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LEARNING-ORIENTED REAL-TIME IMPACT ASSESSMENT (LORTA)

IMPACT EVALUATION BASELINE REPORT FOR FP073: STRENGTHENING CLIMATE RESILIENCE OF RURAL COMMUNITIES IN NORTHERN RWANDA "GREEN GICUMBI PROJECT"

September 2020

GREEN CLIMATE FUND
INDEPENDENT EVALUATION UNIT

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ABOUT THE LORTA PROGRAMME

In 2018, the Independent Evaluation Unit (IEU) of the Green Climate Fund (GCF) started the multi-year Learning-Oriented Real-Time Impact Assessment (LORTA) programme to keep track of the impact of GCF investments. The goal is to measure if GCF projects lead to lower greenhouse gas (GHG) emissions and enhanced resilience to climate change, and if so, by how much. This can be measured with the help of rigorous impact assessments. Empirical evidence on impacts of climate-related projects is rather scarce, which adds to the importance of this programme.

The LORTA programme has two particular aims: embedding real-time impact evaluations (IEs) into approved projects so that GCF project managers can quickly access accurate data on the quality of implementation and likelihood of impact; building capacity within projects to design high quality data which aid the measurement of causal change and impact.

The LORTA programme not only informs on the returns of GCF investments, it also helps GCF projects track implementation fidelity. To do so, LORTA incorporates state-of-the-art approaches for measuring results and informing effectiveness and efficiency into funded projects. It employs mixed method approaches that involve quantitative and qualitative data-collection methods and analysis.

For more information of the LORTA programme, please contact *ieu@gcfund.org*.

ABBREVIATIONS

CRA	Climate Resilient Agriculture
EICV	integrated household living conditions survey
FAO	Food and Agriculture Organization of the United Nations
FGDs	focus group discussions
FONERWA	National Fund for Environment
GCF	Green Climate Fund
GGCRS	Green Growth and Climate Resilient Strategy
GoR	Government of Rwanda
ICC	intra-cluster correlation
IEU	Independent Evaluation Unit
KIIs	Key informants interviews
LORTA	Learning-Oriented Real-Time Impact Assessment
MDES	Minimum Detectable Effect Size
MINECOFIN	Ministry of Finance and Economic Planning
MoE	Ministry of Environment of Rwanda
NAEB	National Agricultural Export Development Board
NDCs	Nationally Determined Contributions
NIRDA	National Industrial Research and Development Agency
NISR	National Institute of Statistics of Rwanda
NST	National Strategy for Transformation
ODK	Open Data Kit
REMA	Rwanda Environment Management Authority
RHA	Rwanda Housing Authority
RLMUA	Rwanda Land Management and Use Authority
SAS	Seasonal Agriculture Survey
SCRCP	"Strengthening climate resilience of rural communities in Northern Rwanda" Project
SESMEC	Social Economic Studies, Surveys, Monitoring and Evaluation Consult Limited

EXECUTIVE SUMMARY

This report presents the findings of the baseline survey for strengthening climate resilience of rural communities in Northern Rwanda commonly known as the "Green Gicumbi Project." It was conducted by Social Economic Studies, Surveys, Monitoring and Evaluation Consult Limited (SESMEC Ltd), on behalf of National Fund for Environment (FONERWA) from June to September 2020. The overall objective of the evaluation was to measure the initial level of impact and outcome indicators before the intervention of the "Green Gicumbi Project," set benchmark indicators and draw recommendations for better performance.

Strengthening Climate Resilience of Rural Communities in Northern Rwanda is a six-year (15 May 2019 to 14 April 2025) project funded by the Green Climate Fund (GCF) and implemented by FONERWA as the executing entity, while the Ministry of Environment (MoE) of Rwanda is the Accredited Entity. The overall project budget is USD 33,154,432 (grant USD 32,794,442 & co-financing USD 359,990). The project is designed with four complementary components: (1) watershed protection and climate resilient agriculture; (2) sustainable forest management and sustainable energy use; (3) climate resilient settlements; and (4) knowledge transfer and mainstreaming. The project aims at increasing the resilience of vulnerable communities to climate change for 248,907 smallholder farmers (men, women, and youth in nine sectors of Gicumbi district namely, Byumba, Bwisige, Cyumba, Kaniga, Manyagiro, Mukarange, Rubaya, Rushaki and Shangasha).

1. APPROACH AND METHODOLOGY

The objective of this exercise is to collect baseline data that will be used to inform the baseline assessments, the monitoring systems and eventually will also feed into the interim and final evaluations (including impact evaluation). An integrated methodology combining the literature review, quantitative and qualitative methods was employed in this study. Primary data was collected from the field while secondary data was obtained from the review of project reports and key published government documents such as the integrated household living conditions survey (EICV), original funding proposal approved by the GCF Board in March 2017, original log frame, Green Gicumbi Project feasibility studies, Gicumbi district development strategy, key statistical data for Gicumbi/Rwanda, Vulnerability Index 2019, among others. The primary data was collected in the field from smallholder farmers and key informants at the district level. Closed-ended questionnaires were used to collect quantitative data, while interview and focus group discussions (FGDs) were used to collect qualitative data. The sample size for quantitative data was calculated using power calculations, at 95 per cent confidence level and the margin error at 5 per cent. By this formula a total of 1,260 was obtained; however, the survey reached 1299 respondents for quantitative data and 55 individuals for qualitative data.

The survey used a multistage sampling method in which the respondents were randomly selected from the clusters and strata of beneficiaries and key stakeholders having direct linkage with the project. The collection of primary data was conducted for a period of 17 days in 18 sectors of the Gicumbi district (nine treatment and nine control). The study targeted all households living in private dwellings during the interviewing period in the 18 sectors, nine of which were in the intervention area of the Muvumba B catchment, and the other nine serving as a control group outside the intervention area of the Gicumbi district and located in the Muvumba watershed. Tablets containing the questionnaires developed in Open Data Kit (ODK) together with printed interviews and FGD guides were used to collect data. Primary and secondary data were compiled, analysed and interpreted. To the extent possible, SESMEC Ltd engaged with the Independent Evaluation Unit (IEU) of the GCF that had begun measuring results at different parts of the theory of change of the

Green Gicumbi Project. Owing to this, the determination of the control group was selected in collaboration with the IEU.

2. EXPECTED OUTCOMES

The project aims to restore and enhance ecosystem services in the sub-catchment B of the Muvumba watershed, improve the capacity of communities to renew and sustainably manage forest resources and support smallholders to adopt climate resilient agriculture. The project plans to invest in climate resilient settlements for vulnerable families currently living in areas prone to landslides and floods and support community-based adaptation planning and livelihoods diversification. It also aims to increase knowledge and the resilience of local communities in dealing with and reducing the adverse impacts of climate change.

3. SUMMARY OF THE MAIN FINDINGS

The results of this study were grouped according to the four main objectives of the project.

1. ***Watershed protection and climate resilient agriculture:*** The baseline found that 62.4 per cent and 42.4 per cent of beneficiary and control group respondents were household heads, while 30.3 per cent and 48.3 per cent were spouses in the same areas. Only 6.5 per cent of the sons/daughters of beneficiary household heads were interviewed in the absence of household heads and spouses against 8.5 per cent in the control group area. The survey results show that 87.3 per cent and 88.1 per cent of beneficiary and control group households respectively own land. The study shows that among the 1139 households owning land, only 2.6 per cent and 2.8 per cent of the beneficiary and control groups respectively do not use parcels for agricultural activities, while 97.4 per cent and 97.2 per cent of the beneficiary and control groups respectively have parcels for farming. The majority of land (86.3 per cent and 89.4 per cent in the beneficiary and control group areas respectively) is located on hillsides, compared to only 5.4 per cent and 4.2 per cent in the same areas which are in marshlands and 7.6 per cent and 6.1 per cent being on steep slopes.

   The large majority of parcels (undivided and divided in plots) (98.4 per cent and 98.3 per cent) owned by beneficiary and control groups respectively were almost equally cultivated during the last agricultural year. This implies that their lands are continuously being cultivated without putting them to fallow to regenerate their fertility. It was also revealed that organic manure was applied by beneficiary and control group households on 84.5 per cent and 86.9 per cent of parcels respectively, against 23.8 per cent and 28 per cent on which chemical fertilizers were applied. Thus, the parcels owned by control group respondents are in better position in receiving organic manure and chemical fertilizers.

   It was declared that in the past 12 months, heavy rainfall has led to fluvial erosion and destroyed crops as reported by the majority of respondents. Around 50 per cent of respondents said that heavy rainfall caused the destruction of family properties, while 37.2 per cent and 29 per cent of beneficiary and control group respondents confirmed that heavy rain caused flooding episodes. Slightly less than 9 per cent of respondents reported human deaths caused by such rainfall, with around 2.2 per cent reporting heavy rain to have caused other consequences (for example, the death of animals). Though severe deforestation of the watershed was seen during the data collection, 35 per cent and 31.6 per cent of beneficiary and control group households respectively confirmed that they possessed forests. Moreover, it was reported in the Muvumba Catchment Plan 2018-2024 that the total forested area covers 23 per cent of the catchment area.

2. ***Sustainable forestry and energy use:*** Regarding energy used for cooking, the survey revealed that the vast majority, 88 per cent and 85.3 per cent of beneficiary and control group respondents respectively, reported using firewood, with only 17.5 per cent of beneficiary households and 20.8 per cent of the control group using straw, and 3.7 per cent of beneficiary households and 3.5 per cent of the control group using charcoal. Just 1.1 per cent and 0.2 per cent of the beneficiary and control group respondents respectively confirmed using electrical power or gas for cooking. None of the beneficiary respondents declared using biogas for cooking, and only 0.3 per cent of control group households use this source of energy. This indicates the possibility of a high rate of deforestation, depending on the extent of current reforestation efforts.
3. ***Climate resilient settlements:*** Results from the survey revealed that 96.5 per cent and 96.8 per cent of households live in their own homes in intervention and control group areas respectively, against 3.5 per cent and 3.2 per cent who do not own homes in the same areas. Precisely, 47.5 per cent and 60.4 per cent of the beneficiary and control groups respectively confirmed to have homes in flat areas, and their homes did not experience any damage in the past 12 months, against 21.2 per cent and 20.9 per cent who have homes in similar (flat) areas, which were damaged by heavy rains. Moreover, 7.3 per cent and 6.9 per cent of those settled in high-risk zones in the beneficiary and control group areas respectively reported not to have experienced any damage to their homes. The study revealed that only 29.5 per cent and 23.6 per cent of beneficiary and control group households respectively also use rainwater. Only 10.3 per cent and 8.0 per cent of the beneficiary and control group households respectively declared to have a water tank inside the homestead. Most of the beneficiary and control group (more than 70 per cent) households possess chairs, beds or mattresses, while 61.1 per cent and 70.2 per cent of the beneficiary and control group households respectively possess a table. However, 10.7 per cent and 12 per cent of the beneficiary and control group respondents respectively do have a sofa, with approximately 13 per cent of each possessing only benches. Many households (57.1 per cent and 46 per cent of the beneficiary and control groups respectively) confirmed using improved stoves for cooking, against 40.4 per cent of beneficiary households and 55.7 per cent of the control group that still use traditional stoves, and less than 1 per cent using electric or gas stoves.
4. ***Knowledge management and mainstreaming:*** The study revealed most household heads (more than 80 per cent) in both the project intervention and control group areas are engaged in farming activities. The study shows that the majority (73.1 per cent and 79.9 per cent) of respondents for both the beneficiary and control groups respectively are married, compared to 7.8 per cent and 8.3 per cent who are single in these same groups. Alternatively, 13.2 per cent and 8.3 per cent of respondents from the beneficiary and control group areas respectively are widows. It was declared that 52 per cent and 49.5 per cent of the control and beneficiary household heads respectively attained primary school education, against 33.5 per cent and 32.1 per cent who did not attend school. The percentage of household heads who completed secondary school or university is still very low (less than 10 per cent in each group).

The study shows that around 63.9 per cent of beneficiary households and 63.3 per cent of the control group of households are aware that the Muvumba watershed and control group areas have experienced an increase in temperature throughout the years against 90.6 per cent and 90.7 per cent of the beneficiary and control group respondents respectively who reported to have experienced an increasing trend in the amount of rainfall. Most respondents pointed out heavy rainfall to have caused fluvial erosion and the destruction of crops, and a similar percentage of respondents mentioned drought episodes and long dry spells to have led to poor crop productivity and a shortage of food. Additionally, they mentioned floods have destroyed their crops and caused poor agricultural

productivity. Moreover, households are not very active in adopting climate resilient technologies, as only less than 2 per cent are able to use an alternative source of energy other than biomass and less than 1 per cent can afford to use the irrigation system in their farmland. Exactly 42.4 per cent and 39.3 per cent of the control group and beneficiary households respectively have been able to adopt the use of crop varieties, while around 20 per cent of both groups declared to have developed technologies for rainwater harvesting, wastewater management at the household level and protecting their housing infrastructure against lightning.

Overall, the survey results highlight that, on average, beneficiary households are poor and vulnerable and will benefit considerably from the Green Gicumbi Project. A key focus of the project is to transform existing practices into high resilient practices embedded within communities and enabling them to continue adapting to future climate variability and change beyond the lifetime of the project. By doing so, the livelihoods of local communities in the project intervention area will be improved.

A. GENERAL INTRODUCTION

1. BACKGROUND AND CONTEXT OF THE CONSULTANCY

Rwanda is increasingly experiencing the impacts of climate change. Rainfall has become increasingly intense and its variability is predicted to increase by 5 per cent to 10 per cent (Government of Rwanda (GoR), 2018). Changes in temperature and precipitation, and their distributions, are the key drivers of climate and weather-related disasters that negatively affect Rwandans and the country's economy. These disasters include droughts, floods and landslides, which result in damage to infrastructure, loss of lives and property (including crops), and contribute to soil erosion and water pollution. Rwanda is highly reliant on rain-fed agriculture both for rural livelihoods and exports of tea and coffee, in addition to its dependence on hydropower for half of its electricity generation. The country's ongoing economic growth is therefore highly threatened by climate change.

Rwanda's commitment to sustainable environmental and climate change management dates back to the year 2000 (GoR, 2018). This commitment is embodied in the Vision 2020 on to Vision 2050 as a cross-cutting issue underpinning the aspiration to achieve middle income status by 2050. Rwanda has learned meaningful lessons on various development facets to effectively transition from Vision 2020 towards achieving "High Standards of Living," as underpinned by the new and emerging global commitments such as the Nationally Determined Contributions (NDCs) under the Paris agreement.

Recognition of this has been subsequently reflected in the National Strategy for Transformation (NST) (2018 –24) that is informed by cross-sectoral strategies, including the Green Growth and Climate Resilient Strategy (GGCRS) and the NDCs for climate change mitigation and adaptation. The NST contributes to Vision 2050 by emphasizing on sustainable management and utilization of the environment and natural resources to achieve green growth.

The GGCRS aims at providing a roadmap to achieving a climate resilient, low carbon economy by 2050. GGCRS goals include sustainable land use and water resource management, sustainable forestry, agroforestry and biomass energy, and reduced vulnerability to climate change (GGCRS, 2018). GGCRS will effectively support soil erosion control through the construction of radical and progressive terraces, increase irrigation from 48,508 ha (2016) to 102,284 ha by 2024, promote research and develop new seed varieties that are climate resilient, develop agroforestry to increase and maintain forest cover to 30 per cent and ensure their sustainable exploitation, increase agriculture productivity on key crops with an increase of 30 per cent to 100 per cent for various crops, reduce by half the use of firewood from 83.3 per cent (2014) to 42 per cent by 2024 and promote climate resilient human settlements. Households settled in integrated planned settlements will increase from 55.8 per cent in 2014 to 80 per cent by 2024. All these priorities have been consolidated to inform the integrated Gicumbi project "Strengthening climate resilience of rural communities in Northern Rwanda" (SCRCP) and seek to contribute to Rwanda's sustainable development towards Vision 2050.

Rwanda's accredited entity to the Green Climate Fund (GCF), the Ministry of Environment (MoE), submitted a funding proposal that was approved by the GCF Board in March 2018 to implement a USD 32,794,442 GCF-financed project. The project activities will be executed directly by National Fund for Environment (FONERWA) and implemented by GoR agencies either at the district or sector level. These investments are planned to build climate resilience of landscapes and communities through support for watershed protection, forest management, climate resilient agriculture and the construction of low carbon social housing for highly vulnerable households. It is

in this regard that the Social Economic Studies, Surveys, Monitoring and Evaluation Consult Limited (SESMEC Ltd) was selected to conduct a baseline survey for the project known as "Strengthening climate resilience of rural communities in Northern Rwanda" (SCRCP).

2. BASELINE HOUSEHOLD SURVEY AND CONSULTANCY OBJECTIVES

The household baseline data constitutes a milestone in the implementation and evaluation of the various activities included under SCRCP. To that end, SESMEC Ltd was hired to collect quantitative baseline data on the livelihoods of farmers residing in the Gicumbi district, their agricultural activities, their levels of resilience to climate-related hazards and the consequences of the latter.

The baseline data will contribute to conducting the impact evaluation as described in the Learning-Oriented Real-Time Impact Assessment (LORTA) design report and will be used to assess initial differences between future beneficiaries and comparison groups (LORTA design report, 2019).

Specifically, the baseline study provided the team with detailed baseline data on key project indicators, household level characteristics and agricultural practices as contained in the table below:

Table 1. Level and indicators that will be used to collect baseline information

SN	LEVEL OF SURVEY	BASELINE INFORMATION
1	Key project indicators	Indicators are defined in the project documents. Those include among others: 1) Tons of carbon dioxide equivalent reduced because of Fund-funded projects 2) Number of males and females benefiting from the adoption of diversified, climate resilient livelihood options 3) Hectares of land or forests under improved and effective management that contributes to CO_2 emission reductions 4) Number of technologies and innovative solutions transferred or licensed to support low-emission development because of Fund support 5) Use by vulnerable households, communities, businesses and public-sector services of Fund-supported tools, instruments, strategies and activities to respond to climate change and variability 6) Area (ha) under erosion control 7) Area (ha) under (i) protective forest cover (ii) agroforestry 8) Area (ha) of slope stabilized with Napier grass 9) Area (ha) of higher elevations planted with tea/coffee 10) Number of smallholders trained in climate resilience agriculture through farmer field schools 11) Area (ha) of forest renewed with high quality plants and best practice establishment 12) Area (ha) of seed stands established and managed 13) Number of high quality seedlings raised in time for the start of planting season 14) Number of community members trained in tree nursery management 15) Number of tree nurseries, tree growers and bee keeping cooperatives or associations operational 16) Number of households or institutions installing and operating efficient energy technologies for cooking 17) Reduced CO_2 emissions from the Mulindi tea factory 18) Number of rainwater harvesting tanks, cisterns and ponds installed

SN	Level of survey	Baseline information
		19) Number of low carbon social housing units developed and occupied by climate vulnerable families 20) Number of stormwater management structures installed 21) Website developed, maintained and promoted to users 22) Number of farmer-to-farmer participatory videos made and viewed by other farmers 23) Number of staff from GoR and non-governmental organizations trained in climate resilient forestry, watershed management and green settlements 24) Number of people (women, men) trained in green and climate resilient construction 25) Number of climate resilience plans adopted and implemented 26) Number of tea/coffee policy changes or investment decisions influenced by climate information
2	Household level characteristics	1) Basic information on respondents sex: males and females, position, age, housing ownership, size of house, occupation 2) Economic situation of households: Ubudehe (collective active) classification, economic activities, employment types 3) Households income generation (Different sources of income) 4) Different existing economic potentialities 5) Firewood and alternative energy usage 6) Social protection programmes 7) Housing status 8) Poverty level 9) Farm and off farm activities 10) Saving and financial literacy 11) Health status 12) Other indicators agreed with the client
3	Agricultural practices to identify attributable changes in target or project beneficiary communities throughout the project	1) Environment protection measures: erosion control (progressive and radical terracing) 2) Use of inputs (fertilizers, improved seeds, pest management) 3) Land use consolidation 4) Use of agricultural methods 5) Agroforestry status 6) Harvesting and post-harvest management 7) Marketing of agricultural products 8) Livestock practices 9) Natural disasters 10) Rural settlement 11) Watershed protection 12) Irrigation practices 13) Other indicators agreed with the client

The remainder of this report is organized as follows. Section B presents the project background, its key components and objectives. Section C introduces the impact evaluation strategy of the adaptation and mitigation activities of the SCRCP project. Section D reviews the household survey methodology. Section E presents the statistical analysis of the baseline household survey while section F concludes the report.

B. PROJECT BACKGROUND

1. PROJECT AREA

The SCRCP project has been selected to be implemented in nine sectors (Byumba, Bwisige, Cyumba, Kaniga, Manyagiro, Mukarange, Rubaya, Rushaki and Shangasha) out of the 21 sectors of the Gicumbi district by the MoE of Rwanda through FONERWA. The project intervention area includes 248,907 people or 63 per cent of the district's population, and all nine sectors fall within sub-catchment B of the Muvumba River and is comprised of 252 villages (LORTA design report, 2019).

The targeted area by the project is very sensitive and exposed to adverse effects of climate change with low adaptive capacity of the local community. It has been frequently affected by series of climate-related hazards such as floods and landslides that have left devastating effects particularly on those with low adaptive capacity and resilience to climate change. The high dependency on rain-fed agriculture, the hilly topography, landslide vulnerability, flood risk, high erosion rate, low access to climate information and the depletion of forest stocks have been identified as some of the factors exacerbating the area's vulnerability to the adverse effects of climate change (Rwanda Environment Management Authority (REMA), 2019).

Furthermore, the Gicumbi district has one of the highest rates of households experiencing crop loss, food insecurity, animal disease and fluctuations in livelihoods due to extreme weather events. For instance, a loss of 2300 ha of tea plantation at Mulindi was registered over the last six years along with a production loss ranging between 2.0 to 3.3 million tons of green leaf per year, with an equivalent market loss of USD 2.5 to 4.1 million. These are not only the results of high watershed degradation due to changes in climate, but are also caused by watershed mismanagement, poor land farming methods, existence of steep slopes and shallow soils of the project intervention area (LORTA design report, 2019; MoE, 2019).

Therefore, the SCRCP project is expected to improve the resilience of vulnerable communities to climate change through restoring and enhancing ecosystem services of sub-catchment B of the Muvumba watershed, increasing the capacity of communities to renew and sustainably manage forest resources and support smallholders to adopt climate resilient agriculture.

2. PROGRAMME KEY COMPONENTS AND OBJECTIVES

The project will restore and enhance ecosystem services in a major sub-catchment of the Muvumba watershed, increase the capacity of communities to renew and sustainably manage forest resources and support smallholders to adopt climate resilient agriculture. The project will also invest in green settlements for vulnerable families currently living in areas prone to climate-related disasters and support community-based adaptation planning and livelihoods diversification. These investments will lead to enhanced resilience to climate change impacts and will make a major (and long-lasting) contribution to delivering Rwanda's GGCRS, 2011. Knowledge and capacity developed during implementation will be mainstreamed at the sector and national level. A theory of change, presented in the next section, captures the key areas of intervention, the main drivers of climate vulnerability and GHG emissions and the expected outcomes and impacts (LORTA design report, 2019).[1] The project components and subcomponents are listed in Table 2.

[1] The project will focus on one of Rwanda's most climate vulnerable districts, Gicumbi. Interventions will particularly target poor, climate vulnerable households located in nine sectors of the Gicumbi district (Rubaya, Cyumba, Kaniga, Mukarange, Rushaki, Shangasha, Manyagiro, Byumba, and Bwisige) where approximately 248,907 people (63 per cent of the district's population) live.

There are three underlying principles to the project: 1) supporting climate resilient and sustainable rural livelihoods; 2) developing practical approaches that are cost-effective, technologically viable and transferable to other areas of Rwanda; and 3) increasing knowledge and understanding of climate risk among key decision makers in government and business leaders.

Table 2. Project components and sub-components

COMPONENT	SUB-COMPONENT
Component 1: Watershed protection and climate resilient agriculture	1.1 Strengthen community-based adaptation
	1.2 Reduce slope erosion to sustainable levels
	1.3 Stabilize rivers, roadsides and steep slopes with protective forestry
	1.4 Integrate agroforestry into farming systems on 9790 ha of the watershed
	1.5 Support 1800 smallholder crop-livestock farmers to adopt agroecological approaches to increase climate resilience
	1.6 Increase climate resilient farming practices with tea cooperatives in Mulindi with a target of 5000 smallholders
	1.7 Integrate climate resilient practices into local extension services
	1.8 Provide weather and climate services for tea and coffee farmers to increase productivity and reduce losses from weather and climate variability
	1.9 Increase capacity for pest monitoring, surveillance and Integrated Pest Management (IPM) to address current and future climate change.
	1.10 Increase climate resilient practices with 1000 coffee growers to reduce susceptibility to climate change and protect slopes in the watershed
Component 2: Sustainable forest management	2.1 Increase forest productivity and sustainable forest management
	2.2 Strengthen forest management skills to sustain investments in forestry and watershed management
	2.3 Establish, restore and manage degraded woodlots across 297 ha of the watershed
	2.4 Strengthen community capacity to provide forest products and services
	2.5 Increase the use of biogas and efficient cookstoves to reduce deforestation of the watershed
	2.6 Reduce the demand for fuelwood and greenhouse gas (GHG) emissions at the Mulindi tea factory through energy efficiency measures
Component 3: Climate resilient settlements	3.1 Manage surface water run-off from settlements to reduce gully formation, floods and landslides
	3.2 Increase rainwater capture and storage to counter inter-annual rainfall variability
	3.3 Construct a green social housing development in Kabeza to reduce the number of vulnerable households living in high-risk zones (100 houses + green infrastructure)
	3.4 Construct a green social housing development in Kaniga to reduce the number of vulnerable households living in high-risk zones (100 houses + green infrastructure)
Component 4: Knowledge transfer and mainstreaming	4.1 Communicate project results and lessons learned
	4.2 Awareness building, promotion and advocacy to support replication and scale up in other districts
	4.3 Increase capacity of local institutions and communities to sustain investments in watershed protection and climate resilient settlements

COMPONENT	SUB-COMPONENT
	4.4 Mainstream climate resilient approaches into existing forestry programmes and practices to support scale up and replication
	4.5 Mainstream approaches to climate resilient agriculture for smallholders into existing plans and programmes to support scale up and replication
	4.6 Mainstream climate resilient approaches into existing agricultural extension programmes to support scale up and replication
	4.7 Mainstream energy efficiency into the tea industry to support scale up and replication

Source: MoE inception report, 2019

The main project goals are as follows:

1) Sub-catchment B of the Muvumba watershed restored and small scale tea and coffee farmers supported to adopt climate resilient practices
2) Communities supported to implement sustainable forest management and adopt fuel efficient cooking methods
3) Human settlements developed and/or modified to increase climate resilience
4) Successful adaptation and mitigation approaches communicated and mainstreamed at the national level

There are two expected outcomes from the project, linked to both mitigation and adaptation: 1) improved management of land or forest areas contributing to emissions reductions; and 2) strengthened adaptive capacity and reduced exposure to climate risks (Green Climate Fund proposal, 2018).

C. IMPACT EVALUATION DESIGN

1. THEORY OF CHANGE

In order to assess whether the Gicumbi project has reached the objectives described under section B, an impact evaluation exercise will be conducted on the first three components compromising the project and listed under Table 2. Each of the three components of interest of the Gicumbi project seeks to address different core problems faced by vulnerable communities. The first component is concerned with the low adaptive capacity at the community and landscape scales while the second component focuses on the degradation and unsustainable management of forest management. The last component aims to provide solutions to rural populations living in houses and areas susceptible to landslides and flooding with limited access to water and other essential services. We present below the theories of change for each of these components that have been developed by the LORTA team (LORTA design report, 2019).

Table 3. Theory of change of project components

Theory of Change	Inputs	Activities	Outputs	Outcomes	Goals
Component 1: Watershed protection and climate resilient agriculture	Staff and financial resources	• Public awareness campaigns on climate change issues, erosion control and improved soil management practices • Training and demonstrations (adaptation planning, utilization and maintenance of infrastructure, climate resilient techniques, integrated pest management) • Continuous technical assistance • Development of Community Adaptation Facility (revolving Fund) • Building terraces and biological control measures • Replanting of steep slopes, the Mulundi tea estate, roadsides • Inputs delivery (tree seedlings, resilient tea and coffee varieties, animal health inputs) • Setting up green irrigation systems in the Mulundi tea estate • Weather and climate services are tailored to coffee and tea farmers	• Dissemination of risk reduction and adaptation practices • Enhanced capacity of sector and district technicians in CRA • Reception of technical assistance • Financial barriers to adaptation practices are alleviated • Terraces are built, biological control measures are set up • Trees and shrubs are planted on steep slopes, the Mulindi tea estate and roadsides • Reception of inputs • Green irrigation systems are installed • Weather and climate information is sent to coffee and tea farmers • Jobs are created	• Enhanced knowledge of smallholder farmers on CRA • Implementation of risk reduction practices • Reduction in soil erosion and stabilization of river buffer-zones, roadsides, and steep slopes • Reduction in flooding's • Increase in permanent vegetation cover • Weather and climate information is used to inform tea and coffee farming practices • Increase in agricultural production and productivity • Decrease in livestock mortality • Increase in income • Improved health	• Restoration of watershed • Strengthened resilience of landscapes and communities to climate hazards
Component 2:	Staff and financial resources	• Public awareness campaigns on using and installing cookstoves	• Promotion of cleaner energy	• Farmers with cows produce biogas	• Reduction in GHG emissions

Theory of Change	Inputs	Activities	Outputs	Outcomes	Goals
Sustainable forest management and sustainable energy		• Training and demonstrations (sustainable forest management, high quality seeds, more drought tolerant species, livelihoods around forest products and services, biogas) • Continuous technical assistance • Inputs delivery (high quality germplasm) • Provision of cleaner cookstoves and fuels • Establish community tree nurseries • Support the establishment of woodlot cooperatives • Financial support of the Mulundi Tea Factory Company by The Wood Foundation for energy efficiency improvements	• Enhanced knowledge on sustainable forest management and climate resilient forestry • Reception of technical assistance • Reception of inputs, cleaner cookstoves and fuels • Community tree nurseries are installed • Mulundi tea factory receives technical and financial support for energy efficiency improvements • Jobs are created	• Use of cleaner energy by households and the Mulundi tea factory • Reduction in tree cutting • Increase in tree production diversity • Cooperatives are formed • Reduction in soil erosion of woodlots • Increase in forest cover on farmers' land • Increase in the diversification of source of livelihoods • Increase in income • Improved health	• Strengthened resilience of landscapes and communities to climate hazards
Component 3: Climate resilient settlements	Staff, financial resources and equipment	• Construction of green dwelling units in Kabeza and Kaniga villages • Construction of murram roads • Installation of water management infrastructure (e.g., stormwater controls, water harvesting tanks, sandbed filters, underground cisterns, soft drains, ditches, soak-away pits, dams, gully plugs) • Provision of cows, construction of cow sheds, water ponds • Installation of equipment for producing and using biogas	• The most vulnerable households living in high-risk zones are resettled in the newly built green social housing • Roads and water infrastructure are installed • Cows are received • Enhanced knowledge on water management and maintenance of	• Reduced exposure to climate hazards and landslides • Improved access to roads, water and services (markets, schools, health centres) • Production of biogas • Use of cleaner energy • Reduction in tree cutting • Reduced exposure to flooding	• Reduction in GHG emissions • Strengthened resilience of vulnerable farm households to climate hazards

Theory of Change	Inputs	Activities	Outputs	Outcomes	Goals
		• Establishment of kitchen gardens • Technical assistance • Training on maintenance of small scale infrastructure and water management • Establishment of an operation and maintenance structure for green infrastructure	small scale green infrastructure • Reception of technical assistance • An operation and maintenance structure is in place • Jobs are created	• Increase in dairy products and vegetable production • Improved dietary and food diversification • Improved health	

Source: LORTA design report, 2019

The main hypothesis of the impact evaluation is that the Gicumbi project contributes to incremental and transformational climate change adaptation and the mitigation of GHG emissions (LORTA design report, 2020).

The above hypothesis is examined in light of six main research questions that will be answered using quantitative methods and a seventh research question addressed using qualitative data.

a. Research questions

EQ1) Do adaptation interventions of components 1 and 2 lead to an increase in farmers' adoption of CRA practices?

EQ2) Do adaptation activities of components 1 and 2 lead to an increase in food security and diversity?

EQ3) Do components 1 and 2 activities lead to an increase in smallholder farmers' resilience? What dimensions of resilience are most influenced by the project activities?

