AGROFORESTRY RWANDA - Improving resilience of farmers' livelihoods to climate change through innovative, research proven climate-smart agroforestry and efficient use of tree resources in the Eastern Province and peri-urban areas of Kigali city

Objectives of the project

The general objective is to increase the pace and scale of agroforestry-based restoration of degraded agricultural lands and sustainable use of biomass energy, with associated improvements in land health, livelihoods and poverty reduction.

The specific objective is to effectively understand and demonstrate the ecological, social and economic pathways to, and resultant benefits from, the scale-up of agroforestry-based restoration and sustainable biomass use in Eastern Province and in the peri-urban Kigali city of Rwanda.

Examples of agroforestry systems tested and to be promoted in Kigali Peri-urban(above) and Eastern Province of Rwanda (below)

Background

The economy of Rwanda is greatly dependent upon its land, water, and biodiversity resources, with the agriculture sector contributing about 29% of the GDP. About 96% of rural households rely directly or indirectly on agriculture for their livelihoods, and 85 to 95% of households use fuel wood as a source of cooking energy. Nonetheless, Rwanda is very vulnerable to climate change, ranking the twelfth most vulnerable country in the world (ND-GAIN Index). In recent years, extreme weather events increased in frequency and magnitude with floods and landslides reported in the Western province and Kigali City while drought devastated the Eastern Province. Furthermore, Rwanda has the highest population density in Africa (World Bank, 2015), and the rapid population growth in Kigali City and the Eastern Province has increased pressure on land, forest, and water resources. The large gap between supply and demand in fuel wood is leading to over-exploitation and degradation of trees/shrub resources (both in forest and crop/agroforestry lands) with consecutive exposure of soils to erosion.

In 2010, the Government of Rwanda, aiming to resolve these challenges, committed to restoring the ecological health of two million hectares of land, which essentially represents the whole country. This commitment was the first in Africa, and a foundational commitment to the Bonn Challenge, a global target to restore 150 million ha of degraded land by 2020. Agroforestry provides a potential restoration solution to land degradation in Rwanda, and the eastern province in particular, providing multiple benefits including the reduction of soil loss, an increase of wood biomass, plant and soil carbon, and soil nutrients, provision of essential farm resources such as livestock fodder, fruits, and fuel wood for cooking energy and construction materials. Evidence has shown a positive relationship between tree cover and indicators of children's dietary quality and increased consumption of fruits and tree leafy vegetables. Agroforestry products ranging from timber and firewood to fruits and nuts (e.g., macadamia) are all trade goods sold locally as well as in the sub-national, national, and regional commodity markets.

The Eastern Province of Rwanda targeted by this project presents 500,000 ha of agroforestry restoration potential (MINIRENA, 2014), while the peri-urban areas of Kigali City present particular

challenges including high population density and high climate disaster (landslide) risks. Agroforestry potential in these peri-urban areas is estimated at 40,000 ha with opportunities to develop horticultural value chains (MINIRENA, 2014).

The theory of change to achieve the objectives

The project seeks to increase the uptake of innovative agroforestry options by the farmers and foster greater resilience through economic and ecological diversification, generating higher farm productivity and more diversified food through capturing more value from high commercial and nutritious agroforestry products. The project is using an evidence-based approach to generate knowledge and to propose a more diverse portfolio of agroforestry-based landscape restoration options and improved cooking stove technologies suiting different landscapes and household circumstances in the Eastern province and peri-urban areas of Kigali city.

The theory of change of the project is built around five interlinked results: (i) Tested knowledge on scalable agroforestry systems and components suited to the Eastern Province and peri-urban areas of Kigali City from an ecological services perspective (including biodiversity, carbon sequestration, water retention, microclimate and productivity); (ii) Tested and proven knowledge in the further development and diversification of climate resilient, high nutrition value chains from agroforestry landscapes suited to the Eastern Province and peri-urban areas of Kigali city; (iii) Locally tested expertise and knowledge on high efficient, durable, affordable and user-friendly Improved Cooking Stoves (ICS) and their supply chains in the Eastern Province and peri-urban areas of Kigali City ; (iv) The most important socio-economic barriers to restoration and adoption of agroforestry practices in the Eastern Province and peri-urban areas of Kigali City are identified, tackled and new opportunities for economic incentives are implemented; (v) Institutional capacity to create enabling conditions for agroforestry-based landscape restoration and sustainable use of biomass energy enhanced.

