ANNEX 2

Summary Report – Feasibility Study

Version 4

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RE-GAIN: Scaling Solutions for Food Loss in Africa

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Executive Summary

Africa's food insecurity challenge is intensifying due to the impacts of climate change, particularly in Sub-Saharan Africa, where a growing population of 1.5 billion faces severe threats to agricultural productivity (World Bank, 2023; Worldometer, n.d.). The region faces a myriad of challenges, including environmental degradation, which manifests in low crop yields, deforestation, and increased vulnerability to climate shocks, all of which exacerbate food insecurity and economic hardships. Extreme weather events, such as floods, droughts, and desertification, are becoming more frequent and severe, leading to declining agricultural viability and projected yield reductions of up to 50% by 2030, with small-scale farmers bearing the brunt of these impacts (IPCC, 2019).

In recent decades, significant attention has been devoted to understanding the impacts of climate change on crop production, with extensive research focusing on how climate variability affects crop yields and exploring potential management strategies to address these challenges. As concerns about food security and the livelihoods of current and future generations grow, the emphasis on mitigating climate change risks to food production has intensified. However, food security is influenced not only by changes in crop production but also by the entire crop value chain, including post-harvest stages. It is essential to consider how climate change affects all aspects of the value chain, from production to harvesting, storage, aggregation, processing, and distribution. While most research and resources have traditionally focused on production, **the RE-GAIN project seeks to address the often-overlooked post-harvest stages, including harvesting, handling, storage, processing, transportation, and logistics**. The 2015 IFAD report has underscored the importance of addressing climate change concerns in these post-harvest stages, highlighting the need for targeted adaptation interventions to enhance resilience throughout the entire value chain (IFAD, 2015).

To address these challenges, AGRA has developed the RE-GAIN Programme, focusing on seven key countries with the aim of reducing food loss in key value chains and bolstering climate resilience. The programme emphasizes raising awareness and building capacity for the adoption of Food Loss Reduction Solutions (FL-RS). It aims to equip end users and service providers with practical strategies, improve financial access for farmers and MSMEs to invest in climate-resilient FL-RS, and encourage vendors, manufacturers, and suppliers to embrace these approaches while strengthening the infrastructure needed for climate-resilient food handling. **Key crops, identified through expert assessments in collaboration with AGRA and each country's National Designated Authority (NDA), were chosen for their alignment with national agricultural priorities, their critical role in food security, and the significant losses they face within the value chain.** These crops are pivotal to each country's agricultural landscape, engaging a large number of smallholder farmers, and are essential for advancing food security and sustainability. Better management of these crops is also expected to substantially reduce greenhouse gas emissions, contributing to the countries' Nationally Determined Contributions (NDCs). The prioritized crops/value chains are as follows:

- Burkina Faso – Rice and Cowpea
- Ethiopia – Wheat and Teff
- Kenya – Beans and Maize
- Uganda – Beans and Maize
- Tanzania – Rice and Maize
- Malawi – Groundnuts and Maize
- Zambia – Soybeans and Maize

All seven countries, in varying capacities, have implemented a range of national policies and programmes aimed at supporting climate change adaptation, mitigation, and reducing post-harvest food losses through various approaches. These efforts take the form of national climate change policies, agricultural policies, development initiatives, and investment plans, to name a few. While these initiatives are encouraging and demonstrate a commitment to addressing these critical issues, they are often insufficient in scope and impact. Broadly speaking, many of these efforts lack the necessary scale and are not adequately targeted to address the specific challenges of post-harvest losses, particularly those faced by smallholder farmers and other vulnerable groups. As a result, the effectiveness of these policies and programmes in achieving meaningful and sustainable outcomes remains limited, highlighting the need for a more comprehensive and focused strategy.

This is particularly pertinent as the impacts of climate change become increasingly felt. Over the coming decades, climate-related hazards such as extreme weather events, pests, and diseases are expected to intensify (IPCC, 2018)**, leading to more severe impacts on post-harvest processes**. Increased temperatures, unpredictable rainfall patterns, and more frequent droughts and floods can accelerate the spoilage of crops during storage and transportation, reduce the effectiveness of traditional drying methods, and increase the vulnerability of stored goods to mould and contamination such as aflatoxins. Additionally, climate change is likely to expand the range and activity of pests and diseases, further threatening the integrity of harvested crops. These intensified hazards can lead to higher post-harvest losses, diminishing food security and exacerbating the challenges faced by smallholder farmers who rely on these crops for their livelihoods. As a result, strengthening post-harvest management and adopting climate-resilient practices are crucial to safeguarding food supplies in an increasingly changing climate.

The impacts felt by climate change are exacerbated by the expansion and intensification of land use, driven by the dual pressures of feeding a growing population and spurring economic development (WRI, 2022). As the global population rises, the demand for food grows, leading to a steady increase in cropland areas as agriculture shifts from subsistence farming to more extensive and commercialized practices. Compounding this issue, significant post-harvest losses force farmers to convert even more land to agriculture in an effort to compensate for the losses and ensure adequate yields. This cycle of expanding agricultural land to make up for inefficiencies further depletes natural resources, exacerbates deforestation, and heightens the environmental challenges already posed by climate change.

To address the challenge of post-harvest food losses exacerbated by climate change, an evaluation of proposed physical Food Loss-Reduction Solutions (FL-RS) was conducted, identifying those with the highest potential to mitigate food losses and protect harvests from climate hazards. The evaluation began by exploring physical solutions that could reduce the impacts of increasing climate risks. Through both national and local level workshops across seven countries, critical insights were gathered, revealing advantages, disadvantages, and barriers to implementation, especially for smallholder farmers. This led to the development of a **shortlist of seven tailored physical FL-RS solutions, as a basis for the final selection of those to be supported and disseminated by the RE-GAIN programme.** Prioritization factors included environmental impact, farmer awareness, frequency of use, potential to reduce food losses, availability, affordability, and scalability for job creation. Affordable solutions, like solar-powered small-scale mechanized tools, are prioritized, and combining hermetic storage with moisture meters is essential to prevent spoilage and aflatoxin contamination, particularly in maize and beans. The final shortlist considers synergies and the potential for maximum impact on food loss reduction. **Communal-use solutions include mechanical threshers and shellers, moisture meters, and communal storage, while individual-use solutions comprise tarpaulins, silos, hermetic bags, and biological storage protectants.** Partnerships with agricultural service providers are recommended for implementing high-cost solutions, such as harvest machines, as proper usage awareness and service model support are crucial for their effectiveness.

To complement these physical solutions, the programme will deploy non-physical solutions through extension services, including awareness-raising, demonstrations and capacity-building activities. These efforts aim to enhance understanding of the importance of food loss reduction and build competencies for implementing FL-RS solutions. Merely providing access to physical solutions is insufficient to strengthen smallholder farmers' resilience to climate change; building community knowledge is crucial as a lack of understanding is a key barrier to adoption. Planned extension activities include educating smallholder farmers about food losses, moisture content, aflatoxin contamination, pests, proper storage methods, and environmental and safety considerations. Farmers will also receive training in accessing finance, farm management, climate change impacts, and crosscutting themes like gender and youth. Training and capacity building will be facilitated through a network of village-based advisors (VBAs), leveraging AGRA's expertise, and training lead farmers to become VBAs to ensure programme sustainability and broad knowledge dissemination. The training will cover various aspects of agriculture, including use of weather data and information, crop maturity and harvest timing, harvesting methods, machinery operation and maintenance, as well as the proper use and upkeep of FL-RS like moisture meters, drying methods, hermetic bags, and silos. For traders and processors, the focus will be on transport logistics, packaging, quality standards adherence, and value addition to enhance profitability and sustainability.

To address the challenges of financing FL-RS, the RE-GAIN Programme proposes innovative financing mechanisms tailored to the needs of smallholder farmers, improving access to and affordability of credit by relieving them of the need for loan collateral, mitigating high interest rates, and facilitating capital access. The programme will explore opportunities such as developing financial products for Micro, Small and Medium Enterprises (MSMEs) in agriculture, partnering with financial institutions, NGOs, and MSMEs to share risks and costs, and connecting MSMEs with organizations offering business management and recordkeeping support. Despite the benefits of FL-RS, smallholder farmers face difficulties securing credit from traditional institutions due to a lack of collateral, credit history, and transaction records. Financial institutions often view the agricultural sector as high-risk due to weather and market volatility, leading to high interest rates and short repayment periods, making loans inaccessible for smallholders. To overcome these barriers, **the RE-GAIN Programme focuses on improving financial access, creating better financial products, and enhancing market linkages through indirect grants, support for youth groups and cooperatives, and developing collective structures to improve creditworthiness and reduce borrowing costs.** Three financial models have been identified: conditional procurement of FL-RS from manufacturers, facilitating access to finance for MSMEs providing FL-RS to smallholders, and tripartite agreements for youth groups to unlock larger-ticket items and value-adding equipment. These measures aim to enhance uptake and market development for FL-RS by MSMEs and smallholder farmers.

To ensure the RE-GAIN Programme's positive effects are sustainable, the programme will support policy revisions to facilitate FL-RS investments, including tax exemptions, certification and standards for FL-RS quality, and promoting successful FL-RS business models for scaling and replication. Active government involvement, both central and local, will be crucial, and the programme will align with other projects and policies on food loss reduction, MSME promotion, and smallholder support. Effective programme management will include rigorous monitoring and incorporating lessons learned. Stakeholder engagement will be essential, involving raising awareness, providing programme information, and ensuring inclusivity for women, youth, minority groups, and all value chain actors. A grievance mechanism will also be implemented. Ensuring the availability of quality FL-RS and access to finance is vital for long-term continuation.

The RE-GAIN Programme's comprehensive approach—combining physical and non-physical solutions with innovative financing mechanisms and policy support—is designed to help farmers adapt to climate change and mitigate climate impacts,

reduce post-harvest food losses, provide extensive support to smallholder farmers, and reduce GHG emissions. By prioritizing scalable, affordable technologies and strengthening community knowledge and access to finance, the programme aims to build sustainable agricultural practices that protect harvests and contribute to long-term food and nutrition security and socio-economic stability. Successful implementation will require continued stakeholder collaboration, government support, and a focus on inclusivity to ensure that all segments of the agricultural value chain benefit.

1 Introduction

1.1 PROGRAMME BACKGROUND

A great deal of attention has been paid in recent decades to the impacts of climate change on crop production, i.e., on growing risks to agricultural productivity. Scholarly investigations and public and private research have invested heavily in identifying and – where feasible – quantifying the ramifications of climate change on crop yields, yield stability over seasons, and in exploring plausible management options for the emerging challenges (CGIAR, 2023). As governments and societies look at how to minimize the risks of climate change, the impact of these changes on food production is increasing, fuelling concerns about food security and livelihoods for current and future generations.

Food security, however, is affected not only by changes in crop production but by changes occurring throughout the crop value chain, including during post-harvest phases (Akoth, 2020)**.** It is therefore crucial to examine the impacts of climate change on a crop's value chain, including production, aggregation, storage, transportation, processing, and distribution. Each stage comprises several sub-processes, and climate change may plausibly affect many or all of the sub-processes too.

With the lion's share of research and resources for resilience interventions in the agricultural sector having been focused on production, the RE-GAIN project is an effort to give dedicated focus to harvest and post-harvest stages of the value chain – specifically, harvesting, post-harvesting handling and storage, processing, transportation, and logistics. As summarized in Table 1-1, the International Fund for Agricultural Development (IFAD) report highlights a range of climate change concerns in the post-production stages of value chains and potential adaptation interventions that could increase resilience against such climate change concerns (IFAD, 2015).

Table 1-1 - Illustrative climate change risks and climate change risk management interventions in post-production value chain processes (adapted from IFAD, 2015)

Value Chain Components	Climate Risk Issues	Risk Management Interventions
Post-harvest management	Rising losses in harvest volume; declining safety, market quality and nutritional value due to increasing temperatures, humidity, pests and diseases.	Improve knowledge sharing on harvesting techniques to reduce losses. incentivize waste reduction measures and value addition for by-products; provide renewable energy sources to cover changing requirements for cooling, drying, milling, and threshing.
Siting of processing facilities	Extreme climate events (such as, floods, heatwaves, and storms) may damage processing facilities; shifting climatic conditions may render some sites redundant or increase transportation costs. It could create sustainable environment to pests and diseases, affecting both product quality and its suitability for consumption	Use hazard exposure and crop suitability maps to inform the siting of processing facilities; retrofit processing facilities with protective features; insure processing facilities against extreme climate events.
Energy in processing	High dependence on local bioenergy (wood, charcoal, dung, crop residues) has trade-offs with better soil management; rising temperatures require more energy for cooling.	Provide renewable energy sources (such as solar photovoltaic panels for cooling/drying/milling/heating, wind, biogas); equip processing facilities with energy-saving appliances (e.g., solar lighting, solar charging, efficient cook stoves); adopt pollution control measures.
Water in processing	Declining and more irregular water supplies; growing competition with other domestic or industrial users.	Re-site facilities closer to more suitable water sources; increase water storage and distribution capacity (water harvesting, communal ponds,

Value Chain Components	Climate Risk Issues	Risk Management Interventions
		groundwater recharge); introduce demand-side water efficiency measures; support conflict resolution for different water users (e.g., water user groups).
Packaging materials and methods	Rising temperatures and humidity may increase or decrease post-harvest losses and waste, as well as impact food safety, particularly if current packaging materials are impacted by high temperatures leading to produce damage or poor quality.	Design suitable packaging materials in parallel with waste and storage management strategies.
Processing infrastructure	Buildings and roads are exposed to higher peak rainfall, winds, and heat stress.	Introduce protective features and reinforcements into the design of critical infrastructure to handle run-off and higher temperatures; improve ventilation in buildings; harvest surplus water and energy from rooftops and appliances; use early warning systems.
Transport hubs and routes	Routes may become seasonally or permanently impassable (or open up); extreme events will disrupt logistics.	Re-site hubs; develop contingency plans for road, rail, water, and air transport; co-design value addition, storage, and transport components to avoid high-risk transport routes and seasons; upgrade docks, jetties, roads, and railways.
Refrigeration and cold chains	Temperature rises increase requirements for and costs of refrigeration; rising energy requirements increase greenhouse gas emissions.	Conduct cost-benefit analyses of dependency on refrigerated cold chains to assess best routes; introduce renewable energy sources for cooling and ventilation; optimize storage and transport management.
Just-in-time logistics	Extreme climate events (floods, storms, heatwaves) can make it impossible to comply with "just-in time" requirements.	Develop contingency plans for climate shocks and extreme events; create contingency storage opportunities; link into regional markets to avoid over-dependence on high-value export markets.
Demand from retail and consumers	Shifts in quantity and quality requirements and seasonality with climatic trends; disruptions in demand with climate variability, hence higher price fluctuations.	Assess market risks and opportunities before value chain implementation, including likely climatic impacts on high-value markets; strengthen and diversify storage to buffer price fluctuations; diversify into "off- season" crops.
Commodity labelling and certification	Increased consumer awareness as climate change may create new markets for sustainably produced and processed commodities with a low carbon footprint.	Explore opportunities for sustainable procurement, green labelling, and certification.

AGRA is a continental institution working in 15 African countries addressing food systems focussing on smallholder farmers' production, marketing and nutrition. In the countries where AGRA operates, which are highly diverse in terms of climate, soils, crop choices and institutional capacity, neither all of these climate-related concerns may be applicable, nor all of these potential interventions possible. **Even within the range of what may be applicable, this programme is likely to look at a subset of risks that may be viable to address, and – given resource constraints – only a limited number of high-priority resilience interventions may be feasible to design and deploy.** RE-GAIN is an effort to identify the most salient risks, select the most impactful solutions, and implement the priority interventions through a well-structured, strategic, multi-country programme.

1.2 BRIEF PROGRAMME DESCRIPTION

There is a clear gap in knowledge, data and interventions designed to target the impacts of climate change at the harvest and post-harvest stages of the value chain, despite the mounting evidence of the ramifications on food loss and the impact this has on land use changes and associated climate change mitigation. The majority of the current programmes designed to tackle climate-induced food loss focus on the pre-harvest stages of the value chain.

To address the pressing need for broader implementation of solutions aimed at reducing climate-related harvest and post-harvest food loss, the proposed programme is designed to raise awareness and build capacity to promote the adoption of Food Loss Reduction Solutions (FL-RS). It will do this by creating institutional capacity, facilitating the uptake of FL-RS by end users and service providers, increasing options of solutions' availability, and enabling practical application through policy interventions. This will include enhanced financial access for farmers and Micro, Small, and Medium Enterprises (MSMEs), empowering them to invest in climate-friendly FL-RS and incentivising vendors, manufacturers, and suppliers of climate-adapted FL-RS, fostering a robust market ecosystem.

A key focus is on strengthening the capabilities of countries to develop climate-resilient post-harvest infrastructure, both through providing physical solutions alongside capacity building along the value chains. This includes investing in strategic frameworks and implementation plans, including a regulated quality-based pricing system and tax exemptions on imports, for reducing food loss. By enhancing access to markets, the programme will encourage farmers to adopt FL-RS products and services, thereby boosting their climate and economic resilience.

1.2.1 Target Countries Overview

During the 2023–2027 period, AGRA plans to target 28 million farmers across 15 Sub-Saharan African countries, 40% of which will be women. The RE-GAIN Programme focuses on AGRA's activities in seven target countries, as shown in Figure 1-1 below. The RE-GAIN Programme is designed to combat food loss during the post-harvest stages and to boost climate resilience by fostering awareness and by building capacity for the adoption of Food Loss Reduction solutions (FL-RS). The programme aims to transfer these solutions to end users and service providers for practical application while facilitating financial access to farmers and Micro, Small, and Medium Enterprises (MSMEs) to invest in climate-resilient FL-RS. The programme plans to incentivize vendors, manufacturers, and suppliers to adopt these solutions and enhance the capacity of countries to develop climate-resilient post-harvest food handling infrastructure.

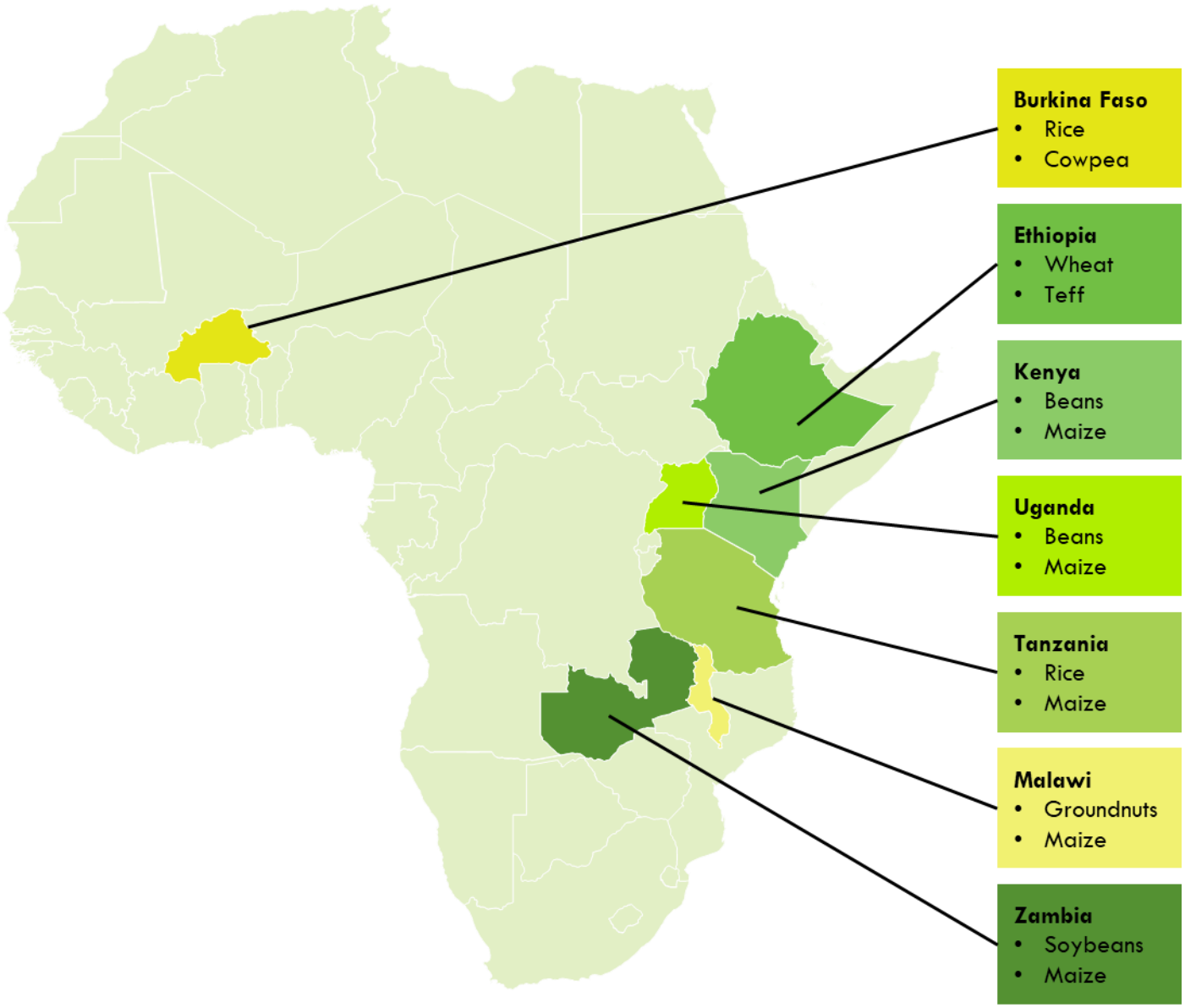


Figure 1-1 Focus Geographies for AGRA (2023-2027)

1.2.2 Crop selection

Key crops were identified by major stakeholders in the respective countries and expert assessments, supported by AGRA and the National Designated Authority (NDA) of each target country. Two major crops per target country were selected, based on area coverage, importance for food security and income, and climate vulnerability, to ensure that sufficient resources would be available for the crafting and execution of targeted solutions. Selected crops are representative of the agricultural dynamics of each country and aligned with the specific needs and strategic agricultural goals of the nation. In addition, these crops hold substantial importance to the country's food security and/or experience particularly high rates of loss within the value chain. Finally, these crops are produced in large parts of the respective countries by a significant number of smallholder farmers. The key crops, therefore, reflect the agronomic and economic realities of each country and provide opportunities for targeted enhancement of food security and sustainable agricultural practices. Additionally, the improved management of these crops is also expected to significantly reduction of GHG emissions contributing to the NDC targets of the countries involved. Figure 1-2 highlights the key crops selected for each of the countries within the programme.

1.2.3 Harvesting and Post Harvesting Definition

For the RE-GAIN programme, the key value chain stages considered are shown in Figure 1-2.

Figure 1-2 Strategic value chain stages included in the RE-GAIN Programme

The harvesting process within this RE-GAIN Programme proposal is defined as the interval between the culmination of agricultural production, marked by the crop reaching its maturity, and the initiation of post-harvest treatment. This process encompasses the identification of the optimal harvesting time and is further delineated into four distinct stages:

1. Removal of contaminated seeds, heads or cobs of matured crops at harvest
2. Reaping, which involves cutting, pulling, or gathering the mature crops.
3. Threshing, the process of separating the grain from the rest of the plant.
4. Cleaning, such as winnowing, to remove chaff and other impurities.
5. Hauling, which entails the transportation of the harvested produce to storage or processing facilities.

The post-harvest handling and storage stage commences once the crop exits the field and is typically conducted on the farm[1]. This stage encompasses several key operations, including:

1. Threshing, which can be performed manually or with mechanical threshing machines.
2. Drying, utilizing cribs, tarpaulins, and similar methods.
3. Cleaning and sorting, such as through winnowing, to remove impurities.
4. On-farm storage, which includes the use of granaries, hermetic bags, ordinary bags, stacks, metal silos, and plastic silos.
5. In some instances, primary processing activities, such as grinding, hulling, pounding, milling, drying, and sieving, are also conducted during this stage.

The processing, transportation, and logistics stage involves farmers selling their harvested crops either directly to traders, who collect the produce from the farm, or to collection centres and processors. These market participants then undertake the tasks of product accumulation, initial processing, quality control, grading, packaging, and transportation to wholesale buyers.

[1] In this instance, a field is where the crops are grown, and a farm consists of the whole small holding including the small aggregation site.

1.3 REASONING FOR REQUESTED FUNDING

Africa's food insecurity challenge has been exacerbated by climate change. Sub-Saharan Africa stands at a crossroads with an unprecedented opportunity for food systems transformation, driven by the demands of a rapidly growing population of 1.5 billion and the pressures of a changing climate (World Bank, 2023) (Worldometer, n.d.)**.** The continent faces significant development challenges including food insecurity, resource degradation, poverty, gender inequality, and social exclusion. The vicious cycle of poverty and environmental degradation in Africa is evident in low crop productivity, deforestation, land degradation, conflict, migration, and vulnerability to climate shocks, which perpetuate persistent food insecurity and poverty. The effects of climate change are expected to be severe in Africa, where the capacity to adapt and respond to a changing climate is weak.

The impacts of climate change have increased over the past decades in Africa, manifesting in more frequent, intense, and prolonged extreme weather events, such as floods, droughts, heatwaves, locust outbreaks, desertification, and sandstorms. These extreme weather events have resulted in increased temperatures and humidity, shifts in precipitation patterns, water stress, and soil erosion. Most African countries already face recurrent droughts that affect growing seasons, often leading to short growing periods reducing the viability of farming in marginal agricultural areas. Projected reductions in crop yields in some countries could reach as much as 50% by 2030, and crop net revenues may fall by up to 90% by 2100, with smallholder farmers being the most affected (IPCC, 2018).

Therefore, the RE-GAIN programme aims to enhance the climate resilience and adaptive capacity of smallholders by promoting the widespread adoption of FL-RS in seven African countries. According to the World Bank estimates, a one percent reduction in post-harvest losses in Sub-Saharan Africa could lead to economic gains of $40 million each year, and most of the benefits would go directly to smallholder farmers (World Bank, 2011). Moreover, food loss and waste are the result of an extremely inefficient use of resources and account for about 3.3 gigatonnes of greenhouse gas emissions globally (FAO, 2013). Large amounts of water and fertilizer also go into the production of food that never reaches human mouths. Recovering the food that is lost during harvest and post-harvest handling some can help close that calorie gap in Africa while strengthening livelihoods and improving food security— without imposing any additional environmental cost. Therefore, facilitated by the Green Climate Fund (GCF) investment, RE-GAIN will roll out a suite of physical interventions alongside capacity building and enhanced financial and market access. Not only will this benefit the respective countries as whole, but it also has the potential to benefit the region and the wider planet.

1.4 PROGRAMME GOAL STATEMENT

IF the capacity of the target countries and communities to respond to climate-triggered food losses is strengthened through improved and inclusive access to financing, promotion of context-specific and gender-responsive innovations to reduce food losses, and better enabling conditions for public and private investments, **THEN** smallholder farmers will have enhanced food security and livelihood resilience,, **BECAUSE** the widespread use of food loss-reduction technologies will reduce food loss and reduce the carbon footprint of food systems, while increasing household income and building the resilience of smallholder farmers, MSMEs and rural communities to climate shocks.

1.5 PURPOSE AND STRUCTURE OF THE REPORT

The purpose of this report is to provide an assessment of the climate hazards and vulnerabilities affecting each country and the distinct challenges they pose for the selected crops, and to propose a set of solutions designed to address these concerns. The analysis considers the country contexts, alongside the appropriateness of the solutions from an environmental, social, and financial perspective.

This report provides a summary of the different country-specific contexts of the seven countries in the scope of the engagement, followed by a summary of the climate analysis covering adaptation and mitigation analysis, before looking at a summary of the key food-loss areas, potential solutions and their proposed prioritisation, as well as the current state of the market for these solutions. Finally, this report provides a view of how these different aspects of the feasibility study fit into the RE-GAIN Programme's Theory of Change. This summary report is based on the seven country-specific feasibility studies conducted to design the programme which are appendixes to this Annex 2.

2 Country Context

This chapter provides an overview of the specific local context of the seven countries, including the importance of agriculture for the local economies and livelihoods, as well as the key role that the country-specific value chains have in each country. This chapter will further discuss the current land use change trends that influence GHG emissions, as well as the enabling environment and current programming to respond to evolving climate change and build resilience across agricultural value chains.

2.1 SITUATION ASSESSMENT

Agriculture is a critical component of the economy in Africa, supporting millions of livelihoods and providing essential food supply. This chapter explores the state of agriculture in the seven countries chosen for this study—Burkina Faso, Ethiopia, Kenya, Malawi, Tanzania, Uganda, and Zambia. It also addresses how the increasing challenges posed by climate change, further analysed in Chapter 3 of this summary report, will have a profound impact on the livelihoods of countless smallholder farmers. This subchapter summarises the high-level observation of the current situations in each of the seven target countries, with more details and specific value chain losses provided in the country studies (see individual Appendixes to this Annex for in-depth country assessments).

Burkina Faso's agricultural sector contributes an average of 32% to the Gross Domestic Product (GDP) (Republic of Burkina Faso, 2021) and serves as the primary source of income for around 80% of the country's working population, including youth (World Bank, 2011). Sorghum, millet and maize are the major staple food crops and are grown on about 80% of the arable land area. Production of cowpea and horticulture are important and expanding (IFAD, 2019). Only rice, sugar cane, vegetable and fruit crops are irrigated, with the rest of Burkinabé agriculture dominated by rain-fed subsistence systems characterized by small family farms (from 1.5 to 12 hectares (ha) per household) (IFAD, 2019). The majority of farmers in Burkina Faso are smallholders with an average farm size less than 3 ha. Farmers cultivate small parcels of land, which often lack the required inputs like irrigation, fertilizer, and efficient agronomic practices. Women account for over half of the agricultural workforce and produce more than two-thirds of the food consumed in the country.

Agriculture is the backbone of the ***Ethiopian*** economy; In 2022, it contributed 37.6% to the nation's GDP (World Bank, 2023) and provided employment for approximately 75% of the workforce. The sector is dominated by smallholder farmers, who practice rain-fed mixed farming by employing traditional technology, adopting a low input and low output production system, and producing a wide range of crops. Smallholder farmers manage 95% of the land under agricultural use, producing over 90% of the total agricultural output (IGAD, 2018). Teff, wheat, barley, and pulses have been staples in the Ethiopian diet for generations. Ethiopia is also the largest wheat producer in Sub-Saharan Africa (United States International Trade Administration, 2024). Grain production is the second most significant sector after livestock in Ethiopia's agriculture-based economy. It accounts for nearly 80% of the cultivated land and employs 60% of the rural workforce, most of whom manage less than one hectare of land (FAO, 2015).

Kenya has a vast agricultural land base, with 28 million ha designated for farming representing over 48% of the country's total land area (Statistica, 2024). As of 2022, Kenya's population was approximately 56.5 million, with 27.9% living in urban centres. The agricultural sector remains a cornerstone of Kenya's economy, contributing directly to 20% to the Gross Domestic Product (GDP) in 2022 (Central Bank of Kenya, 2023). It employs over 40% of the overall population and more than 70% of

the rural population (Farm to Market Alliance, 2022). The sector is crucial for Kenya's export economy, generating 65% of export earnings, and supports over 80% of the population providing employment, income, and food security (FAO Kenya, n.d.)

The crops sub-sector plays a pivotal role in achieving the Sustainable Development Goals (SDGs) of reducing poverty and hunger. It aligns with Kenya's Vision 2030 and the Agriculture Sector Transformation and Growth Strategy (2019-2029), which emphasize enhancing agricultural productivity and sustainability (Food Crops Directorate, 2024). Smallholder farmers are the backbone of Kenyan agriculture, with around 7.5 million smallholders producing 80% of the country's total agricultural output (Farm to Market Alliance, 2022). These farmers typically manage plots between 1 to 5 acres (less than 2 hectares), and predominantly rely on rainfed agriculture, making them particularly vulnerable to drought and erratic weather patterns exacerbated by climate change (Farm to Market Alliance, 2022).

Agriculture is a pivotal sector for ***Malawi***, contributing 40% to Gross Domestic Product (GDP) (Republic of Malawi, 2021) and employing about 80% of the population, with women accounting for 59% of agricultural labourers (CIAT, World Bank, 2018). The sector's composition is dualistic and includes both smallholder farms (less than 1 ha), and large-scale (more than 25 ha) producers (CIAT, World Bank, 2018). Large scale producers are almost exclusively involved in production of tobacco, tea, sugar, and macadamia nuts for export. (CIAT, World Bank, 2018). Smallholder farmers in Malawi number approximately 3.1 million farm families who collectively manage 6.5 million hectares of land, constituting 69% of the country's total agricultural land under customary tenure (CCARDESA, 2024). These farmers operate on an average farm size of 0.7 hectares, with about 60% cultivating less than 1 hectare (CCARDESA, 2024). These small-scale producers are mostly subsistence farmers cultivating maize, rice, cassava, legumes and sweet potato.

Economic growth in Malawi is linked to growth in agricultural contribution to GDP, which depends on a favourable climate (CIAT, World Bank, 2018). The major domestic food crops are maize (grown by 95% of the farmers), rice, cassava, legumes, sweet potato and Irish potato (CIAT, World Bank, 2018). Smallholder farmers produce approximately 80% of all food consumed in Malawi, and 20% of agricultural exports (CIAT, World Bank, 2018). Women play an important role and constitute 70% of full-time farmers, carry out 70% of the agricultural work, and produce more than 80% of subsistence crops (CIAT, World Bank, 2018).

Most smallholder farmers still use rudimentary farming practices (e.g. hand-held hoes and watering cans) and depend on family labour. Use of inputs (e.g. fertilizers) is still low, albeit higher than regional averages, with disparities between urban and rural farmers: 70% of urban farmers use fertilizer, compared to only 55% of the rural ones (CIAT, World Bank, 2018). More than 90% of agricultural production in Malawi relies on rain-fed methods, with only 4% of the total cultivated area benefiting from irrigation (AGRA, 2018). Women, who manage farms, face significant disadvantages in accessing irrigation technologies and financial resources (Murray, Gebremedhin, Brychkova, & Spillane, 2016).

In ***Tanzania*** cropland accounts for 44.62% of the country's land area, 24% of which is used for crop cultivation (AECF, 2022). Agriculture is vital for Tanzania's economy and contributes approximately 25% of GDP and 85% of exports (AECF, 2022). It is the main economic activity for 70% of Tanzanian households, and 75% of all jobs in the country are located within the agricultural sector (Rweyemamu, Mruma, & Nkanyani, 2024). Up to 80% of all agricultural produce comes from smallholder farmers (United States of America, Department of Commerce, 2022). On average, smallholder farmers in Tanzania own and cultivate small plots of land, typically ranging from 0.5 to 2 hectares. Land tenure varies, with many farmers holding customary rights rather than formal titles (AECF, 2022). The majority of Tanzania's farming systems are rainfed and small scale (Rweyemamu, Mruma, & Nkanyani, 2024). Small-scale farming, typically characterized by mixed crop–livestock systems and partial commercial production, occupies approximately one-third of the country's land area. Majority of Tanzania's smallholder

farmers largely practice subsistence farming. Intercropping is common, allowing them to maximize land use and reduce risks associated with crop failure (Rweyemamu, Mruma, & Nkanyani, 2024). Farming activities are predominantly manual, relying on family labour, with limited use of machinery (Rweyemamu, Mruma, & Nkanyani, 2024).

The agricultural landscape of Tanzania comprises a variety of staple foods, with maize being the main staple food, followed by rice, sorghum, millet, pulses, cassava, and bananas (Rweyemamu, Mruma, & Nkanyani, 2024). More specifically, up to 80% of maize is produced by smallholders which makes up roughly 40% of all calorific consumption in Tanzania (AECF, 2022). Although other staple crops such as millet may be more resilient in low rainfall conditions, dietary preferences favour maize. Maize covers approximately 70% of the land planted with arable crops, compared to rice which covers approximately 17% (AECF, 2022).

Agriculture plays a crucial role in **Uganda's** economy, as highlighted by the (Uganda Bureau of Statistics, 2022a) and the (United States of America - Department of Commerce, 2023). In 2022, the agricultural sector was responsible for about 24% of the country's GDP and contributed 35% to its export earnings (United States of America - Department of Commerce, 2023). Agriculture employs around 72% of Uganda's workforce (Uganda Bureau of Statistics, 2022b). Crop production is the predominant agricultural activity in Uganda, with over 90% of agricultural households involved (Uganda Bureau of Statistics, 2022a). The average holding size of agricultural households in Uganda is 1.3 ha. However, 67% of agricultural households have holdings of less than 1 ha, and only 13% have more than 2 ha (Uganda Bureau of Statistics, 2022b).

Uganda's agriculture is dominated by several key staple crops essential for food security and the economy. Maize, bananas (especially matoke), cassava, beans, sweet potatoes, sorghum, millet, and groundnuts are the primary staples grown across various regions of the country (Uganda Bureau of Statistics, 2022a). Overall, maize, beans and cassava, are the most cultivated crops: more than 50 percent of the agricultural households involved in their cultivation during 2019 (Uganda Bureau of Statistics, 2022a). Post-harvest losses in Uganda are significant, with up to 30% of some crops lost between harvest and consumption (Kalita, 2017).

Fifty-eight percent of **Zambia's** territory is classified as medium-to high-potential for agriculture production (Ministry of Agriculture of Zambia, 2022). The country also has abundant water resources for irrigation and hence significant potential for intensifying its agricultural production (Ministry of Agriculture of Zambia, 2022).

Zambia has a population of approximately 20 million inhabitants with an estimated ~2.3 million farming households; more than 70% of the population relies on agriculture. Zambian agricultural sector includes an estimated 1.6 million smallholder farmers of which over 20% are headed by women. Women also constitute about 65% of the agricultural labour force and play a significant role in both production and processing activities (Farm To Market Alliance, 2022). According to the Ministry of Agriculture of Zambia, farmers are broadly classified into small-scale (cultivating up to 5 ha), medium-scale (cultivating 5-20 ha) and large-scale (with a cropped area of 20+ha) farmers. Out of 1.6 million small and medium scale farming households, over 72% of these cultivated less than 2 ha of land, 21% cultivate between 2 and 4.99 ha of land. The remaining 7% cultivate between 5 and 19.99 ha (Farah Hegazi, 2024). Small-scale farmers in Zambia apply a range of farming strategies: hand hoe cultivation is used on land less than 1 ha mainly to produce household food; and for those cultivating 3-4 ha, at least 2-3 ha of which is usually allocated to cash cropping. Agricultural cultivation in Zambia is mostly non-mechanized, and the sector is mostly rain-fed due, in part, to the increasing use of irrigation (CGIAR, CCAFS, CIAT, 2019). The key crops cultivated in Zambia include staple crops such as maize, sorghum, millet, cassava, and sweet potatoes. Legumes and oilseeds, such as groundnuts, soybeans, and sunflower, play an important role in the agricultural landscape.

2.2 TRENDS OF LAND USE CHANGE

Africa has experienced significant changes in land use, particularly with the expansion of agricultural areas in the past decade. The total agricultural land area has increased by approximately 15 million hectares (ha) since 2014, driven by the need to meet the food demands of a growing population and to boost economic development (WRI, 2022). This subchapter examines the drivers, impacts, and future implications of agricultural land expansion in the seven countries selected for the study. Detailed information is available in individual country Appendixes to this Annex.