EQ4) To what extent do mitigation activities of component 2 lead to the production and use of cleaner energy for cooking?

EQ5) Do mitigation activities of components 1 and 2 lead to an increase in permanent vegetation cover and in diversity of tree species of targeted areas?

EQ6) Do the project activities of components 1 and 2 contribute to an increase in women's participation in economic life? Do the impacts of the project differ by the gender of the household head?

EQ7) How do green settlements affect the resilience of vulnerable households? What are the factors that helped or hindered transformative change?

b. Impact indicators

The above-mentioned evaluation questions will be primarily answered by measuring changes in the following indicators:

EQ1) Number of farmers that adopt CRA practices; number and type of CRA practices adopted by farmers

EQ2) Coping Strategies Index (CARE, 2008)[2]; number of days members of the household did not eat three meals a day; Household Dietary Diversity Score (Food and Agriculture Organization of the United Nations (FAO), 2010)[3]

EQ3) Production of agricultural, animal and forest products; agricultural, animal and forest productivity; income; number of sources of livelihoods; share of the agricultural production not for household consumption; climate resilience index

EQ4) Production of biogas; quantity of firewood used for cooking (bundles/day)

EQ5) Permanent vegetation cover, type and location (measured by satellite images)

EQ6) Above-mentioned indicators disaggregated by gender; women's access to Community Adaptation Fund (CAF)

Additional indicators (secondary indicators) will also be collected to better inform the mechanisms

[2] This index is based on a series of questions (to be adapted to the local context) related to how households manage to cope with food shortage, measuring both the frequency of coping behaviours and their severity. For more information on how to build this index, refer to: The Coping Strategies Index: Field Methods Manual – Second Edition, Copyright © 2008 Cooperative for Assistance and Relief Everywhere, Inc. (CARE).
[3] This tool aims to capture the economic ability of a household to access a variety of foods in a simple and practical manner. For more information, refer to: FAO. 2013. Guidelines for Measuring Household and Invidual Dietary Diversity.

at play.

2. IMPACT EVALUATION DESIGN

The lifespan of the SCRCP is 6 years. During the life of the project three rounds of data collection will be conducted: baseline household survey (June – July 2020); midline household survey (April-May 2023); and an endline survey (April-May 2025). Additionally, an impact evaluation assessment will take place at midline and endline to evaluate the success of the project against the above defined objectives.

The impact evaluation design is explained in detail in the LORTA design report and follows a mixed method approach that combines quantitative and qualitative data analysis. Using a mixed approach will contribute with different insights to the overarching research question; hence, it will provide a complete picture of the ability of the project to impact climate change adaptation and mitigation of GHG emissions (LORTA design report, 2020). The suggested quantitative design makes use of a difference-indifference approach combined with matching. Together, the two techniques assist in overcoming bias led by systematic differences between the treated and the control groups. Matching consists of using statistical techniques to construct an artificial comparison group. The idea is to select, for every treated unit (for instance, a beneficiary community), a non-treated unit that has the most similar observable characteristics (LORTA design report, 2020). To contribute to this approach, SESMEC LTD selected sectors and villages within the Gicumbi district that are comparable to the treated villages based on several characteristics including a number of geographic and demographic characteristics.

In a second step, the technique will make use of household level data collected at baseline, to match beneficiary households to non-beneficiary households in selected comparison communities based on sociodemographic characteristic. Any potentially remaining differences between the two groups, especially on non-observable characteristics, can be accounted for through the difference-in-difference technique. As long as initial differences that influence the outcomes of interest are constant over time in absence of the intervention, this method enables the causal identification of the impacts of the project. This approach is also robust to external shocks, if these shocks affect both groups similarly (LORTA design report, 2020).

The LORTA design report also speaks of qualitative research methods that will complement the quantitative evaluation by focusing on the beneficiaries' perception of the transformational change triggered particularly by component 3 of this project.

Finally, the same quantitative evaluation design will be used at midline and endline. At midline, the described impact evaluation approach will be able to detect the impact of the project (if any) on variables such as awareness, adaptation of CRA practices and use or demand for firewood; whereas other variables such as food security, vegetation cover, resilience to climate change and deforestation are expected to evolve slowly over time and therefore, are more likely to be detected at endline.

D. DESCRIPTION OF THE APPROACH AND SURVEY METHODOLOGY

An integrated methodology combining the literature review, quantitative and qualitative methods was employed in this study. While the quantitative methods are free from personal biases and thus, help ensure objectivity of findings, the qualitative methods better reflect the beneficiary and control group perceptions and experiences and uphold humanistic values essential to understanding perceptions. The literature consulted for this review is described in the Executive summary. We now turn to the survey design, sampling and power calculations.

1. SURVEY DESIGN AND DATA COLLECTION TOOLS

Survey research is an efficient way of gathering data to address a research question. The main challenge is developing reliable and valid measures and sampling representative data. Survey design is critical in determining the quality of research. It is in this view that the sampling and sample size was determined. Both quantitative and qualitative approaches were used with a triangulation of data collection/generation methods and techniques.

In view of the survey objectives, the questionnaire, focus group discussions (FGDs) and key informant interviews (KIIs) guides were designed based on the indicators highlighted in the terms of reference, and the guidance provided by the client (FONERWA) and the LORTA team. The latter helped fine-tune the questionnaire to fit with the expected reporting requirements for the impact evaluation of the project (described in section C).

The modules of the quantitative questionnaire are as follows:

Module 1 was used to collect information on household characteristics.

Module 2 was used for collecting information on basic socioeconomic characteristics and for identification of the respondent.

Module 3 was used for collecting data on the sources of household income/livelihoods. This includes the main source of household income in the last year, household income per month, reared domestic animals and used medical treatment for livestock.

Module 4 was used to collect data on land property with specific focus on land ownership, land size and use.

Module 5 was used for collecting data on the home/homestead characteristics. It captures information on house ownership, the number of rooms in the house, materials used on the walls, materials used for foundation, materials used for the roof, possession of housing equipment, quality of toilets, causes of damage experienced on the house and location of the house.

Module 6 was used to collect data on household financial assets and savings especially on the possession of a bank account, access to a loan/credit, membership to tontines and cooperatives.

Module 7 was used to collect information on the possession of health insurance by household, morbidity in the household and distance to the nearest health centre.

Module 8 was used for collecting information on food security, especially on the capacity of households in terms of number of meals per day, most important meal of the day, preferable meal, assistance received in terms of food or money from the government or other institutions, experiences of food shortage and main causes of food shortages.

Module 9 was used to collect information on access to basic facilities and infrastructure. This includes the main source of water for domestic use and for irrigation activities, the quantity of water used per day for domestic usage, possession of water tanks or any other tools used for rainwater collection, possession of infrastructure to clean water, responsible person for getting domestic water, distance to the water source, the main source of energy used for cooking, use of firewood and charcoal, the main mode used for cooking, the main source of energy used for light in houses and possession of transport and communication means.

Module 10 was used to collect information on the access to weather/climate information, including reception of weather/climate information and of technical advice or training related to the use of weather information, adoption of climate resilient technologies, cropping and agricultural activities, possession of a kitchen garden, growing tea and coffee plantations, possession of forest and progressive terraces in farmland, other methods used to protect land against flooding, soil erosion

and landslides, skills used on the plots, visits by extension services and members of household who received any agricultural inputs in the last 12 months.

Module 11 was used to collect information on the experiences of climate change and variability, including exposure to climate change during the last 12 months, observed changes in temperature and rainfall, experienced or observed dry spells, the consequences of drought and flooding episodes, occurrences of strong winds and their consequences, experienced severe thunderstorms and their consequences and awareness of the adverse effects of climate change.

Module 12 was used to collect information on the capacity to adapt to the impacts of climate change. This includes change in woodland areas, membership to any Forest Management Units, the capacity to deal with climate change, knowledge on the appropriate adaptation measures to be undertaken to deal with climate change, awareness of improved soil management practices and awareness of erosion control practices.

The main topics covered in the KIIs are the sources of income for households in areas under investigation, the observed negative impacts of climate change on household welfare and adaptation measures used by households to deal with them. Furthermore, the KIIs guide was used to investigate on the support received by households in coping with the adverse effects of climate change, and the existing relationship between food security in the area and climate change. The key informants were also asked on the appropriate measures that should be employed to deal with the adverse impacts of climate change in the areas under investigation.

As for the FGDs, the main modules covered the following topics: main sources of income for the family, negative impacts experienced due to drought, dry spells or flooding episodes, negative impacts faced due to any other extreme weather events, support received in the event households were affected by extreme weather events and strategies in place to mitigate the negative impacts of extreme weather events.

All quantitative interviews were held at the respondents' home. The questionnaire was administered to the head of the household when available, or a representative over 18 years old.

KIIs took place at the respondents' office premises or even in the office itself, while the FGDs were held in an environment where it was easy for the group to meet and hold a discussion, such as a common room, outside under a tree shade or anywhere in the compound of the institution or homestead.

2. BASELINE SAMPLING AND POWER CALCULATION

a. Target group

The target population for the survey included all households living in private dwellings during the interviewing period (June-July 2020) in the 18 sectors of the Gicumbi district. Nine of the 18 sectors were in the project intervention area of the Muvumba B catchment while the remaining nine served as a control group and lied outside the intervention area of the Gicumbi district.[4]

Qualitative interviews were administered to the targeted sample of KIIs of selected people who were most knowledgeable of the community. The purpose of KIIs is to collect information from a wide range of people including community leaders and professionals from various governmental and non-governmental institutions who have first-hand knowledge about the local community and the objectives of the ongoing project. On the other hand, qualitative interviews were also administered

[4] Those in the intervention area included the Kaniga, Rubaya, Cyumba, Rushaki, Shangasha, Mukarange, Manyagiro, Byumba and Bwisige sectors, while the Bukure, Kageyo, Muko, Mutete, Nyankenke, Nyamiyaga, Rukomo, Ruvune and Rwamiko sectors served as a control group.

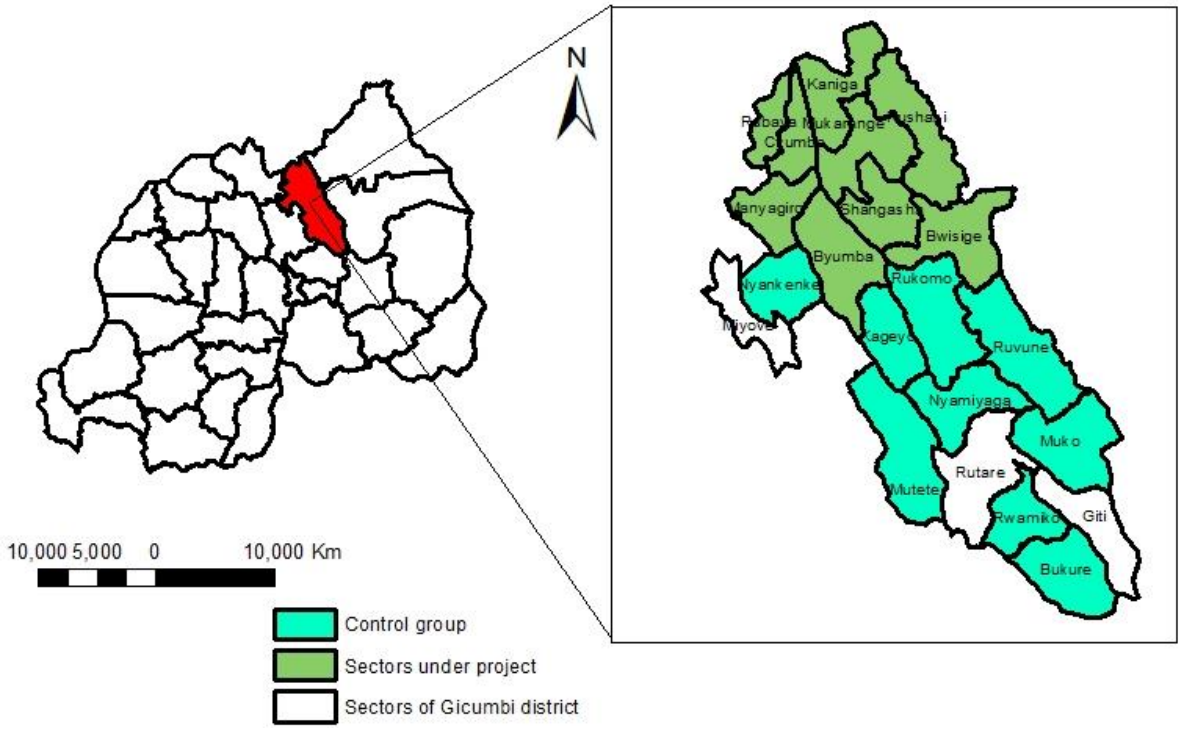
to targeted sample FGDs that yielded qualitative data at the community level by facilitating interaction between participants; hence, eliciting new ideas and explanations which would not have come up during individual or household interviews.

b. Sampling

The sample size was determined based on the power calculations. Statistical power is maximized when the study sample is evenly split between a beneficiary and a control group, i.e., 50 per cent of the sampled units will receive treatment and 50 per cent will not. Based on this, the sample was divided into two groups: nine treated sectors and nine control sectors. As the Gicumbi district is composed of 21 sectors and nine of them are under project intervention, it was clear that nine control sectors had to be selected from 12 remaining sectors that would not benefit directly from project interventions. This implies that only three sectors had to be left out for the study. Therefore, the sectors most similar to the project intervention area in terms of physical, population and socioeconomic characteristics, especially in agriculture and settlements, were selected from the remaining 12 sectors to serve as control sectors.

It is necessary to mention that the division of the sectors into treated and control groups was necessary for the impact evaluation exercise where the control group acts as the comparison group. Within each of the 18 sectors, villages were selected following the procedure described below. The control villages were selected such that the distribution (and thus, average value) of key village level variables were similar to the extent possible between the project area and the control villages.

Figure 1. Location of project area and control group in the Gicumbi district



The sample in the intervention area was selected in two stages: at area (village/umudugudu) and household level. At the village level, treated villages were selected randomly using SPSS software with equal representation. At the household level, the sampling rates were determined separately for each stratum (village) and sample units (households). It was systematically selected with a random starting number in each stratum using the list of all households established at the village level.

The control villages were selected such that the distribution (and thus, average value) of key village level variables were similar to the extent possible between the project area and the control villages.

Secondary data on agroecological zones, exposure to hazard risks, distance to river/water bodies, distance to all-weather roads, population density, poverty level, elevation, main crops cultivated in the village/land use and exposure to other interventions/programmes in agriculture and environmental protection were used to select seven villages in each of the nine control sectors (Bukure, Kageyo, Muko, Mutete, Nyankenke, Nyamiyaga, Rukomo, Ruvune and Rwamiko). The households within each of the treated and control villages were randomly selected.

c. Power calculations

We present below the power calculations conducted in the LORTA design report. Power calculations determine the minimum sample size needed in order to detect the impact of a given intervention. At baseline is sufficient to detect an impact of the project activities, considering an equal allocation ratio between treatment and control groups.

Power calculations were performed by the LORTA team using the following power formula that relates the sample size to the Minimum Detectable Effect Size (MDES) between the mean outcomes of two groups:

$$MDES = (t_{1-\kappa} + t_{\alpha})\sqrt{\frac{1}{P(1-P)}}\sqrt{1+\rho(m-1)}\sqrt{\frac{\sigma^2}{N}}\sqrt{1-R^2}$$

where $\boldsymbol{t_{1-\kappa}}$ and $\boldsymbol{t_{\alpha}}$ are t-statistics representing the required power and level of statistical significance, $\boldsymbol{P}$ represents the proportion in one of the two compared groups (allocation ratio), $\boldsymbol{\rho}$ is the intra-cluster correlation (ICC), $\boldsymbol{m}$ is the number of individuals per cluster, $\boldsymbol{\sigma^2}$ is the variance of the outcome of interest within our population, $\boldsymbol{N}$ is the total sample size and $\boldsymbol{R^2}$ represents the extent to which baseline characteristics predict the endline outcome.

The MDES was estimated for a power of 80 per cent and a level of statistical significance of 5 per cent. We consider a clustered design in which a cluster corresponds to a village. The similarity between farmers residing in similar villages is measured by the intra-cluster correlation, which compares the variance in outcomes within villages and between villages. When the similarity in outcomes within villages increases and at the same time, there is heterogeneity across villages, the variability of the responses of farmers to the interventions reduces. As a result, the sample size required to detect a significant difference between beneficiaries and the comparison group increases. The table below taken from the LORTA design report presents three different values of ICC: 0.05, 0.10, 0.15 and 0.20.

Table 4. Sample size and power calculations

Indicator	Mean	Baseline SD	ICC	Total sample	R2	MDES in % point	Needed endline level	% change
Vulnerability index	0.472	0.5	20%	1200	30%	0.113	0.359	24.0%
Vulnerability index	0.472	0.5	20%	1200	0%	0.135	0.337	28.7%
Vulnerability index	0.472	0.5	15%	1200	30%	0.104	0.368	22.0%
Vulnerability index	0.472	0.5	15%	1200	0%	0.124	0.348	26.3%
Vulnerability index	0.472	0.5	10%	1200	30%	0.093	0.379	19.7%

Indicator	Mean	Baseline SD	ICC	Total sample	R2	MDES in % point	Needed endline level	% change
Vulnerability index	0.472	0.5	10%	1200	0%	0.111	0.361	23.6%
Vulnerability index	0.472	0.5	5%	1200	30%	0.081	0.391	17.3%
Vulnerability index	0.472	0.5	5%	1200	0%	0.097	0.375	20.6%

Source: Impact evaluation design report, Rwanda: GCF Independent Evaluation Unit

Using the formula above and referring to one of the main outcome variables of interest: vulnerability to climate change, the table above shows that at a sample size of 1200 a percentage change between 17.3 per cent and 28.7 per cent can be detected. The sample size of 1200 has been adjusted to 1260 households to account for an equal dispersion of households in intervention and control areas. Seven villages were sampled in each sector located in the intervention area (Kaniga, Rubaya, Cyumba, Rushaki, Shangasha, Mukarange, Manyagiro, Byumba and Bwisige) and control group (Bukure, Kageyo, Muko, Mutete, Nyankenke, Nyamiyaga, Rukomo, Ruvune and Rwamiko) to have 120 villages in total and 1260 households. The samples were drawn from the villages in Appendix 4.

3. Sample selection and distribution of targeted sample for KIIs and FGDs

a. Focus group discussions (FGDs)

One FGD was held in each sector under investigation to enhance in-depth understanding of the topic under study. Hence, 18 FGDs were undertaken in course of this study. FGDs were composed of four to six participants selected from respondents with similar characteristics such as gender, social status, locality, age, professional occupation and educational level to ensure that everyone had an opportunity to express their views freely. The FGDs venue was near the participants' place of residence/work to avoid transportation expenses.

b. Key Informant Interviews (KIIs)

The KIIs were also conducted during this study and mainly focused on local leaders at the sector, cell and village levels and other leaders relevant to the project to be implemented in the Gicumbi district. Furthermore, the interviews were well sought and conducted with FONERWA staff. Table 5 highlights the respondents for the KIIs.

Table 5. List of key informants interviewed

SN	Institution/informants	Number	Location of head office
1	Vice Mayor of Economic Affairs, Gicumbi district	1	Gicumbi
2	Infrastructure Director, Gicumbi district	1	Gicumbi
3	District forest officer	1	Gicumbi
4	Sector Executive Secretary	5	Gicumbi
5	Forest technician sector level	2	Gicumbi
6	Social affairs at sector level	1	Gicumbi

SN	INSTITUTION/INFORMANTS	NUMBER	LOCATION OF HEAD OFFICE
7	Cell Executive Secretary	3	Gicumbi
9	Forest cooperative representatives	3	Gicumbi
10	Socio Economic Development Officer (SEDO) at cell level	3	Gicumbi
11	Director of agriculture at district level	1	Gicumbi
12	Chairperson of Watershed Committee	1	Gicumbi
13	FONERWA	2	Kigali
14	Ministry of Agriculture and Animal Resources (MINAGRI)	1	Kigali
15	Ministry of Finance and Economic Planning (MINECOFIN)	1	Kigali
16	Ministry of Infrastructure (MININFRA)	1	Kigali
17	National Agricultural Export Development Board (NAEB)	1	Kigali
18	Rwanda Environment Management Authority (REMA)	1	Kigali
19	National Industrial Research and Development Agency (NIRDA)	1	Kigali
20	Ministry of Environment (MoE)	1	Kigali
21	Rwanda Housing Authority (RHA)	1	Kigali
22	Rwanda Land Management and Use Authority (RLMUA)	1	Kigali
23	Rwanda National Institute of Statistics in Rwanda	1	

4. FIELDWORK AND DATA COLLECTION

a. Secondary data collection

Secondary data was used to complement the primary field data. Project data was sourced from FONERWA and other stakeholders involved in the Gicumbi district project while climatic data was obtained from the MoE, specifically from Rwanda Meteorology Agency (Meteo - Rwanda) and the REMA. Additional data on social economic activities, especially agricultural activities, was sourced from the National Institute of Statistics of Rwanda (NISR) and other relevant governmental and non-governmental institutions which hosted a comprehensive and complete dataset necessary to perform this assignment. Furthermore, secondary data was also obtained from published articles, books, theses, and papers. These types of data were collected by the consultant. The secondary data was used to support findings offered by primary data during the analysis.

b. Primary data collection

i. Training of enumerators and supervisors

In the preparation of fieldwork phase, SESMEC, together with representatives from FONERWA, were actively involved in training sessions, analysis of the completeness, comprehension and usability of the individual questionnaire and FGDs/KIIs guides for data collection. The translated questionnaire in Kinyarwanda was validated by the client and thereafter digitalized and uploaded on the tablets using ODK. This training was organized and completed over the course of two days (Thursday, 11 June – Friday, 12 June 2020), followed by a pilot survey on Saturday, 13 June, which

was conducted in the Nduba sector of the Gasabo District of Kigali City. This helped to fine-tune the questionnaire and train the enumerators as well as assess the potential challenges including the average time taken to interview each respondent. Thereafter, the paper questionnaire was shared with the LORTA team who mad edits and suggested several additional questions required to measure the outcome variables and impact indicators listed in Table 2 and Table 3. This required SESMEC to organize a refresher training session for enumerators and supervisors focusing especially on the additional questions. The refresher training took place on 22 June 2020 to ensure the enumerators understood the additional knowledge provided by the LORTA team.

It is worth noting that the use of ODK helps to collect field data on a mobile device and transmit it to a server from where they are extracted for analysis. In addition, the global positioning system (GPS) incorporated in ODK helps to regularly monitor the geographical location and progress of interviews. This enhanced quality validity and the reliability of the findings. Moreover, the use of ODK allowed the submission of data progress reports showing the total interviews completed, remaining interviews and challenges faced.

ii. Pre-test of survey tools

In order to ensure the feasibility of all data collection tools used, a pre-test was undertaken after the training of supervisors and enumerators. The key objective of the pre-test was to test the procedures of data collection and any irregularities that could exist in the questionnaire and FGDs/KIIs guides. It also helped to find out how many questionnaires an enumerator could complete in a day. The survey manager received feedback from the field teams which were accounted for in the main fieldwork. The final version of the individual questionnaire and FGDs/KIIs guides were developed and translated in Kinyarwanda.

The pre-test was carried out in the Bumbogo sector, Nyabikenke and Musave cells. In the Nyabikenke cell, the villages of Kamatamu and Karama were selected, and in the Musave cell the villages of Rebero and Rugando were selected. In each village, six households were selected. This area was selected purposively due to its rural characteristics and proximity to Kigali City where the training of enumerators and supervisors had taken place.

iii. Fieldwork

The fieldwork for data collection began on 24 June and was finalized on 11 July 2020. The data collection lasted as planned for 17 days. The 12 enumerators were appointed to conduct interviews in the 18 sample sectors and three supervisors conducted FGDs and KIIs at the project intervention area. The teams were organized in such a way that every supervisor was heading a team of four enumerators. The average number of interviews per enumerator was 108 households, and the daily rate was approximately six households per day.

The enumerators used SAMSUNG Galaxy 2016 tablets as devices and a SESMEC developed data collection and transmission application for Android, which helped facilitate a daily data collection check-up.

Face masks were worn and a distance of at least one and a half (1.5m) metres was respected amid the COVID-19 pandemic. Interviews were planned to be conducted with 1,260 household representatives; however, the enumerators were instructed to interview at least two additional households in each sector to be used in correcting any outliers. Table 6 shows that a balance between female and male respondents in each sector.

Table 6. Distribution of respondents by sector and gender

Sector	Male		Female		Total	
	Respondents	%	Respondents	%	Respondents	%
Bukure	34	47.9 %	37	52.1 %	71	100.0 %
Bwisige	40	57.1 %	30	42.9 %	70	100.0 %
Byumba	28	38.9 %	44	61.1 %	72	100.0 %
Cyumba	35	49.3 %	36	50.7 %	71	100.0 %
Kageyo	28	38.9 %	44	61.1 %	72	100.0 %
Muko	27	37.5 %	45	62.5 %	72	100.0 %
Kaniga	35	46.7 %	40	53.3 %	75	100.0 %
Manyagiro	26	36.6 %	45	63.4 %	71	100.0 %
Mutete	33	46.5 %	38	53.5 %	71	100.0 %
Mukarange	32	43.8 %	41	56.2 %	73	100.0 %
Rukomo	36	49.3 %	37	50.7 %	73	100.0 %
Nyamiyaga	27	36.5 %	47	63.5 %	74	100.0 %
Nyankenke	27	37.5 %	45	62.5 %	72	100.0 %
Rubaya	32	43.8 %	41	56.2 %	73	100.0 %
Ruvune	28	40.0 %	42	60.0 %	70	100.0 %
Rushaki	30	41.7 %	42	58.3 %	72	100.0 %
Rwamiko	26	35.6 %	47	64.4 %	73	100.0 %
Shangasha	26	35.1 %	48	64.9 %	74	100.0 %
Grand Total	**550**	**42.3 %**	**749**	**57.7 %**	**1,299**	**100.0 %**

Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020

Table 7 and Table 8 reveal that females and males comprise 57.7 per cent and 42.3 per cent of total respondents, respectively. The number of female respondents was higher because they were dominantly present at home during the data collection period. Additionally, it should be noted that decision-making in Rwandan households is a shared responsibility between husband and wife, especially in matters related to agricultural activities and economic welfare which is 50 per cent each by law (RLMUA, 2017). Therefore, if the husband was unavailable for the interview as he was working away from the household, the wife could be interviewed since she is equally responsible and knowledgeable.

Table 7. Distribution of respondents by gender

Gender	Frequency	%
Male	550	42.3
Female	749	57.7
Total	**1,299**	**100.0**

Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020

The gender balance of respondents was checked to see if it reflected the Rwandan context. Table 8 shows that in Gicumbi district the number of females (51.6 per cent) was higher than males (48.4 per cent).

Table 8. Distribution of all members of household by gender

GENDER	FREQUENCY	%
Male	3,031	48.3 %
Female	3,249	51.7 %
Total	**6,280**	**100.0 %**

Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020

These percentages are almost similar to the national data published in annual reports by the National Institute of Statistics in 2019.

c. Data quality assurance and non-completion rates

SESMEC Ltd takes data quality assurance as a priority in its survey activities and accordingly, ensures all enumerators and supervisors are trained thoroughly in the use of ODK and transported to the households or to places nearest to them. The use of GPS to monitor enumerators' location during interviews is helpful because they use tablets that are easily monitored. Supervisors also check the work accomplished by each enumerator throughout the exercise. Furthermore, non-completion rates were checked. The planned number of respondents was 1260. As indicated in Table 6 the final number of interviewed respondents was 1299, indicating that there were 39 additional respondents or 3.09 per cent extra coverage. It is worth noting that the success of field data collection from the above-mentioned respondents was facilitated due to high cooperation from local leaders, FONERWA staff, professionals and the respondents themselves.

d. Research ethics

The research was subject to ethical approval. The research was underpinned by a commitment to integrity, honesty and competence. Participation in the research was engaged on a voluntary basis; all informants were asked to give informed consent. All interviews were carried out in private and respondents were promised confidentially and anonymity. All survey data were stored to ensure that there was no possibility of data leakage. Participants in FGDs were asked to respect the confidentiality of what members of the group say. During the interviews, the enumerators adhered to the Ministry of Health guidelines to ensure the safety of interviewers and respondents from the Covid-19 pandemic. Hence, they made sure that they kept a distance of 1.5 metres from the respondents, wore face masks and also asked respondents to do likewise. All the enumerators and supervisors carried hand sanitizers as per health guidelines.

e. Data cleaning and analysis

The ODK Collect software installed in the tablets sent data to the server hosted by the consultant. ODK Collect has inbuilt cleaning checks on outliers and automatically sends observed errors to the systems administrator so that he/she in turn can verify the data with the enumerator in question. The dataset was exported from the server in CSV format from the server and converted to SPSS format for tabulation and analysis.

Data cleaning was done using the latest version of SPSS. Once the data files were produced and exported, tabulation was generated using SPSS statistical software and a detailed analysis of the

results was presented in the form of a report. The data collected was organized in a form that allows quantification by use of codes and numbers.

During the analysis, descriptive and inferential statistics were employed to inform the research. The analysis was done by considering the key indicators and components of the projects. The key findings from the individual questionnaire, FGDs and KIIs were presented in the form of tables and graphics and then discussed and interpreted during the process of compiling the final baseline report.

The table below shows how the questionnaire responds to the key indicators, components and expected outcomes of the SCRCP project selected to be implemented in nine sectors (Byumba, Bwisige, Cyumba, Kaniga, Manyagiro, Mukarange, Rubaya, Rushaki and Shangasha).

