Funded by
the European Union

==========

A RESEARCH ON CLIMATE RESILIENCE AND AGRO-ECOLOGICAL PRACTICES IN NYARUGURU, NYAMAGABE, NYAGATARE AND KIREHE DISTRICTS OF RWANDA

FINAL REPORT

Kigali, October 2021

ACKNOWLEDGEMENT

On behalf of the consortium implementing the E.U. Funded project called “ “, CCOAIB is recognising efforts of various stakeholders and partners towards availing this very important research findings’ report on climate resilience and agroecology practices in Rwanda, especially in the districts of Kirehe, Nyagatare, Nyamagabe and Nyaruguru. This is a helpful tool for policy engagement for a more climate resilient society with healthy soil, healthy food and healthy people.

First of all our gratitude goes to the European Union for the financial support provided to this research through the overall funding of the CRA project.

Many thanks to all the participants in this study, including Rwanda’s Government’s institutions (ministries, agencies and districts), the civil society organisations (both national and international NGOs) and Development Partners. The information provided will serve to increase climate resilience in Rwanda while promoting agroecology for a sustainable food-energy system.

A special appreciation goes to the small scale farmers of the above mentioned districts who, despite the covid-19 pandemic context, have kindly accepted to respond to the questions of the household survey and participating in the planned FGDs. The outcome of this study will contribute to strengthening their climate resilience and sustainable food security.

Finally, we really appreciate the scientific work done by the team of consultants led by Mr.Raphael Rurangwa and including Dr.Pascal Rushemuka , Dr. Alain Ndoli and Mr. Philippe Rumenera towards availing this report.

Executive Summary

CCOAIB together with OXFAM Germany, OXFAM UK/Rwanda, and DUTERIMBERE ONG received funds from the European Union to implement a project entitled "Rwandan CSOs Engage in Climate Resilient Agriculture and Sustainable Energy Initiative (CRA project)". Through this project, a research was commissioned on (i) climate resilience practices with a focus on food-energy systems and (ii) agroecological approaches with a focus on the agriculture sector in Nyagatare, Kirehe, Nyaruguru and Nyamagabe districts of Rwanda. As per the Terms of Reference (ToRs), the main goal of the research is to generate data and information that will help CSOs to ensure that relevant policies and plans on climate resilience reflect smallholder farmer's needs, thereby fostering sustainable rural development and food security.

This document is the Final Report. It sets out the work that the team of consultants has done from June 2021 to date on tasks. It documents the key findings from both quantitative and qualitative approaches: a desk review of existing relevant policy documents, the findings from the household survey that presents the existing and new agroecological approaches conducted in four districts, and Focus Group Discussion (FGDs). Key Informant Interviews (KIIs) with district officials, ministry officials, members of the civil society, academic, research institutions, and private sector members. The report includes our analysis of policy gaps, existing challenges, and opportunities for funding to advance adoption of agroecological practices and food energy system initiatives, reduce vulnerability, and avoid maladaptation in Rwanda.

Study results from the household survey indicate that; crop rotation, organic fertilizers, terracing, agroforestry and eco-friendly chemical fertilizers are the top five highly ranked agroecological practices (AEPs) among farmers, and the least common practices are cultural, biological control, and push and pull in terms of knowledge and practice. The study established the connection between farmer preferences of AEPs and the knowledge farmers have on it in general. Farmers' preference and adoption of AEPs is highly linked to the type of information and knowledge provided to them by extension services. The results show that if adequate knowledge is provided to farmers, adoption rates are expected to be high and consistent.

The household surveys confirmed that firewood is continuously still the most dominant source of cooking energy in rural areas, followed by crop residue, while charcoal was the primary source in urban areas, seconded by firewood.

Our review of policies relevant to agroecological approaches and food-energy system highlighted some gaps including; inadequate definition of AEPs and food-energy system, lack of clear indicators for the approaches in the policies and strategies, lack of institutionalization of agroecological approaches and food-energy systems, and limited focus on research for agroecological approaches and food-energy systems.

Some of the recommendations featured in this report include: need to institutionalize AEPs and increase coordination and planning to enhance the impact of AEPs interventions by fostering synergies at the policy level. There is a need for elaboration of clear and measurable indicators in line ministries, as well as, the development of a solid extension system for AEPs through resources and training on innovation to reach more farmers.

Table of Contents

Tables and figures

List of table

List of Figures:

Chapter 1. Background of the study

The global goals commonly known as the Sustainable Development Goals (SDGs) are a broad and universal policy agenda adopted in 2015 by all United Nations Members States and serves as a "call to action to **end poverty**, **protect the planet**, and ensure that all people enjoy peace and prosperity by 2030"[i]. Food and Energy are keys to achieve SDGs as they contribute to almost 100% of the global Greenhouse Gas (GHG) emissions (Ritchie, 2019[ii]). In the aftermath of the SDGs, voices have been raised again in favor of **Agro-Ecological approaches** as new **food system approach** more appropriate to achieve a **climate resilience agriculture** compatible with **climate change mitigation and adaptation** (Sinclair et al., 2019[iii]). The promotion of Agro-Ecology (AE) is by opposition to the current global food system/industrial agriculture which is unsustainable because, as currently practiced, is a major driver for climate change and the breaching of other planetary boundaries (Sinclair et al., 2019) as it contributes to 26% of global GHG emissions (Poore and Nemecek, 2018[iv]).

This high contribution of agriculture to GHG emissions is attributed in part to the significant use of fossil fuels and unsustainably harvested wood energy and biomass for cooking and heating (Bogdanski, 2012[v]). Continuing on this path is not an option as it is putting additional pressure on the already stressed natural resource base and local livelihoods, while climate change is further reducing the resilience of agro-ecosystems and smallholder farmers (Bogdanski, 2012). Agro-ecological approaches that combine both food and energy production, as agroforestry or integrated crop-livestock-biogas systems, could substantially mitigate these risks while providing both food and energy to rural and urban population (Bogdanski, 2012). Already in 2011, the former UN Special Rapporteur on this right to food, Olivier de Schutter has made strong advocacy of AE arguing that it can sustainably double food production in 10 years without harming the natural resource production base (de Schuter, 2011[vi]).

Acting as a facilitator to enable debates and foster collaboration among a variety of actors in order to advance science, knowledge, public policies, programs and experiences, FAO organized the International Symposium on AE for Food Security and Nutrition in September 2012 in Rome, Italy. This symposium was followed by three regional meetings in Sub-Saharan Africa, as well as meetings in Asia and the Pacific, and Latin America and the Caribbean. The Multi-stakeholder Consultation on AE for Sub-Saharan Africa was held in Dakar, Senegal on 5-6 November 2015 (FAO, 2016). More recently, after discussions among different schools of taught (Industrial versus AE agriculture), the UN Food System Summit to be held in September 2021, in New York, and whose presummit has occurred in July 2021 in Rome, unfortunately AE has finally not been retained as an important theme of discussion despite support of developing countries and their civil societies (IPES-Food[vii]).

In Rwanda, CCOAIB together with OXFAM Germany, OXFAM UK/Rwanda, and DUTERIMBERE ONG have received fund from the European Union to implement a project entitled "Rwandan Civil Society Organizations (CSOs) engage in Climate Resilient Agriculture (CRA) and sustainable energy initiatives (CRA project)". Through this project, CCOAIB and the consortium members commissioned a research on (i) Climate Resilience Practices, and (ii) Agro-

Ecological Approaches (AEPs) with a focus on Agriculture Sector in Nyagatare, Kirehe, Nyaruguru, and Nyamagabe Districts of Rwanda.

The main objective of the assignment is to generate data and information that will help CSOs to ensure that relevant policies and plans on climate change resilience reflect smallholder farmers' needs, thereby fostering sustainable rural development and food security.

The specific objectives of the assignment are:

1. Highlight policy and finance opportunities needed to advance mitigation strategies in food-energy systems, reduce vulnerability and avoid investments that unintentionally cause maladaptation;
2. Generate recommendations on best ways to build urban resilience to climate change, especially in poor, vulnerable communities of cities in Rwanda;
3. Document the existing and new agroecological approaches relevant to the Rwanda context and highlight some of these agroecological elements which could be quick and long term/big wins in mitigating and adapting to the effects of climate change in locations of the project;
4. Identify the main handles and needs of smallholder farmers in order to follow agroecological approaches that can benefit Rwandan smallholder farmers.

This report is structured as follows:
This short introduction is followed by a chapter of the definition and review of key concepts. The key concepts chapter is followed by a chapter of methodological approaches. The latter is followed by a chapter of results' presentation. The result presentation is followed by a general discussion, conclusion and recommendations.

Chapter 2. Description and Review of the Key Concepts

Agro-ecological Approaches

The agroecology concept, as a science, originated in 1930s when scientists started to use it as the application of ecological principles to agriculture, since that time, its scale and dimension had grown tremendously. In the 1960s, social concerns for the environment and opposition to industrialized agriculture gave agroecology another dimension as a form of social movement, in particular in Latin America, and in Western Europe to some extent. Later in the 1980s, Agro-Ecology (AE) applied more broadly to agroecosystem and from the 2000s on to the food system as a whole. The approach is often (mis-) understood as having a particular focus on soil fertility and the promotion of agrobiodiversity. alternatives to synthetic fertilizers and pesticides. Agroecology follows an ecosystem approach, builds on the co-creation of knowledge and covers also the promotion of local markets that reward producers with fair prices and the setting-up of local and regional processing and marketing networks (e.g. community supported agriculture).

Today, all three natures of agroecology as a science, a movement, and a practice, still co-exist. Scientific experts, practitioners, advocators, and producers contribute to make agro-ecology an approach to **producing, processing and consuming food that includes environmental, social and economic concerns**.

The current regain of interest of agro-ecological approaches is motivated by the unsustainability of the current food production system that is recognized to be a major contributor to climate change and the pressing need to achieve resilient agriculture compatible with climate change adaptation. Agroecological approaches involve the application of integrated ecological, economic and social principles to the transition of smallholder farming system, towards greater resilience. This involves adapting 13 generic agroecological principles (Table 1) to local circumstances. Adaptation is building on the traditional knowledge of farmers and further developed together with scientists and other stakeholders with the aim to co-create concrete, demand-led and context-specific solutions to pressing problems as they are experienced locally rather than imposing externally prefabricated solutions that may not be locally appropriate (Weiz et al., 2020[viii], Sinclair et al., 2019). Each principle is a summary of a very deep theory backed by one or more scientific disciplines (Table 1).

Table 1. Generic Agro-ecological principles and brief explanations

	Principle	Rationale	Description/Author's notes
1	Recycling	Preferentially use local renewable resources and close, as far as possible, resource cycles of nutrients and biomass.	Recycling is the cornerstone of AE as it a key for other AE principles (2,3, 4, 5 and 7). It combines the 2 principles of Conservation Agriculture (keeping biomass residues in situ, and limited soil disturbance). It is all about improving biological interactions and increasing soil organic matter stock/carbon sequestration and finally reduces dependence to external chemical inputs via improvement of soil physical, chemical and biological properties.
2	Input reduction	Reduce or eliminate dependency on external inputs	As soil properties improve through recycling, the need of fertilizer and pesticides reduce or even disappear, towards organic farming.
3	Soil health	Secure and enhance soil health and functioning for improved plant growth, particularly by managing organic matter and by enhancing soil biological activity.	Improving diversity above and below the ground, legumes, crop rotation, erosion control, minimum soil disturbance, permanent soil cover (by crop residues and/or cover crops, manure and agroforestry species). This is what soil science is all about. The soil pH and Total Organic Carbon are good earlier warning soil health indicators.
4	Animal health	Ensure animal health and welfare	Descent nutrition, lodgement and health care of livestock. The descent nutrition is guaranteed by growing diversified and balance fodder in own farm (integrated crop-livestock-system)
5	Biodiversity	Maintain and enhance diversity of species, functional diversity and genetic resources and maintain biodiversity in the agroecosystem over time and space at field, farm, and landscape scales	This encompasses the principle of crop diversification of conservation agriculture and should insist on the biodiversity above and below ground. The underground biodiversity is ensured by the recycling and minimum soil disturbance principle
6	Synergy	Enhance positive ecological interaction, synergy, integration, and complementarity among the elements of agroecosystems (plants, animals, trees, soil, water).	This is to emphasize that no single principle is a standalone practice. By nature, AE is a multidisciplinary/trans disciplinary approach. Therefore, many principles need to be combined to solve an identified problem in a given biophysical environment and socio-economic context.
7	Economic diversification	Diversify on-farm incomes by ensuring small-scale farmers have greater financial independence and	Diversification of organically produced food and of marketing outlets allows farmers to better cope with external shocks such as

		value addition opportunities while enabling them to respond to demand from consumers	price volatility and climate change risks and to alleviate financial risks associated with climate change extreme events.
8	co-creation of knowledge	Enhance co-creation and horizontal sharing of knowledge, including local and scientific innovation, especially through farmer-to-farmer exchange	Adaptation is building on the traditional knowledge of farmers and further developed together with scientists and other stakeholders to co-create concrete, demand-led solutions to pressing problems as they are context-specific and experienced locally
9	Social values and diets	Build food systems based on the culture, identity, tradition, social and gender equity of local communities that provide healthy, diversified, seasonally, and culturally appropriate diets	Equal control over productive resources, equal access to education and agro-ecological advice, and equal say in households, organizations, and political processes: all these are a vital part of agroecology. Taking into consideration farmers preferences because they have experiential reasoning behind their choices. Markets that provide a wide range of foodstuffs promote a local supply of diverse, fresh and healthy food.
10	Fairness	Support dignified and robust livelihoods for all actors engaged in food systems, especially small-scale food producers, based on fair trade, fair employment, and fair treatment of intellectual property rights.	Everything is framed by policy. The fairness principle starts in policy documents of each country. It is here where AE become a movement to advocate for fair global and national food system policies.
11	Connectivity	Ensure proximity and confidence between producers and consumers through promotion of fair and short distribution networks and by re-embedding food systems into local economies	This is about fair market system incl. fair producer prices within a country to ensure adequate remuneration of all actors including farmers but with consumers having their say about the quality they want.
12	Land and natural resource governance	Recognize and support the needs and interests of family farmers, smallholders, and peasant food producers as sustainable managers and guardians of natural and genetic resources	Valuing and preserving traditional and other open pollinated crop varieties and animal breeds. Decrease dependence on high yielding crops varieties from seed companies, most of time hybrids. Farmers must have the right to and control over land, seed, water, biodiversity, and knowledge.
13	Participation	Encourage social organization and greater participation in decision-making by food producers and consumers to support decentralized governance and local adaptive management of agricultural and food systems.	By nature, AE is a multidisciplinary/trans disciplinary approach, knowledge-intensive and problem-solving approach. It is a participatory, bottom-up and not a top-down approach.

