be the regional 'go to' place for anyone seeking to understand issues related to breeding and germplasm management in forestry. In order to achieve this aspiration, TIGRP will combine innovative, high quality research with investment in strategic outreach and partnerships, including keeping abreast of and offering connections to the work of related organizations while being fully gender responsive.

4.2 Goal, Mission, Vision and Core Values

Goal: To identify, develop and conserve superior genotypes of economically important and well adapted tree/plant species in Uganda.

Mission: To conduct tree improvement research, provide information and technologies for enhanced productivity of forestry and allied natural resources for social economic development.

Vision: To be an internationally recognized centre of excellence in tree improvement research, development and technology transfer.

Core Values: The Tree Improvement and Germplasm Research Programme operates under an environment that is guided by:

a) Creativity and innovation
b) Professionalism
c) Gender responsiveness
d) Integrity
e) Team work
f) Clean and healthy environment
g) Partnership

4.3 Research Areas

4.3.1 Improvement of suitable trees for health, food security and nutrition

Figure 1: Grafting experiments for *Vitellaria paradoxa* (shea butter) trees, an important tree species in local livelihoods and food security

Rural households and communities in Uganda rely heavily on tree resources for their livelihoods. Tree resources are particularly vital in guaranteeing food and nutritional security, energy, shelter, incomes and environmental services. A diversity of wild food, medicinal and high value plants occur in the natural vegetation of the country. According to the FAO (2003), Uganda's loss of forest cover continues at an alarming rate of 2.0% per annum. This has led to high value tree species such as *Prunus africana, Carissa edulis, Warburgia ugandensis, Zanthoxylum chalybeum, Entanda abyssinica* and many others to be threatened with extinction.

Rural communities in Uganda depend on many wild food plants, which however, are greatly under-researched (Agea *et al*. 2011). There is need of adapting, planting and intentionally managing the wild food plants. Therefore, our research will aim at investigating all aspects, from the genetic level to domestication, of trees for health, food security and nutrition threatened high value plant species.

Figure 2: Stem cutting propagation of *Carissa edulis,* an important medicinal tree species

4.3.2 Improvement of appropriate trees for timber (and energy)

Our research will improve trees to meet the increasing demand for high quality timber and energy. This will also involve multiplication and promotion of the use of high quality planting materials of original genetic material for forest establishment in Uganda. Whereas the immediate solution to the timber and biomass energy demand is tree planting to increase supply, there is need for improvement to reduce maturity and maintain the quality of trees.

The demand for high quality timber and energy trees will be met through:

1) Reducing **rotation of timber and energy tree species.** Deliberate emphasis will be put on indigenous traditional tree species to reduce their rotation and maintain wood quality. Indigenous species are unparalled for their wood qualities but have long rotation species for energy.

2) **Increasing quality of emerging timber and energy tree species.** Our research will emphasize improving the quality of the emerging timber and energy species most available on the market. For example, an increase in per capita seed production of *Jatropha curcas* can increase oil production as well as productivity (Turinayo *et al.*, 2015). This can improve the economic viability for investment in *Jatropha curcas* (Shinoj *et al.*, 2010; Van Eijck & Romijn, 2008; Wahl *et al.*, 2009). Other critical and economically important oil trees include *Vitellaria paradoxa, Balanites aegyptiaca, Aleurites molucanna*, and a range of others. Oil tree improvement will therefore focus on combining tree traits for increased oil production and oil quality.

3) Improving trees for pest and disease resistance

The changing climate is attracting many pests and diseases in forest trees. The Eucalyptus gall forming wasp (*Leptocybe invasa*) is one of the pests that have invaded Uganda and caused considerable economic losses to some farmers (SPGS, 2015). The demand for resistant and tolerant varieties is timely.

The following technologies will be used:

- Cloning biotechnology as it has been demonstrated to yield superior gains in *Eucalyptus* maturity age. Clonal trials of selected species will be established.
- Marker Assisted Selection as an approach to identify superior genotypes before field trials. Clonal tests will be correlated to field performance and molecular markers to ascertain superior genotypes.
- Efficient management of pollination and grafting programmes in tandem with somatic embryogenesis and cryopreservation for different species identified for timber and energy.
- Genetic variation and economic value of various traits contributing towards the desirable properties of timber and energy species.