Table 9. Linkage of questionnaire to the project indicators, components and expected changes from project interventions

Outcome's Indicators	Project components	Sources of data				Reference to the questionnaire
		HH Survey	KII	FGD	2nd data	
Component 1: Watershed protection and climate resilient agriculture						
Restoration of ecosystem functions and services in the Muvumba watershed to reduce the risk of landslides and flooding and to enhance the resilience of small holder tea and coffee producers to climate change	Sub-component 1.1 Strengthen community-based adaptation	√	√	√	√	Questionnaire: Sub-title 4.6 Agricultural practices to reduce adverse effects of climate change Questionnaire: Sub-title 13: Evidence of climate change and variability exposure to climate change (1-6)
	Sub-component 1.2 Reduce slope erosion to sustainable levels	√	√	√	√	Questionnaire: Sub-title 13 Evidence of climate change and variability exposure to climate change (7-9)
	Sub-component 1.3 Stabilize rivers, roadsides and steep slopes with protective forestry		√	√	√	FGDs and KIIs guides Questionnaire: Sub-title 12.7, 12.8, 12.9, and 12.10 Agricultural practices to reduce adverse effects of climate change
	Sub-component 1.4 Integrate agroforestry into farming systems on 9790 ha of the watershed	√	√	√	√	Questionnaire: Sub-title 14 Capacity to adapt to climate change impacts
	Sub-component 1.5 Support 1800 smallholder crop-livestock farmers to adopt agroecological approaches to increase climate resilience	√	√	√	√	Questionnaire: Sub-title 14 Capacity to adapt to climate change impacts
	Sub-component 1.6 Increase climate resilient farming practices with tea cooperatives in Mulindi	√	√	√	√	Questionnaire: Sub-title 12.2, 12.3, 12.4, 12.5, 12.7, 14

Outcome's Indicators	Project components	Sources of data				Reference to the questionnaire
		HH Survey	KII	FGD	2nd data	
	(with planting for future climate change) - targets 5000 smallholders					FGDs and KIIs guides
	Sub-component 1.7 Integrate climate resilient practices into local extension services	√	√	√	√	Questionnaire: Sub-title 12 Cropping and agricultural activities
	Sub-component 1.8 Provide weather and climate services for tea and coffee farmers to increase productivity and reduce losses from weather and climate variability	√	√	√	√	Questionnaire: Sub-title 12 FGDs and KIIs guides
	Sub-component 1.9 Increase capacity for pest monitoring, surveillance and Integrated Pest Management in full term to address current and future climate change	√	√	√	√	Questionnaire: Sub-title 12.6, 12.7, 12.8 FGDs and KIIs guides
	Sub-component 1.10 Increase climate resilient practices with 1000 coffee growers to reduce susceptibility to climate change and protect slopes in the watershed (planting for future climate change)	√	√	√	√	Questionnaire: Sub-title 14, 12.5, 12.6, 12.7, 12.2, 12.3 FGDs and KIIs guides
Component 2: Sustainable forest management and sustainable energy						
Increased productivity of forest resources and reduced deforestation	Sub-component 2.1 Increase forest productivity and sustainable forest management	√	√	√	√	Questionnaire: Sub-title 12 Cropping and agricultural activities
	Sub-component 2.2 Strengthen forest management skills to sustain investments in forestry and watershed management	√	√	√	√	Questionnaire: Sub-title 12 Cropping and agricultural activities
	Sub-component 2.3 Establish, restore and manage degraded woodlots across 297 ha of the watershed	√	√	√	√	Questionnaire: Sub-title 14 FGDs and KIIs guides

Outcome's Indicators	Project components	Sources of data				Reference to the questionnaire
		HH Survey	KII	FGD	2nd data	
	Sub-component 2.4 Strengthen community capacity to provide forest products and services	√	√	√	√	Questionnaire: Sub-title 12, 14 FGDs and KIIs guides
	Sub-component 2.5 Increase the use of biogas and efficient cooking stoves to reduce deforestation of the watershed	√			√	Questionnaire: Sub-title 9.6, 9.7, 9.8, 9.9 FGDs and KIIs guides
	Sub-component 2.6 Reduce the demand for fuelwood and GHG emissions at the Mulindi tea factory through energy efficiency measures		√		√	Questionnaire: Sub-title 9.7, 9.8 FGDs and KIIs guides
Component 3: Climate resilient settlements						
Reduced exposure of human settlements to flooding and landslides	Sub-component 3.1 Manage surface water run-off from settlements to reduce gully formation, floods and landslides	√	√	√	√	Questionnaire: Sub-title 12.10 FGDs and KIIs guides
	Sub-component 3.2 Increase rainwater capture and storage to counter inter-annual rainfall variability	√	√	√	√	Questionnaire: Sub-title 9.3 FGDs and KIIs guides
	Sub-component 3.3 Construct a green social housing development in Kabeza to reduce the number of vulnerable households living in high-risk zones (100 houses + green infrastructure)	√	√	√	√	Questionnaire: Sub-title 5.7, 5.8 FGDs and KIIs guides
	Sub-component 3.4 Construct a green social housing development in Kaniga to reduce the number of vulnerable households living in high-risk zones (140 houses + green infrastructure)	√	√	√	√	Questionnaire: Sub-title 5.7, 5.8 FGDs and KIIs guides
Component 4: Knowledge transfer and mainstreaming						
Successful adaptation and mitigation	Sub-component 4.1 Communicate project results and lessons learned		√	√	√	Direct observation on the field, FGDs, KIIs guides

Outcome's Indicators	Project components	Sources of data				Reference to the questionnaire
		HH Survey	KII	FGD	2nd data	
approaches communicated and mainstreamed at the national level	Sub-component 4.2 Awareness building, promotion and advocacy to support replication and scale up in other districts		√	√	√	Direct observation on the field, FGDs, KIIs guides
	Sub-component 4.3 Increase capacity of local institutions and communities to sustain investments in watershed protection and climate resilient settlements		√	√	√	Direct observation on the field, FGDs, KIIs guides
	Sub-component 4.4 Mainstream climate resilient approaches into existing forestry programmes and practices to support scale up and replication		√	√	√	Direct observation on the field, FGDs and KIIs guides
	Sub-component 4.5 Mainstream approaches to climate resilient agriculture for smallholders into existing plans and programmes to support scale up and replication		√	√	√	Direct observation on the field, FGDs and KIIs guides
	Sub-component 4.6 Mainstream climate resilient approaches into existing agriculture extension programmes to support scale up and replication		√	√	√	Direct observation on the field, FGDs and KIIs guides
	Sub-component 4.7 Mainstream energy efficiency into the tea industry to support scale up and replication		√	√	√	Direct observation on the field, FGDs and KIIs guides
Household level characteristics		√	√	√	√	Questionnaire: Sub-title 3 Sources of household income Questionnaire: Sub-title 4 Land property Questionnaire: Sub-title 5 House / homestead characteristics

Outcome's Indicators	Project components	Sources of data				Reference to the questionnaire
		HH Survey	KII	FGD	2nd data	
						Questionnaire: Sub-title 6 Household Financial Assets and savings Questionnaire: Sub-title 7 Health Questionnaire: Sub-title 8 Food security FGDs and KIIs guides
Impact indicators		√	√	√	√	Questionnaire: All questions 3-14 FGDs and KIIs guides

E. Analysis of data and presentation of results

The section below provides the findings from the survey including demographic and socioeconomic characteristics of respondents, accessibility and use of energy and water in households, the accessibility to health services, food security, agricultural practices along with climate change and its impacts as well as adaptation options used by smallholder farmers in the study area.[5]

1. Demographic characteristics of respondents and household heads

a. Demographic characteristics of respondents

The distribution of respondents by sex, age, relationship with household head, education and occupation are presented in the table below.

Table 10. Distribution of respondents

Classification		Beneficiaries		Control		Total	
		Freq.	%	Freq.	%	Freq.	%
Gender	Male	284	43.6%	266	41.0%	550	42.3%
	Female	367	56.4%	382	59.0%	749	57.7%
	Total	*651*	*100.0%*	*648*	*100.0%*	*1,299*	*100.0%*
Education	None	203	31.2%	163	25.2%	366	28.2%
	Primary school	331	50.8%	347	53.5%	678	52.2%
	Junior high school	46	7.1%	79	12.2%	125	9.6%
	Higher school	58	8.9%	54	8.3%	112	8.6%
	University	13	2.0%	5	0.8%	18	1.4%
	Total	*651*	*100.0%*	*648*	*100.0%*	*1,299*	*100.0%*

[5] The test of balance of the key variables will be considered in the later publications of this evaluation, as the evaluation progresses.

Classification		Beneficiaries		Control		Total	
		Freq.	%	Freq.	%	Freq.	%
Age group	< 20	16	2.5%	17	2.6%	33	2.5%
	20 - 30	149	22.9%	137	21.1%	286	22.0%
	30 - 40	161	24.7%	175	27.0%	336	25.9%
	40 - 50	141	21.7%	137	21.1%	278	21.4%
	50 - 60	112	17.2%	107	16.5%	219	16.9%
	60 - 70	55	8.4%	60	9.3%	115	8.9%
	>70	17	2.6%	15	2.3%	32	2.5%
	Total	*651*	*100.0%*	*648*	*100.0%*	*1,299*	*100.0%*
Relationship with household head	Head of household	406	62.4%	275	42.4%	681	52.4%
	Spouse	197	30.3%	313	48.3%	510	39.3%
	Son/daughter	42	6.5%	55	8.5%	97	7.5%
	Grandchild	5	0.8%	5	0.8%	10	0.8%
	Other relation	1	0.2%	0	0.0%	1	0.1%
	Total	*651*	*100.0%*	*648*	*100.0%*	*1,299*	*100.0%*
Occupation	None/no job	27	4.1%	13	2.0%	40	3.1%
	Student	7	1.1%	16	2.5%	23	1.8%
	Farmer	573	88.0%	576	88.9%	1,149	88.5%
	Artisan	8	1.2%	11	1.7%	19	1.5%
	Commerce/transport	6	0.9%	17	2.6%	23	1.8%
	Civil servant	15	2.3%	6	0.9%	21	1.6%
	Private employee	15	2.3%	9	1.4%	24	1.8%
	Total	*651*	*100.0%*	*648*	*100.0%*	*1,299*	*100.0%*

Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=1299, Beneficiaries=651, Control= 648)

In addition to the differences by gender, Table 10 shows that the highest number of respondents (24.7 per cent and 27 per cent) are between 31 to 40 years old, followed by those in the 21 to 30 years old category (22.9 per cent and 21.1 per cent in the beneficiary and control group areas respectively). The majority of respondents are aged between 20 and 60 years. Those between 18 and 20 years old are less represented as they are relatively unlikely to be married at these ages while those belonging to the older age group (above 60 years) which reflects the national average (NISR, 2019).

Table 10 shows that 62.4 per cent and 42.4 per cent of beneficiary and control group respondents were household heads, while 30.3 per cent and 48.3 per cent were spouses. In the absence of household heads and spouses, 6.5 per cent of sons/daughters of the beneficiary household heads were interviewed against 8.5 per cent in the control group area. Furthermore, a negligible percentage (less than 1 per cent) of grandchildren living with his/her grandparent(s) were respondents.

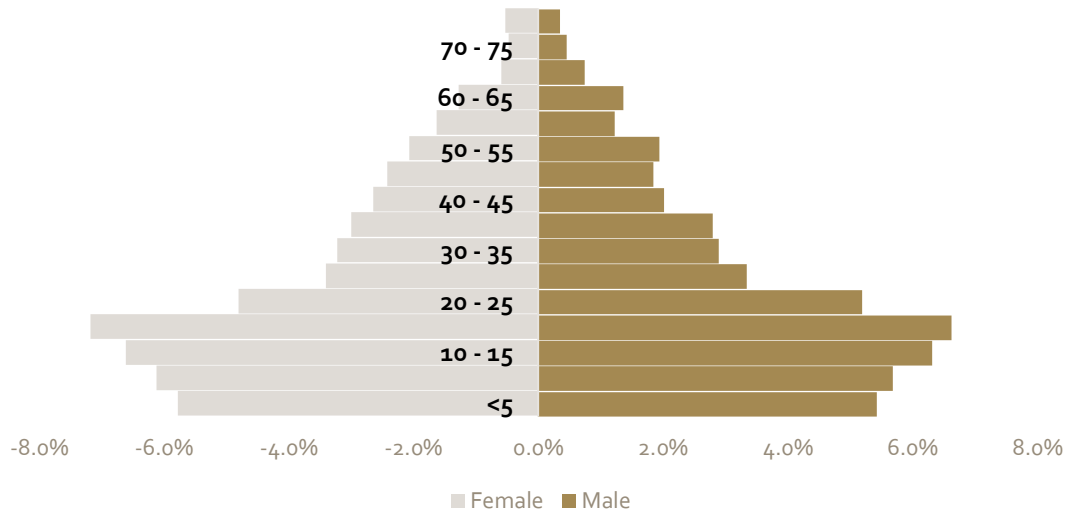
Table 11. Reading and writing ability of respondent

Classification		Male		Female		Total	
		Frequency	%	Frequency	%	Frequency	%
Beneficiaries	Yes	193	29.6%	259	39.8%	452	69.4%
	No	81	12.4%	102	15.7%	183	28.1%
	Can read only	10	1.5%	6	0.9%	16	2.5%
	Total	*284*	*43.6%*	*367*	*56.4%*	*651*	*100.0%*
Control	Yes	210	32.4%	282	43.5%	492	75.9%
	No	49	7.6%	96	14.8%	145	22.4%
	Can read only	7	1.1%	4	0.6%	11	1.7%
	Total	*266*	*41.0%*	*382*	*59.0%*	*648*	*100.0%*
Total	Yes	403	31.0%	541	41.6%	944	72.7%
	No	130	10.0%	198	15.2%	328	25.3%
	Can read only	17	1.3%	10	0.8%	27	2.1%
	Total	***550***	***42.3%***	***749***	***57.7%***	***1299***	***100.0%***

Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=1299, Beneficiaries=651, Control= 648)

Table 11 shows that 69.4 per cent and 75.9 per cent of beneficiary and control area respondents respectively possessed reading and writing abilities, against 28.1 per cent and 22.4 per cent who did not. On the other hand, 2.5 per cent and 1.7 per cent of beneficiary and control group area respondents respectively had reading abilities only. The following age-sex pyramid depicts the family structure of interviewed respondents.

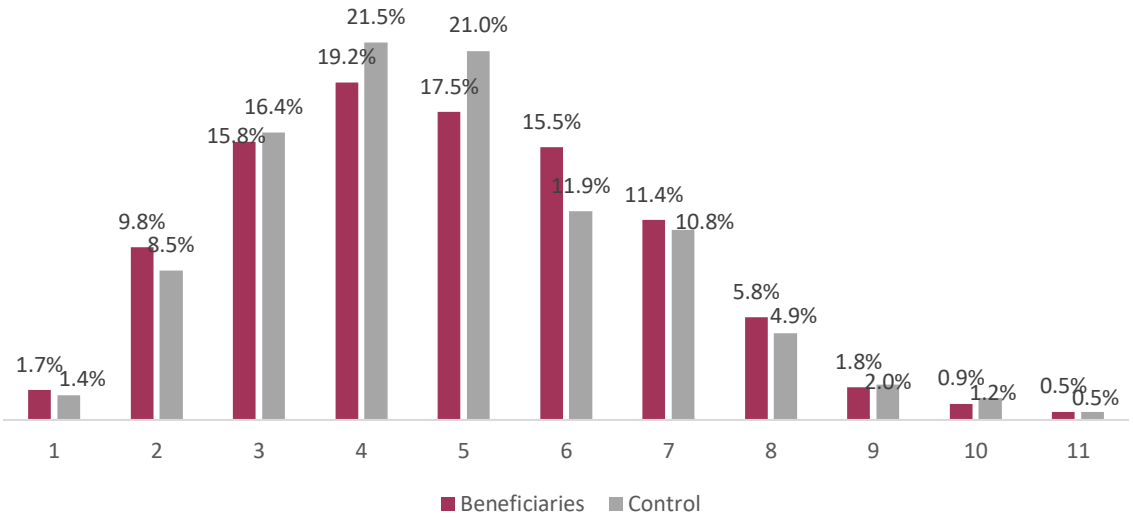
Figure 2. Age pyramid of the family members of interviewed respondents



Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=6,280: Male=3,031 and Female 3,249)

The pyramid in Figure 2 is wide at the base, narrowing rapidly as it reaches the upper age limits. This is a common shape indicating a population with high fertility and high mortality. Thus, the same shape is seen at the national level. A decrease in population growth rate from 2.6 per cent was registered in 2012 to 2.35 per cent in 2018. However, it is still high compared to the current world population growth rate of 1.2 per cent (NISR, 2019).

Figure 3. Number of family members of respondents



Soure: Baseline survey, 2020 (n=1299, Beneficiaries=651, Control= 648)

Figure 3 above shows that the number of family members varies between one and 11 with the highest being four members (19.2 per cent and 21.5 per cent in the beneficiary and control group areas). Over 85 per cent of households are composed of between three and eight members. The average household size is 4.8 people in both project intervention and control group areas, which is slightly higher than the national average of 4.2 people reported in 2018 (NISR, 2019).

Table 12. Marital status of respondents

Classification		Male		Female		Total	
		Frequency	%	Frequency	%	Frequency	%
Beneficiaries	Single	27	4.1%	24	3.7%	51	7.8%
	Married	212	32.6%	264	40.6%	476	73.1%
	Divorced	6	0.9%	11	1.7%	17	2.6%
	Separated	3	0.5%	16	2.5%	19	2.9%
	Polygamy	1	0.2%	1	0.2%	2	0.3%
	Widow(er)	35	5.4%	51	7.8%	86	13.2%
	Total	*284*	*43.6%*	*367*	*56.4%*	*651*	*100.0%*
Control	Single	30	4.6%	24	3.7%	54	8.3%
	Married	222	34.3%	296	45.7%	518	79.9%
	Divorced	2	0.3%	6	0.9%	8	1.2%

Classification		Male		Female		Total	
		Frequency	%	Frequency	%	Frequency	%
	Separated	6	0.9%	13	2.0%	19	2.9%
	Polygamy	6	0.9%	43	6.6%	49	7.6%
	Widow(er)	30	4.6%	24	3.7%	54	8.3%
	Total	*266*	*41.0%*	*382*	*59.0%*	*648*	*100.0%*
Total	Single	57	4.4%	48	3.7%	105	8.1%
	Married	434	33.4%	560	43.1%	994	76.5%
	Divorced	8	0.6%	17	1.3%	25	1.9%
	Separated	9	0.7%	29	2.2%	38	2.9%
	Polygamy	1	0.1%	1	0.1%	2	0.2%
	Widow(er)	41	3.2%	94	7.2%	135	10.4%
	Total	***550***	***42.3%***	***749***	***57.7%***	***1,299***	***100.0%***

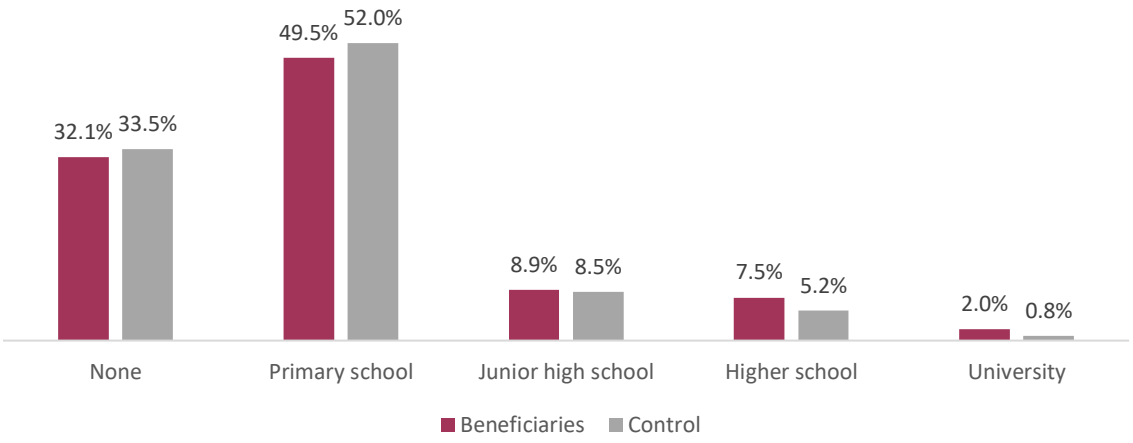
Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=1299, Beneficiaries=651, Control= 648)

Table 12 above shows that the majority (73.1 per cent and 79.9 per cent) of the beneficiary and control groups respectively are married, compared to 7.8 per cent and 8.3 per cent in the same groups who are single. Alternatively, 13.2 per cent and 8.3 per cent of respondents from the beneficiary and control group areas respectively are widows. The percentage of divorced, separated and polygamous households is very low (less than 5 per cent, which is common across Rwanda) (NISR, 2019).

b. Education and literacy attainment of household heads

Figure 4 shows the education and literacy level of household heads in project intervention and control group areas as reported by respondents.

Figure 4. Education attainment of household heads



Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=1299, Beneficiaries=651, Control= 648)

Figure 4 reveals that 52 per cent and 49.5 per cent of the control and beneficiaries respectively attained primary school education against 33.5 per cent and 32.1 per cent who did not attend. The number of household heads who completed secondary education or university is still very low (less than 10 per cent in each group). This implies that a limited number of students continued to secondary schools and universities not only in the Gicumbi district, but also countrywide, due to various reasons including limited availability of secondary schools/universities, schooling costs, the need to start working for money and early-marriage.[6]

c. Professional characteristics of household heads

When a high percentage of the working population is largely or entirely dependent upon rain-fed agriculture for their livelihoods, there is a disproportionately high vulnerability to the impact of climate change. Table 13 below presents the professional occupations of household heads in the study area, as reported by survey respondents.

Table 13. Main occupation of household heads by gender

Classification		Male		Female		Total	
		Frequency	%	Frequency	%	Frequency	%
Beneficiaries	None/no job	9	1.4%	22	3.4%	31	4.8%
	Student	0	0.0%	0	0.0%	0	0.0%
	Farmer	243	37.3%	293	45.0%	536	82.3%
	Artisan	6	0.9%	10	1.5%	16	2.5%
	Commerce/ transport	7	1.1%	5	0.8%	12	1.8%
	Civil servant	9	1.4%	16	2.5%	25	3.8%
	Private employee	10	1.5%	21	3.2%	31	4.8%
	Total	*284*	*43.6%*	*367*	*56.4%*	*651*	*100.0%*
Control	None/no job	8	1.2%	15	2.3%	23	3.5%
	Student	0	0.0%	1	0.2%	1	0.2%
	Farmer	239	36.9%	324	50.0%	563	86.9%
	Artisan	3	0.5%	9	1.4%	12	1.9%
	Commerce/ transport	10	1.5%	10	1.5%	20	3.1%
	Civil servant	3	0.5%	12	1.9%	15	2.3%
	Private employee	3	0.5%	11	1.7%	14	2.2%
	Total	*266*	*41.0%*	*382*	*59.0%*	*648*	*100.0%*
Total	None/no job	17	1.3%	37	2.8%	54	4.2%

[6] As a response to this challenge, in 2012 the GoR built on the success of the Nine-year Basic Education Programme to take a more ambitious move in extending the programme to 12 years of basic education. This programme has been very successful to the point that in 2018, the Gicumbi district had 104 and 83 primary and secondary schools respectively and 15 Technical and Vocational Education and Trainings (TVETs), from 99 and 74 primary and secondary schools respectively and 4 TVETs in 2012.

Classification		Male		Female		Total	
		Frequency	%	Frequency	%	Frequency	%
	Student	0	0.0%	1	0.1%	1	0.1%
	Farmer	482	37.1%	617	47.5%	1,099	84.6%
	Artisan	9	0.7%	19	1.5%	28	2.2%
	Commerce/ transport	17	1.3%	15	1.2%	32	2.5%
	Civil servant	12	0.9%	28	2.2%	40	3.1%
	Private employee	13	1.0%	32	2.5%	45	3.5%
	Total	***1,042***	***80.2%***	***257***	***19.8%***	***1,299***	***100.0%***

Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=1299, Beneficiaries=651, Control= 648)

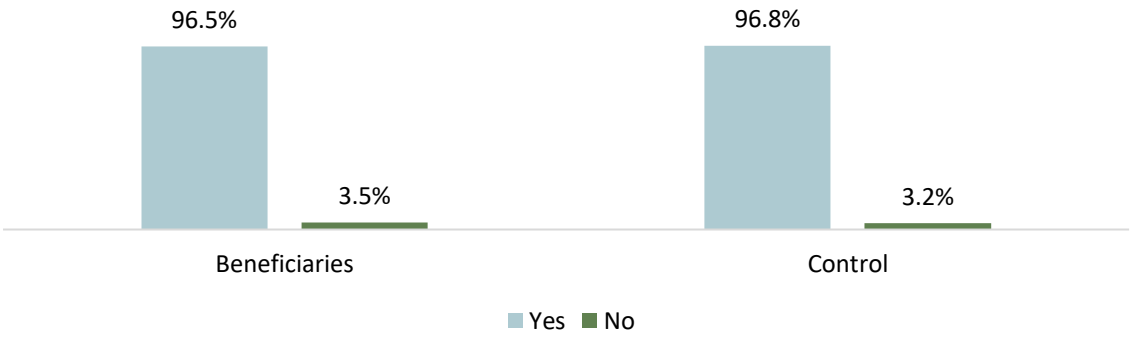
Table 13 shows that the majority of household heads (more than 80 per cent) in both project intervention and control group areas are engaged in farming activities. This percentage is higher than the national average of 54 per cent from 2018. The percentage of public/private servants and those doing artisanal and business activities is very low in both beneficiary and control group areas. It is clear that households in both project intervention and control group areas depend mainly on farming for their livelihood. Therefore, they may be particularly vulnerable to the negative impacts of climate change.

2. Socioeconomic characteristics of households of the study area

a. Homestead characteristics

Assessing housing quality is important to understand the level of development of households in a given area.

Figure 5. Home ownership



Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=1299, Beneficiaries=651, Control= 648)

Figure 5 above reveals that 96.5 per cent and 96.8 per cent of households live in their own homes in the project intervention and control group areas respectively, against 3.5 per cent and 3.2 per cent

who do not own homes in the same areas. Table 14 below indicates the building materials used for walls and foundation.

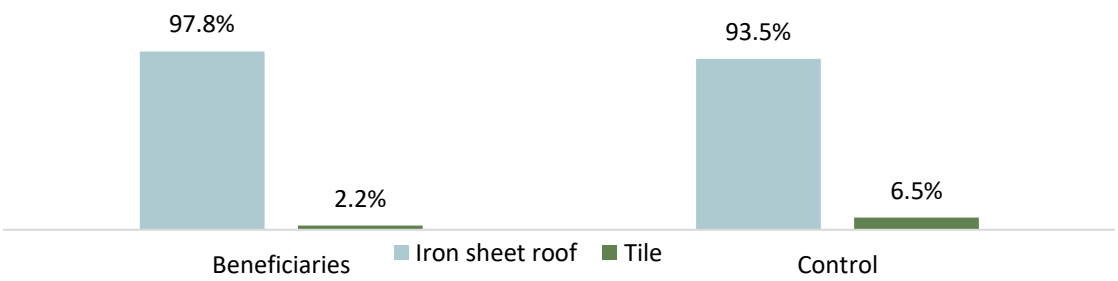
Table 14. Materials used on the walls and foundation

Category of household location	Materials used on the walls of main house	Materials used for foundation				
		None	Baked clay bricks/Adobe bricks	Stones	Other	Total
Beneficiaries	Baked clay bricks	0.0%	0.3%	1.0%	0.0%	1.3%
	Adobe bricks	12.4%	22.5%	57.0%	1.3%	93.2%
	Cement blocks	0.0%	0.2%	0.2%	0.0%	0.3%
	Wood	0.0%	0.0%	0.0%	0.0%	0.0%
	Trees	4.3%	0.2%	0.8%	0.0%	5.3%
	Total	*16.7%*	*23.1%*	*58.9%*	*1.3%*	*100.0%*
Control	Baked clay bricks	0.0%	0.0%	1.3%	0.0%	1.3%
	Adobe bricks	6.2%	11.6%	51.0%	0.6%	69.5%
	Cement blocks	0.0%	0.0%	0.0%	0.0%	0.0%
	Wood	0.0%	0.0%	0.0%	0.0%	0.0%
	Trees	27.4%	0.0%	1.6%	0.2%	29.2%
	Total	*33.7%*	*11.6%*	*53.9%*	*0.8%*	*100.0%*

Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020, (n=1255, Beneficiaries=628, Control= 627)

The table above shows that 57 per cent and 51 per cent of beneficiary and control group respondents respectively have homes constructed with adobe bricks for the walls with a foundation of stones, and 22.5 per cent of beneficiaries and 11.6 per cent of the control group confirmed having homes constructed with adobe bricks for the walls with a foundation in either baked clay bricks or adobe bricks. Moreover, 4.3 per cent and 27.4 per cent of beneficiary and control group respondents, respectively, declared to have constructed their homes using trees for the walls without a foundation. The differences between beneficiary and control households suggest considerable wealth differences between these areas. However, there were no systematic differences between the two groups in terms of roofing, which we turn to now.

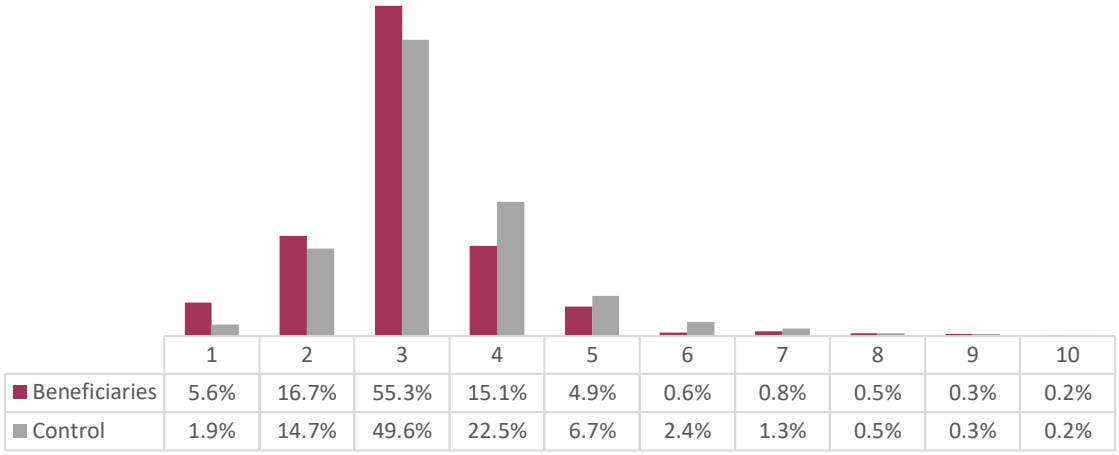
Figure 6. Material used for roofs



Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=1255, Beneficiaries=628, Control= 627)

Figure 6 above shows that 97.8 per cent and 2.2 per cent of homes were roofed with iron sheets and tiles respectively in the intervention area against 93.5 per cent and 6.5 per cent in the control group area. Presently, there are no grass thatched houses. This may be due to the "Bye bye Nyakatsi campaign" introduced by the GoR in 2010 which was targeting to eradicate grass thatched roofs.

Figure 7. Number of rooms in the home



	1	2	3	4	5	6	7	8	9	10
Beneficiaries	5.6%	16.7%	55.3%	15.1%	4.9%	0.6%	0.8%	0.5%	0.3%	0.2%
Control	1.9%	14.7%	49.6%	22.5%	6.7%	2.4%	1.3%	0.5%	0.3%	0.2%

Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=1255, Beneficiaries=628, Control= 627)

Figure 7 above shows that the number of rooms in the home vary between one and nine for project beneficiaries and control group respondents, but the majority possesses homes with two to four rooms including a sitting room. This implies that there is congestion at the household level as the average family size is 4.8 people in the intervention and control group areas while the mean number of rooms in the house is 3.08 and 3.35 in the same areas; hence, not every family member can have his/her own room. Table 15 below presents the equipment possessed in the home.

Table 15. Possession of home equipment

Classification		Beneficiaries	Control	Total
Possession of home equipment	Benches only	12.9%	13.4%	13.1%
	Chairs	83.4%	82.5%	82.9%
	Sofa	10.7%	12.0%	11.3%
	Beds	79.9%	79.9%	79.9%
	Mattress	74.4%	71.8%	73.1%
	Cupboard	6.8%	6.1%	6.5%
	Table	61.1%	70.2%	65.7%
Quality of latrine	None	1.6%	1.9%	1.8%
	Non-covered latrine	16.2%	17.1%	16.7%
	Covered latrine but not cemented	73.6%	74.8%	74.2%
	Covered latrine and cemented	7.8%	6.1%	6.9%

Classification		Beneficiaries	Control	Total
	Modern flashing latrine	0.8%	0.2%	0.5%

Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=1255, Beneficiaries=628, Control= 627)

Table 15 reveals that the majority of the beneficiaries and control group (more than 70 per cent) possesses chairs, beds or a mattress, while 61.1 per cent and 70.2 per cent of beneficiaries and control group households respectively possess a table. However, 10.7 per cent and 12 per cent of beneficiaries and control group respondents respectively do have a sofa, while approximately 13 per cent of each possesses only benches. These percentages depict that the majority of households do not have the basic equipment in their homes.

The baseline study shows that households of the control group area perform slightly better in possession of a covered latrine that is not cemented (74.8 per cent) and a non-covered latrine (17.1 per cent) compared to a covered latrine (73.6 per cent) and a non-covered latrine (16.2 per cent) seen in the beneficiary area. However, 1.9 per cent of control group households e without latrines compared to a lower figure of 1.6 per cent of beneficiary households. Furthermore, the beneficiary area has more households with covered latrines that are cemented (7.8 per cent) and modern flashing latrines (0.8 per cent) compared to the control group area (with 6.1 per cent and 0.2 per cent respectively). Table 16 shows information on the location of respondents' homes.

Table 16. Location of home and causes of damage experienced on the house, if any, over the past 12 months

Classification		Beneficiaries			Control			Total		
		Flat areas	Less than 50 meters from the river or marshland	In high risk zone	Flat areas	Less than 50 meters from the river/ marshland	In high risk zone	Flat areas	Less than 50 meters from the river/ marshland	In high risk zone
No damage	Frequency	298	27	45	379	5	43	677	32	88
	%	47.5%	4.3%	7.2%	60.4%	0.8%	6.9%	53.9%	2.5%	7.0%
Flooding	Frequency	3	2	1	1	0	0	4	2	1
	%	0.5%	0.3%	0.2%	0.2%	0.0%	0.0%	0.3%	0.2%	0.1%
Heavy rain	Frequency	133	22	39	131	6	18	264	28	57
	%	21.2%	3.5%	6.2%	20.9%	1.0%	2.9%	21.0%	2.2%	4.5%
Rain off	Frequency	12	3	3	11	0	4	23	3	7
	%	1.9%	0.5%	0.5 %	1.8%	0.0%	0.6%	1.8%	0.2%	0.6%
Landslides	Frequency	18	0	26	4	1	5	22	1	31
	%	2.9%	0.0%	4.1%	0.6%	0.2%	0.8%	1.8%	0.1%	2.5%
	Frequency	49	4	11	34	1	11	83	5	22

Classification		Beneficiaries			Control			Total		
		Flat areas	Less than 50 meters from the river or marshland	In high risk zone	Flat areas	Less than 50 meters from the river/ marshland	In high risk zone	Flat areas	Less than 50 meters from the river/ marshland	In high risk zone
Heavy winds	%	7.8%	0.6%	1.8%	5.4%	0.2%	1.8%	6.6%	0.4%	1.8%
Other	Frequency	7	0	1	10	0	2	17	0	3
	%	1.1%	0.0%	0.2%	1.6%	0.0%	0.3%	1.4%	0.0%	0.2%

Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=1255, Beneficiaries=628, Control= 627)

Table 16 shows that 47.5 per cent and 60.4 per cent of the beneficiary and control households respectively have homes in flat areas, and their homes did not experience any damage from extreme weather events. This compares to 21.2 per cent and 20.9 per cent with homes in the same areas (flat areas) that were damaged by heavy rains. Moreover, 7.3 per cent and 6.9 per cent of those settled in high-risk zones in beneficiary and control group areas, respectively, reported to have not experienced any damage to their homes. Strong winds also caused damage to homes in flat areas as declared by 7.8 per cent and 5.4 per cent of the beneficiary and control group respondents respectively.