Source: adapted from Sinclair et al., 2019

Food-Energy System

The concept of Food-Energy system has been documented comprehensively by Bogdanski, 2012. Energy is part of food security and they have mutual influences on each other and therefore they should be addressed together. Without access to energy there is no food security (Bogdanski, 2012). The Integrated Food Energy System (IFES) can be considered an Agro-Ecological approach, but it may help to better understand the complex and dynamic interrelationships between the energy and food sector, so that we can use and manage our limited resources sustainably. The IFES forces people to think of the impacts a decision in one sector can have not only on that sector, but also on the other. In fact, anticipating potential trade-offs and synergies allow a proper design, appraisal, and prioritize response options that are viable across both sectors.

It is estimated that at a global level, food production and its supply chain consume about 30% of total energy (FAO's water, food, energy nexus, 2014[ix]). **Energy is directly and indirectly embedded in food production and preparation: it** is required to produce, transport and distribute and cook food as well as to extract, pump, lift, collect, transport and treat water for irrigation as well as other agricultural-related activities. It is projected that to meet food demand, agriculture in 2050 will need to produce almost 50 per cent more food, feed and biofuel than it did in 2012 (FAO, 2017).

On the other hand, if well thought/reasoned Agro-ecological practices can present a good opportunity to address the concern for energy to be used in this sector. This can be done through integrating tree, crop, livestock and biogas and solar energy. The industrial production of food is heavily reliant on non-renewable energy resources such as synthetic fertilizers, fuel for on-farm machinery and irrigation. However, a gradual phase-out of fertilisers and pesticides as foreseen in AE would result in significant energy savings at the manufacturing and distribution stages.

Considering the important role of energy in food production and consumption, renewable energy is a crucial prerequisite for resilient livelihoods, strongly contributing to the adaptive capacity of rural communities in light of climate change.

The lack of availability and access to renewable energy can considerably limit the ability of a system to cope with the effects of climate change and wider development pressures.

Nevertheless, the importance of renewable energy for food security and the adaptive capacity of smallholders have still not been recognized widely. The renewable energy- so vital for food security and resilient livelihoods, is often dealt with as a separate issue. This has detrimental impacts, especially for those who still depend on traditional bioenergy sources such as fuel wood, charcoal, and animal dung for cooking.

Unless food and renewable energy production are well balanced within the agro-ecosystem, energy remains just another external input for smallholder farming systems. In many situations, this means that women and children need to spend hours collecting fuel wood. In other cases, it means high expenditures for charcoal.

Where fuel wood sources are already fully depleted like in many parts of Rwanda, especially in the East, people rely on **crop residues for cooking**. In such an agricultural environment it becomes impossible to adopt agro-ecological approaches such as conservation Agriculture

without addressing the burning issue of cooking energy. This situation leads to declining soil organic matter and other soil nutrient depletion and reduced soil biodiversity and productivity because of removing the nutrients found in such residues and ultimately to the appearance of invasive species. In such a situation, in both rural areas and cities, people not only experience food famines but also fuel wood famines.

On the other hand, in this situation, it can become easy to adopt an IFES like Agroforestry, livestock-biogas and solar or wind energy provided that the suitable design and management that do not compete with crop production are well identified and accepted by farmers.

Considering the above it becomes clear that bioenergy and food provision cannot be addressed in isolation from each other and the environment on which they depend. They need to be equally addressed to strengthen people's adaptive capacity to climate change. Yet at the same time, both food and bioenergy production and consumption can have detrimental impacts on ecosystems, on which rural livelihoods depend, if not adequately managed.

Climate Resilient Practices

Resilience is the capacity of social-ecological systems to cope with a hazardous event, trend, or disturbance, responding or reorganizing in ways that maintain the systems' essential function, identity, and structure while also maintaining the capacity for adaptation, learning, and transformation.
Adaptation is the process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm, or exploit beneficial opportunities.
Climate resilient practices capture activities, which build the capacity to deal with current and future climate variability. These activities comprise many existing development investments and policies including those in agriculture, food security, health, land management and infrastructure sectors.
AE approaches are climate resilient practices and major contributor to climate change adaptation. They are opposed to the current global food system because agriculture, as currently practiced, has been judged to be a major driver of climate change and the breaching of other planetary boundaries (Sinclair et al., 2019).

Food system approach

A food system approach is a way of thinking and doing that considers the food system in its totality, taking into account all the elements, their relationships and related effects (FAO, 2018[x]). Food systems (FS) encompass the entire range of actors and their interlinked value-adding activities involved in the production, aggregation, processing, distribution, consumption, and disposal of food products that originate from agriculture, forestry or fisheries, and parts of the broader economic, societal and natural environments in which they are embedded (FAO, 2018). AE is a food system approach by excellence.

Greenhouse Gas Emission

Food production is responsible for approximately 26% of global GHG emission (Ritchie, 2019). Further literature shows that food production is responsible for GHG emissions between 21 and 37% (IPCC, 2021).

Table 2 shows four key elements to consider when trying to quantify food GHG emission and their respective contribution to GHG emissions.

Table 2. GHG emission in the agricultural sector

	Activity	Contribution to GHG (%) of food emission
1	Livestock & fisheries	31
2	Crop production	27
3	Land use	24
	Supply chains	18

Source: Adapted from Ritchie, 2019

For some sources of GHG emission AE can contribute to the solution. For instance, the improvement of soil fertility and the recycling can allow for the phase out of fertilizer and pesticides. However, for other sources there are not clear solutions. For instance, we can not stop cattle and rice from producing methane (Ritchie, 2019). However, we can indirectly reduce the GHG emission by reducing the wastage of food which contribute to 6% of the global food GHG emission (Ritchie, 2019). Land use is a big issue!

Chapter 3. METHODOLOGY

In this specific chapter on methodology, the main purpose is to describe the research strategy and the empirical techniques chosen and applied to undertake the study also to demarcate the real scope and limitations of this research on agro-ecological approaches and food-energy systems for climate-resilient agriculture in Rwanda. This study used both quantitative and qualitative approaches with the aim to gather quality information. Data collection techniques applied were desk review of pre-existing relevant documents (documentary research to draw on the in-depth knowledge of previous studies on similar topics, relevant policy documents and other related reports), administering questionnaires at the household level at a rural and urban level at the project districts, facilitating Focus Group Discussions (FGDs) and in-person interviews with key informants (KIIs). This study used a multi-stage methodology as described in the chapters below.

Detailed methodology

Key major phases of the methodology to deliver the expected objectives of the assignment included: (1) inception phase and stakeholder workshop; (2) collection of primary and secondary data; (3) data processing and draft report preparation; and (4) validation workshops and finalisation of the report. Accounting for the qualitative data collection, the research used KII and FGD questionnaires/checklists to collect relevant information to different key stakeholders, for the household survey for both rural and urban household. A team was formed to undertake the assignment, which included a team leader and Policy expert, Soil scientist and agronomy expert, Agro-ecology and research methodology expert, Socio-economist and gender expert; Environment and Climate change expert and twelve enumerators.

Inception

The research started with the draft of an inception report, afterwards a stakeholders' validation workshop held on July 23, 2021 into an online platform with purpose to share the detailed methodology approach, the work plan, collect inputs from stakeholders, requesting their contribution in the implementation of the study. This meeting served to introduce relevant team members and ensure a shared understanding with the client of the scope of the assignment, the timeline, collect additional information on key stakeholders and required facilitation for the field works.

Data Collection

Desk Review

The research team undertook thorough review of the key documents and publications that are relevant to climate resilience agriculture, agro-ecological practices, and food energy systems. Thus, the consultants will read all the revelant published books and reports, review policy documents, and project related documents such as project design, baseline, as well as final impacts assessments.

The documents were collected from different relevant sources including the public institutions (Ministry of environment, MINAGRI, Ministry of Infrastructure and energy,

REMA, MINECOFIN, MINICOM, FONERWA and review different policies such as Vision 2050, NST1, National Agriculture policy, PSTA4, NDC II, GGCRS, etc, Development partners and from web-based sources. A detailed analysis of documents above will include identification of policy gaps, existing challenges, and opportunity for funding of the agroecological practices and food energy system in Rwanda. The findings of the literature will be triangulated with the results of the field survey and consultations with key stakeholders.

Field data collection

Determination of sample size

The sample size was computed on the basis of various parameters such as the desired degree of precision, target population size, timing and budget. Basing on definite population, the sample size needed was calculated using the Slovin formula below (eq. 1):

$$n = \frac{N}{(1 + N * e^2)} \ (eq. 1)$$

Where n= sample size,
***N**= Population (Total number of farmers)*
***e**= margin of error (1-Zα), Zα is the critical value for normal distribution for 95% confidence interval*
The Sample using slovin sample Size Calculator, is placed at approximately to 400 farmers.

Explanatory note:

Based on the sample size, list of land consolidated sites was provided at each of the 4 Districts including all farmers operating within those sites thereafter the selection of sample farmers was done by a simple systematic random sampling selection using the following steps:

- Random selection of two land consolidated sites in each district and,
- Selection of two non-consolidated land sites closets to the selected consolidated land sites,
- Calculate the sampling interval (the number of farmers in population divided by the number of Targeted farmers needed for the sample)
- Select a random start between 1 and sampling interval
- Repeatedly add sampling interval to select subsequent farmers

Selecting number of farmers interviewed within the land consolidated area and non-consolidated area

Therefore, our sample was equally distributed in land consolidated sites and the closest non-consolidated land sites which means that our margin of error was 0.05 which gave a number of farmers in the districts. Also, we have randomly selected households in the urban areas in the same districts to collect information of the food-energy systems. The table below shows the size of the sample.

Table 3. The number of farmers targeted by district in the study

Province	District picked from the CRA project area	Criteria (Crop selected in AEC)	Total population of farmers in those districts	Proportion	Sample E = 0.05
South	Nyaruguru	Wheat, Maize, Tea	127,748	21	84
	Nyamagabe	Wheat, Maize, Tea	137,605	23	92
East	Kirehe	Maiza, Banana	159,612	27	108
	Nyagatate	Beans, Maize, Rice	175,652	29	116
		Total	**600,617**	**100**	**400**

Household survey data collection both at farmer and urban level

Data collection tools were developed: namely, a household quantitative questionnaire. Before starting field work, enumerators were recruited to perform the duty of data collection. The enumerators and supervisors were trained about the key concepts of the survey, ethical considerations of fieldwork and tools to be used in data collection. The training of the enumerators aimed to increase the capacity of enumerators and supervisors and to enhance their performance in collecting quality, reliable, relevant, and accurate data. In additional to this, each enumerator must understand each question properly. In this regard, the research team organized two days of the training of enumerators held on 29th July 2021 and 1st August 2021 from 8:30 am to 17:00 PM at Saint Francois D'acise Kicukiro. The participants composed a team of 12 enumerators, 2 supervisors and 3 consultants (The list is attached to this report). Supervisors were recruited basing on their academic and research profiles.

After the training, the team of enumerators and supervisors were deployed in the 4 project districts, two teams of enumerators were formed to support the data collection, and the first team was deployed in Nyamagabe and Nyaruguru while the second team worked Nyagatare and Kirehe. The survey took place over the period of August 2021.

Qualitative technique

The qualitative technique mainly consisted of (FGDs) and KIIs as presented in table 3 and 4 below respectively. The data collection used purposive sampling and snowball sampling techniques. The purposive sampling was particularly used to sample key respondents who were deemed able to provide relevant information on EAPs/ CSAs and on the food-energy system.