The project is carrying out research on agroforestry systems including assessment of biophysical conditions and ecosystemic services provision (Result 1), on value chains development and market opportunities to promote high-profitable and nutritious agroforestry products (Result 2), and on the socio-economic characteristics of the farmers, the barriers to adoption of agroforestry and the profitability of agroforestry systems and agroforestry technologies (Result 4). This knowledge is building the foundation for addressing economic, ecological, and behavioural constraints to the adoption of agroforestry systems and improved technologies (from production to cooking stoves). The knowledge is translated into evidence that supports the adaptation, adoption, and scaling out of technologies and that inform policy decisions in agroforestry-based restoration activities. The project supports explicit gender transformative processes, understanding and prioritizing agroforestry-based landscape restoration, and ICS options that women and young people can benefit from. To be successful, this project intervention has been settled as being the research component of the TREPA program (Transforming Eastern Province through Adaptation) supported by the Green Climate Fund (GCF) and implemented by the International Union for Conservation of Nature (IUCN), the Belgian Development Agency (ENABEL), the Rwanda Forestry Authority (RFA), and the International Centre for Research in Agroforestry (ICRAF), which will apply and scale up, through a community-based approach and in strong collaboration with local District and Sector authorities, the best-tested agroforestry and cooking stoves technologies and practices into 60.000 ha of agroforestry and forestry landscapes of the Eastern Province (EP).

However, it is also assumed that sustainable agroforestry practices by smallholders will be reached out if the present and future availability of biomass energy is used sustainably (Result 3). For this purpose, the project is carrying out studies to understand the supply and demand of biomass and analyse the use of current cooking stoves by households and test different options of improved

cooking stoves. The project is modelling the supply and demand projection over the next 20 years of biomass energy for the EP and is developing tools allowing to play different scenarios, to support policy decision makers. The project provides technical assistance to local ICS producers to boost their expertise through iterative designs, testing, and production of locally adapted ICS models.