Burkina Faso's land area accounts for 273,600 km^2, including a large area of arable land, estimated at 90,000 km^2, of which only 46% is in agricultural use (FAOSTAT, 2022). The country has two large agro-ecological zones: the Sahelian zone in the North where pastoralism and agro-pastoralism predominate, and the Sudanian zone with most of the cultivable land (USAID, 2016). Forests cover 25% of the land, with an average deforestation rate of 0.3% (USAID, 2016). Agricultural expansion activities are a major driver of deforestation in the country. In the recent past, Burkina Faso has experienced a significant loss of savanna, woodlands, and forests, primarily due to agricultural expansion (Knauer, Gessner, Fensholt, Forkour, & Kuenzer, 2017). Between 1960 and 2019, forest cover in Burkina Faso remained relatively stable, with only about 3% forest loss in AGRA's target regions. During this period, cropland expanded by approximately 42%. Deforestation that occurred between 2001 and 2020 primarily resulted in the land being converted to large and small-scale agriculture, pasture, settlements, cashew plantations, and other land uses (Masolele et al., 2024).

In 2021, **Ethiopia**'s agricultural land comprised approximately 38.7 million ha, while forest land covered around 17 million hectares out of its total area of 113.6 million ha. Out of those 38.7 million hectares designated for agricultural land in Ethiopia in 2021, about 18.8 million hectares were used for cropland, and around 20 million hectares were used as permanent meadows and pastures. Between 2019 and 2022, the forest land in Ethiopia decreased from 17,141.5 ha to 16,922.5 ha, primarily due to the increase of agricultural land (including arable land) (FAOSTAT, 2022). This trend of expanding agricultural areas at the expense of forested regions has significant implications for climate change, contributing to higher greenhouse gas (GHG) emissions due to deforestation and land use changes (IPCC, 2019)

Kenya's total area is 580, 367 square kilometres, which includes 11, 227 square kilometres of inland water bodies such as Lake Victoria and Lake Turkana (Index Mundi, 2021). However, only about 20% of this land is rates as having high and medium agricultural potential, characterized by adequate and reliable rainfall for arable farming (KIPPRA, 2023). Kenya's land cover comprises various types including forests, savannahs, grasslands, wetlands, fresh and saline water bodies, and deserts (Kenya Land Alliance, 2021). Common land uses encompass agriculture, pastoralism, water catchments, nature reserves, urban and rural settlements, industry, mining, transport, communications, tourism, and recreation. Additionally, land is used for cultural sites, fishing, forestry, and energy production (Kenya Land Alliance, 2021).

Approximately 2.4% of Kenya's land cover consists of indigenous and exotic forests (Kenya Land Alliance, 2021). About 12% of the country benefits from high rainfall, supporting the cultivation of tea, coffee, pyrethrum, horticultural products, floriculture, and food crops like maize, wheat, potatoes, and pulses, along with dairy farming (Kenya Land Alliance, 2021). Semi-arid areas, making up about 32% of the total land, have moderate rainfall, supporting mixed crop and livestock farming. Recently, irrigated flower farming has become prominent alongside agropastoralism (Kenya Land Alliance, 2021). Over half of the land is arid, characterized by very low and erratic rainfall, and is mainly used for extensive livestock production under nomadic systems (Kenya Land Alliance, 2021).

Small farm holdings, averaging 1.2 ha and primarily located in high-potential areas, constitute 98% of farms and cover 46% of the farmed land (KIPPRA, 2023). Medium farms, ranging from 10 to 60 ha (average 20 has), represent 1.9% of holdings and occupy 15% of farmed land (KIPPRA, 2023). Large farms, averaging 77.8 ha, account for only 0.1% of farm holdings but span 39% of the farmed area (KIPPRA, 2023). Per capita arable land has decreased from 0.42 has in 1961 to 0.11 has in 2020 and continues to shrink (KIPPRA, 2023). In addition, rapid urbanization and the connected increase of real estate projects are putting pressure on agricultural land (KIPPRA, 2023). The percentage of the population living in urban areas grew from 23.9% to 28.5% between 2011 and 2021, resulting in the growth of towns even in formerly rural areas creating a demand for residential houses for commercial use (KIPPRA, 2023). This has led to increased pressure on agricultural land, resulting in its conversion to urban uses such as residential, commercial, and industrial.

Malawi's total area of 118,484 km^2, 20% of which is covered by water. While 5.738 million ha (approximately 61% of the land area) are suitable for agriculture, only 2.500 million ha are under cultivation (CIAT, World Bank, 2018). Permanent meadows and pastures, forest area, and other forms of land cover account for roughly 20%, 34% and 5% of land area, respectively (CIAT, World Bank, 2018). Land ownership is skewed toward the wealthy who own more land and have better tenure security. Only 32% of agricultural landholders are women. Estates hold 13% of land, and smallholders own 69% (CIAT, World Bank, 2018).

Land tenure in Malawi is classified into customary, public land, and private land, accounting for 68%, 20% and 12% of the land respectively (CIAT, World Bank, 2018). Like many African countries, Malawi has experienced challenges with land tenure security. Most smallholder farmers still lack documented land rights which translates into inefficient use of scarce resources, low agricultural productivity, and increased risk of land degradation. Between 1972 and 1990, Malawi lost over 40% of forest coverage, and then another 15% of its forest and woodland habitat from 1990 to 2005 (Ngwira & Watanabe, 2019). Today, only 3% of Malawi is forested (Heneine & Stephens, 2020). This can be attributed, in large part, to unsustainable land management and agricultural practices. In addition to cutting down trees to meet food needs of Malawi's growing population, trees are also used as biomass which currently fuels 89% of Malawi's energy supply (Heneine & Stephens, 2020). This extensive use of biomass has resulted in significant forest cover loss, exacerbated by illegal logging and commercial-scale tree cutting to meet both local and international demand for wood products.

Tanzania covers an area of approximately 945,087 square km, making it the 13th largest country in Africa (Ministry of Foreign Affairs and East African Cooperation, The United Republic of Tanzania, 2024). Since 2010, Tanzania has undergone significant land use changes, largely driven by agricultural expansion, deforestation, and urbanization, as well as growing population (Msofe, Sheng, & Lyimo, 2019). Overall, nearly 48% of Tanzania's total land area is now used for agriculture. Of this, 78% consists of meadows and pastures, while the remaining 22% is devoted to agriculture, with 21% as arable land and 1% as permanent crops. The key agricultural regions are situated in the Central, Western, and Rift Valley areas (World Bank, CGIAR, CIAT, 2015). Since 1990, there have been an extensive agricultural land area expansion in some regions. On average, the agricultural land and grassland increased by 11.3% and 13.3%, respectively, while the floodplain wetland area decreased from 4.6% to 0.9% (Msofe, Sheng, & Lyimo, 2019). This expansion is primarily for subsistence crops such as rice and maize. Deforestation also has significantly impacted Tanzania's landscapes, particularly in areas earmarked for agricultural development. The country has lost about 8 million has of forest between 1990 and 2010, representing 19% of its forest cover. This translates to an average annual deforestation rate of around 0.97%. Besides the agricultural expansion, charcoal and firewood production also significantly contribute to forest degradation, as over 90% of Tanzanian households rely on wood for energy (Yusuph, 2022). Wetlands also have been heavily impacted by land use changes. The conversion of wetlands to agricultural land has significantly reduced floodplain areas, disrupting ecological balances and reducing the provision of

ecosystem services. This transformation affects not only biodiversity but also the livelihoods of communities that depend on these ecosystems (Msofe N. K., 2019). Finally, urbanization and the expansion of infrastructure have further driven land use changes in Tanzania. Improved road networks and market access facilitate agricultural expansion but also lead to habitat fragmentation and increased human-wildlife conflicts (Leah Worrall, 2017).

Uganda occupies about 241,550.7 km^2, of which 41,027.4 km^2 is open water and swamps while 200,523.5 km^2 is land. The country is highly engaged in agriculture as the main source of livelihood. Cropland is the largest source of land cover, followed by grasslands, open water, forests, bushlands, wetlands, and built-up area (Mwanjalolo, et al., 2018). The land use/cover utilization types are highly influenced by the amounts of rainfall received. Agriculture is one of Uganda's key growth sectors and plays an important role in Uganda's plans to achieve socio-economic transformation and middle-income status by 2040 (M. B. Byaruhanga, 2024).

In terms of land use, only 35% of Uganda's arable land is currently being cultivated, despite the fact that about 80% of the country's land is considered arable (United States of America - Department of Commerce, 2023). This indicates a significant potential for further agricultural development if proper management practices and infrastructure improvements are implemented. Over the past decade, Uganda has experienced significant changes in land use and land cover (LULC), driven primarily by agricultural expansion, deforestation, and urbanization. The most notable change is the increase in farmland. By 2021, farmland covered 35.8% of Uganda's total land area, up significantly from 7.2% in 1985. This expansion is mainly attributed to the conversion of grasslands and wetlands into agricultural land, driven by population growth and the increasing need for food production (Kuule, et al., 2022). Grassland cover, which was 31.7% in 1985, dropped to 18.5% by 2021. Deforestation has also been a significant issue, with forested areas shrinking due to logging, agriculture, and settlement expansion. From 1990 to 2016, according to the (Ministry of Water and Environment, Republic of Uganda, 2016), Uganda lost approximately 63% of its forest cover (from 4.9 million has to around 1.8 million has). Woodland areas have been particularly affected, being converted into farmland and urban spaces. For example, between 2005 and 2015, Uganda lost about 15% of its forest cover due to agricultural expansion and illegal logging. Forest degradation is also closely linked to the increased demand for wood fuel, accounting for about 90% of Uganda's energy needs. Urbanization has further contributed to the reduction of natural habitats. Rapid urban growth has led to the conversion of peri-urban and rural lands into residential, commercial, and industrial areas. This urban sprawl has further encroached on wetlands and grasslands, exacerbating environmental degradation (Kuule, et al., 2022).

Zambia's territory covers 75 million hectares (752.000 km^2). The trends in land use change in Zambia's agricultural sector are characterized by expansion and intensification of agricultural activities, deforestation, a shift towards commercial farming, and the impacts of climate change. Expansion of agricultural land over the past years largely driven by the increasing demand for both food and cash crops, which often leads to the conversion of forests and other natural ecosystems into farmland (Phiri, Morgenroth, & Xu, 2019). According to the FAO, Zambia's cropland area has been steadily increasing over the years (from 280,000 km^2 in 2015 to 296,000 km^2 in 2023) (FAOSTAT, 2022), reflecting a shift from subsistence farming to more extensive agricultural practices. A major consequence of this expansion is deforestation. This trend poses a significant threat to biodiversity and contributes to GHG emissions. Another notable trend is the intensification of agriculture. There is a growing adoption of more intensive farming techniques, including the use of improved seeds and fertilizers, aimed at increasing productivity on existing agricultural land rather than expanding into new areas (World Bank Group; Government of Zambia, 2019). Climate-smart agriculture practices are being promoted to enhance resilience to climate change while maintaining or increasing productivity. Additionally, there is a shift from smallholder farming to more large-scale commercial farming. This transition is encouraged by government policies designed to boost agricultural productivity and attract private investment in

the sector (Ministry of Agriculture and Cooperatives, Republic of Zambia, 2011). The development of farm blocks and agricultural zones facilitates large-scale farming and agro-industrial activities, reflecting this trend towards commercialization. Climate change is also significantly influencing land use patterns. Some areas in Zambia are experiencing changes in the suitability for certain crops, leading to shifts in the types of crops being cultivated and the regions where they are grown. The increasing frequency of droughts and erratic rainfall patterns are prompting changes in land use practices, with a growing emphasis on cultivating drought-resistant crops and implementing irrigation systems to ensure sustainable agricultural production.

2.3 NATIONAL AND SECTORAL POLICY LANDSCAPE

Development of national policies, strategies, frameworks and implementation plans aiming to address agrifood systems and climate change challenges has been a priority for many of the African governments in the recent years. Investments in the field of climate-smart agriculture are growing. Projects targeting improved agricultural practices are being developed and implemented by national governments, United Nations, International development organisations and development banks, NGOs, and private sector. A general overview of the current national policies for each of the target countries in this study are provided below, with more specific details included in the country profiles (Appendixes to Annex 2).

The table below highlights the key policies and strategies per country that focus on climate and agriculture-focused development.

Table 2-1 - Key policies and strategies per country

Country	Key Policies and strategies
Burkina Faso	• National Sustainable Development Policy (PNDD) • National Economic and Social Development Plan II (PNDES II) 2021-2025 • National Agricultural Investment Programme (PNIA) • National Strategy for the Development of Agricultural Entrepreneurship by 2025 • Agricultural Value Chain Development Strategy (SDFA) 2019-2023 • Agro-sylvo-pastoral Production Sectoral Policy (PS-PASP) 2018-2027 • National Climate Change Adaptation Plan (PNA) • Revised Nationally Determined Contribution (NDC) for 2021-2025
Ethiopia	• Ten-Year Development Plan (2021-2030) • Homegrown Economic Reform Agenda • Climate Resilient Green Economy Strategy (2011-2025) • Agricultural Transformation Agenda • National Agricultural Investment Plan (NAIP 2022) • Second Growth and Transformation Plan • Agricultural Sector Policy and Investment Framework • Nationally Determined Contribution • National Adaptation Plan • Agricultural Extension Strategy • Nutrition Sensitive Agriculture Strategy • Post-Harvest Strategy in Grains • Working Strategy for Strengthening Ethiopia Teff Value Chain
Kenya	• Kenya Vision 2030 • The National Climate Change Action Plan • Nationally Determined Contribution • National Adaption Plan • Climate-Smart Agriculture Strategy • Agricultural Sector Transformation and Growth Strategy • Climate Risk Management Framework • Agricultural Sector Development Strategy (ASDS 2010-2020)

	• National Agriculture Investment Plan (NAIP 2019-2024) • The Kenya Climate Smart Agriculture Implementation Framework (2018-2027) • Kenya Strategic Investment Framework (KSIF) for Sustainable Land Management (2017-2027) • National Policy on Climate Finance (2016)
Malawi	• Malawi 2063 • Malawi Growth Development Strategy (MGDS III 2017-2022) • National Agriculture Policy (NAP 2016-2020) • National Adaptation Framework (2020) • National Environment Policy (2004) • National Climate Change Management Policy (2016) • National Agricultural Investment Plan (NAIP 2017/18-2022/23) • National Climate Change Investment Plan (2013-2018) • Climate Change Learning Strategy (2013-2030) • Vision 2020: National Long-Term Development Perspective • Nationally Determined Commitments (2021) • National Environment and Climate Change Communication Strategy (2013-2020)
Tanzania	• Tanzania Development Vision 2025 • Long-Term Perspective Plan (LTPP 2011-2021) • National Strategy for Growth and Reduction of Poverty • Third National Five-Year Development Plan • Agricultural Sector Development Programme Phase II (2017/18-2027/28) • Agricultural Sector Development Strategy (2015/16-2024/25) • National Climate Change Strategy (2012-2018) • Updated Nationally Determined Contribution (2021) • National Post-harvest Management Strategy (2019-2029) and its Implementation Plan (2019-2024) • Agriculture Climate Resilience Plan (2014-2019) • National Agriculture Policy (2013) • National Environment Policy (2021) • National Climate Change Response Strategy (2021-2026)
Uganda	• Uganda Vision 2040 • Green Growth Development Strategy (2017/18-2030/31) • Third National Development Plan (2020-2025) • National Agriculture Policy (2013) • National Cooperative Policy (2011) • National Agricultural Extension Strategy (2016/17-2020/21) • National Grain Trade Policy (2015) • National Climate Change Policy (2015) • Updated Nationally Determined Contribution (2022) • National Organic Agriculture Policy (2020) • Water and Environment Sector Investment Plan (2018-2030) • Environment and Social Safeguards Policy (2018)
Zambia	• 8th National Development Plan (2022-2026) • Second National Agricultural Policy (2016) • National Agriculture Policy (2012-2030) • National Food and Nutrition Policy • Climate Smart Agriculture Investment Plan (2019) • National Policy on Climate Change (2016) • Nationally Determined Contribution (2015-2030) • National Climate Change Response Strategy (2021-2026) • National Environmental Action Plan (2013) • National Environment Policy (2021)

2.4 LEGAL AND REGULATORY LANDSCAPE

Besides a variety of national policies, frameworks, strategies and plans related to the agricultural sector in general, and post-harvest food losses and climate change adaptation and mitigation in particular, some of the focus countries also have

different legal acts in place. Not every country has specific legal and regulatory frameworks in place to build on climate resilience to agriculture, with specific legal and regulatory environments identified in Kenya, Tanzania, Uganda and Zambia in this context.

In Kenya, the Climate Change Act (2016) guides climate policy and the National Climate Change Action Plan (Republic of Kenya, 2016). It integrates climate responses into development planning, enhances resilience and adaptive capacity, and incorporates disaster risk reduction. The Act emphasizes gender and intergenerational equity, promotes low-carbon technologies, and encourages private sector involvement. It focuses on capacity building, public participation, and transparent financial management. Additionally, it supports climate change research, training, and sustainable development principles, ensuring climate considerations are integrated into all governance levels, fostering cooperation between national and county governments for effective climate governance.

Tanzania's *Climate-smart Agriculture (CSA) Guideline* of 2017 is a step towards achieving global and national goals of sustainable agriculture production in a changing climate (Ministry of Agriculture, Livestock and Fisheries of Tanzania, 2017). The Guideline aims to guide the identification of suitable technologies and practices for successful Climate Smart Agriculture (CSA) implementation to enhance agricultural production, identify crucial approaches and requirements for CSA, facilitate planning for its implementation and up-scaling, and inform policymakers on formulating supportive policies and incentives. It also aims to guide development actors, extension services, research institutions, and the private sector in promoting CSA practices, create awareness and build capacity on CSA for climate change mainstreaming and environmental management in agriculture, and monitor CSA implementation. This Guideline is based on a gender-responsive, community-based, and farmer-centred research, learning, and training approach.

Among the key national legal and regulatory frameworks in **Uganda** that are crucial for addressing climate change adaptation and mitigation, particularly in the agricultural sector and post-harvest food loss management, the National Climate Change Act (2021) stands out (The Republic of Uganda, 2021). This Act was enacted to legally enforce Uganda's commitments under international climate agreements, including the United Nations Framework Convention on Climate Change (UNFCCC), the Kyoto Protocol, and the Paris Agreement. The Act outlines comprehensive measures for responding to climate change, including strategies for adaptation and mitigation, and sets out mechanisms for Uganda's participation in global climate initiatives. Additionally, the Act establishes a robust system for measuring, reporting, and verifying greenhouse gas emissions, ensuring that accurate data supports climate action. It also provides a framework for institutional coordination and implementation of climate response measures, ensuring that various sectors, including agriculture, are aligned in their efforts. Moreover, the Act details the financial mechanisms necessary for supporting climate change initiatives, emphasizing the importance of sustainable funding to achieve long-term climate resilience and food security. Guidelines for Mainstreaming Climate Change Adaptation and Mitigation in Agricultural Sector Policies and Plans (Ministry of Agriculture, Animal Industry and Fisheries, 2018), were developed with the main objective of providing practical, step-by-step guidance for all stakeholders in the agriculture sector, including the MAAIF Agencies and Local governments, on how to mainstream climate change adaptation and mitigation in their planning and decision-making processes. National Environment Act (The Republic of Uganda, 2019) aims to provide for the management of the environment for sustainable development; to continue the National Environment Management Authority as a coordinating, monitoring, regulatory and supervisory body for all activities relating to the environment; to provide for emerging environmental issues including climate change; to provide for strategic environmental assessment; to provide for procedural and administrative matters; and for related matters.

Zambia has several legal and regulatory frameworks aimed at governing agricultural production, and related environmental and climate aspects of it. These laws and regulations are designed to enhance productivity, ensure food security, and promote

sustainable agricultural practices. The Environmental Management Act No 12 of 2011 (Republic of Zambia, 2011) ensures environmental protection and sustainable use of natural resources in all sectors, including agriculture. Key provisions cover environmental impact assessments, guidelines for sustainable farming practices, and measures to mitigate the environmental impact of agricultural activities. The Agricultural Credit Act No 35 of 2010 (Republic of Zambia, 2010) facilitates access to credit for farmers to invest in agricultural inputs and infrastructure. Key provisions include regulations on the provision of agricultural loans, guarantees, and subsidies. The Food and Nutrition Act No 3 of 2020 (Republic of Zambia, 2020) includes strategies for improving food production, nutrition education, etc. The Act sets up a Coordinating Committee responsible for coordination of the multi-sectoral response to national food and nutrition programme and provides for the membership to represent permanent secretaries of health, agriculture, community development, fisheries and livestock.

2.5 GCF COUNTRY PROGRAMME DETAILS

The Green Climate Fund (GCF) plays a pivotal role in enhancing agricultural resilience and mitigating climate impacts across Africa and in the countries selected for the RE-GAIN programme. Key funding and programmes per country are highlighted below.

Burkina Faso has engaged with the Green Climate Fund (GCF) on multiple fronts, implementing 12 projects with a total GCF financing of USD 135.3 million. Of these, relevant projects include:

Table 2-2 - GCF Projects in Burkina Faso

Project Name	Description	Focus Area	Project Code(s)	Year
CATALI.5°T Initiative	Supports climate start-ups and small enterprises in West Africa and Latin America.	Climate start-ups and small enterprises	FP198	2022-2029
Inclusive Green Financing Initiative (IGREENFIN I)	Part of the Great Green Wall initiative, targeting the reversal of land degradation and enhancement of climate resilience in 13 countries, including Burkina Faso. Provides access to credit and technical assistance for climate-resilient and low-emission agriculture and agroforestry practices.	Agriculture resilience and land degradation	FP183	2022-2030
Africa Integrated Climate Risk Management Programme	Focuses on building and scaling up the resilience of smallholder farmers in the Sahel region. Emphasizes capacity building and institutional development in integrated climate risk management. Includes access to agricultural insurance and improved climate weather information services.	Agriculture resilience and risk management	FP162	2021-2029
Programme for Integrated Development and Adaptation to Climate Change in the Niger Basin (PIDACC/NB)	Addresses sustainable natural resource management, ecosystem fragility, and social vulnerability.	Sustainable natural resource management	FP092	N/A
Africa Hydromet Programme	Aims to strengthen climate resilience by enhancing climate information systems, focusing on optimizing the supply and demand of climate information. Expected to improve rural livelihoods, increase food security, and reduce vulnerability to weather-related disasters.	Climate resilience and information systems	FP074	2018-2025
Readiness Activities	Four country-level readiness activities approved with a budget of USD 5.2 million, of which USD 2.2 million has been disbursed.	Capacity building and institutional development	N/A	N/A

In ***Ethiopia,*** Green Climate Fund (GCF) is implementing 8 projects with a total GCF financing of 29 million USD (Green Climate Fund, 2024). Of these, relevant projects include:

Table 2-3 - GCF Projects in Ethiopia

Project Name	Description	Focus Area	Project Code(s)	Year
Resilient landscapes and livelihoods project	Aims to enhance climate resilience, land productivity, and carbon storage, and increase access to diversified livelihood activities in vulnerable rural watersheds of Ethiopia.	Climate resilience and land productivity	FP136	2021-2026
Inclusive green financing initiative (IGREENFIN I)	Designed to green agricultural banks and the financial sector to support climate-resilient, low-emission smallholder agriculture in the Great Green Wall countries. Enhances access to credit and technical assistance for local farmers, farmer organizations, cooperatives, and micro and small enterprises.	Agriculture resilience and low-emission practices	FP183	2024-2030
Responding to the increasing risk of drought	Aimed to build gender-responsive resilience in the most vulnerable communities by providing essential water supplies for year-round drinking water and small-scale irrigation to mitigate drought risks and other climate impacts.	Drought resilience and gender responsiveness	FP058	2019-2023
Readiness Activities	Five country-level readiness activities approved, with a total budget of USD 4.5 million, of which USD 2.6 million has been disbursed.	Capacity building and institutional development	N/A	N/A

Kenya's GCF portfolio includes 19 projects, with notable relevance to agriculture found in FP220 and FP078 (Green Climate Fund, 2024). Of these, relevant projects include:

Table 2-4 - GCF Projects in Kenya

Project Name	Description	Focus Area	Project Code(s)	Year
Africa Rural Climate Adaptation Finance Mechanism (ARCAFIM) for East Africa region	Introduces financing models to mobilize private sector investments for climate adaptation in agriculture, particularly benefiting micro, small, and medium-sized enterprises.	Climate adaptation in agriculture	FP220	2024-2036
Acumen Resilient Agriculture Fund	Supports agribusinesses that enhance climate resilience for smallholder farmers, shifting investment patterns towards long-term sustainability.	Climate resilience for smallholder farmers	FP078	2019-2030
Readiness Activities	Five country-level readiness activities approved, with a total budget of USD 4.5 million, of which USD 3.7 million has been disbursed.	Capacity building and institutional development	N/A	N/A

In ***Malawi,*** GCF is implementing 5 projects, with 4 country level readiness activities approved with a total approved readiness support budget of USD 4.1 million, of which USD 3.7 million has been disbursed (Green Climate Fund, 2024). Of specific relevance for the agriculture sector in Malawi are:

Table 2-5 - GCF Projects in Malawi

Project Name	Description	Focus Area	Project Code(s)	Year
Scaling up the use of modernized climate information and early warning systems in Malawi	Focuses on safeguarding lives and sustaining livelihoods by enhancing early warning systems and strengthening community resilience amid increasing climate-related disasters. Expands the meteorological network, improves weather information dissemination, and enhances flood modeling and emergency response capacities.	Early warning systems and community resilience	FP002	2015-2021
Readiness Activities	Four country-level readiness activities approved, with a total budget of USD 4.1 million, of which USD 3.7 million has been disbursed.	Capacity building and institutional development	N/A	N/A

Tanzania's GCF portfolio features 8 projects, with significant agricultural relevance found in FP220, FP218, and FP179 (Green Climate Fund, 2024).

Table 2-6 - GCF Projects in Tanzania

Project Name	Description	Focus Area	Project Code(s)	Year

Africa Rural Climate Adaptation Finance Mechanism (ARCAFIM) for East Africa region	Supports private sector investments in climate adaptation for smallholders.	Climate adaptation in agriculture	FP220	2024-2036
Building climate resilience in the Kigoma region through integrated landscape approaches	Focuses on building climate resilience in the Kigoma region through integrated landscape approaches.	Climate resilience and integrated landscape management	FP218	2023-2029
Enhancing the agricultural sector's resilience by facilitating access to climate adaptation technologies	Enhances the agricultural sector's resilience by facilitating access to climate adaptation technologies. Aims to mitigate climate risks, improve water management, and boost agricultural productivity.	Climate adaptation technologies in agriculture	FP179	2021-2027
Readiness Activities	Eight projects have been approved, with significant agricultural relevance found in FP220, FP218, and FP179.	Capacity building and institutional development	N/A	N/A

Uganda benefits from 13 GCF projects, with FP220, FP034, and FP078 being crucial for agriculture (Green Climate Fund, 2024). GCF in Uganda has approved two country level readiness activities, with a USD 3.6 million approved, and USD 2.1 million already disbursed.

Table 2-7 - GCF Projects in Uganda

Project Name	Description	Focus Area	Project Code(s)	Year
Africa Rural Climate Adaptation Finance Mechanism (ARCAFIM) for East Africa region	Mobilizes private sector investments for climate adaptation in agriculture.	Climate adaptation in agriculture	FP220	2024-2036
Restoring wetlands to improve ecosystem services and enhance livelihoods	Focuses on restoring wetlands to improve ecosystem services and enhance livelihoods.	Ecosystem services and livelihoods	FP034	2016-2026
Acumen Resilient Agriculture Fund	Supports agribusinesses to increase smallholder farmers' climate resilience.	Climate resilience for smallholder farmers	FP078	2019-2030
Readiness Activities	Two country-level readiness activities approved, with a total budget of USD 3.6 million, of which USD 2.1 million has been disbursed.	Capacity building and institutional development	N/A	N/A

GCF is currently implementing nine projects in **Zambia**, with a total financing amount of USD 138.7 million (Green Climate Fund, 2024). Additionally, the GCF has approved four country-level readiness activities with a combined budget of USD 3.1 million, out of which USD 2.6 million has already been disbursed.

Table 2-8 - GCF Projects in Zambia

Project Name	Description	Focus Area	Project Code(s)	Year
Strengthening climate resilience of agricultural livelihoods in Agro-Ecological Regions I and II	Targets increasing the climate resilience of smallholder farmers in designated regions. Focuses on smallholder farmers across five provinces: Eastern, Lusaka, Muchinga, Southern, and Western. Adopts a value-chain approach, enhancing access to climate information services, support for climate-resilient agricultural inputs and practices, sustainable water management, and alternative livelihood options.	Climate resilience in agriculture	FP072	2018-2025
Readiness Activities	Four country-level readiness activities approved, with a total budget of USD 3.1 million, of which USD 2.6 million has been disbursed.	Capacity building and institutional development	N/A	N/A

2.5.1 Planned, current, and past climate change-related projects

Besides GCF-funded projects in the focus countries, there are also a number of ongoing, planned or recently completed projects relevant for the agricultural sector and climate change mitigation and adaptation efforts. These projects are summarised in Table 2-9 below.

Table 2-9 – Planned, current and past climate change related projects across countries

Country	Project Name	Description	Focus Area	Funded by
Burkina Faso	West Africa Food System Resilience Programme (FSPR)	Enhances food security and improves the resilience of food systems across multiple countries, focusing on the dissemination of advanced agricultural technologies and value chains to create jobs and improve nutrition for vulnerable groups. Targets thousands of smallholder farmers across West Africa.	Food security and resilience	(GAFSP, 2017)
	Agricultural Value Chains Promotion Project (PAPFA)	Focuses on developing value chains for rice, vegetables, sesame, and cowpea to increase productivity and promote rural entrepreneurship. Targets 300 000 smallholder farmers.	Value chains and rural entrepreneurship	(IFAD, 2024).
	Integrated Financial and Technical Services project	Supports climate resilience through parametric insurance, enhancing smallholder farmers' adaptation to drought and other climate challenges. Targets 50 000 farmers for climate insurance coverage.	Climate resilience and insurance	(InsuResilience Solutions Fund, 2024)
Ethiopia	Climate Resilient Wheat Value Chain Development Project (CREW)	Aims to enhance wheat production and increase farmers' incomes through climate-smart productivity, market infrastructure, linkages, and agri-finance. Benefits 500 000 small-scale farmer households.	Wheat production and climate resilience	(African Development Bank, 2023),
	Feed the Future Ethiopia Transforming Agriculture	Aims to increase incomes and reduce malnutrition rates by improving agricultural productivity and resilience in the face of climate challenges and global disruptions. Expected to benefit 1 million farmers.	Agricultural productivity and resilience	USAID (2024)
	Feed the Future Ethiopia Seed Systems	Supports seed system development to enhance agricultural productivity and resilience. Targets 300 000 farmers to improve seed access and quality.	Seed systems and resilience	USAID (2024)
Kenya	FAO and Rockefeller Foundation Partnership	Strengthened food value chains, improved markets and infrastructure, and supported post-harvest loss reduction mechanisms. Reached over 100 stakeholders and technical staff. Developed a national post-harvest strategy.	Post-harvest loss reduction	FAO and Rockefeller Foundation (2016-2019)
	YieldWise Programme	Targeted smallholder farmers to reduce post-harvest losses through modern technologies like cooling chambers and airtight bags, extending produce shelf-life and enhancing market value. Benefited over 50 000 farmers.	Post-harvest loss reduction	Rockefeller Foundation
	Kenya On-Farm Storage Challenge Project	Used a Pay-for-Results prize competition to incentivize private sector participants to create, market, and sell on-farm storage solutions, significantly reducing post-harvest losses of grains and enhancing food security and farmer incomes. Distributed 1 390 777 improved storage devices, creating 413 265 metric tonnes of improved storage capacity.	On-farm storage solutions and food security	AgResults (2014-2018)
	Kenyan Government Initiative	The Kenyan government has committed to reducing post-harvest losses from 30% to 5%. Efforts include creating awareness among farmers about proper handling and storage techniques, improving drying methods, and enhancing transportation infrastructure.	Post-harvest loss reduction and food security	Government of Kenya
Malawi	Food Systems Resilience Programme	Aims to boost the commercialization of agricultural products and food system resilience through multi-sectoral interventions. Targets 500 000 smallholder farmers.	Food system resilience	World Bank (2024)
	Food Loss Research Programme	Addresses food loss in various agricultural value chains through innovative local solutions and foresight exercises. Conducted across multiple countries, including Malawi.	Food loss reduction	ACIAR and IDRC (2024)
Tanzania	Tanzania Initiative for Preventing Aflatoxin Contamination (TANIPAC)	Focuses on minimizing aflatoxin contamination in maize and groundnut value chains to improve food safety and nutrition. Targets thousands of farmers in maize and groundnut production.	Food safety and nutrition	Government of Tanzania (2019)

	AGRI-CONNECT programme	Supports inclusive economic growth by promoting private sector development and job creation in agriculture, aligning with Tanzania's industrialization efforts. Expected to create thousands of jobs in the agricultural sector.	Agricultural productivity and job creation	European Union
	Agricultural Sector Development Programme Phase II (ASDP II)	Aims to transform the agricultural sector through increased productivity and commercialization, supporting smallholder farmers to achieve sustainable market linkages. Targets millions of smallholder farmers.	Agricultural transformation and commercializatio n	Government of Tanzania (2024)
	Southern Agricultural Growth Corridor of Tanzania (SAGCOT)	A Public-Private Partnership aimed at transforming agriculture, enhancing productivity, improving food security, reducing poverty, and ensuring environmental sustainability through the commercialization of smallholder agriculture. Expected to benefit hundreds of thousands of farmers.	Agricultural productivity and food security	Government of Tanzania, WEF, and various partners (2010-2030)
Uganda	Fostering Sustainability and Resilience for Food Security in Karamoja sub-region	Improves food security and environmental sustainability by addressing the root causes of food insecurity and reducing GHG emissions. Aims to avoid/reduce 480 508 Mt CO2e of GHG emissions. Targets 100 000 beneficiaries in the Karamoja sub-region.	Food security and environmental sustainability	FAO and UNDP
	Waste Less Food project	Works with 300 farmers to reduce food waste through improved grain storage and community stores, ensuring food security for the region. Provides storage for 30 tons of food.	Food waste reduction and storage solutions	Farmers Overseas Action Group (FOAG) (2016)
	Uganda Climate Smart Agricultural Transformation Project	Increases productivity, market access, and resilience of select value chains, responding to crises or emergencies. Benefits millions of smallholder farmers.	Climate-smart agriculture and market access	World Bank (2023-2028)
Zambia	FAO and WFP initiatives	Focus on reducing post-harvest losses through training and improved storage technologies. Aims to benefit tens of thousands of farmers across Zambia.	Post-harvest loss reduction	FAO and WFP (2024)
	USAID/Prosper Africa/Bechtel Zambia Partnership	Aims to build smart integrated centers to enhance maize production and market dynamics, reducing losses and improvig food security. Benefits over 50 000 smallholder farmers.	Maize production and food security	USAID, Prosper Africa, Bechtel (2022)

2.5.2 Complementarity of the RE-GAIN to ongoing activities across the countries

Based on the projects and programmes described above, the table below indicates how the RE-GAIN programme will work to complement some of the key initiatives – GCF funded or not – across the 7 countries in scope, as described on the table below

Table 2-10 Complementarity of the RE-GAIN programme with ongoing activities across the countries in scopex

	Project Description	Objectives	Opportunities for complementarity
Burkina Faso	Title: CATALI.5°T Initiative Funding: GCF; $40.0m Timeframe: 2022-2029	Supports climate start-ups and small enterprises in West Africa and Latin America.	RE-GAIN teams will engage with the CATALI.5°T teams to leverage lessons learnt for demonstrating market feasibility of innovative, low emission technologies, and business models.
	Title: Africa Integrated Climate Risk Management Programme Funding: GCF; $143.3m Timeframe: 2021-2029	Focuses on building and scaling up the resilience of smallholder farmers in the Sahel region. Emphasizes capacity building and institutional development in integrated climate risk management. Includes access to agricultural insurance and improved climate and weather information services.	While this project focuses on production, RE-GAIN will add the dimension of post-harvest loss reduction. RE-GAIN will also draw on the climate and weather information services as part of the capacity development.
	Title: West Africa Food System Resilience Program (FSPR) Funding: GAFSP; $401.0m Timeframe: 2021-2027	Enhances food security and improves the resilience of food systems across multiple countries, focusing on the dissemination of advanced agricultural technologies and value chains to create jobs and improve nutrition for vulnerable groups. Targets thousands of smallholder farmers across West Africa.	While this project focuses on production, RE-GAIN will add the dimension of post-harvest loss reduction, linking where possible with the value chain development and drawing lessons.

	Title: Agricultural Value Chains Promotion Project (PAPFA) Funding: IFAD; $73.82m Timeframe:2017-2024	Focuses on developing value chains for rice, vegetables, sesame, and cowpea to increase productivity and promote rural entrepreneurship. Targets 300 000 smallholder farmers.	RE-GAIN will draw on value-chains that have been developed for target crops of cowpea and rice as part of the value chain development strategy in the country.
Ethiopia	Title: Inclusive green financing initiative (IGREENFIN I) Funding: GCF; $194.4m Timeframe:2024-2030	Designed to green agricultural banks and the financial sector to support climate-resilient, low-emission smallholder agriculture in the Great Green Wall countries. Enhances access to credit and technical assistance for local farmers, farmer organizations, cooperatives, and micro and small enterprises.	While this project focuses on production, RE-GAIN will add the complementary dimension of post-harvest loss reduction in Ethiopia.
	Title: Climate Resilient Wheat Value Chain Development Project (CREW) Funding: African Development Banks; $94m Timeframe: 2023-2028	Aims to enhance wheat production and increase farmers' incomes through climate-smart productivity, market infrastructure, linkages, and agri-finance. Benefits 500 000 small-scale farmer households.	While this project focuses on production, RE-GAIN will add the complementary dimension of post-harvest loss reduction in Ethiopia, while drawing on the market linkages that are being established.
	Title: Feed the Future Ethiopia Transforming Agriculture Funding: USAID; $67m Timeframe: 2022-2027	Aims to increase incomes and reduce malnutrition rates by improving agricultural productivity and resilience in the face of climate challenges and global disruptions. Expected to benefit 1 million farmers.	While this project focuses on production, RE-GAIN will add the complementary dimension of post-harvest loss reduction in Ethiopia.
Kenya	Title: Africa Rural Climate Adaptation Finance Mechanism (ARCAFIM) for East Africa region Funding: GCF; $200.0m Timeframe: 2024-2036	Introduces financing models to mobilize private sector investments for climate adaptation in agriculture, particularly benefiting micro, small, and medium-sized enterprises.	While this project focuses on production, RE-GAIN will add the complementary dimension of post-harvest loss reduction in Kenya. Options for aligning finance partnerships developed for production with those for post-harvest systems will be explored.
	Title: Acumen Resilient Agriculture Fund Funding: GCF; 56.0M Timeframe: 2019-2023	Supports agribusinesses that enhance climate resilience for smallholder farmers, shifting investment patterns towards long-term sustainability.	While this project focuses on production, RE-GAIN will add the complementary dimension of post-harvest loss reduction in Kenya.
	Title: FAO and Rockefeller Foundation Partnership Funding: FAO and Rockefeller Foundation Timeframe: 2016-2019	Strengthened food value chains, improved markets and infrastructure, and supported post-harvest loss reduction mechanisms. Reached over 100 stakeholders and technical staff. Developed a national post-harvest strategy.	AGRA is partnered with Rockefeller to scale this initiative to introduce/promote wholegrain processing practices.
	Title: Advancing Availability of Biofortified Foods in Institutions (Schools) Funding: Rockefeller Foundation; $14M Timeframe: 2022-2025	The intervention targets food producers – millers in particular – providing technical assistance along several themes, including: i) developing MSME capacity; ii) raising awareness of market opportunities for wholegrains; iii) support for technology transfers; and iv) facilitating access to finance.	RE-GAIN will contribute to this initiative in promoting wholegrain food for use in institutional markets (such as schools).
	Title: YieldWise Programme Funding: Rockefeller Foundation; $130M Timeframe: 2016-2030	Targeted smallholder farmers to reduce post-harvest losses through modern technologies like cooling chambers and airtight bags, extending produce shelf-life and enhancing market value. Benefited over 50 000 farmers.	AGRA is partnered with Rockefeller to scale this initiative to introduce/promote wholegrain processing practices.
	Title: Kenya On-Farm Storage Challenge Project Funding: AgResults; $12m Timeframe: 2014-2018	Used a Pay-for-Results prize competition to incentivize private sector participants to create, market, and sell on-farm storage solutions, significantly reducing post-harvest losses of grains and enhancing food security and farmer incomes. Distributed 1 390 777 improved storage devices, creating 413 265 metric tonnes of improved storage capacity.	RE-GAIN has drawn lessons from this initiative and will scale best practice.
Malawi	Title: Food Systems Resilience Program Funding: World Bank; $95m Timeframe: 2018-2023	Aims to boost the commercialization of agricultural products and food system resilience through multi-sectoral interventions. Targets 500 000 smallholder farmers.	While this project focuses on production, RE-GAIN will add the complementary dimension of post-harvest loss reduction in Malawi.
	Title: Food Loss Research Program	Addresses food loss in various agricultural value chains through innovative local	RE-GAIN has drawn lessons and adopt best practice from this initiative.