Focus group discussion

Focus group discussion are a type of in-depth interview conducted in a in a group with particular characteristics defined with respect to the proposal, size, composition, and interview procedures. FGD allows richness and flexibility in the collection of data that are not usually achieved with a survey. At the same time FGDs allow for spontaneity of interaction among the participants. In this regard, we conducted 8 FGDs in the selected districts of intervention and each group included between 7 and 11 participants. Thus, FGDs included:

Table 4. Number of Focus Group Discussions per district

	Name of district	FGD	Participants in FGD
1	Kirehe	2	22
2	Nyagatare	2	14
3	Nyamagabe	2	14
4	Nyaruguru	2	16
	Total	8	66

During the discussion sessions, participants had an equal opportunity to express their views freely.

Figure 1. Focus group discussion illustration in Nyagatare District

Figure 2. Focus group discussion illustration Nyamagabe District

Key Informant Interviews

FGDs results were aligned with in-depth interviews which supplemented and extended our knowledge about individual perceptions on the studied topic. According to Martin Woods (2011), the primary advantage of in-depth interviews is that they provide much more detailed information than that made available through other data collection methods, such as surveys. They also may provide a more relaxed atmosphere in which to collect information – people may feel more comfortable having a conversation with you as opposed to filling out a survey questionnaire[xi].

In order to obtain more in-depth information relevant to the EAPs/CSA practices, the research team conducted key informant interviews. These were conducted with the representative of central government authorities (Government Ministries, Agencies, etc.),

local government officers, development partners in agriculture sector, CSO representatives and academics operating in the field of Agriculture.

Table 5. List of key informant interviews

N°	Name of Institutions	Position of key personnel to be interviewed
Government Institutions		
1	Ministry of Environment (MoE)	DG Land, Water, and Forestry
2	Ministry of Agriculture and Animal Resources (MINAGRI)	Former Environment & Climate Change Specialist – Now SPIU Coordinator
3	Ministry of Infrastructure (MININFRA)	Biomass Energy Specialist
4	Rwanda Forestry Authority	Forestry Officer
5	Rwanda Agricultural and Animal Resources Board (RAB)	Research and Extension Officer
6	Rwanda Environment Management Authority	Project Officer
7	Districts (Nyamagabe, etc)	Agronomists, Sector Agronomists, CDO
Intergovernmental Institutions/Development Partners		
8	European Union (EU-Delegation to Rwanda)	Programme Officers: Agriculture and Rural Development, Infrastructure Chapter
9	FAO Rwanda	National Project Coordinator (KnoWat Project)
10	IFAD Rwanda	CPO
Civil Society (Local/National NGOs)		
11	RWCA	Executive Director
12	CARE Rwanda or TROCAIRE Rwanda	Gender Officer or Livelihood and natural resources program manager
13	RCCN (Rwanda climate change network)	Executive secretary
Civil Society (International NGOs)		
13	ICRAF	Country representative
14	IUCN	Senior Programme Officer
15	WCS	Senior Programme Officer
16	ARCOS Network	Executive Director
17	Vi-Agroforestry	Senior Programme Officer
18	World Vision Rwanda	FLR Project coordinator/manager
Academia		
19	University of Rwanda	Forestry and Nature Conservation Department
20	Centre of Excellence in Biodiversity and Natural Resources (CoEB)	Director

Direct observation

In addition to the data collection technics as above mentioned, the evaluation team conducted a direct observation and took note on the existing practices of the AEPs practices in the study areas, availability of physical infrastructure and investments put in place by stakeholders and farmers, observation of gaps at the project intervention as shown in the photo below.

Illustration of mulching in Nyagatare District

Small-scale irrigation by farmer

Government funded irrigation scheme in Kirehe District

Data management and analysis

After data were collected, they cleaned using SPSS. There was no data entry because data was collected using tablets (with pre-programed ODK questionnaire), and immediately converted into SPSS format. The team of consultants had designed the do-files for data cleaning and correction to ease the analysis using SPSS software. The findings from different respondents were presented in the form of tables and graphs.

Quality assurance and ethical consideration

In addition to in-house quality assurance mechanism, the team of consultants worked closely with the client to ensure that the overall output from this assignment is of high quality.

Limitations

At the time of the data collection process, the GoR enacted strict COVID-19 measures for different sectors and districts including the research areas which make the field work & data collection quite difficult during the data collection process. As mitigation measures in order to protect our research team together with our respondents, it was mandatory for rapid covid-19 test for our all-field team before the field work, strict respect of the social distancing, hands washing and use of face masks. In some districts, the research team faced difficulties with meeting all of the targeted respondents; some were not at their offices in Nyamagabe (urban sector) and Kigali city, majority of KIs were reached by phone call. Owing to the social distancing measures, some FGDs were difficult to organize, for example at the market places.

Chapter 4. Findings and analysis

4.1. Key findings from review of the existing institutional and regulatory framework for agroecology, climate resilient and food energy system in Rwanda

The review work to the Rwandan institutional and regulatory framework for Agroecology, Climate Resilient and food energy system was done by considered the following policies(i)National Strategy for Transformation (NST1), (ii)National Agriculture Policy (NAP), Strategic Plan for Agriculture Transformation (PSTA4), National Environment and Climate change Policy, Rwanda Green Growth Climate Resilience (GGRS), National Determined Contributions (NDCs), Rwanda Energy Policy (2015) , Energy Sector Strategic Plan (2018).

Although the current agricultural practices in Rwanda are mainly driven by the Crop Intensification Program (CIP), ‘**’a program which had been introduced in 2007 with the objective to respond to a growing demand on food security’’**, Since its introduction, it has been focusing on land use consolidation, promoting the intensive use of agro- inputs (such as chemical fertilizer, pesticides, access to improved seeds through provision of financial subsidies as well as bulking marketing.

However, In the light of this environment, the findings from policies’ review work have revealed that the agroecology and climate resilient aspects are still considered at policy level. The concern for agriculture sustainability coupled with the urgent need for addressing the issues of climate change are the main drivers for integration of agroecology, climate resilient and food energy practices into key national development policies across different sectors.

4.1.1. Agroecology, Climate Resilient Practices and Food-Energy System in the National Strategy for Transformation (NST1)

The NST1 is a flagship strategy for the Country development. It aims at setting Rwanda on the path to achieving the ambition of becoming an upper middle-income country by 2035 and a high-income country by 2050, while eradicating poverty by 2035. The NST1 prioritizes a number of Agroecology and climate resilient practices that contribute to the achievement of two major priorities namely: (i) modernize and increase productivity of Agriculture and livestock as well as the (ii) promote Sustainable Management of Natural Resources and Environment to Transition Rwanda. The specific actions in relation to promoting agroecology and Climate resilient under NST1 are summarized in Table 6

Table 6. Key agro-ecology and climate resilient practices highlighted in NST1

NST Outcome	AEPs	Units	Baseline 2016/17	Targets	
				2020/2021	2023/2024
Increased productivity, quality and sustainability of crop production	A. Increase Ha of irrigation developed within an Integrated Water Resources Management	Ha	48,508	77,084	102,284
	B. Increase area of consolidated land	Ha	635,603	877,703	980,000
	C. Proportion of farm operations mechanized	Per cent	25	37	50
	D. Area of Land under erosion control measures and used optimally (Radical terraces)	Ha	110905 (2017)	125,000	142,500
	E. Area of Land under erosion control measures and used optimally (Progressive terraces)		923604 (2017)	965,604	1,007,624
	F. Percentage of farmers using quality seeds on consolidated sites	Per cent	52	63	75
	G. Quantity of fertilizer applied	Kg per ha per annum	32	60	75
Increase and sustain the area covered by forest through forest landscape restoration	Area of land under (Agroforestry: Ha)	NA	NA	NA	NA

Source: adapted from NST1[xii]

In summary, the main Agroecology and climate resilient actions prioritized under NST1 include: irrigation, erosion control, use of quality seeds and agroforestry. Furthermore, the table gives baseline data for each of the prioritized EA&CRP (except agro-forestry). In fact, the baseline data reflects the status in 2016/17 together with the intended targets respectively for the fiscal years (2020/21) marking the end of the Vision 2020 as well as the target as per 2023/24 which marks the end of NST1.

4.1.2. Agroecology, Climate Resilience and Food-Energy System in the National Environment and Climate Change Policy

The findings from this policy review have revealed that there is an existing opportunity to benchmark the existing policy actions while promoting agroecology and climate resilient practices in Rwanda. However, this policy falls in short in terms of providing political orientation with regard to advancing the issues of food energy system.

In fact, the second policy objective of this policy contains a diverse of policy actions which seek to advance both Agroecology and Climate resilient practices such as (i)Ensure the protection of wetlands, riverbanks, hilltops and slopes from ***unsustainable practices to***

***prevent soil erosion and environmental degradation,(ii)*to** promote **sustainable farming practices** that suit the holistic nature of local agricultural practices, are not disruptive and are inclusive of economic, social, cultural and gender considerations,(iii) **Ensure teaching of ecological agriculture at all educational levels and in relevant research institutes**.

Furthermore, the AE& CR practices are contained throughout the fourth Policy objective which is entitled **''Promote climate change adaptation, mitigation and response''**. They include but not limited to: (i) Mainstream green, ecological and climate resilient practices and interventions in all development sectors and districts, including their plans, budgets, functions and actions, (ii)Promote and encourage water storage at different levels (institutional, households, etc.) and improve storm water management, such as capturing and using storm water for localised irrigation to support agriculture and green space vegetation, (iii) Promote ecosystem-based approaches to climate change adaptation in local development agendas. (iv) Promote afforestation and reforestation of critically- degraded and residential areas.

However, the issue of food-energy system has got very little consideration under this policy, there are only some actions which is related to promotion of clean source of energy. They include but not limited to (I) Promote the use of alternative forms to biomass fuel (e.g. gas and electricity) in urban and rural areas, Promote renewable energy to achieve universal access to electricity, Promote waste recovery options as a high value resource stream especially in urban areas, etc.

4.1.3. Agroecology, Climate Resilient and Food-Energy systems highlighed the Nationally Determined Contribution (NDC II)

The recently updated NDC of 2020 have shade lighter to different components and practices of sustainability and Climate resilient as well as on food energy related issues. It includes a quite number of actions that completely fall into the broader context of the subject matter, as per table 7.

Table 7. NDC II selected adaptation, mitigation interventions by sector, water, agriculture, land and forestry in connection to agroecology, climate resilient and food-energy systems

Adaptation actions		
Water	1	A national water security through water conservation practices, wetlands restoration, water storage and efficient water use
	2	Water resource models, water quality testing and hydro-relatedinformation
	3	Develop and implement a management plan for all level 1catchment
Agriculture	4	Develop climate resilient crops and promote climate resilientlivestock
	5	Develop climate resilient post-harvest and value additionfacilities and technologies
	6	Strengthen crop management practices
	7	Develop sustainable land use management practices
	8	Expand irrigation and improve water management
	9	Expand crop and livestock insurance
Land and Forestry	10	Development of Agroforestry and sustainable agriculture

	11	Promote afforestation / reforestation of designated areas
	12	Improve forest management for degraded forest resources
	13	Integrated approach to planning and monitoring forsustainable land use management
	14	Harmonized and integrated spacial data management systemfor sustainable land use
	15	Inclusive land administration that regulate and provide guidance for land tenure security
Mitigation actions		
	1	**Soil and water conservation (crop rotation)** Continuous crop rotation of up to 600,000 Ha, leading to prevention of soil erosion and reduction of CO2 and N2O emissions and carbon sequestration in soils.
	2	**Improved livestock husbandry:** Promotion of better livestock feed (i.e. legume fodder species) and training in better livestock management, under the Rwanda Livestock Master Plan. Reduction in CH4 emissions from enteric fermentation
	3	**Improved manure management:** Adoption of more efficient manure management systems, including promotion of collective farms and training, under the Rwanda Livestock Master Plan. Reduction in GHG emissions from manure management
	4	**Improved fertilizers:** Increased use of organic waste in soil fertilizers, supported by target to apply composting within all agricultural households by 2030, and more judicious fertilizer use and promotion of fertilisation to enhance fertilizer uptake.
	5	**Soil and water conservation (terracing):** Installation of 165,000 Ha land protection terracing structures in sloped arable areas to present soil erosion, leading to reduction of CO2 and N2O emissions and carbon sequestration in soils.
	6	**Soil and water conservation (multi-cropping)** Multi-cropping of coffee and bananas of up to 40,000 Ha, leading to prevention of soil erosion and reduction of CO2 and N2O emissions and carbon sequestration in soils.
	7	**Conservation tillage:** Reduction in vertical movement of soil, leaving more crop residue on the soil surface, thereby reducing soil erosion, reduction of CO2 and N2O emissions and carbon sequestration in soils.
	8	**Improved livestock species and population:** Replacement of 10% domestic cows with improved cow species; expansion of fish farming, poultry, and other small livestock to increase protein food supply without increasing cows; and change in livestock mix. Reduction in CH4 emissions from enteric fermentation

Source: adapted from the Enhanced NDC 2020[xiii]

In fact, the content of this policy indicates that the issues of agroecology, climate resilient and food energy system are very well addressed at policy level i.e all thematic areas of the subject matter (such as Conservation tillage, Soil-related fertility management, Soil management practices that increase biotic activity and soil organic matter levels, Cultural practices, irrigation, Agriculture water management practices, Agroforestry, Sustainable management of Pests & diseases, Crop diversification) are very well addressed under NDC.