4.3.3: Development of a robust tree seed sector

The government of Uganda supports forestry development as a key approach for environmental protection, climate change amelioration, poverty reduction, food security and economic development. In the National Forest Plan, the government focuses on enhancing forest production and productivity, access to markets, creating an enabling environment, and institutional development. A robust seed sector in Uganda will contribute to integral forest development that contributes to all the aspects of forestry. Seed sector development intends to build upon the strengths of both the informal (farmers and community-based) and formal (public and private) seed systems and seek for their integration to build a strong sector.

Seed sector development will be guided by specific interventions in identified seed systems, linking superior tree quality with the provision of quality forest products to private sector development; and aligning and harmonizing seed policies, programmes and practices in Uganda (Zomer *et al.* 2009). Supporting the development of superior tree seed sector in Uganda requires tree improvement research which will substantially contribute to increased food security and household livelihood improvement. This will involve the setting up of a

one stop tree seed laboratory where seed research is conducted. Our research programme will focus on developing a vibrant, pluralistic and market-oriented tree seed sector through seed research to enlighten both the public and private sectors in seed and seedling productivity, marketing and utilization.

4.4 Strategic Objectives and Outputs

Tree improvement and forestry development rely on a series of interlinked activities in order to enhance the provision of forest products and services. Without these activities, it is impossible to imagine how tree improvement and germplasm research can make a significant impact on the forestry sector in Uganda. Therefore, the following strategic objectives are envisioned to guide the delivery of this strategy during the ten year period:

4.4.1 Strategic Objective 1: To establish a participatory breeding programme for priority tree species for enhanced provision of tree products and services

During the ten year period of this plan, the TIGRP will establish and implement a rigorous and participatory breeding programme for priority tree species involving cutting edge research. Participatory plant breeding is a strategy used to strengthen on-farm conservation by encouraging farmers to search, select, and manage local seed supply systems. In so doing, the farmer's role in setting breeding goals and selecting diverse genetic materials will be consolidated. During this strategic planning period, the priority species for participatory breeding will include *Vitellaria paradoxa* and *Warburgia ugandensis*, important oil and medicinal trees respectively.

Strategic Outputs (SO)

SO 1.1: Seed system and seed flow for 10 priority tree species among local communities determined by 2016.
SO 1.2: Rates and mechanisms of seed flow among the two species among local communities determined by 2020.
SO 1.3: Base populations of selected tree species with high genetic diversity identified for utilization and introduction into the breeding program by 2021.
SO 1.4: Participatory breeding network of local communities established to improve on provision of goods and services from the two priority tree species by 2025

4.4.2 Strategic Objective 2: To identify, propagate and multiply priority tree species for health, food security and nutrition

Propagation involves the selection of appropriate plant material, treating it with fungicide and plant growth substances, use of suitable growing media and subsequent location in the environmental conditions will enhance plant growth. The success rate depends upon the best combination of factors for that particular plant species. The selection of plant material for propagation is usually made from plants that display particular desirable characteristics. These may be related to flower color and size, time of flowering, vase life, the habit of the plant or adaptability to certain environmental and cultural conditions. To complement and

contribute to the availability of planting material, the TIGRP will in the next ten years perfect the propagation techniques of priority tree species for health, food security and nutrition.

Strategic Outputs (SO)

SO 2.1: Thirty priority tree species for health, food security and nutrition identified by 2017
SO 2.2: Appropriate propagation methods and protocols for priority tree species for health, food security and nutrition developed by 2019
SO 2.3: Progeny and Provenance trials of priority tree species established and managed for food security and nutrition by 2025

4.4.3 Strategic objective 3: To conduct tree seed research for sustainable seed supply in Uganda

Due to increased interest to conserve a wide range of forestry tree species, there is need to know how to process and conserve the seeds of a given species in an optimum and cost-efficient way. At present, information on seed storage behaviour (i.e. survival and longevity of seed under various storage conditions) is available for only a small percentage of tree species (Hong and Ellis, 1996). During the period of this strategic plan, the TIGRP will conduct research and establish protocols for (i) seed storage behaviour for tree species in which information is currently lacking and (ii) recommend appropriate environments for medium-term and short-term seed storage for species with intermediate or recalcitrant seed storage behaviour. The Programme will also establish important next generation improved tree species trials and nursery production systems for education and training of forestry professionals, nursery practitioners, conservation biologists, and public and private individuals.