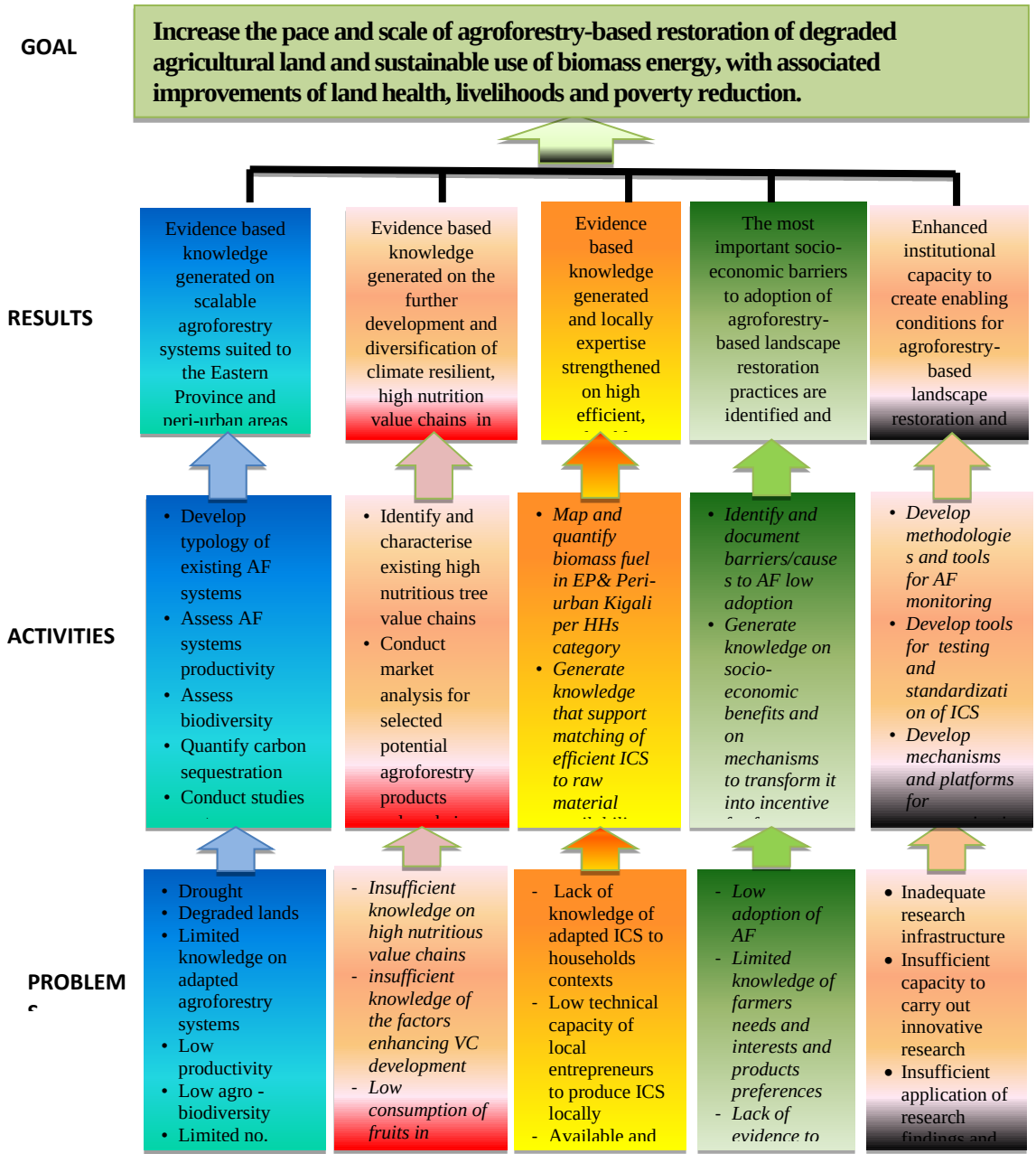

Figure 1. ***Theory of change of the project showing the causal pathways from problems through activities via results towards the project goal.***

Also for ease of understanding and uptake of innovative research results by farmers, private entrepreneurs and decision-makers, and to further facilitate the adoption of improved agroforestry technologies and innovations, it will be essential that actions have to be taken to remove the barriers through the development of new opportunities and economic incentives (Result 4). For this purpose,

the project is analysing transformational mechanisms that incentivize farmers to adopt agroforestry systems while testing the adoption answer from different extension methods and services.

On the basis of scientific knowledge and evidence generated, targeted institutional capacity development activities and dissemination of research findings are progressively undertaken (Result 5), particularly by involving and promoting active participation of all stakeholders including beneficiary farmer groups in the development of indicators, methods and monitoring tools, and by supporting knowledge sharing events.

Main activities

This Agroforestry Action-Research project is implemented mainly through 4 PhD fellowships provided to Rwandan Nationals who are conducting thematic research across the above-mentioned expected results of the project. These PhD research fellows are seconded by a number of Master's students who are conducting internship research on sub-themes in collaboration with the PhD fellows and their promoters. The developmental aspects of the project are implemented and coordinated on the field by the project management unit set up at both Enabel and IUCN.

The main activities are including:

Under Result 1:

- ✓ Typology assessment of existing agroforestry systems and components;
- ✓ Assessment and characterization of existing agroforestry systems productivity;
- ✓ Assessment of the tree's contribution to the conservation of biodiversity and support to ecological functions;
- ✓ Measurement of carbon sequestration potential across different agroforestry systems;
- ✓ Measurement and modelling of effects of trees on water balance in semi-arid landscapes;
- ✓ Assessment and modelling of microclimatic effects of the different agroforestry systems;
- ✓ Development of scenarios and simulation of trade-offs between various environmental and socio-economic benefits of different agroforestry systems.

Under Result 2:

- ✓ Identification and characterization of existing high nutritious (fruits /nuts/fodder) value chains;
- ✓ Analysis of markets for selected potential fruits, nuts, and fodder value chains.

Under Result 3:

- ✓ Assessing the biomass fuel resource potential of the Eastern Province and Peri-Urban areas of Kigali city, as well as modelling the sustainable supply of biomass, with a particular emphasis on sourcing options for different types of biomass fuels;
- ✓ Inventory of existing improved cook stoves (ICS) technologies and characterization testing for efficiency, fuel consumption, health effects, cooking behaviour, adaptability to locally available biomass and user acceptability;
- ✓ Cost-benefit simulations of changes in ICS technologies at household level context;
- ✓ Technical assistance to Small and Medium size Entreprises (SMEs) to boost their expertise through iterative designs, testing and production of locally adapted ICS models of Tiers 3 level.