4.1.4. Agroecology, Climate Resilient and Food-Energy System in National Agriculture Policy (NAP)

The findings from the review of this policy have revealed that there are some policy pillars which focus on the aspects of sustainability and climate resilient the third Pillar of NAP which focuses on productivity, and Sustainability is one of them. The main agroecology actions prioritized are quite similar with the one prioritized under NSTI. They include among others: irrigation, area of consolidated land, increase inputs (fertilizers, improved seeds and pesticides) sustainable climate smart practices; protecting agricultural land against fragmentation, erosion, and degradation as provided in table 8.

Table 8. Specific agroecology and Climate Resilient actions in the National Agriculture Policy

Policy Objective	Policy Actions
Promote sustainable land husbandry practices to address soil erosion and degradation	• Continue efforts on terracing • Encourage use of a wide range of cost-effective erosion control solutions such as structures: check dams, soils/water detention trenches, cut off drains, waterways; erosion control measures: tree belts, contour belts, grass strips, contour bunds, planting of fodder grasses on bunds/ridges, use of permanent, perennial vegetation on contours, etc.; and agro-forestry: intercropping, integration of trees on farm plots, tree belts, protective forests, food production and nitrogen fixing, erosion control, etc
Promoting Irrigation and Sustainable Water Management	• Increase the area under irrigation and establish maintenance fee collection for irrigation schemes • Promote private sector- led models of irrigation scheme management. • Support efforts to increase the capacity of on-farm water harvesting, storage and usage; develop groundwater use and improve drainage and flood management.
Increase on-farm productivity sustainably	• Promote the adoption of integrated soil fertility management • Promote Integrated Pest Management technologies • Support production and use of soil specific fertilizer blends; • Facilitate access to inputs by promotion of use of seed and fertilizers by increasing agro-dealership networks;
Crop and Soil system	• Promote research to develop high yielding crop varieties resistant to biotic and abiotic stresses (e.g. disease, drought, and pests); • Invest in domestic production and multiplication of quality/certified planting materials by enhancing research efforts to develop improved seed varieties and improve their availability; • Promote research on nutrient-rich crops through bio-fortification, • Research on bio-fertilizers technologies and organic fertilizer use among farmers
Promoting Nutrition	Expand and revise kitchen garden programmes

Source: adapted from MINAGRI, NAP, 2018

4.1.5. Agroecology, Climate Resilient and Food-Energy System highlighted in the Strategy for Agriculture Transformation (PSTA4)

The Rwanda's Strategic Plan for Agriculture Transformation (PSTA4) is an overarching strategy for agriculture development in Rwanda. This strategy reckons also that the development of the sector requires the agro-ecological knowledge at hands of smallholder farmers in order for them to cope with the impact of progressive land degradation and climate change, while maintaining agricultural growth.

In fact, finding from the review work of this strategy indicates that the majority of the strategic actions fall under agroecology, climate resilient and food energy system practices as described under chapter one.

With regard to agro-ecological issue, the Rwanda's strategy for agriculture transformation addresses them holistically. Firstly, it seeks to promote the following practices: (a) Area of land under erosion control (Radical and progressives terraces), (b) Biological soil conservation practices development, (c) Percentage of use quality of seeds, (d) Percentage of farmers who practice integrated pest management, (e) Percentage of mechanized farm as detailed in the table 9. For each AEP, PSTA4 has set a baseline and annual targets for each indicator as depicted in the table 9.

Moreover, the strategy targets to promote adoption of integrated soil fertility management that combines agri-environmental practices, resource recovery and reuse of fertilizer-enriched products, incorporating manure, crop residues and composting into current systems of agricultural practices. On the other hand, it seeks to Support and provide training on farm-level production and organic fertilizer application, effective and sustainable use and disposal of pesticides and other agrochemicals. In the long run, farmers will reduce the use of inorganic inputs for the benefit of organic inputs, with the support of trained agronomists.

The PSTA 4 also promotes soil and water conservation as part of integrated watershed management programs, considering that the most successful approaches are those involving local communities, particularly to reconcile the use of crops, water, livestock and trees. PSTA 4 also encourages the use of a wide range of cost-effective erosion control measures, whereas previous strategies have focused primarily on terraces.

Concerning the issue of food -energy system, the strategy presents a dedicated strategic action on it, '***'Innovative Research on Agro-forestry''*** which is under the first impact area '***'Research and Innovation Development''***. It is recognized that the integration of agroforestry in crop production can contribute significantly to soil health and fixation. Research efforts shall concentrate on tree/crop/soil interfaces and developing suitable models and technologies to increase agroforestry. Furthermore, the strategy seeks to run pilots in order to explore opportunities for promoting urban agriculture through introducing fruit trees in urban areas.

Table 9. Key sustainability aspects, climate resilient and food energy systems related indicators in PSTA 4

INDICATOR	UNIT	BASELINE	TARGET	
			2018/19	2023/24
Priority area 2: Productivity and Resilience				
OUTCOME 2: Increased productivity, nutritional value and resilience through sustainable, diversified, and integrated crop, livestock and fish production systems				
OUTPUT 2.1: Sustainable, diversified, and climate smart crop practices implemented				
Area of land under erosion control measures (cum.)	Ha	1,034,509 (2017)	1,098,104	1,495,624
a. Radical terraces	Ha	110,905 (2017)	115,000	142,500
b. Progressive terraces		923604(2017)	937,604	1,007,624
c. Biological soil conservation practices development	Ha dev	TBD	25,000	150,000
d. Agro-forestry	Ha	20,000	500	75,500
a. Percentage of farmers use quality seeds on consolidate sites/large-scale (disaggregated by gender	Per cent	52 (2017)	55	75
Percentage of farmers who practice integrated pest management	Per cent	TBD	1	11
OUTPUT 2.2: Effective and efficient irrigation developed under an IWRM framework				
Ha of irrigation developed within an Integrated Water Resources Management Framework (cum.)	Ha	51,884(2017)	60,284	102,284
a. Hillside (medium-large)	Ha	8, 789(2017)	11,189	23,189
b. Marshland (medium-large scale)	Ha	36,521(2017)	39,521	23,189
c. Small –scale hill side		6,574(2017)	9,574	24,574

Source: adapted from MINAGRI PSTA4, 2018[xiv]

Table 10. Agro-ecology and sustainable practices thematic areas

Agro-ecological and sustainable practices thematic areas	AEPs
Conservation agriculture	Crop rotation
Soil-related fertility management	Organic fertilizers
Irrigation	Sprinkler irrigation;
Agriculture water management practices	Terracing
	Recycled harvested rain water
Agro-forestry	Agroforestry (Fruits) trees
Sustainable management of Pests & diseases	None

4.1.6. National Fertilizer Policy and Agroecology, Climate Resilient and Food-Energy related topics

Under PSTA3, CIP has increased access to fertilizer and the area of crops under consolidated land use approximately 18-fold (28,016 to 524,185 ha) between 2008 and 2011. Subsidized inorganic fertilizer distribution increased from 4,000 to 32,000 tons/year between 2007 and 2013 helping farmers to increase productivity and enhance food security. This has however had significant adverse environmental impacts, as outlined by a study (REMA 2014). Where inorganic fertilizers become the main input to crop production a linear nutrient pathway is developed, with ever increasing application of fertilizers required meeting the original yields and increasing production costs for farmers. During this process valuable carbon matter is not returned to the soils and natural soil fertility is lost, including a range of micronutrients, which are not supplied in NPK-based fertilizer products. Thus, over time, soils become exhausted. The use of inorganic fertilizers can also have other adverse effects including: leaching and run-off into waterways and eutrophication of water bodies (surface and ground water supplies); human health effects from exposure during application or consumption of contaminated water and food; and GHG emissions through the manufacture and transport of inorganic fertilizers.

4.1.7. Rwanda's Green Growth Climate Resilience Strategy and Agroecology, Climate Resilient and Food-Energy related matters

Rwanda's Green Growth Climate Resilience Strategy (GGCRS) identifies the dependency on externally sourced carbon-based agro-chemicals including imported fertilizers as a cause of vulnerability due to fluctuating oil prices. Reducing the dependency on inorganic fertilizers is one of three Big Wins proposed in the strategy which highlights the use of inorganic fertilizers, without other important soil management interventions, contribution to soil degradation.

The GGCRS and the 2011 Strategic Environmental Assessment of the Agriculture sector proposes measures to reduce emissions from soil fertility management, which have not been effectively mainstreamed into policies and strategies. These include optimizing the use of inorganic fertilizers based on nutrient needs; training farmers on fertilizer handling and application; and monitoring environmental levels of fertilizers. These can be combined with more efficient management of the nutrient cycle, better crop residue management, green manure, organic manure and composting as well as agro-forestry.

Agro-ecological approaches, conservation agriculture, resource re-use and recovery proposed under Program 1 of the GGCRS could significantly reduce use of inorganic fertilizers, improve nutrient recycling and soil fertility, and improve livestock productivity but have not been widely mainstreamed.

Sustainable intensification of small-scale farming using agro-ecological approaches including Integrated Soil Fertility Management (ISFM) has a number of benefits. ISFM practices, such as mulching, compost making and manure management, help to increase soil moisture and water retention in soil, reducing crop vulnerability to short dry spells.

4.1.8. Rwanda Energy Sector Strategic Plan and Food-Energy System

This strategy seeks to bring sustainable biomass solutions by halving the number of HH using traditional cooking technologies to achieve a sustainable balance between supply and demand of biomass through promotion of most energy efficient technologies. It anticipates implementing a biomass Strategy which shall deliver a policy interventions and strategies to unlock barriers to the uptake of alternative fuel sources, such as LPG and biogas. It is envisaged that the uptake shall be supported by increased urbanization. The biomass subsector will be prioritized to ensure the rate of progress is significantly increased. Coordination between all stakeholders should be improved and enabling environment for private sector market development established.

Table 11. Priority biomass actions in relation to this strategy

No	Action	Description
1	Biomass Energy Strategy	Forecasts demand and supply balance across scenarios and includes action plan to deliver targets – focused on efficiency.
2	National Biomass Programme (NBP)	Presents clear initiatives to promote use of efficient and alternative cooking technologies and establish sustainable biomass consumption.

4.2. Opportunities for funding of the agroecological practices and food-energy system initiatives in Rwanda

Agriculture, agroecology and Food-energy systems and climate change are inseparably linked. All agriculture sectors are extremely vulnerable to climate change. By necessity, the transition to climate-resilient agriculture is critical. However, the amount of financing required to transition to climate resilient practices can be locally limited, or applicants limited capacity for resource mobilization, which in return limit dissemination of agroecological practice and food-energy systems.

In Rwanda, farmers are the biggest investors in agriculture at their own farms and most agricultural investments are financed from domestic public and private sources, with a small share flowing from international sources.

Finance for agroecology and food energy system initiatives features many different funding channels with different objectives and eligibility criteria. These funding source present an opportunity to remove barriers, enhance institutional capacities, and create enabling environment for agroecology and food-energy system transition.

The information provided in the paragraph below illustrate potential examples of source of finance for Civil Society Organization engaged in agroecology, climate resilience, and food-energy system initiatives in Rwanda, their sectors of focus, the type of funding provided, as well as, their websites.