Moreover, those who reported to have homes less than 50 metres from a river or marshland may also be included in high-risk zones as these areas are exposed to flooding episodes. Therefore, around 25.5 per cent and 15 per cent of beneficiary and control group households require resettling to safe areas. The project expects to build housing for those currently staying in high-risk zones.

b. Land ownership and mode of operations

The new law governing land in Rwanda, which was passed in 2013, recognizes the state as the sole authority to grant rights of occupation and use of land. It also provides for equal access to land rights with no discrimination based on sex or origin. The same law grants rights to transfer land rights through succession, gift, inheritance, rent, sale, sub-lease, exchange, servitude, mortgage or any other transaction, in conformity with the conditions and methods provided for by laws and regulations (GoR, 2013; ; Institute of Policy Analysis and Research, 2015). To that end, the GoR put in place the Land Tenure Regularization Programme which succeeded to provide land certificates to landowners as evidence of land possession. Therefore, a person is known as the landowner when he/she has a land certificate for a specific parcel of land on which his/her name is registered. In the case of a legally married wife and husband, both must be registered in the land certificate.

Table 17. Land ownership

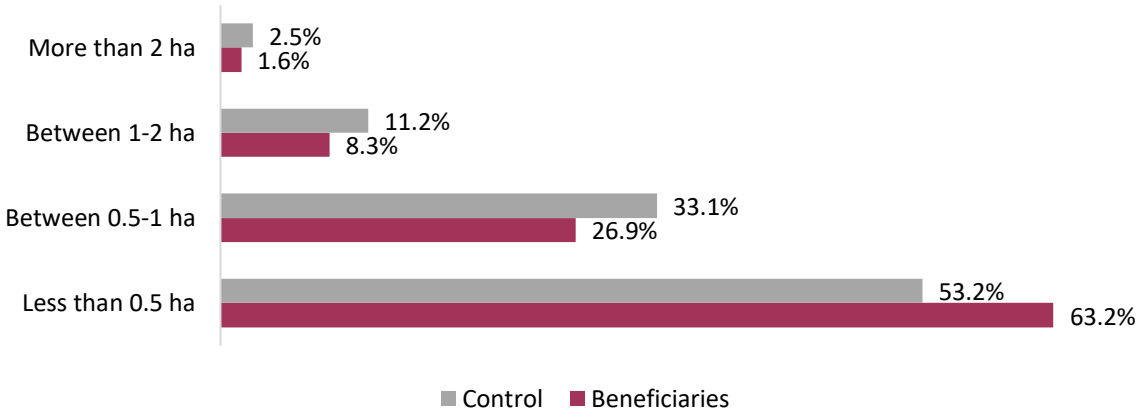
Classification		Beneficiaries		Control		Total	
		Freq	%	Freq	%	Freq	%
Owning land	Yes	568	87.3%	571	88.1%	1,139	87.7%

Classification		Beneficiaries		Control		Total	
		Freq	%	Freq	%	Freq	%
	No	83	12.7%	77	11.9%	160	12.3%
	Total (n=1,299)	*651*	*100.0%*	*648*	*100.0%*	*1,299*	*100.0%*
Number of parcels	No parcel	15	2.6%	16	2.8%	31	2.7%
	One parcel	196	34.5%	188	32.9%	384	33.7%
	Between 2 and 3 parcels	256	45.1%	259	45.4%	515	45.2%
	More than three parcels	101	17.8%	108	18.9%	209	18.3%
	Total (n=1,139)	*568*	*100.0%*	*571*	*100.0%*	*1,139*	*100.0%*

Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020

Table 17 above shows that 87.3 per cent and 88.1 per cent of beneficiary and control group households respectively do own land; only 12.7 per cent and 11.9 per cent in the same groups do not. The study shows that among 1139 households owning land, only 2.6 per cent and 2.8 per cent of the beneficiaries and control group respectively do not own parcels for agricultural activities, while 97.4 per cent and 97.2 per cent of beneficiaries and control groups respectively own parcels for farming. The study reveals that 34.5 per cent and 32.9 per cent of beneficiary and control group households respectively own one parcel, compared to 45.1 per cent and 45.4 per cent who own between two and three parcels. Furthermore, 17.8 per cent and 18.9 per cent of beneficiary and control group households own more than three parcels reserved for farming activities. The average size of owned land is summarized in Figure 8 below.

Figure 8. Average size of farmland

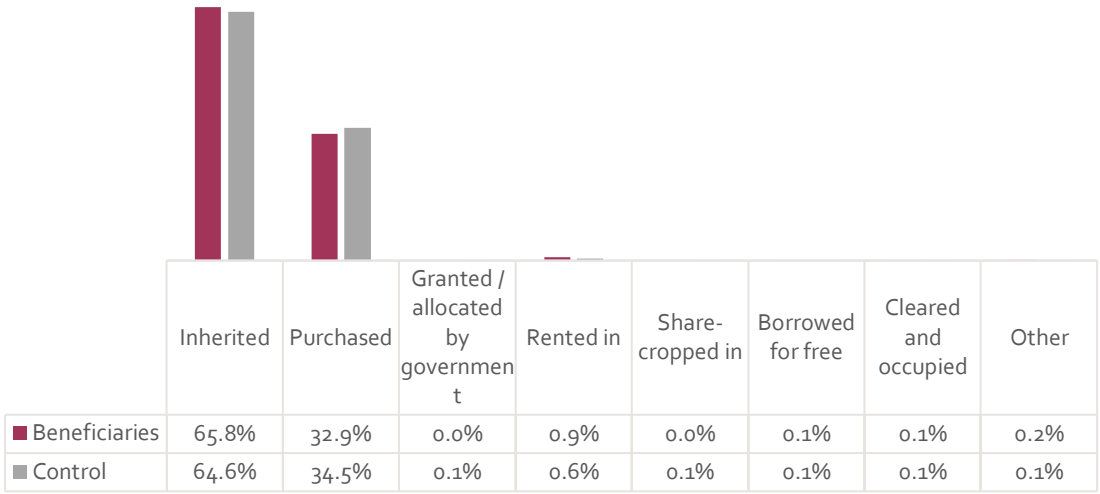


Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=1139, Beneficiaries=568, Control= 571)

It was reported that more than 90.1 per cent and 86.3 per cent of beneficiary and control group households respectively owned less than 1 ha of land where 53.2 per cent and 63.2 per cent possessed less than 0.5 ha. The data corresponds to land ownership per household at the national level where the average land owned by a household decreased from 1.2 ha in 1984 to 0.89 ha in 1990, 0.6 ha in 2010 and less than 0.5 ha in 2017 (RLMUA Household Survey, 2017). Additionally, the Rwanda Land Management and Use Authority reported in 2017 that 62 per cent of Rwandan households owned less than 0.5 ha (NISR, 2017; RLMUA Household Survey, 2017).

It is worth noting that these small plots are overexploited, leading to soil degradation and exhaustion. This culminates in reduced crop productivity. Hence, there is a call to use compost and chemical fertilizer wisely to improve land fertility and productivity in the areas under investigation. The following figure depicts the modes in which the households acquired their land.

Figure 9. Mode of parcel land acquisition by household

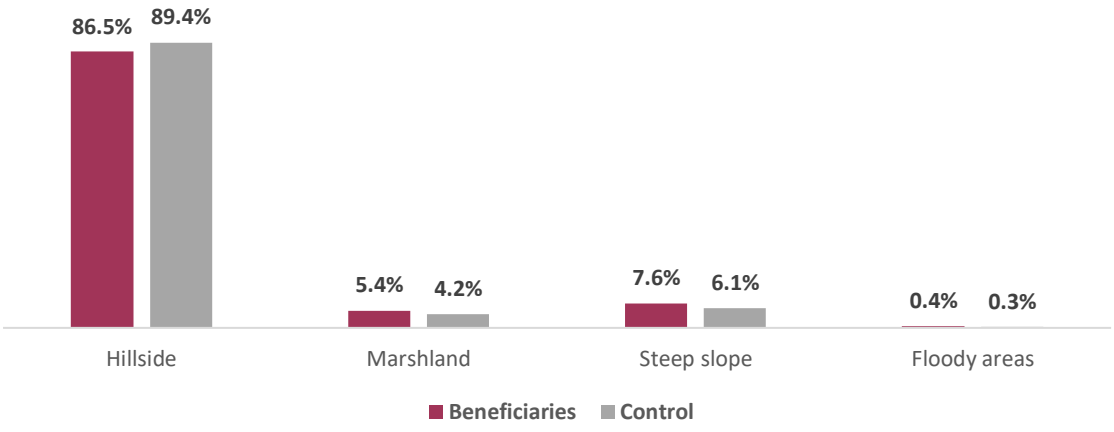


	Inherited	Purchased	Granted / allocated by government	Rented in	Share-cropped in	Borrowed for free	Cleared and occupied	Other
Beneficiaries	65.8%	32.9%	0.0%	0.9%	0.0%	0.1%	0.1%	0.2%
Control	64.6%	34.5%	0.1%	0.6%	0.1%	0.1%	0.1%	0.1%

Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=2,684, Beneficiaries=1,419, Control=1,265)

This study explored the mode of parcel acquisition by beneficiary and control group households, and 65.8 per cent and 64.6 per cent of parcels owned by households of each group respectively were obtained through inheritance. Exactly 32.9 per cent and 34.5 per cent of parcels owned by the beneficiary and control group respectively were purchased, with a very negligible percentage (less than 2 per cent) which was said to have been received as a grant from the government or as a kind of gift, servitude, mortgage, exchange, sub-lease, rent, among others. The households were also asked about the location of their land as shown in Figure 10 below.

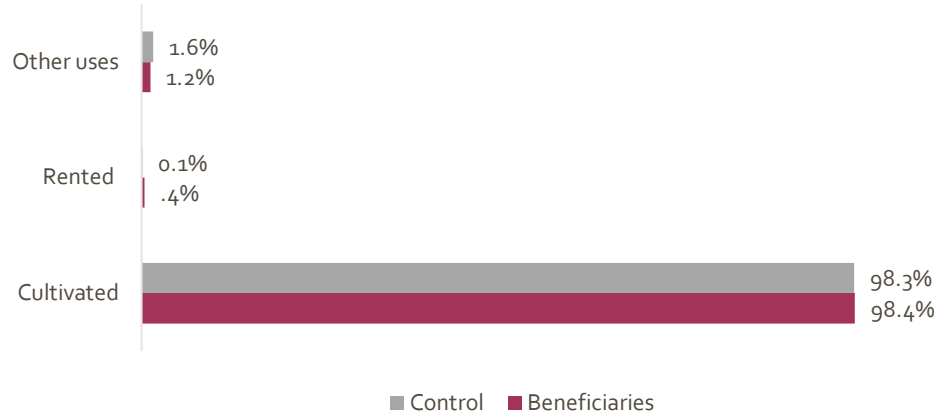
Figure 10. Location of farmland



Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=2,684, Beneficiaries=1,419, Control=1,265)

The majority of lands (86.3 per cent and 89.4 per cent of beneficiary and control group areas respectively) are located on hillsides, compared to only 5.4 per cent and 4.2 per cent in the same areas which are marshlands, and 7.6 per cent and 6.1 per cent being on steep slopes. There is also a small percentage of land in areas exposed to floods. Agricultural fields in marshland constitutes an advantage as they are exploited throughout the year, including dry periods (June – September), corresponding with agricultural season C, while the hillside is only cultivated during rainy seasons, corresponding to agricultural seasons A and B.

Figure 11. Land use in the last agricultural year



Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=2,684, Beneficiaries=1,419, Control=1,265)

Figure 11 shows that the majority of parcels (98.4 per cent and 98.3 per cent) owned by both beneficiary and control groups respectively were cultivated during the last agricultural year. This implies that their lands are continuously being cultivated without putting them to fallow to regenerate fertility. This is different from national statistics where fallow land represented 15 per cent of the total arable land of Rwanda in 2019 (NISR, 2019). Furthermore, it is worth noting that 94.8 per cent and 98.4 per cent of beneficiary and control group respondents respectively confirmed that their land was cultivated as one plot with only 5.2 per cent of beneficiaries and 1.6 per cent of the control group declaring to have divided their land into different plots.

Moreover, 90.9 per cent and 82.8 of the beneficiaries and control group respectively declared to have grown seasonal crops against 7.8 per cent and 13.5 per cent who planted permanent crops, while 1.4 per cent and 3.7 per cent confirmed to have grown both. The seasonal and permanent crops covered 53 per cent and 21.7 per cent of the total district area respectively (ibid.).

Table 18 illustrates the main crops grown in season A.[7]

Table 18. Crops grown in the last agricultural season A

Crop	Beneficiaries (n=975)	Control (n=1,039)	Total (n=2,014)
Beans	44.51%	42.54%	43.5%
Sweet potatoes	21.33%	18.38%	19.81%
Maize	14.46%	11.36%	12.86%

[7] During the last agricultural year, the Gicumbi district prioritized a number of crops to be grown on consolidated lands. These crops included maize (6,777 ha), wheat (5,359 ha), Irish potatoes (12,018 ha), cassava (231.5 ha) and beans (31,896 ha). Additionally, 1,312 ha of banana plantations were rehabilitated by farmers themselves thanks to the mobilisation made by the Gicumbi district and technical support provided by Farmer's Promoters (Gicumbi district, 2020).

CROP	BENEFICIARIES (N=975)	CONTROL (N=1,039)	TOTAL (N=2,014)
Sorghum	8.41%	7.31%	7.85%
Irish potatoes	3.69%	8.66%	6.26%
Peas	1.95%	0.67%	1.29%
Vegetables	1.64%	1.06%	1.34%
Bananas	1.13%	4.62%	2.93%
Colocasia	0.82%	0.29%	0.55%
Wheat	0.83%	0.67%	0.75%
Tea	0.41%	0%	0.2%
Cassava	0.31%	3.08%	1.74%
Fruit	0.31%	0.1%	0.2%
Coffee	0.1%	0.29%	0.2%
Small nuts	0.1%	0.77%	0.45%
Onions	0%	0.19%	0.1%
Total	*100%*	*100%*	*100%*

Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=2,014, Beneficiaries=975, Control=1,039)

Agricultural season "A" lasted from September 2019 to February 2020. Beans were the most frequently grown crop by both beneficiary and control group households (representing 44.5 per cent and 42.5 per cent of all crops grown, respectively), followed by sweet potatoes (21.3 per cent and 18.4 per cent, respectively) and maize (14.5 per cent and 11.4 per cent of all the crops grown in season "A" respectively). Other crops like colocasia, peas, cassava, vegetables, fruit and cash crops were grown by limited numbers of both beneficiary and control households (less than 1 per cent of the total crops grown in season "A"). These results correspond with the findings of the seasonal agricultural survey (NISR, Seasonal Agriculture Survey 2019) where beans were dominantly grown (21,143 ha), followed by bananas (8,007 ha) and sweet potatoes (7,696 ha) during season A, while maize and Irish potatoes were grown on 5,570 ha and 5,252 ha in the Gicumbi district. The remaining crops were grown in very small areas as highlighted by this baseline survey (NISR, SAS, 2019). The most frequently grown crops in agricultural season B are presented below. [8]

Table 19. Crops grown in the last agricultural season B

CROP	BENEFICIARIES (N=574)	CONTROL (N=462)	TOTAL (N=1,036)
Beans	33.3%	37.5%	35.1%
Sweet potatoes	47.9%	27.7%	38.9%
Irish potatoes	5.1%	2.4%	3.9%
Maize	4.2%	2.6%	3.5%

[8] The same survey revealed that bananas and cassava had a dominant yield of 14,442 kg/ha and 13,433 kg/ha respectively followed by Irish potatoes and sweet potatoes with 9,618 kg/ha and 8,911kg respectively. Beans, which were dominantly grown in the Gicumbi district, yielded 999 kg/ha with maize yielding 2,146 kg/ha (NISR, SAS, 2019).

Crop	Beneficiaries (n=574)	Control (n=462)	Total (n=1,036)
Bananas	3.7%	28.6%	14.8%
Vegetables	2.1%	0.2%	1.3%
Tea	1.9%	0.0%	1.1%
Sorghum	1.2%	0.7%	1.0%
Fruit	0.4%	0.0%	0.2%
Cassava	0.2%	0.2%	0.2%
Peas	0.2%	0.2%	0.2%
Total	*100%*	*100%*	*100%*

Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=1,036, Beneficiaries=574, Control=462)

The agricultural season "B" here refers to the period from March to June 2020. During this season, sweet potatoes were grown most frequently by beneficiary households (47.9 per cent of crops grown) while beans were most frequent (37.5 per cent of crops grown) in the control group area. Beans came in second (33.3 per cent of crops grown) with beneficiary households, as was the case for sweet potatoes (27.7 per cent of crops grown) in the control group area. Irish potatoes occupied third place (5.1 per cent of crops grown) by beneficiary households while bananas came in third in the control group area. Peas, cassava, vegetables, sorghum, fruit and cash crops (tea and coffee) were grown by fewer households (less than 3 per cent of crops grown) in both areas under investigation. These results are mainly in line with the seasonal agricultural survey findings conducted by the NISR in 2019.

It is worth noting that the crops grown in agricultural seasons "A" and "B" are rather similar to those grown countrywide as reported by the NISR in 2019. These include beans (23.42 per cent of the total cultivated area), bananas (19.6 per cent of the total cultivated area), cassava (15.57 per cent of the total cultivated area), sorghum (10.9 per cent of the total cultivated area), sweet potatoes (6.72 per cent of the total cultivated area) and maize (6.07 per cent of the total cultivated area). Other crops represented 24 per cent of the total cultivated area.[9] The crops grown in agricultural season "C" are presented in Table 20.

Table 20. Crops grown in the last agricultural season C

Crop	Beneficiaries (n=629)	Control (n=687)	Total (n=1316)
Bananas	2.06%	4.65%	3.41%
Cassava	1.27%	4.51%	2.96%
Coffee	0.31%	1.01%	0.68%
Colocasia	0%	0.29%	0.15%
Fruit	1.27%	0.14%	0.68%
Irish potatoes	6.83%	11.9%	9.49%

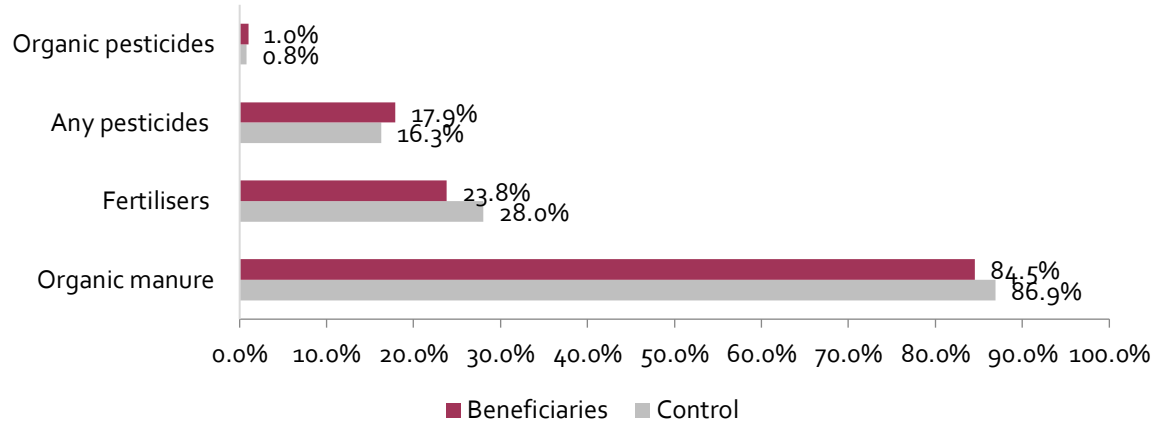
[9] Furthermore, the seasonal agricultural survey of 2019 conducted by NISR revealed that cassava and bananas had the highest yield of 19,530 kg/ha and 12,062 kg/ha across the Gicumbi district during season B of 2019. They were followed by Irish potatoes and sweet potatoes with 8,479 kg/ha and 7,246 kg/ha respectively, while maize and beans had a yield of 1,290 kg/ha and 928 kg/ ha. This shows that season "A" had a better yield than season "B" for most similar crops grown.

CROP	BENEFICIARIES (N=629)	CONTROL (N=687)	TOTAL (N=1316)
Maize	18.7%	15.4%	17.02%
Peas	2.7%	2.32%	2.51%
Sorghum	26.7%	22.7%	24.62%
Sweet potatoes	34%	32.89%	33.43%
Tea	0.63%	0.73%	0.68%
Vegetables	3.97%	1.31%	2.58%
Wheat	1.43%	2.1%	1.74%
Total	*100%*	*100%*	*100%*

Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=1,316, Beneficiaries=629, Control=687)

Agricultural season "C" covered June to September 2020, corresponding with the dry climatic season. During this season, sweet potatoes were grown most frequently by both beneficiaries (34 per cent of crops grown) and the control group (32.9 per cent of crops grown) followed by sorghum with 26.7 per cent and 22.7 per cent of crops grown in the same areas. Maize and Irish potatoes came in third and fourth for both beneficiary and control group areas. All these crops were grown during season "B" and harvested in season "C." The remaining crops represent less than 5 per cent of crops cultivated in season "C." Table 20 shows that the crops grown during season "C" have the capacity to resist long dry spells. Only 42 ha were reported to be under small scale irrigation, with 300 ha being used to grow vegetables as confirmed by the Director of Agriculture in the Gicumbi district. We now turn to Figure 12 which shows the use agricultural inputs.

Figure 12. The use of agricultural inputs in the last agricultural year

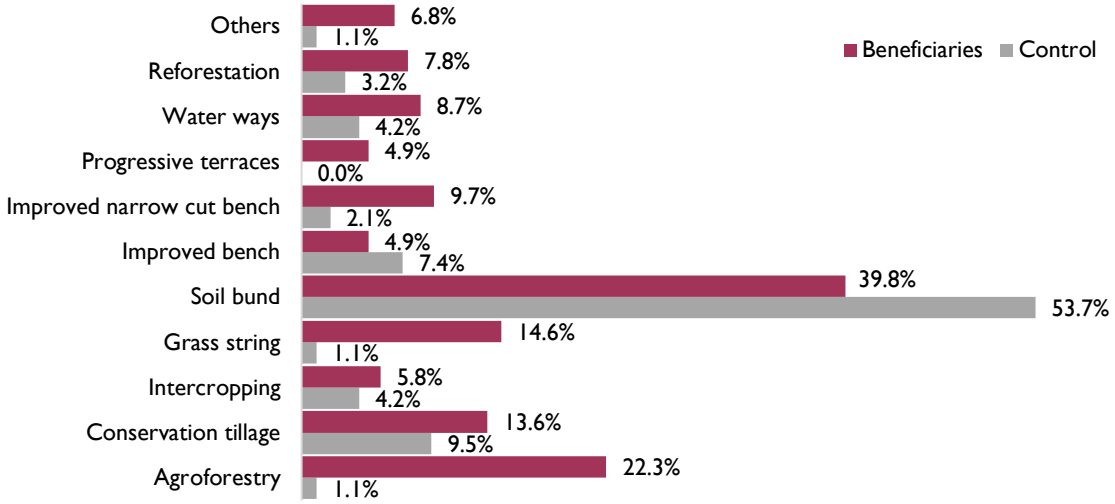


Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=2,684, Beneficiaries=1,419, Control=1,265)

Agricultural intensification through the adoption of improved inputs and practices is one of the guiding themes of Rwanda's agricultural strategy and "Green Gicumbi Project." Figure 12 above shows data on the use of inputs: fertilizers, pesticide/insecticides. It reveals that 84.5 per cent and 86.9 per cent of parcels possessed by beneficiary and control group households respectively received organic manure, against 23.8 per cent and 28 per cent on which chemical fertilizers were applied. Moreover, 17.9 per cent and 16.3 per cent of parcels from beneficiary and control groups

received pesticides. However, the application of organic pesticides on crops needs to improve as the use rate is very low (around 1 per cent in each area). Figure 13 depicts the main agricultural practices applied on parcels in which respondents used technology.

Figure 13. Agricultural practices applied on plots



Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=2,684, Beneficiaries=1,419, Control=1,265)

Figure 13 indicates that soil bunds are the dominant agricultural practice used in the last agricultural year, and was applied on 39.8 per cent and 53.7 per cent of parcels of beneficiary and control group households respectively. This implies that the control group households use this practice more frequently as well as using an improved bench, in comparison with beneficiary households. The opposite situation was seen in agroforestry where it was applied on 22.3 per cent and only 1.1 per cent of parcels owned by beneficiary and control group households. Furthermore, the other agricultural practices were much more applied on parcels owned by beneficiaries than those of the control group. These include conservation tillage, intercropping, grass string, improved narrow cut bench, progressive terraces, water ways, reforestation and other technologies.

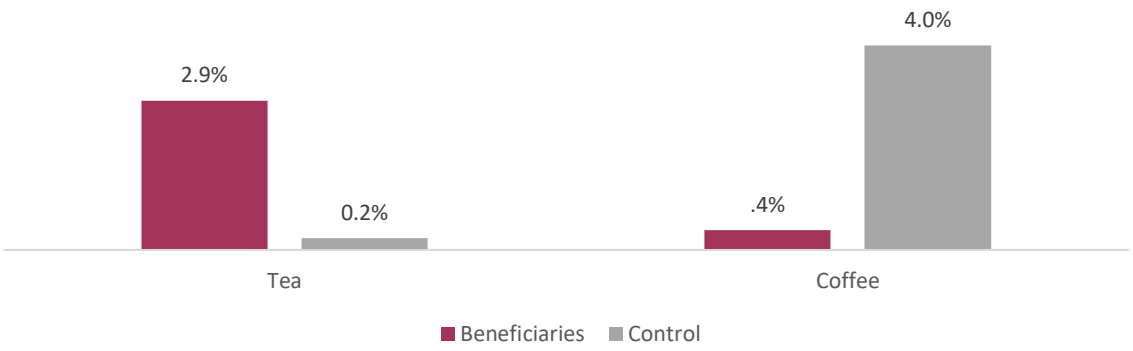
The ownership of kitchen gardens by household is presented in Figure 14 below.

Figure 14. Possession of kitchen gardens

Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=1299, Beneficiaries=651, Control= 648)

It illustrates that 68 per cent and 65.1 per cent of beneficiary and control group households respectively possess kitchen gardens. With regard to the cultivation of cash crops such as tea and coffee, the feedback from households is reported in Figure 15 below.

Figure 15. Possession of tea and coffee



Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=1299, Beneficiaries=651, Control= 648)

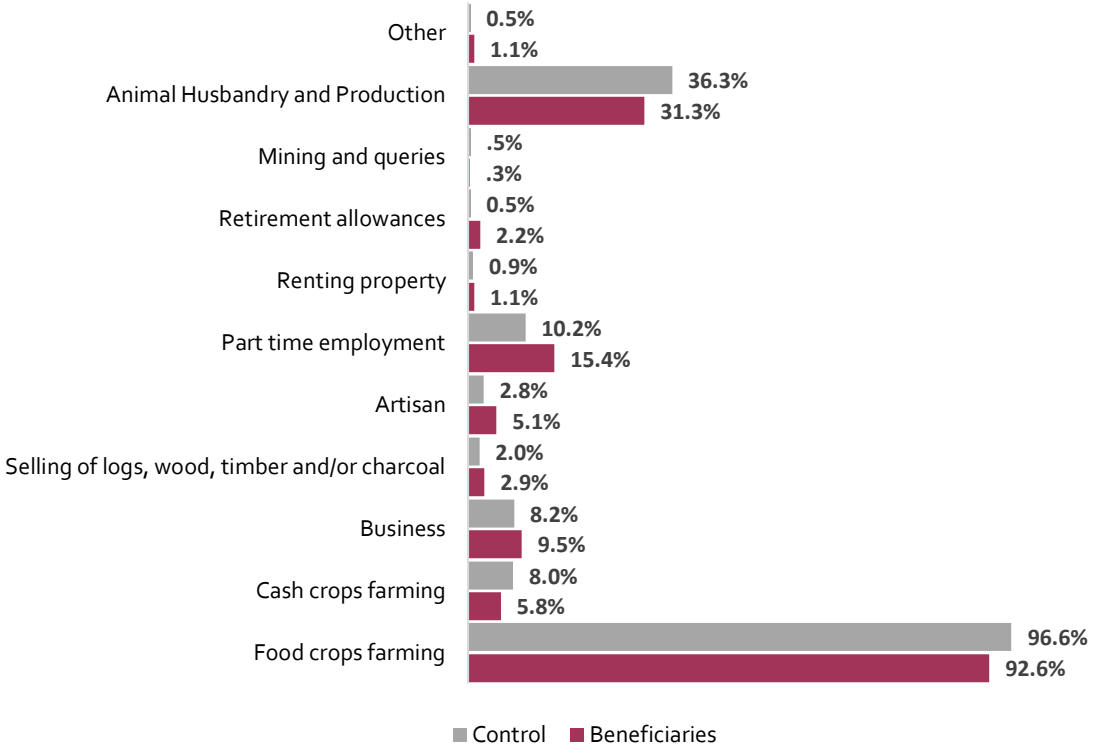
Figure 15 indicates that only 2.9 per cent and 0.2 per cent of beneficiary and control group respondents grew tea against 0.4 per cent and 4 per cent in the same groups who grew coffee. Respondents during group discussion interviews explained that they do not have farms in marshlands to grow tea. Therefore, they hoped to gain support in obtaining tea seedlings which may easily survive on the hillside. Other households requested support for coffee seedlings, though a good number reported to have challenges by having small pieces of land that needed to be used to grow both food and cash crops.

The adoption of cash crops would contribute to increasing the households' income for both project intervention and control group households and both crops are widely grown in Gicumbi district. The majority of tea and coffee plantations are owned by private companies, especially the Mulindi Tea Company Ltd.

c. Main sources of household income / livelihood

According to EICV five published in 2018, approximately 54 per cent of the Rwandan working population is engaged in farming activities. Rwandan agriculture is dominated by food crops, namely bananas, which occupy more than one third of the country's farmland, as well as potatoes, beans, rice, sweet potatoes, cassava, wheat and maize. Coffee and tea are the major cash crops for export. Animals raised in Rwanda include cows, goats, sheep, pigs, chicken and rabbits, with geographical variations in the relative importance of each. Figure 16 below reflects the dominance of agriculture within Gicumbi district.

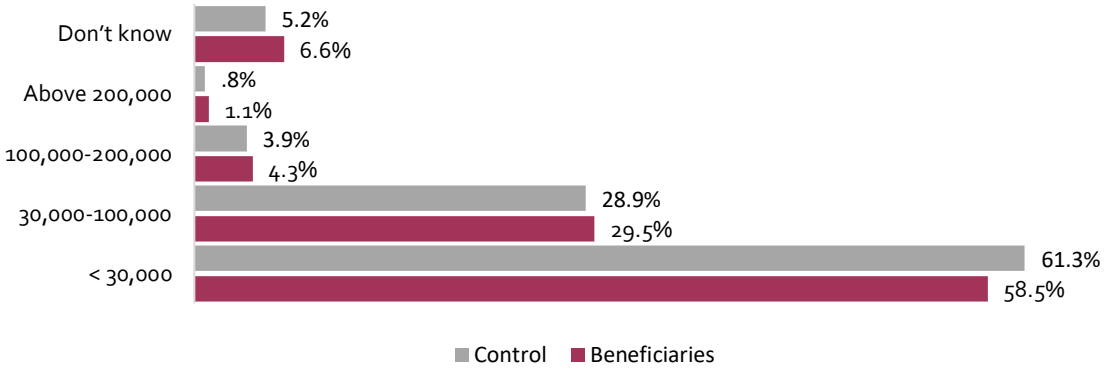
Figure 16. Main sources of household income / livelihood



Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=1299, Beneficiaries=651, Control= 648)
Note: Categories are not mutually exclusive

Figure 16 shows that the majority of households reported farming activities as their main occupation as reported by 92.6 per cent and 96.6 per cent of beneficiary and control group respondents respectively. The same was confirmed during the FGDs and KIIs. Furthermore, 15.4 per cent and 10.2 per cent of the beneficiaries and control group respectively confirmed they were engaged in part time employment, while 31.3 per cent and 36.3 per cent earned some income from animal husbandry and production.