Under Result 4:

- ✓ Investigating the barriers and causes of low adoption of agroforestry by generating evidence on key drivers to low adoption, as well as assessing real needs and expectations of the farmers;
- ✓ Determining the economic household level benefit and costs associated with adoption agroforestry under various scenarios while comparing with the non-adoption;

- ✓ Assess the willingness of farmers to pay for agroforestry ecosystem services (including both private household and societal benefits) ;
- ✓ Assess transformational mechanisms that incentivize farmers to adopt agroforestry systems ;
- ✓ Comparison of different agroforestry extension methods and services.

Under Result 5:

- ✓ Testing and adapting/improving the existing agroforestry monitoring and evaluation system in country by involving and promoting active participation of all stakeholders including beneficiary farmer groups in the development of indicators, methods and monitoring tools;
- ✓ Building the capacity of farmers and value chain stakeholders to uptake and apply appropriate agroforestry principles and practices;
- ✓ Training the key public agency (central and local) staff involved in agroforestry extension service delivery, by involving them in analysis and testing of incentive mechanisms, and producing technical guidelines and manual on incentive mechanism implementation towards large scale of adoption of agroforestry;
- ✓ Improving the national capacity in ICS testing and standardization;
- ✓ Set up a national platform to improve the coordination of agroforestry research and resultant application of policy actions, including the support of regular agroforestry conference to disseminate and exchange on research results.

Results achieved to date (May 2023)

On Result 1: Ecological services of scalable agroforestry systems and components

Typology and productivity of existing Agroforestry systems conducted showing 70% of plots with scattered trees. Intercropping is rare, rather 60% of plots are boundary planting.

- ✓ Effects of trees on water balance and microclimate in agroforestry semi-arid landscapes;
- ✓ Biodiversity, tree biomass production, and carbon sequestration potentials in agroforestry systems assessed in 10 districts;
- ✓ 6 farm plots established for soil-water balance and productivity in AF systems;
- ✓ 20 farm plots were established for biodiversity assessment in Nyagatare while 60 plots were assessed.

Effect of well managed agroforestry system on maize production in Gatsibo district
(Photo taken: EU delegation field visit in February 2023

On Result 2: Knowledge for the development and diversification of climate-resilient, high-nutrition value chains from agroforestry landscapes

- ✓ Existing high nutritious value chains (fruits) identified and characterized in the landscape, especially mango, avocado and macadamia nut.
- ✓ Market assessment for selected potential agroforestry value chains conducted.

On Result 3: Biomass inventories have been undertaken in forestry, agroforestry and shrubland (1,429 sample plots) in the overall landscapes of the EP to estimate the available wood stocks.

- ✓ 102 Permanent plots established in 2015 in agroforestry stratum have been re-measured to estimate their wood biomass supply capacity;
- ✓ Papyrus biomass and crop residue as sustainable alternative for cooking have been assessed;
- ✓ Import/Export of biomass from/to EP have been assessed;
- ✓ First draft of biomass supply/demand scenario models for the EP have been developed under LEAP software;
- ✓ The main ICS suppliers have been assessed and the currently used ICS have been tested in laboratory and in the field (Kitchen Performance Test);
- ✓ Household (HH) survey have been undertaken (960 HHs) to assess the current (baseline) use of different cooking technologies and fuels;

- ✓ A study has been conducted to analyse and identify potential ICS suppliers and ICS model with high opportunity for improvement and success for disseminating cooking stoves.

On Result 4: Socio-economic barriers to restoration and adoption of agroforestry practices have been identified, tackled and new opportunities for economic incentives were implemented

- ✓ Household survey (960 HHs), to generate knowledge on the current status of and barriers to agroforestry adoption in the Eastern Province;
- ✓ Farm-level counting of agroforestry trees (Nov-Dec 2021): The purpose of this activity was to get baseline on pre-existing agroforestry trees on about 3,000 farmlands;
- ✓ Field experiment to explore the existing extension methods, and to identify extension methods suitable for agroforestry adoption in the Eastern Province: (i) baseline survey on 560 selected households, (ii) training of 28 farmer promoters who will facilitate this implementation, and (iii) distribution of 21,000 agroforestry tree seedlings to households in treatment category. Level of adoption by category of extension/incentive treatment are still under assessment.