4.2.1 Rwanda Green Fund, FONERWA

General info: the Rwandan Green Fund mobilizes and disburses finance for numerous national initiatives including conducting bi-annual or annual call for proposals under different thematic areas, where eligible applicants include public entities, private sector, academic institutions, international organizations, and civil society organizations to address Rwanda's environment and climate change challenges. The call for proposal focuses on mainstreaming of environmental protection, climate change and green growth into Rwanda's economic development
Field: Climate change adaptation, mitigation, cross-cutting
Sector: Conservation biodiversity, forestry management and land-use, agriculture, renewable energy, water management, disaster risk management, waste management
Funding provided: Grant
Website: www.fonerwa.org

4.2.2. European Union Commission, Civil Society and Local Authorities Thematic Programme

General info: The European Commission under the CSO and LA thematic programme offers support to CSO for the development of awareness raising initiatives of development issues, including agriculture, conservation biodiversity, water, land use management and forestry. The thematic programme, in addition, offers capacity development of civil society in terms of programme, project and financial management.
The goal is to enhance CSOs contributions to governance and development processes, eradicating poverty and contributing towards sustainable development.
Field: Climate change adaptation, Development, Cross-cutting
Sector: Climate change, gender equality, youth
Funding provided: Grants
Website: https://ec.europa.eu/international-partnerships/our-partners/civil-society_en

4.2.3. The Critical Ecosystem Partnership Fund (CEPF)

General info: The Critical Ecosystem Partnership Fund is a joint initiative of l'Agence Française de Development, Conservation International, the European Union, the GEF, the World Bank, the Government of Japan, and the MacArthur Foundation. CEPF supports the development of conservation strategies driven by local input and providing grants non-governmental and private sector organizations to conserve vital ecosystem.
Field: Environmental protection, Adaptation
Sector: Biodiversity, land degradation, forestry
Funding provided: Grants
Website: www.cepf.net/

4.2.4. International Fund for Agricultural Development (IFAD)

General info: International Fund for Agricultural Development's goal is to empower poor rural women and men in developing countries to improve their incomes, resilience to climate change and food security. To achieve that, IFAD works with multiple agencies including farmers and civil society organizations
Field: Climate change adaptation, food security
Sector: Agriculture, water, nutrition,

Funding provided: Grant financing
Website: www.ifad.org/en/ngo

4.2.5. Global Environment Facility (GEF) – Small Grants Program (SGP)

General info: The Small Grant Program is a corporate program of the Global Environment Facility (GEF) implemented by the UNDP since 1992. SGP grantmaking promotes community-based innovation, capacity development, and empowerment of local communities and CSOs. With special consideration for women and youth.
Field: project corresponding to GEF focal areas, Adaptation and mitigation
Sector: Agriculture, biodiversity, education, climate change, land degradation, sustainable forest management, water, chemical, health
Funding provided: Grants of up to USD 50,000 directly to CSOs
Website: www.sgp.undp.org/

4.2.6. Least Developed Countries Fund

General info: Least Developed Countries Fund (LDCF) focuses on reducing the vulnerability of key sectors and financing on-ground adaptation activities with clear results to support their efforts to enhance adaptive capacity. LDCF works through formally accredited GEF Agencies. Among them are UN agencies, multilateral and regional development banks, national government institutions, and international and non-governmental organisations.
Field: Adaptation, capacity building
Sector: LDCF targets sectors including agriculture and food security, water, disaster risk management, fragile ecosystems, waste management and health
Funding provided: Grants (as incremental cost finance to address climate change adaptation relative to a development baseline), no-financing required
Website: www.thegef.org/gef/ldcf
Example: Reducing Vulnerability to Climate Change by Establishing Early Warning and Disaster Preparedness Systems and Support for Integrated Watershed Management in Flood Prone Areas Projection (GEF ID 3838)

4.2.7. Global Environment Facility (GEF) – Trust Fund

General info: The Global Environment Facility (GEF) – Trust Fund's objective is to finance the incremental costs of measures to address environmental issues such as climate change, relative to a business as usual. The trust fund is meant to leverage additional funding from the Multilateral Development Banks' own budget or from national government
Field: Adaptation, mitigation, capacity building
Sector: Biodiversity, energy efficiency, climate change, forestry, land degradation, renewable energy, land use, water, health, chemicals and waste
Funding provided: Grant, concessional loans, equity, guarantees. (co-financing is required)
Website: www.thegef.org/gef/climate_change

4.2.8. Green Climate Fund (GCF) – Readiness Program

General info: The Green Climate Fund (GCF) – Readiness Program provides resources for strengthening the institutional capacity and create enabling environments, as well as, assist with scoping and project preparation. The readiness program is a component of the larger

GCF, which was set up to promote fundamental shift towards low-emission and climate-resilient development pathways by offering support to developing countries.
Field: Adaptation, Mitigation, Cross-cutting
Sector: Agriculture, Ecosystem adaptation, Energy efficiency, forestry and land-use, renewable energy, health, gender, poverty, water
Funding provided: Resources may be provided in the form of grant up to USD 1million per country or technical assistance, in-kind contributions
Website: https://www.greenclimate.fund/readiness

4.2.9. International Climate Initiative (IKI)

General info: IKI is a funding program launched by the German government in 2008, that aims to support measures that are essential for implementation of the UNFCCC and Convention on Biological Diversity (CBD). The key areas supported by the fund are ecosystem-based adaptation, climate related extreme event risk management, and implementation of national adaptation strategies. IKI also offer Small Grants aimed at non-government and non-profit organizations for small scale projects.
Field: IKI's funding priorities are around mitigation of greenhouse gas emissions, adaptation to climate change, carbon sinks/REDD+, and conservation biodiversity.
Sectors: Agriculture, Ecosystem adaptation, Energy efficiency, Forestry and Land-Use, Renewable Energy, Waste management, water
Funding provided: Grant (grant, T.A, research grants, trainings…):
Website: www.international-climate-initiative.com/

4.2.10. Clim-Dev Special Fund (CDSF)

General info: Clim-Dev Special Fund (CDSF) was established to support African communities to build climate resilience. The program administered by the African Development Bank. Among other things, it allows organizations to pilot and implement adaptation practices that demonstrate the value of mainstreaming climate information in development planning and practices. The CDSF has financed projects in areas such as building disaster resilience to natural hazards, weather monitoring and early warning systems.
Field: Adaptation and Capacity-building
Sector: All sectors
Funding provided: Grants
Website: www.climdev-africa.org

4.2.11. Canada fund for African climate resilience

General info: Canada fund for African climate resilience (CFACR) supports projects that focus on reducing the effects of climate change and improving local adaptation to the impacts of climate-related challenges in Africa
Field: Adaptation, mitigation, disaster reduction
Sector: Agriculture, climate resilient, energy, fisheries, forestry, land use, low-carbon, natural resource management, renewable energy, sustainable land management, water
Funding provided: Grants
Website: https://climate-change.canada.ca/finance/continent.aspx?id=4

4.2.12. Adaptation for Smallholder Agriculture Programme

General info: Adaptation for Smallholder Agriculture Programme (ASAP) offers climate finance to smallholder farmers so that they can access the information tools and technologies that help build their resilience to climate change. Most investments funded in the past were on resilient agricultural production.
Field: Adaptation and disaster risk reduction
Sector: Agriculture, natural resource management, sustainable land management, water
Funding provided: Grant, Co-financing
Website: https://www.ifad.org/en/asap

4.2.13. Nordic Climate Facility (NCF)

General info: Nordic Climate Facility (NCF) is financed and managed by the Nordic Development Fund (NDF). The facility finances early-stage climate change projects in low-income countries. **However, projects should be implemented through partnerships between Nordic and local partners**. Applicants must be active institutions holding a registered place of operations in Denmark, Finland, Iceland, Norway or Sweden
Field: Climate change adaptation, mitigation, cross-cutting
Sectors: Agriculture, ecosystem adaptation, forestry and land-use, gender, health, disaster risk reduction, renewable energy, waste management, water
Funding provided: €250 – 500 k in grant funding, however the project partner must mobilize co-financing equal to at least 25% of the requested NCF grant as loan, equity and/or grant
Website: https://www.ndf.int/what-we-finance/projects/project-database/nordic-climate-facility-ncf.html

4.2.14. Special Climate Change Fund (SCCF)

General info: The Special Climate Change Fund was established to support and adaptation and technology transfer projects that are cost-effective and integrated into national sustainable development and poverty-reduction strategies. The goal is to strengthen resilience and reduce vulnerability to the impacts of climate change through innovation and technology transfer and fostering enabling environments.
Field: Climate change adaptation, mitigation, capacity building
Sector: Agriculture, ecosystem adaptation, renewable energy, forestry, industry, transport, waste management
Funding provided: Grant
Website: www.thegef.org/gef/SCCF

4.3. Existing AE Practices (HH survey data)

4.3.1. Description of the production systems in Nyamagabe, Nyaruguru, Kirehe, and Nyagatare

The survey involved 411 households in Nyamagabe, Nyaruguru, Kirehe, and Nyagatare districts. Farmers in consolidated and unconsolidated land use practices were interviewed. To grasp the context of food-energy nexus, some households in the urban areas from the four districts were also interviewed. The following table summarizes the distribution of households interviewed among the categories and per district.

Table 12. Distribution of households interviewed in consolidated (LUCA), unconsolidated land uses (Non-LUCA) and in urban areas

District	LUCA	NON-LUCA	Urban	Total
Kirehe	48	30	37	115
Nyagatare	38	54	24	116
Nyamagabe	29	45	17	91
Nyaruguru	36	32	21	89
Total	**151**	**161**	**99**	**411**

Agriculture is the predominant livelihood in the four districts. Around 79.4% of all the interviewed households live on agriculture. Majority of the population (61.1%) were found in the poorest wealth categories i.e. category 1 and 2 of '*Ubudehe*' with only 70.8% owning land while around 43.3% rent land where they practice agriculture. 46% of the households have joined cooperatives. The mobile telephone is a common asset with 90% of households owning it, followed by radios (56.7%). This hints to an adequate potential to access agricultural information through media. The following Table X. highlights the common crops grown in each district as indicated by the communities.

Table 13. Crops grown per season in the last past 2 years in Kirehe, Nyagatare, Nyamagabe, and Nyaruguru Districts

Season	Crops	Kirehe	Nyagatare	Nyamagabe	Nyaruguru	Total	%
19A	Maize	74	87	68	47	276	67.2
	Wheat			9		9	2.2
	Irish Potatoes	1	2	26	26	55	13.4
	Bush Beans	43	21	4		68	16.5
	Climbing beans	2		60	62	124	30.2
	Cassava	3	2	4	1	10	2.4
	Soya Bean	5	1			6	1.5
	Banana	2	5			7	1.7
	Sweet Potatoes	1		14	22	37	9.0
	Sorghum	1	1	3	3	8	1.9
	Vegetable & fruits	6		14	12	32	7.8
	Tea			10	6	16	3.9
	None		1	1	1	3	0.7
19B	Maize	22	33	7	16	78	19.0
	Wheat			59	20	79	19.2
	Irish Potatoes	2		25	23	50	12.2
	Bush Beans	47	68	2		117	28.5
	Climbing beans	1		35	49	85	20.7
	Cassava			1	1	2	0.5
	Soya Bean	9	7		1	17	4.1
	Banana		2			2	0.5
	Sweet Potatoes			13	19	32	7.8
	Sorghum	16	3	4	19	42	10.2
	Vegetable & fruits	17	4	19	13	53	12.9
	Tea			8	5	13	3.2
	None		1	1	2	4	1.0
19C	Maize	18	22	4	8	52	12.7
	Wheat			22	3	25	6.1
	Irish Potatoes		6	15	11	32	7.8
	Bush Beans	8	13	4	1	26	6.3
	Climbing beans			18	7	25	6.1
	Cassava				1	1	0.2
	Soya Bean	1				1	0.2
	Banana		2			2	0.5
	Sweet Potatoes			10	12	22	5.4
	Sorghum	2	1	4	5	12	2.9
	Vegetable & fruits	48	16	11	11	86	20.9
	Tea			6	4	10	2.4
	None	13	46	30	39	128	31.1

Results show that maize is the common crop across the districts with more than 67.2% farmers cropping it mainly in the agricultural 'season A'. Bush beans are the second crop, mainly grown in Season B in Nyagatare and Kirehe districts mainly located in the Eastern Savannah and partly in Eastern plateau agro-ecological zones, while climbing beans are the second crop in Nyamagabe and Nyaruguru mainly are located in the Congo Nile Watershed divide. The two agro-ecological zones are different in terms of rainfall (length of the seasons), altitude, and access to tree resources. The Eastern Savannah has low rainfall, low altitude, and low tree cover (low access to stakes) which influences adoption of bush beans rather than climbing beans. Fruits and vegetables are ranked on the third position and are

grown across the three seasons, mainly because vegetables need irrigation and therefore grown in season C in valleys and bottom of hillsides.

Pigs, cows, and goats are the most common livestock respectively reared by 35%, 32%, and 31% of the households practicing agriculture as their main livelihood in the four districts of Nyaruguru, Nyamagabe, Kirehe, and Nyagatare. In contrast, agriculturalists in the Southern province (Nyaruguru and Nyamagabe) tended to have more livestock than those in the Eastern province (Nyagatare and Kirehe) probably due to the higher need for manure and the predominance of a mixt/integrated livestock-cropping system in the former. Livestock in the Eastern province are more reared by pastoralists as their main livelihood while few combine it with arable agriculture. Table 14 below shows the frequency of livestock ownership in those cited districts.

Table 14. The number of interviewed households with different livestock per district

DISTRICT	**COWS**	**CHICKEN**	**GOAT**	**SHEEP**	**PIG**	**RABBIT**	**NONE**
KIREHE	14	26	39	1	34	7	42
NYAGATARE	16	22	42	4	14	3	40
NYAMAGABE	48	31	19	2	64	15	9
NYARUGURU	54	38	27	3	33	8	12
TOTAL	**132**	**117**	**127**	**10**	**145**	**33**	**103**

Resources allocation by farmers in the farming systems of Nyamagabe, Nyaruguru, Kirehe, and Nyagatare Districts

Inputs and management in any farming system is the major determinant of the productivity. In Nyamagabe, Nyaruguru, Kirehe, and Nyagatare districts, 96.2% of the farmers reported to use mineral fertilizers with an average of 93% reporting an increasing trend of mineral fertilizer use over the last 3 years.

The use of pesticides in the districts is common with 80.4% of interviewed farmers reporting to frequently use them. The top four most used pesticides are respectively *Rocket, Dithane,* Dudu *abamectine, and Ridomil. 'Rocket'* alone was reported by 73% of the farmers to be the most used pesticides, making it the leading pesticide in their farming systems.

The use of improved seeds is still low with only 66% of interviewed farmers reporting their use. Reasons vary but the main ones could be the limited access and affordability to the improved seeds in the area. Nevertheless, the high number of farmers (24%) reporting not to be sure whether they use improved seeds or not could be seen as an indicator for the lack of knowledge on the existing options in seeds and their differences in their productivity. Table 15. below shows the use of the frequent inputs in the farming systems of the researched districts.