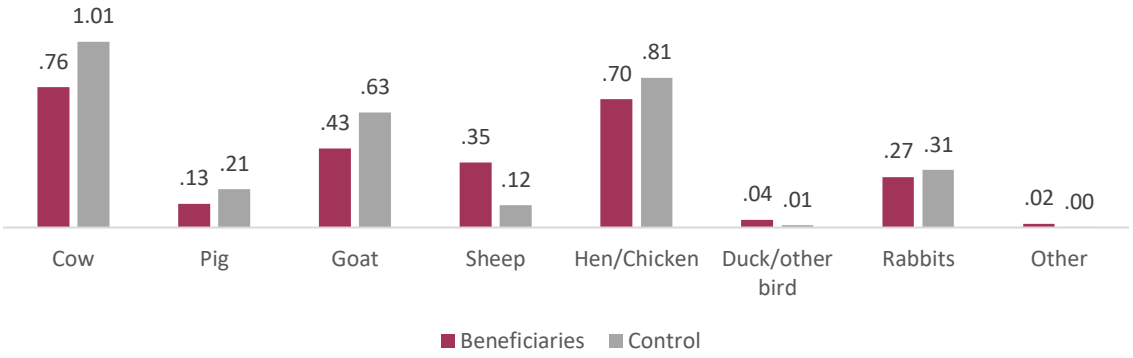
Figure 17. Household income per month for the past 12 months



Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=1299, Beneficiaries=651, Control= 648)

Figure 17 above reveals that 58.5 per cent and 61.3 per cent of beneficiary and control group households respectively earned less than 30,000 RWF per month during the past 12 months. Less than six per cent in both categories earned more than 100,000 RWF. The animals reared in Gicumbi are presented in Figure 18 below.

Figure 18. The mean average of reared domestic animals per household



Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=1299, Beneficiaries=651, Control= 648)

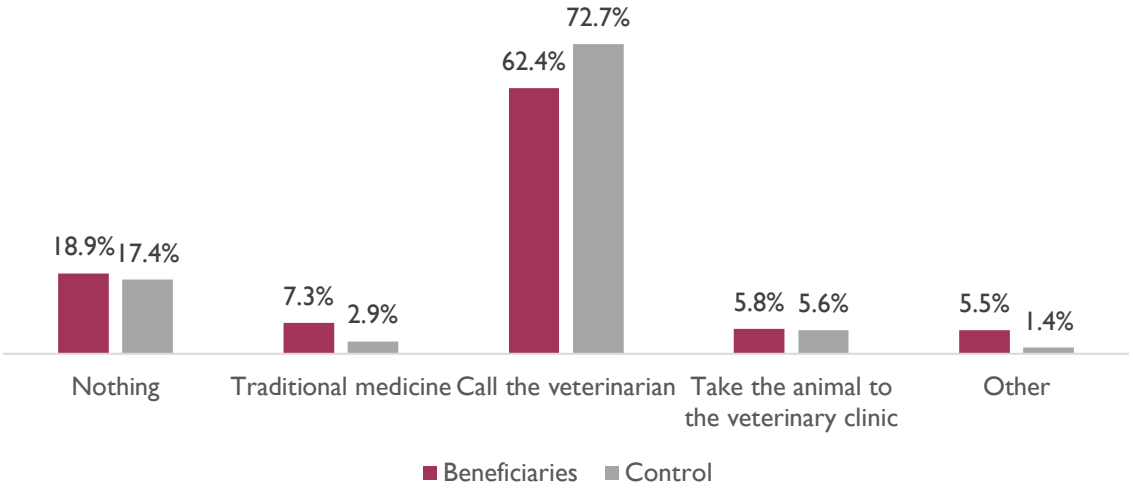
Figure 18 shows that cows, pigs, goats, hens/chickens, ducks and other types of birds and sheep are the most reared animals in both beneficiary and control group areas. There were, on average, 1.01 and 0.76 cows in control and beneficiary households respectively, while hens/chickens were reared at an average of 0.70 and 0.81 in the beneficiary and control groups respectively. Furthermore, the same groups reported having 0.43 and 0.63 goats on average, respectively. Overall, in 2020 the Gicumbi district reported having 86.010 cows owned by 60.180 households, 72.856 goats and 52.311 sheep across the district. The highest rate of cow ownership was facilitated by the adoption of the Girinka, programme introduced by the GoR in 2006. In this programme, a farmer was given an in-calf heifer and was obliged to pass on the first female offspring to another programme beneficiary selected by local administration authorities and validated by MINAGRI/RAB (Sindayayigaya et al., 2014, Gicumbi district report, 2020).

Figure 19. Households with one or more domestic animal

Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=1299, Beneficiaries=651, Control= 648)

Figure 19 shows that 76.7 per cent and 81.3 per cent of beneficiary and control group households respectively own at least one domestic animal. One of the main purposes to have animals is for organic manure. The commonly used veterinary services are reported in Figure 20 below.

Figure 20. Commonly used veterinary services by households



Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=1299, Beneficiaries=651, Control= 648)

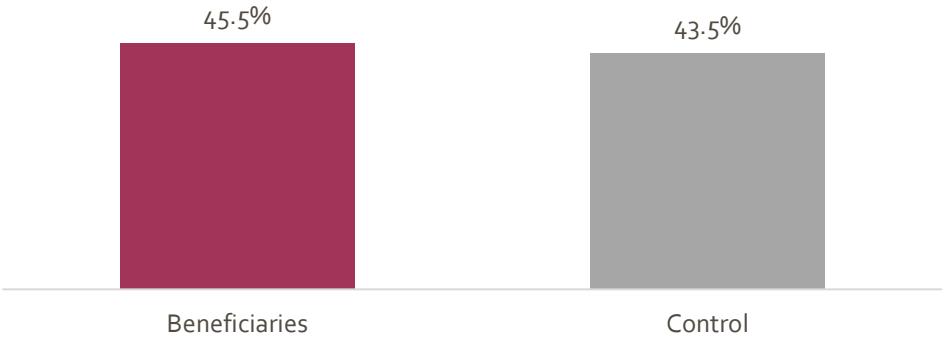
Respondents reported that the most common veterinary services were calling the veterinarian, with 62.4 per cent and 72.7 per cent in beneficiary and control group areas, respectively, taking this course of action, against 5.8 per cent and 5.6 per cent in beneficiary and control group areas, respectively, who took the animal to the veterinary clinic. Overall, 80 per cent of households that owned at least one animal called the veterinarian, less than 10 per cent took the animal to the veterinary clinic and less than of 10 per cent used the remaining services. In FGDs, a small proportion of respondents declared they obtain animal medicine from pharmacies and district veterinary clinics.[10]

d. Household financial assets and savings

Savings status, personal loans, credit, and cooperative memberships can provide an idea of the standard of living and socioeconomic development of a given community. To that end, those aspects were studied, and the findings are presented in the figures below.

[10] Artificial insemination for animal breeding is done by para-veterinary and veterinary staff to improve the quality of animals. In this regard, 9,831 cows were inseminated while 143,083 domestic animals were vaccinated across the district during the last agricultural year (Gicumbi district, 2020).

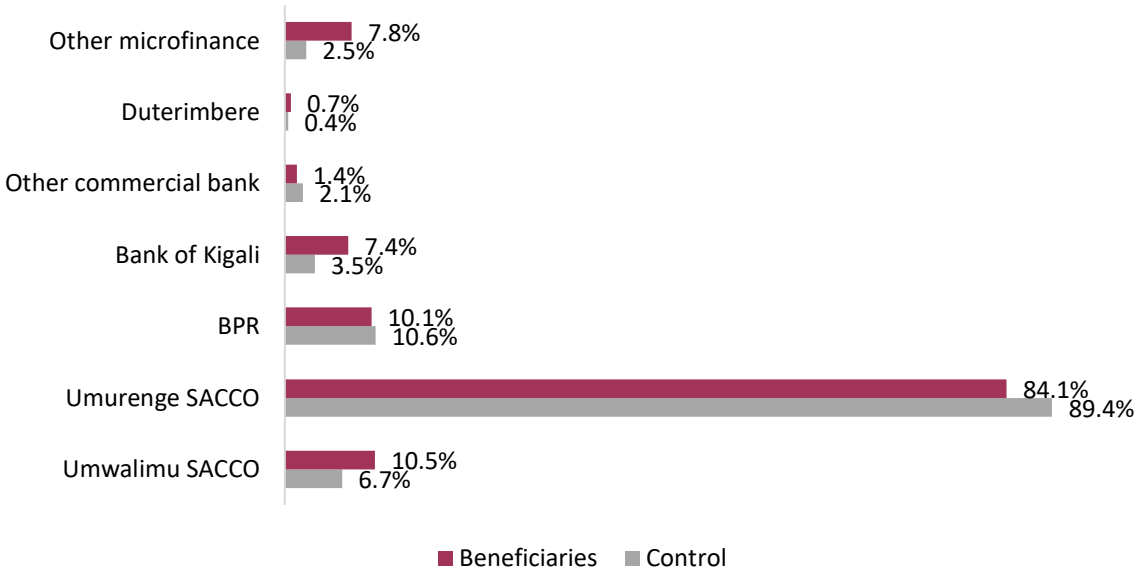
Figure 21. Household members with a bank account



Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=1299, Beneficiaries=651, Control= 648)

Figure 21 above shows that 45.5 per cent and 43.5 per cent of households in the project intervention and control group areas respectively had at least one family member with a bank account. The main banking institutions used by local communities in the areas under study are shown below.

Figure 22. Main banking institutions



Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=578, Beneficiaries=296, Control= 282)

Since the Green Gicumbi Project aims to provide jobs to beneficiary households, information on the main banking institutions operating in the area was deemed useful as they would facilitate money transactions during the project implementation phase. It was revealed that Umurenge SACCO is the most utilized banking institution as reported by 84.1 per cent and 89.4 per cent of beneficiary and control group respondents respectively. This can be attributed to easy accessibility to this cooperative (SACCO) compared to banks. Though BPR is the oldest banking institutions in the area, this bank has is only used by approximately 10 per cent of respondents. Umwalimu SACCO is also used at the same rate as BPR in the project intervention area, while only 6.7 per cent confirmed to be affiliated to this bank in the control group. The responses on personal loans are presented in Figure 23 below.

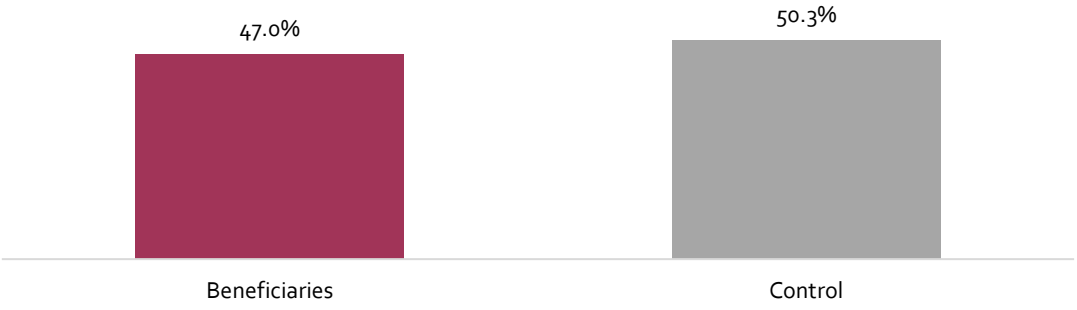
Figure 23. Personal loans by family members

Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=578, Beneficiaries=296, Control= 282)

Figure 23 shows that only 42.6 per cent and 40.8 per cent of those holding accounts in the project beneficiary and control group areas respectively have taken out loans/debt. Despite these low percentages in personal loans, they're still higher than 38 per cent reported by the World Bank study in 2012 after conducting a credit market survey in Rwanda. This can be supported by the fact that the credit market in Rwanda is relatively thin, with 40 per cent of households having applied for loans in the year up to 2016 (NISR, 2016).

During FGDs and KIIs, district and sector officials stated that many households still fear taking out loans as a result of not having a safe and sustainable income that would help them pay back the loans. Other officials said that some households are not skilled enough to plan and implement a project that would sustainably generate money to pay back the loans. In response to these issues, the GoR has promoted cooperatives and associations that may help many households to manage collectively developmental projects. Tontine and cooperative memberships are depicted in the figure below.

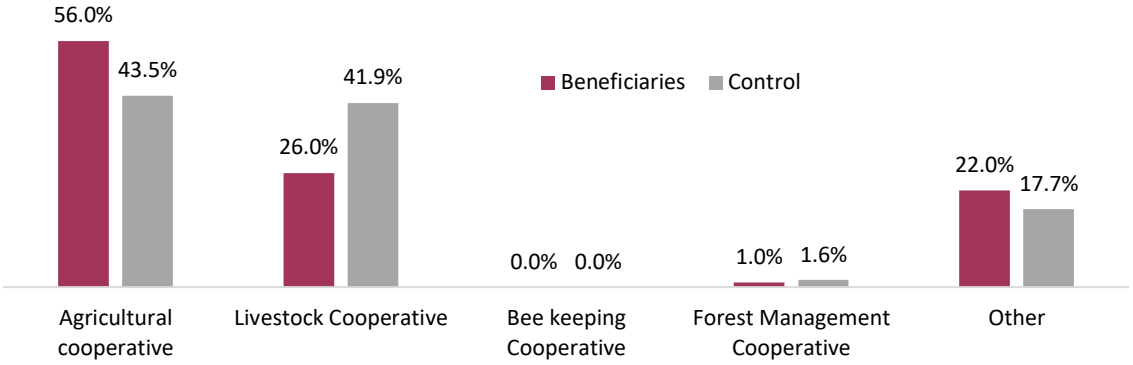
Figure 24. Household members belonging to tontines and cooperatives



Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=1299, Beneficiaries=651, Control= 648)

Figure 24 shows that 47 per cent of project beneficiaries and 50.3 per cent of control group respondents confirmed to have at least one family member belonging to a tontine or cooperative. However, only 15.4 per cent and 9.6 per cent of beneficiary and control group respondents respectively confirmed having a family member belonging to a cooperative. Therefore, the remainder were members of tontines. We now turn to cooperatives.

Figure 25. Family member belonging to cooperatives



Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=1299, Beneficiaries=651, Control= 648)

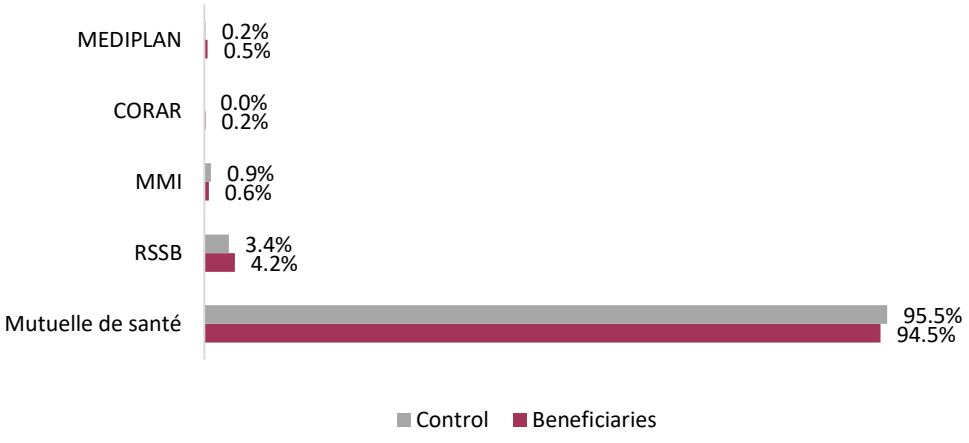
Figure 25 shows that at least one family member belonged to an agricultural cooperative at a rate of 56 per cent and 43.5 per cent in beneficiary and control group areas respectively, against 25 per cent and 41.9 per cent belonging to a livestock cooperative. Only around one per cent of households had at least one family member in a forest management cooperative in both beneficiary and control group areas. Bee keeping cooperatives were absent in both areas.

e. Access to health services

The GoR has promoted different health insurance schemes. The most affordable health insurance known as "Mutuelle de Santé" has had a significant impact on improving the standards of living and community health in Rwanda, by enabling the largest segment of the population to gain access to preventive, curative, rehabilitative and palliative health services.

This "Mutuelle de Santé" scheme has also been credited with mitigating the catastrophic out-of-pocket expenses of health care and promoted the culture of seeking early treatment, consequently reducing the burden of health bills on households and minimizing the use of unorthodox treatments. The possession of a health insurance scheme by households is presented in the figure below.

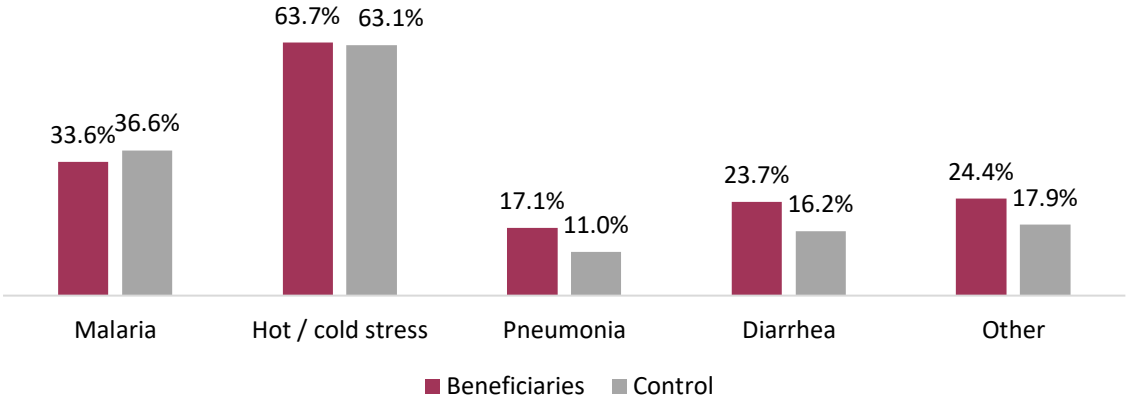
Figure 26. Possession of a health insurance scheme



Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=1299, Beneficiaries=651, Control= 648)

Figure 26 shows that more than 94 per cent of investigated households possessed an activated "Mutuelle de Santé" with the remaining households having access to another health insurance scheme (e.g., RSSB, MMI, CORAR, MEDIPLAN) available in Rwanda. It is worth mentioning that in 2015, the GoR moved the management of "Mutuelle de Santé" to the Rwanda Social Security Board to improve its efficiency and augment access across the country. Local communities have been very pleased with this health insurance scheme as it was scaled up to cover any type of necessary medical treatment (EICV 5, 2018). The main sicknesses/illnesses that recently affected household members in the area of the study were investigated and reported in the figure below.

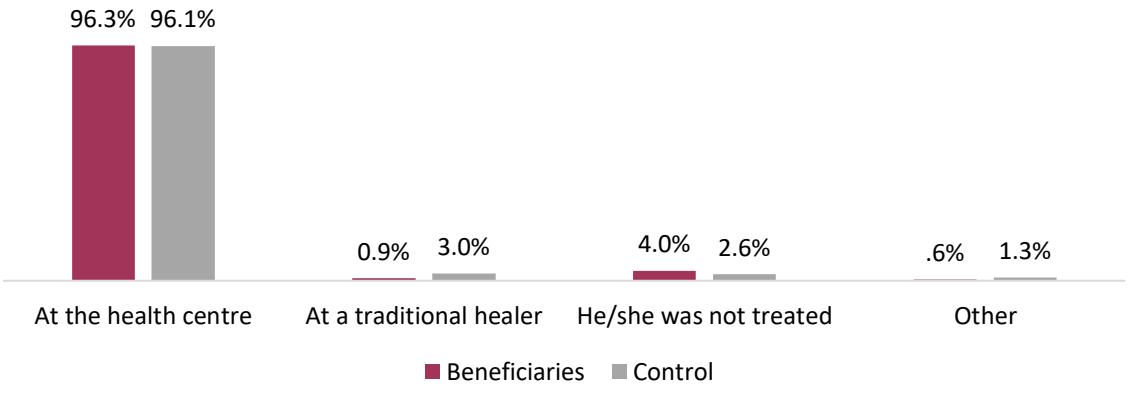
Figure 27. Main reported sickness/illness in the past 12 months



Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=1299, Beneficiaries=651, Control= 648)

Figure 27 shows that 63.7 per cent and 63.1 per cent of households in the beneficiary and control group areas respectively reported to have had at least one family member who suffered from hot/cold stress, while 33.6 per cent and 36.6 per cent of the same areas had at least one family member who suffered from malaria. Cases of diarrhoea and pneumonia were 23.7 per cent and 17.1 per cent respectively in the project intervention area against 16.2 per cent (diarrhoea) and 11 per cent (pneumonia) in the control group area. The figure below describes how these sicknesses/illnesses were treated.

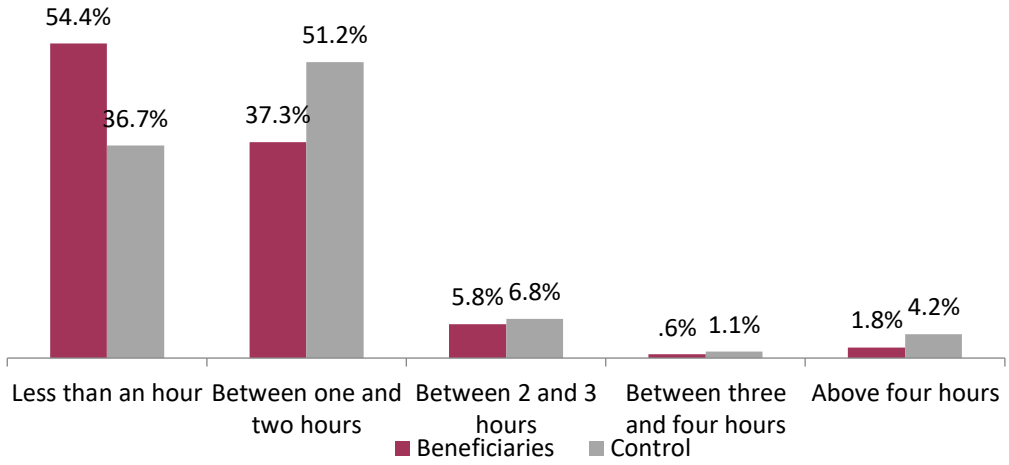
Figure 28. Places where treatment of reported sickness/illness took place in the past 12 months



Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=1081, Beneficiaries=545, Control= 536)

Figure 28 above revealed that the majority of family members (more than 95 per cent) who became sick/ill in the investigated areas were treated at a health centre, with less than 5 per cent being treated traditionally or left untreated. The accessibility to health centres is shown in the figure below.

Figure 29. Distance to health facility where treatment took place in the past 12 months



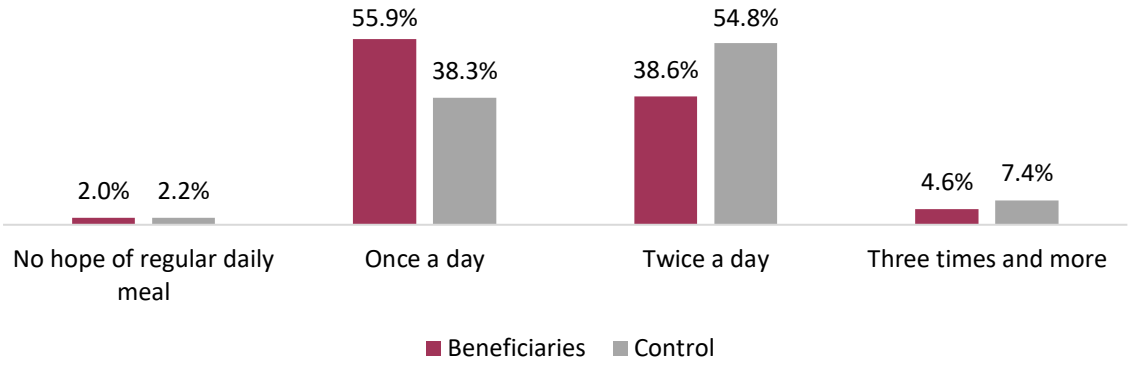
Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=1081, Beneficiaries=545, Control= 536)

Figure 29 shows that 54.4 per cent and 36.7 per cent of beneficiary and control group respondents declared that the one way travel time to their local health centre was less than an hour with 37.3 per cent and 51.2 per cent in the same groups confirming less than two hours to reach a health centre especially during the dry season. Moreover, 4.2 per cent and 1.8 per cent of control group and beneficiary respondents respectively stated that it took more than four hours to reach a health centre. Though the majority have good access to health centres, there is still a small proportion of households who struggle to reach health treatment areas. The interviewees in the FGDs mentioned poor road connectivity to the health centres, especially during rainy periods as the most challenging issues to deal with. It should be noted that the times recorded above refer to the length of time to walk to health centres.

f. Food security

According to the World Food Summit (1996) and FAO (2001), food security exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life (that is, without resorting to emergency food supplies, scavenging, stealing or other coping strategies). The present study focused on the number of meals a day per household, composition of meals and availability of meals throughout the year as proxies for the food security status of households.

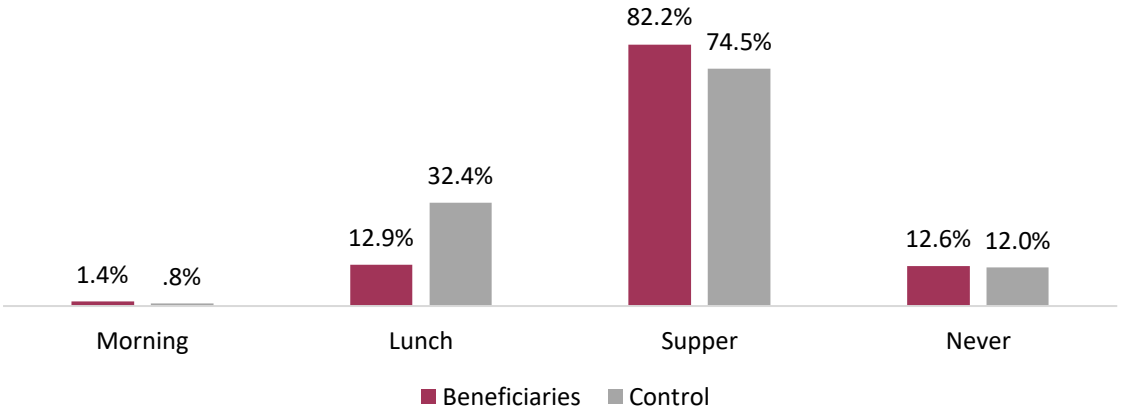
Figure 30. Number of meals per day



Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=1299, Beneficiaries=651, Control= 648)

Figure 30 shows that 38.6 per cent and 54.8 per cent in beneficiary and control group households respectively reported eating twice a day, with 55.9 per cent of beneficiary households and 38.3 per cent of control group households in the same areas being able to eat once a day only. Only 4.6 per cent and 7.4 per cent of beneficiary and control group households respectively were able to eat three times or more per day. Only 2 and 2.2% of beneficiary and control groups reported not having the ability to eat a meal once a day. During the last year, 37,143 extremely poor households were supported across the district through social protection measures (Gicumbi district, 2020).

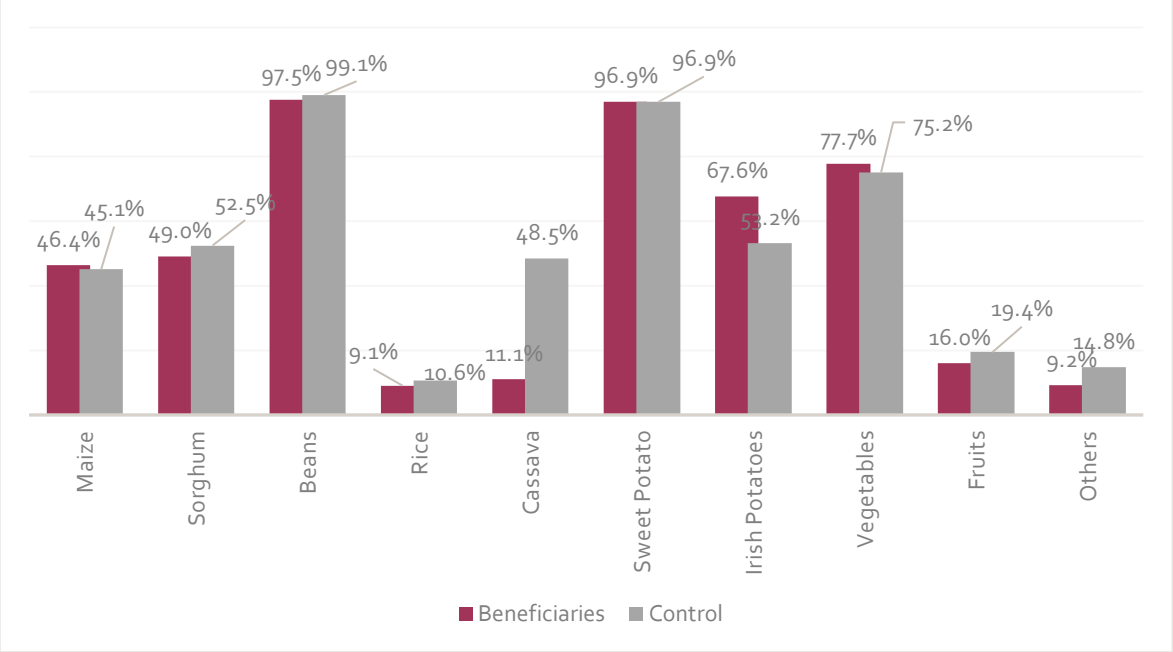
Figure 31. Most important meal of the day



Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=1299, Beneficiaries=651, Control= 648)

The majority of beneficiary (82.2 per cent) and control group (74.5 per cent) respondents reported that supper was the most important meal of the day, against 12.9 per cent of beneficiary and 32.4 per cent of control group households who reported lunch as the most important meal of the day. The respondents were also asked about the main composition of the meal. The responses given are summarized in the figure below.

Figure 32. Main composition of the meal



Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=1299, Beneficiaries=651, Control= 648)

The most commonly consumed foods include beans (97.5 per cent and 99.1 per cent for beneficiary and control group households respectively), sweet potatoes (96.9 per cent) and vegetables (77.7 per cent and 75.2 per cent for beneficiary and control group households respectively), which are common foods for rural households in Rwanda. Irish potatoes, maize and sorghum are next on the list of commonly consumed foods. Moreover, cassava is a common food in the control group area (48.5 per cent). Other consumed foods include rice and fruit, while other non-specified foods were reported by 9.2 per cent and 14.8 per cent in the beneficiary and control group areas respectively. This shows that the households consume crops which are commonly grown in the area (Table 18, Table 19 and Table 20). With regard to experiencing food shortages, respondents provided feedback as reported in the figure below.

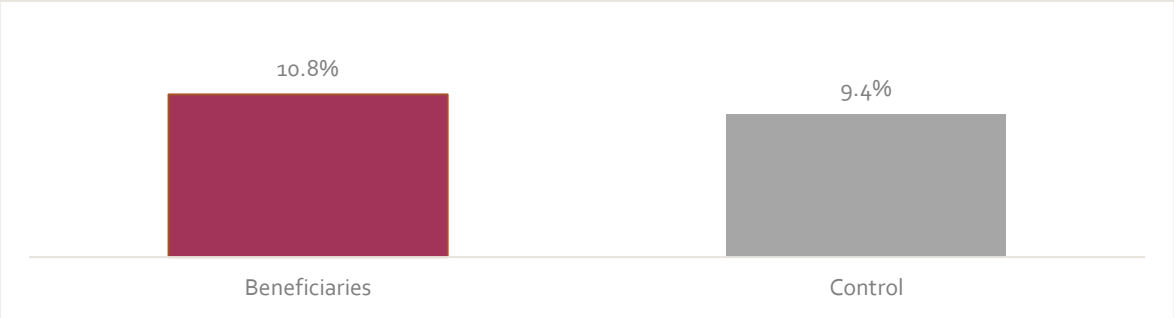
Figure 33. Households that experienced a food shortage in the past 12 months

Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=1299, Beneficiaries=651, Control= 648)

Figure 33 reveals that 49.8 per cent and 33.6 per cent of the beneficiary and control groups respectively declared to have had a period of food shortage in the past 12 months preceding the

survey. It is worth noting that a food shortage refers to a situation in which food supplies are not sufficient in quantity and do not provide the energy and nutrients needed by family members. Food shortages also coincide with inadequate calorie production where the foods consumed are deficient in protein or micronutrients. When asked about the assistance received in terms of food or money, the information provided by respondents is shown in Figure 34.