On Result 5: Increased institutional capacity to create enabling conditions for agroforestry-based landscape restoration and improved and sustainable use of biomass energy

- ✓ National research capacity improved through organized national conference on agroforestry in November 2022 for exchanging research findings and proposing improvement strategy to fill the gap in Agroforestry research capacity;
- ✓ Support the Ministry of Infrastructure / Energy Development Corporation Limited (MININFRA/EDCL) in the review of the Ministerial Guidelines on clean cooking technologies, approved in December 2022;
- ✓ Involved and train 2 operators of the Rwanda Standards Board (RSB) in the use of sensors for detailed measurement of ICS efficiency and cooking process;
- ✓ Agroforestry monitoring capacity by setting up indicators, methods and monitoring tools enhanced and training AF monitoring conducted;
- ✓ Capacity of farmers and fruit value chain stakeholders improved through a needs assessment of key actors, producers (cooperative), and existing financing incentives mechanisms for increased adoption and access to markets.

Organization

This Agroforestry Action-Research resulted from a joint application of the Belgian Development Agency (Enabel) in Rwanda and the International Union for Conservation of Nature (IUCN). A division of Action Results has been defined between the two institutions, whereby IUCN is responsible for the component of research on agroforestry systems (Result 1) as well as the value chains development (Result 2), while Enabel leads on results related to sustainable use of biomass energy (Result 3) and socio-economics of agroforestry-based landscape restoration (Result 4). The institutional capacity building (Result 5) remains cross-cutting in both components led by IUCN and Enabel.

Given that the main implementation approach of this research project is through the provision of PhD fellowships, IUCN is partnering with the University of Ghent (UG) and the University of Rwanda (UR) to train 2 PhD candidates, while Enabel is partnering with the University of Leuven (KUL) and UR to train the other 2 candidates. For the successful implementation, the project takes a multi-stakeholder approach, involving other in-country partners, mainly the International Centre for Research in Agroforestry (ICRAF) which is involved in the biomass supply capacity assessment, the Ministry of Environment (MoE) and the Rwanda Forestry Authority (RFA), the Rwanda Agriculture and Animal Resources Development Board (RAB), and the Ministry of Infrastructure (MININFRA) through its Agency, Rwanda Energy Group (REG) for the matters pertaining to biomass consumption, as well as the Rwanda Standards Board (RSB) for the testing and certification of improved cooking stoves.

While Enabel and IUCN ensure the day –to-day implementation and coordination of their respective results components, a steering committee chaired by the Ministry of Environment (MoE) and co-chaired by the EU Delegation in Rwanda (EUDEL) oversee the overall project results coordination. For the operational follow-up of the actions, a technical committee chaired and co-chaired by IUCN and Enabel is set–up. For the research protocols, methodologies, and results validation, a scientific committee bringing together all involved research institutions is also set up, and is coordinated by KUL.

Implementing organizations

IUCN is responsible for results 1, 2, and 5.
Enabel is responsible for results 3, 4, and 5

Partners of the project

University of Ghent, University of Leuven, University of Rwanda and ICRAF will be directly involved in the implementation of the project. Climate Solution Consulting has been hired to support the improvement of ICS prototypes.

Other main stakeholders

Ministry of Environment (MoE), Rwanda Forestry Authority (RFA), Ministry of Agriculture (MINAGRI) and Rwanda Agriculture and Animal Resources Development Board (RAB), Ministry of Infrastructure (MININFRA), Rwanda Energy Group (REG), and Rwanda Standards Board (RSB).

Location
Eastern Province of Rwanda (7 districts) and peri-urban areas of Kigali City.

Funding and co-funding

EU / IUCN coordination	€ 2,000,000
EU / Enabel coordination	€ 2,000,000
Total budget	€ 4,000,000

Duration
Five (5) years; February 2020 – January 2025

Website
www.desira-af-rwanda.org

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