	Funding: ACIAR and IDRC Timeframe: 2024	solutions and foresight exercises. Conducted across multiple countries, including Malawi.	
Tanzania	Title: Africa Rural Climate Adaptation Finance Mechanism (ARCAFIM) for East Africa region Funding: GCF; $200.0m Timeframe: 2024-2036	Introduces financing models to mobilize private sector investments for climate adaptation in agriculture, particularly benefiting micro, small, and medium-sized enterprises.	While this project focuses on production, RE-GAIN will add the complementary dimension of post-harvest loss reduction in Tanzania. Options for aligning finance partnerships developed for production with those for post-harvest systems will be explored.
	Title: Tanzania Agriculture Climate Adaptation Technology Deployment Programme (TACATDP) Funding: GCF; $200.m Timeframe: 20214-2027	Enhances the agricultural sector's resilience by facilitating access to climate adaptation technologies. Aims to mitigate climate risks, improve water management, and boost agricultural productivity.	While this project focuses on production, RE-GAIN will add the complementary dimension of post-harvest loss reduction in Tanzania.
	Title: Tanzania Initiative for Preventing Aflatoxin Contamination (TANIPAC) Funding: Government of Tanzania; $24m Timeframe: 2018-2025	Focuses on minimizing aflatoxin contamination in maize and groundnut value chains to improve food safety and nutrition. Targets thousands of farmers in maize and groundnut production.	RE-GAIN has drawn lessons and adopt best practice from this initiative for Maize value chains.
	Title: Agricultural Sector Development Programme Phase II (ASDP II) Funding: Government of Tanzania Timeframe: 2018-2023	Aims to transform the agricultural sector through increased productivity and commercialization, supporting smallholder farmers to achieve sustainable market linkages. Targets millions of smallholder farmers.	While this project focuses on production, RE-GAIN will add the complementary dimension of post-harvest loss reduction in Tanaznia, while drawing on the market linkages that are being established.
Uganda	Title: Africa Rural Climate Adaptation Finance Mechanism (ARCAFIM) for East Africa region Funding: GCF; $200.0m Timeframe: 2024-2036	Introduces financing models to mobilize private sector investments for climate adaptation in agriculture, particularly benefiting micro, small, and medium-sized enterprises.	While this project focuses on production, RE-GAIN will add the complementary dimension of post-harvest loss reduction in Uganda. Options for aligning finance partnerships developed for production with those for post-harvest systems will be explored.
	Title: Acumen Resilient Agriculture Fund Funding: GCF; $56.0m Timeframe:2019-2030	Supports agribusinesses to increase smallholder farmers' climate resilience.	While this project focuses on production, RE-GAIN will add the complementary dimension of post-harvest loss reduction in Uganda.
	Title: Uganda Climate Smart Agricultural Transformation Project Funding: World Bank; $350.0m Timeframe: 2023-2028	Increases productivity, market access, and resilience of select value chains, responding to crises or emergencies. Benefits millions of smallholder farmers.	While this project focuses on production, RE-GAIN will add the complementary dimension of post-harvest loss reduction in Uganda, while drawing on the market linkages that are being established.
	Title: Waste Less Food project Funding: Farmers Overseas Action Group (FOAG) Timeframe: 2016	Works with 300 farmers to reduce food waste through improved grain storage and community stores, ensuring food security for the region. Provides storage for 30 tons of food.	RE-GAIN has drawn lessons and adopt best practice from this initiative.
Zambia	Title: Strengthening climate resilience of agricultural livelihoods in Agro-Ecological Regions I and II Funding: GCF; $137.3 Timeframe: 2018-2025	Targets increasing the climate resilience of smallholder farmers in designated regions. Focuses on smallholder farmers across five provinces: Eastern, Lusaka, Muchinga, Southern, and Western. Adopts a value-chain approach, enhancing access to climate information services, support for climate-resilient agricultural inputs and practices, sustainable water management, and alternative livelihood options.	While this project focuses on production, RE-GAIN will add the dimension of post-harvest loss reduction. RE-GAIN will also draw on the climate information services as part of the capacity development.
	Title: FAO and WFP initiatives Funding: FAO and WFP Timeframe: 2024	Focus on reducing post-harvest losses through training and improved storage technologies. Aims to benefit tens of thousands of farmers across Zambia.	RE-GAIN has drawn lessons and adopt best practice from this initiative.
	Title: USAID/Prosper Africa/Bechtel Zambia Partnership Funding: USAID, Prosper Africa, Bechtel; Timeframe: 2022	Aims to build smart integrated centers to enhance maize production and market dynamics, reducing losses and improving food security. Benefits over 50 000 smallholder farmers.	RE-GAIN has drawn lessons and adopt best practice from this initiative.

3 Climate Analysis – Adaptation

3.1 PROJECTED CLIMATE CHANGE TRENDS FOR KEY HAZARDS IN RE-GAIN COUNTRIES BY 2040

Our climate change risk assessment adhered to the conceptual framework of climate risk articulated by the Intergovernmental Panel on Climate Change (IPCC) in its fifth and sixth assessment reports (AR5 and AR6). Under this framework, risk is a combination of climate change hazards, vulnerability factors or characteristics, and the exposed subject matter (exposure). Our approach was to develop a hybrid, mixed-methods analysis that combined a quantitative estimation of climate risk (derived as a function of graded levels of hazard indicators, vulnerability indicators, and exposure indicators) coupled with a qualitative elaboration of climate risk (narrative commentary about risks to each crop at each stage of the post-harvest value chain, derived from national and local stakeholder inputs and from literature review).

The table below captures the core of the climate change risk assessment, focusing on the *level of change projected for relevant climate hazards* in RE-GAIN countries by 2040 (taking into account two scenarios – SSP 2-4.5 and SSP5-8.5; relying on projection data from the World Bank's climate change knowledge portal). Stakeholders and country experts in national and sub-national workshops reviewed and validated these findings, and emphasized (across all seven countries and fourteen crops) that the hazards that are the **greatest threat to post-harvest value chain stages of the crops – and thus of highest interest – are excessive or erratic rainfall, high temperatures and extreme heat, and flooding.** Thus, these hazards and their impacts, repeatedly underscored by stakeholders, are the priority hazards to which RE-GAIN's interventions respond.

Table 3-1 Climate change risk assessment: Focusing on the level of change projected for relevant climate hazards in RE-GAIN countries by 2040

Key:

Very High	High	Moderate	Low	Very Low

Country	Average Surface Temperature	Average Rainfall	Days Over 35°C	Days Over 20 mm rain	Largest 1-Day Rainfall	Largest 5-Day Rainfall	Water Scarcity / Drought	Extreme Heat / Heat Waves	Floods	Wildfires	Landslides	Cyclones	Sea Level Rise
Burkina Faso												N/A	N/A
Ethiopia													N/A
Kenya													
Malawi													N/A
Tanzania													
Uganda													N/A
Zambia													N/A

3.2 IMPLICATIONS OF CLIMATE CHANGE FOR CROPS TO BE COVERED BY RE-GAIN

A review of scholarly studies and peer-reviewed scientific articles highlighted that there is a **paucity of literature on the impacts of climate change on the *post-harvest* value chain stages of crops**. While there is a wealth of information on the observed and projected impacts of climate change on crop production pre-harvest (i.e., germination, fruiting, cultivation, maturation, seed or grain quality, and most of all yields), relatively little attention has been paid to how climate change hazards affect harvesting, post-harvest handling and storage (e.g., threshing, sorting, drying, warehousing), and processing, transport, and logistics (grading, packaging, storage, transport, distribution, and marketing).

While RE-GAIN focuses on post-harvest stages of the crop value chains, our analysis nevertheless makes note of projected climate change impacts on crop production. This is because a programme like RE-GAIN which is designed to reduce post-harvest losses, should also be cognizant of the pressure that climate change is putting on productivity and yields of the targeted crops. In developing and deploying effective interventions, **RE-GAIN can strive to offset some of the expected climate change-driven losses in yields (pre-harvest) by reducing avoidable post-harvest losses, and be particularly conscious of the crops that are expected to suffer the largest crop yields in the coming decades.** In other words, RE-GAIN is aiming to reduce the volume of total losses in post-harvest stages of the value chain of certain crops, through interventions that would protect the harvested crop from climate-induced damage and loss *post-harvest*. Even if such crops experience climate change-driven reductions in yield including due to changes in crop suitability areas, RE-GAIN aims to ensure that overall volumes reaching the market remain stable by reducing or avoiding the additional losses that climate change impacts could create during post-harvest phases.

Table 3-2: Summary of Projected Climate Change Impacts on Crop Production (Extracted from Country Reports[2])

Country	*Crop*	*Key Features*	*Projected Climate Change Impacts*
Burkina Faso	Cowpea	***Moderate sensitivity*** to climatic factors. Cash crop; Accounts for the largest share of cultivated land area after land used for cereal crops; Crop quality is affected negatively by high moisture levels.	Area suitable for cowpea production is projected to decrease over time as a result of climate change (due to northerly shift of isohyets or rainfall belts).
	Rice	***Moderate sensitivity*** to climatic factors. Staple crop; Accounts for 5% of the cultivated land area used for cereal crops, and 10% of the volume of cereal production.	The timing of the growing season is expected to shift as a consequence of climate change, including a possible shortening of the cropping season; Projections about the impacts of climate change on rice yields are mixed, with some possibility of an initial increase and expected declining trends in the second half of the century.

[2] Sources: See Appendices 1, 2, 3, 4, 5, 6, and 7 to Annex 2.
Detailed references for all aspects of the analysis are integrated in country **profiles attached as Appendixes to this Annex**.
Key Sources include (German Federal Ministry for Economic Development and Cooperation, 2018; Town, 2020) (The World Bank, CIAT, CCAFS & CGIAR, 2018 & 2019) (IFAD and the University of Cape Town, 2020) (Abel Chemura, 2023)

Ethiopia	Teff	***Moderate sensitivity*** to climatic factors. Staple crop; used to largely be a subsistence crop but has also emerged as a cash crop in recent years; Accounts for an estimated 28% of the cultivated land area used for cereal crops; Cultivation is dominated by small-holder farmers; High reliance on rainfall, due to limited irrigation; Low levels of mechanization and productivity.	Teff yields in Ethiopia are projected to decrease as a result of climate change, in both a drier-hotter future and a wetter-warmer future; Future yields are also expected to be affected by the detrimental impacts of topsoil loss, from a projected increase in heavy rainfall events, runoff, and flooding; Projections suggest a slight decrease of areas suitable for teff cultivation under future climate change scenarios by mid-century, as a consequence of increased temperatures and potential decreases in rainfall.
	Wheat	***High sensitivity*** to climatic factors. Staple crop. Accounts for an estimated 18% of the cultivated land area used for cereal crops; Cultivation is dominated by small-holder farmers; High reliance on rainfall, due to limited irrigation; Low levels of mechanization and productivity.	Wheat yields in Ethiopia are projected to decrease in a drier-hotter future but potentially increase marginally in a wetter-warmer future; Climate projections suggest an increased risk of drought in the coming decades, which would in turn result in depressed wheat yield due to reduced water availability.
Kenya	Maize	***High sensitivity*** to climatic factors. Staple crop; Accounts for an estimated one-third of caloric intake of the population; Approximately 80% of all framing in Kenya is small-scale subsistence cultivation; High dependency on rain, with an estimated 98% of cultivated area being rainfed; Low levels of mechanization and productivity; As much as 36% of the crop is lost in post-harvest stages of the value chain.	Under climate change, regions in Kenya's north (highlands) are projected to experience an increase in the land area suitable for cropping, while the arid and semi-arid regions in much of the country are likely to experience a decrease in land area suitable for cropping; Maize yields are projected to increase, as a consequence of climate change, in the highlands and great lakes regions, by the 2030s, but are projected to decline in the arid and semi-arid lowlands; Infestations by pests and contamination by mycotoxins like aflatoxin (due to mould) are projected to increase.
	Beans	***Moderate sensitivity*** to climatic factors. Subsistence crop as well as cash crop. Major source of dietary protein; Approximately 80% of all framing in Kenya is small-scale subsistence cultivation; High dependency on rain, with an estimated 98% of cultivated area being rainfed; Low levels of mechanization and productivity; As much as 12% of the crop is lost in post-harvest stages of the value chain.	Under climate change, regions in Kenya's north (highlands) are projected to experience an increase in the land area suitable for cropping, while the arid and semi-arid regions in much of the country are likely to experience a decrease in land area suitable for cropping; Projections suggest a future decrease in yields due to higher temperatures. However, the uncertainty in projections about water availability results in projections showing both an increase in yields (if water availability rises) and a decrease (under more water stress); Infestations by pests and contamination by fungal diseases, such as mycotoxins like aflatoxin (due to mould), are projected to increase.
Malawi	Maize	***High sensitivity*** to climatic factors. Staple crop, grown by approximately 97% of Malawi's farmers; Accounts for an estimated 60% of calories consumed;	Climate change is projected to make rainfall more erratic and shift rainfall timing. Delays in rainfall could result in farmers incurring additional costs due to the need for replanting, the need for additional weeding,

		Cultivation is dominated by small-holder farmers, who account for 70% of the agricultural labour-force; Leading crop in terms of land use – accounts for 28% of harvested areas; High dependency on rain, with 90% of agriculture being rainfed; Low levels of mechanization and productivity.	ridging, drying/shelling; Maize yields in Malawi are projected to decrease by mid-century as a result of climate change (higher temperatures, more frequent and prolonged heat waves, and higher ambient moisture levels); Infestations by pests and contamination by mycotoxins like aflatoxin (due to mould) are projected to increase.
	Groundnut	***Moderate sensitivity*** to climatic factors. Cash crop, with an important role in exports; Second most important crop in terms of land use – accounts for 6% of harvested areas; High dependency on rain, with 90% of agriculture being rainfed; Low levels of mechanization and productivity.	Climate change is projected to make rainfall more erratic and shift rainfall timing. Late onset of rains could result in farmers incurring additional costs due to the need for replanting of seeds that do not germinate because of the lack of moisture; Groundnut yields in Malawi are projected to decrease by mid-century as a result of climate change (higher temperatures, more frequent and prolonged heat waves, and erratic rainfall during crucial growth and development periods; Infestations by pests and contamination by fungal diseases, such as mycotoxins like aflatoxin (due to mould), are projected to increase.
Tanzania	Maize	***High sensitivity*** to climatic factors. Staple crop; Leading crop in terms of land use – accounts for 24% of harvested area; High dependency on rain, with over 98% of agriculture being rainfed; Low levels of mechanization and productivity; High prevalence of small-holder farmers in the agriculture sector.	Maize yields in Tanzania are projected to decrease by mid-century as a result of climate change (increased heat stress, drying conditions, soil erosion, and flood damage); Beyond yield declines, maize harvests in Tanzania are expected to face the threat of increased droughts, storms, pests, or diseases linked to unpredictable weather;
	Rice	***Moderate sensitivity*** to climatic factors. Staple crop, as well as a commercial drop; Accounts for an estimated 40% of calories consumed; Third largest footprint in terms of land use – accounts for 7% of harvested area; High dependency on rain, with over 98% of agriculture being rainfed; Low levels of mechanization and productivity; High prevalence of small-holder farmers in the agriculture sector.	Some studies indicate that rice yields in Tanzania are projected to decrease modestly as a consequence of climate change (while area under rice cultivation may increase) by mid-century; However, there are also projections to the contrary, suggesting rice yields could benefit from climate change and increase substantially by mid-century.
Uganda	Maize	***High sensitivity*** to climatic factors. Staple crop; Accounts for an estimated 40% of calories consumed; Leading crop in terms of land use – accounts for 7% of harvested areas; High dependency on rain; Low levels of mechanization and productivity;	Maize yields in Uganda are projected to decrease by mid-century as a result of climate change (higher temperatures, more frequent and prolonged heat waves, and higher ambient moisture levels). Infestations by pests and contamination by mycotoxins like aflatoxin (due to mould) are projected to increase.

		Has become an export cash-crop, benefiting many small-holders.	The area suitable for growing maize in Uganda is projected to decrease due to changing climatic conditions by mid-century.
	Beans	***Moderate sensitivity*** to climatic factors. Subsistence crop as well as cash crop. Major source of dietary protein; Second most important crop in terms of land use – accounts for 5% of harvested areas; Prevalence of small-holder farmers; Low levels of mechanization and productivity; Has become an export cash-crop, benefiting many small-holders.	Bean yields in Uganda are projected to decrease by mid-century as a result of climate change (higher temperatures, more frequent and prolonged heat waves, erratic rainfall, and higher ambient moisture levels). Infestations by pests and contamination by fungal diseases, such as mycotoxins like aflatoxin (due to mould), are projected to increase. The area suitable for growing beans in Uganda is projected to broadly remain the same even with changing climatic conditions by mid-century.
Zambia	Maize	***High sensitivity*** to climatic factors. Staple crop; High prevalence (60%) of small-holder farmers in the maize crop, cultivating for subsistence purposes; Accounts for an estimated 60% of calories consumed; Leading crop in terms of land use – accounts for nearly half (49%) of harvested area; High dependency on rain; Low levels of mechanization and productivity.	Maize yields in Zambia are projected to decrease by mid-century as a result of climate change (Erratic and variable rainfall; higher temperatures, more frequent and prolonged heat waves, and higher ambient moisture levels). Infestations by pests and contamination by mycotoxins like aflatoxin (due to mould) are projected to increase. The area suitable for growing maize in Zambia is projected to decrease due to changing climatic conditions by mid-century.
	Soybeans	***Moderate sensitivity*** to climatic factors. Commercial / cash crop, but also a growing source of dietary protein; High prevalence of small-holder farmers; Legumes, including soybeans, account for 14% of total harvested area; Prevalence of small-holder farmers; Low levels of mechanization and productivity.	Soybean yields in Zambia are projected to decrease by mid-century as a result of climate change (higher temperatures, more frequent and prolonged heat waves, erratic rainfall, and higher ambient moisture levels). Infestations by pests and contamination by fungal diseases, such as mycotoxins like aflatoxin (due to mould), are projected to increase. The area suitable for growing soybeans in Zambia is projected to decrease marginally by mid-century with changing climatic conditions.

3.3 ADAPTIVE CAPACITY OF THE COUNTRIES IN THE RE-GAIN PROGRAMME

All seven RE-GAIN countries are recognized as having low adaptive capacity and low readiness for climate change impacts, in terms of their relative global standing. Per the ND-GAIN index (Notre Dame Global Adaptation Initiative, n.d.), based on scores for 2021, the countries' ranking on adaptive capacity[3] and readiness[4] – out of 192 countries – is as follows:

[3] Under the ND GAIN Index, 'Adaptive Capacity' is the ability of society and its supporting sectors to adjust to reduce potential damage and to respond to the negative consequences of climate events. This captures a collection of means, readily deployable to deal with sector-specific climate change impacts.
[4] Under the ND GAIN Index, 'Readiness' is the ability to make effective use of investments for adaptation actions thanks to a safe and efficient business environment. Readiness has three components: economic readiness, governance readiness, and social readiness.

Table 3-3: Applicable ND-GAIN Adaptive Capacity Rankings for RE-GAIN countries

Country	Adaptive Capacity Rank (out of 192)	Readiness Rank (out of 192)
Burkina Faso	154 (low adaptive capacity)	158 (low readiness)
Ethiopia	159 (low adaptive capacity)	156 (low readiness)
Kenya	133 (low adaptive capacity)	152 (low readiness)
Malawi	150 (low adaptive capacity)	157 (low readiness)
Tanzania	141 (low adaptive capacity)	151 (low readiness)
Uganda	147 (low adaptive capacity)	163 (low readiness)
Zambia	103 (low adaptive capacity)	141 (low readiness)

This economy-wide low level of adaptive capacity also applies to the agricultural sector, including post-harvest management of value chains. This was affirmed and validated through inputs in national and sub-national stakeholder workshops, at which stakeholders identified several factors that contribute to low adaptive capacity against climate-induced risks and impacts. While the workshops were country-focused and were designed to elicit guidance from stakeholders and country experts on factors specific to the two crops in the respective countries, a review of stakeholder inputs across all 14 crops in the seven countries points to consistent, common factors in all fourteen value chains (of eight different crops).
This consistency is both understandable (given common or similar barriers in all seven countries' agricultural value chains) and valuable (as it offers opportunity for RE-GAIN's responses to align and harmonize at a cross-national scale, enabling programmatic efficiencies and economies of scale). Across the board, the major factors of vulnerability that impede adaptive capacity, highlighted by stakeholders in all seven countries, are summarised in Table 3-4 below.

Table 3-4: Summary of Stakeholder Feedback on Factors That Constrain Adaptive Capacity in the Post-Harvest Value Chains (Synthesis Drawn From Country Stakeholder Workshop Reports)

Countries	Crops	Non-Climate Hazard	Why is it a barrier to the ability to anticipate and respond to climate change risk and impact
Burkina Faso; Ethiopia; Kenya; Malawi; Tanzania; Uganda; Zambia	Maize; Wheat; Rice; Teff; Beans; Soybeans; Cowpeas; Groundnuts	Infrastructure	Reliance on climate-vulnerable (non-climate-robust) storage and transport infrastructure leads to greater vulnerability and exposure to ambient temperature and moisture, as well as during extreme weather conditions such as flooding and heavy rainfall events.
		Finance	Lack of access or limited access to credit reduces the ability for risk-management, and limits financial capacity to invest in climate-adaptive technology, equipment, facilities, and tools. Limited information about markets reduces the ability to plan for volumes of storage, transport, and sale, with the risk of more of the harvested crop being exposed to temperature and humidity than optimal.
		Technology	Reliance on traditional methods and practices rather than greater mechanization and specialized tools (for harvesting, threshing, sorting, grading, packaging) reduces ability to protect the harvested crop from the impacts of high temperatures, moisture, humidity, and exposure to flooding. Limited information about pest control also increases the harvested crop's exposure to climate-sensitive pests (including insects). The lack of / limited access to climate information services (such as early warning systems and weather alerts) also straitjackets adaptive capacity against hazards like extreme weather events.
		Capacity	Lack of/limited access to technology, equipment, facilities, and tools (for threshing, drying, storage, and transport) reduces ability to protect harvested crop from the impacts of high temperatures, moisture, humidity, and increases exposure to flooding and heavy rains.

3.4 RISK SUMMARY FOR CROPS TARGETED BY THE RE-GAIN PROGRAMME

Published literature offers a high-level recognition that **temperature and moisture play a key role in post-harvest losses**, both directly (by affecting grain/seed quality and causing decay) and indirectly (through enhanced conditions for the growth of

pests and diseases), and that extreme weather events such as heavy rainfall and flooding cause damage and disruption to crops during harvest and to equipment and infrastructure (including storage and transport facilities).

Beyond this, to develop a more granular and context-relevant picture for RE-GAIN, our assessment also sought **input from stakeholder and country experts** (through national and sub-national workshops, and comments provided on early drafts) to identify major climate change impacts of concern. Table 3-5 below captures salient findings for the fourteen crops, principally reflecting inputs from country experts and other stakeholders at national and sub-national workshops.

The consequences of such climate change-driven impacts, leading to losses in the post-harvest stages, include reduced revenue for farmers and traders, diminished income, and reduced availability of the commodities for consumption, which in turn has food security impacts. **All of these reduce adaptive capacity and must be ameliorated to ensure resilience of smallholder farmers in the seven countries.**

Table 3-5: Summary of Identified Climate Hazards of Concern for Post-Harvest Value Chains and Their Impacts on Post-Harvest Value Chain Stages (Extracted from Country Reports, Combined with Stakeholder Feedback in National and Subnational Workshops[5])

Country	Crop	Vulnerabilities	Hazards	Climate Change Risks / Impacts in the Post-Harvest Value Chain
Burkina Faso	Cowpea	Lack of/limited access to technology, mechanization, equipment, facilities, and infrastructure (for harvesting, threshing, drying, sorting, storage, packaging, and transport); Prevalence of pests, insects, and vermin; Lack of/limited knowledge of or access to reliable and actionable information (including climate information services and markets-related information).	Flooding; Excessive and/or erratic rainfall (including heavy rainfall events); High temperatures (extreme heat)	***Harvesting Processes***: shattering of the grain/seed due to heat; challenges to field drying due to excessive rainfall; rotting, mould, and mycotoxin (aflatoxin) contamination due to high moisture content; damage to stored harvest from flooding. ***Post-Harvest Handling and Storage***: damage to or decay of grain/seed quality from high temperatures and humidity; rotting, mould, and mycotoxin (aflatoxin) contamination due to moisture content damage to storage infrastructure from flooding.; ***Processing, Transport, and Logistics***: damaged or inaccessible road networks and transport infrastructure due to flooding; damage to processing and storage facilities and infrastructure from excessive rainfall and flooding; damage to or decay of grain/seed quality from high temperatures and humidity, and lower shelf life; disruption of mobility and access to markets due to extreme weather, impeding distribution and marketing.

[5] Sources: See Appendices 1, 2, 3, 4, 5, 6, and 7 to Annex 2.
Detailed references for all aspects of the analysis are integrated in **each country profile report**. Principally, sources include (but are not limited to):
World Bank Climate Change Knowledge Portal, Climate change baseline data (averaged for 1950-2014) on climate change indicators (hazards), derived from the CMIP6 daatset, available per country at https://climateknowledgeportal.worldbank.org/#country-map
World Bank Climate Change Knowledge Portal, Climate change projection data (for 2040, for SSP 2-4.5) on climate change indicators (hazards), derived from the CMIP6 dataset, available per country at https://climateknowledgeportal.worldbank.org/#country-map
World Bank Climate Change Knowledge Portal, Climate change projection data (for 2040, for SSP 5-8.5) on climate change indicators (hazards), derived from the CMIP6 dataset, available per country at https://climateknowledgeportal.worldbank.org/#country-map
World Bank and GFDRR hazard index, Thinkhazard, available per country at https://thinkhazard.org/en/
FAO Food Loss and Waste Database https://www.fao.org/platform-food-loss-waste/flw-data/en/
APHLIS Database https://www.aphlis.net/en
IFPRI, *Global Food Policy Report 2022: Climate Change and Food Systems – Chapter 11* (2022), available at https://ebrary.ifpri.org/utils/getfile/collection/p15738coll2/id/135889/filename/136101.pdf.

	Rice	Lack of/limited access to technology, mechanization, equipment, facilities, and infrastructure (for harvesting, threshing, drying, sorting, storage, packaging, and transport); Prevalence of pests, insects, and vermin; Lack of/limited knowledge of or access to reliable and actionable information (including climate information services and markets-related information).	High temperatures (extreme heat) Flooding; Excessive and/or erratic rainfall (including heavy rainfall events);	***Harvesting Processes***: shattering of the grain/seed due to heat; challenges to field drying due to excessive rainfall; rotting, mould, and aflatoxin contamination due to high moisture content; damage to stored harvest from flooding. ***Post-Harvest Handling and Storage***: damage to or decay of grain/seed quality from high temperatures and humidity; rotting, mould, and aflatoxin contamination due to moisture content damage to storage infrastructure from flooding.; ***Processing, Transport, and Logistics***: damaged or inaccessible road networks and transport infrastructure due to flooding; damage to processing and storage facilities and infrastructure from excessive rainfall and flooding; damage to or decay of grain/seed quality from high temperatures and humidity, and lower shelf life; disruption of mobility and access to markets due to extreme weather, impeding distribution and marketing.
Ethiopia	Teff	Reliance on traditional methods and practices rather than greater mechanization and specialized tools (for harvesting, threshing, sorting, grading, packaging); Lack of/limited access to technology, equipment, facilities, and infrastructure (for threshing, drying, storage, and transport); Lack of/limited access to credit, and constrained financial capacity. [Note: stakeholders also mentioned system-wide disruptions due to supply chain interruptions and forced internal displacement, linked to civil unrest.]	Excessive and/or erratic rainfall (including heavy rainfall events); Flooding; High temperatures (extreme heat)	***Harvesting Processes***: shattering of the grain/seed due to heat; challenges to field drying due to excessive rainfall; rotting, mould, and aflatoxin contamination due to high moisture content; damage to stored harvest from flooding. ***Post-Harvest Handling and Storage***: damage to or decay of grain/seed quality from high temperatures and humidity; rotting, mould, and aflatoxin contamination due to moisture content damage to storage infrastructure from flooding.; ***Processing, Transport, and Logistics***: damaged or inaccessible road networks and transport infrastructure due to flooding; damage to processing and storage facilities and infrastructure from excessive rainfall and flooding; damage to or decay of grain/seed quality from high temperatures and humidity, and lower shelf life; disruption of mobility and access to markets due to extreme weather, impeding distribution and marketing.
	Wheat	Reliance on traditional methods and practices rather than greater mechanization and specialized tools (for harvesting, threshing, sorting, grading, packaging); Lack of/limited access to technology, equipment, facilities, and infrastructure (for threshing, drying, storage, and transport); Lack of/limited access to credit, and constrained financial capacity. [Note: stakeholders also mentioned system-wide disruptions due to supply chain interruptions and forced internal displacement, linked to civil unrest.]	Excessive and/or erratic rainfall (including heavy rainfall events); Flooding; High temperatures (extreme heat)	***Harvesting Processes***: shattering of the grain/seed due to heat; challenges to field drying due to excessive rainfall; rotting, mould, and aflatoxin contamination due to high moisture content; damage to stored harvest from flooding. ***Post-Harvest Handling and Storage***: damage to or decay of grain/seed quality from high temperatures and humidity; rotting, mould, and aflatoxin contamination due to moisture content damage to storage infrastructure from flooding.; ***Processing, Transport, and Logistics***: damaged or inaccessible road networks and transport infrastructure due to flooding; damage to processing and storage facilities and infrastructure from excessive rainfall and flooding; damage to or decay of grain/seed quality from high temperatures and humidity, and lower shelf life; disruption of mobility and access to markets due to extreme weather, impeding distribution and marketing.
Kenya	Maize	Lack of/limited access to technology, mechanization, equipment, facilities, and infrastructure (for harvesting,	Excessive and/or erratic rainfall (including	***Harvesting Processes***: shattering of the grain/seed due to heat; challenges to field drying due to excessive rainfall; rotting, mould, and aflatoxin contamination due to high moisture content; damage

		threshing, drying, sorting, storage, packaging, and transport); Prevalence of pests, insects, and vermin; Lack of/limited knowledge of or access to reliable and actionable information (including climate information services and markets-related information); Lack of/limited access to credit, and constrained financial capacity.	heavy rainfall events); High temperatures (extreme heat); Climate-driven increase in pests and diseases.	to stored harvest from flooding. ***Post-Harvest Handling and Storage***: damage to or decay of grain/seed quality from high temperatures and humidity; rotting, mould, and aflatoxin contamination due to moisture content damage to storage infrastructure from flooding.; ***Processing, Transport, and Logistics***: damaged or inaccessible road networks and transport infrastructure due to flooding; damage to processing and storage facilities and infrastructure from excessive rainfall and flooding; damage to or decay of grain/seed quality from high temperatures and humidity, and lower shelf life; disruption of mobility and access to markets due to extreme weather, impeding distribution and marketing.
	Beans	Lack of/limited access to technology, mechanization, equipment, facilities, and infrastructure (for harvesting, threshing, drying, sorting, storage, packaging, and transport); Reliance on traditional methods and practices rather than greater mechanization and specialized tools (for harvesting, threshing, sorting, grading, packaging); Lack of/limited knowledge of or access to reliable and actionable information (including climate information services and markets-related information)	Climate-driven increase in pests and diseases; Excessive and/or erratic rainfall (including heavy rainfall events); High temperatures (extreme heat).	***Harvesting Processes***: shattering of the grain/seed due to heat; challenges to field drying due to excessive rainfall; rotting, mould, and aflatoxin contamination due to high moisture content; damage to stored harvest from flooding. ***Post-Harvest Handling and Storage***: damage to or decay of grain/seed quality from high temperatures and humidity; rotting, mould, and aflatoxin contamination due to moisture content damage to storage infrastructure from flooding.; ***Processing, Transport, and Logistics***: damaged or inaccessible road networks and transport infrastructure due to flooding; damage to processing and storage facilities and infrastructure from excessive rainfall and flooding; damage to or decay of grain/seed quality from high temperatures and humidity, and lower shelf life; disruption of mobility and access to markets due to extreme weather, impeding distribution and marketing.
Malawi	Maize	Lack of/limited access to technology, equipment, facilities, and infrastructure (for threshing, drying, storage, and transport); Reliance on traditional methods and practices rather than greater mechanization and specialized tools (for harvesting, threshing, sorting, grading, packaging); Lack of/limited knowledge of or access to reliable and actionable information (including about pest control and markets-related information).	Excessive and/or erratic rainfall (including heavy rainfall events); Flooding; High temperatures (extreme heat)	***Harvesting Processes***: shattering of the grain/seed due to heat; challenges to field drying due to excessive rainfall; rotting, mould, and aflatoxin contamination due to high moisture content; damage to stored harvest from flooding. ***Post-Harvest Handling and Storage***: damage to or decay of grain/seed quality from high temperatures and humidity; rotting, mould, and aflatoxin contamination due to moisture content damage to storage infrastructure from flooding.; ***Processing, Transport, and Logistics***: damaged or inaccessible road networks and transport infrastructure due to flooding; damage to processing and storage facilities and infrastructure from excessive rainfall and flooding; damage to or decay of grain/seed quality from high temperatures and humidity, and lower shelf life; disruption of mobility and access to markets due to extreme weather, impeding distribution and marketing.
	Groundnut	Lack of/limited access to technology, equipment, facilities, and infrastructure (for threshing, drying, storage, and transport); Reliance on traditional methods and practices rather than greater mechanization and specialized tools (for harvesting, threshing, sorting, grading, packaging);	Drought / dry spells; Flooding (including as a result of including heavy rainfall events); High temperatures	***Harvesting Processes***: shattering of the grain/seed due to heat; challenges to field drying due to excessive rainfall; rotting, mould, and aflatoxin contamination due to high moisture content; damage to stored harvest from flooding. ***Post-Harvest Handling and Storage***: damage to or decay of grain/seed quality from high temperatures and humidity; rotting, mould, and aflatoxin contamination due to moisture content damage to storage infrastructure from flooding.;

		Low-income levels and limited purchasing power, especially for advanced tools and equipment.	(extreme heat)	***Processing, Transport, and Logistics***: damaged or inaccessible road networks and transport infrastructure due to flooding; damage to processing and storage facilities and infrastructure from excessive rainfall and flooding; damage to or decay of grain/seed quality from high temperatures and humidity, and lower shelf life; disruption of mobility and access to markets due to extreme weather, impeding distribution and marketing.
Tanzania	Maize	Lack of/limited access to technology, equipment, facilities, and infrastructure (for threshing, drying, storage, and transport); Reliance on traditional methods and practices rather than greater mechanization and specialized tools (for harvesting, threshing, sorting, grading, packaging); Lack of/limited knowledge of or access to reliable and actionable information (including climate information services and markets-related information)	Flooding (including due to erratic and/or heavy rainfall events); Drought / dry spells; High temperatures (extreme heat)	***Harvesting Processes***: shattering of the grain/seed due to heat; challenges to field drying due to excessive rainfall; rotting, mould, and aflatoxin contamination due to high moisture content; damage to stored harvest from flooding. ***Post-Harvest Handling and Storage***: damage to or decay of grain/seed quality from high temperatures and humidity; rotting, mould, and aflatoxin contamination due to moisture content damage to storage infrastructure from flooding.; ***Processing, Transport, and Logistics***: damaged or inaccessible road networks and transport infrastructure due to flooding; damage to processing and storage facilities and infrastructure from excessive rainfall and flooding; damage to or decay of grain/seed quality from high temperatures and humidity, and lower shelf life; disruption of mobility and access to markets due to extreme weather, impeding distribution and marketing.
	Rice	Lack of/limited access to technology, equipment, facilities, and infrastructure (for threshing, drying, storage, and transport); Reliance on traditional methods and practices rather than greater mechanization and specialized tools (for harvesting, threshing, sorting, grading, packaging); Lack of/limited knowledge of or access to reliable and actionable information (including climate information services and markets-related information)	Rainfall variability (including erratic, unpredictable, or heavy rainfall events); Flooding; High temperatures (extreme heat)	***Harvesting Processes***: shattering of the grain/seed due to heat; challenges to field drying due to excessive rainfall; rotting, mould, and aflatoxin contamination due to high moisture content; damage to stored harvest from flooding. ***Post-Harvest Handling and Storage***: damage to or decay of grain/seed quality from high temperatures and humidity; rotting, mould, and aflatoxin contamination due to moisture content damage to storage infrastructure from flooding.; ***Processing, Transport, and Logistics***: damaged or inaccessible road networks and transport infrastructure due to flooding; damage to processing and storage facilities and infrastructure from excessive rainfall and flooding; damage to or decay of grain/seed quality from high temperatures and humidity, and lower shelf life; disruption of mobility and access to markets due to extreme weather, impeding distribution and marketing.
Uganda	Maize	Lack of/limited access to technology, equipment, facilities, and infrastructure (for threshing, drying, storage, and transport); Reliance on traditional methods and practices rather than greater mechanization and specialized tools (for harvesting, threshing, sorting, grading, packaging); Lack of/limited knowledge of or access to reliable and actionable information (including climate information services and markets-related information)	Excessive and/or erratic rainfall (including heavy rainfall events); Flooding; High temperatures (extreme heat)	***Harvesting Processes***: shattering of the grain/seed due to heat; challenges to field drying due to excessive rainfall; rotting, mould, and aflatoxin contamination due to high moisture content; damage to stored harvest from flooding. ***Post-Harvest Handling and Storage***: damage to or decay of grain/seed quality from high temperatures and humidity; rotting, mould, and aflatoxin contamination due to moisture content damage to storage infrastructure from flooding.; ***Processing, Transport, and Logistics***: damaged or inaccessible road networks and transport infrastructure due to flooding; damage to processing and storage facilities and infrastructure from excessive rainfall and flooding; damage to or decay of grain/seed quality from high temperatures and humidity, and lower shelf life; disruption of mobility

				and access to markets due to extreme weather, impeding distribution and marketing.
	Beans	Lack of/limited access to technology, equipment, facilities, and infrastructure (for threshing, drying, storage, and transport); Reliance on traditional methods and practices rather than greater mechanization and specialized tools (for harvesting, threshing, sorting, grading, packaging); Lack of/limited knowledge of or access to reliable and actionable information (including climate information services and markets-related information)	Excessive and/or erratic rainfall (including heavy rainfall events); Flooding; High temperatures (extreme heat)	***Harvesting Processes***: shattering of the grain/seed due to heat; challenges to field drying due to excessive rainfall; rotting, mould, and mycotoxin (aflatoxin) contamination due to high moisture content; damage to stored harvest from flooding. ***Post-Harvest Handling and Storage***: damage to or decay of grain/seed quality from high temperatures and humidity; rotting, mould, and mycotoxin (aflatoxin) contamination due to moisture content damage to storage infrastructure from flooding.; ***Processing, Transport, and Logistics***: damaged or inaccessible road networks and transport infrastructure due to flooding; damage to processing and storage facilities and infrastructure from excessive rainfall and flooding; damage to or decay of grain/seed quality from high temperatures and humidity, and lower shelf life; disruption of mobility and access to markets due to extreme weather, impeding distribution and marketing.
Zambia	Maize	Lack of/limited access to technology, equipment, facilities, and infrastructure (for threshing, drying, storage, and transport); Reliance on traditional methods and practices rather than greater mechanization and specialized tools (for harvesting, threshing, sorting, grading, packaging); Lack of/limited knowledge of or access to reliable and actionable information (including climate information services and markets-related information)	Rainfall variability (including erratic, unpredictable, or heavy rainfall events that cause flooding); Drought / dry spells; High temperatures (extreme heat)	***Harvesting Processes***: shattering of the grain/seed due to heat; challenges to field drying due to excessive rainfall; rotting, mould, and mycotoxin (aflatoxin) contamination due to high moisture content; damage to stored harvest from flooding. ***Post-Harvest Handling and Storage***: damage to or decay of grain/seed quality from high temperatures and humidity; rotting, mould, and mycotoxin (aflatoxin) contamination due to moisture content damage to storage infrastructure from flooding.; ***Processing, Transport, and Logistics***: damaged or inaccessible road networks and transport infrastructure due to flooding; damage to processing and storage facilities and infrastructure from excessive rainfall and flooding; damage to or decay of grain/seed quality from high temperatures and humidity, and lower shelf life; disruption of mobility and access to markets due to extreme weather, impeding distribution and marketing.
	Soybeans	Lack of/limited access to technology, equipment, facilities, and infrastructure (for threshing, drying, storage, and transport); Reliance on traditional methods and practices rather than greater mechanization and specialized tools (for harvesting, threshing, sorting, grading, packaging); Lack of/limited knowledge of or access to reliable and actionable information (including climate information services and markets-related information)	Rainfall variability (including erratic, unpredictable, or heavy rainfall events that cause flooding); Drought / dry spells; High temperatures (extreme heat)	***Harvesting Processes***: shattering of the grain/seed due to heat; challenges to field drying due to excessive rainfall; rotting, mould, and mycotoxin (aflatoxin) contamination due to high moisture content; damage to stored harvest from flooding. ***Post-Harvest Handling and Storage***: damage to or decay of grain/seed quality from high temperatures and humidity; rotting, mould, and mycotoxin (aflatoxin) contamination due to moisture content damage to storage infrastructure from flooding.; ***Processing, Transport, and Logistics***: damaged or inaccessible road networks and transport infrastructure due to flooding; damage to processing and storage facilities and infrastructure from excessive rainfall and flooding; damage to or decay of grain/seed quality from high temperatures and humidity, and lower shelf life; disruption of mobility and access to markets due to extreme weather, impeding distribution and marketing.