Strategic Outputs (SO)

SO 3.1: Tree seed collection areas in Uganda identified and mapped by 2019
SO 3.2: Tree seed handling techniques (collection, processing, storage and packaging) improved by 2018
SO 3.3: A laboratory for generation of improved tree seed technologies established at NaFORRI by 2022
SO 3.4: Capacity of tree seed collectors, suppliers and nursery operators in Uganda enhanced for quality germplasm and networking by 2025

4.4.4 Strategic Objective 4: To establish and maintain *in-situ* and *ex-situ* collections of genetically diverse, priority tree species in Uganda

Genetic resources form a very deep-seated foundation for a country's heritage. The establishment of large, tree-gene pool specific germplasm collections can significantly assist in breeding programmes and the maintenance of a nation's heritage. Germplasm collections are, no doubt, an important precursor to a more systematic, well-coordinated approach to conservation of threatened germplasm and can lead to the development of an effective, long-term conservation programme of useful tree genetic resources. Whilst attention will be paid to conservation of threatened tree genetic resources during the period of this strategic

plan, in-situ conservation will also be addressed by conservation and management of genetic resources in their natural or traditional environments.

The TIGRP will utilize the recent advances in molecular genetics, genomics, modern biotechnology, bioinformatics and conventional approaches, such as techniques in in-vitro and cryopreservation to establish genetically diverse conservation collections of priority tree species in the country. Recommendations on the most suitable germplasm will therefore be passed on to the Tree Conservation and Management Programme which will promote the growing of such superior germplasm. This will form a strong point of synergy between the TIGRP and other research programmes at the institute.

Strategic Outputs (SO)

SO 4.1: Conservation status of priority tree species assessed and documented by 2021
SO 4.2: Genetic diversity of priority tree species determined and mapped by 2022
SO 4.3: Base populations of tree species with high gene conservation value identified by 2025
SO 4.4: In-situ and ex-situ gene banks of priority tree species established and managed for future breeding research by 2025

4.4.5 Strategic Objective 5: To develop and maintain sustainable means of mobilizing financial resources for facilitating tree improvement and germplasm research for development

During the implementation period of this Plan, the TIGRP will strive to seek strategic partnerships and funding mechanisms to enhance research outputs for the country. In doing this, the Programme will always carry out a “soul searching” process in light of the current globalization (increased inter-connectivity), greater opportunities available for individual talent, partnership and engagement as well as cutting edge innovation. The Programme realizes that presently, resource providers now prefer to be called “investors”, as opposed to “development partners” before now, and “donors” in the 1990s. The investors are interested in supporting agile inter-disciplinary start-ups, innovation platforms, incubators that can ably demonstrate capacity to generate innovations for addressing grand global challenges and delivering goods and services to millions of people while maximizing benefits/value and minimizing waste. The emphasis will be placed on “lean thinking” i.e. organizing staff activities to deliver goods and services using lesser resources (human, finance, natural and physical). Therefore, in partnership with identified investors, the TIGRP will form multi-institutional, multi-stakeholder, multi-sectoral innovation platforms using the Innovation Systems Approach to address major constraints that have solutions in tree improvement and germplasm research and thereby contribute to improved livelihoods.