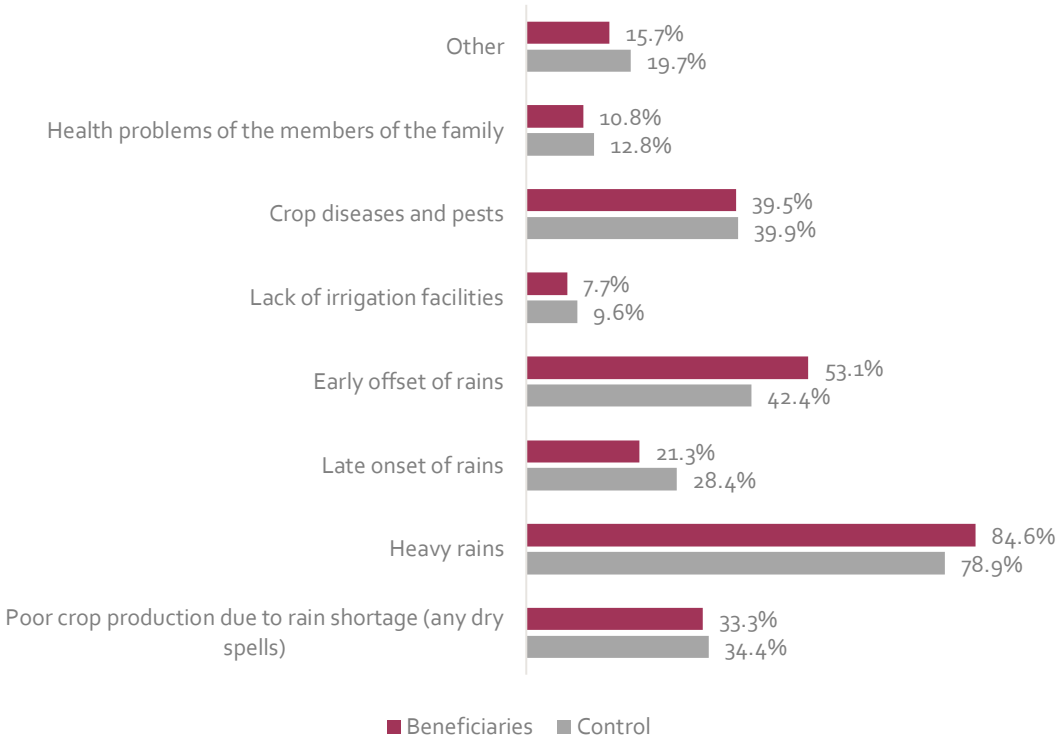
Figure 34. Assistance received in terms of food or money from the government or other institutions



Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=1299, Beneficiaries=651, Control= 648)

Only 10.8 per cent and 9.4 per cent of the project beneficiary and control group respondents respectively confirmed to have received assistance in terms of food or money during meal shortage periods. The households confirmed that they managed to cope with the food shortage by reducing the number and quantity of meals, and that the period of shortage did not cause any deaths. The following figure illustrates the main causes of food shortage.

Figure 35. Main causes of food shortage in the past 12 months



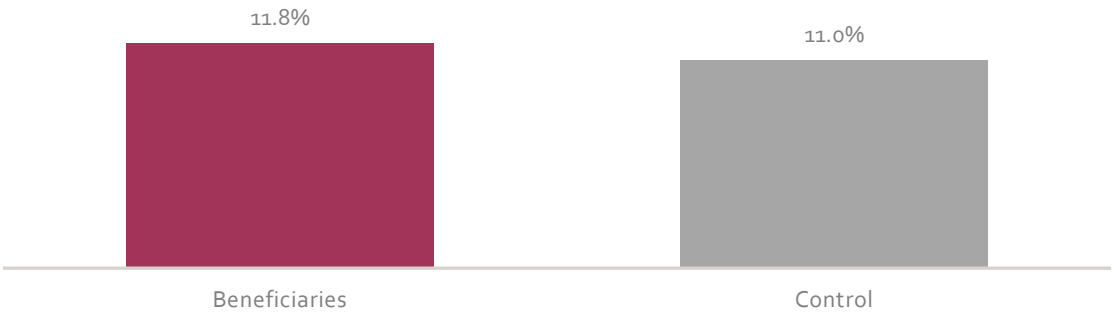
Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=542, Beneficiaries=324, Control=218)

Figure 35 shows the important impacts of the climate on food security, with poor crop productivity due to rain shortages, changes in the offset/onset of rain and heavy rains reported as the main causes of food shortage in the areas under investigation. Heavy rains were the leading cause in food shortage as declared by 84.6 per cent and 78.9 per cent in the project intervention and control group areas respectively, followed by an early offset of rains as confirmed by 53.1 per cent of beneficiary households and 42.2 per cent of the control group. Poor crop production due to rain shortages (any dry spells) was also mentioned to have caused food shortage as declared by 33.3 per cent and 34.4 per cent of beneficiary and control group respondents respectively, while approximately 39 per cent of investigated households pointed out that crop diseases and pests contributed to the poor crop productivity resulting into food shortages. Late on set of the rains was also mentioned by 21.3 per cent and 28.4 per cent of the beneficiary and control group respectively to have also contributed to the food shortage in the past 12 months. Other causes were reported by a small number of interviewees.

g. Access to basic facilities and infrastructure

Access to clean water for households is one of the indicators of a population's well-being in a given area. In this regard, access to basic facilities and infrastructure by the project intervention and control group households was gathered and presented in the figure below.

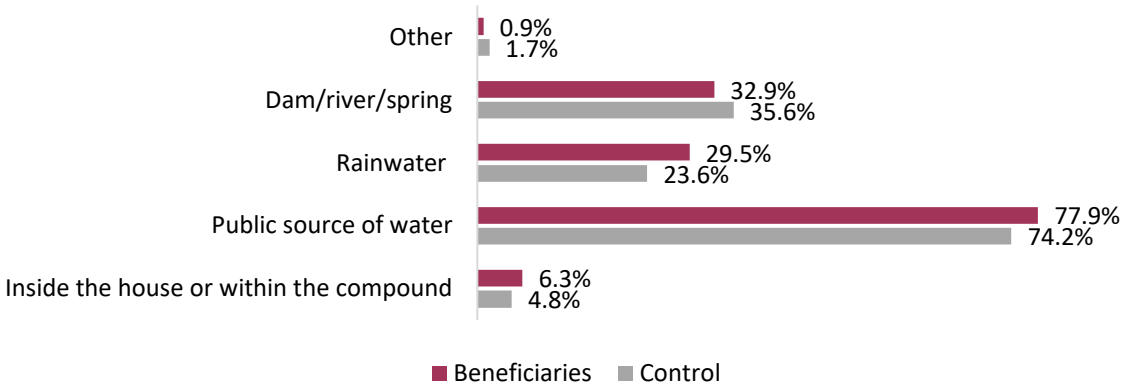
Figure 36. Availability of infrastructure to clean water in the past 12 months



Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=1299, Beneficiaries=651, Control=648)

Figure 36 above indicates that only 11.8 per cent and 11 per cent of the beneficiary and control group households respectively had appropriate infrastructure for clean water for drinking purposes (clean water was considered as potable water that is safe to drink or use for food preparation). Therefore, around 89 per cent were still drinking unsafe water. Those who had appropriate infrastructure to boil water were included in the survey as well as those who purchased bottled water from stores.

Figure 37. Main sources of water for domestic use



Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=1299, Beneficiaries=651, Control=648)

Figure 37 shows that 77.9 per cent and 74.2 per cent of beneficiary and control group households respectively obtain water for domestic use from a public source, with only 6.3 per cent and 4.8 per cent in the same areas having access to water inside the home or within the compound. It is worth noting that access to water is not regular, especially during dry seasons as reported by the respondents during the FGDs and KIIs in both the intervention and control areas. In this case, people must fetch unsafe water from dams, rivers and springs, which may potentially impact public health through. The study revealed that only 29.5 per cent and 23.6 per cent of the beneficiary and control group households respectively also use rainwater. Moreover, around one third of households use unclean water from dams, rivers, springs and marshlands. This corresponds to findings reported in the Muvumba Catchment Plan 2018-2024 that approximately half of the population settled in the Muvumba catchment uses dirty water from streams, dams, valleys or swamps and thus, does not have access to safe and reliable supplies of water for productive and domestic use. Information on the availability of tanks to harvest rainwater is presented below.

Figure 38. Availability of water tanks at the homestead in the past 12 months

Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=1299, Beneficiaries=651, Control=648)

Figure 38 reveals that only 10.3 per cent and 8.0 per cent of the beneficiary and control group households respectively have a water tank inside the homestead. Rainwater harvesting technologies should be one of the mechanisms to be promoted in order to save local communities from using unsafe water and travelling long distances in search of water for domestic use. Harvesting rainwater would also contribute to the reduction of run-off and fluvial erosion if it is done at a large scale with

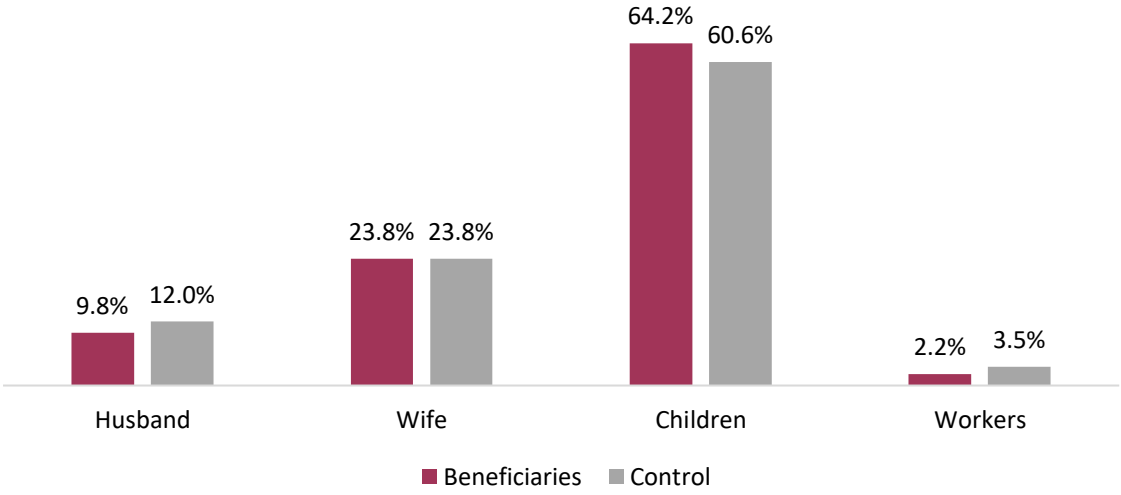
large containers. To that end, this project on Strengthening climate resilience of rural communities in Northern Rwanda will make interventions in improving the rainwater harvesting rate by households in the project intervention area.

Figure 39. Average quantity of water used (jerry-cans of 20l) per day for domestic use

Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=1299, Beneficiaries=651, Control=648)

Figure 39 above reveals that households in both areas use an average of 2-3 jerry-cans of water per day. For an average family of five as reported in Figure 4, the numbers are far below the 50 litres per person/per day recommended by the United Nations (Institute of Water for Africa, 2016). The household members often responsible for fetching water for domestic use are represented below.

Figure 40. Person responsible to fetch water for domestic use

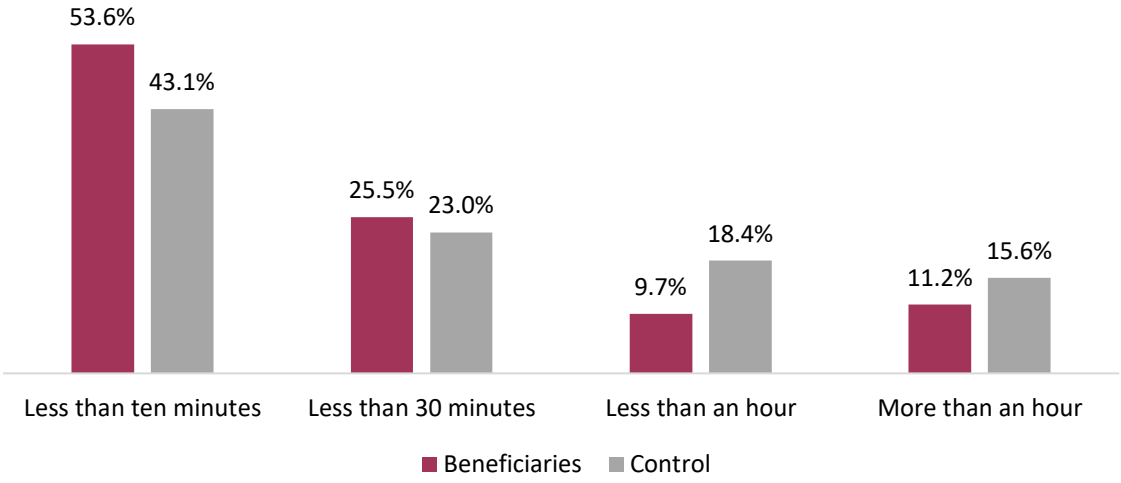


Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=1299, Beneficiaries=651, Control=648)

Figure 40 shows that children are responsible for collecting water in 64.2 per cent and 60.6 per cent of beneficiary and control group households respectively followed by women at 23.8 per cent and 23.8 per cent of the same groups. Only 9.8 per cent and 12 per cent of beneficiary and control group respondents respectively reported that men are responsible for fetching water, while 2.2 per cent and 3.5 per cent of the same groups stated that fetching water is done by hired workers. The high involvement of children in fetching water for home use may negatively impact education levels, especially for those who walk more than an hour to get water. The time taken by women and men

will detract from attention to productive and domestic activities. The time taken from home to the water sources are shown in the figure below.

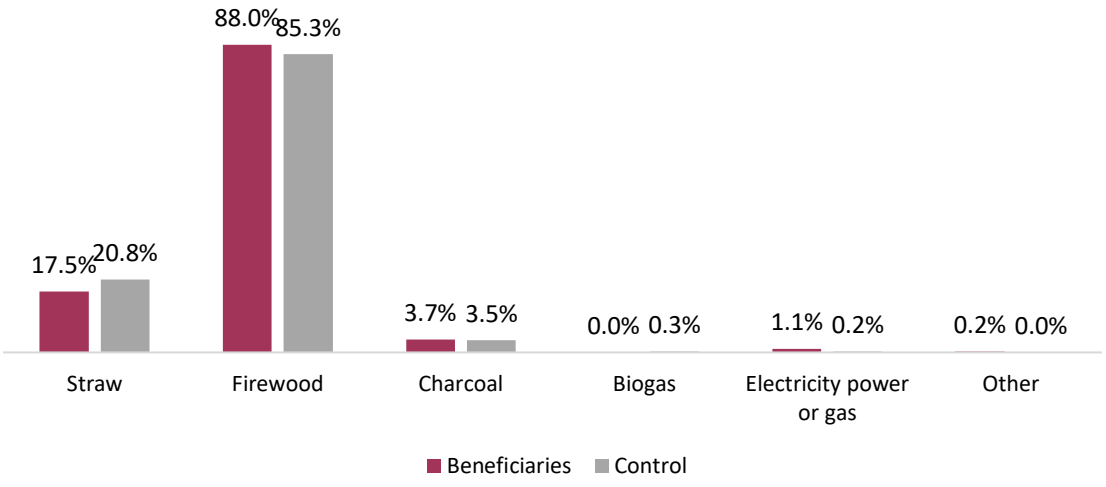
Figure 41. Average time taken from home to the water source



Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=1299, Beneficiaries=651, Control=648)

Figure 41 shows that a large number of beneficiary (53.6 per cent) and control group (43.1 per cent) households reported that it took less than 10 minutes from home to reach water sources, while 25.5 per cent of the beneficiary and 23 per cent of the control groups required 10 and 30 minutes, 9.7 per cent of the beneficiary and 18.4 per cent of the control groups needed 30 minutes to one hour and 11.2 per cent of the beneficiary and 15.6 per cent of the control groups required more than one hour. At the national level, 27 per cent of households are within 0 to 4 minutes walking distance of an improved drinking water source, while 61 per cent of households are within 0 to 14 minutes walking distance each way (EICV 5, 2018; NISR, 2018). Therefore, the average time used to reach water sources is much higher in the areas under investigation than the national average and this time would be used for other important activities for the households. The following figure represents the main source of energy used for cooking in the areas under investigation.

Figure 42. Main source of energy used for cooking

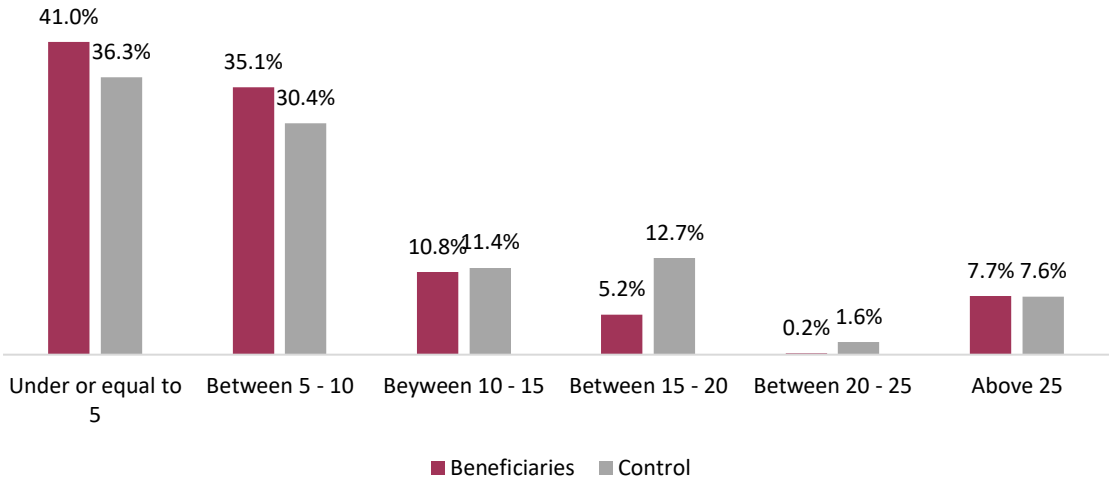


Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=1299, Beneficiaries=651, Control=648)

Regarding energy used for cooking, the vast majority, 88 per cent and 85.3 per cent of beneficiary and control group respondents respectively reported that they use firewood, with only 17.5 per cent of beneficiary households and 20.8 per cent of control and 3.7 per cent of beneficiary households and 3.5 per cent of control group using straw and charcoal respectively. Only 1.1 per cent and 0.2 per cent of beneficiary and control group respondents respectively confirmed using electrical power or gas for cooking. None of the beneficiary respondents declared using biogas for cooking, and only 0.3 per cent of control group households use it. These results are almost the same as those reported in Muvumba Catchment Plan 2018-2024 where it was highlighted that 82 per cent of households use firewood to cook meals, while the use of alternative energy sources.[11]

Cooking with biogas instead of firewood or charcoal also reduces the amount of smoke emitted in the kitchen and thus, is better for the health of family members especially that of women and children who are predominantly present for meal preparation. Also, if properly stored, treated and applied to the fields, biogas plant effluent, known as slurry, has a far higher fertilizer value than ordinary farmyard manure.

Figure 43. Number of firewood bundles and sacks of charcoal used per month

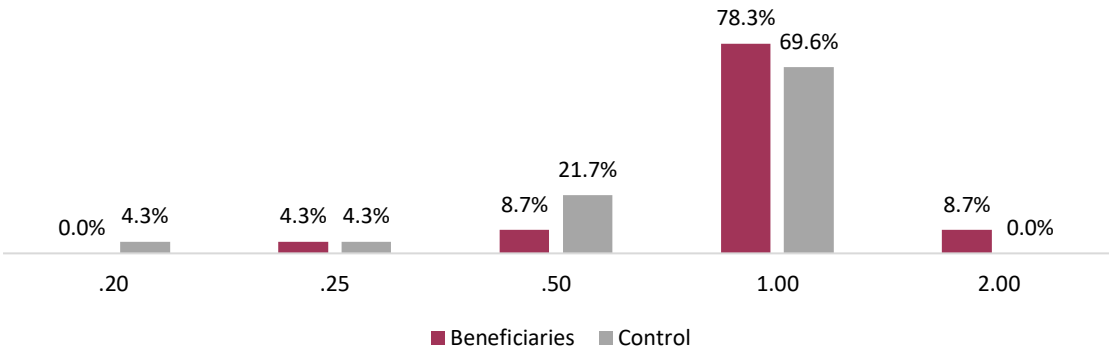


Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=1126, Beneficiaries=573, Control=553)

Figure 43 shows that the majority of both beneficiary and control group households use between 1 and 10 bundles of firewood per month. The information about the quantity of sacks of charcoal used per week is reported in the figure below.

[11] It is worth noting that domestic biogas plants have a direct positive effect on rural peoples' energy supply, environment, health and agricultural production. Biogas is part of a closed ecological cycle, which makes it a sustainable and renewable source of energy. By replacing traditional energy sources (notably, firewood) and by digesting cow dung in a closed environment, it results in a significant reduction in the emission of methane, which is a greenhouse gas. This has a positive gender sensitive factor as it reduces the burden on women through collecting firewood.

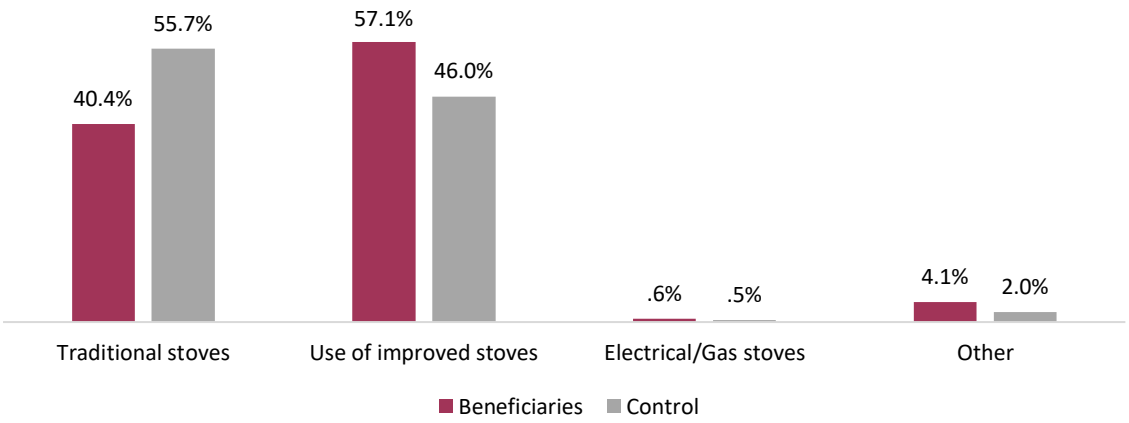
Figure 44. Number of sacks of charcoal for the past 12 months



Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=46, Beneficiaries=23, Control=23)

Figure 44 shows that the majority of beneficiary (78.3 per cent) and control group (69.6 per cent) declared that they use 1 sack per week, with only 8.7 per cent of beneficiary households who confirmed to use 2 sacks a week. Slightly less than one quarter of beneficiary households confirmed to use less than one sack in a week. The highest quantity of charcoal was seen to be used in urban centres compared to rural areas where firewood is dominantly used (EICV5, 2018).

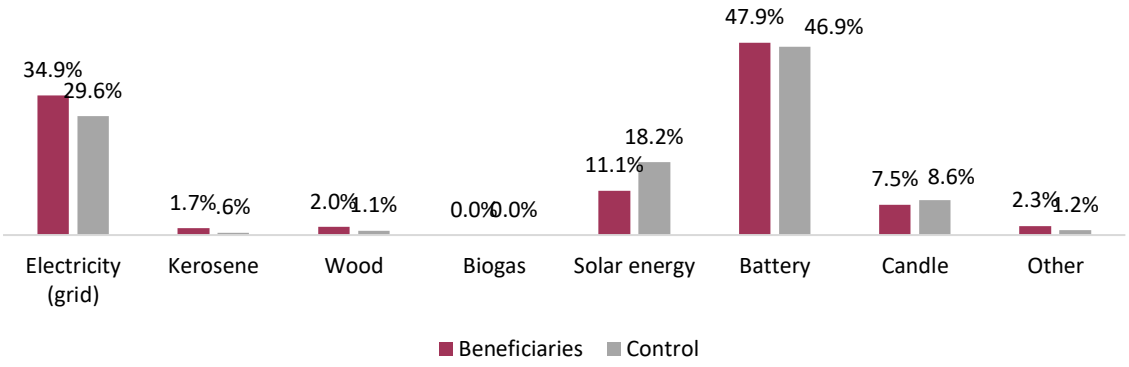
Figure 45. Main mode used for cooking



Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=1257, Beneficiaries=636, Control=621)

Figure 45 shows that a large number of households (57.1 per cent and 46 per cent of beneficiary and control group respectively) confirmed using improved stoves for cooking against, 40.4 per cent of beneficiary households and 55.7 per cent control group who still use traditional stoves. Less than 1 per cent using electric or gas stoves. Only 4.1 per cent and 2 per cent of beneficiary and control group households respectively use another mode of cooking. The main sources of energy used for lighting in homes are presented in the figure below.

Figure 46. Main source of energy used for lighting in homes



Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=1299, Beneficiaries=651, Control=648)

Figure 46 shows that only 34.9 per cent and 29.6 per cent of the beneficiary and control group households respectively had access to centrally generated grid electricity. Exactly 11.1 per cent and 18.2 per cent of beneficiary and control group respondents respectively reported having access to solar energy. As households had insufficient access to electricity to light their homes, they acquired other alternatives such as batteries (47.9 per cent and 46.9 per cent of the beneficiary and control groups respectively), candles (7.5 per cent and 8.6 per cent of beneficiary and control group households respectively). Kerosene, wood and biogas constitute a very small proportion.

This data is in line with the overall connectivity rate of Rwandan households (52.8 per cent), including 38.5 per cent connected to the national grid and 14.3 per cent accessing energy through off-grid systems (mainly solar), as reported in December 2019. During the elaboration of the EDPRS II, the GoR took a clear policy decision to diversify the sources of electricity from a traditional dominant grid to include off-grid connections. Subsequently, households far away from the planned national grid coverage have been encouraged to use alternatively cheaper connections such as mini-grids and solar photovoltaics to reduce the cost of access to electricity whilst relieving constraints on historical government subsidies. We now turn to the time taken to get to basic infrastructure.

Table 21. Time taken to get access to basic infrastructures

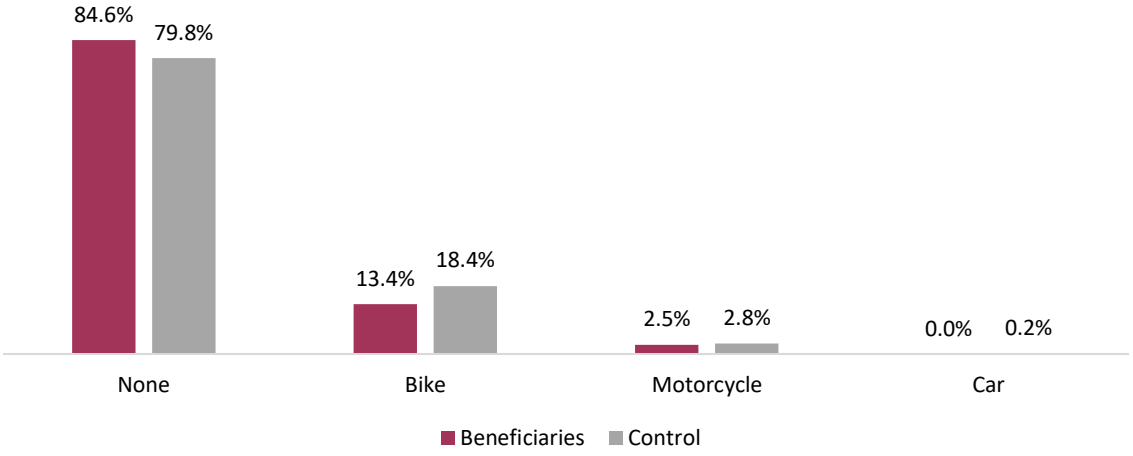
		Beneficiaries		Control		Total	
		Freq.	%	Freq.	%	Freq.	%
Bus stop or taxi	Less than 30 minutes	180	13.9 %	153	11.8 %	333	25.6 %
	Between 30 minutes and 1 hour	146	11.2 %	172	13.2 %	318	24.5 %
	Between 1 hour and 2 hours	147	11.3 %	170	13.1 %	317	24.4 %
	More than 2 hours	177	13.6 %	150	11.5 %	327	25.2 %
	I do not know	1	0.1 %	3	0.2 %	4	0.3 %
	Total	651	50.1 %	648	49.9 %	1299	100.0 %
Primary school	Less than 30 minutes	344	26.5 %	309	23.8 %	653	50.3 %
	Between 30 minutes and 1 hour	222	17.1 %	247	19.0 %	469	36.1 %

		Beneficiaries		Control		Total	
		Freq.	%	Freq.	%	Freq.	%
	Between 1 hour and 2 hours	63	4.8 %	79	6.1 %	142	10.9 %
	More than 2 hours	22	1.7 %	11	0.8 %	33	2.5 %
	I do not know	0	0.0 %	2	0.2 %	2	0.2 %
	Total	651	50.1 %	648	49.9 %	1299	100.0 %
Health centre	Less than 30 minutes	280	21.6 %	185	14.2 %	465	35.8 %
	Between 30 minutes and 1 hour	198	15.2 %	249	19.2 %	447	34.4 %
	Between 1 hour and 2 hours	133	10.2 %	173	13.3 %	306	23.6 %
	More than an 2 hours	38	2.9 %	40	3.1 %	78	6.0 %
	I do not know	2	0.2 %	1	0.1 %	3	0.2 %
	Total	651	50.1 %	648	49.9 %	1299	100.0 %
Main market for food products	Less than 30 minutes	91	7.0 %	54	4.2 %	145	11.2 %
	Between 30 minutes and 1 hour	141	10.9 %	134	10.3 %	275	21.2 %
	Between 1 hour and 2 hours	154	11.9 %	286	22.0 %	440	33.9 %
	More than an 2 hours	261	20.1 %	174	13.4 %	435	33.5 %
	I do not know	4	0.3 %	0	0.0 %	4	0.3 %
	Total	651	50.1 %	648	49.9 %	1299	100.0 %
Main market for animal products	Less than 30 minutes	65	5.0 %	38	2.9 %	103	7.9 %
	Between 30 minutes and 1 hour	94	7.2 %	88	6.8 %	182	14.0 %
	Between 1 hour and 2 hours	157	12.1 %	266	20.5 %	423	32.6 %
	More than an 2 hours	322	24.8 %	253	19.5 %	575	44.3 %
	I do not know	13	1.0 %	3	0.2 %	16	1.2 %
	Total	651	50.1 %	648	49.9 %	1299	100.0 %
Closest all-weather road	Less than 30 minutes	103	7.9 %	97	7.5 %	200	15.4 %
	Between 30 minutes and 1 hour	106	8.2 %	115	8.9 %	221	17.0 %
	Between 1 hour and 2 hours	155	11.9 %	124	9.5 %	279	21.5 %
	More than 2 hours	286	22.0 %	307	23.6 %	593	45.7 %
	I do not know	1	0.1 %	5	0.4 %	6	0.5 %
	Total	651	50.1 %	648	49.9 %	1299	100.0 %

Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=1299, Beneficiaries=651, Control=648)

Table 21 shows it takes less than one hour to reach primary schools for the majority of both beneficiary and control group respondents while it takes one hour or more to reach bus stops or taxis, main markets for food and animal products and the nearest all-weather roads as reported by the majority of households. This reveals good access to basic services.