4 Climate Change – Mitigation Analysis

4.1 NATIONAL GREENHOUSE GAS REPORTING

4.1.1 National emissions

The seven target countries presented their National Greenhouse Gas Inventories (GHGI) in either their Second National Communications (SNC) or Third National Communications (TNC) to the United Nations Framework Convention on Climate Change (UNFCCC), released between 2014 and 2023 (Table 4-1). The National Communications cover emissions data in the agriculture, energy, industrial processes, waste, and Land Use, Land Use Change and Forestry (LULUCF) sectors for a given baseline/reference period (Table 4-1). In addition to these data, updated analyses from the Global Carbon Budget 2023 (Ritchie et al. , 2020) (Friedlingstein et. al, 2023) provides country level GHG emission estimates.

Table 4-1. National Greenhouse Gas (GHG) Inventory reporting per country

COUNTRY	NATIONAL GHG INVENTORY REPORTING	REFERENCE PERIOD
BURKINA FASO	THIRD NATIONAL COMMUNICATION TO THE UNFCCC (2022)	1995 TO 2015
	FIRST BIENNIAL UPDATE REPORT (2021)	1995 TO 2015
ETHIOPIA	THIRD NATIONAL COMMUNICATION TO THE UNFCCC (2023)	1994 TO 2018
KENYA	SECOND NATIONAL COMMUNICATION TO THE UNFCCC (2015)	2010
MALAWI	THIRD NATIONAL COMMUNICATION TO THE UNFCCC (2021)	2010
	FIRST BIENNIAL UPDATE REPORT (2021)	2001 TO 2017
TANZANIA	SECOND NATIONAL COMMUNICATION TO THE UNFCCC (2014)	1995 TO 2005
UGANDA	THIRD NATIONAL COMMUNICATION TO THE UNFCCC (2022)	1995 TO 2017
	FIRST BIENNIAL UPDATE REPORT (2019)	2005 TO 2015
ZAMBIA	THIRD NATIONAL COMMUNICATION TO THE UNFCCC (2020)	1994 TO 2010
	FIRST BIENNIAL UPDATE REPORT (2020)	2011 TO 2016

GHG emissions from fossil fuels have demonstrated an increasing trend in all seven countries since the 1950s.In the last ten years emissions have more than doubled as populations have grown by between 19% and 27%, resulting in an increase in economic activities in key sectors (United Nations, 2022). Despite these increasing trends in emissions, Africa as a whole contributed only 3.8% of the global annual emissions[6] in 2022. The total GHG emissions for each of the seven countries reported in 2022, accounted for less than 1% in each case of the global emissions in that year.

[6] Noting, this is Share of global annual CO_2 emissions (excluding land use and forestry)

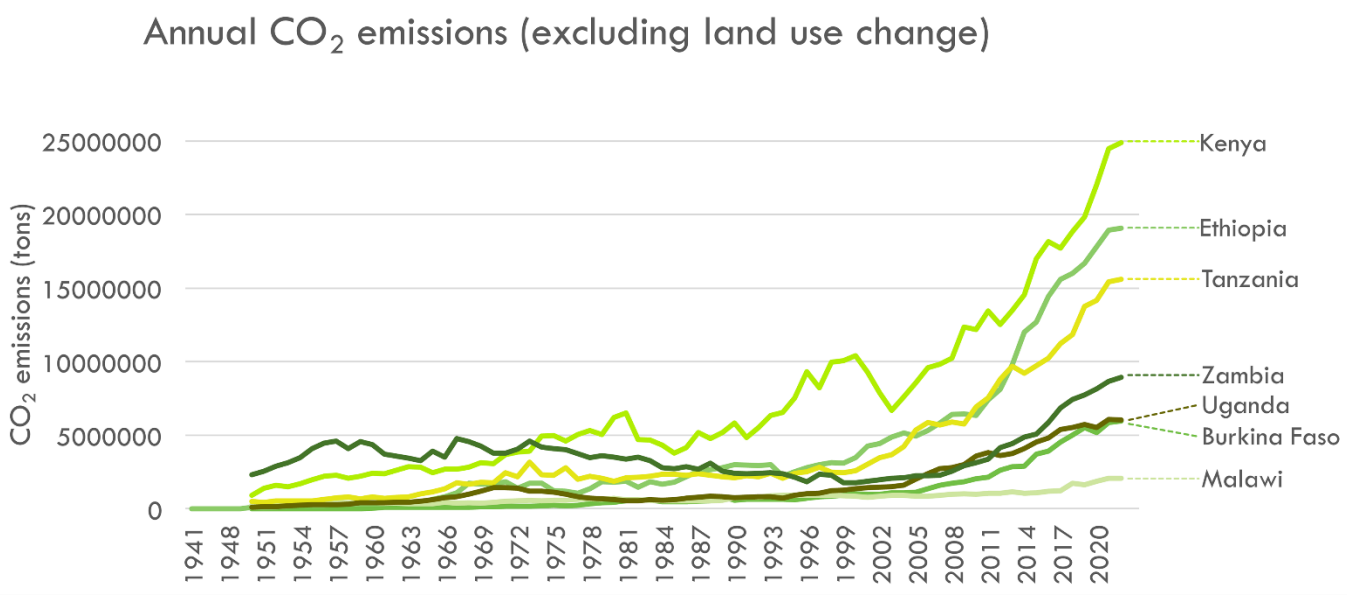


Figure 4-1 - Annual CO2 emissions (excluding land use change) (Friedlingstein et. al, 2023)

The contribution of land use change to emissions has varied considerably over time for all seven countries (Friedlingstein et. al, 2023)Changes in the Land Use, Land-Use Change, and Forestry (LULUCF) sector – also referred to as Forestry and Other Land Use (FOLU) or Agriculture, Forestry and Other Land Use (AFOLU) sector – can result in positive or negative gains in emissions over time (Friedlingstein et. al, 2023).

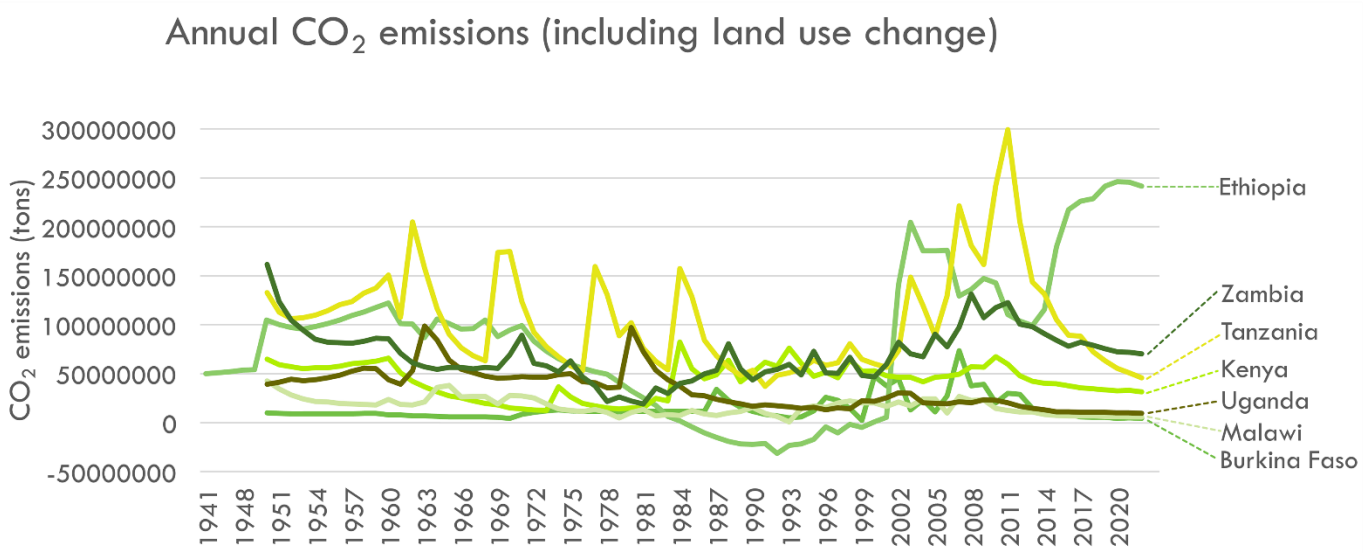


Figure 4-2 - Annual CO2 emissions (including land use change) (Friedlingstein et. al, 2023)

The agriculture and LULUCF sectors are the greatest contributors of emissions across all seven countries (Figure 4-3). The exception is Malawi, where the energy sector is reported the largest emitter in the Third National Communication (TNC), followed closely by the agriculture and LULUCF sectors.

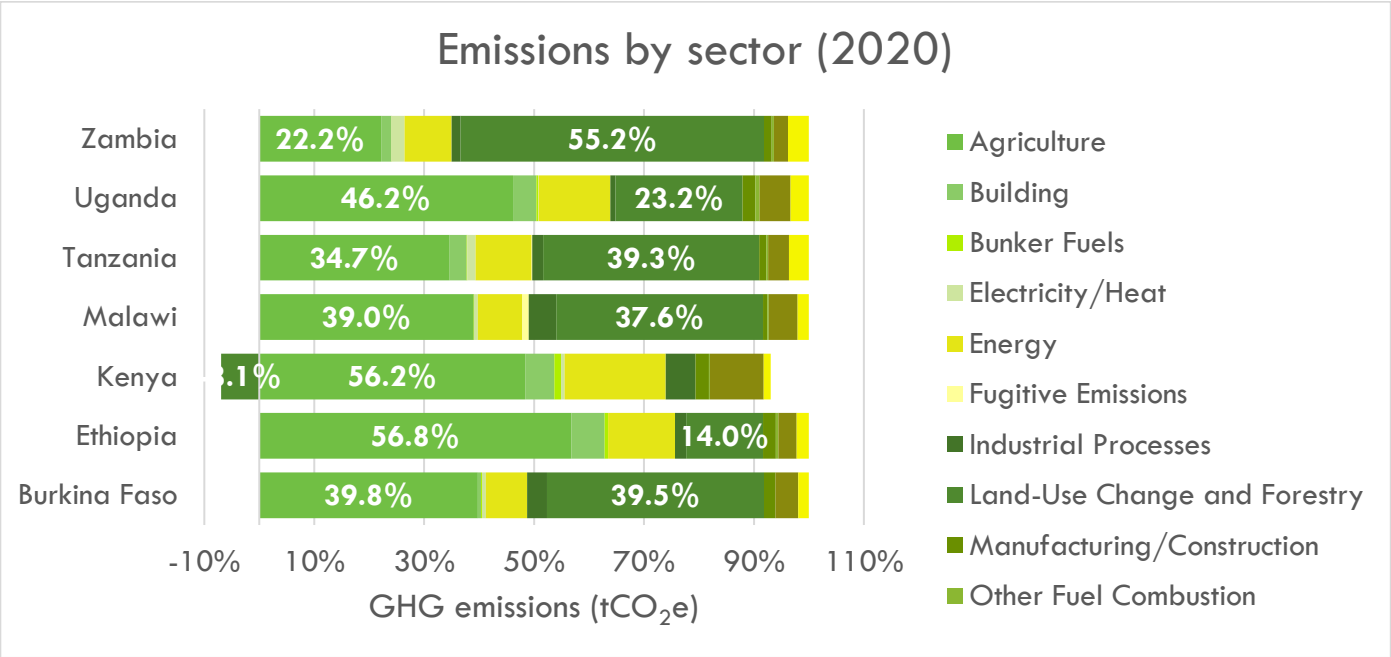
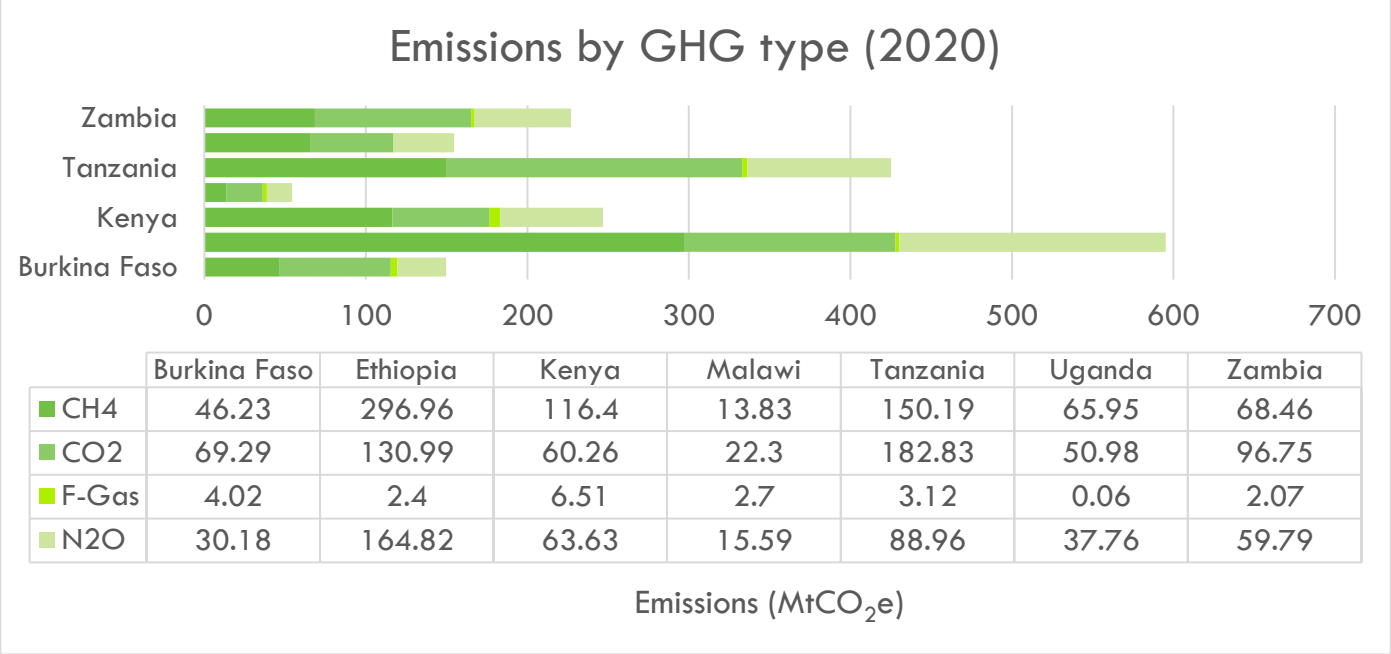


Figure 4-3. Sectoral combined GHG emissions in 2020, highlighting the contributions of the agriculture and LULUCF sectors (Friedlingstein et. al, 2023)

Given that the agriculture and LULUCF sectors are the largest contributors of emissions, it is not surprising that methane (CH_4), together with carbon dioxide (CO_2) typically form the largest proportion of national emissions across the seven countries (Figure 4-4).



	Burkina Faso	Ethiopia	Kenya	Malawi	Tanzania	Uganda	Zambia
CH4	46.23	296.96	116.4	13.83	150.19	65.95	68.46
CO2	69.29	130.99	60.26	22.3	182.83	50.98	96.75
F-Gas	4.02	2.4	6.51	2.7	3.12	0.06	2.07
N2O	30.18	164.82	63.63	15.59	88.96	37.76	59.79

Figure 4-4. GHG emissions by type (2020) (Friedlingstein et. al, 2023)

4.2 CROP VALUE CHAIN EMISSION BASELINES

Global analyses indicate that on-farm activities and land use are the greatest contributors to emissions for commodities related to maize, rice, wheat, peas, soy and groundnuts (Nemecek, 2018). Farm activities account for up to 82% of emissions

from rice, while land use contributes more than 45% of emissions from soybean (Figure 4-5). Food losses account for a significant proportion of emissions (Figure 4-5), particularly in smallholder value chains.

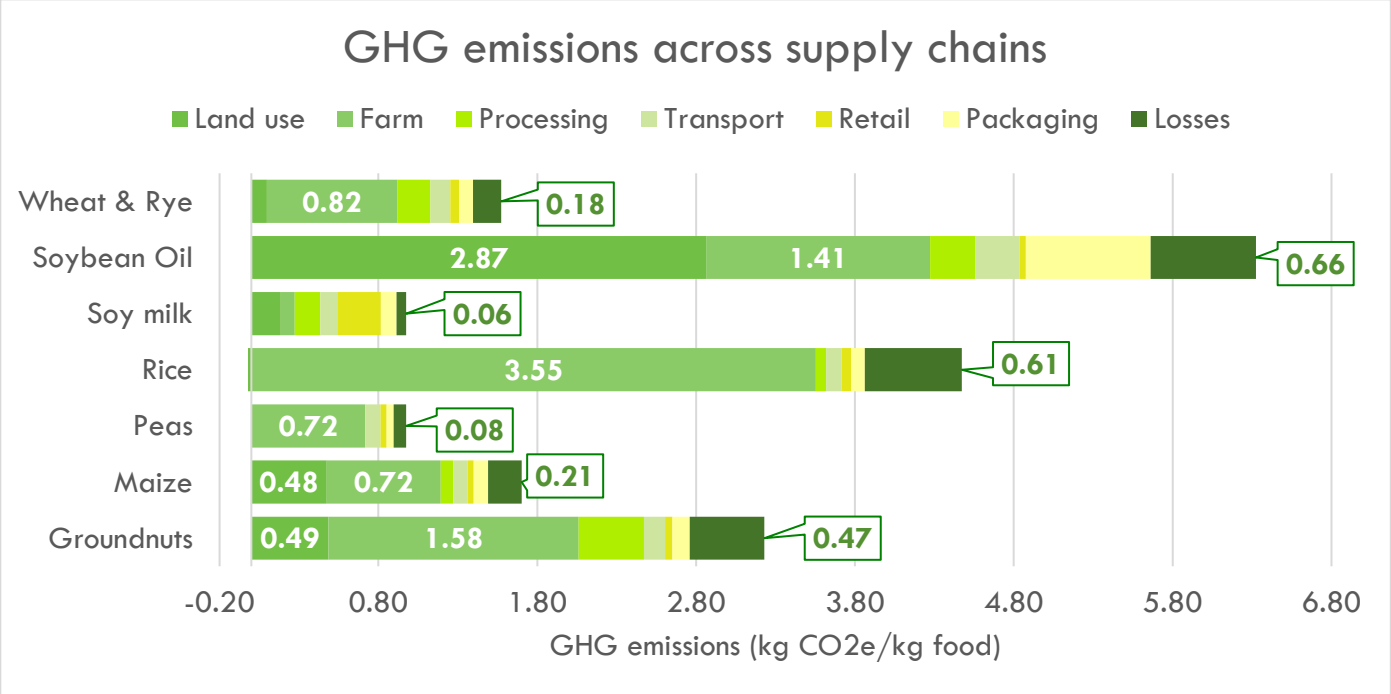


Figure 4-5. Average GHG emissions (kg CO_2e/kg food) for agricultural commodities across value chains (Nemecek, 2018), data processed by Our World in Data

Typical losses and emissions sources across agricultural value chains are depicted in

Figure 4-6 below. The bulk of post-harvest losses from field to market occur during processing and on-farm storage of agricultural produce. Pest damage, spillage, inefficient processing and spoilage account for the bulk of losses.

Value chain	Pre-harvest			Post-harvest							
	Land use change	Inputs	Harvest	On-farm processing	Storage	Transport	Storage and handling	Value-added processing	Transport and logistics	Marketing and distribution	End user
Emissions sources	• Deforestation • Burning for land clearing • Erosion and soil loss	• Inputs • Irrigation/ pumping • Fertilisers	• On-farm mechanisation • Management practices	• On-farm mechanisation • Management practices	• On-farm storage	• Farm to collection center • Collection center to processing/ market	• Moisture control • Mechanised sorting/ packaging	• Drying • Grinding • Milling	• Warehousing • Road, rail and maritime transport	• Packaging • Retail	• Cooking • Transport • Household appliances
Typical losses	• NA	• NA	• Spillage during manual harvesting	• Spillage during threshing and milling • Leakage from machinery • Poorly maintained machinery	• Pest damage in storage • Contamination and spoilage	• Spillage during transport on farms • Spillage during transport to dealers or storage facilities	• Pest damage • Moisture, mould and spoilage • Storage of untreated grain	• Loss during manual processing • Leakage from machinery • Poorly maintained machinery	• Loss/ spoilage during transport	• Spillage at wholesale sites	• Food waste • Spoilage

Figure 4-6. Typical sources of emissions and food losses across agricultural value chains, elaborated from Sims et al. (2015) and data sourced from APHILIS and the FAO Food Loss and Waste Database

On-farm post-harvest losses make up the majority of losses and result from climate impacts, inefficient processing practices, poor storage conditions, pests and spoilage. Such loss reduces income to smallholder farmers and affecting household food security. They also contribute indirectly to value chain emissions because of their impact on farmer behaviour. To compensate for post-harvest losses, farmers are likely to expand their agricultural lands, resulting in transformation of forests and other natural vegetation types. This land-use change results in an increase in GHG, both from the practices used to achieve the land use change (e.g., burning), as well as annual emissions from the loss of natural cover and carbon sequestration capacity.

By reducing on-farm post-harvest losses in key crops, the planned interventions will reduce compensatory expansion of agricultural land, thereby avoiding upstream emissions associated with land use change.

Food losses in the selected African countries are driven by a combination of factors. Smallholder farmers, who constitute the majority, often lack adequate resources such as irrigation and mechanization, relying heavily on rain-fed subsistence farming. Climate hazards, including droughts, floods, and unpredictable rainfall, exacerbate these challenges. Post-harvest losses are significant across various stages: from harvesting and drying to storage and transportation, mainly due to inadequate facilities, poor handling practices, pest infestations, and inefficient agronomic techniques. Additionally, issues such as land insecurity, especially for youth and women, limited access to financial and non-financial services, and traditional farming methods further contribute to these losses. Addressing these issues through improved infrastructure, better farming practices, and enhanced support systems is crucial for reducing food losses and ensuring food security.

Table 4-2 below summarizes countries' general situation overviews specifically in the context of food losses for each of the selected value chains. Table 4-3 provides further details on the key causes of those losses.

Table 4-2 Overview of food losses for the selected crops in each of the target countries. The loss estimates are based on data available from several sources, with first priority given to data from the African Post-harvest Losses Information System (APHLIS). Where APHLIS did not have data available on losses for a specific country, crop and value chain stage, the FAO Food Loss and Waste Database (FAO FLWD) was the second priority data source. If any other estimate was used, these are specified per country/crop.

Nr.	Value chain stage	Burkina Faso		Ethiopia		Kenya		Malawi		Tanzania		Uganda		Zambia	
		Rice	Cowpea	Teff	Wheat	Maize	Beans	Maize	Groundnut	Rice	Maize	Maize	Beans	Maize	Soybeans
1	Harvesting, field drying	4.40%	12.00%	3.50%	4.40%	6.40%	3.60%	6.30%	6.00%	4.40%	6.40%	6.40%	3.60%	6.10%	4.00%
2	Threshing/shelling	3.10%	3.50%	3.50%	3.50%	1.30%	4.10%	1.40%	11.00%	3.10%	1.30%	1.30%	4.10%	1.40%	4.00%
3	Winnowing	2.50%		2.50%	0.00%					2.50%					
4	Drying	2.82%	1.80%	2.00%	2.00%	4.00%	1.80%	4.00%	5.00%	2.82%	4.00%	4.00%	1.80%	3.90%	1.80%
5	Transport to farm		0.30%	2.50%	2.50%	2.40%		2.40%	14.00%	1.30%	2.40%	2.40%	0.71%	2.40%	
6	On-farm storage	2.70%	8.00%	0.30%	4.80%	2.50%	4.45%	4.20%	15.00%	1.00%	5.20%	2.60%	8.50%	4.40%	2.74%
7	Transport to market	1.30%		1.00%	2.50%	1.70%		1.60%		0.00%	0.00%	1.70%		1.50%	
8	Bulk/market storage			2.70%	2.70%	2.70%		2.70%		0.00%	0.00%	2.70%		2.70%	
9	Wholesale														
10	Retail														
Total		**16.82%**	**25.60%**	**18.00%**	**22.40%**	**21.00%**	**13.95%**	**22.60%**	**51.00%**	**15.12%**	**19.30%**	**21.10%**	**18.71%**	**22.40%**	**12.54%**
Notes		1	2	3	4		5		6	7			8		9

Table 4-3 Notes on loss values, assumptions and sources

Note	Explanation
1	Values for losses (%) during the dry stage were not available from APHLIS for the target country. The FAO FLWD provides values for losses during drying for other West African countries (Benin, Ghana and Sierra Leone). An average of these loss values has been used as a proxy.
2	Values for losses during value chain stages were not available from either APHLIS or the FAO Food Loss and Waste Database. Values for the following value stages were derived from FAO, PAM & FIDA (2019): Harvesting/field drying, threshing/shelling, transport to farm and on-farm storage. Values for losses during drying were derived from estimates available for Uganda from the FAO Food Loss and Waste Database, which has been assumed to be a reasonable estimate in this case.
3	No data on losses during the drying stage for teff or wheat could be found for Ethiopia, or other African countries on either APHLIS or the FAO FLWD. A loss value of 2% was therefore proposed as a reasonable assumed estimate based on the range of losses during the drying stage available for other crops and countries (1.8% to 4%).
4	No data on losses during the drying stage for teff or wheat could be found for Ethiopia, or other African countries on either APHLIS or the FAO FLWD. A loss value of 2% was therefore proposed as a reasonable assumed estimate based on the range of losses during the drying stage available for other crops and countries (1.8% to 4%).
5	The FAO FLWD provides a value for losses during drying from Uganda, this value was assumed to be a reasonable proxy for Kenya, for which no estimates were available from APHLIS or the FAO FLWD. The FAO, WFP & IFAD (2019) report provides values for losses for beans in Uganda, these values were assumed to be a reasonable proxy for Kenya, for which no estimates were available from APHLIS or the FAO Food Loss and Waste Database for the harvesting/field drying and threshing/shelling stages.
6	Values for losses for groundnuts were taken from the FAO FLWD.
7	Values for losses (%) during the dry stage were not available from APHLIS for the target country. The FAO FLWD provides values for losses during drying for other West African countries (Benin, Ghana and Sierra Leone). An average of these loss values has been used as a proxy.
8	The FAO FLWD provides a value for losses during drying from Uganda, which was missing in APHLIS. The FAO, WFP & IFAD (2019) report provides values for losses for beans in Uganda, which were otherwise not available from APHILIS or the FAO FLWD.
9	Values for the harvesting/field drying and threshing/shelling phases derived from Ambler et al. (2018), as no estimates were available from either APHLIS or the FAO FLWD. Loss values for the on-farm storage phase were taken from the FAO FLWD. Values for losses during drying were derived from estimates available for Uganda from the FAO FLWD, which has been assumed to be a reasonable estimate in this case.

Table 4-4 General overview of the critical loss causes per value chain stage

	Value chain stage	Loss causes
1	Harvesting, field drying	Shattering of seeds as a result of manual harvesting, untimely rains, strong winds; losses in the field due to late harvesting and climate hazards impacting the drying in the field (rains, winds, pests and rodents, etc.)
2	Threshing/shelling	Often done manually/by animals, resulting in contamination with soil particles, physical damage, losses, high grain moisture content
3	Winnowing	Manual winnowing in fields
4	Drying	Losses due to birds, rodents, livestock
5	Transport to farm	Shattering due to poor packaging/transport means
6	On-farm storage	High humidity, insects, rodents, moisture, moulds, aflatoxins, inadequate storage facilities
7	Transport to market	High humidity, inadequate packing, bad transport means and handling
8	Bulk/market storage	Inadequate storage, moisture, high humidity, insects, rodents
9	Processing/milling	Inadequate milling machinery, handling
10	Retail	Inadequate storage and packaging, moisture, humidity, pests

4.2.1 Emissions associated with food loss

The emissions associated with food loss across the agricultural values chains considered by the RE-GAIN Programme could amount to 8 229 817 tCO_2e, based on smallholder production values (Figure 4-7, Table 4). The largest portion of these emissions (Figure 4-7) are from maize (4,397,613 tCO_2e) and rice (1,089,023 tCO2e)), but the value for maize may be an inflated estimate as a result of the larger planting area for this crop.

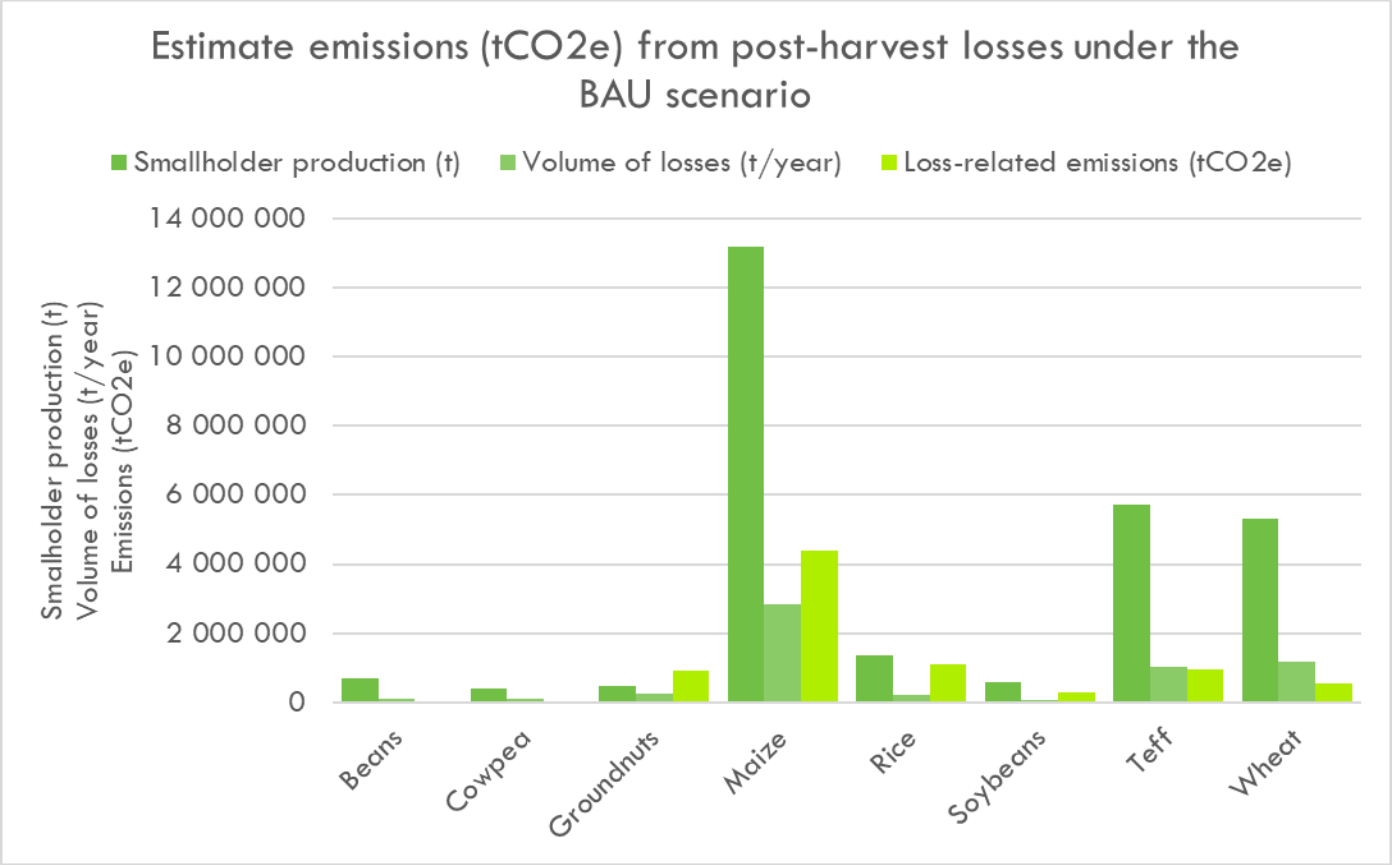


Figure 4-7. Estimated losses across agricultural value chains for key commodities

A note on the calculation methodology: Using the total maximum losses possible under the loss scenarios presented in the tables above, a possible total loss (%) per commodity was calculated, as presented in Table 4-5 below. The maximum values were used to represent the worst-case scenario. Smallholder production statistics were sourced from production statistics provided by national statistical offices. Where smallholder production statistics were not made available, the national production statistics were adjusted to represent the percentage of smallholders in the relevant value chain. The emissions factors used were published in (Porter et al, 2016) and have been used in several studies to estimate emissions.

Table 4-5. Estimated emissions (t CO_2e/t food) calculated using total maximum losses per commodity, total national annual smallholder production (tonnes) and emissions factors for food loss emissions published by (Porter et al, 2016)

COUNTRY	CROP	SMALLHOLDER PRODUCTION (T)	LOSS RATE (%)	VOLUME OF LOSSES (T/YEAR)	LOSS-RELATED EMISSIONS (TCO2E)
BURKINA FASO	COWPEA	383 514	25.60%	98 180	11 782
	RICE	319 855	16.82%	53 800	281 372
ETHIOPIA	TEFF	5 733 627	18.00%	1 032 053	959 809
	WHEAT	5 305 821	22.40%	1 188 504	546 712

KENYA	BEANS	384 707	13.95%	53 667	6 440
	MAIZE	1 819 362	21.00%	382 066	596 023
MALAWI	GROUNDNUTS	456 429	51.00%	232 779	917 148
	MAIZE	3 339 758	22.60%	754 785	1 177 465
TANZANIA	MAIZE	2 828 634	19.30%	545 926	851 645
	RICE	1 021 340	15.12%	154 427	807 651
UGANDA	BEANS	321 392	18.71%	60 132	7 216
	MAIZE	2 071 183	21.10%	437 020	681 750
ZAMBIA	MAIZE	3 121 365	22.40%	699 186	1 090 730
	SOYBEANS	595 201	12.54%	74 638	294 075
TOTAL					**8 229 817**

4.3 COUNTRY AND SECTORAL EMISSIONS PROJECTIONS

The GHG inventories developed by each of the target countries (see Table 4-1 above), provide projected emissions to at least 2030 for key sectors under business-as-usual (BAU) and alternative scenarios, which are also used as part of the Nationally Determined Contributions (NDCs). An overview of projected national emissions under the BAU scenario for the seven target countries across all sectors is provided below (Figure 4-8). Note, that for Tanzania, the baseline year is 2014, rather than 2020. In addition, the GHG inventories for Malawi and Tanzania do not report values for the year 2025.