Strategic Outputs (SO)

SO 5.1: Research funding from off-budget projects enhanced by 2025
SO 5.2: A diversity of strategic partnerships with investors as well as research and development organizations created by 2025

SO 5.3: Staffing levels in the TIGRP enhanced through increased funding of research activities by 2025

SO 5.4: Research capacity in the TIGRP enhanced through strategic advanced training of staff at MSc and PhD level by 2025

4.5 Implementation matrix

Table 1. Matrix for implementation of the Strategic Plan

Strategic Objectives	Indicators	Milestones	Strategic activities	Years									
				1	2	3	4	5	6	7	8	9	10
To establish a participatory breeding programme for two priority tree species (*Vitellaria paradoxa* and *Warburg is ugandensis*) for enhanced provision of tree products and services	1. No. of local seed systems identified for the two species among local communities in Uganda 2. Rates and mechanisms of seed flow among the two species determined among local communities determined. 3. No. of populations of the two species identified for implementation of a breeding programme. 4. No. of local communities identified and participating in breeding programmes for the two priority tree species	1. Genetic diversity of the two priority tree species determined by Year 3 2. Desirable traits among the two priority tree species identified and linked to Quantitative Trait Loci (QTL) and Single Nuclear Polymorphisms (SNPs) to form a breeding programme for the two priority species by Year 4. 3. Breeding value of the two selected priority tree species documented by Year 6	Socioeconomic study of the importance and useful traits for breeding of the two species	■									
			Characterization of genetic diversity and identification of QTLs and SNPs of the two species		■	■	■						
			Marker Assisted Selection (MAS) of plus trees and base populations			■	■	■	■				
			Establishment of experiments to breed for desired traits						■	■	■	■	■
To identify, propagate and multiply priority tree species for health, food security and nutrition	1. No of priority tree species identified for health, food security and nutrition identified 2. No of technical protocols developed for the propagation of priority trees species 3. Quantity of tree germplasm multiplied and disseminated 4. No of progeny and provenance trials of priority tree species established and managed for food security and nutrition	1. Priority tree species for health, Food security and Nutrition identified by Year 2 2. Progeny and Provenance trials of priority tree species health, food security and nutrition established by Year 8 3. Priority species multiplied and disseminated to farmers by Year 6	Identification of priority tree species for health, food security and nutrition	■	■								
			Collection and propagation of priority tree species		■	■	■						
			Establishment of progeny and provenance trials of priority tree species					■	■	■	■		
			Multiplication and dissemination of germplasm for priority trees species						■	■	■	■	■
To conduct tree seed research for sustainable seed supply in Uganda	1. No of tree seed collection areas in Uganda identified and mapped 2. No of tree seed handling (collection, processing, storage and packaging) protocols developed 3. A laboratory for generation of improved tree seed technologies established at NaFORRI 4. No of tree seed	1. Tree seed collection areas in Uganda identified and mapped by Year 3 2. At least 2 functional nurseries established and providing tree seed research functions by Year 3 3. Laboratory infrastructure (equipment, materials and buildings) procured and established by Year 8	Identification and mapping of tree seed collection areas	■	■	■							
			Establishment of tree nurseries for research and germplasm production		■	■							
			Construction of tree seed laboratory at NaFORRI				■	■	■	■			
			Procurement of laboratory equipment and materials						■	■	■		

	collectors, suppliers and nursery operators in Uganda trained 5. No of networks for improved tree seed handling facilitated	4. Two hundred fifty seed collectors, processors, suppliers and nursery operators trained by Year 10 5. Linkages with tree seed companies, private sector and networks strengthened (continuously)	Training of tree seed collectors, processors, suppliers and nursery operators	
			Strengthening linkages with tree seed companies, private sector and networks	
To establish and maintain in-situ and ex-situ collections of genetically diverse, priority tree species in Uganda	1. No of species whose conservation status is documented 2. Genetic profiles of priority tree species developed 3. No of base populations of tree species with high gene conservation value identified 4. No of In-situ and ex-situ gene banks of priority tree species established and managed for future breeding research	1. Conservation status of priority tree species determined by Year 6 2. DNA database of priority tree species developed by Year 7 3. In-situ and ex-situ gene banks established by Year 10	Assessment of conservation status of priority tree species	
			Characterization of genetic diversity of priority tree species	
			Establishment of in-situ and ex-situ gene banks	
To develop and maintain sustainable means of mobilizing financial resources for facilitating tree improvement and germplasm research for development	1. No of off budget projects implemented 2. No of strategic partnerships with investors as well as research and development organizations created 3. No of staff employed on both government and off-budget projects in the Programme 4. No of scientists at PhD and MSc level performing research activities in the Programme	1. At least 1 large off-budget project proposal developed and submitted to investors and research partners each year (continuous) 2. At least 3 strategic partnerships (in line with the Programme Focus Areas) established with investors, R4D institutions as well as the private sector to promote research and source for funding support by Year 5 3. At least 14 scientists, 14 technicians and 32 casual workers employed by the Programme by Year 10 4. At least 6 scientists and 7 technicians trained up to PhD and MSc level by Year 10	Identification of funding priorities and submitting responsive research proposals	
			Identification and negotiation of strategic partnerships with investors, R4D institutions, private sector as well as eminent scientists	
			Identification and recruitment of relevant scientific and technical staff for the Programme	
			Strengthening the research capacity of the Programme through short and long training programmes	