Table 15. Inputs use in the farming systems of Nyamagabe, Nyaruguru, Kirehe, and Nyagatare Districts

Input 1. Types of fertilizers used		
Fertilizers	Frequency (number of HH)	%
DAP	294	94.2
Urea	292	93.6
NPK	158	50.6
Lime	11	3.5
Input 2. Pesticides used		
Rocket	229	73.4
Dithane	82	26.3
Dudu abamectine	63	20.2
Ridomil	53	17.0
Sumicombi	9	2.9
Thiodan	8	2.6
Copper oxychloride	5	1.6
Cypermethrin	1	0.3
Input 3. Improved Seeds		
Yes	272	66.2
No	40	9.7
Don't know	99	24.1

4.3.2.Challenges and mitigation measures in the farming practices in Nyamagabe, Nyaruguru, Kirehe, and Nyagatare Districts

The majority of farmers (90.4%) in these districts reported to face challenges in their farming practices over the last three years. Around 66.4% of the interviewed farmers reported to face the problem of rainfall shortage and dry spells that led to frequent crop failures. Apart from the climate related stress, other major stress to crop production are disease and pests (reported by 27.6% of HH), and crop raiding by animals (reported by 25.6% of HH). Table 16 below highlight the major stresses/challenges faced by farmers in the studied districts.

Table 16. Challenges faced by farmers in Nyamagabe, Nyaruguru, Kirehe, and Nyagatare District

TYPE OF STRESSES	**FREQUENCY**	**%**
Drought	121	38.8
Heavy rainfall	129	41.3
Insufficient rainfall	167	53.5
Inadequate fertilizer	39	12.5
Late sowing	20	6.4
Flood	5	1.6
Landslide	4	1.3
Crops destroyed by animals (grazed)	80	25.6
DISEASES AND PESTS	86	27.6
UNFERTILE SOIL	42	13.5
Inadequate fertilizer	39	12.5
Delay of inputs	1	0.3
High price of seeds	1	0.3
Insufficient of agriculture land	1	0.3

Lack of lime	1	0.3

Interviewed farmers proposed some mitigation measures to address the above mentioned challenges. Responses hint to the need for climate adapted seeds, supplementary irrigation, and alternative off-farm livelihoods. Table 17. below summarize the mitigation measures as proposed by farmers in the studied districts.

Table 17. Mitigation measures to address farming practices challenges

Mitigation measures	*Frequency*	*%*
Supplementary irrigation	77	24.7
Adapted crops	86	27.6
Earlier maturing crop varieties	76	24.4
Crop diversification	10	3.2
Rearing livestock	12	3.8
Practicing off farm activities	88	28.2

4.3.3. Agroecological approach to climate resilient agriculture in Nyamagabe, Nyaruguru, Kirehe, and Nyagatare Districts

Farmers in Nyamagabe, Nyaruguru, Kirehe, and Nyagatare Districts were interviewed on their knowledge , preference, challenges and mitigation measures in agroecological practices. The chapters below describe their responses.

4.3.3.1. Knowledge in agroecological practices to climate resilient agriculture in Nyamagabe, Nyaruguru, Kirehe, and Nyagatare Districts

Farmers knowledge on the 25 common agroecological practices in Rwanda were assessed in Nyamagabe, Nyaruguru, Kirehe, and Nyagatare districts. In general, 14.3% of respondents were found with required knowledge, 14% had used agroecological practices in the last 10 years, while only 13.9% were still applying the practices at the time of interviews (i.e. year 2021). This shows that almost everyone who has had adequate knowledge on AEP has adopted them and the drop out form the practices is quite low or insignificant. This is a great promise that if adequate knowledge is provided to farmers, adoption rates are expected to be high and consistent.

The low proportion of farmers practicing the EAPs was also report in the KIIS indicating that the extension system focuses on the promotion of intensification programs with the mass use of fertilizers instead of promotion of the EAP best practices. Also, the front-line extension services (Agronomists) interviewed in the KIIs reported that the low implementation of the EAPs is due to lack of enforcement, others reported on lack of policymaker's guideline on the implementation of the EAPs.

Results show that top 5 high ranked AEP in the decreasing order are (i) crop rotation, (ii) organic fertilizers, (iii) terracing, (iv) agroforestry, and (v) eco-friendly chemical fertilizers. The lowest ranked AEP were cultural, biological control, and push and pull in terms of knowledge and practice. Figure 3. below shows the number of farm households per AEP in terms of knowledge and practice.

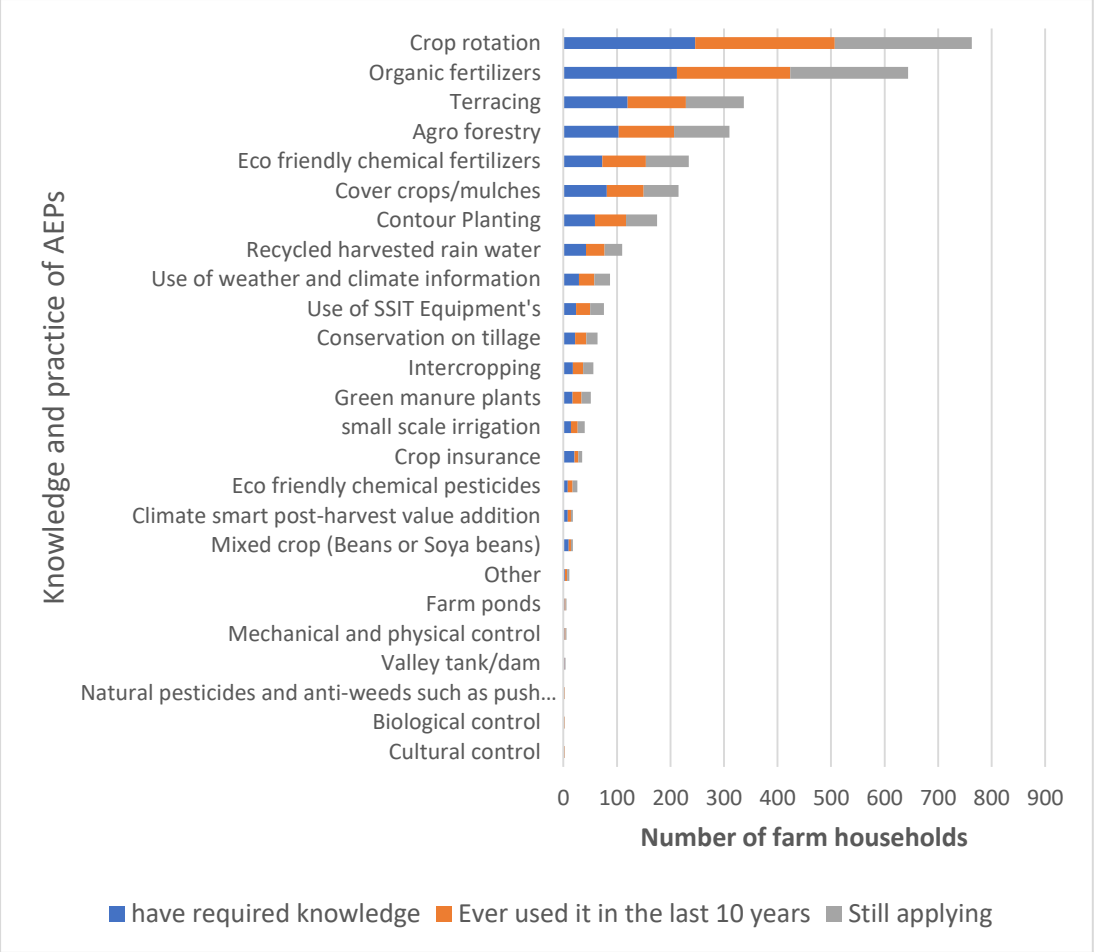

Figure 3. Farmers' knowledge and application of AEP in Nyamagabe, Nyaruguru, Kirehe, and Nyagatare Districts

4.3.3.2. Adoption of agroecological practices in Nyamagabe, Nyaruguru, Kirehe, and Nyagatare Districts

Adoption of any agricultural practice depends on farmers' preferences, which are usually rational based on their needs and the farming resources the household has at hand. Farmers' preferences among AEPs were assessed in Nyamagabe, Nyaruguru, Kirehe, and Nyagatare districts. Preferences were consistent across the districts and farmers preferred (i) crop rotation, (ii) organic fertilizers, (iii) terracing, (iv) agroforestry, and (v) eco-friendly chemical fertilizers. Preference rating exactly matches with the knowledge farmers have in AEPs. Figure 4. below shows the farmers' preferences of AEPs per district.

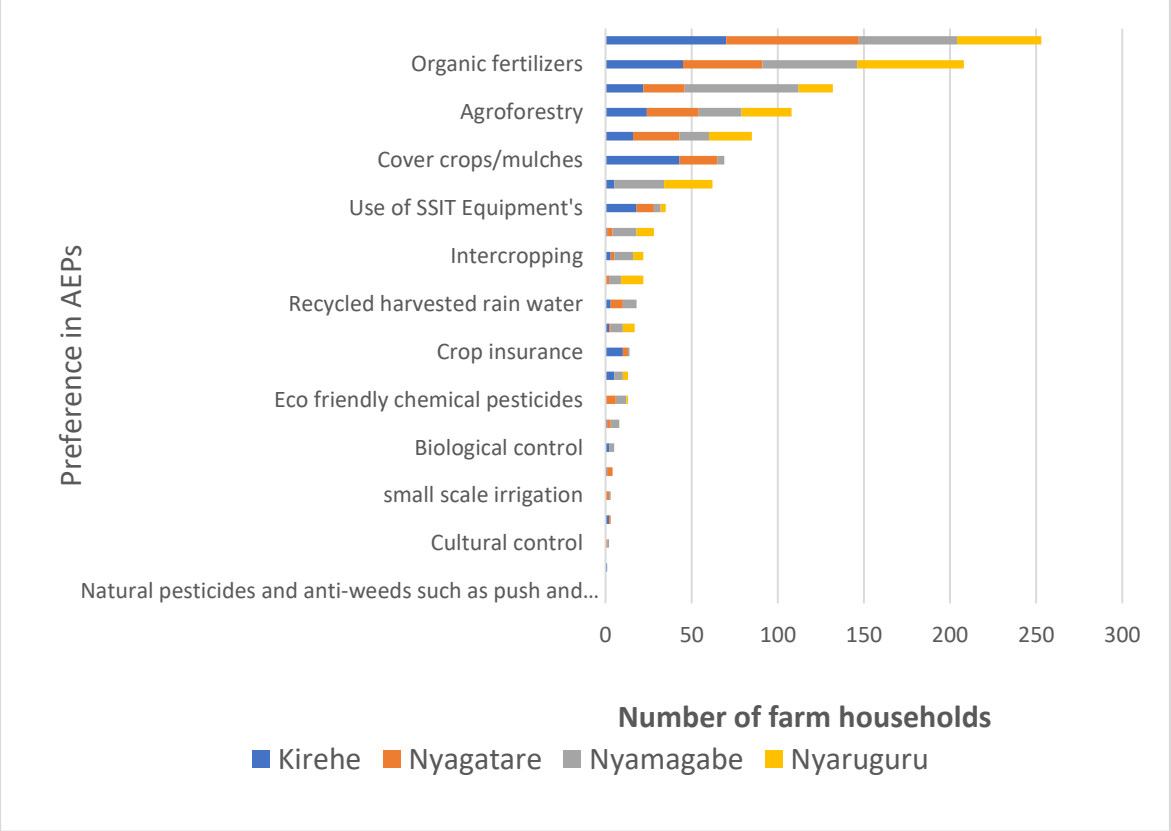

Figure 4. Farmers' preference of AEP in Nyamagabe, Nyaruguru, Kirehe, and Nyagatare Districts

Similarly, the focus group discussions (FGDs) with farmers in Nyamagabe, Nyaruguru, Kirehe, and Nyagatare Districts revealed that some AEPs preferences by farmers; crop rotation, application of organic fertilizers, terracing, agroforestry. In Nyaruguru and Nyamagabe preferred contour planting, and irrigation in Nyagatare and Kirehe Districts.

"Farmers in Nyagatare said that they are so grateful to the irrigation schemes in Kagitumba as it has enabled them to grow crops all agriculture seasons without depending on the rain"

The KII interviews with key partners informed a list of EAPs that are being promoted as presented in the table below:

Organization	Type of EAPs promoted
AEBR	Cover cropping (GM/CC) (Mucuna, jack beans, cowpeas, lab lab) Agro-forestry (fruit species, acacia, leucine Organic manure/compost Mulching
Vi-Agroforestry	Agro-forestry species Organic farming Production and use of organic manure through training of farmers on compost making
ACORD	Crop rotation, complementary crops, protecting crops, agroforestry, cover crop/mulching, fertilization (mineral combine with organic

	manure), pest and disease control, organic fertilizer preparation (green manure and compost), use of improved seeds, rainwater harvesting, ecosystem & biodiversity, cost benefit calculation
IUCN	Agroforestry, small-scale irrigation, mulching practices, push and pull, and conservation/ minimum tillage
TUBURA	Agroforestry, compost, early improved seeds, chemical fertilizers
ICRAF	Progressive terraces, hedgerows, green manure, agroforestry (e.g. tree-shed in coffee plantations), fodder trees
CoEB	Rainwater harvesting, agroforestry, small-scale irrigation, improved seeds, organic fertilizer
RAB	Rotation, small-scale irrigation, terraces, agroforestry, organic manure, mulching for some crops.
Agronomists	Rotation, small-scale irrigation, terraces, agroforestry, organic manure, mulching for some crops

The preferences are also linked to the extension type received by farmers. 77% of the interviewed farmers confirmed that they received extension services on agroecological practices to climate resilient agriculture. In did, access to the extension services were reported to be 61%, 60.3%, 58.4%, and 51.3% in Nyamagabe, Nyagatare, Nyaruguru, and Kirehe district respectively.