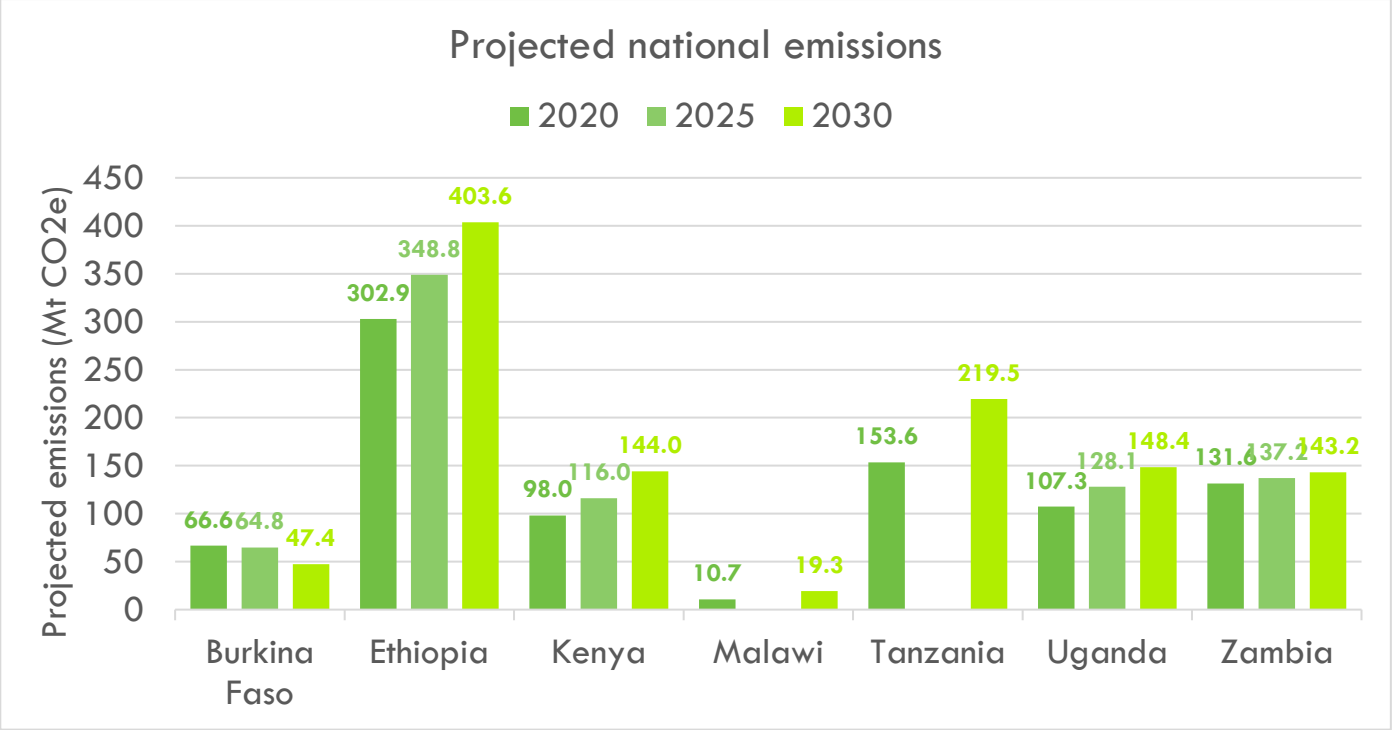


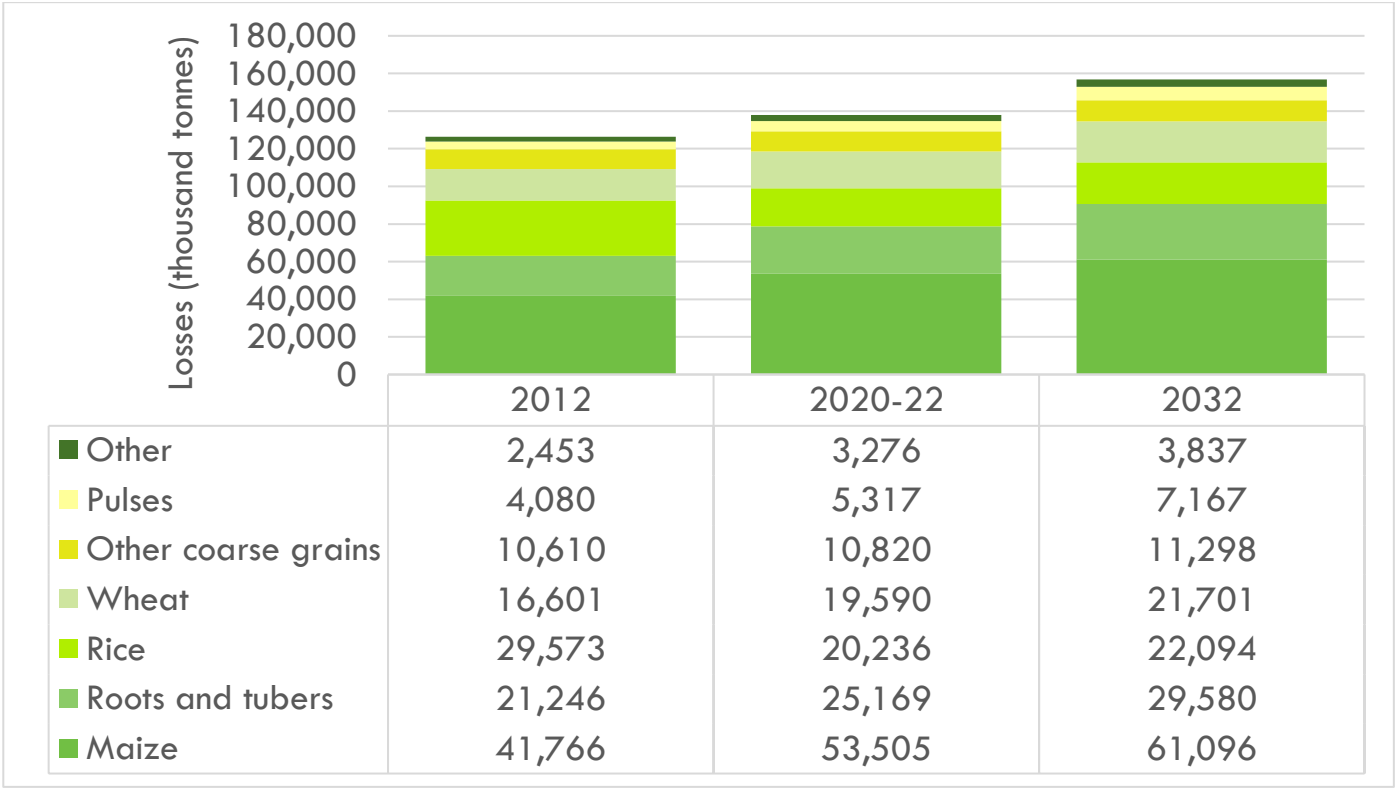
Figure 4-8. Projected emissions across target countries, incorporating all sectors

4.4 EMISSIONS PROJECTIONS BY CROP VALUE CHAIN

The OECD-FAO Agricultural Outlook 2023–2032 (OECD & FAO, 2023) highlights the necessity of raising crop production in Sub-Saharan Africa (SSA) over the coming decade to match the projected growth in demand. Production of agricultural and fish products is anticipated to grow by 24% in net value-added terms, but this is only a 2.2% average annual gain, which is lower than the projected population growth. Most of the projected growth in production is related to an increase in crop production, which is anticipated to account for 70% of the total agricultural value by 2032. The production of food crops in particular, is projected to increase by 27%, as a result of intensification, productivity gains and changes to the crop mix, with a 7% expansion in land used for crop production by 2032 (OECD & FAO, 2023).

The gap between production and demand is concerning given that SSA has arguably the highest concentration of impoverished and undernourished people globally, with low calorie availability per capita across the region (OECD & FAO, 2023). The COVID-19 pandemic and the war in Ukraine have exacerbated baseline food insecurity in many areas. Staple crops contribute approximately 70% of the total calories available to people in SSA as of 2020–2022. Maize, root crops and tubers constitute the bulk of these staple crops. While this is unlikely to change towards 2032, the relative contribution of rice and maize is expected to increase while roots and tubers remain consistent (OECD & FAO, 2023).

Globally, crop losses along the value chain are estimated to increase up to 157 Mt by 2032, compared to 137.9 Mt in the 2020–2022 period (Figure 4-9). Without significant intervention, losses will undermine regional efforts to improve food security.



	2012	2020-22	2032
Other	2,453	3,276	3,837
Pulses	4,080	5,317	7,167
Other coarse grains	10,610	10,820	11,298
Wheat	16,601	19,590	21,701
Rice	29,573	20,236	22,094
Roots and tubers	21,246	25,169	29,580
Maize	41,766	53,505	61,096

Figure 4-9. Projected losses across global agricultural value chains for key commodities towards 2032 (OECD & FAO, 2023)

By using available estimates of losses as presented in Table 4 above, we can make use of the projected estimates for crop yields and harvested area as presented in the OECD-FAO Agricultural Outlook 2023–2032 (OECD & FAO, 2023) to calculate potential post-harvest losses and associated emissions for the 2032. In Table 4-5 below, projected emissions from post-

harvest losses for the year 2032 are presented. These are an underestimation as they do not consider the impacts of climate change on either yields or post-harvest losses. Changing rainfall regimes and increasing temperatures, as well as the associated predicted increases in the occurrence and severity of droughts and floods, are likely to have negative impacts on smallholder agricultural production if no adaptation actions are undertaken.

A note on the calculation methodology: The OECD-FAO Agricultural Outlook (OECD & FAO, 2023) provides projected estimates of changes in production, yields and harvested area for key commodity groups across SSA. By using the data available from Table 4 and its sources, the OECED & FAO (OECD & FAO, 2023) projections were used to calculate estimates for production of the crops in the target countries. These values assume that loss estimates remain unchanged by both adaptation interventions and climate change impacts.

Table 4-5. Estimated emissions (t CO_2e) for the year 2032 under the BAU scenario calculated using projected losses per commodity, total smallholder annual production (tonnes) and emissions factors for food loss emissions (Porter et al, 2016)

Country	Crop	Projected production 2032 (tonnes)	Projected losses 2032 (tonnes)	Projected loss-related emissions 2032 (tCO2e)
Burkina Faso	Cowpea	464 185	118 831	14 260
	Rice	369 352	62 125	324 914
Ethiopia	Teff	6 622 860	1 192 115	1 108 667
	Wheat	5 641 858	1 263 776	581 337
Kenya	Beans	465 629	64 955	7 795
	Maize	2 204 299	462 903	722 128
Malawi	Groundnuts	510 714	260 464	1 026 228
	Maize	4 046 378	914 481	1 426 591
Tanzania	Maize	3 427 111	661 432	1 031 835
	Rice	1 179 390	178 324	932 633
Uganda	Beans	388 996	72 781	8 734
	Maize	2 509 400	529 483	825 994
Zambia	Maize	3 781 778	847 118	1 321 504
	Soybeans	640 068	80 265	316 242
Total		**32 252 019**	**6 709 055**	**9 648 862**

Without intervention, emissions related to post-harvest losses on smallholder farms are expected to increase by between ~6% and ~17% across the target countries (Figure 4-10). This presents the minimum expected losses as climate change is likely to exacerbate these numbers.

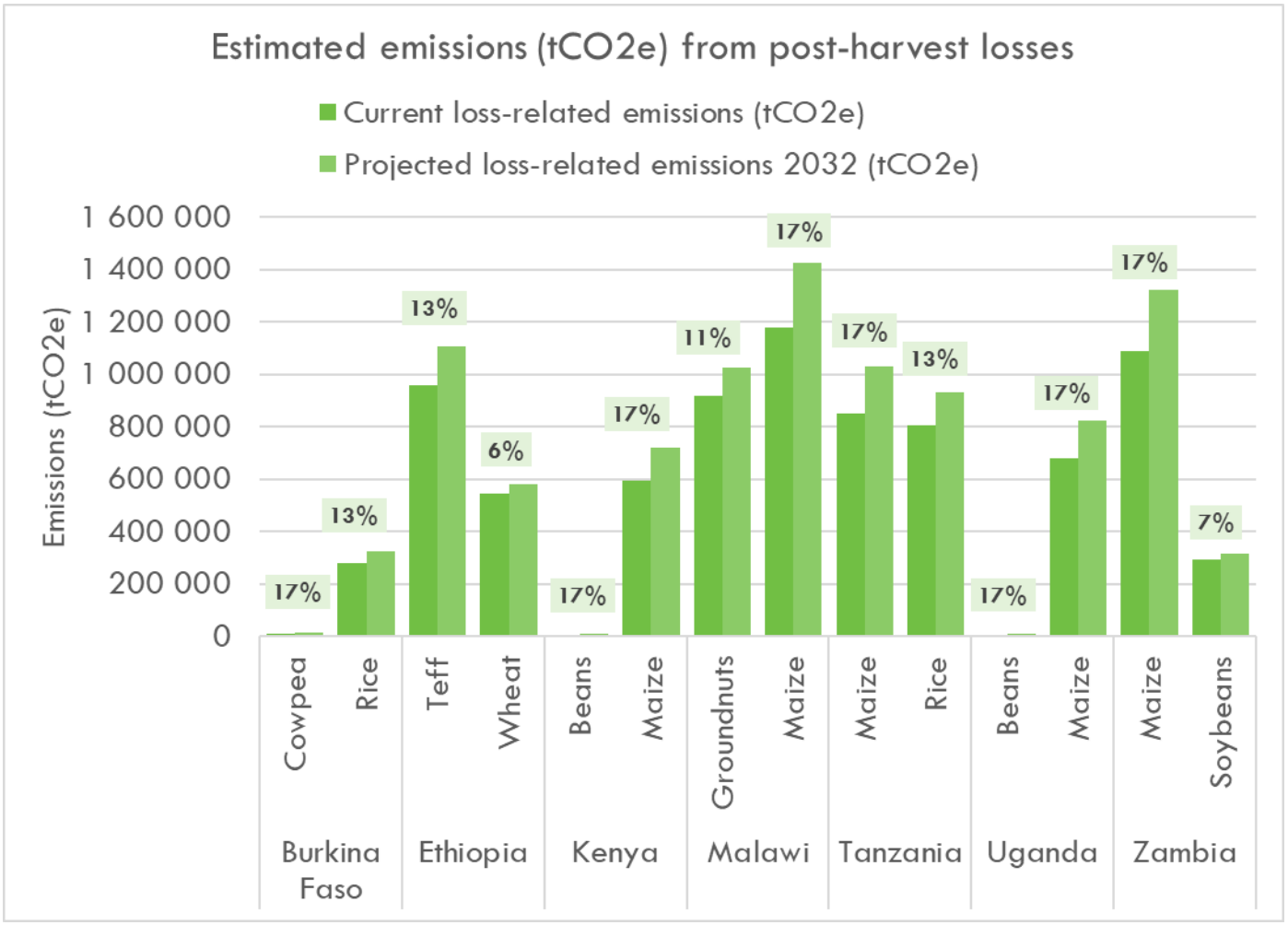


Figure 4-10. Estimated emissions from post-harvest losses in 2022 and 2032 for key crops across target countries, percentage values indicate projected increase in emissions

5 Solutions for the RE-GAIN Programme

5.1 PHYSICAL SOLUTIONS IDENTIFIED TO RESPOND TO CLIMATE RISKS

A key aspect of developing the RE-GAIN programme is the strategic deployment of physical food loss reduction solutions (FL-RS) with the highest potential to minimize food losses. The selection of these FL-RS was guided by several criteria; unit cost and overall cost-effectiveness, target audience, distinguishing between agricultural cooperatives and individual farmers; accessibility of the solution, including available supply, location of target farmers and suppliers; estimated reduction in food losses/ positive impact of the FL-RS; possibility of using the solution for different crops, and technical and implementation feasibility, and existing bottlenecks/barriers. Considering these criteria, the following ten physical solutions were evaluated:

- Harvesting machinery (e.g., multi-crop harvesters)
- Mechanical multi-crop threshers and shellers
- Tarpaulins and plastic sheets
- Wooden and metal cribs
- Metal and plastic silos
- Hermetic and other plastic bags
- Moisture meters
- Storage structures (e.g., huts, baskets, grain sheds)
- Storage protectants and control agents (biological fumigants, insecticides, and pesticides)
- Transport packaging (e.g., wooden crates and bags)

An evaluation of the ten physical FL-RS was conducted across all seven RE-GAIN target countries to identify the solutions with the highest potential to reduce post-harvest food losses and safeguard harvests against the increasing impacts of climate hazards. Stakeholder engagements in each country provided valuable insights, highlighting the advantages, disadvantages, and barriers to adoption, particularly for smallholder farmers.

Beyond the initial prioritization criteria, the final selection process incorporated additional factors aligned with the programme's climate rationale to ensure the RE-GAIN Programme achieves its objectives while driving lasting systemic change in each target country. These additional factors included consideration of the solution's estimated potential in reducing food losses, estimated contribution of the solution to environmental pollution/ GHG emissions during implementation, farmers' current level of awareness of the farmers about the solution's proper use and maintenance, availability of selected FL-RS in the country, and the potential for scalability and job creation through locally produced or assembled solutions and improved market linkages.

The evaluation results, including major climate hazards for each country, a package of proposed solutions, the food loss reduction potential, and existing barriers to their increased adoption are all presented in Table 5-1.

Table 5-1 Shortlisted solutions for the RE-GAIN countries, and key barriers to their adoption

Country	Major Climate Hazards	Shortlisted solutions	Solution's potential in reducing PHL	Key barriers to adoption
Burkina Faso	• Extreme heat and heatwaves, and hot days over 35 °C • Heavy rains (days with rainfall > 20mm • large 1-day rains and large 5-day rains) • River and/or urban floods	Mechanical multi-crop threshers and shellers	10-30% (Amponsah, 2017); (FarmBiz Africa, 2020); (Getachew, 2022); (Soybean Innovation Lab, 2016)	• High energy consumption and maintenance requirements • Small farm size • Diversity of fields
		Tarpaulins and plastic sheets	10-20% (Hodges, 2011); (Grolleaud, 2002); (Affognon, 2015); (Kitinoja, 2011)	• Limited accessibility • Variable quality • Limited durability
		Metal and plastic silos	10-50% (Njoroge, 2019); (World Bank, 2023)	• High costs • Limited storage capacity • Difficulty adapting for small producers
		Hermetic bags	20-30% (Williams, 2017); (De Groote H. K., 2012); (Koskei, 2020)	• Affordability • Limited availability • Variable durability
		Moisture meters	Up to 25% (Hossain, 2016); (Koskei, 2020)	• Limited availability • High costs • Know how on role and utilization
		Communal storage structures	Up to 15% (Befikadu, 2014); (FAO, 2014); (Ansah, 2018)	• High sustaining costs • Scarcity of construction materials • Overall high cost of these structures • Diversity of interests
		Storage protectants and control agents	30-40% : (Tefera, 2011); (Abass, 2014)	• High pollution risks • Health concerns associated with the use of chemical products
Ethiopia	• Increased average temperatures • hot days over 35 °C • extreme heat and heatwaves • Heavy rains (days with rainfall over 20 mm, large 1-day rains and large 5-day rains) • River and/or urban floods	Harvesting machinery	10-15% (Hasan, 2020); (Mutungi, 2023); (Muhammad Yasin, 2019); (Aparna Kumari, 2023); (Mathanker, 2014)	• High costs of procurement and maintenance • Need for large-scale operations to justify the investment • Need for technical skills and knowledge about operating those harvesters • Small farm size • Diversity of fields
		Mechanical multi-crop threshers and shellers	10-30% (Amponsah, 2017); (FarmBiz Africa, 2020); (Getachew, 2022); (Soybean Innovation Lab, 2016)	• High initial cost of purchase • Need for technical skills and knowledge about operating those multi-crop threshers and shellers • Maintenance expenses
		Tarpaulins and plastic sheets	10-20% (Hodges,	• Short lifespan and the difficulty in accessing these materials consistently

			2011); (Grolleaud, 2002); (Affognon, 2015); (Kitinoja, 2011)	
		Metal and plastic silos	10-50% (Njoroge, 2019); (World Bank, 2023)	• High cost • Need for monitoring and maintenance
		Hermetic bags	20-30% (Williams, 2017); (De Groote H. K., 2012); (Koskei, 2020)	• High cost of construction and maintenance • Scarcity of materials required for building these structures
		Moisture meters	Up to 25% (Hossain, 2016); (Koskei, 2020)	• Affordability / cost of the bags • Limited access to finance • Know how on operation and record keeping
		Communal storage structures	Up to 15% (Befikadu, 2014); (FAO, 2014); (Ansah, 2018)	• Lack of funds • Need for proper training of farmers to use it effectively • Different interest of farmers
		Storage protectants and control agents	30-40% (Tefera, 2011); (Abass, 2014)	• Need for personal protective equipment • Need for knowledge and skills to use these agents safely
Kenya	• Hot days over 35°C • Heavy rains (days with rainfall > 20mm, large 1-day rains and large 5-day rains) • River and/or urban floods	Mechanical multi-crop threshers and shellers	10-30% (Amponsah, 2017); (FarmBiz Africa, 2020); (Getachew, 2022); (Soybean Innovation Lab, 2016)	• Potential unavailability and affordability • Variable quality and limited durability of the materials, which can compromise their reliability
		Tarpaulins and plastic sheets	10-20% (Hodges, 2011); (Grolleaud, 2002); (Affognon, 2015); (Kitinoja, 2011)	• Prohibitive costs • Limited accessibility and availability • High fuel costs • Technical challenges in both acquisition and use
		Metal and plastic silos	10-50% (Njoroge, 2019); (World Bank, 2023)	• High costs • Limited awareness, • Challenges in transportation and provision
		Hermetic bags	20-30% (Williams, 2017); (De Groote H. K., 2012); (Koskei, 2020)	• Affordability • Limited availability • Durability issues • Environmental impact of plastic waste if not properly managed
		Moisture meters	Up to 25% (Hossain, 2016); (Koskei, 2020)	• High initial procurement costs • Limited availability • Lack of knowledge about their usage and management • Limited know-how
		Storage structures	Up to 15% (Befikadu, 2014); (FAO, 2014); (Ansah, 2018)	• High initial costs • Lack of quality materials • Accessibility issues • Security concerns

		Storage protectants and control agents	30-40% (Tefera, 2011); (Abass, 2014)	• High costs • Need for proper knowledge about the safety measures • Safety of pesticide residues on stored produce
Malawi	• Increased average temperatures • hot days over 35°C • extreme heat and heatwaves • Heavy rains (large 1-day rains and large 5-day rains) • River and/or urban floods	Mechanical multi-crop threshers and shellers	10-30% (Amponsah, 2017); (FarmBiz Africa, 2020); (Getachew, 2022); (Soybean Innovation Lab, 2016)	• High initial cost of purchase • Need for technical skills and knowledge about operating those multi-crop threshers and shellers • Maintenance expenses
		Tarpaulins and plastic sheets	10-20% (Hodges, 2011); (Grolleaud, 2002); (Affognon, 2015); (Kitinoja, 2011)	• Short lifespan and the difficulty in accessing these materials consistently
		Metal and plastic silos	10-50% (Njoroge, 2019); (World Bank, 2023)	• High cost • Need for monitoring and maintenance
		Hermetic bags	20-30% (Williams, 2017); (De Groote H. K., 2012); (Koskei, 2020)	• Affordability/cost of the bags • Limited access to finance
		Moisture meters	Up to 25% (Hossain, 2016); (Koskei, 2020)	• High costs for common farmers • Limited accessibility • Lack of technical knowledge on using them • Limited know-how
		Storage structures	Up to 15% (Befikadu, 2014); (FAO, 2014); (Ansah, 2018)	• High cost of construction and maintenance • Scarcity of materials required for building these structures
		Storage protectants and control agents	30-40% (Tefera, 2011); (Abass, 2014)	• Need for personal protective equipment • Need for knowledge and skills to use these agents safely
Tanzania	• Increased average temperatures • Hot days over 35°C • Heavy rains (days with rainfall > 20mm, large 1-day rains and large 5-day rains) • River and /or urban floods • Water scarcity/ droughts	Harvesting machinery	10-15% (Hasan, 2020); (Mutungi, 2023); (Muhammad Yasin, 2019); (Aparna Kumari, 2023); (Mathanker, 2014)	• High capital investment • High maintenance and operational costs • Limited applicability to smallholder farming
		Mechanical multi-crop threshers and shellers	10-30% (Amponsah, 2017); (FarmBiz Africa, 2020); (Getachew, 2022); (Soybean Innovation Lab, 2016)	• Expensive for vulnerable communities • High cost of conventional fuels • Inaccessibility of fuel in some areas
		Tarpaulins and plastic sheets	10-20% (Hodges,	• Lack of knowledge of proper use and maintenance

			2011); (Grolleaud, 2002); (Affognon, 2015); (Kitinoja, 2011)	• Limited use for large-scale production
		Metal and plastic silos	10-50% (Njoroge, 2019); (World Bank, 2023)	• High initial investment costs • Limited availability in rural areas • Primarily suitable for small-scale storage
		Hermetic bags	20-30% (Williams, 2017); (De Groote H. K., 2012); (Koskei, 2020)	• Use of non-recycled/single-use plastics • Affordability • Limited availability in remote rural areas • Limitations for small-scale farmers
		Moisture meters	Up to 25% (Hossain, 2016); (Koskei, 2020)	• Availability and affordability • Require technical skills for the right application, calibration, maintenance and repair • Limited know-how
		Storage structures	Up to 15% (Befikadu, 2014); (FAO, 2014); (Ansah, 2018)	• Lack of capital • Challenges in operating and maintaining those structures • Limited availability of local materials for construction
		Storage protectants and control agents	30-40% (Tefera, 2011); (Abass, 2014)	• Need for knowledge and skills to use these agents safely
Uganda	• Increased average temperatures • Hot days over 35°C • Extreme heat and heatwaves • Days with rainfall > 20mm, large 1-day rains • River and /or urban floods	Mechanical multi-crop threshers and shellers	10-30% (Amponsah, 2017); (FarmBiz Africa, 2020); (Getachew, 2022); (Soybean Innovation Lab, 2016)	• High purchase and maintenance costs • Inadequate training systems • Accessibility issues
		Tarpaulins and plastic sheets	10-20% (Hodges, 2011); (Grolleaud, 2002); (Affognon, 2015); (Kitinoja, 2011)	• High cost for rural farmers • Limited accessibility • Concerns about long-term sustainability
		Metal and plastic silos	10-50% (Njoroge, 2019); (World Bank, 2023)	• High cost/ limited affordability • Limited availability
		Hermetic bags	20-30% (Williams, 2017); (De Groote H. K., 2012); (Koskei, 2020)	• Limited accessibility • High costs for average farmers • Need for appropriate training and knowledge on usage
		Moisture meters	Up to 25% (Hossain, 2016); (Koskei, 2020)	• Limited accessibility due to cost • Lack of knowledge of proper use and maintenance
		Storage structures	Up to 15% (Befikadu, 2014); (FAO, 2014); (Ansah, 2018)	• High cost of construction/ lack of funds • Need for training and skills for storage structure maintenance

		Storage protectants and control agents	30-40% (Tefera, 2011); (Abass, 2014)	• Need for knowledge and skills to use these agents safely
Zambia	• Increased average temperatures • Hot days over 35°C • Extreme heat and heatwaves • Days with rainfall > 20mm, large 1-day rains • Water scarcity	Mechanical multi-crop threshers and shellers	10-30% (Amponsah, 2017); (FarmBiz Africa, 2020); (Getachew, 2022); (Soybean Innovation Lab, 2016)	• High costs • Limited accessibility in rural areas • High fuel costs • Lack of locally produced machinery
		Tarpaulins and plastic sheets	10-20% (Hodges, 2011); (Grolleaud, 2002); (Affognon, 2015); (Kitinoja, 2011)	• Limited scaling opportunities • Susceptibility to weather conditions, pests, and contamination
		Metal and plastic silos	10-50% (Njoroge, 2019); (World Bank, 2023)	• High costs/ need for substantial investment • Lack of local knowledge and skills in operation and maintenance • Limited availability
		Hermetic bags	20-30% (Williams, 2017); (De Groote H. K., 2012); (Koskei, 2020)	• High cost • Limitted availability • Limited capacity for handling large volumes • Requires optimal grain drying
		Moisture meters	Up to 25% (Hossain, 2016); (Koskei, 2020)	• Farmers' literacy in using the meters • Availability • Cost and affordability • Limited know how
		Storage structures	Up to 15% (Befikadu, 2014); (FAO, 2014); (Ansah, 2018)	• High investment costs • Theft susceptibility • Pest exposure
		Storage protectants and control agents	30-40% (Tefera, 2011); (Abass, 2014)	• Need for proper knowledge about the safety measures • Prices are high

Considering the above-mentioned points, the FL-RS adaptation strategy of the RE-GAIN Programme for all target countries is to deploy bespoke combinations of solutions from a basket of options. So, for example, mechanical multi-crop threshers and shellers (preferably solar-powered) might be combined with moisture meters for monitoring the level of moisture of the target crops, and communal storage structures, alongside FL-RS applied at the individual farm level, such as tarpaulins and plastic sheets for drying crops, hermetic storage technologies (hermetic bags, silos) used for storage of the crops, and storage protectants and control agents (preferably of a biological origin).

5.2 NON-PHYSICAL SOLUTIONS TO REDUCE VULNERABILITIES IN THE RE-GAIN PROGRAMME'S TARGET COUNTRIES

To ensure the successful adoption of FL-RS and overcome the knowledge barriers that hinder their demand, usage, and maintenance, the RE-GAIN program will incorporate non-physical interventions aimed at raising awareness and strengthening capacity building amongst smallholder farmers. These efforts will focus on key areas, including the effects of climate change

on harvesting and post-harvesting processes, the correct use of FL-RS, and proper maintenance practices to maximize the reduction of avoidable food losses within targeted value chains and fostering strong market linkages. This extension service initiative will be executed through a range of a comprehensive range of capacity-building activities, such as hands-on training and educational resources. Two primary methods will be employed to deliver this training: direct instruction to smallholder farmers and a "training of trainers" model. In the latter approach, community focal points will undergo in-depth capacity-building activities. Upon completing their training, these focal points will be equipped to share their knowledge with their communities, ensuring the inclusion of men, women, and youth in the transfer of critical skills and information. The list of extension services, such as awareness-raising and capacity-building activities proposed is provided in Table 5-2:

Table 5-2 Extension Services elements of RE-GAIN Programme

	Awareness Raising	Capacity building
Objectives:	To increase awareness and understanding of post-harvest food losses and the impact of climate change among farmers, stakeholders, and the general public, with the aim of reducing these losses through education, technology adoption, and active involvement of all key stakeholders.	To educate smallholder farmers on improved climate smart crop management and storage techniques and use of available climate information for reducing food losses and to maintain quality of produce, increase farmers' income by reducing losses and improving marketability, and improve supply of financial services and FL-RS to smallholders and other value chain actors
Target Audience	Smallholder farmers, agricultural extension workers, (local) government officials, NGOs and agricultural organizations, agro-dealers, other stakeholders, and the general public	
Key topics and modules	1. **RE-GAIN programme** and its objectives to reduce food losses and for climate change adaptation. 2. **Impact of post-harvest losses on food security**, income, economy, and the environment (incl. climate change) and the importance to reduce FL. 3. **Causes of PH-FL and best practices and improved technologies and methods** (e.g., timing of harvesting, methods and technologies for harvesting, storage, etc.) to reduce in post-harvest losses and their benefits (food security, income environment). 4. Role of different actors (local government, extension services, farmer organisations, agro-dealers, financial institutions) to provide access for FL-RS. 5. **Cross-cutting themes**: climate change awareness, climate smart agriculture, farm management, marketing, product quality management, access to finance, gender and youths, etc.	**1. For all groups of stakeholders:** Introduction to the REGAIN programme, climate change, PH food losses, causes, overview of solutions, providers of solutions, financial literacy and access to credit, product quality, farm records, food security, marketing and aggregation. Gender, youths, food security, environmental aspects and climate change. **2. Training of trainers for extension workers, agro-dealers** Introduction to the RE-GAIN programme, overview of PH losses, climate change and use of available climate information for harvest and post-harvest decision making, causes, priority solutions, providers of loss reduction solutions, setup of trainings and demonstrations, use of promotion materials, advise to smallholders, etc. **3. Trainings for smallholder farmers:** • Identification of the optimal timing of harvesting • Use of available weather forecast information. • Appropriate harvesting methods. • Key reasons of food losses during harvesting and post-harvest management and storage. • Major impacts of climate change on agriculture and postharvest management. • Technical approaches on maintaining crop quality during harvesting, post-harvest handling and storage. • Approaches to measuring and keeping optimal moisture content in crops to prevent aflatoxin contamination. • Approaches and solutions to prevent pest attacks, and proper storage methods. • Best harvesting methods and tools, including mechanization to reduce food losses. • Proper use and maintenance of physical FL-RS, including operation and maintenance of machinery, and their environmental and safety aspects. • Record-keeping, financial literacy and access to finance. Packaging and marketing of crops. • Methods and materials for proper on-farm storage, safe and proper use of pesticides and fungicides, pre-storage crop treatment and preparations, and monitoring storage losses and quality of crops during storage • Facilitate linkages between small holders and market actors

	Awareness Raising	Capacity building
		4. Training for agricultural traders and processors: Proper package materials and methods, quality control, proper transport / aggregation methods and systems. Climate change and PH food losses at the trade and processing stages, their causes and solutions, quality management and adherence to quality standards, transport logistics and packaging, sustainable use of storage protectants and storage, processing (including whole grain processing), value addition, supplier management, effective marketing strategies, access to finance. **5. Training for FI-RS providers (manufacturers, importers, agrodealers)** Proper service management, safe, effective, efficient and sustainable operation of the equipment and provision of the services. **6. Institutional capacity building** Enhancing the capacities of extension services, meteorological services, monitoring of FL, FL reductions and opportunities for upscaling and replication. Capacities for value chain and market networking.
Activities	• Mass media campaigns: radio, television, digital platforms and social media. • Collaboration with local governments and farmer organisations. • Monitoring outreach and impact.	**For smallholders:** • Information/training meetings at district and community level • Demonstrations, using e.g. the "mother-baby" approach practiced by VBAs in other AGRA programmes, • Exchange visits. **For providers of FL-RS and institutional target groups:** • training seminars/workshops • exchange visits.
Materials	**For smallholder farmers:** • Training and capacity building (including advisory services) organized through the network of village-based advisors (VBAs), complemented by extension workers and NGOS (where necessary) • Educational materials • Demonstration materials • Training of trainers **For traders, processors, FL-RS manufacturers and suppliers/ importers/ agrodealers** • Printed and online materials • Trainings and seminars	

Given the nature of the key barriers for the adoption of FL-RS, these extension services will be implemented in all countries from the very beginning of the Programme.

In the various countries covered by the RE-GAIN Programme, multiple approaches are being employed to support and facilitate the implementation of extension services. A key method that AGRA has successfully used across most of these countries (excluding Zambia) involves mobilizing and leveraging village-based advisors (VBAs). VBA networks, at varying levels of maturity, are already being established and are operational across these regions. The aim is to implement this component of the program by collaborating with lead farmers, preferably from younger demographics, to serve as VBAs. These VBAs will play a pivotal role as focal points for learning and service delivery, working with local agro-suppliers to conduct demonstrations and collaborate with other VBAs, locally-led cooperatives, and farmer organizations. This approach will create opportunities to develop sustainable local agro-service partnerships and even foster the growth of micro, small, and medium enterprises (MSMEs).

In addition to leveraging AGRA's existing VBA networks, the RE-GAIN Programme will collaborate with additional partners to implement these extension services. Partners will be carefully selected in each country, taking into account the specific context and needs of each region. The selection process will be guided by transparent criteria, ensuring adherence to local

laws and regulations while fostering effective partnerships that bring together diverse resources, skills, and expertise. This inclusive approach aims to maximize impact and drive meaningful outcomes across the targeted areas.

5.2.1 Eligibility Criteria for Extension Services Recipients

The different training activities will target actors across the agricultural value chain, including smallholder farmers and the communities that they form, agrodealers, food processors, manufacturers of FL-RS, financial service providers, and MSMEs or service providers that act across the value chain. Below is the eligibility criteria across these different groups under the RE-GAIN programme. to be included in extension services.

5.2.1.1 Eligibility Criteria for Smallholder Farmers and Communities (for activity 1.1.1, activity 1.1.2, activity 1.1.6 and activity 1.2.1)

- Smallholder farmers in specific or selected project geographical location with land sizes of between 0 – 2.5 hectares;
- Smallholder farmers (as defined above) that growing relevant crops (usually staples crops);
- Smallholder farmers that are members of local farmer groups in the targeted geographical areas;
- Smallholder farmers with limited access to farming inputs;
- Smallholder farmers with limited or level of access to extension services;
- . Smallholders that are below the local poverty line or that are food insecure;
- Farmers selected by local community and/or government leadership as priority and or vulnerable farmers (these usually include productive farmers that serve as model farmers, youth, women, special/marginalised groups)

5.2.1.2 Eligibility Criteria for Agricultural Traders, Processors, and Agrodealers (for activity 1.1.3 and activity 1.1.7)

These partners will be selected in the RE-GAIN programme's target countries based on the criteria below:

- Legal capacity to operate: Registration (and ability to produce registration certificate) as a sole trader, partnership, franchise, cooperative, or limited liability company in good order with the local tax authorities;
- If operating as an importer, evidence of compliance with import permits;
- If appropriate, demonstrated compliance with any Environmental standards or requirements to obtain licences or environmental impact assessments, reports or management plans as required by local laws;
- Proof of VAT registration;
- Preferably a track record of stocking and selling FL-RS as defined as part of the RE-GAIN programme preferably of the selected manufacturer or importer;
- Evidence of record keeping, including financial records.
- Willingness and financial capacity to stock hermetic technology at the right time (harvest);
- Presence in the target regions in the selected countries for the programme
- Preferably engaging in the provision of additional services to small scale producers like moisture meters, training, credit and after sales services (aggregation, access to markets).

5.2.1.3 Eligibility Criteria for Village- Based Advisors (VBAs) (for activity 1.1.4)

The selection process should ensure that the VBA is:

- A resident of the community or resides in the geographical location/area of the target beneficiaries/farmers;
- At least 10th grade education;
- Knowledge of farming, must have at a minimum .05 hectare of farmland
- Existing 'lead farmers' that have been identified in communities by other government or partner programmes

- A member of existing community-based groups (farmer cooperative, farmer groups, nutrition groups youth groups etc)
- Entrepreneurial skills are an advantage
- Where local practices demand, the VBA will be selected or endorsed by local community leaders
- Women and youth will be preferred VBA candidates

5.2.1.4 Eligibility Criteria for Manufacturers of FL-RS (for activity 1.1.5)

These partners will be selected in the RE-GAIN programme's target countries based on the criteria below:

- Legal capacity to operate: Registration (and ability to produce registration certificate) as a sole trader, partnership, franchise, cooperative, or limited liability company in good order with the local tax authorities
- If operating as an importer, evidence of compliance with import permits
- If appropriate, demonstrated compliance with any Environmental standards or requirements to obtain licences or environmental impact assessments, reports or management plans as required by local laws
- Proof of VAT registration
- Preferably a track record of producing and selling FL-RS as defined as part of the RE-GAIN programme (that is approved by the national authorities
- Evidence of record keeping, including financial records; Willingness and financial capacity to expand the production levels and distribution network (agrodealers, cooperatives, development projects,) for the FL-RS
- Willingness and financial and human capacity to develop and deploy (subsidized) marketing efforts to enhance uptake of the FL-RS among small scale producers
- Presence in the target regions in the selected countries for the programme;
- Preferably engaging in the provision of solutions for smallholder farmers

5.2.1.5 MSMEs and Cooperatives (for activity 2.1.1 and activity 2.1.2)

These partners will be selected in the RE-GAIN programme's target countries based on the criteria below:

- Registration certificate if formally required under national laws
- Copy of constitution, and full list of members and officials
- Preferably a track record (based on physical records) as a service provider to small scale producers (can be in extension, aggregation of produce, selling of inputs or provision of mechanized services)
- Preferably in the target regions in the selected countries for the programmeand qualified staff or members that have experience in operating, repairing and servicing the machinery
- Willingness and ability to buy machinery for the purpose of renting it out to small scale producers
- Willingness and financial capacity to develop and deploy marketing efforts to enhance uptake of the FL-RS services among farmers
- Preference will be given to women and youth-led MSMEs;
- Preference will be given to those already engaging with business planning activities

5.2.2 Eligibility Criteria for Extension Services Delivery Partners

The potential [programme/implementing] partners are not-for-profit, non-governmental organizations, private sector organizations, regional economic or specialized bodies, government departments with technical expertise and competencies in agrifood systems, policy development, monitoring and implementation, project management, scientific and social research,

natural resources management, climate change, training, capacity building, knowledge management and other relevant areas.