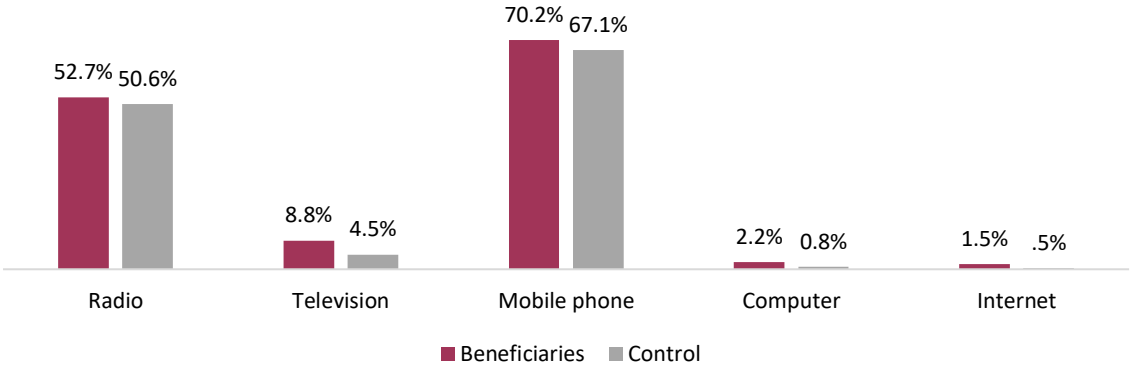
Figure 47. Ownership of means of transport



Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=1299, Beneficiaries=651, Control=648)

Figure 47 shows that the majority of both beneficiary and control group respondents (84.6 per cent and 79.8 per cent) confirmed they did not possess any means of transport. Exactly13.4 per cent of beneficiary households and 18.4 per cent of the control group owned bikes and 2.5 per cent of beneficiary households and 2.8 per cent of the control group in the same areas had motorcycles. Only 0.2 per cent of the control group had cars. This demonstrates the lack of transport, potentially resulting in difficulties to move agricultural and other products to the market.

Figure 48. Ownership of means of communication



Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=1299, Beneficiaries=651, Control=648)

Figure 48 shows that 70.2 per cent and 67.1 per cent of beneficiary and control group households respectively possess mobile phones, while 52.7 per cent of beneficiary households and 50.6 per cent of the control group have radios and 8.8 per cent of beneficiary households and 4.5 per cent of the control group have televisions. The ownership rate of computers, by 2.2 per cent and 0.8 per cent of beneficiary and control group households respectively, is very low. Only 1.5 per cent of beneficiary households and 0.5 per cent of the control group have wired internet connectivity. The mobile phone ownership rate is satisfactory for such rural areas. It suggests that these mobile phones could be used to inform households timely on market prices (MINAGRI e-Soko). In the same way, they can also be also used as a tool to mobilize farmers in extension services and campaigns (mulching, pruning

operations, fertilization and pesticides application, harvesting periods, early warning information, etc.).

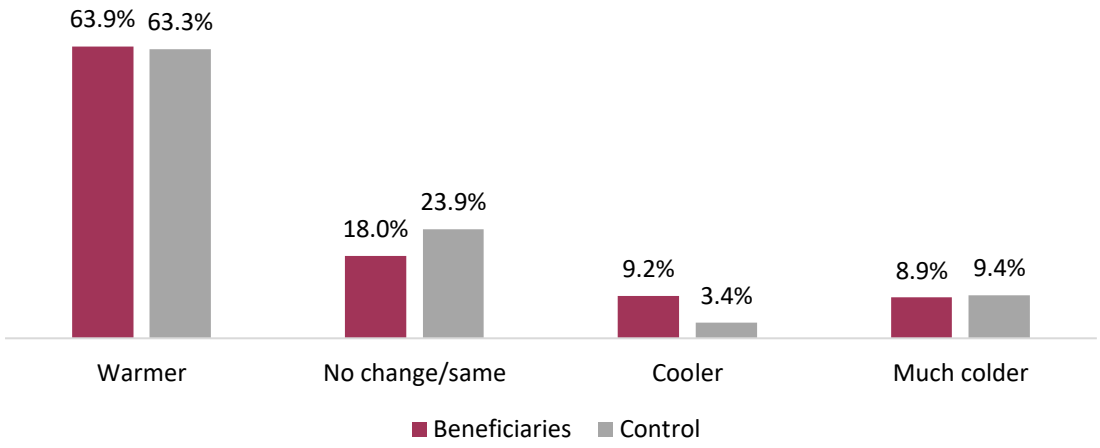
h. Climate change and variability, and their impacts

Since most of the agricultural activities in Rwanda are rain-fed, any adverse change in climate is likely to have a significant effect on agricultural production and the livelihood of the majority of the population in the survey area (Stringer et al., 2009; Muhire et al., 2016). Climate change and variability information will improve agricultural outcomes when it is integrated into a framework for decision-making.

Evidence of climate change and variability

The perceptions of the respondents on the changes in mean temperature are presented below.

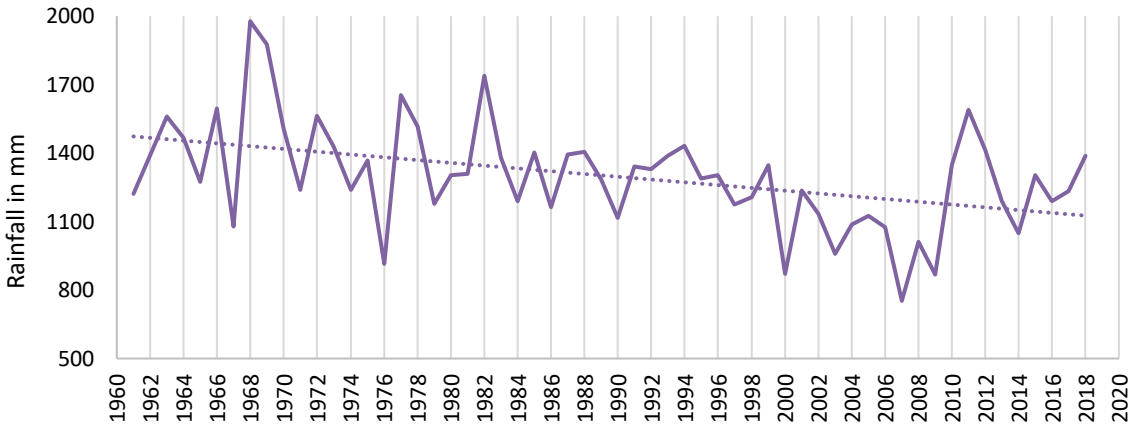
Figure 49. Reported changes in temperature in the past 12 months



Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=1299, Beneficiaries=651, Control=648)

Figure 49 shows that around 63.9 per cent of beneficiary households and 63.3 per cent of the control group were aware that the Muvumba watershed and control group area experienced an increase in temperature throughout the years. Observed frequent fluctuations in the frequency and intensity of rain are presented below.

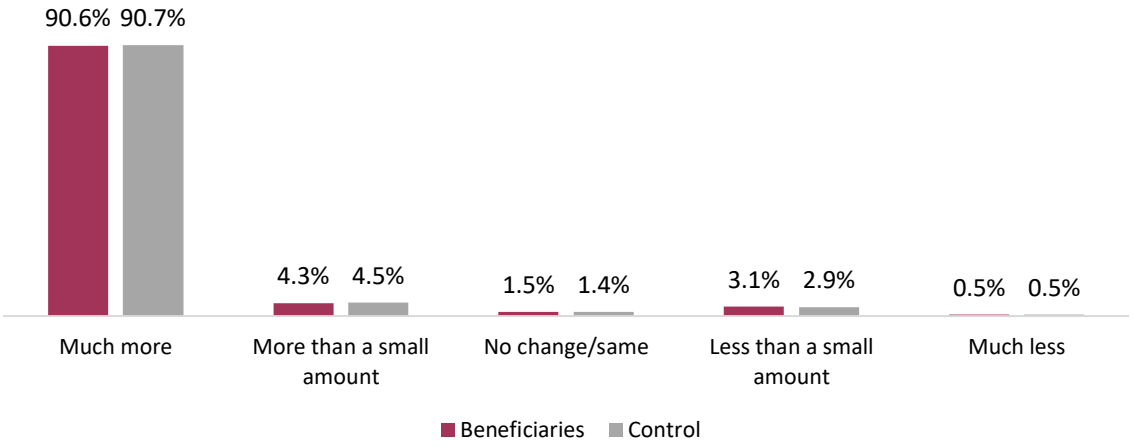
Figure 50. Annual fluctuations in mean rainfall (in mm) of the Byumba weather station in the Gicumbi district



Source: Meteo Rwanda, 2019

Figure 50 shows a declining trend in the mean annual rainfall from 1961 to 2018 at the Byumba weather station. The highest rainfall for the analysed period was 1977.6 mm in 1968, while the lowest registered was 752.8 mm in 2007 at the Byumba weather station. The following figure shows how respondents perceived changes in the mean rainfall in the 12 months prior to the survey.

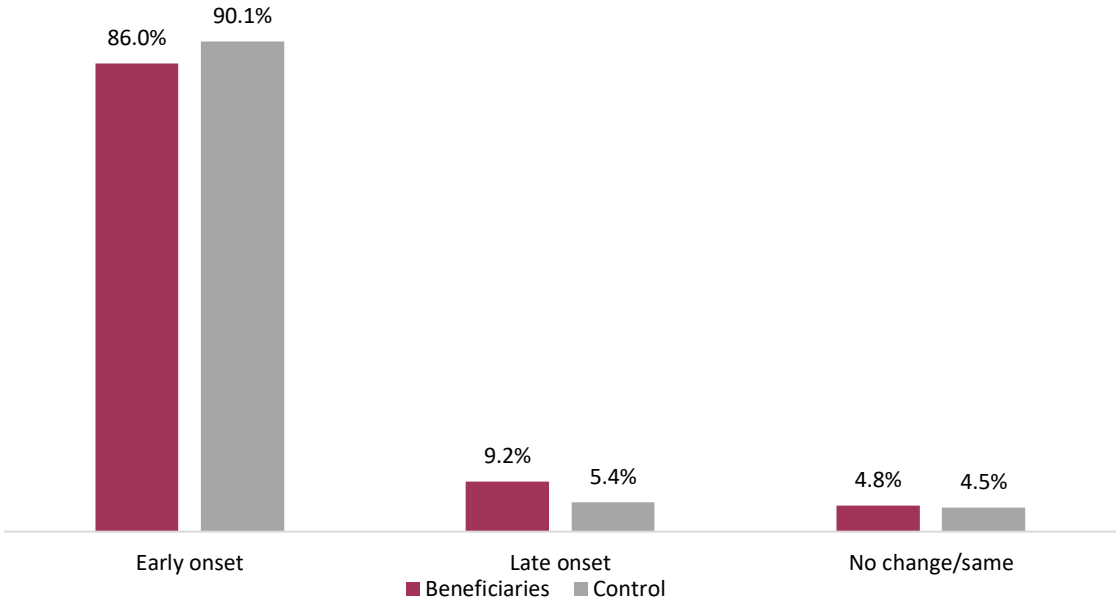
Figure 51. Observed changes in mean rainfall for the past 12 months



Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=1299, Beneficiaries=651, Control=648)

Though the data from Meteo Rwanda in Figure 50 above revealed a general decreasing trend in the mean rainfall up to 2018, 90.6 per cent and 90.7 per cent of beneficiary and control group respondents respectively reported to have experienced an increasing trend in the amount of rainfall in the 12 months prior to the survey.

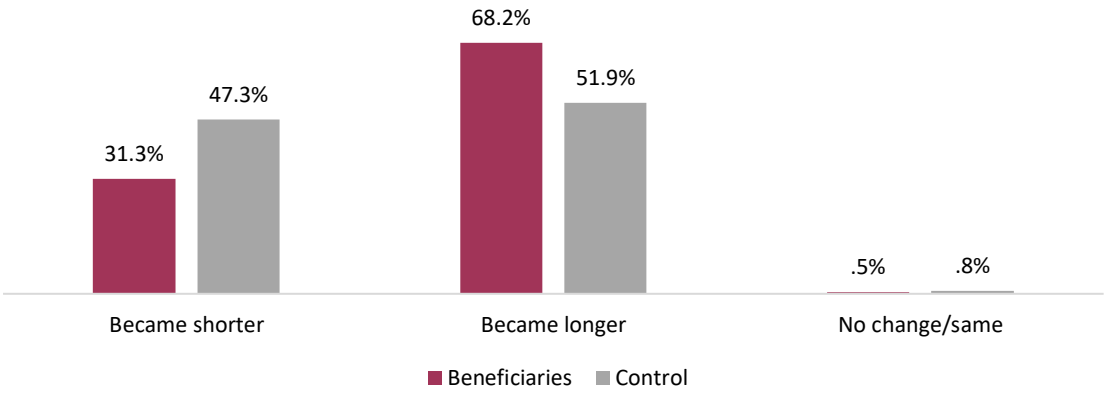
Figure 52. Changes in rainfall onset in the past 12 months



Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=1299, Beneficiaries=651, Control=648)

Rainfall onset affects the cropping period either positively or negatively. When rainfall is received earlier than normal, it attracts farmers to grow crops immediately after receiving the rainfall, while a late rainfall onset leads to delayed crop growing, reducing the agricultural season and poor crop productivity. Figure 52 shows that 86 per cent and 90.1 per cent of beneficiary and control group respondents respectively reported an early rainfall onset. This may have resulted from the fact that much more than normal rainfall was received across the country during the short dry season (December-January-February), which explains the reported early rainfall onset.

Figure 53. Changes in the rainy period in the past 12 months



Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=1299, Beneficiaries=651, Control=648)

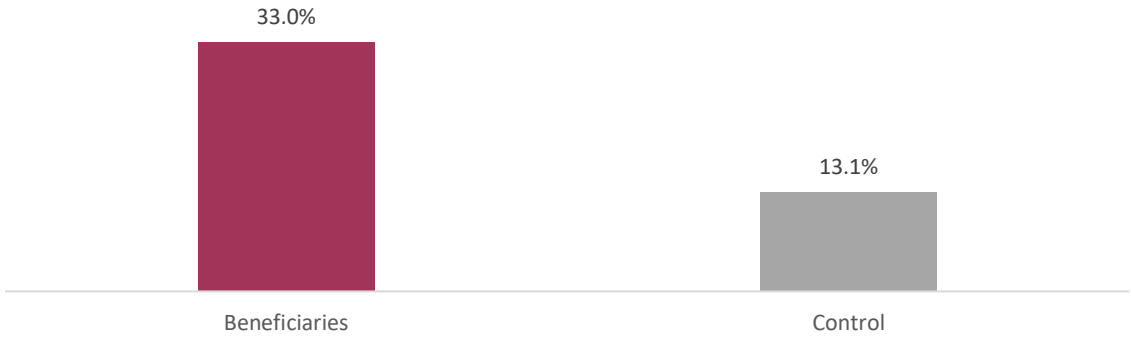
Figure 53 shows that 68.2 per cent and 51.9 per cent of beneficiary and control group respondents respectively state that the rainy seasons became longer, against 31.3 per cent of beneficiary households and 47.3 per cent of control group respondents respectively in the same areas declaring the opposite (shorter rainy seasons). A negligible percentage (less than one per cent) confirmed to have not seen any change in rainy seasons.

Figure 54. Occurrences of flooding episodes in the past 12 months

Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=1299, Beneficiaries=651, Control=648)

Approximately one quarter of respondents reported to have experienced flooding episodes (27.5 per cent and 21.8 per cent of beneficiary and control group respondents respectively). Moreover, participants of the FGDs reported to have experienced more intense storms (daily rainfall) which caused floods, landslides, soil erosion and other associated impacts. The households that suffered most were those that had grown crops (especially tea and vegetables) in the marshlands. The situation regarding the occurrences of dry spells is reported below.

Figure 55. Occurrences of dry spells in the past 12 months



Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=1299, Beneficiaries=651, Control=648)

Figure 55 shows that only 13.1 per cent and 33 per cent of control group and beneficiary respondents respectively confirmed to have noticed long dry spells throughout the year. This may be due to a particularly long rainy season across the country, which extended from mid-September 2019 to mid-May 2020. The occurrences of strong winds were reported in the figure below.

Figure 56. Occurrences of strong winds in the past 12 months

Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=1299, Beneficiaries=651, Control=648)

Figure 56 shows that only 39 per cent and 28.7 per cent of beneficiary and control group respondents respectively reported the occurrences of strong winds in the past year.

Figure 57. Occurrences of severe thunderstorms with lightning in the past 12 months

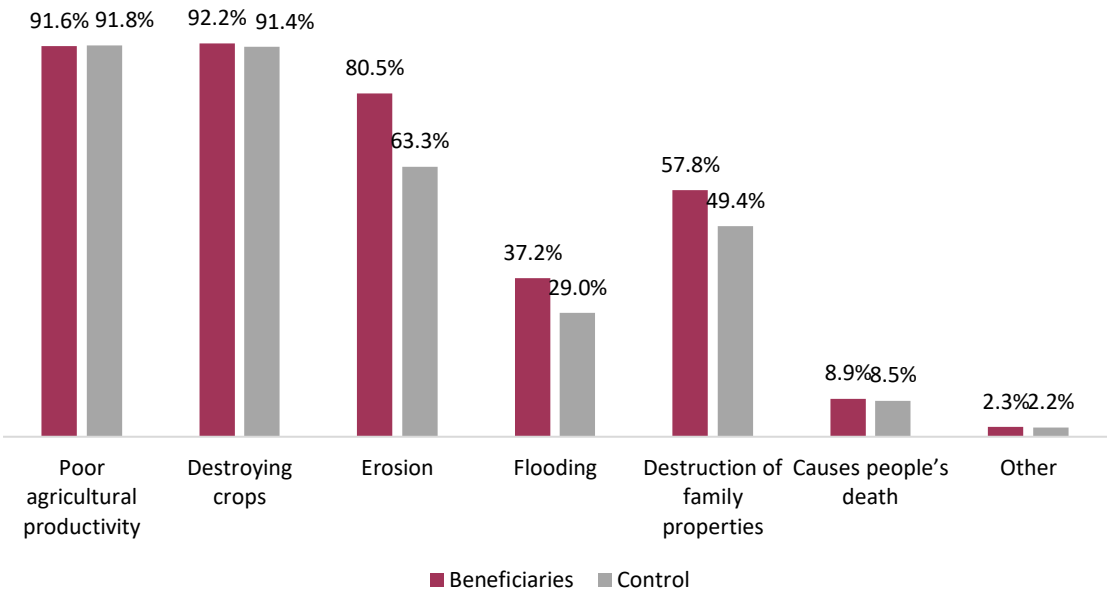
Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=1299, Beneficiaries=651, Control=648)

Moreover, Figure 57 show that 26.4 per cent and 24.7 per cent of beneficiary and control group households respectively reported having experienced severe thunderstorms with lightning. These observed changes in climate over the Gicumbi district in general, and over the areas under investigation specifically, may affect human activities and physical environment either positively or negatively. We now offer an analysis of the perceived impacts of climate change and variability on people's livelihoods in the area under investigation.

Impacts of climate change and variability

The occurrence of more extreme weather events (e.g. droughts, strong winds, thunderstorms with lightning and floods), the increase in temperatures and in fluctuations of seasonal rainfall patterns, duration and intensity, inevitably have immediate impacts on cropping patterns, timing of growing crops, agronomic practices and household needs. This does not only affect food production but also food and water safety and availability, livelihood assets and human health and properties (IPCC, 2007; FAO, 2008; Mary and Majule, 2009). Therefore, the impacts of climate change on various aspects in the area under investigation were undertaken.

Figure 58. Impact of changes in rainfall amount on households' livelihoods during the past 12 months

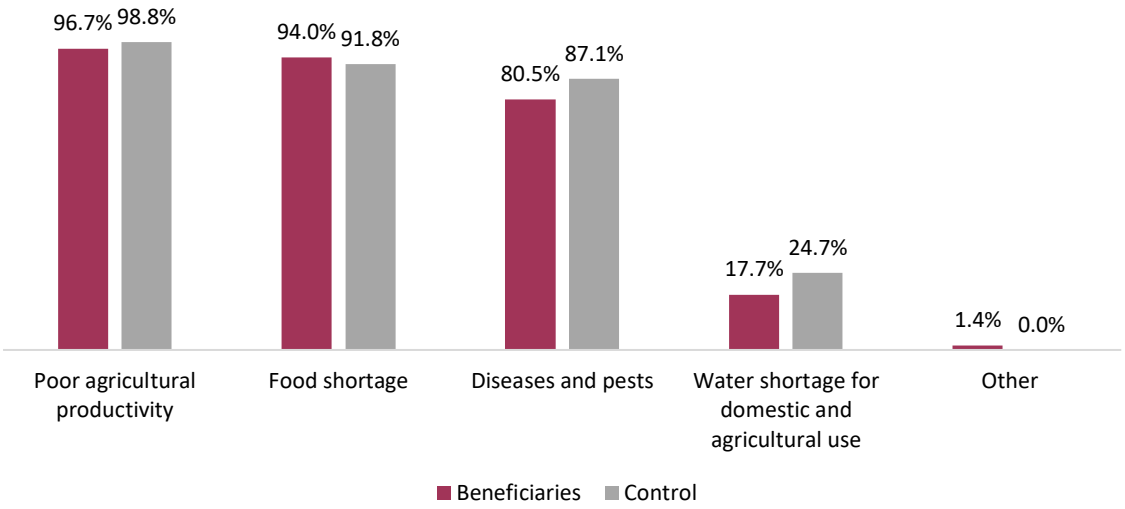


Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=1299, Beneficiaries=651, Control=648)

Figure 58 shows that respondents reported that changes in rainfall led to poor agricultural productivity, fluvial erosion and destroyed crops. Around 50 per cent of respondents said that heavy rainfall caused the destruction of family properties, while 37.2 per cent and 29 per cent of beneficiary and control group respondents respectively confirmed that heavy rain caused flooding episodes. Slightly less than 9 per cent of respondents reported seeing or hearing about human deaths caused by such rains with around 2.2 per cent reporting other consequences (death of animals).[12]

[12] It is important to note that the 9 per cent represents respondents who reported human deaths does not provide information on the actual deaths within a predetermined population. These are respondents who had seen or heard of individuals who had passed away due to heavy rainfall. It is possible that two or more respondents could be reporting on the death of the same victim creating potential for overlap in reporting on human deaths.

Figure 59. Impacts of observed drought episodes and dry spells in the past 12 months

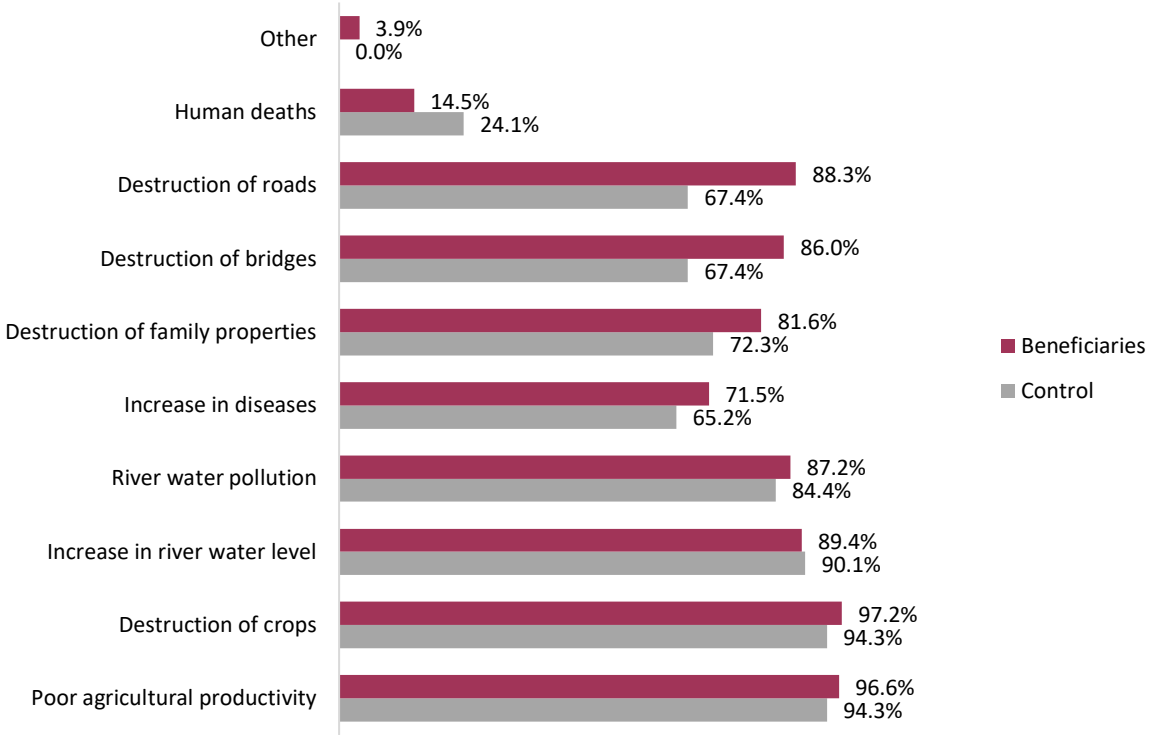


Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=300, Beneficiaries=215, Control=85)

Figure 59 shows that the majority of respondents declared that drought episodes and long dry spells led to poor crop productivity, shortages of food and diseases and pests. A smaller number of respondents (less than 25 per cent) experienced water shortages for domestic agricultural use due to occurrences of droughts and dry spells.

The FGDs with the Muvumba watershed households revealed that dry spells, occurring especially in June to August, frequently subjected them to reduced water storage leading to crop failure. This may also be attributed to the lack of irrigation systems in the area and to the limited use of manure and fertilizers on farms. The same groups confirmed that dry spells caused banana plantations to dry up, domestic animals to suffer from water of food shortages.

Figure 60. Impacts of observed flooding episodes in the past 12 months



Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=320, Beneficiaries=179, Control=141)

When asked about the impacts of flooding episodes, the majority of households of the Muvumba watershed and control group area (around 95 per cent) declared that these events destroyed their crops and caused poor agricultural productivity. Between 65 per cent and 80 per cent of beneficiary and control group respondents respectively confirmed that flooding episodes caused the destruction of family properties, roads and bridges, pollution of river water and an increase in crop diseases. Exactly 24.1 per cent and 14.5 per cent of the control group and beneficiary households respectively reported cases of human deaths as a consequence of flooding in the past 12 months.[13] The flooding episodes devastated local communities of the Muvumba watershed and control group areas as illustrated in Figure 60.

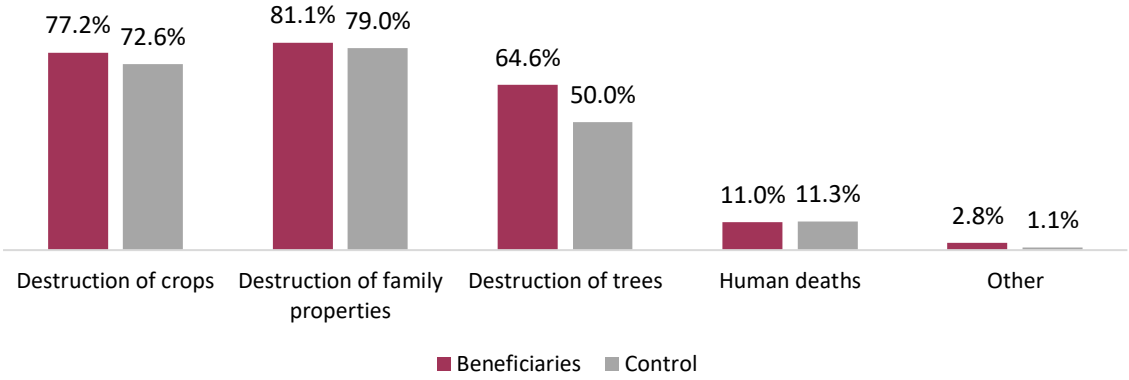
Notwithstanding that the floods brought sediment and silts into the marshlands, they also washed out fertile soil, destroyed crops and polluted waters as testified by participants in the FGDs and KIIs. The floods occurred during the long rainy season from March to May 2020 and also caused the destruction of bridges as can be seen in the figure below.

The flooding episodes also caused the deterioration of local and national roads which harms the safe transport of goods and people in the Muvumba watershed, as reported by respondents during the FGDs and KIIs. Constructed bridges and water canals were not strong enough to resist the strong floods which took place during March to May 2020. Thereafter, households requested support to develop rainwater harvesting technologies and construct water canals, especially in the marshlands,

[13] It is important to clarify the precise meaning of the per cent of respondents who reported human deaths. These are respondents who had seen or heard of individuals who had passed away due to flooding – not necessarily individuals from within the household that the respondent is part of.

to reduce the negative effects of occasional flooding episodes. In addition to floods, strong winds have also been very harmful to the project intervention and control group households.

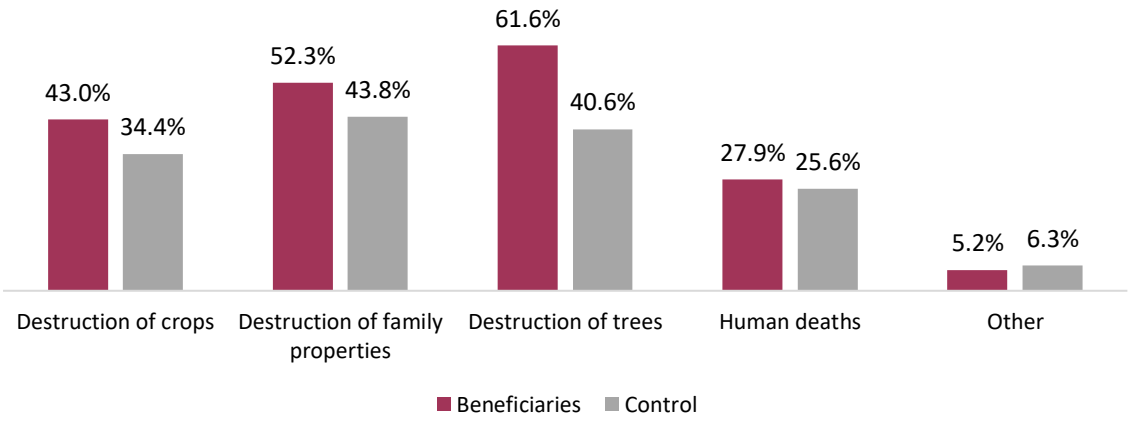
Figure 61. Impacts of observed strong winds in the past 12 months



Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=440, Beneficiaries=254, Control=186)

Figure 61 shows that the majority of respondents (81.1 per cent and 79.0 per cent of beneficiary and control group respondents) confirmed that strong winds caused destruction to family properties, and 77.2 per cent and 72.6 per cent of beneficiary and control group respondents respectively said their crops were destroyed resulting from the same cause. There were around 11 per cent of respondents who reported human deaths due to strong winds, while 2.8 per cent and 1.1 per cent of beneficiary and control group respondents respectively declared to have experienced other negative effects.[14] It was reported by participants in the FGDs that strong winds destroyed banana plantations along with other types of trees, as was also confirmed by 64.6 per cent and 50 per cent of beneficiary and control group households respectively.

Figure 62. Impacts of observed severe thunderstorms with lightning in the past 12 months



Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=332, Beneficiaries=172, Control=160)

[14] It is important to clarify the precise meaning of the per cent of respondents who reported human deaths. These are respondents who had seen or heard of individuals who had passed away due to strong winds – not necessarily individuals from within the household that the respondent is part of.

Figure 62 shows that severe thunderstorms with lightning destroyed crops and trees as reported by 61.6 per cent and 40.6 per cent of beneficiary and control group respondents respectively. 43 per cent and 34.4 per cent of beneficiary and control group respondents respectively confirmed that severe thunderstorms with lightning led to the destruction of crops and family properties in the area. Additionally, 27.9 per cent and 25.6 per cent of beneficiary and control group respondents respectively reported human deaths caused by the aforementioned weather events.[15] Additionally, 5.2 per cent and 6.3 per cent of beneficiary and control group respondents confirmed to have witnessed animal deaths (reported as other) due to severe thunderstorms with lightning.

In reference to the above-mentioned impacts of climate change on people's livelihoods, appropriate adaptation measures to cope with ongoing climate variability are necessary to help decision makers in general, and local communities in particular, to move from a state of unpreparedness to actionable knowledge and prevention mechanisms; not only in the Muvumba watershed, but also across the Gicumbi district and eventually, all across Rwanda.