This research found that most of the extension information was received by farmers from government extensionists (56.7% of respondents), from NGOs (28.3% of respondents), and from Radio (21.5% of respondents).

4.3.3.3. Advantages of agroecological practices in Nyamagabe, Nyaruguru, Kirehe, and Nyagatare Districts

Farmers perceptions of advantages they get from applying AEPs in Nyamagabe, Nyaruguru, Kirehe, and Nyagatare districts were assessed. Below is a table detailing their perceptions in general as it did not significant vary across the districts.

Table 18. Advantages of using the AEPs

AEPs & CSAPs	*Increased soil fertility*	*Improved crop productivity*	*Improved soil water retention*	*Improvement in HH nutrition*	*Increased level of adaptation to CC effects*	*Decreased incidence of crop pest and diseases*	*Reduction of losses to farmers*	*% of HH*
Crop rotation	178	235	33	158	4	32		**34.2**
Organic fertilizers	185	198	84	116	8	24		**32.9**
Agroforestry	65	44	60	40	12	19		**12.8**
Terracing	56	69	56	39	5	9		**12.5**
Eco friendly chemical fertilizers	47	79	11	33	1	3		**9.3**
Contour Planting	33	30	44	16	15	19		**8.4**
Cover crops/mulches	52	40	32	13	4	13		**8.2**
Recycled harvested rain water	18	27	17	17	2	3		**4.5**
Conservation on tillage	19	18	17	5		7		**4.2**
Intercropping	11	18		16		5		**4**
Use of weather and climate information	18	26	1	20	2	2		**3.7**
Green manure plants	16	14	3	9	2	3		**2.5**
Use of SSIT Equipment's	8	18	4	6	4	3		**2.3**
Crop insurance							7	**2.2**
small scale irrigation	6	12	3	5		1		**1.7**
Climate smart post-harvest value addition	6	4	4	4	1	1		**1.1**
Eco friendly chemical pesticides	3	2	3			4		**1**
Mechanical and physical control	1	1	1	2		2		**0.4**
Mixed crop (Beans or Soya beans)	1	2		1	1	1		**0.4**
Cultural control		1		1				**0.3**
Biological control	1	1		1				**0.3**
Natural pesticides and anti-weeds such as push and pull						1		**0.3**
Valley tank/dam		1	1					**0.3**
Farm ponds	1	1		1				**0.3**
Average for last years	36	38	22	25	5	8	7	
%	**8.8**	**9.3**	**5.4**	**6.1**	**1.1**	**1.9**	**1.7**	

4.3.3.4. Policy gap and proposed action for advocacy

The results of the KIIs highlighted the policy option for the EAPs as presented in the Table 19. Below.

Organization	Policy gaps and advocacy
AEBR	Lack of promotion of conservation agriculture in the actual farming system by policymakers, the effort is made to the use of inorganic fertilizers. We propose to advocate for the promotion of conservation agriculture
Vi-Agroforestry	The policy gap reported is a competition between the industrial farming system supported by the Government (subsidized agriculture) versus the agro-ecological practices which are not greatly promoted "the big gap is lack of promotion of the EAPs" Also, there is a lack of evidence-based recommendations from the research showing the impact and benefits of the EAPs, which would inform and motivate farmers to adopt the EAPs. What is required is the policy influence for the implementation of the EAPs The relevant action for advocacy is the policy influence for the promotion of the sustainable farming system through the use of the EAP
ACORD	The current farming system promote massive use of inputs which foes not take into account the sustainability of soil fertility and biodiversity; the solution is to promote only agro-ecological practices that contribute to the natural regeneration of mineral salts and that protect the soil. We need policy advocacy to include the EAPs in the farming system and promote the use of indigenous seeds An integration between the inorganic and EAPs
IUCN	Policies are available, however, there is a lack of incentives such as premium prices for farmers involved in organic farming Current policies are not well known among the communities Action: there is need to translate the EAP relevant policies in Kinyarwanda and conduct an awareness campaign for farmers
TUBURA	Promotion of compost for having enough organic manure
ICRAF	Energy is an issue that is integrated, and should not be isolated from other policies, related to agroforestry
CoEB	Promoted intercropping, not the policies encouraging monocropping Advocate for policy dialogue between agriculture agencies and environmental agencies

RAB	In RAB there is limited enforcement of the conservation agriculture or EAPs
Agronomists	Inclusion of EAPs in the performance contracts for agronomists and policy dialogues would go to enhance adoption of the practice e.g.: Imihigo they ask you to meet a target, you are accountable to meet the target without accounting for other Agroecological efforts being implemented Promote cleaner energy source

4.3.4. Food-Energy System in Nyamagabe, Nyaruguru, Kirehe, and Nyagatare Districts

Rural and to some extent urban populations in Rwanda are still heavily depending on unsustainably harvested wood energy and charcoal for cooking. While biomass recycling is at the heart of agroecology approach, trade-offs often exist in the use of crop residues which are usually used by farmers as a source of cooking energy rather than for improving the soil organic matter. Agroecosystem approaches that combine both food and energy production, such could substantially mitigate climate change risks to agro ecosystems and smallholder farmers. This study assessed the farming systems in Nyagatare, Nyaruguru, Kirehe, and Nyamagabe districts in terms of their level of integrating the food-energy systems and results are presented in the following chapters.

4.3.4.1. Characterizing the food-energy systems in Nyamagabe, Nyaruguru, Kirehe, and Nyagatare Districts

This study found out that firewood is the most dominant source of cooking energy in rural areas (97% of households) seconded by crop residues (22.4% of households), while charcoal was the first source in urban areas (55.6%) seconded by firewood (49.5%). The FGDs together with farmers with KIIS indicated that the most dominant source of cooking energy in rural areas is firewood, seconded by Dry grass which they locally call 'Maviyakuku' in Nyagatare and Kirehe, along with crop residue. Note that in Nyaruguru and Nyamagabe, the reported source of cooking energy is firewood due to high density of trees and the favourable climate and land topography which allow smart growth of agroforestry trees, followed by crop residues.

Table 20. Type of cooking energy used by households

Type of energy	**Rural**		**Urban**		**Overall**	
	Frequency	% HH	Frequency	% HH	Frequency	% HH
Firewood	303	97.1	49	49.5	352	85.6
Charcoal	23	7.4	55	55.6	78	19.0
Crop residues	70	22.4	0	0.0	70	17.0
Biogas	5	1.6	2	2.0	7	1.7
Diesel	4	1.3	0	0.0	4	1.0
Solar energy	4	1.3	4	4.0	8	1.9
Electricity	2	0.6	40	40.4	42	10.2
Gas	0	0.0	5	5.1	5	1.2

Since most of the households were found using firewood and crop residues, additional questions were asked to know the source of these biomass materials. Most households collect firewood from forest (60% of households) and from their own farms (56%). Crop residues are mainly corrected from household farms as reported by 92% of the households. Table 21 below summarize the sources of firewood and crop residues used by households for cooking.

Table 21. Sources of firewood and crop residues used by households for cooking

	Firewood		Crop residues	
Source of firewood	Frequency	% HH	Frequency	% HH
My own farm	170	56	65	92.9
Buy them	96	32	3	4.3
Collecting them from the forest	182	60	9	12.9

Households were requested to suggest recommendations for the most suitable source of cooking energy in their own districts. Most households (41.8%) still recommended firewood, electricity (38.4%), biogas (20.2%), and charcoal (18.7%). It seems the districts in the southern province (Nyamagabe and Nyaruguru) do not have adequate access to LPG (Gas) since no single household recommended it as it was the case for their counterpart households in the Eastern province. In contrast to Kirehe and Nyagatare districts, households in Nyamagabe and Nyaruguru districts highly recommended charcoal. This reflects the difference in the accessibility of charcoal because of higher tree cover in Nyamagabe and Nyaruguru districts. In did, charcoal business is booming in the latter districts.

Table 22. Most suitable types of cooking energy recommended by households in Kirehe, Nyagatare, Nyamagabe, and Nyaruguru districts

Row Labels	Kirehe	Nyagatare	Nyamagabe	Nyaruguru	Total	%
Firewood	31	53	42	46	172	41.8
Charcoal	10	12	32	23	77	18.7
Crop residues	2	8		1	11	2.7
Biogas	30	16	14	23	83	20.2
Diesel	13	6	11	4	34	8.3
Solar energy	18	4	33	15	70	17.0
Electricity	41	41	47	29	158	38.4
Gas (LPG)	7	8			15	3.6

4.3.4.2. Capacity of AEPs to address issues in the food-energy systems in Nyamagabe, Nyaruguru, Kirehe, and Nyagatare Districts

Results show that Agroforestry, contour planting, and crop rotation were top ranked as 'very good' in terms of addressing the problems of food-energy systems while cultural and biological control and push and pull were the ranked as the least contributors. A significant proportion of respondents (18.1%) reported that inorganic fertilizers do not at all address the food-energy issues. Below is a figure on the general perception of the capacity of AEPs to address problems in the food-energy systems in the four studied districts.

The figure below shows the farmers' perceptions in terms of the capacity of the practices AEPs to address the problems in food-energy systems.

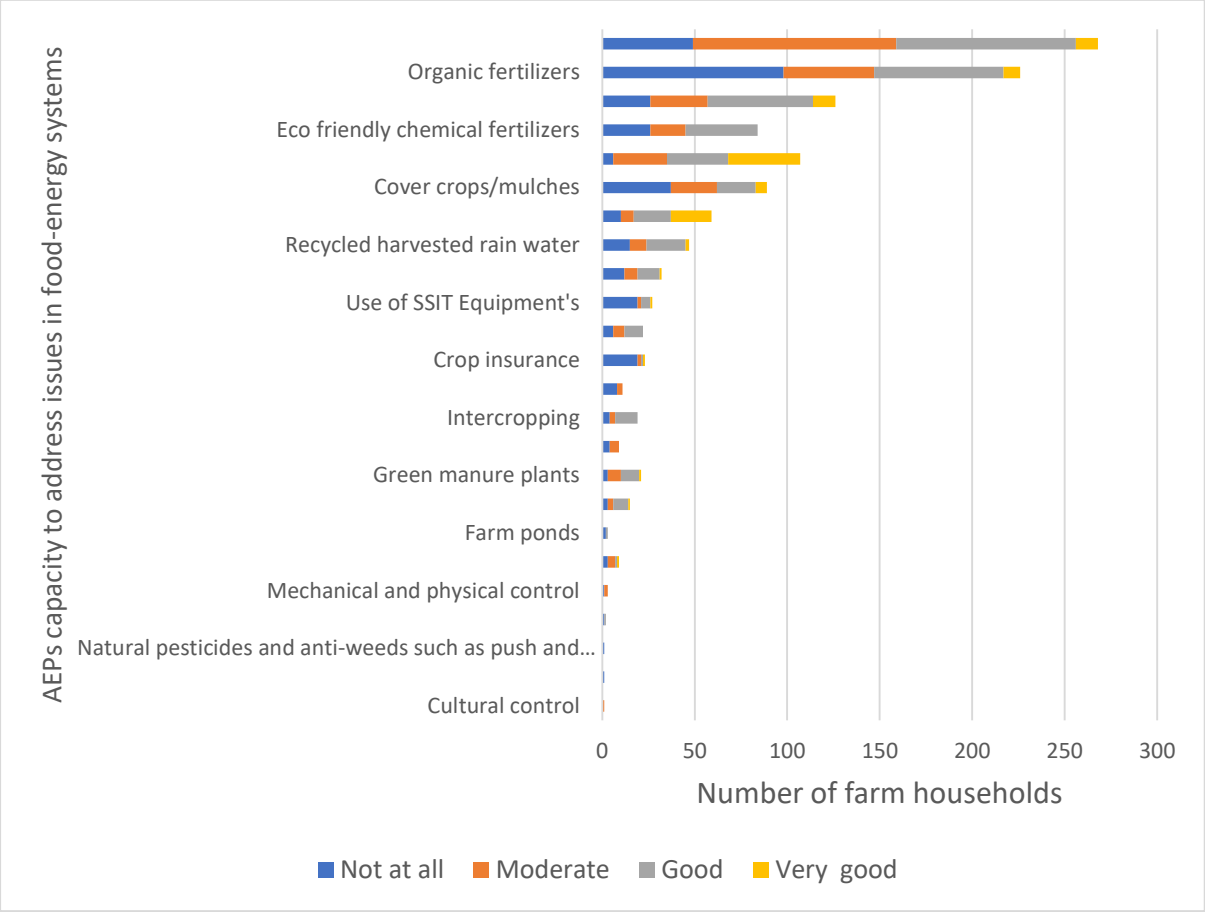

Figure 5. Farmers perception of AEPs in terms of addressing the issues of Food-Energy systems

Overall, the majority (35%) of respondents perceive that AEPs are good, and very good (9%) in terms of addressing issues in food-energy systems. Nevertheless, a significant proportion of respondents perceived that AEPs are contribute moderately (27%) or not at all (29%) to addressing the issues in the food-energy system. This shows the need to educate continuously farmers on the benefits of AEPs in the food-energy systems without which adoption will continue to be a challenge.