5.2.2.1 Fit for Purpose

Institutions/organizations intending to work with AGRA in this area of work must demonstrate that they meet the following requirements to be eligible to receive financing from AGRA:

- Unless specifically stated otherwise in this section, must be registered in the national country with valid registration documents;
- For its stated area of expertise, organization must produce certifications, marks or permits as required by national legislations, demonstrating adherence with relevant codes of practice, industry standards etc
- Organization's primary business activity must be in the stated focal countries;
- Organization must be in a sound financial condition;
- Organization must have sufficient existing capability/capacity to perform as required. AGRA may consider limited funding for capacity building only if the entity's proposal is determined to be of interest to AGRA;
- Organization must have demonstrated favorable past performance record;
- Organization must have accounting systems, procurement practices and corporate integrity/ethics aligned to AGRA systems and values;
- Organization must not have been previously excluded from the eligibility to receive funding from any of AGRA's partners;
- Demonstrate inclusivity and promote sustainability principles in past project activities

5.2.2.2 Technical Competencies

Other key considerations – these will be dependent on the thematic focus of the work being undertaken:

a) Minimum of 5-7 years of demonstrable organization working experience in any/all or a combination of the following systems level areas: Value Chain Development, Sustainable Farming, Seed systems, Fertilizer and Soil health systems, Market and Financial Access systems, MSME development, Agriculture and/or Food systems policy, Climate Change, Natural Resources Management, Extension and Input Distribution systems, and Climate-smart Agriculture in Africa;
b) Demonstrable ability to work with private sector partners and have experience leading/facilitating value chain development, linkage of smallholder farmers to markets, and resilience building initiatives;
c) Experience working with women and youth (and other underserved groups);
d) A team with experience working in smallholder agriculture value chains in Africa; experience in natural resources management, climate change, MSME development and working with national institutions;
e) Present qualified personnel/CV's of key staff proposed
f) Applications should be in line with the RE-GAIN Programme's E&S policy, as further described on Annex 6

AGRA may request additional documentation to be submitted as part of the pre-award process. Organizations are advised that any funds made available are subject to AGRA's accountability and audit requirements.

5.2.2.3 Evaluation Criteria/Scoring Weights

The selection of partners will follow the below scoring criteria, and percentages may vary slightly.

1. Fit-for-Purpose (Governance and management) 20%
2. Technical Ability and past experience 50%
3. Personnel Qualification and others 20%
4. Approach and methodology 10%

5.3 RECOMMENDATIONS AND PROGRAMMATIC CONSIDERATIONS FOR INTRODUCTION OF FOOD LOSS REDUCTION SOLUTIONS (FL-RS)

To ensure the success of the RE-GAIN Programme and achieve lasting systemic changes across the target countries beyond the programme's duration, several key factors must be in place:

- Strong alignment of the proposed physical solutions with the capacity-building and awareness-raising activities
- Availability of selected FL-RS in the country, and potential for the supply scalability
- Focus on strengthening market-driven approach, and developing strong market linkages
- Efficient communication and information dissemination about the programme
- Proactive inclusion of women in the training and capacity-building activities
- Effective financing mechanisms
- Enabling environment for the uptake of FL-RS

Strong alignment of the proposed solutions with the capacity-building and awareness-raising activities

Raising awareness is a fundamental for reaching a large number of smallholder farmers and MSMEs, motivating them to adopt and increase the use of FL-RS. Training and capacity-building efforts focused on the technical and managerial aspects of FL-RS are vital for the program's success. These efforts will enhance farmers' understanding of climate information, the effects of climate change on harvest and post-harvest activities, and the practical application of FL-RS to significantly reduce food losses. This, in turn, will support farmers in boosting food security, increasing income, and ensuring a return on investment, all contributing to the overall success of the program. The requirements for awareness-raising and capacity-building, which are key to achieving these outcomes, have been detailed earlier in this chapter. These activities will not only empower farmers but also strengthen their ability to adopt sustainable practices that are essential for long-term resilience and program sustainability.

Availability of selected FL-RS in the country, and potential for the supply scalability

The success of the RE-GAIN Programme relies heavily on the availability, affordability, quality, and scalability of the selected FL-RS technologies. These include harvesting machinery, mechanical multi-crop threshers and shellers, tarpaulins, plastic sheets, metal and plastic silos, hermetic bags, moisture meters, and storage structures. It is crucial that these technologies not only exist in sufficient quantities within the market but also remain continuously accessible to target farmers in remote and rural areas, both during and after the programme.

This will be accomplished through market mapping and the development of a robust network of local manufacturers and importers/agro-dealers to assess the current supply of FL-RS and their potential for scalable production, as part of creating sustainable market linkages. To ensure FL-RS reach remote regions, stronger collaboration between solution manufacturers

and local agro-dealers will be essential. This partnership will help guarantee both the availability and accessibility of these solutions for farmers, fostering long-term adoption and sustainability.

Focus on strengthening market-driven approach, and developing strong market linkages

For RE-GAIN Programme to create sustainable change, it will focus on fostering market linkages between smallholders, MSMEs, and potential buyers such as retailers, processors, and exporters using AGRA's proven consortia model. This will build on the market mapping, which will identify key agricultural value chain actors, including potential institutional markets not yet fully accessible to smallholders. Utilising this information, the RE-GAIN Programme will support farmers in connecting with other actors in the value chain, including providing technical assistance to secure formal off-take agreements for produce that meets quality standards of institutional markets.

Efficient communication and information dissemination about climate risk and the programme

Effective communication about the programme, its goals, and its benefits—notably reducing post-harvest food losses amid changing climate conditions—is vital for achieving successful outcomes across all seven countries. Communication efforts will focus on ensuring that available weather information is widely shared, complemented by the development of informational materials. A dedicated communication platform will be established, enabling FL-RS suppliers, manufacturers, and other key stakeholders to communicate with one another and provide information on their available solutions. Additionally, outreach to farmers, including details on available financial resources like bank loans and FL-RS distribution opportunities, will be facilitated through village-based advisors, ensuring that essential information reaches even the most remote communities.

Proactive inclusion of women, youth, and Indigenous people (where present) in the training and capacity-building activities

As identified during the stakeholder engagements and confirmed by the official data, women, youth and indigenous people (where present) play crucial roles in the agricultural sector in Sub-Saharan Africa, especially in the stages of harvesting and post-harvest handling. Therefore, it is critical to ensure their efficient representation and active participation in the capacity building and awareness raising activities of RE-GAIN programme. This will be achieved by targeted selection of participants/ audience for the capacity-building activities. Beyond this, RE-GAIN will also encourage MSMEs to engage with informal youth groups to engage in the services provision of FL-RS services, in which the youth groups will operate under the supervision and contractual responsibility of the MSMEs, ensuring accountability and providing the youth group with an opportunity to build a track record of successful operations and governance.

Effective financing mechanisms

Effective financing mechanisms are crucial for expanding access to food loss reduction solutions across all seven countries. These mechanisms are particularly important when the benefits and return on investment for harvest and post-harvest technologies are not yet well-established among smallholder farmers and agribusinesses, and when the private sector needs to develop new product-market combinations. The delivery of physical FL-RS to farmers and other target stakeholders, facilitated by these financial mechanisms, will begin in the second year of the programme, ensuring that access to these solutions is supported by sustainable financial models that foster long-term adoption and growth.

Enabling environment for the uptake of FL-RS

For the successful implementation of the RE-GAIN programme, it is essential to prioritize activities that ensure its long-term sustainability. As the programme builds knowledge about climate risks and their impact on agriculture, enhances both the demand for and supply of FL-RS, improves access to financing, and strengthens market linkages, it will also focus on

supporting policy development and reform. Key policy initiatives will include advocating for tax exemptions, establishing certification and quality standards for FL-RS, promoting scalable and replicable FL-RS business models, and improving the accessibility of weather information for smallholder farmers.

Active involvement and support from both central and local government organizations will be critical to the programme's success. The RE-GAIN programme will align with other relevant projects and initiatives to create synergies, leverage existing laws and policies related to food loss reduction, MSME development, and smallholder support, and ensure effective programme management. This will involve rigorous monitoring, continuous improvement, and the integration of lessons learned to enhance outcomes and ensure long-term impact.

5.4 THE DIFFERENT COMPONENTS OF THE RE-GAIN PROGRAMME

The RE-GAIN programme tackles climate change and food losses by addressing both physical and non-physical solutions within the selected value chains. It is organized into three key components and five targeted outputs; each designed to maximize impact and ensure a comprehensive approach to reducing post-harvest losses. Each component is designed with targeted activities to improve awareness, access, and the enabling environment, all aimed at increasing the adoption of FL-RS and driving significant reductions in post-harvest food loss. The expected outputs and respective activities, together with the identified barriers they aim to address, are presented in Table 5-3:

Table 5-3 Proposed Activities Set and Outputs of the RE-GAIN Programme, aligned with the identified risks, needs and barriers in access to FL-RS

Identified risks, needs and barriers	Activity sets	Outputs
Technical and Operational Challenges • Technical challenges in use of technologies and equipment • Susceptibility of crops to weather conditions, pests, and contamination • Limited access to markets for smallholder products • Limited awareness of impact of climate change on harvest and post-harvest crop management • Limited awareness of the use of climate information for decision making **Skills and Knowledge Requirements** • Limited awareness of impact of climate change on harvest and post-harvest crop management • Limited awareness of the use of climate information for decision making • Need for proper training, knowledge, and technical skills for effective use and maintenance of equipment and post-harvest technologies • Limited awareness and knowledge about proper usage and management of FL-RS **Health, Safety, and Environmental Risks** • High pollution risks and environmental impacts of certain harvesting technologies • Health and safety concerns associated with the use of chemical products as storage protectants	**Activity Set 1** • Gender-responsive awareness campaign on the impacts of CC on post-harvest food losses and the availability of FL-RS. • Demonstration, training and tech. transfer for the use of weather/ climate information, FL-RS and related practices • Capacity development of extension services and agro-dealers	Output 1.1. Smallholder farmers supported to adopt FL-RS
	Activity Set 2 • Facilitate market linkages between institutional markets & other buyers & smallholders, Support to structuring of value chains & coordination between market actors	Output 1.2. Improved market linkages between agri-value chain actors
Cost and Economic Constraints	**Activity Set 3**	Output 2.1. Business development support for

Identified risks, needs and barriers	Activity sets	Outputs
• High initial costs and ongoing maintenance expenses of machinery and technologies • Affordability challenges, especially for vulnerable communities • Lack of capital and limited access to finance • Inaccessibility of fuel and high fuel costs in some areas, high energy consumption and maintenance requirements of harvesting machinery **Market constraints** • Lack of available FL-RS, especially in remote and rural areas • Limited accessibility and (perceived) high cost of FL-RS, especially in rural areas • Limited availability of quality materials and resources for production of FL-RS	• Provide business development support & market intelligence for FL-RS manufacturers • Capacity and market development for all market actors • Training of new FL-RS providers (MSMEs, cooperatives, incl. women- and youth - led initiatives) • Facilitate access to finance for FL-RS providers through innovative de-risking schemes **Activity Set 4** • Support inclusion of FL-RS in climate-resilient input packages • Structure prefinancing partnership arrangements that include FL-RS • Facilitate the development and deployment of smart subsidy and catalytic grant models, as well as 'lease-to-own models for FL-RS focussing on women and youth as key beneficiaries.	the improved provision of FL-RS on local markets Output 2.2. Financial mechanisms for smallholders and MSMEs to support the adoption of FL-RS
Quality and Reliability Concerns • Variable quality and limited durability of FL-RS present in the market, affecting their reliability **Other concerns** • Lack of access to solutions and agricultural finance for women • Limited awareness among farmers about the effectiveness and economic benefits of FL-RS	**Activity Set 5** • Support the revision of policies that enable FL-RS investments, including tax exemptions, certification and standards for FL-RS quality • Promote successful FL-RS business models for scaling-up & replication	Output 3.1. Enhanced capacity of national institutions to enable investments in FL-RS

5.5 OVERVIEW OF IMPLEMENTATION ARRANGEMENTS

For the RE-GAIN to be a successful programme, it will leverage AGRA's expertise both from its headquarters as well as its country offices.

AGRA HQ senior leadership and technical leads will be responsible for the overall supervision and coordination of the project including ensuring: i) funds are effectively managed to deliver results and achieve objectives; ii) the quality of project monitoring; and iii) liaison with the GCF. AGRA will also leverage expertise from its wider technical leadership and support by AGRA's Heads of Markets and Trade, Inclusive Finance, Sustainable Farming, Private-sector Partnerships, Strategy, Policy and State Capability, Monitoring and Evaluation and Knowledge Management. The AGRA HQ team will be the primarily liaison with the GCF.

5.5.1 Executing Entity (EE)

The project will be executed directly by AGRA through its) Programme Implementation Unit (PIU). Through this unit, AGRA will provide key resources, including Finance, Grant Management and Procurement Officers who will provide financial and administrative management, overseeing financial, contractual, procurement and logistics aspects for the project from the Nairobi Headquarters. The unit will oversee planning and quality assurance; supervise programme monitoring, evaluation and reporting; ensure timely realization of all programme deliverables; provide leadership and technical support to implementing partners; and ensure smooth communication flow across all programme partners. This executing role will be fulfilled both through the Nairobi-based headquarters, and AGRA's country offices, and will report to the AGRA senior leadership.

The EE is responsible for:

- Execution of the project,
- Procurement of services specifically (major procurement and Subgrant contracting),
- Facilitating partnerships,
- Managing contracts, monitoring results,
- Annual reporting by county offices to the PIU

AGRA deploys a diverse set of delivery models to deliver its country and institutional strategy. It offers services through its **expert staff**, placed at headquarters in Nairobi; at the East, Southern and West Africa regional offices; as well as at country offices. AGRA staff work with downstream partners and local organizations to implement **specific components** of a contracted programme area with the aim to improve local organizations' capacity, build institutional capacity and ensure long term ownership and sustainability of its interventions. AGRA provides **Technical Assistance (TA) in the form of short- to medium-term expertise support** (through consultants where needed) embedded within or seconded to mandated national, regional and continental institutions (e.g., government ministries, regional economic communities) to drive desired change, and in some instances consultants are hired to support specific assignments that require skilled expertise. AGRA is a **convener (brings stakeholders together around a change agenda, e.g., the Africa Food Systems Summit)** facilitating connections and interactions between different actors and stakeholders within the agriculture and food systems sector. AGRA utilizes advocacy and communication as key tools for change. The specific delivery models will be determined at the implementionl stage and will depend on each country context.

5.5.2 Responsible Units

The EE team at the Nairobi HQ will be supported by AGRA country offices in each of the seven target countries who will serve as responsible units. These units will support on-the-ground coordination and implementation, as well as being mandated for specific outputs/activities.

5.5.3 Programme Governance

Programme Advisory Group:

AGRA will establish a Programme Advisory Group (PAG) made up of senior representatives from AGRA's Integrated Programme Management (IPM) unit[7] that will serve as the starting point to guide innovation, impact scale and adaptive thought leadership to shape the partnership at continental level. AGRA envisions this Advisory Group will meet quarterly as part of IPM meetings

Programme Implementation Unit

A central Programme Implementation Unit (PIU) will be established at AGRA's Nairobi headquarters to oversee implementation of the entire programme across all seven countries. This unit will report to the PAG and be comprised of two sub-groups; a Programme Management Unit (PMU) and a Technical Expert Group (TEG), as described below.

- *Programme Management Unit*
  The Programme will establish a management unit that will be functional for the entire duration and be responsible for day-to-day implementation of the project. The PMUwill offer overall management, implementation and general technical direction of the entire programme, ensuring an integrated vision among different components. The PMU

[7] Vice presidents, relevant business line or programme directors/heads, Lead of PMU , Head of MEL

will consist of five full time positions: i) PMU Lead; ii) Senior Finance Officer; iii) Procurement Officer; iv) Project Analyst; and v) M&E Officer.. The PMU will be based in AGRA Nairobi Headquarters, with in-country support from responsible units in the country offices.

- *Technical Expert Group*
  The TEG, also situated within the Nairobi Headquarters, will provide expertise to assist the PMU in the technical implementation of the RE-GAIN programme. The TEG will include several full-time positions, including: i) Program Officer — Gender, Youth and Inclusion; ii) Technical Advisor — Inclusive Finance and BDS; iii) Technical Advisor — Extension and Value Chain Development. These full-time roles will be supported by several part-time technical team members, including: i) Technical Advisor — Inclusive Markets and Finance; ii) Lead — Sustainable Farming, Distribution and Youth in Extension; iii) Technical Advisor — Livelihood Resilience and Climate Adaption; iv) Head: M&E; and v) Technical Advisor — Food Loss Reduction Analytics.

Country-level Implementation Units

The PIU will be assisted in project implementation within each target country by a country-level implementation unit (CIU) which will be established in each of the AGRA country offices[8] and will be comprised of country-office staff. The CIUs will be responsible for managing day-to-day operations in each country, reporting directly to the PIU, as well as providing regular reports to the relevant Project Steering Committee (see below).

Programme Steering Committee

At the country level, the programme will be implemented under the overall guidance of a Programme Steering Committee (PSC) co-chaired by a representative of the NDA, and AGRA country managers. The PSC will include representatives of other key government departments and agencies, the private sector and civil society organizations. These partners will likely include Ministries of Agriculture and their Departments for Land Resources Conservation, Crop Development, Agriculture Extension Services and Agriculture Planning Services. The role of the PSC will be to: i) provide overall guidance and direction to the project in country; ii) address project issues as raised by the advisory group; iii) review the project progress and provide direction and recommendations to ensure that the agreed deliverables are produced satisfactorily and within the approved project framework; iv) review and approve annual work plan and budget (AWPB) and provide necessary strategic guidance for its implementation; v) appraise the annual project implementation report, including the quality assessment rating report; vi) make recommendations for subsequent work plans to build on achievements and address any shortcomings; and vi) provide ad hoc direction and advice for exceptional situations or when requested by the GCF, strategic advisory group or PSC members.

Each national PSC will include representatives of private sector actors in addition to key government institutions. A list of potential private partners is presented in Appendix 9 of Annex 2. The selection of specific partners for each country will be led by AGRA and will be dependent on specific criteria as outlined in Annex 2. At country level there will annual forums for feedback and policy dialogues that will be organized by each county office. The lessons learned through the project monitoring, evaluation and learning systems in each participating country will be shared to all other participating countries through two approaches: i) Cross-country presentations at AGRA's internal Quarterly Performance Review Meeting, where all

[8] Which fall under the same legal entity as the PSAA Applicant

country directors and program officers participate; and ii) an annual planning and review session organized by the PMU in which all countries and partners participate to promote cross country learnings, exposure and innovation. In addition, at continental level, the AFSF will organization special sessions for cross country learning and feedback.

Each National PSC will convene in an interval of 3 months (quarterly) with a provision for additional extraordinary meetings when required and to be called by the chair and co-chair or if requested by members. The PSC will report to the NDA who oversees all GCF project in the individual countries.

Table 5-4: Country PSC Representatives

Country	PSC Representatives
Tanzania	• Vice President Office (PS/NDA) • Ministry of Agric (PS/Postharvest and Marketing Unit/Food Security) • Ministry Industry and Trade (PS/Dept of Trade/TANTRADE) • Agric Council of Tanzania
Uganda	• Ministry of Agriculture Animal Industry and Fisheries (MAAIF) • Ministry of Trade, Industry and Cooperatives (MATIC)
Ethiopia	• Ministry of Agriculture (State Minister, Agriculture & Horticulture Sector) • Ethiopian Agricultural Transformation Institute. • Ethiopian Agricultural Authority (regulatory body) • Ministry of Planning and Development (NDA) • Green Agro-Solutions • Dashen Bank
Kenya	• Ministry of Agriculture • Ministry of Treasury • Ministry of Environment • Council of Governors
Burkina Faso	• The General Directorate of Rural Economy Promotion (DGPER) – Ministry of Agriculture • The General Directorate of Studies and Statistics (DGESS) – Ministry of Agriculture • The National Designated Authority – Prime Ministry Office
Zambia	• National Development Planning • Local Government • Health • Energy • Agriculture • Environment and Natural Resources • Communications • Minerals Development • Information and Broadcasting • Works and Supply • Home Affairs • Disaster Management and Mitigation

	• Gender

Malawi	• NDA – Director of Environmental Affairs
	• PS Agriculture represented by
	  • Director of Crop Development Department
	  • Director of Agriculture Extension Services
	• CEO of Farmers Union of Malawi (FUM) or National Association of Farmers (NASFAM)
	• UNDP or Representative of the Donor Committee on Environment.
	• CASANET

Stakeholder Engagement

Across the different countries, AGRA will liaise with different governmental agencies during the implementation of the different outputs to ensure that the RE-GAIN programme is aligned with country-specific policies. A non-exhaustive list of these stakeholders is provided is section B.4 of the funding proposal band will be further updated through engagement with the NDA's selected representative in each country.

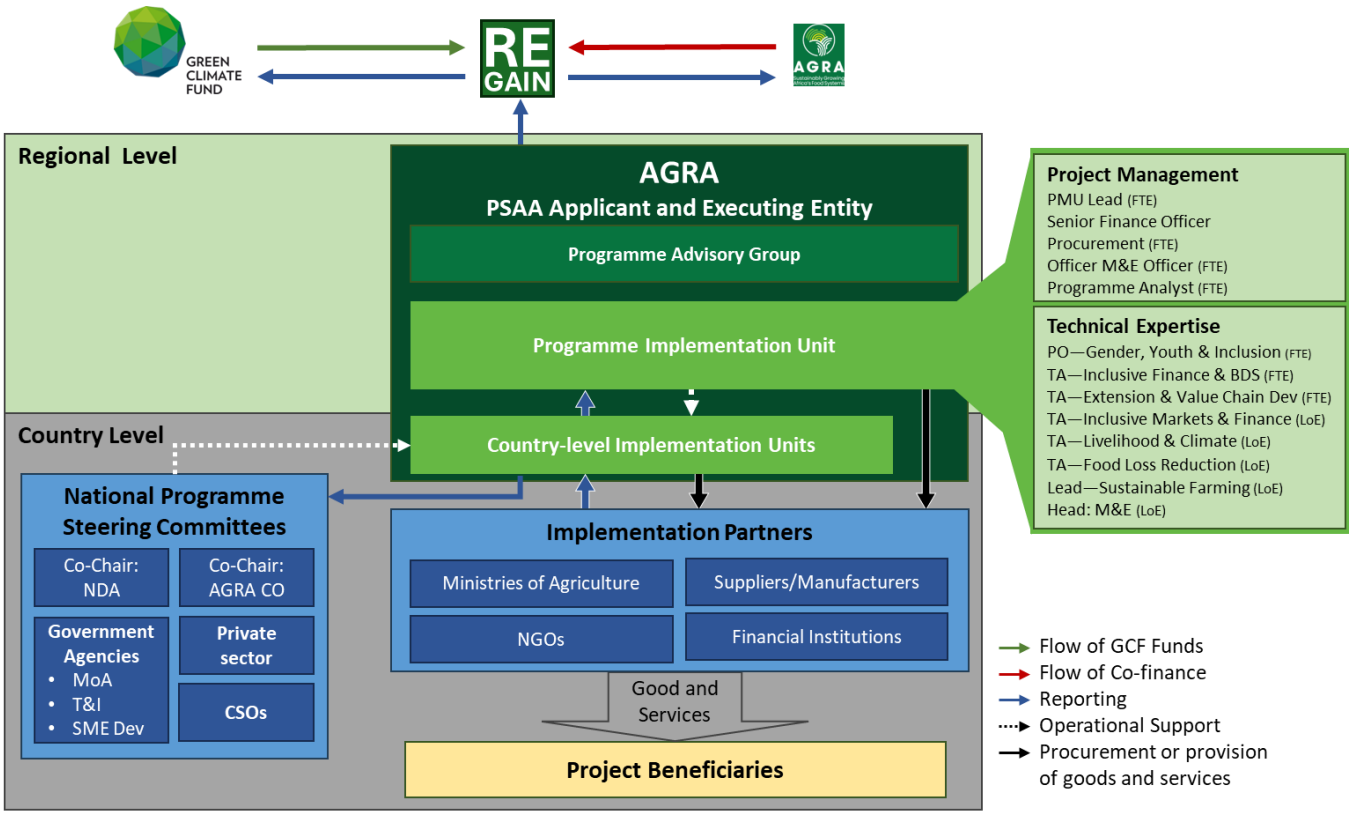


Figure 5-1 Implementation Arrangements for the RE-GAIN Programme

5.6 PROGRAMME AREA

Climate risks were carefully considered for the countries under consideration (as detailed in Chapter 3), evaluating factors to identify locations that align with the programmes goals. This analysis helps us make informed decisions, ensuring the selected

location is well-suited for long-term success without causing any adverse impacts. Alongside this assessment, we have carefully considered the additional criteria listed below to further refine our choice, ensuring a holistic approach to decision-making.

5.6.1 Eligibility criteria for programme area

- Selection of geographical location in the target countries for the RE-GAIN project. Below is the selection criteria that will be considered:
- Areas that have significant smallholder agriculture production.
- Production areas that are recognized by local government as high productivity areas. Consultation will be key in the selection process
- Proximity to or existing agro-dealer network and or agriculture input and output businesses,
- Where selected value chains are being produced and or traded
- Where there is existing AGRA investments in extension systems, enhanced productivity and support to market systems
- Areas that have previously and are currently being serviced by financial products by financial institutions
- Existing infrastructure communications infrastructure to allow accessibility to the area
- Demographics: Areas that have a potential for spillover or scaling effect due to the existence of a significant number of value chain actors (farm to market).
- Synergies with other existing projects and initiative

6 Market Study

As the RE-GAIN Programme is designed to promote market-led adoption and implementation of FL-RS, to reduce food losses, increase incomes and contribute to climate change adaptation and mitigation, it is also key to understand the current market for physical and non-physical FL-RS in each of the programme's countries. This chapter describes the supply and demand for prioritized FL-RS, Financial Services, and Extension Services focusing on Smallholder farmers.

6.1 SUPPLY AND DEMAND OF PHYSICAL FL-RS ACROSS THE RE-GAIN PROGRAMME'S COUNTRIES

The results for each target country are presented in the tables below, while detailed information about the key manufacturing and importing companies operating on the national markets for each of the solutions are presented in relevant country Appendixes to this Annex 2 submission.

Table 6-1: Overview of the supply, demand and existing market challenges of selected FL-RS in Burkina Faso

Solution	Supply	Demand	Challenges
Mechanical multi-crop threshers	Limited local manufacturing, dominated by imports from China, India, and Europe.	High among smallholder farmers seeking to reduce labour costs and increase efficiency. Preference for solar-powered machinery.	High costs, limited local production, expensive imports, and inadequate distribution networks.
Tarpaulins and plastic sheets	Widely available from local and regional manufacturers. Importers from neighbouring countries supplement supply.	Substantial demand for reducing post-harvest losses during drying and storage stages.	Logistical challenges in distribution to remote areas, inconsistent quality, and durability issues.
Hermetic bags	Growing local manufacturing. International suppliers like GrainPro and PICS bags are present.	High demand for hermetic bags due to ease of use and affordability.	Hermetic bags face distribution challenges.
Metal and plastic silos	Growing local manufacturing, yet supply is mostly import-dependent.	Silos have growing demand but require significant investment.	Silos are expensive and require skilled installation, limiting accessibility.
Moisture meters	Predominantly imported from Europe and Asia. Limited local manufacturing capabilities.	Increasing demand as awareness of benefits grows. Essential for ensuring grains are adequately dried before storage.	High costs, limited affordability for smallholder farmers, scarcity of local alternatives.
Storage structures	Locally constructed using local materials. Advanced solutions are limited and often require collaboration with international donors and development agencies.	High demand for improved storage solutions, including modern granaries and warehouses.	High construction costs, technical expertise required, limited market for advanced storage solutions.
Storage protectants	Widely available through local stores and cooperatives. Supplied by local manufacturers and international agrochemical companies	High demand for controlling pests in stored produce.	Issues related to the correct and safe use of protectants, requiring better training and regulation.

Table 6-2: Overview of the supply, demand and existing market challenges of selected FL-RS in Ethiopia

Solution	Supply	Demand	Challenges
Harvesting machinery	Limited local manufacturing, majority of companies operating in the market import harvesters from China	High demand because of reduced labour costs and efficiency	High costs, lack of knowledge on use and maintenance, need for additional financing for fuel and spare parts
Mechanical multi-crop threshers	Limited local manufacturing. Majority are imported from India and China.	High demand due to efficiency in separating grains, reducing labour, and minimizing grain loss. Farmers seek to improve productivity and grain quality.	High costs, insufficient local manufacturing, expensive imports, sparse maintenance services, lack of affordable credit, inadequate training on usage and maintenance.

Tarpaulins and plastic sheets	More developed market with local manufacturers. Importers from China and India supplement supply.	Strong demand for protecting crops during drying and storage, particularly during harvest seasons.	Quality and durability issues, distribution challenges, especially in remote areas.
Hermetic bags	Growing market with local production and imports from Kenya and India. Distribution facilitated by international programmes like PICS.	High demand for effective grain storage solutions to prevent insect infestation and spoilage.	High initial costs, limited awareness and understanding of benefits, underdeveloped supply chains, especially in rural areas.
Metal and plastic silos	Limited local manufacturing capacity. Most silos are imported from countries like China and India.	Moderate demand for durable storage solutions, particularly for larger-scale storage of grains.	High initial costs, limited adoption, need for training on proper use and maintenance, reliance on imports increasing costs and complicating supply chains.
Moisture meters	Predominantly import-driven market.	Increasing demand as farmers recognize the importance of monitoring grain moisture levels to prevent mould growth.	High costs, limited distribution, lack of training on usage, and scepticism among farmers about investing in these devices.
Storage structures	Constructed by local companies with support from international organizations like WFP and FAO. Local NGOs and cooperatives manage these structures.	High demand for improved storage structures to reduce post-harvest losses and improve crop storage duration for better pricing.	Funding, land, and proper management structure challenges, organizational capacity and governance issues limiting effectiveness and equitable usage of communal facilities.
Storage protectants	Includes both locally produced and imported products from China, India, and the United States.	High demand driven by the need to manage pests and diseases during storage, reducing post-harvest losses, and improving produce quality.	High costs of quality protectants, limited availability, inadequate regulatory frameworks, lack of knowledge among farmers for safe and effective usage, highlighting the need for better extension services and training programmes.

Table 6-3: Overview of the supply, demand and existing market challenges of selected FL-RS in Kenya

Solution	Supply	Demand	Challenges
Mechanical multi-crop threshers	Mostly imported, distributed through a network of dealers and suppliers across Kenya.	Significant demand among farmers cultivating grains and legumes to enhance productivity and reduce labour costs.	High costs, limited local manufacturing, unsuitable for small plots and challenging terrains, sparse maintenance services, and limited availability in rural areas.
Tarpaulins and plastic sheets	Majorly produced locally by companies and sold by agricultural dealers and online shops	Highly preferred by farmers, especially women, for crop drying and protection during post-harvest handling.	Affordability issues due to price fluctuations, quality concerns, and high demand outstripping supply, particularly for high-quality products.
Hermetic bags	Supplied/imported by big and medium-sized companies. Distributed through local vendors.	Increased demand for protecting stored grains from pests and spoilage, popular among smallholder farmers	High costs, issues with durability due to improper usage, instances of counterfeit products, and knowledge gaps leading to improper usage.
Metal and plastic silos	Locally produced by specialized companies.	Moderate demand for reducing post-harvest losses, particularly in larger-scale storage scenarios.	High costs, need for proper installation and maintenance, limited local production capacity, and complex supply chains.
Moisture meters	Predominantly imported by big and medium-sized companies. Available via agrodealers, and online via national marketplaces	Low but growing demand as farmers become more aware of their role in preventing spoilage	High costs, limited distribution, lack of training on proper usage, and scepticism among farmers about the value of investing in moisture meters.
Storage structures	Produced locally or imported as prefabricated items, primarily from China.	High demand for reducing post-harvest losses and extending crop storage duration for better market prices.	High initial investment costs, limited availability, and challenges related to securing funding, land, and management structures for effective use
Storage protectants	Primarily imported and further distributed via local agrodealers	Very popular among farmers for managing pests and diseases during storage, ensuring food safety.	High cost of quality protectants, limited availability of natural/biological alternatives, inadequate regulatory frameworks to prevent substandard products, and lack of training for safe and effective usage.

Table 6-4: Overview of the supply, demand and existing market challenges of selected FL-RS in Malawi

Solution	Supply	Demand	Challenges
Mechanical multi-crop threshers	Mostly imported, with distribution through a network of dealers and agricultural machinery suppliers across Malawi.	Moderate demand driven by efficiency gains and economic benefits. Demand likely to grow as awareness spreads among farmers.	High costs, limited local manufacturing, unsuitable for small plots and challenging terrains, limited access to credit, and lack of knowledge on proper usage and maintenance.
Tarpaulins and plastic sheets	Mostly produced locally and sold directly to farmers by agricultural dealers.	Significant and growing demand for protecting crops from adverse weather and during drying/storage periods.	Affordability issues due to price fluctuations, high-quality products often in short supply, and issues with counterfeit or substandard products.
Hermetic bags	Imported and distributed through local vendors across Malawi.	Increasing demand for reducing post-harvest losses, protecting stored grains from pests and moisture. Farmers show growing willingness to invest in hermetic bags.	High costs, issues with durability due to improper usage, counterfeit products posing risks, and ongoing need for education and promotion to increase awareness and proper usage.
Metal and plastic silos	Locally produced by various manufacturers.	Moderate demand for reducing post-harvest losses, particularly in larger-scale storage scenarios.	High initial costs, need for proper installation and maintenance, limited local production capacity, and complex supply chains.
Moisture meters	Primarily imported, with distribution throughout Malawi via agrodealers and third-party distributors, reaching urban and rural areas.	Low but growing demand as farmers become more aware of the benefits of moisture control in preventing spoilage.	High costs, limited distribution, lack of training on proper usage, and scepticism among farmers about the value of investing in moisture meters.
Storage structures	Produced locally or imported as prefabricated items from other countries. Few companies offer these structures for sale.	High demand for reducing post-harvest losses and extending crop storage duration for better market prices.	High initial investment costs, limited availability, and challenges related to securing funding, land, and management structures for effective use.
Storage protectants	Imported, with distribution through a network of agrodealers primarily located in major cities and reaching different areas of the country.	Very popular among farmers for managing pests and diseases during storage	Prevalence of counterfeit products, high costs, limited availability of natural/biological alternatives, inadequate regulatory frameworks, and lack of training for safe and effective usage.

Table 6-5: Overview of the supply, demand and existing market challenges of selected FL-RS in Tanzania

Solution	Supply	Demand	Challenges
Harvesting machinery	Mostly imported, with minimal local production. Distribution is managed by various importers and local dealers.	High demand due to the need for timely and efficient crop collection	High costs, limited availability, reliance on imports subject to high duties and taxes, lack of local manufacturing, and insufficient technical support and repair services.
Mechanical multi-crop threshers	Limited local production with reliance on imported machines. The supply is insufficient to meet demand, with distribution through a network of importers and dealers.	Significant demand to reduce labour-intensive processes and minimize losses in wheat and teff value chains.	High costs, environmental concerns due to fuel operation, insufficient local production, lack of technical skills for operation and maintenance, and imported machines not always suited to local conditions.
Tarpaulins and plastic sheets	Both locally produced and imported. Distribution managed by retailers and wholesalers across urban and rural areas.	High demand among smallholder farmers for low-cost solutions to reduce losses during drying and temporary storage.	Issues with quality and durability, influx of low-quality imports, concerns about reuse and recycling, and limited availability in remote areas.
Hermetic bags	Limited local production with some imports. Distribution is supported by local vendors and international initiatives.	Growing demand for effective and affordable storage solutions to reduce post-harvest losses.	High costs, presence of counterfeit products, lack of awareness and understanding of benefits, and underdeveloped supply chains, particularly in rural areas.
Metal and plastic silos	Limited local production with reliance on imports. Distribution	Moderate demand for long-term storage solutions to reduce post-harvest losses.	High initial costs, limited local production, underdeveloped distribution networks, lack of

	through a few local manufacturers and importers.		technical knowledge for proper use and maintenance, and reliance on imports increasing costs and availability challenges.
Moisture meters	Primarily imported with limited local production. Distribution managed by agro-dealers and third-party distributors, reaching both urban and rural areas.	Growing demand as awareness of proper drying methods increases, particularly among commercial farmers and cooperatives.	High costs, limited availability, lack of affordable local options, and lack of training and support services for effective use.
Storage structures	Developed using a combination of imported materials and local construction. Distribution and construction often involve local firms and international aid organizations.	High demand for modern storage solutions to reduce post-harvest losses and improve crop storage duration.	High construction costs, lack of technical expertise, limited access to credit facilities, rural infrastructure challenges, and issues related to organizational capacity and governance in managing communal facilities.
Storage protectants	Primarily imported and further distributed via local agrodealers	Popular among farmers for managing pests and diseases during storage, ensuring food safety.	Limited availability of natural/biological alternatives, inadequate regulatory frameworks to prevent substandard products

Table 6-6:Overview of the supply, demand and existing market challenges of selected FL-RS in Uganda

Solution	Supply	Demand	Challenges
Mechanical multi-crop threshers	Primarily imported, with distribution managed by various agricultural machinery suppliers across Uganda.	High demand among medium-sized farmers growing diverse crops to boost productivity and reduce labour expenses.	High costs limited local manufacturing, reliance on imports, and inadequate access to financing.
Tarpaulins and plastic sheets	Widely available through both local production and imports. Distribution is managed by agricultural dealers and online platforms, expanding accessibility across Uganda.	High demand for drying crops like maize and beans, crucial for reducing post-harvest losses.	Affordability issues, high-quality products often in short supply, and influx of low-quality imports.
Hermetic bags	Both locally manufactured and imported, distributed through local vendors across Uganda.	High demand due to their effectiveness in protecting stored grains from pests and spoilage, with increased awareness among farmers.	High costs, issues with durability due to improper usage, presence of counterfeit products, and ongoing need for education and capacity building among farmers
Metal and plastic silos	Both locally produced and imported, available in various capacities to meet different storage needs. Distribution through a mix of local manufacturers and importers.	Moderate demand for effective grain storage solutions.	High costs, need for proper installation and maintenance
Moisture meters	Primarily imported, with distribution through agricultural equipment companies and third-party distributors, reaching both urban and rural areas in Uganda.	Growing demand as farmers recognize their importance in preventing spoilage during storage.	High costs, limited distribution, lack of local manufacturing, and need for training programmes to ensure proper usage.
Storage structures	Developed using a combination of imported materials and local assembly. Distribution managed by local construction companies and private sector firms, with support from international organizations.	High demand for reducing post-harvest losses and improving crop storage duration, especially among smallholder farmers.	High construction costs, limited availability, reliance on imports, lack of proper management and maintenance, and insufficient access to credit facilities.
Storage protectants	Primarily imported, with distribution managed by local vendors across Uganda.	Moderate demand for managing pests and diseases during storage, ensuring food safety.	Prevalence of chemical-based products, limited availability of organic/natural alternatives, and need for more locally produced or imported organic solutions.