5.0 RESEARCH AND MANAGEMENT CAPACITY

5.1 Human resource capacity

Over the next ten years, the TIGRP will endeavor to deliver quality services through transformation of its human resource capacity and cultivating a motivated, engaged and professional work force for continuous performance improvement. Staff skills and capacities will be enhanced by monitoring and evaluating the effectiveness of the human resource. The TIGRP will develop a robust system for setting performance targets and monitoring performance as well as personal development. In addition, the Programme will also enhance and implement systems for recruiting, managing and retaining staff with the right competencies in line with TIGRP skills requirements. This will be done by identifying special programmes for staff exchange and attachment arrangements with other research institutes for development of expertise and building staff exposure.

5.2 Human resource requirements

In 2015/2016, the TIGRP had a total staff establishment of 10 staff comprising of 5 research scientists and 5 technicians. In addition, the Programme was benefitting from the services of 18 casual workers who were distributed as follows: Clonal Eucalyptus nursery (12), General tree nursery (3) and Greenhouses (3). Based on an internal programme staff strength analysis, the TIGRP needs to hire and nurture pre-eminent scientists who will build credibility of the research programme as well as be highly competitive for research grants. The optimum staffing level required to deliver this Strategic Plan would therefore be 14 scientists, 14 technicians and 32 casual workers. These would be distributed as follows:

Table 2. Human resource capacity and requirements for the TIGRP for execution of the Strategic Plan

	Scientists		**Technicians**		**Casual workers**	
	Available	Required	Available	Required	Available	Required
Socioeconomics	0	1	0	1	0	0
Biometrics	0	1	0	1	0	0
Tree breeding	0	3	0	2	0	4
Clonal tree nursery	0	2	2	2	12	15
Horticulture/plant propagation	2	2	1	2	3	8
Tree seed technology	1	1	0	2	0	2
General tree nursery	0	2	1	2	3	10
Molecular biology/ Gene conservation	2	2	1	2	0	4
	5	**14**	**5**	**14**	**18**	**32**

In the short run (5 years), the variance in the staffing levels and skills required will be bridged through recruitment to bring new talent, use of internships and students on attachment in order to empower the upcoming young people, partnerships, contracted staff for some projects or short term assignments (e.g. volunteership), systematic training to equip existing staff with relevant skills, knowledge and attitudes. On the basis of the above outlook for required staff in the TIGRP, implementation of this strategy will be geared towards attaining the following levels of staff capacity:

Table 3. Staff Qualifications or research capacity requirements (in the short run) for implementation of the Strategic Plan

Discipline	Level of Training			
	PhD		MSc	
	Available	Required	Available	Required
Socioeconomics	0	0	0	1
Biometrics	0	0	0	1
Tree breeding	0	2	0	1
Clonal tree nursery management	0	0	0	2
Horticulture/propagation	0	1	3	1
Tree seed technology	0	1	1	1
General tree nursery management	0	0	0	2
Molecular biology/genetics	1	2	1	0
	1	**6**	**5**	**7**

It is envisaged that the socioeconomics and biometrics units will be cross cutting across the institute and the programme will utilize the expertise that will be available in the pool.