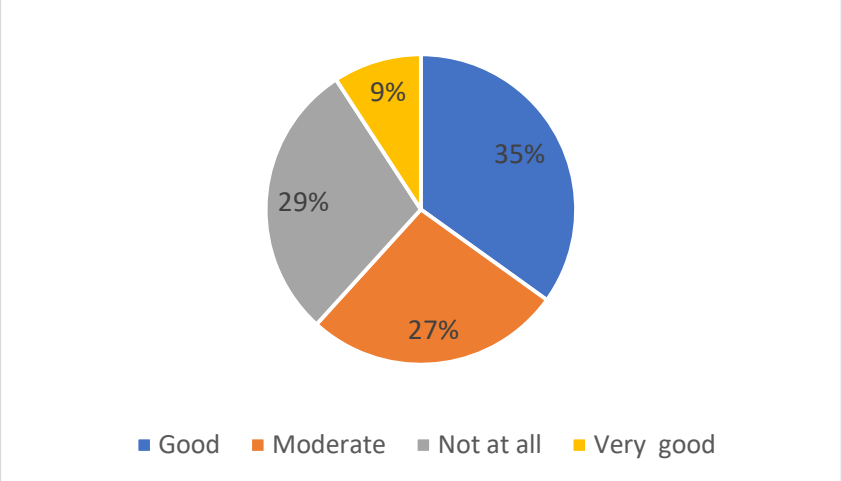

Figure 6. General farmers' perception of the capacity of AEPs in addressing food-energy issues

5. CONCLUSION AND RECOMMENDATIONS

The research on Agroecological approaches and food-energy system for climate resilient agriculture in Rwanda was carried out through a literature review, key informants, household survey and focus group discussions in Nyamagabe, Nyaruguru, Kirehe, and Nyagatare districts during from June to October 2021. The main objective of the assignment was to generate data and information that will help CSOs to ensure that relevant policies and plans on climate change resilience reflect smallholder farmers' needs, thereby fostering sustainable rural development and food security. This chapter summarizes conclusion and recommendations derived from the findings of this study.

5.1. Conclusion

5.1.1. About policy framework and funding opportunities

The review of policies pertinent to agroecological approaches and food-energy system highlighted some gaps including:

i. Inadequate definitions of the agroecological approach and food-energy systems,
ii. Low awareness of the policies among communities and implementing stakeholders,
iii. Lack of institutionalization of agroecological approaches and food-energy system,
iv. Lack of clear indicators for the approaches in the policies and strategies, and,
v. Limited focus on research for agroecological approaches and food-energy systems.

This study intended to highlight policy and finance opportunities needed to advance mitigation strategies in food-energy systems, reduce vulnerability and avoid investments that Unintentionally cause maladaptation. The study found out that Rwanda's agenda for agroecological approaches and food-energy system is quite well embedded in the comprehensive policy framework with their implementing strategies and plans.

In Rwanda, farmers are the biggest investors in agriculture at their own farms and most agricultural investments are financed from domestic public and private sources, with a small share flowing from international sources. This study found out that finance for agroecology and food energy system initiatives features many different funding channels with different objectives and eligibility criteria. These funding sources present an opportunity to remove barriers, enhance institutional capacities, and create enabling environment for agroecology and food-energy system transition.

The table below summarizes key potential sources of finance for civil society organizations operating in agroecology, climate resilience, and food- energy systems in Rwanda.

Donor	Thematic areas of funding and address
Rwanda Green Fund, FONERWA	Biodiversity conservation, forestry management and land-use, agriculture, renewable energy, water management, disaster risk management, waste management Funding provided. www.fonerwa.org
The Critical Ecosystem Partnership Fund (CEPF)	Biodiversity, land degradation, forestry. www.cepf.net/
International Fund for Agricultural Development (IFAD)	Agriculture, water, nutrition. www.ifad.org/en/ngo
Global Environment Facility (GEF) – Small Grants Program (SGP)	Agriculture, biodiversity, education, climate change, land degradation, sustainable forest management, water, chemical, health. www.sgp.undp.org/
GEF-Least Developed Countries Fund.	agriculture and food security, water, disaster risk management, fragile ecosystems, waste management and health. www.thegef.org/gef/ldcf
Global Environment Facility (GEF) – Trust Fund	Biodiversity, energy efficiency, climate change, forestry, land degradation, renewable energy, land use, water, health, chemicals and waste. www.thegef.org/gef/climate_change
Green Climate Fund (GCF) – Readiness Program	Agriculture, Ecosystem adaptation, Energy efficiency, forestry and land-use, renewable energy, health, gender, poverty, water. https://www.greenclimate.fund/readiness
International Climate Initiative (IKI)	Agriculture, Ecosystem adaptation, Energy efficiency, Forestry and Land-Use, Renewable Energy, Waste management, water. www.international-climate-initiative.com/
Clim-Dev Special Fund (CDSF)	Adaptation and Capacity-building. www.climdev-africa.org
Canada fund for African climate resilience	Agriculture, climate resilient, energy, fisheries, forestry, land use, low-carbon, natural resource management, renewable energy, sustainable land management, water. https://climate-change.canada.ca/finance/continent.aspx?id=4
Adaptation for Smallholder Agriculture Programme	Agriculture, natural resource management, sustainable land management, water. https://www.ifad.org/en/asap
Nordic Climate Facility (NCF)	Agriculture, ecosystem adaptation, forestry and land-use, gender, health, disaster risk reduction, renewable energy, waste management, water. https://www.ndf.int/what-we-finance/projects/project-database/nordic-climate-facility-ncf.html
GEF-Special Climate Change Fund (SCCF)	Agriculture, ecosystem adaptation, renewable energy, forestry, industry, transport, waste management. www.thegef.org/gef/SCCF

5.1.2. About agroecological approaches relevant to the Rwandan context

This research aimed at documenting the existing and new agroecological approaches relevant to the Rwanda context and to highlight some of them which could be quick and long term/big wins in mitigating and adapting to effects of climate change in Nyamagabe, Nyaruguru, Kirehe, and Nyagatare districts.

Farmers knowledge on 25 common agroecological practices in Rwanda were assessed in Nyamagabe, Nyaruguru, Kirehe, and Nyagatare districts and results showed that 14.3% of respondents have required knowledge for AEPs, 14% had used agroecological practices (at least one AEP) in the last 10 years, while 13.9% were still applying the practices at the time of interviews (i.e. year 2021). This highlights that almost everyone who has had adequate knowledge on AEP has adopted them, while drop out form the practices is quite low. These results show that if adequate knowledge is provided to farmers, adoption rates are expected to be high and consistent. Top 5 high ranked AEPs in the decreasing order were found to be (i) crop rotation, (ii) organic fertilizers, (iii) terracing, (iv) agroforestry, and (v) eco-friendly chemical fertilizers. The lowest ranked AEPs were cultural, biological control, and push and pull in terms of knowledge and practice. Farmer preferences matched with knowledge farmers have in AEPs and rankings were similar to the above.

Overall, the majority (35%) of respondents recognise that AEPs are good, and very good (9%) in terms of addressing issues in food-energy systems. However, a significant proportion of respondents perceived that AEPs contribute moderately (27%) or not at all (29%) to addressing the issues in the food-energy system. This demonstrates the need to educate continuously farmers on the benefits of AEPs in the food-energy systems without which adoption will continue to be a challenge.

5.1.3. About Food-Energy Systems Initiatives relevant to the Rwandan Context

This study found out that firewood is the most dominant source of cooking energy in rural areas (97% of households) seconded by crop residues (22.4% of households), while charcoal was the first source in urban areas (55.6%) seconded by firewood (49.5%). Nevertheless, it was found that most households use a variety of sources of cooking energy mainly depending on what is readily available and affordable in their neighbourhoods. Most households collect firewood from forest (60% of households) and from their own farms (56%). Crop residues are mainly corrected from household farms as reported by 92% of the households.

Due to the fact that most households (41.8%) still recommended firewood, electricity (38.4%), biogas (20.2%), and charcoal (18.7%), it seems the districts in the southern province (Nyamagabe and Nyaruguru) do not have adequate access to LPG (Gas) since no single household recommended it as it was the case for their counterpart households in the Eastern province. In contrast to Kirehe and Nyagatare districts, households in Nyamagabe and Nyaruguru districts highly recommended charcoal. This reflects the difference in the accessibility of charcoal because of higher tree cover in Nyamagabe and Nyaruguru districts. In did, charcoal business is booming in the latter districts.

In view of the above main challenges, recommendations and possible alternatives were proposed by stakeholders and are elaborated below.

5.2. Recommendations

5.2.1. Policy level

Despite this study found that policy framework in Rwanda well integrates AEPs and due to the lack of its institutionalization and the lack of policy awareness at different levels among stakeholders, the following recommendations are given:

- ✓ There is a need to institutionalize the AEPs to better tailor its scaling up,
- ✓ Clear indicators of AEPs should be elaborated in line ministries (MINAGRI, Ministry of Environment, and MINALOC: which manages local agronomists),
- ✓ Developing a solid extension system for AEPs that go hand in hand with the existing extension system for crop intensification programme to make sure that the country balances production goals vs soil conservation goals,
- ✓ Develop strategy to engage strongly with the private sector in the implementation of AEPs.

5.2.2. Implementation level

Even though farmers have recommended to promote (i) crop rotation, (ii) organic fertilizers, (iii) terracing, (iv) agroforestry, and (v) eco-friendly chemical fertilizers, since the study found that farmers recommend only what they know and have experienced, it is possible that additional AEPs could be welcomed if proper extension is provided. Therefore, in consultation with key informants (agroecological practitioners in Rwanda), the following practices are recommended to be promoted across the districts:

(i) Agroforestry,
(ii) Conservation Agriculture,
(iii) Crop-Livestock Integration,
(iv) Crop-Livestock-energy integration,
(v) Climate Resilient Zero Budget Natural Farming (CRZBNF).

5.2.3. Food-Energy system

Due to the fact that districts do not have adequate access to LPG (Gas), the following recommendations are provided:

-To promote renewable energies and improved cooking stoves to keep biomass for agroecology and reduce greenhouse gas emissions

-In urban areas, to increase the penetration rate of LPG-Gas for cooking and better regulation of charcoal value chain and pricing

.

References

[i] https://sdgs.un.org/goals

[ii] Ritchie H. (2019). Food Production is Responsible for One-Quarter of The World's Greenhouse Gas Emissions https://ourworldindata.org/food-ghg-emissions

[iii] Sinclair, F., Wezel, A., Mbow, C., Chomba, S., Robiglio, V., & Harrison, R. (2019). The contribution of agroecological approaches to realizing climate-resilient agriculture. *GCA: Rotterdam, The Netherlands*.

[iv] Poore, J., & Nemecek, T. (2018). Reducing food's environmental impacts through producers and consumers. *Science*, *360*(6392), 987-992.

[v] Bogdanski, A. (2012). Integrated food–energy systems for climate-smart agriculture. *Agriculture & Food Security*, *1*(1), 1-10.

[vi] De Schutter, O. (2011). Agroecology and the right to food: Report submitted by the Special Rapporteur on the right to food. *United Nations Human Rights Council, New York*.

[vii] http://www.ipes-food.org/_img/upload/files/sfsENhq.pdf; https://docs.google.com/document/d/1Yw7Oq09S8e6Uuv0SphldIYVqCVLsOb_1Emvakb8nlwI/edit; http://www.ipes-food.org/_img/upload/files/UNFSS%20Withdrawal%20Statement.pdf

[viii] Wezel, A., Herren, B. G., Kerr, R. B., Barrios, E., Gonçalves, A. L. R., & Sinclair, F. (2020). Agroecological principles and elements and their implications for transitioning to sustainable food systems. A review. *Agronomy for Sustainable Development*, *40*(6), 1-13.

[ix] FAO. (2014). The water–energy–food nexus: a new approach in support of food security and sustainable agriculture. *Food and Agriculture Organization (FAO) of the United Nation*.

[x] FAO 2018. Sustainable food systems: Concept and framework, FAO

[xi] Woods, M. (2011). Interviewing for research and analysing qualitative data: An overview. *Massey University*, 67-80.

[xii] GoR. National Strategy for Transformation (NST1) 2017-2024.

[xiii] GoR, 2020. Updated Nationally Determined Contribution. Rwanda, Kigali

[xiv] MINAGRI, 2018. Strategic Programme for Agriculture Transformation 2018-2024 (PSTA IV). Rwanda, Kigali