Table 6-7: Overview of the supply, demand and existing market challenges of selected FL-RS in Zambia

Solution	Supply	Demand	Challenges
Mechanical multi-crop threshers	Primarily imported, with distribution managed by various agricultural machinery suppliers across Zambia. Local manufacturing is limited.	High demand among farmers cultivating grains and legumes to enhance productivity and reduce labour costs	High costs, limited local manufacturing, reliance on imports, and insufficient access to financing
Tarpaulins and plastic sheets	Widely available through both imports and local production, distributed by agricultural dealers directly to farmers.	High demand, especially during the rainy season, for protecting crops during drying and storage.	Affordability issues, high-quality products often in short supply, and price variations depending on material and country of origin.

Hermetic bags	Produced locally and imported, with distribution through agro-dealers and third-party distributors nationwide.	Increasing demand due to effectiveness in protecting stored grains from pests and spoilage.	High costs, issues with durability due to improper usage, presence of counterfeit products, and need for ongoing education and capacity building.
Metal and plastic silos	Produced locally with some imports, distributed through agro-dealers and third-party distributors.	Moderate demand for effective grain storage solutions, particularly to reduce post-harvest losses.	High costs, need for proper installation and maintenance, limited local manufacturing capacity, and susceptibility to theft.
Moisture meters	Primarily imported, with distribution through agricultural equipment companies and third-party distributors, reaching both urban and rural areas.	Growing demand as farmers become more aware of their role in preventing spoilage during storage.	High costs, limited distribution, reliance on imports, and need for training programmes to ensure proper usage.
Storage structures	Commonly constructed using a combination of locally available materials or imported prefabricated items	High demand for reducing post-harvest losses and improving crop storage duration, especially among smallholder farmers.	High construction costs, limited availability, reliance on imports for larger structures, and insufficient access to credit facilities.
Storage protectants	Primarily imported, available through agrodealers and local vendors	Moderate demand, primarily for the protectants of natural/ biological origin	Health and food safety concerns due to the cases of wrong applications

Overall, several general trends were identified, including:

- Limited availability of locally produced equipment in the target markets, except for some of the solutions
- Medium potential for scalability of local production of FL-RS
- Challenges with the availability and quality of FL-RS in remote and rural areas
- Limited affordability and unproven return on investment of most solutions in those seven countries,
- Lack of business case and financing mechanisms for larger types of food loss reducing solutions

6.2 ADOPTION OF FL-RS SOLUTIONS

6.2.1 Barriers to adopt FL-RS

6.2.1.1 Smallholder farmer barriers to FL-RS adoption

The benefits and importance of using FL-RS are not known or not implementable by all smallholder farmers across the RE-GAIN programme's target countries. Adoption of new technology by farmers requires awareness creation and evidence that adoption of the FL-RS will give a return on investment to farmers. Farmers are cash constrained, especially at harvest time, and that limits their ability to invest in FL-RS such as hermetic bags and threshing or storage services at the time these investments are most needed. Farmers are hesitant to secure credit from credit institutions, such as microfinance institutions, not only because they are not sure of the return on investment of the FL-RS and the quality of the product but also due to their inability to generate cash from the sales of produce because they lack access to markets. This lack of market access further exacerbates their financial instability, creating a cycle of limited investment in production and low productivity. To address these issues, a multifaceted approach involving improved access to knowledge and incentives to adopt new technology and enhanced market linkages are essential.

6.2.1.2 Agricultural MSME barriers to FL-RS adoption

The use of FL-RS to be operated by Agricultural MSMEs including youth groups and cooperatives, is limited by the lack of proven business cases (capacity utilization, cost of operation, level of service fee) but also due to their limited access to

loan facilities because they lack collateral, a credit history, and have limited investment readiness (insufficient records of transactions and business operations).

6.2.2 Financial Institution barriers to supply agricultural solutions

Financial institutions consider the agricultural sector to be high-risk, due to the inherently unpredictable nature of agricultural profitability, influenced by factors like weather and market volatility, which generates volatile revenue streams. The high risk and cost of the agricultural sector results in banks charging high interest rates over short tenors, which put financial products beyond the reach of Agricultural MSMEs or add to their existing financial burdens. There is a notable lack of financial products tailored to the unique needs of agricultural value chains, which should ideally account for seasonality, climate risk, and the extended lead times between production, off-taking and selling to end consumers.

6.3 CURRENT SUPPLY OF FINANCIAL SOLUTIONS AND POTENTIAL PARTNERS FOR THE RE-GAIN PROGRAMME

In the RE-GAIN target countries, the promotion and financing of FL-RS requires involvement of the financial sector actors as well as enablers such as development programmes and non-government organisation (NGO)-led partnerships dedicated to building capacities and piloting approaches to reduce the high costs and risks related to adoption of FL-RS. In Table 6-8 identifies some potential partners with whom AGRA has been successfully working, who are implementing programmes and initiatives, or providing services that will directly and indirectly support the implementation of the RE-GAIN programme.

Table 6-8 State of Agricultural Finance Services in RE-GAIN countries

Country	Barriers to Access to Finance	Overview of current projects and initiatives focused on financing FL-RS	National Financial Products and Services providers	Potential Financial Partners for RE-GAIN Programme
Burkina Faso	• Financial Barriers: Lack of collateral, high interest rates, limited financial products. • Institutional Barriers: Risk perception, limited rural outreach, bureaucratic processes • Socio-Economic Barriers: Low financial literacy, gender disparities, informal financial practices.	• **Governmental Initiatives :** Fonds de Développement Agricole (FDA), Banque Agricole du Faso (BAF), Subsidy programmes • **Development Projects:** Agricultural Value Chains Support Project (PAPFA) • **Funding by NGOs:** Oxfam, Heifer International • **Microfinance Institutions:** MicroCred, ACEP Burkina, UCEC	• Banque Agricole du Faso (BADF) • Commercial Banks (Ecobank Burkina, Banque de l'Union (BDU), Banque Internationale pour le Commerce, l'Industrie et l'Agriculture du Burkina (BICIA-B), Coris Bank International (CBI) • Microfinance Institutions (RCPB, ACEP Burkina, PAMF) • Cooperative Banks and Savings Groups (Union des Banques Coopératives (UBC) and local cooperatives), Fonds d'Appui à la Sécurité Alimentaire (FASA)	• Banque de l'Union (BDU) • CORIS Bank International (CBI) • Banque Agricole du Faso (BADF)
Ethiopia	• Lack of collateral • Insufficient credit history • Limited financial literacy • Geographic accessibility • High risk in agriculture resulting in high interest rates	• **Government-led Initiatives:** Rural Financial Intermediation Programme (RUFIP), Regional Microfinance Support Programmes • **International Organizations and Donor-led Initiatives:**	• **Commercial Banks:** Commercial Bank of Ethiopia (CBE), Dashen Bank, Awash Bank, Bank of Abyssinia, Bunna Bank • **Microfinance Institutions (MFIs):** Amhara Credit and Savings Institution (ACSI), Oromia Credit and Savings Share Company (OCSSCO),	• Commercial Bank of Ethiopia (CBE) • Development Bank of Ethiopia (DBE) • Oromia Coop Bank (CBO) • Awash Bank • Dashen Bank

		USAID Feed the Future, FAO Microfinance for Agriculture, UNDP Inclusive Finance Programme, AfDB Africa Adaptation Acceleration Programme • **NGO and Private Sector-led Initiatives:** Oxfam RUSACCOs, CARE VSLAs, Farm Africa Access to Finance Programme, Self Help Africa, Vision Fund Ethiopia, Technoserve	Development Credit and Savings Institution (DECSI) • **Agricultural Cooperatives:** Development Bank of Ethiopia (DBE)	• Bank of Abyssinia • Bunna Bank
Kenya	• Lack of collateral • Insufficient credit history • Limited financial literacy • High interest rates • Lack of awareness of available financing options • High-risk perception by financial institutions	• **Government-led Initiatives:** Warehouse Receipt System (WHRS), Kenya Cereal Enhancement Programme, Climate Resilient Agricultural Livelihoods Window (KCEP-CRAL) • **Donor-led Initiatives:** "One to Many" approach by Bountifield and partners, E-soko mobile marketplace • **NGO and Private Sector Initiatives:** Juhudi Kilimo	• **Commercial Banks:** Equity Bank, Agricultural Finance Corporation (AFC), Co-operative Bank of Kenya, Absa Bank • **Microfinance Institutions (MFIs):** Juhudi Kilimo	• Equity Bank • Agricultural Finance Corporation (AFC) • Co-operative Bank of Kenya • Absa Kenya • Juhudi Kilimo • Equity for Kenya (EF-KEN)
Malawi	• Lack of collateral and credit history • Insufficient records of transactions and business operations • Limited financial literacy • High interest rates • Lack of financial products tailored to agricultural needs	• **Government-led Initiatives:** Government Input Subsidy Programme • Agriculture Commercialisation Programme (AGCOM) • Agriculture Commodity Exchange (ACE)	• Standard Bank Malawi • National Bank of Malawi • Malawi Agriculture and Industrial Investment Corporation (MAIIC) • FDH Bank Malawi • NBS Bank	• Malawi Agriculture and Industrial Investment Corporation (MAIIC) • Standard Bank Malawi • NBS Bank •
Tanzania	• Lack of collateral • High interest rates • Limited financial products tailored to agriculture • Limited rural outreach • Bureaucratic processes • Low financial literacy • Gender disparities • Reliance on informal financial practices	• **Government-led Initiatives:** Green Financing Programme, SIDO, Guarantees Scheme to Farmers' Organizations, • **Non-bank financial institutions:** Equity for Tanzania, PASS Leasing • **Donor-led Initiatives:** Farm to Market Alliance • **NGO-led Initiatives:** LULU SACCOS, ADHH Project	• Tanzania Agricultural Development Bank (TADB) • Financial Sector Deepening Trust (FSDT) • Commercial Banks (e.g., CRDB Bank (GCF accredited) , NMB Bank) • Microfinance Institutions • Agricultural Cooperatives and SACCOs	• NMB Bank • Tanzania Commercial Bank (TCB) • Tanzania Agricultural Development Bank (TADB) • Equity for Tanzania • PASS leasing
Uganda	• Lack of collateral • Insufficient credit history • Limited financial literacy • High interest rates	• **Government-led Initiatives:** Agriculture Cluster Development Project (ACDP), Agriculture Credit Facility (ACF), Parish Development Model	• Uganda Development Bank (UDB) • Commercial banks: Centenary Bank, Stanbic Bank • Agricultural Credit Facility (ACF)	• Stanbic Bank • DFCU • Centenary Bank • UDB

	• High-risk perception by financial institutions • Shortage of financial products tailored to agriculture • Lack of market access	• **Donor-led Initiatives:** World Food Programme's initiative, Soil and Land Management Programme • **NGO-led Initiatives:** Microfinance programmes (One Acre Fund), Agro-Ways Limited initiative, Agricultural insurance schemes	• Financial Sector Deepening (FSD) Uganda • Village savings and loan associations	
Zambia	• Lack of collateral • Lack of credit history • High interest rates • High-risk perception by financial institutions • Lack of financial products tailored to agriculture	• **Government-led Initiatives:** Sustainable Agriculture Financing Facility (SAFF), Farmer Input Support Programme (FISP), Citizen Economic Empowerment Commission (CEEC), Constituency Development Fund (CDF) • **Donor-led Initiatives:** Promotion of Village Savings Groups, Global Innovation Challenge/ Maano – Virtual Farmers Market, FL-RS Co-guarantee System (Vision Fund) • **Non-bank financial institution:** AgLeaseCo's Asset Financing	• AB Bank • Absa Bank Zambia Plc • Zambia National Commercial Bank (ZANACO) Plc • Atlas Mara Bank • Indo-Zambia Bank • National Savings and Credit Bank (NATSAVE Bank) • Agora Microfinance • AgLeaseCo	• ZANACO • ABSA • AgLeaseCo • Atlas Mara

The selection of the financial sector partners for the deployment of the financial models will be through a competitive process following the eligibility criteria outlined in section 6.4 for the specific models proposed to be used in the RE-GAIN programme.

6.4 RE-GAIN FINANCING MECHANISMS TO ENHANCE ACCESS TO FOOD LOSS REDUCING SOLUTIONS

The approach taken in the financial model design is focused on strategically using grants to catalyse the development of the market for food loss reducing solutions (FL-RS). These financial mechanisms are designed to address the current market dynamics and challenges faced by smallholder farmers and agricultural MSMEs. The mechanisms do this by enhancing the supply and affordability of FL-RS, thus creating a self-sustaining market and reducing the need for continued programme supportDespite the potential benefits these models offer, there are several challenges that need to be addressed to ensure effective access and leveraging of FL-RS through financing. One of the primary challenges in accessing FL-RS is the high initial cost of these solutions. Smallholder farmers and agricultural MSMEs often operate with limited capital, making it difficult for them to invest in new technologies and equipment without substantial financial support. This high-cost barrier discourages adoption and limits market penetration. Another significant challenge is the lack of financial products tailored specifically to the agricultural sector. Many financial institutions are hesitant to develop and offer products for smallholder farmers and MSMEs due to perceived high risks and low profitability. Consequently, there is a scarcity of suitable financing options that

can support the acquisition and implementation of FL-RS. Smallholder farmers and MSMEs often face difficulties in accessing credit due to stringent requirements set by financial institutions. These requirements typically include collateral, credit history, and other financial credentials that many small-scale agricultural enterprises lack. Without access to credit, these enterprises cannot afford to invest in FL-RS, hampering efforts to reduce food loss.

The effectiveness of FL-RS depends on the quality and appropriateness of the equipment for the local context. Manufacturers need to demonstrate innovation and reliability, but logistical challenges in distribution and maintenance can hinder the uptake of these solutions. Smallholder farmers and MSMEs require assurance that the products will be effectively distributed and maintained, which often involves local partnerships and training programs that are not always readily available. Financial institutions participating in the programme must have robust risk management frameworks to support the sustainability of financial models. However, the agricultural sector is inherently risky due to factors such as weather variability, market fluctuations, and pest outbreaks. These risks need to be adequately managed and mitigated to ensure the viability of FL-RS financing mechanisms.

Activities include interventions at the smallholder and youth group/co-operative levels, improving market linkages, and awareness creation to incentivize adoption of FL-RS. By leveraging partnerships, these models aim to share risks and incentivize market development. Manufacturers must meet specific eligibility criteria, demonstrating innovation and reliability, while financial institutions are required to develop inclusive financial products tailored to the agricultural sector. The programme also includes pathways for MSMEs to access FL-RS through input packages and prefinancing partnership arrangements. Conditional procurement and smart grants will reduce the cost and risk of providing loans to Agricultural MSMEs, aiming to create a self-sustaining market and reduce food loss

The models developed to enhance adoption and uptake of FL-RS consists of (1) conditional procurement for smallholder farmers to reduce the cost of hermetic technology and drying sheets and (2) smart grants to reduce the cost and risk of providing loans to Agricultural MSME buying FL-R equipment and storage solutions.

6.4.1 Solutions for smallholder farmers (part of activity 2.2.1)

Model 1 encourages the local provision of FL-RS interventions by employing conditional procurements to subsidize interventions at the smallholder farmer level, termed 'smart-subsidies.' Essentially, this model allows agro-dealers to offer FL-RS to smallholder farmers at a lower cost by using GCF funds to purchase one item for every two items bought and sold by an agro-dealer, passing the subsidy as a discount on the purchase price to the smallholder farmers:

- to boost production and manufacturing capacity by placing pre-emptive orders of FL-RS while managing risk by conditionally releasing funds to the manufacturer; and
- to lower the cost of interventions at the smallholder farmer level, thereby increasing profitability, driving additional demand, and promoting knowledge sharing about the benefits of these interventions.

An overview of Model 1 is presented in

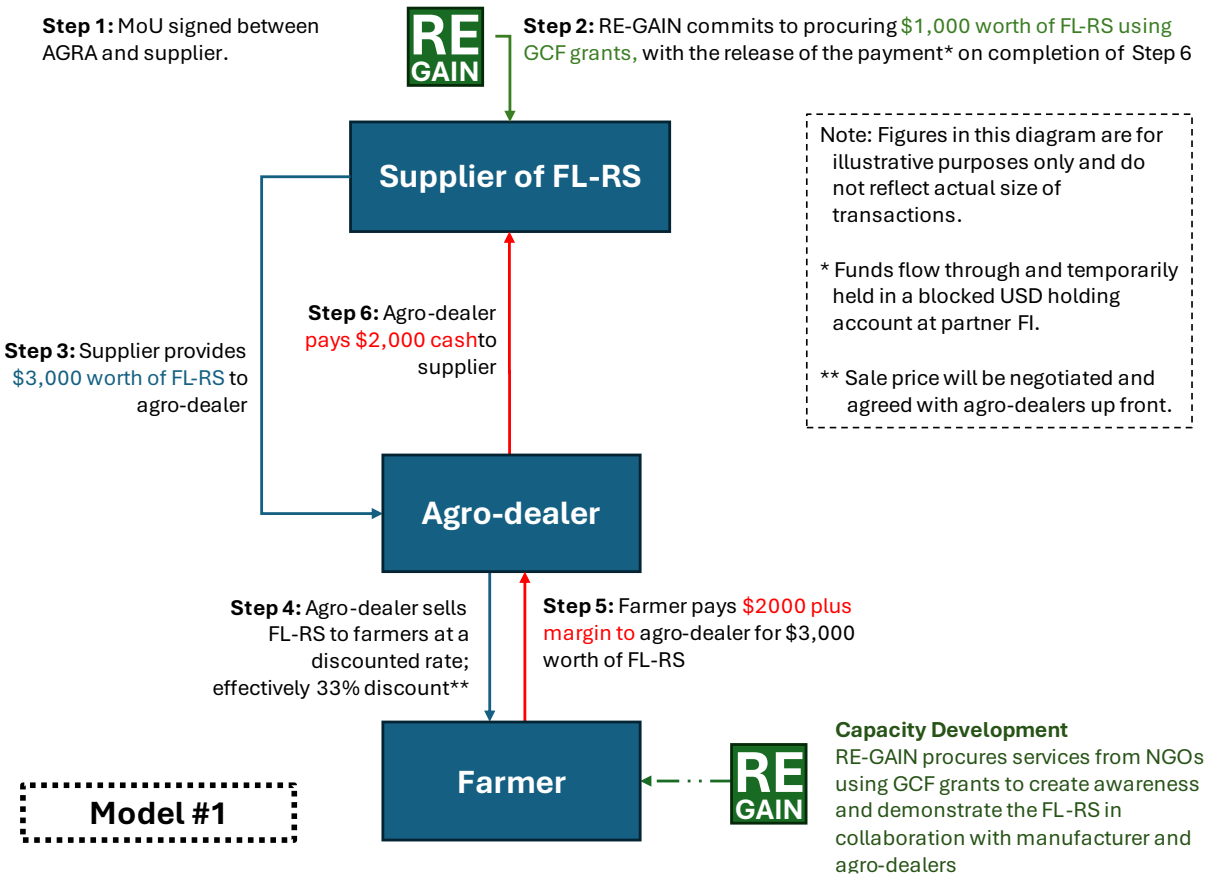


Figure 6-1, with more detailed descriptions of each step in the text that follows.

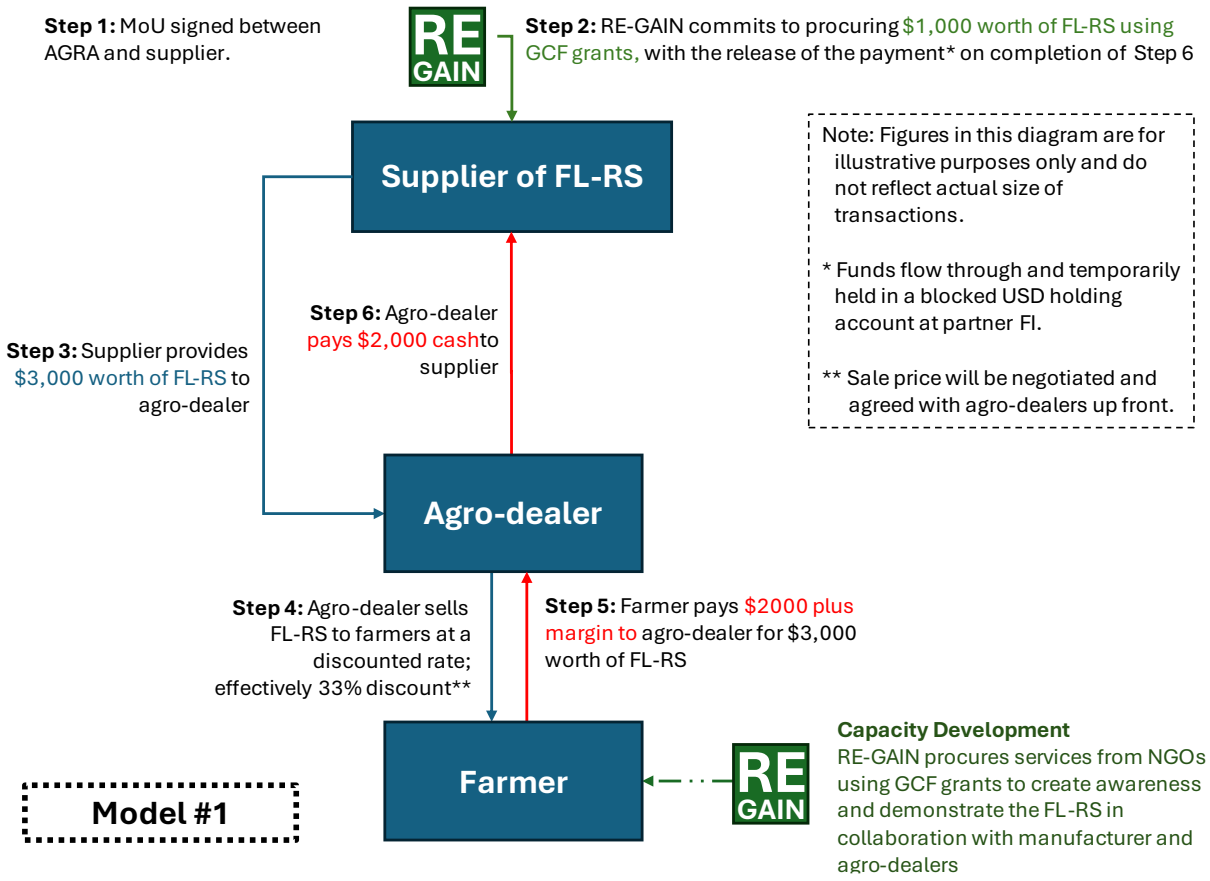


Figure 6-1 Model 1 for RE-GAIN Programme

The implementation of Financial Model 1 within the RE-GAIN programme begins with a facilitation process where AGRA enters into a memorandum of understanding with a supplier. Each supplier will act through its network of agro-dealers in regions where eligible smallholder farmers are located. This agreement sets out the details of the smart subsidy provided by RE-GAIN and the conditions on final sale price offered to the smallholder farmers. This initial step ensures that the eligibility criteria for the subsidies are clearly communicated to the agro-dealers, guaranteeing that the benefits reach the intended target groups.

The next step involves RE-GAIN placing an order for the FL-RS and depositing the value of the order into a holding account. This deposit remains in the holding account until the completion of subsequent steps. The supplier then provides three units to the participating agro-dealers for every one unit procured by RE-GAIN. Depending on the terms of the agreement, agro-dealers either pay for the two non-subsidized units upon delivery or receive them on credit.

Following this arrangement, the agro-dealers offer the FL-RS to smallholder farmers at a discounted rate, effectively transferring the full value of the smart subsidy provided through GCF support. The agro-dealers keep detailed records of the buyers of the subsidized goods, including a limit on how many units each person can purchase to prevent resale and maintain the demonstration goal. This monitoring allows RE-GAIN to ensure the benefits are reaching the target groups and achieving the intended impact.

Smallholder farmers then buy the FL-RS at the discounted rate. The agro-dealers subsequently makes payment to the manufacturer for two units for every one unit of the initial procurement from RE-GAIN (if not already paid on delivery). In cases where an FI is not involved, this payment and a corresponding report trigger the release of the smart subsidy payment from RE-GAIN to the supplier. If an FI was involved, the release of the smart subsidy depends on the repayment of the loan.

Suppliers, agro-dealers, or farmers requiring additional financing for their role in the system can seek support from local financial institutions available in all target countries. For instance, if a supplier needs extra working capital or capital investment to meet increased FL-RS demand, they can arrange a loan with a financial institution to address liquidity requirements for providing FL-RS. Although AGRA may offer guidance to suppliers or agro-dealers on such matters, the agreements themselves will fall outside the scope of the RE-GAIN Programme and will not involve AGRA. The orders placed through RE-GAIN will help mitigate the financial institution's risk in providing loans to suppliers. However, no RE-GAIN Programme funds will be used to lend to suppliers or make payments to financial institutions.

This model benefits all parties involved, with the manufacturer receiving full payment for the FL-RS, the agro-dealer earning income from their markup, and the farmers acquiring FL-RS at a discounted rate. The established market will allow manufacturers to increase production with reduced risk, ultimately lowering the cost of FL-RS in the local market and enabling the smart subsidies to be phased out over time.

The selection of the specific partners AGRA will engage with in the deployment of this model follows the eligibility criteria below:

6.4.1.1 Eligibility Criteria for Suppliers of FL-RS for Individual Farmers

These partners will be selected in the RE-GAIN programme's target countries based on the criteria below:

- Legal capacity to operate: Registration (and ability to produce registration certificate) as a sole trader, partnership, franchise, cooperative, or limited liability company in good order with the local tax authorities
- If operating as an importer, evidence of compliance with import permits
- If appropriate, demonstrated compliance with any Environmental standards or requirements to obtain licences or environmental impact assessments, reports or management plans as required by local laws
- Proof of VAT registration
- Preferably a track record of producing and selling FL-RS as defined as part of the RE-GAIN programme that is approved by the national authorities
- Evidence of record keeping, including financial records;
- Willingness and financial capacity to expand the production levels and distribution network (agrodealers, cooperatives, development projects,) for the FL-RS
- Willingness and financial and human capacity to develop and deploy (subsidized) marketing efforts to enhance uptake of the FL-RS among small scale producers
- Presence in the target regions in the selected countries for the programme;
  Preferably engaging in the provision of solutions for smallholder farmers

6.4.1.2 Eligibility Criteria for Agricultural Traders, Processors, and Agrodealers

These partners will be selected in the RE-GAIN programme's target countries based on the criteria below:

- Legal capacity to operate: Registration (and ability to produce registration certificate) as a sole trader, partnership, franchise, cooperative, or limited liability company in good order with the local tax authorities;
- If operating as an importer, evidence of compliance with import permits;
- If appropriate, demonstrated compliance with any Environmental standards or requirements to obtain licences or environmental impact assessments, reports or management plans as required by local laws;
- Proof of VAT registration;
- Preferably a track record of stocking and selling FL-RS as defined as part of the RE-GAIN programme preferably of the selected manufacturer or importer;
- Evidence of record keeping, including financial records;
- Willingness and financial capacity to stock hermetic technology at the right time (harvest);
- Presence in the target regions in the selected countries for the programme;
- Preferably engaging in the provision of additional services to small scale producers like moisture meters, training, credit and after sales services (aggregation, access to markets).

6.4.1.3 Eligibility Criteria for Smallholder Farmers and Communities

- Smallholder farmers in specific or selected project geographical location with land sizes of between 0 – 2.5 hectares;
- Smallholder farmers (as defined above) that growing relevant crops (usually staples crops);
- Smallholder farmers that are members of local farmer groups in the targeted geographical areas;
- Smallholder farmers with limited access to farming inputs;
- Smallholder farmers with limited level of access to extension services;
- Smallholders that are below the local poverty line or that are food insecure;
- Farmers selected by local community and/or government leadership as priority and or vulnerable farmers (these usually include productive farmers that serve as model farmers, youth, women, special/marginalised groups)

6.4.2 Solutions for Agricultural MSMEs

The second financial model is specifically targeted at assisting Agricultural MSMEs to invest in higher value items FL-RS (equipment and storage), with prioritisation given to vulnerable groups, by employing grants to enable acquisitions.
The primary objectives of Model 2 are twofold:

- Enhancing Creditworthiness: By leveraging repurchase assurances from suppliers, the model aims to reduce the loss given default, thereby enhancing the creditworthiness of the youth groups and cooperatives involved.
- Reducing borrowing costs: Through a combination of the lowered credit risk (as per above) and subsidies on the purchase price. The structure will ensure higher valueFL-RS become more affordable and thus accessible to youth groups who provide services to smallholder farmers.

At the core of Model 2 is the engagement of local youth groups, poised to act as service providers for FL-RS, requiring high-cost equipment that can service multiple farmers. This includes harvesting machinery, mechanical multi-crop threshers and shellers (preferably solar-powered), moisture meters, and communal storage structures. The establishment of these service operations will be supported through business development initiatives, ensuring that youth groups have a solid foundation to provide reliable services. This approach leverages several key concepts to achieve the targeted benefits:

- **Collectivism:** By pooling resources, smallholder farmers benefit from economies of scale through cost sharing and increased bargaining power with off-takers, promoting further profitability and additional demand for FL-RS.
- **Post-harvest Handling:** Enhancing the quality and quantity of agricultural produce allows smallholder farmers to capture more value, thereby increasing their incomes.
- **Inclusion of Financiers:** Engaging financial institutions will unlock access to finance in a traditionally underserved market. The structure aims to reduce credit risk by providing a partial subsidy, which will lower borrowing costs due to the smaller loan size and reduced interest payments.

The concessional support under this model is primarily aimed at youth groups as a means of fostering livelihood development for these vulnerable community members. However, when paired with business development assistance, the RE-GAIN programme enables youth groups to structure their service fees to reflect the actual (discounted) cost of the equipment. This approach allows them to offer services at fair rates, thereby indirectly transferring the benefits of the concessional support to the farmers utilizing these services.

An overview of Model 2 is presented in

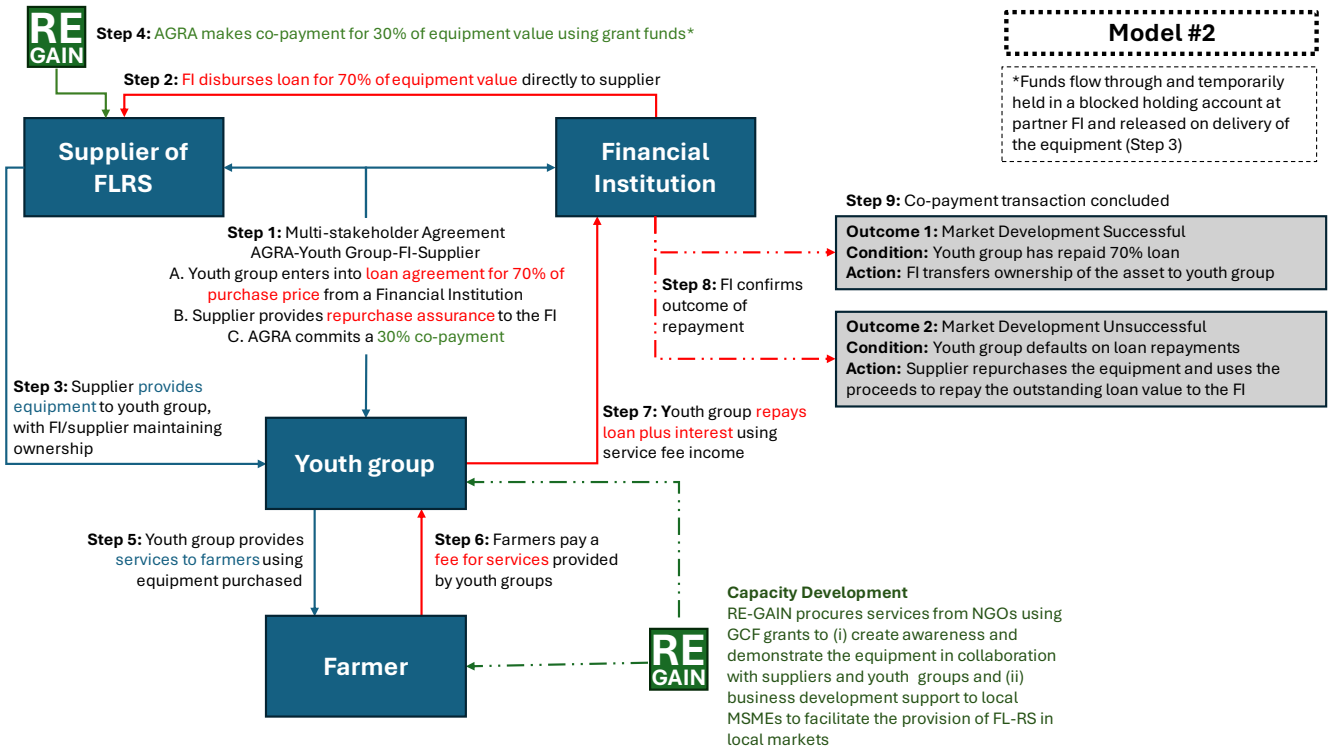


Figure 6-2, with detailed descriptions of each step in the following text. While RE-GAIN will facilitate the establishment of the entire process, its active involvement beyond Step 4, with ownership of Steps 5-9 transitioning to the three partners: youth groups, suppliers, and financial institutionswho will enter into a separate loan agreement to which AGRA will not be a party.

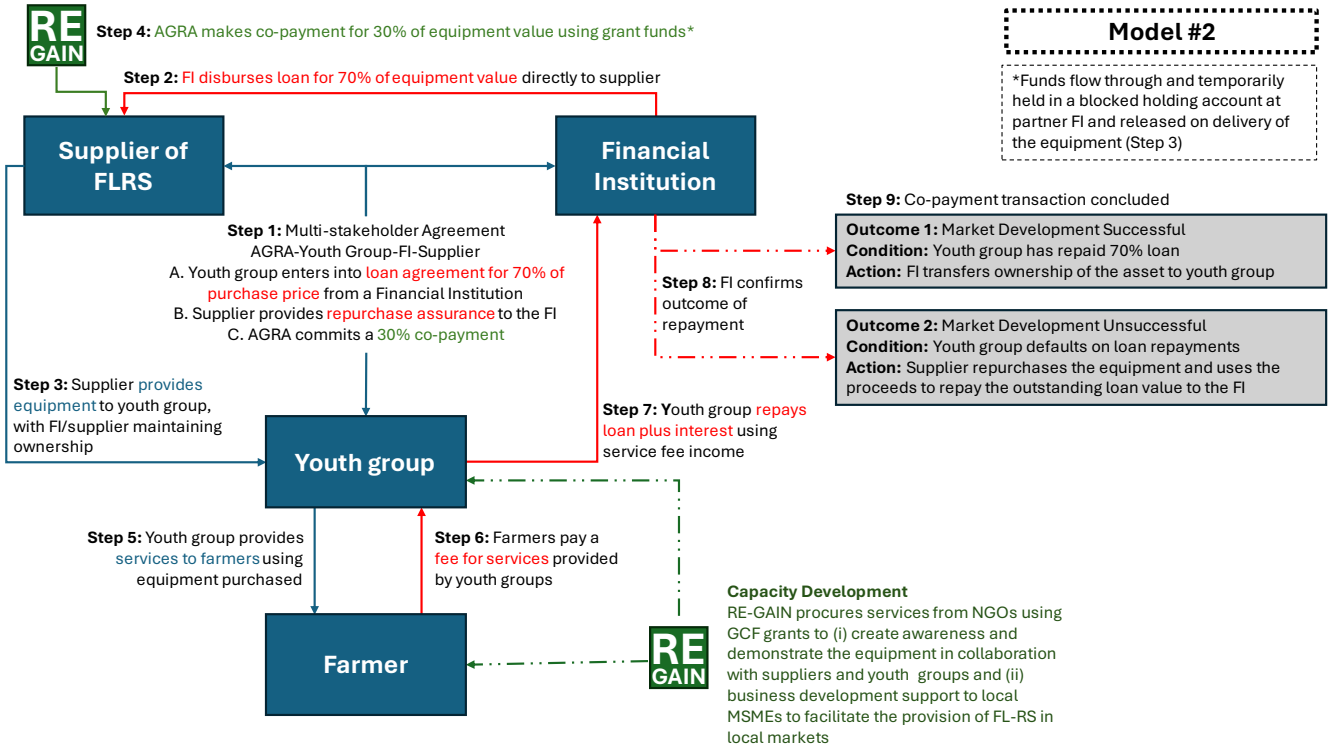


Figure 6-2 Model 2 for RE-GAIN programme

RE-GAIN programme will facilitate the initiation of collaborations between youth groups, suppliers, and financial institutions (FIs). This collaborative effort will be formalized through the signing of a multi-stakeholder agreement. According to this agreement, AGRA commits to an upfront co-payment covering 30% of the purchase price for the specified equipment. This commitment is contingent upon the youth group agreeing to cover the remaining 70% of the cost. To facilitate this payment, the youth group will secure a loan from the partner FI, while the supplier will provide a repurchase assurance, thus distributing the financial risk between the supplier and the FI. RE-GAIN will oversee the negotiations, ensuring that all aspects of the agreement align with the established eligibility criteria.

Once the multi-stakeholder agreement is in place, the FI will transfer the 70% down-payment directly into the supplier's account on behalf of the youth group. This transaction will initiate the next steps. Concurrently, the remaining 30% co-payment will be deposited into a blocked USD holding account, where it will remain until the equipment is delivered, at which point its release will be triggered.

Upon receiving the 70% payment from the FI, the supplier is obligated to deliver the equipment to the youth group. Following the delivery, the supplier will report the successful receipt of the equipment to AGRA's RE-GAIN PIU. Upon receipt of the delivery report from the supplier, AGRA will release the 30% co-payment from the holding account to the supplier, thereby completing the initial purchase agreement. At this juncture, the youth group will assume control over the use of the equipment. However, the ownership of the assets will remain with the supplier or the FI, depending on the terms agreed upon during the initial negotiations.

With the equipment now in their possession, the youth group will commence providing FL-RS services to local farmers. To ensure the successful operation of the service enterprise, capacitation support will be provided, ensuring that the youth groups are adequately trained and capacitated to offer reliable and efficient service.

The smallholder farmers will pay the youth group for the FL-RS service, with the youth group collecting income from multiple farmers, thereby distributing the cost of the equipment across multiple beneficiaries. The youth groups will use the income from the services to make repayments to the FI on the loan, covering the cost of the loan and the agreed interest. The upfront co-payment through RE-GAIN reduces the repayment burden on youth groups compared to a scenario where a 100% loan would have been required, thereby decreasing the loan loss given default.

At the end of the agreed loan period, the FI will conclude the transaction and report on the outcome of the repayment. The conclusion of the transaction will lead to one of two possible outcomes:

- In the first scenario, market development was successful, indicated by the youth group operating an FL-RS service and enabling the full repayment of the loan. Under this outcome, the ownership of the asset will be formally transferred to the youth group, allowing them to continue offering the service beyond the initial agreement, without the costs of servicing the loan.
- In the second scenario, market development was unsuccessful, indicated by the failure of the youth group to make the required repayments on the loan. In this case, the supplier's repurchase assurance is triggered, through which the supplier buys back the asset (accounting for depreciation). The value of the repurchase will first go towards the repayment of any outstanding loan amount and any associated transaction fees. Should the repurchase value exceed the outstanding loan amount, any remaining value after transaction fees will be transferred back to the youth group to compensate for any payments made before default.

Model variations may be introduced depending on the local context and nature of FL-RS. In all cases, GCF grants will be used to make a co-payment on the equipment on behalf of the beneficiary (youth group or MSME), thereby reducing the financial burden of the transaction and de-risking the transaction for the suppliers or FIs involved in the agreement.