5.2 Financial resources

Tree Improvement research has direct benefit in contributing to the conservation of natural resources, enhancement of food security and poverty reduction. However, there is perpetual under-investment in research in developing countries, such as Uganda. There is therefore urgent need to find alternative institutional mechanisms for sustained financing of tree improvement research. Such alternative mechanisms include joint public-private sector ventures, sale of research products, competitive funds, research foundations and farmer managed levies on production.

5.2.1 Projected funding

Tree improvement and Germplasm Programme funding requirements for the planned period 2016 – 2025 is estimated to be 16.215 billion Uganda shillings as in the table below.

Table 4: Budget projections for the period 2016/17–2025/26

Budget by sources (UGX millions)

Year	16/17	17/18	18/19	19/20	20/21	21/22	22/23	23/24	24/25	25/26	TOTAL
GoU	20	25	30	35	40	45	50	55	60	65	**425**
Investors	300	500	800	900	1,200	1,500	1,800	2,100	2,400	2,700	**14,200**
NTR	100	105	110	115	120	125	130	135	140	145	**1,225**
PPP	-	5	10	30	40	50	50	50	60	70	**365**
TOTAL	**420**	**635**	**950**	**1,080**	**1,400**	**1,720**	**2,030**	**2,340**	**2,660**	**2,980**	**16,215**

5.2.2 Strategies for resource mobilization

The main sources of funding for the Tree improvement and Germplasm Programme will be GoU development fund and development donors (ATAAS), non-taxable revenue generated

by TIGRP units including clonal eucalyptus nursery, general tree nursery and green houses. These are likely to continue being the main sources of funds for the Programme. The Programme will employ various strategies to mobilize additional financial resources as detailed below.

5.2.2.1 Government funding

It is notable that Government of Uganda funding has been very small compared to funding from other sources. To meet increasing demand for research outputs and considering the role of tree improvement research in enhancing the value of forestry and its contribution to GDP, the TIGRP will lobby for enhanced financial support from the Government of Uganda.

5.2.2.2 Support from Investors

Tree improvement and Germplasm Research Programme will source funding opportunities from international development donors such as USAID, Bill and Melinda Gates Foundation, UNDP, EU, World Bank amongst others. Strengthening linkages with ICRAF in developing joint proposals is also seen as one way of enhancing the programme's competitiveness in this regard.

5.2.2.3 Internally generated funds (NTR)

Research programmes can help fund their activities by commercializing their research outputs. The TIGRP has three Non-Tax Revenue units which include the clonal eucalyptus nursery, Green houses and the General Tree Nursery. Sale of seedlings and related germplasm will be maximized to form part of the internally generated funds of the Programme. These funds will be passed on to the Institute Finance Department and will form part of the NTR budget releases for Programme activities.

5.2.2.4 Public Private Partnerships (PPP)

The private sector contains huge potential in terms of increasing funding to research system. The private sector can often be pivotal in research partnerships and can provide funds which can provide impetus for generation of research outputs. During the ten year implementation period of this Plan, the TIGRP will explore all possibilities and form partnerships with the private sector (in a PPP arrangement) to bolster research funding.

5.2.2.5 Competitive Research Grants

Competitive funding through grants can enhance the implementation of research activities, lower costs, and help build a more demand-driven research system. The TIGRP intends to position itself to compete for research funds by writing award winning research proposals. The funds generated from competitive research proposals will therefore complement those from Government of Uganda appropriations.

5.2.2.6 Partnerships and membership in international research networks

There are several sub-regional, regional and global networks that coordinate, fund and execute research activities related to tree improvement. Examples of these include Association for Strengthening Agricultural Research in Eastern and Central Africa (ASARECA), Regional Universities Forum for Capacity Building in Agriculture (RUFORUM), Forum for Agricultural Research in Africa (FARA), Consultative Group on International Research (CGIAR), International Union of Forestry Research Organizations (IUFRO), International Tropical Timber Organization (ITTO), and others. Although many of these organizations and networks require membership and contributions from governments, agencies or institutes, often they require partnerships in addressing emerging research needs. It is also increasingly realized that much more harmonization is needed, both in funding and execution of research in order to effectively tackle cross-boundary challenges. The TIGRP will therefore endeavor to tap into these regional and international networks to participate in their initiatives to enhance Programme funding.

5.3 Infrastructure or facilities for the Programme

TIGRP hopes to create a working environment that facilitates research activities and communication of technologies. This will be done through the acquisition of relevant research infrastructure and rehabilitation of those that already exist. The approach is described appropriately under each research unit as follows:

5.3.1 Clonal Tree Production Unit

Figure 3. Clonal eucalyptus production facility at NaFORRI

This unit operates a clonal eucalyptus nursery comprising of a mother garden and a clonal plantlets production facility that includes a pump house, screen house and hardening off yard. The unit also operates all the propagation work of the programme and as such is currently operating the propagation tunnels for *Zanthoxylum chalybeum* and *Carissa edulis* which are under research by the programme. This unit is charged with generation of Non-Tax Revenue in addition to training, generation and dissemination of technologies. During the implementation period of this Plan, this unit will endeavor to provide information and quality tree planting materials (germplasm) that compliments government policies and environmental initiatives by setting standards and economics in forestry investments.

The present capacity in the clonal eucalyptus mother garden is 10,000 rammets with an annual production capacity of 120,000 clonal plantlets. The next ten years of implementation of this Plan will therefore focus on expanding and revamping the operational sections including the mother garden, production house, shed/screen houses, hardening off section, pump house stores (for materials and supplies).

5.3.2 Horticulture Unit

Figure 4. Green house facility used by the Horticulture unit for research and germplasm multiplication

This unit operates the greenhouse facilities of the Programme that comprise of a fully automated as well as manual greenhouse. The current activities include production of trees for health, nutrition and income, including mangoes, avocado, shea butter, Prunus, Mellea, citrus, etc. This unit is also charged with generation of Non-Tax Revenue in addition to training, generation and dissemination of technologies. However, this unit is only becoming functional after the recruitment of relevant personnel.

Although tree planting in the country has achieved enormous successes in Uganda, there are very serious incidences of diseases and low production mainly due to the use of poor quality seed and seedlings/germplasm. One low-cost method to meet the enormous demand for suitable, disease-free tree planting material is the use of tissue culture techniques. For full research and rapid multiplication of tree germplasm in the horticulture and plant propagation unit of the Programme, one of the focal areas during the next ten years will be the acquisition of a plant tissue culture laboratory. This will be the first tissue culture facility in the country dedicated solely to research and multiplication of tree germplasm.

5.3.3 Tree Seed Technology Unit

This unit is still under development although it has already made substantial contribution to the acquisition and processing of seed for the institute. This unit is intended to acquire, process and deliver quality seed for all the institute programs and projects upon request and facilitation. This is not yet the case but it is intended that this will be a service unit for the institute. Although the unit is presently staffed with a highly motivated and professional scientist, it still needs to recruit support staff (laborers/workers) that are an essential component of seed processing.

Figure 5. Packaged seed from the Tree Seed Technology Unit at NaFORRI

In the next ten years of implementation of this Plan, the TIGRP will focus on acquiring seed technology (ISO certified) laboratory for research, education and training. The seed technology laboratory will conduct research and offer commercial services involving tests such as germination, purity, vigor, viability, disease as well as varietal identification.

5.3.4 Molecular Biology Unit

This unit is still under development although it has already made substantial contribution with regards to genetic characterization of forage for improved dairy production in Uganda. This unit forms the core of the Programme as it provides the basis (genetic information) upon which tree improvement decisions are made. Although the unit is presently staffed with a highly motivated and professional scientist, it still needs to recruit support staff (laborers/workers) that are an essential component of molecular laboratory work.

In the next ten years of implementation of this Plan, the TIGRP will focus on acquiring at least a class II Molecular Biology and Biotechnology Laboratory for research, education and training. The Programme intends that the laboratory will offer research and commercial services such as reagent preparation, pre-extraction sample preparation, DNA and protein extraction, amplification, gel electrophoresis, Sequencing, etc. Commercial services will help to subsidize the running costs of the laboratory.