The selection of the specific partners AGRA will engage with in the deployment of this model follows the eligibility criteria below:

6.4.2.1 Eligibility Criteria for Supplier FL-RS for Equipment

These partners will be selected in the RE-GAIN programme's target countries based on the criteria below:

- Legal capacity to operate: Registration (and ability to produce registration certificate) as a sole trader, partnership, franchise, cooperative, or limited liability company in good order with the local tax authorities
- If operating as an importer, evidence of compliance with import permits
- If appropriate, demonstrated compliance with any Environmental standards or requirements to obtain licences or environmental impact assessments, reports or management plans as required by local laws
- Proof of VAT registration
- Preferably a track record of producing and selling FL-RS as defined as part of the RE-GAIN programme that is approved by the national authorities
- Evidence of record keeping, including financial records;
- Willingness and financial capacity to expand the production levels and distribution network (agrodealers, cooperatives, development projects,) for the FL-RS

- Willingness and financial and human capacity to develop and deploy (subsidized) marketing efforts to enhance uptake of the FL-RS among small scale producers
- Presence in the target regions in the selected countries for the programme;
- Preferably engaging in the provision of solutions for smallholder farmers

6.4.2.2 Eligibility criteria for financial institutions

These partners will be selected competitively in the RE-GAIN programme's target countries based on the criteria below:

- Financial institutions must demonstrate they are licensed, regulated and supervised by the relevant authorities (Central Bank, MFI regulatory body, cooperative agency) and in compliance with any prudential liquidity requirements
- Experience and willingness to offer asset financing facilities of between USD 1.000 and USD 10.000 to equipment buyers and/or operators
- Willingness and ability to engage with Agricultural MSMEs or cooperatives and other key actors in the value chains;
- Willingness to open an escrow account in AGRA's name at no/low cost and interest rate offered on the AGRA deposit
- Preferable presence (branch or agents) in theregions where the programme will be implemented

6.4.2.3 Eligibility criteria for Youth Groups, MSMEs and Cooperative

These partners will be selected in the RE-GAIN programme's target countries based on the criteria below:

- Registration certificate if formally required under national laws;
- Copy of constitution, and full list of members and officials;
- Preferably a track record (based on physical records) as a service provider to small scale producers (can be in extension, aggregation of produce, selling of inputs or provision of mechanized services);
- Preferably presence in the target regions in the selected countries for the programme and qualified staff or members that have experience in operating, repairing and servicing the machinery;
- Willingness and ability to buy machinery for the purpose of renting it out to small scale producers;
- Willingness and financial capacity to develop and deploy marketing efforts to enhance uptake of the FL-RS services among farmers;
- Preference will be given to women and youth-led MSMEs;
- Preference will be given to those already engaging with business planning activities

6.5 SUPPORTING AN ENABLING ENVIRONMENT FOR FL-RS ADOPTION AND UPTAKE

Besides the availability and affordability of FL-RS, building a strong enabling environment remains a critical factor for the success of RE-GAIN programme implementation. The lack of progress in food loss reduction is attributable to several factors, including inadequacies in policy and regulatory frameworks and the general lack of capacity among mandated institutions to

drive effective strategies, technologies, practices, and initiatives for post-harvest loss reduction. These barriers can be solved by leveraging activities that can strengthen policy and regulatory frameworks and institutions on post-harvest losses, enhancing the enabling environment in the programme countries to best drive systemic changes in the post-harvest food loss space. This will be addressed through the Component 3 of the Programme and its specific activities, working with mandated government institutions in the areas of focus across the different countries in scope of the programme. The activities include:

1. Examine existing national and sub-national legislation and policies related to food loss reduction, to identify gaps, and inconsistencies and address policy barriers.
2. Support policy and regulatory reforms that change the incentive structure; create an enabling environment to attract investments; and encourage the adoption of best practices on food loss reductions. Specific policy reforms include:
    - Regulated quality-based pricing system as an incentive to invest in loss-reduction technologies and practices;
    - Tax exemption on imports, financial incentives (including subsidies) for local manufacturers of post-harvest technologies to make proven technologies more available, accessible, and affordable;
    - Efficient Warehouse Receipt Systems to accelerate the efficient removal of the crop from the farmer into safe centralized storage;
    - Development of national policy and technical regulation for aflatoxin control;
    - Policies and programmes that promote science, innovation and the adoption of climate-smart technologies and practices;
    - Develop new legislation to promote compliance with regulatory standards and uptake of interventions to reduce post-harvest loss

AGRA will also support legislative bodies and mandated institutions to enact necessary laws and regulations to support the implementation of these policies:

1. Support domestication of existing Regional Post-harvest Loss Management Strategies;
2. Support the development of national strategies, policies, and legislation enabling food loss reduction in line with national agrifood system objectives and policy frameworks;
3. Support the development of programmes and initiatives to improve the availability of accessible weather information;
4. Support the development and implementation of national food loss strategies and action plans, ensuring policy coherence and mutual accountability through multistakeholder, intersectoral and inter-ministerial collaboration and coordination to align visions and interests of all stakeholders and sectors;
5. Support the development of collaboration platforms across industry players and key value chain actors, including academia, research centers and innovation hubs to share knowledge and best practices on food loss reduction;
6. Supporting Public-Private Partnerships, that allow for greater collaboration between the government and private sector to invest in innovative post-harvest technologies, modern storage facilities and transportation logistics;
7. Strengthen institutional capacity for effective partnership, cooperation, and engagement of post-harvest management stakeholders to facilitate the execution of planned interventions

Active involvement and support from government organizations, both central and local, will be crucial. RE-GAIN programme will align with other projects and programmes mentioned in Chapter 2, to leverage synergies, utilize existing laws and policies on FL reduction, smallholder farmer support, and ensure effective and efficient programme management. In all seven

countries, RE-GAIN programme will prioritize inclusivity for women, youth, indigenous people (where present), and minority groups, and all value chain actors in the planned activities.

Table 6-9 summarises strategic approach for the RE-GAIN programme for all seven target countries:

Table 6-9 Systematic approach to creating enabling environment for the success of the RE-GAIN programme

Strategic pillar	Key activities	Expected Outcome
Policy Support and Revision	• **Examine existing national and sub-national legislation and policies:** Review current legislation and policies related to food loss reduction to identify gaps, inconsistencies, and barriers. • **Support policy and regulatory reforms**: Facilitate reforms that change the incentive structure, create an enabling environment for investments, and encourage the adoption of food-loss best practices. Specific policies and regulatory frameworks are described above.	A supportive policy environment that enables the successful implementation of the RE-GAIN programme and widespread adoption of FL-RS solutions.
Legislative Support and Capacity Building	• **Develop national strategies and policies:** Support the creation of strategies and legislation that align food loss reduction efforts with national agrifood system objectives. • **Support Public-Private Partnerships (PPPs):** Promote PPPs to enhance collaboration between government and the private sector, investing in innovative post-harvest technologies, modern storage facilities, and transportation logistics. • **Strengthen institutional capacity:** Build capacity for effective partnerships and stakeholder engagement to facilitate the execution of planned interventions.	Advocate for the development of initiatives and legislation that can strengthen both food-loss reduction activities as well as strengthen institutions to drive systematic transformation.
Awareness and Communication:	• **Establish platforms for knowledge sharing**: Support the creation of collaboration platforms among industry players, value chain actors, academia, and research centers to share best practices in food loss reduction • **Advocate for distribution of accessible weather information:** Support governments' initiatives to provide more easily accessible weather information, and support campaigns to raise the profile of these initiatives across the different countries	Strong awareness about the impact of increased FL-RS adoption and its impact on food loss reduction, climate change mitigation, and incomes of smallholder farmers
Government Alignment and Synergy Building	• **Actively involve central and local government:** Establish formal partnerships with relevant government bodies at both central and local levels. Facilitate regular meetings and consultations to ensure alignment of the RE-GAIN programme with national and regional development priorities. • **Promote collaboration across sectors**: Facilitate the development and implementation of national food loss strategies and action plans through multistakeholder, intersectoral, and inter-ministerial collaboration. • **Coordinate with other projects to create synergies:** Work closely with other development projects and programmes to identify areas of overlap and collaboration. Develop joint action plans, share resources, and coordinate activities to maximize impact and avoid duplication of efforts.	Strong collaboration with government entities and other programmes, leading to a more cohesive and impactful implementation process.

6.6 CONCLUSIONS ON THE MARKET STUDY

The proposed solutions at the RE-GAIN programme are not unknown in the markets in scope for the RE-GAIN programme. However, there are clear challenges and gaps that the programme aims to focus on to tackle by empowering both supply and demand of these solutions, as well as improving the capacity of those using these solutions, alongside with mainstreaming knowledge related to climate resilience in the harvest and post-harvest stages of the selected value chains. Beyond working closely with smallholder farmers, there is also a need to influence and strengthen the enabling environment to reduce food losses.

The proposed RE-GAIN programme leverages what already exists in the target countries when it comes down to harvest and post-harvest food losses and aims to further strengthen and build the market in the country for harvest and post-harvest solutions by tackling the challenge from different angles and ultimately strengthening the country's agrifood system's climate resilience.

7 Theory of Change

7.1.1 Goal Statement

IF the capacity of the target countries and communities to respond to climate-triggered food losses is strengthened through improved and inclusive access to financing, promotion of context-specific and gender-responsive innovations to reduce food losses, and better enabling conditions for public and private investments, **THEN** smallholder farmers will have enhanced food security and livelihood resilience, **BECAUSE** the widespread use of food loss-reduction technologies will reduce food loss and reduce the carbon footprint of food systems, while increasing household income and building the resilience of smallholder farmers, MSMEs and rural communities to climate shocks.

7.1.2 Barriers

Several barriers currently impede the uptake of food loss-reducing solutions in Africa. While the specifics of each barrier might vary between countries and farming systems, six common barriers have been identified, cutting across several themes, including limited knowledge of the options available and capacities to use what is available, access to and supply of affordable harvesting and post harvesting equipment and technologies, and access to sustainable and inclusive finance opportunities, all encompassed by an overarching lack of an enabling environment. An outline of these core barriers is presented below, with deeper country-specific analysis provided in the appendices to the Feasibility Study (Annex 2).

Barrier 1: Inadequate access to information and solutions for smallholder farmers

While most smallholder farmers are acutely aware of the impacts of post-harvest losses on their food and income security, many do not have access to the information needed to adopt improved post-harvest processing and storage practices needed reduce such losses. The resulting knowledge gaps extend across the full range of peri- and post-harvest processes — including harvesting, handling, storage, transporting, and packaging of agricultural commodities – and are typically more significant for women-managed farms, contributing to notable gender gaps in farm productivity and profitability. For some farmers, the knowledge gaps are fundamental, in that they lack the basic understanding of resilient post-harvest processes and the options available to reduce food loss. For others, there is a general understanding of the need for improved practices, or even the availability of food loss-reducing solutions (FL-RS) but lack the understanding of where and how to access such solutions, or how to properly implement them. These knowledge gaps are systemic in the agriculture sector of the target countries, with limited integration of FL-RS information into sectoral policies and agricultural extension services. As a result, farmers lack access to the required information to adopt FL-RS. Overcoming this barrier requires a combination of targeted and inclusive awareness raising among smallholder farmers, as well as the establishment of an enabling environment in which information on FL-RS is mainstreamed into agriculture sectoral policies and support services.

Barrier 2: Limited awareness of climate change and climate risks

As noted above, climate change impacts the agriculture sector across its entire value chain – from production, through harvest, storage, processing and distribution. Despite this significant impact, many smallholder farmers do not fully understand climate change and the associated climate risks and the impacts they have on food security, and consequently are not adequately motivated to adopt resilient solutions. Given that the impacts of climate change on the agricultural sector are expected to increase in the future, the consequences of inaction stemming from limited awareness will become increasingly severe. Although there is growing understanding among farmers of the impacts of climate change on production – particularly as observed during increasingly frequency extreme climate events – such awareness is less prevalent for post-harvest losses. This is partly due to the links being less obvious to the observer, for example where a changing climate

influences the prevalence of pests or disease during storage. This lack of awareness perpetuates the information gaps noted in Barrier 1. Specifically, when a farmer does not understand the links between climate change and food loss, efforts to seek resilient solutions are often subdued. Moreover, a lack of awareness of potential future climate trajectories exacerbates the problem, as farmers are less likely to act early if they don't understand how the problem of climate change-induced food loss will increase over time.

Barrier 3: Lack of appropriate harvest and post-harvest technology

While a wide range of FL-RS options have been developed globally, penetration of such solutions into smallholder farming communities in Africa is limited due to limited access to technologies and practices, low community engagement and insufficient demand and perceptions of risk from FL-RS providers. This lack of market penetration has been attributed to several closely linked factors. First, because of the limited awareness noted in Barriers 1 and 2, there is currently limited demand for FL-RS in rural communities. The lack of demand is further exacerbated by unavailability of working capital or access to affordable finance (see Barrier 4 below), with many farmers therefore considering it unfeasible even if they wanted to adopt improved FL-RS.

Second, as a result of the limited demand, suppliers have not demonstrated sufficient interest to develop the market for FL-RS. In particular, without the economies of scale driven by sufficient demand, FL-RS providers are not incentivised to develop localised production, distribution networks and markets that would bring the cost of FL-RS down. This also inhibits research into improving FL-RS solutions that could improve efficiency or affordability of the products.

Third, the development of local markets for FL-RS is further constrained by the perceived risk for suppliers of engaging with smallholder farmers. As with financial institutions, FL-RS providers need to balance risk in setting up operations within, and providing services to, smallholder farming communities. Creating a market for smallholder farmers – for whom working capital is limited – requires innovative market tools to be developed, many of which require the sharing of risk between different stakeholders – including providers, users and financial operators. However, such systems ultimately rely on the ability of smallholder farmers to secure sufficient income from their produce. Consequently, FL-RS suppliers often perceive smallholder farmers as high risk because of their general limited capacity to sustainably produce, process and market agricultural goods.

The ultimate result of these challenges is that smallholder farmers do not have easy access to affordable FL-RS. To overcome this barrier, a catalyst is required to initiate demand and establish a sustainable local market that would provide the necessary incentives to attract FL-RS providers.

Barrier 4: Limited access to finance for FL-RS uptake

As noted above, the market for FL-RS for smallholder farmers in Africa is influenced by the lack of access to markets for smallholder farmers, working capital for MSMEs and access to finance for equipment purchase. While there is a diverse financial market across all target countries — ranging from commercial banks to micro-finance institutions (MFIs) — several inter-related factors impede access to finance. First, MSMEs are perceived as high risk, largely because of the uncertainty of production (particularly for rainfed agriculture under changing climate conditions) and limited access to smallholder produce. The feasibility of agricultural loans is dependent on MSMEs being able to develop a profitable business case for the FL-RS equipment to be able to repay the loan at the end of the season. However, the vast array of factors that impact the business case creates a high level of uncertainty, while inadequate on-farm post-harvest storage and processing can lead to further food losses before a farmer is ever able to use the FL-RS services . This uncertainty is being exacerbated by climate change, with growing risk that entire harvest can be lost in a single extreme climate event. Consequently, FIs are often hesitant to provide agricultural loan products that target agrifood MSMEs in instances where financial products have been developed, the terms of the credit are often untenable for agrifood MSMEs .

Second, and exacerbating the risk perceptions mentioned above, is the lack of or limited collateral and track record among smallholder farmers and the companies serving them, including youth groups, agro dealers and cooperatives. To offset the risk and comply with Central bank regulation, FIs generally require collateral from the borrowers, generally in the form of an immovable asset, such as land or property. However, most small and medium sized enterprises especially women and youth led businesses lack suitable collateral or have already pledged their assets, restricting access to available finance products. For example, land tenure arrangements in rural areas of Africa are generally dominated by communal land rights, in which land is not owned by the individual, but rather an individual is given access to land under customary law. In such instances, the land cannot be used as collateral, and in the absence of other valuable assets, entrepreneurs cannot meet the collateral requirements. This challenge is generally amplified for women and other vulnerable groups who have less access to and control of assets due to sociocultural norms and practices that override the implementation of gender equitable laws (which now in exist in many African countries) relating to land and inheritance. Another factor commonly used to offset risk is the presence of a strong track record; the business case for FL-RS service provision is not proven in many countries, hence the hesitation for financial institutions to invest in productive assets that will be rented out or used by small scale farmers. To create sustainable and more equitable markets for FL-RS, it is essential to improve access to affordable finance for agripreneurs. This requires innovation in the market, working with various stakeholders to develop innovative finance products that share the risk and maximise opportunities for the sustainable adoption of FL-RS. Such innovations need to consider – and address – gender disparities in access to collateral, farm productivity, and control over use of proceeds, to ensure such financial support is accessible to both women and men. This includes enabling activities, such as the sensitization of local communities on women's land rights, as a basis for promoting women's greater ownership and control over land and other productive assets, all of which are key enablers for securing credit

Barrier 5: Inadequate policy and regulatory frameworks to enable FL-RS investments

Development of national policies, strategies, frameworks and implementation plans aiming to address agricultural sector and climate change challenges has been a priority for many of the African governments in the recent years. Despite this, there are still considerable gaps in the policy and regulatory environment across the target countries that impede the mainstreaming of sustainable FL-RS in the agricultural sector. This gap is underpinned by several factors. First, there is limited or no use of the scientific evidence base in the formulation of policies and strategies on post-harvest loss reduction. This challenge is exacerbated by limited technical and institutional capacities and systems for institution-level data collection, monitoring, and evaluation of implementation and effectiveness policies and programmes.

Second, policies generally lack coordination and harmonisation across sectors, limiting opportunities for integrated approaches to building resilience in the agriculture sector. For example, the volatility and vulnerability of food systems, and associated food loss, is often exacerbated by poor infrastructure and/or uneven and deteriorating power or energy access; and the lack of harmonisation of policies across these different sectors prevents collaborative action, perpetuating the challenges.

Third, where policies or regulatory frameworks are in place, they are often constrained to agricultural input subsidies — mainly for fertilizer and seeds — with no subsidy on post-harvest technologies. This further extends to the focus of information and extension services, which are generally geared towards primary production, and less so to post-harvest processes. Similarly, existing taxation regimes do not favour or incentivise investments in storage and processing technologies for food in the smallholder system.

The underdeveloped private sector in these countries require policy incentive mechanisms, for example import tax exemption that would enable reduction of cost of import and distribution of FS equipment and services. Further, tax exemptions on key

components that can be used in the manufacturing or assembly of FL-RS should also be a key consideration in these countries.

The lack of access to finance as described above is also restricted by Central bank regulation and prudential guidelines on loan loss provisioning, consideration of movable assets as collateral and value of guarantees for banks in reducing their reserve requirements. Addressing these policy barriers can unlock financing for equipment (movable assets), storage facilities (fixed assets) and other FL-RS identified. The existence of warehouse receipt legislation and authorities are also an important factor to consider enhancing the uptake and usage of storage solutions. Without cash in hand at harvest, farmers will be hesitant to store their produce.

Barrier 6: Insufficient public sector capacity to steer investments in FL-RS

Actions to overcome the full range of barriers described above require a strong public sector to create the enabling environment and steer investments into FL-RS. The public sector plays an important role in steering investment, not only by creating an enabling policy environment (see Barrier 5), providing context-specific extension and advisory services to smallholder farmers but also through its role in coordination and as a facilitator of public-private-community partnerships. However, public sector actors across the target countries currently have limited technical and institutional capacity to create the required enabling environment. This barrier is partly rooted in human capacity constraints, with insufficient staff available in key public institutions stretching available human resources; but also in the technical capacity of those staff that are available to facilitate investments, technology adoption and partnerships. This includes public sector staff having limited understanding and awareness of FL-RS and the innovative models available to develop sustainable business and market opportunities.

7.1.3 Proposed Solution

The proposed project will contribute to food security in seven African countries by promoting the wide-scale adoption of Food Loss-Reduction Solutions (FL-RS) among smallholder farmers. In addition to increasing the amount of food available for consumption due to reduced losses, this approach will also improve the quality of produce leaving the farms, thereby increasing nutritional value, marketability and income potential, while simultaneously reducing the substantial GHG emissions associated with food loss. To achieve the project goal, and actions, will be taken across three primary pathways — farmer-centric, supplier-centric, and institutional support — which together will form the foundation of a sustainable and scalable market for FL-RS in the target countries. Interconnected solutions addressing food loss under smallholder setting of Africa.

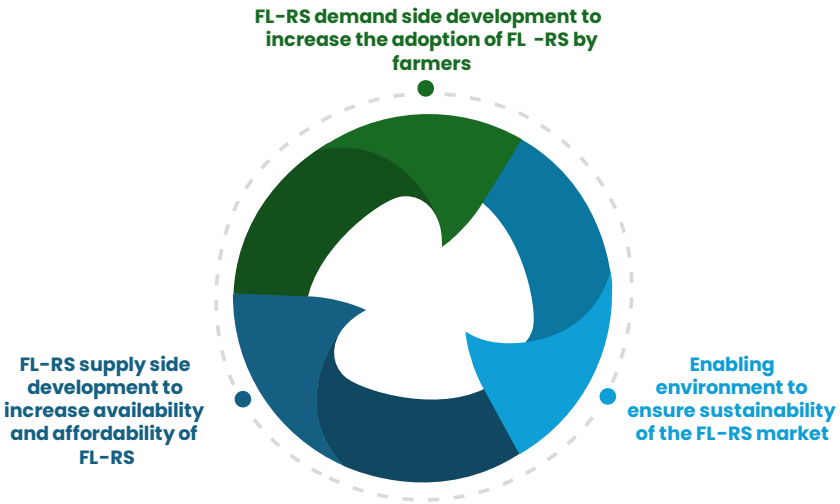


Figure 7-1. Interconnected solutions addressing food loss under smallholder setting of Africa

The first development pathway focuses on increasing demand and absorption capacity for FL-RS among smallholder farming communities. Activities under this pathway will target overcoming Barriers 1 and 2, raising awareness among farmers of the impacts of climate change on post-harvest food loss, as well as on the availability of FL-RS options on the market and how FL-RS will help reduce food loss under changing climate conditions. This awareness raising will be coupled with training on the use of specific FL-RS that have been identified for key crops in each country as well as on the effective use of weather information and advisories, while supporting the initial transfer of suitable technologies to the farmers to catalyse uptake and demonstrate the effectiveness of FL-RS. These combined activities will be catalysing the demand and build the absorption capacity needed to achieve short-term Outcome 1: FL-RS adopted by smallholder farmers. Contributions to Outcome 1 are further enhanced through Output 1.2, which will improve market linkages between farmers and agri-value chain actors such as processors and aggregators. This will enhance the value-add of FL-RS, ensuring that the increased quality produce resulting from improved post-harvest handling, storage, and processing is able to make it to suitable markets to maximize income; creating sustainability in the whole value chain that will enable future scaling of and maintain demand for FL-RS.

The second development pathway complements the demand-side activities by enhancing the supply and affordability of FL-RS (Outcome 2). This component involves two Outputs, one focused on business development for the improved provision of FL-RS on local markets, and the second focused on complementary financial mechanisms for smallholders and MSMEs to enable the adoption of FL-RS. Activities under Output 2.1 will support business development linked to the local supply of FL-RS, targeting both existing suppliers, as well as entrepreneurs seeking to enter the market – particularly MSMEs, local cooperatives and youth groups. The business development support will include providing access to market intelligence, as well as facilitating access to existing credit/guarantee schemes as well as any new financial mechanisms established under Output 2.2. Support to local businesses will increase the supply of FL-RS in local markets, which in turn will enable cost reduction, underpinning the outcome of improved affordability. This will be complemented by activities under Output 2.2 aimed at establishing innovative financial mechanisms for smallholders and MSMEs to support the adoption of FL-RS. In particular, the project will establish partnerships across the FL-RS value chain to create accessible finance opportunities based on the foundations of risk sharing and cooperation. These partnerships will bring together key stakeholders — including suppliers, agro-dealers, financial institutions, MSMEs and local farmers — to establish finance models that stimulate the FL-RS market. Catalytic co-payments and 'smart subsidies' under the system using GCF grants will provide added security to the transactions, further enhancing the risk-sharing nature of the approach. Finance models will be adapted to fit the local context of each target community, considering the nature of the targeted crop and the required solutions, the needs of the local

farmers, and the capacity of stakeholders to absorb risk. Where available, the development of financial modalities will integrate existing credit lines available from local FIs, as well as supporting the inclusion of FL-RS in climate-resilient input packages.

Combined, the increased demand from Outcome 1 and the enhanced supply and affordability of FL-RS from Output 2 will be catalytic in the market, overcoming Barriers 3 and 4. Specifically, the transactions facilitated by the project will stimulate the market, enabling suppliers to develop products and services that are affordable to smallholder farmers, thereby facilitating a balance between supply and demand, and establishing a self-sufficient market that will operate beyond the project support. The integrated nature of these Outputs and the causal pathways reinforcing the market development are depicted in Figure 7-2 below.

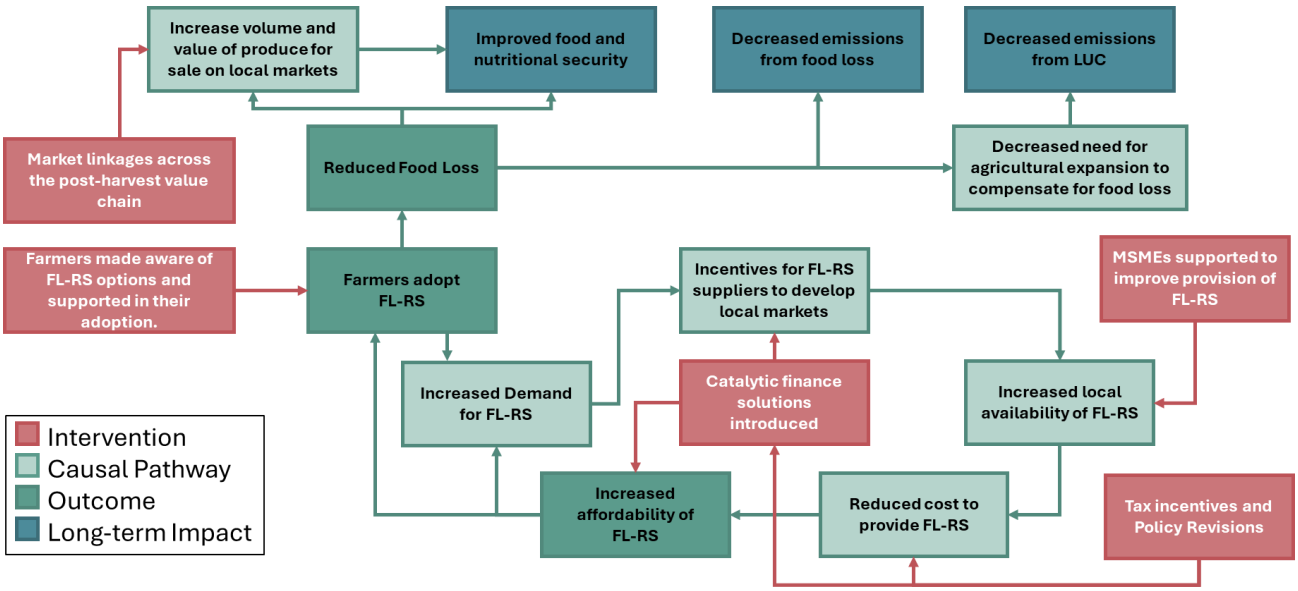


Figure 7-2: Causal pathways underpinning the Theory of Change.

These first two development pathways will be underpinned and sustained by the third, which seeks to create an enabling environment for the uptake of FL-RS (Outcome 3); which together with Outcome 2 will not only mobilise increased investment in the sector but also provide wider policy interventions in strengthening the market systems and advisory services. Through Output 3.1, the capacity of national institutions will be enhanced to enable investments in FL-RS – specifically tackling Barriers 5 and 6. This will involve policy revisions and put in place enforcement mechanisms in each of the target countries in support of enabling FL-RS — including stimulating tax incentives and promoting standards for FL-RS quality — as well as creating platforms for the scaling and replication of successful FL-RS business models.

Overall, the resulting uptake of FL-RS, at scale, will reduce food loss, improve food quality and enhance local capacity, thereby enabling the long-term outcome of improved food and nutritional security. This will have the co-benefit of increasing food safety, while the increased investment in FL-RS resulting from Outcome 3 will create additional employment opportunities in the market. Moreover, the project will reduce GHG emission, both directly – through the reduced emissions from the wasted food itself – and indirectly by reducing land use change for agricultural expansion driven by the need to compensate for food losses.

7.1.4 Assumptions

The Theory of Change described above and illustrated in

Figure 7-3, is underscored by several assumptions. These assumptions are outlined below, and mapped against specific Outcomes and Outputs in Section E.

- The proposed FL-RS technologies are market-ready in Africa or globally (i.e. transfer and adoption ready).
- MSMEs and smallholder farmers are receptive to capacity development and adopt alternative post-harvest management technologies, with focus on managing contamination by mycotoxins and adaptation practices for key crops and value chains, including the use of renewable energy.
- MSMEs and smallholder farmers, mainly youth and women, are willing to adopt climate-smart postharvest handling techniques, land-use practices and RETs & are motivated to sustain them over the programmes duration (5 years) and lifetime (25 years).
- Market actors (input suppliers and off-takers) are interested in providing the FL-RS solutions and in buying improved FL-RS at better prices.
- Existing financial schemes and local financial institutions are willing to participate in the proposed interventions.
- Accurate weather information and climate advisory is readily available to be disseminated to farmers to enhance FL-RS effectiveness.

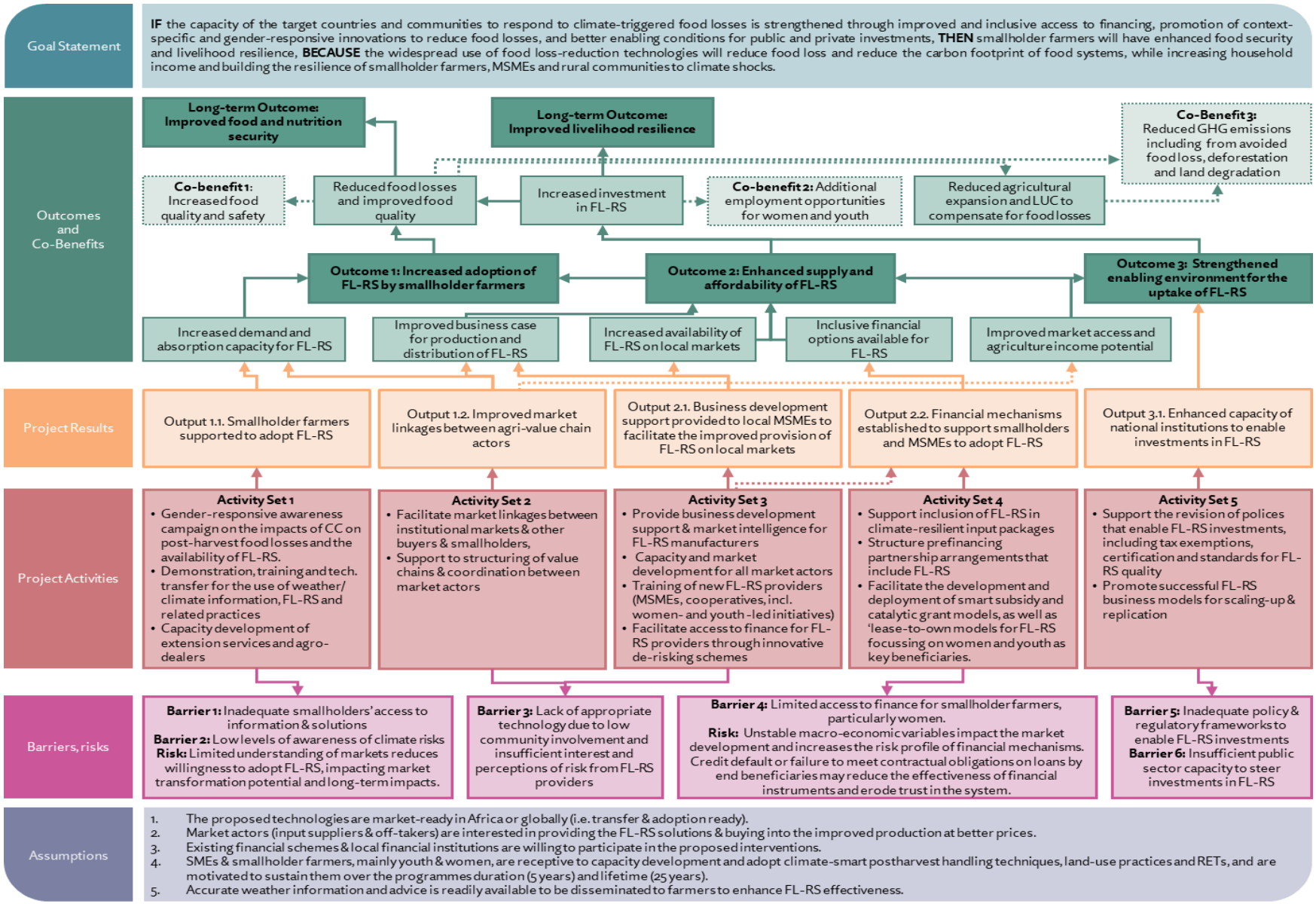


Figure 7-3 - Theory of Change RE-GAIN Programme

8 Conclusion

Food loss is a growing challenge in Sub-Saharan Africa, with significant losses during harvest and post-harvest stages for key crops in the target countries of the RE-GAIN programme. As previously discussed, climate change is likely to exacerbate this situation, further impacting the resilience of smallholder farmers involved in crop production and threatening food security across Burkina Faso, Ethiopia, Kenya, Malawi, Tanzania, Uganda and Zambia. Given the critical role of the value chains identified for this project in the country's economies and overall food supply, food losses have significant implications for the livelihoods of smallholders and the nation's nutrition. Additionally, food losses contribute to emissions and influence land use change dynamics. This context underscores the critical need for a programme like RE-GAIN, which plays a pivotal role in fostering greater climate resilience in the continent by addressing the key barriers identified during this phased study. This summary report provides an overview of the country-specific feasibility studies, which follow the structure as described in the image below:

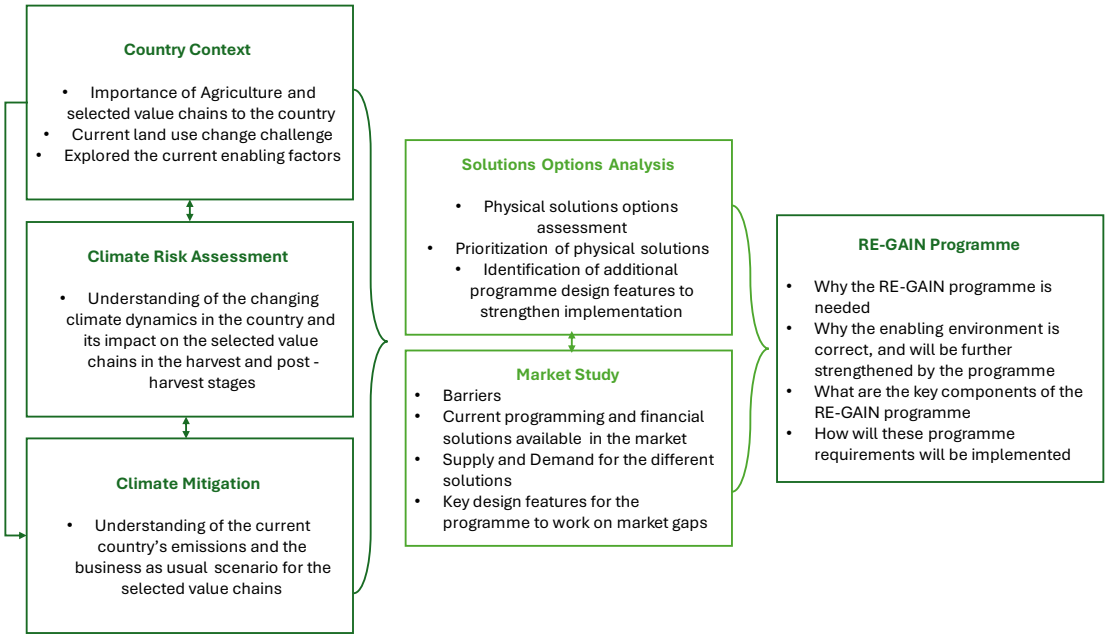


Figure 8-1 Content Summary of Country-Specific Appendix Feasibility Study for the RE-GAIN programme

With this in mind, this feasibility study aimed at assessing the most viable programme to support smallholder farmers in the harvest and post-harvest stages of the selected value chains for the target countries. Our analysis focused on the country's vulnerability to climate change, the structure of its agriculture sector, its economic profile, and the current food-loss landscape. Sub-Saharan Africa is highly vulnerable to the impacts of climate change, which constrain the countries' sustainable development ambitions and threaten the lives and livelihoods of vulnerable communities. These findings underscore the necessity of this project.

The identification and analysis of relevant policies in the agricultural and environmental sectors demonstrate that the countries prioritized for the RE-GAIN programme have foundational enabling environment for a comprehensive food-loss reduction programme aimed at promoting both the supply and demand of food loss reduction solutions. However, despite this supportive framework, there is a clear need for a programme like RE-GAIN. Currently, there is no existing programmes that specifically focuses on simultaneously building climate resilience and addressing harvest and post-harvest food losses.

Most initiatives either concentrate solely on enhancing climate resilience by focusing on general agricultural issue in a country or focus independently on improving preharvest agricultural production.

Our analysis revealed that the challenges with food-loss solutions and their effective usage are complex and multifaceted. Notably, our market study revealed that the current solutions available are insufficient for smallholders to build their resilience in worsening climate conditions. There are both supply and demand challenges for the physical food-loss solutions in the market, particularly regarding financial accessibility and sufficient availability of high-quality solutions. Additionally, smallholder farmers face capacity challenges in various areas, such as understanding the impact of climate on their harvest and post-harvest activities and leveraging physical solutions to address climate challenges and improve food security. Building on the current enabling environment, the programme will collaborate with various levels of the country-specific's government departments and the national private sector to further enhance existing frameworks. This includes implementing quality standards and other regulatory policies to enhance the supply and demand of food-loss solutions. These interconnected barriers and challenges underscore the need for a comprehensive programme like RE-GAIN. By addressing these diverse issues, RE-GAIN can significantly reduce food losses and bolster the resilience of smallholder farmers, with a co-benefit of GHG emission reduction.

This study has provided a comprehensive analysis of how climate is impacting harvest and post-harvest activities across the different RE-GAIN programme's countries, and highlighted the lack of a unified initiative that can respond to these growing challenges and support each country's mitigation initiatives. RE-GAIN offers a solution by reducing food losses across the key value chains selected in the programme's countries, ultimately benefiting the large population involved in their production and enhancing food security. It facilitates access to physical solutions that bolster smallholders' climate resilience and adaptive capacity, while providing additional support through extension services that can guarantee the long-lasting impact of the programme. By focusing on strengthening the enabling environment, RE-GAIN also aims to drive systemic changes that promote effective food loss management during harvest and post-harvest activities.

Ultimately, this study illustrates how the RE-GAIN programme has been strategically designed to address the challenges of increasing food loss and escalating climate vulnerability in the identified countries and regions. A successfully implemented RE-GAIN programme will provide comprehensive solutions to harvest and post-harvest food loss challenges, resulting in a long-term, and transformative impact on the selected target countries. Over time, this programme will become self-sustaining, significantly improving the resilience and sustainability of the country's agricultural sector.

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