6.0 STRATEGY FOR MONITORING AND PERFORMANCE EVALUATION FRAMEWORK

Monitoring and evaluation is critical for building a strong evidence base around the actions intended and those being implemented. The purpose of monitoring and evaluation is to track implementation and outputs systematically, and measure the effectiveness of the tools, approaches, logistical application and personnel in achieving timely planned objects. It is therefore an important tool for identifying and documenting successful activities and approaches and tracking progress toward common indicators across related objectives. During the course of implementation of this Plan, monitoring and evaluation will form the basis for modification of interventions and assessing the quality of activities being conducted. Our strategy for monitoring and evaluation is to approach it at three levels as described below:

6.1 Advisory Committee Level

The NaFORRI Advisory Committee plays a very important policy guidance role and their contribution in monitoring and evaluation of Institutional Programme activities is very paramount. The development of policy related advice from the TIGRP has to meet institutional requirements and shall therefore be screened and vetted by the Advisory Committee before being published. The Advisory Committee shall therefore monitor, evaluate and provide guidance to research activities on key aspects in the TIGRP work plan and outputs. This will be done through review and vetting of work plans and budgets as well as important policy documents.

6.2 NaFORRI Management Level

NaFORRI management will monitor the performance of TIGRP through review of annual/quarterly work plans and the actual deliverables (outputs) achieved during the reporting period. The TIGRP is required to provide routine back to office/monthly/quarterly and annual Units/Programme reports to the institute management. The institute management will therefore utilize these reports to evaluate performance. In addition,

management will monitor the performance of this Plan through regular visits to project sites and/or TIGRP units/laboratories

6.3 Programme Management Level

The Programme Leader is responsible for the day to day supervision of the activities that are implemented in the TIGRP. With the help of Project Leaders and Unit Managers, the Programme Leader will identify any short falls from the plans well in time and apply remedial approaches.

7.0 RISK MANAGEMENT STRATEGY

Table 5. Risk Management Strategy for implementation of the Strategic Plan

Risk	Risk Level	Risk Rating	Risk Control measure	Responsibility	Time Frame
Lack of ISO Certified research infrastructure	Institute	High	International certification for tree improvement/breeding research facilities	Director	Annual
Inadequate Resources	Programme	High	Develop funding proposals, partner with private sector, enhance internal revenue	Programme Leader; Project Leaders	Continuous
Departure of staff	Institute	High	Increase staff incentives and welfare.	Director	Annually
Poor workers' health and safety	Programme	High	Provide safety tools and training to staff	Programme Leader (NaFORRI)	Annually
Low prestige	Programme	Medium	Recruit and/or collaborate with eminent scientists, build research capacity, conduct relevant research and produce viable outputs	Director (NaFORRI), Programme Leader (TIGRP)	Quarterly

8.0 COORDINATION AND MANAGEMENT OF THE STRATEGIC PLAN

The coordination role of the activities in this Strategic Plan is bestowed on the Programme Leader (TIGRP). The Programme Leader will keep track of strategic outputs and ensure that the necessary inputs are made available according to the work plans and budgets. As the leader of the Programme, he/she will guide the resource mobilization strategy. He/she will engage Scientists and Technicians into writing funding proposals and lead the search for strategic partnerships.

This Strategic Plan will also be implemented in conjunction with other strategic partner institutions. In NARO, for instance, crop breeders and other biotechnology scientists at different ZARDIs/PARIs will provide focal points for collaboration. Other strategic partners in the implementation of this Plan will be Universities, Non-Government Organizations, Farmers and other research organizations. The TIGRP will also search for other potential partners to collaborate with on different aspects of Tree Improvement research.

The program will internalize her core values (i.e. aspiration for excellence, integrity, accountability, innovativeness, inclusivity and transparency) and adopt them as enduring tenets influencing the way the program will do business. In spite a hierarchical structure, the program will adopt an open-minded, inclusive and participatory leadership style to enable diverse viewpoints. The program activities will be guided by the program vision and mission.

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