Adaptation measures to climate change

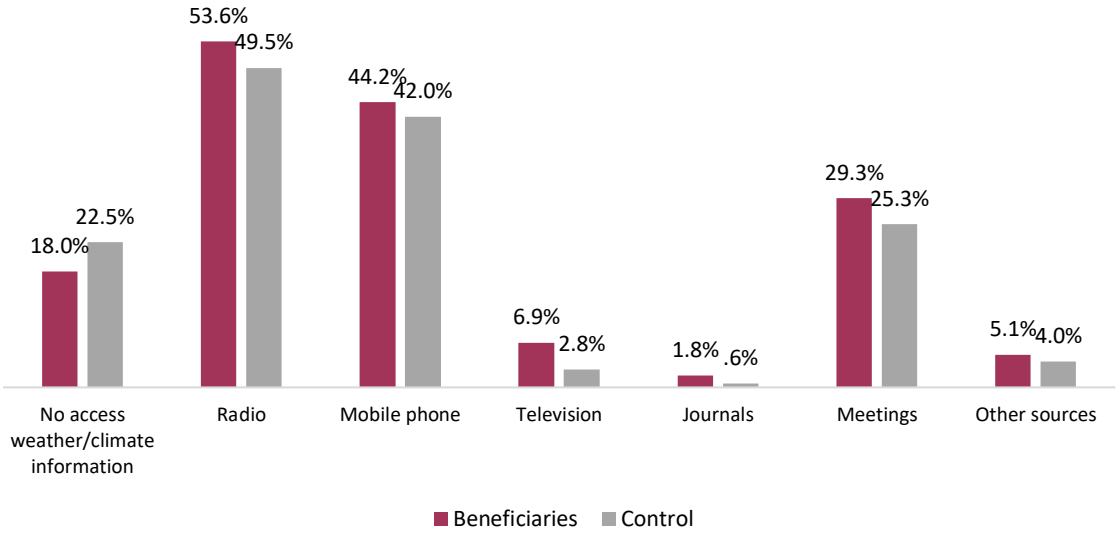
Climate change and the more frequent occurrences of extreme climatic events are a reality, and the situation is very likely to worsen in the future. Within the context of the increase in the rural population and reduction in average landholdings, it is clear that the pressure on the subsistence agricultural sector and livelihoods of small farmers is very acute. Developing and enhancing a climate change adaptation and mitigation plan for the study area (and throughout Rwanda) should be continuously encouraged.

It is in this regard that the assessment of the adaptation capacity of households in the Muvumba watershed and control group areas was undertaken in order to evaluate the local capacity to deal with the effects of climate change in the area, and recommend the appropriate measures to be undertaken based on the reality of the area.

It is becoming possible for farmers to obtain timely and accurate weather/climate information for crops monitoring, early warning and disaster management and the selection of appropriate crops to grow in specific agroclimatic zones and seasons. This study explored the accessibility of obtaining weather/climate information in the area under investigation as summarized in the figure below.

[15] It is important to clarify the precise meaning of the per cent of respondents who reported human deaths. These are respondents who had seen or heard of individuals who had passed away due to thunderstorms – not necessarily individuals from within the household that the respondent is part of.

Figure 63. Access to weather/climate information in the past 12 months



Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=1299, Beneficiaries=651, Control=648)

Figure 63 shows that 53.6 per cent and 49.5 per cent of beneficiary and control group respondents respectively received weather/climate information through the radio, and 44.2 per cent and 42 per cent of respondents through mobile phones. 29.3 per cent and 25.3 per cent of the beneficiary and control group households respectively were informed of weather/climate information through meetings, with a small proportion of households (less than 2 per cent) obtained information from journals. Additionally, 5.1 per cent and 4 per cent of beneficiary and control group respondents respectively confirmed to have received weather information from Field Farmers Schools as reported in other sources. Nonetheless, a good number of households (around 20 per cent) declared not to have access to weather/climate information. It is very encouraging to hear that the majority of both beneficiary and control group respondents confirmed to have access to weather/climate information. The percentages of households that received technical advice/training related to the use of weather information in their daily activities are shown below.

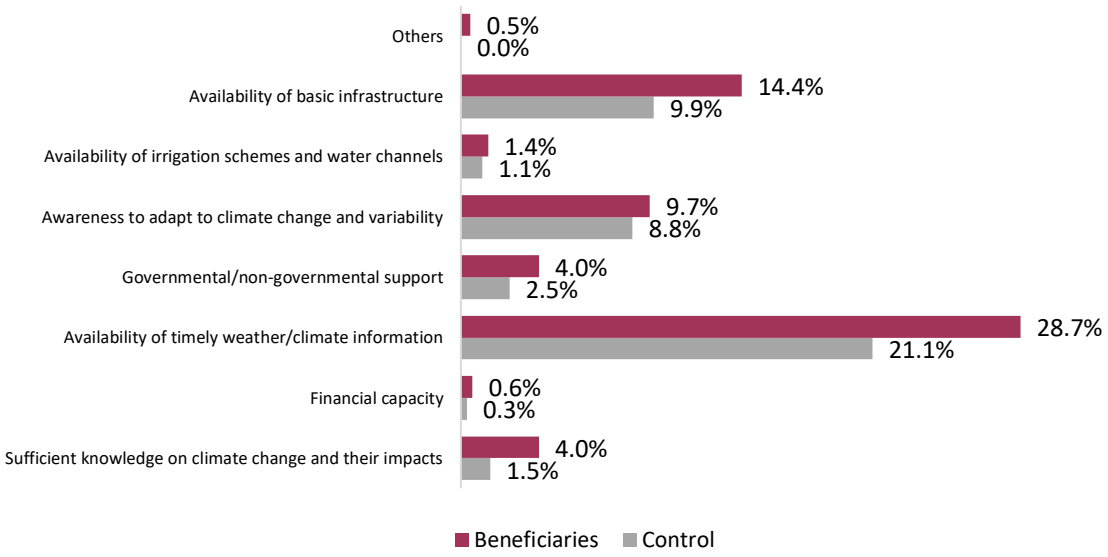
Figure 64. Received technical advice/training related to the use of weather information during the last 12 months

Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=1299, Beneficiaries=651, Control=648)

Figure 64 above depicts that only 14.3 per cent and 13.1 per cent of beneficiary and control group households respectively received technical advice related to the use of weather information. This shows that there is still room to provide greater support to farmers in integrating weather

information in their daily activities and in taking stock of the effects of climate change and weather variability. The following figure shows the rates of household capacities to deal with the impacts of climate change and variability.

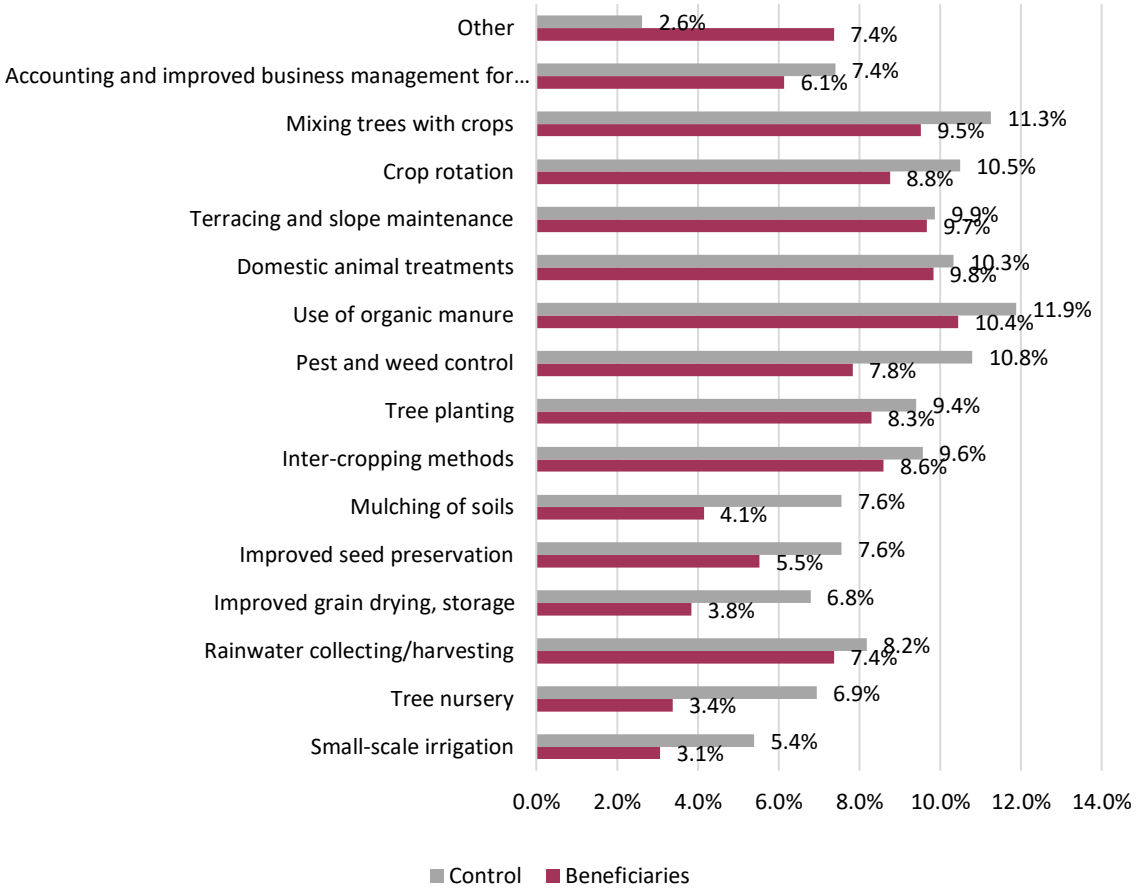
Figure 65. Capacity to deal with the impacts of climate change and variability



Source Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=1299, Beneficiaries=651, Control=648)

Figure 65 shows that household capacities to deal with the impacts of climate change and variability were still low for both beneficiary and control group areas. Access to timely weather/climate information was reported as an aspect of this capacity by only 28.7 per cent and 21.1 per cent of beneficiary and control group households respectively. Only 8 per cent to 15 per cent of respondents in both areas confirmed the availability of basic infrastructure and the awareness to adapt to climate change and variability, with a negligible percentage (less than 5 per cent) confirming the necessary financial support and to have received governmental and non-governmental support for the above-mentioned purpose. Irrigation schemes were almost non-existent. It is worth noting that the project intervention area appears better equipped in all aspects than the control group in terms of the capacity to deal with the adverse impacts of climate change and variability. More interventions from various stakeholders are needed to help local communities around the Muvumba watershed and control group areas deal with ongoing changes in climate. Specialized training and promoting access to the required finance and technologies, equipment, knowledge and technical support will be crucial to implementing long-term, innovative and far-reaching climate change mitigation and adaptation practices. The following figure shows the training that households received in the year preceding the survey. The following topics are the main areas in which members of households were trained.

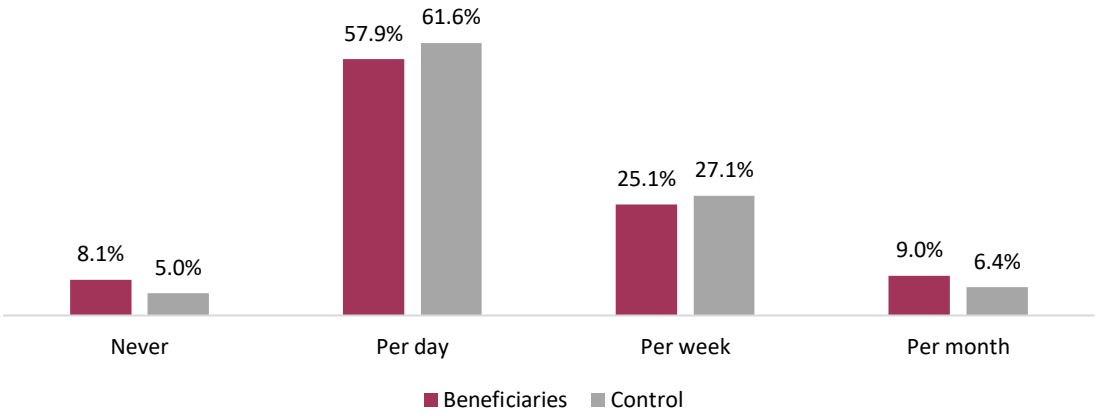
Figure 66. Received training related to adaptation measures to climate change in the past 12 months



Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=1299, Beneficiaries=651, Control=648)

Figure 66 shows that group households received more training compared to beneficiary households. Nevertheless, less than 10 per cent of respondents confirmed to have at least one family member who had been trained in the following: small scale irrigation, tree nursery, rainwater harvesting technologies, improved grain drying and storage, improved seed preservation, mulching of soils, inter-cropping methods, tree planting, pest and weed control, use of organic manure, domestic animal treatments, terracing and slope maintenance, crop rotation, mixing trees with crops and accounting and improved business management. The figure below shows the frequency of weather/climate information received.

Figure 67. Frequency of weather/climate information received in the past 12 months



Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=1036, Beneficiaries=534, Control=502)

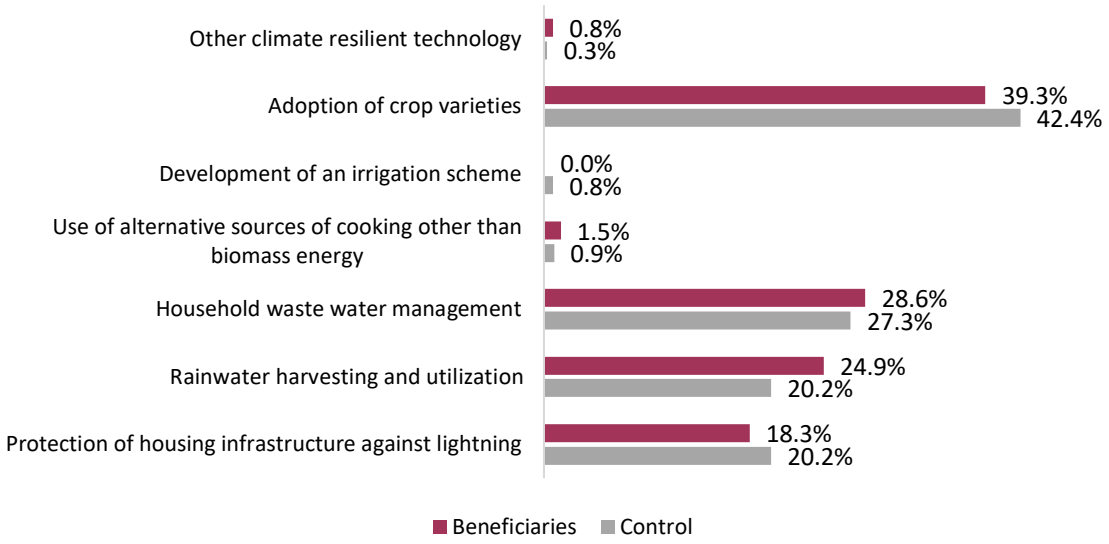
Figure 67 show that among those with access to weather/climate information, the information was received daily by 57.9 per cent and 61.6 per cent of the beneficiary and control group households respectively, while around 25.1 per cent of beneficiary households and 27.1 per cent of control group households received it weekly. Exactly 9 per cent and 6.4 per cent of the beneficiary and control group households respectively confirmed they received it monthly. Participants also shared their views on their awareness of the adverse effects of climate change as summarized in the figure below.

Figure 68. Awareness of the adverse effects of climate change

Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=1299, Beneficiaries=651, Control=648)

Figure 68 shows that 78.8 per cent and 76.9 per cent of beneficiary and control group households respectively confirmed to be aware of the adverse effects of climate change.

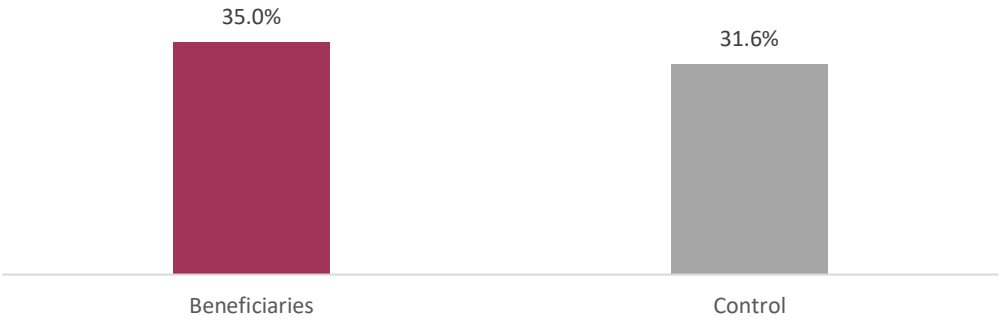
Figure 69. Adopted climate resilient technologies in the past 12 months



Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=1299, Beneficiaries=651, Control=648)

Figure 69 shows that 42.4 per cent and 39.3 per cent of control group and beneficiary households respectively were able to adopt the use of crop varieties, while around 20 per cent declared to have developed technologies for rainwater harvesting, wastewater management at the household level and protecting their housing infrastructure against lightning.

Figure 70. Possession of forests



Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=1299, Beneficiaries=651, Control=648)

Though severe deforestation of the watershed was seen during the field data collection, Figure 70 shows that 35 per cent and 31.6 per cent of beneficiary and control group households respectively confirmed that they possessed forests. Moreover, it was reported in the Muvumba Catchment Plan 2018-2024 that the total forested area covers 23 per cent of the catchment area, which is below the national average of 30.4 per cent (MoE, 2019). Approximately one third is considered to be degraded, i.e. shows signs of tree falling or other forms of degradation. Efforts are required to increase both the area of land covered by forest and to improve the management of existing (and new) forest areas. In this regard, the Director of Agriculture confirmed that 13,507.71 ha were occupied by agroforestry across the Gicumbi district, 317.57 ha of degraded forests had been

rehabilitated and 227,004 trees were planted during the last agricultural year (Gicumbi district, 2020). However, there are still hilly areas with steep slopes that are not covered by vegetation.[16] Though Gicumbi seems to be a very forested district, there are very degraded forests amounting to 853 ha located in south Gicumbi.[17]

It is worth noting that the local communities realized the importance of a number of activities regarding adaptation to climate change such as planting trees on rugged mountains as well as constructing radical terraces and water canals in marshland.

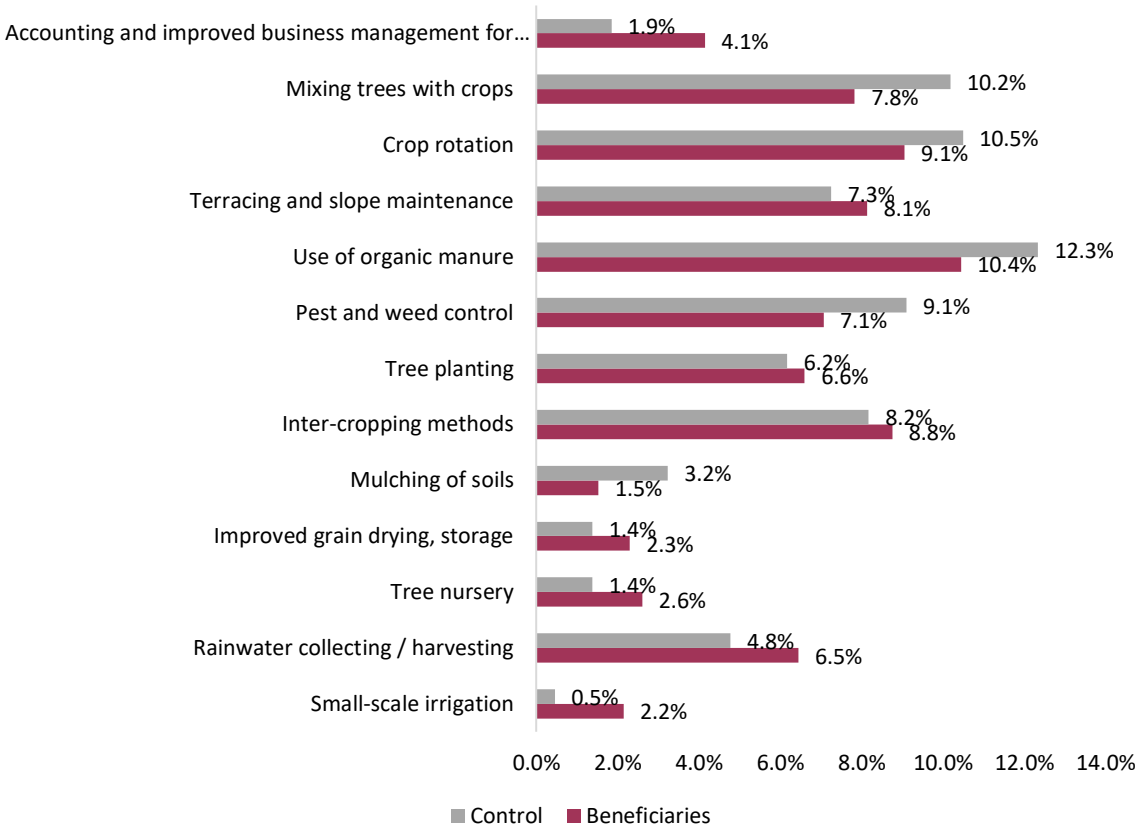
Figure 71. Radical terraces in farmland in the past 12 months

Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=1299, Beneficiaries=651, Control=648)

Figure 71 shows that one of the key activities to be supported by the Rwanda Project on Strengthening climate resilience of rural communities in Northern Rwanda is the construction of radical terraces. Figure 71 shows that only 28 per cent and 20.7 per cent of the beneficiary and control group households respectively report having radical terraces on their farmland. Moreover, households reported using different adaptation options on different plots as depicted in the figure below.

[16] The forest cover mapping report of November 2019 revealed that the forests in the Gicumbi District cover 23,024 hectares, about 28 per cent of the total district land area, and almost 100 per cent are forest plantations. The highest forested sectors are Ruvune with 2,213 ha (37 per cent), Coko with 2,018 ha (43 per cent), Rushaki with 1,900 ha (41 per cent), Rukomo with 1,721ha (34 per cent), Mutete with 1,696 ha (30 per cent) and Nyamiyaga 1,224 ha (32 per cent of the sector land area). The least forested sectors are Bukure with 667 ha, about 17 per cent of the total sector land, Cyumba with 381ha (17 per cent), Giti with 648 ha (18 per cent) and Nyankenke with 566 ha, about 18 per cent of the sector land.
[17] The District Forest Management Plan (DFMP) should identify South Gicumbi as areas to restore the productivity of forest land, and at the same time, afforestation should take place in the Bukure, Cyumba, Gitiand and Nyankenke sectors to upgrade its forest cover where the District Land Use Master plan has indicated suitable land for forests (Ministry of Environment, 2019).

Figure 72. Adaptation options which have been used on any of the plots



Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=1299, Beneficiaries=651, Control=648)

Figure 72 shows that a small minority of beneficiary and control group households have implemented adaptation options on this farmland. Options with a low adoption rate include: tree planting, inter-cropping methods, mulching of soils, improved grain drying, storage, tree nursery, rainwater collecting/harvesting and small scale irrigation where more beneficiaries (1.4 per cent-8.8 per cent) have adopted this practice than in the control group (0.5 per cent-6.2 per cent).

On the other hand, there are adaptation methods in which both beneficiaries and control groups indicate higher participation, with a larger percentage within the control group. These adaptation options include: agroforestry, mixing trees with crops, crop rotation, terracing and slope maintenance, use of organic manure and pest and weed control.[18]

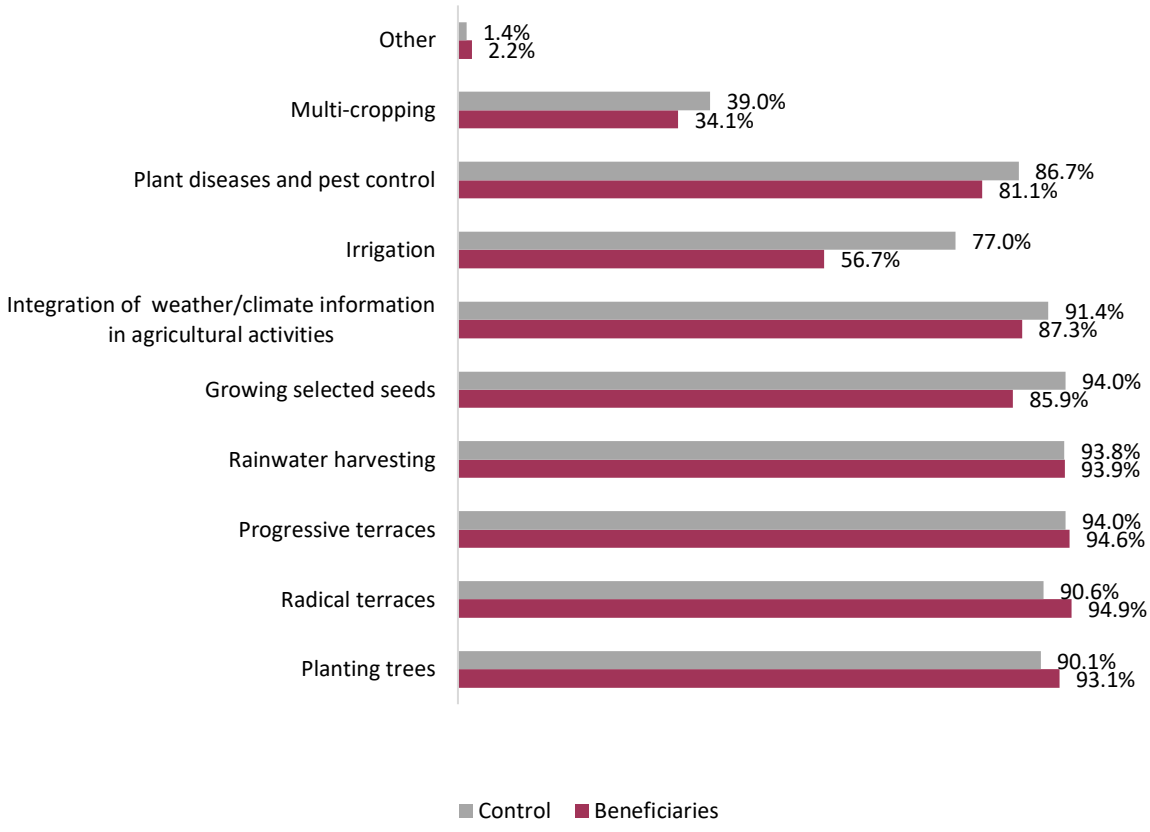
[18] Despite the low percentage of households having an irrigation scheme in their areas, the Director of Agriculture in the Gicumbi district informed that 42 ha of land were under small scale irrigation during the last agricultural year (Gicumbi district, 2020).

Figure 73. Households that received agricultural inputs in the last 12 months

Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=1299, Beneficiaries=651, Control=648)

Figure 73 shows that agricultural inputs were received by 8.6 per cent of the households in the project intervention area against 9.7 per cent in the control group area.

Figure 74. Awareness of the appropriate adaptation measures to be undertaken to deal with the effects of climate change



Source: Strengthening climate resilience of rural communities in Northern Rwanda baseline survey, 2020 (n=1299, Beneficiaries=651, Control=648)

It was encouraging to hear that the majority of respondents (more than 80 per cent) were aware of the appropriate adaptation measures to be undertaken to deal with the effects of climate change, with the exception of multi-cropping. The awareness of beneficiaries is higher than control group

households on planting trees, radical terracing, progressive terracing and rainwater harvesting; whereas it is the opposite on growing selected seeds, integration of weather/climate information, irrigation, pest and disease control and multi-cropping.

F. CONCLUSIONS

The baseline study provides the project team with detailed baseline data on key project indicators. The target population for the survey includes all households living in private dwellings during the interviewing period in 18 sectors of the Gicumbi district, nine of which are in the intervention area of the Muvumba B catchment, and the other nine serving as a control group outside the intervention area of the Gicumbi district and located in the Muvumba watershed.

This baseline study has shown that the area under study (Gicumbi district) has experienced extreme weather events (e.g., droughts, strong winds, thunderstorms with lightning and floods), an increase in temperature and fluctuations of seasonal rainfall duration and intensity. Interviewed households have reported impacts on cropping patterns, the timing of growing crops and agronomic practices with impacts on food production, food and water safety and availability, livelihood assets, human health and property.

Around 50 per cent of respondents said that heavy rainfall caused the destruction of family properties, while 37.2 per cent and 29 per cent of beneficiary and control group respondents confirmed that heavy rain caused flooding. Slightly less than 9 per cent of respondents reported human deaths caused by such rains, with around 2.2 per cent reporting heavy rains to have caused other consequences (standing for the death of animals). The study shows that around 63.9 per cent of beneficiary households and 63.3 per cent of the control group are aware that the Muvumba watershed and control group areas experienced an increase in temperature and 90.6 per cent and 90.7 per cent of beneficiary and control group respondents respectively reported an increasing trend in the amount of rainfall. Households are not very active in adopting climate resilient technologies, as only less than 2 per cent are able to use an alternative source of energy other than biomass and less than one per cent can afford to use an irrigation system on their farmland. Exactly 42.4 per cent and 39.3 per cent of the control group and beneficiary households respectively have been able to adopt new crop varieties, while around 20 per cent have developed technologies for rainwater harvesting, wastewater management at the household level and protecting their housing infrastructure against lightning. The flooding episodes have also caused the deterioration of local and national roads which harms the safe transport of goods and people in the Muvumba watershed. In addition to the floods, strong winds have also been very harmful to the project intervention and control group households.

The survey results show that 87.3 per cent and 88.1 per cent of the beneficiary and control group households respectively own land. The study shows that among the 1139 households owning land, 97.4 per cent and 97.2 per cent of the beneficiaries and control group respectively use parcels of land for farming. The majority of lands (86.3 per cent and 89.4 per cent in the beneficiary and control group areas respectively) are located on hillsides, compared to only 5.4 per cent and 4.2 per cent in the same areas that are in marshlands and 7.6 per cent and 6.1 per cent on steep slopes.

The large majority of parcels (98.4 per cent and 98.3 per cent) owned by the beneficiary and control groups respectively was cultivated during the last agricultural year. This implies that their lands are continuously being cultivated without putting them to fallow to regenerate their fertility. It was also revealed that organic manure was applied by beneficiary and control group households on 84.5 per cent and 86.9 per cent of their parcels respectively, against 23.8 per cent and 28 per cent on which chemical fertilizers were applied.

Regarding energy used for cooking, the survey revealed that the vast majority, 88 per cent and 85.3 per cent of beneficiary and control group respondents respectively, reported that they use firewood, with only 17.5 per cent of beneficiary households and 20.8 per cent of the control group reporting using straw, and 3.7 per cent of beneficiary households and 3.5 per cent of the control group using charcoal. Exactly 1.1 per cent and 0.2 per cent of beneficiary and control group respondents respectively confirmed to use electrical power or gas for cooking. None of the beneficiary respondents declared using biogas for cooking, and only 0.3 per cent of control group households do use this source of energy. This indicates a possibility of a high rate of deforestation, depending on the extent of current reforestation efforts. Overall, the survey results highlight that, on average, beneficiary households are poor and vulnerable and will benefit considerably from the Green Gicumbi Project.

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APPENDICES

Appendix 1. INDICATOR RESULTS

OUTCOME GROUP	INDICATORS AND VARIABLE OF INTEREST	BASELINE DATA
1. Watershed protection and climate resilient agriculture	Area under erosion control	8,653.5 ha (EICV5/2016-2017)
	Area under (i) protective forest cover	18,501.6 ha (forestry)
	Number of Napier grass seedlings planted (Mulindi)	13,507.7 ha (agroforestry)
	Area of higher elevations planted with tea/ coffee	Coffee: 602.2 ha Tea: 1,817.2 ha
	Reared animals (2019-2020)	86,010 cows by 60,180 households 72,856 goats 52,311 sheep
	Land ownership (July 2020)	87.3%
	Land located hillside (July 2020)	86.3%
	Land located in marshland (July 2020)	7.6%
	Land use consolidation (2019-2020)	maize (6,777 ha), wheat (5,359 ha), Irish potatoes (12,018 ha), cassava (231.5 ha), beans (31,896 ha)
	Rehabilitated banana plantations (2019-2020)	1,312 ha
	Yields of major crops in season A (2019-2020)	bananas (14,442 kg/ha), cassava (13,433 kg/ha), Irish potatoes (9,618 kg/ha), sweet potatoes (8,911kg), beans (999 kg/ha), maize (2,146 kg/ha)
	Yields of major crops in season B (2019-2020)	cassava (19,530 kg/ha), bananas (12,062 kg/ha), Irish potatoes (8,479 kg/ha), sweet potatoes (7,246 kg/ha), maize (1,290 kg/ha), beans (928 kg/ ha)
	Area of forest renewed with high quality plants and best practices establishment	317.57 ha rehabilitated forests (Gicumbi district)

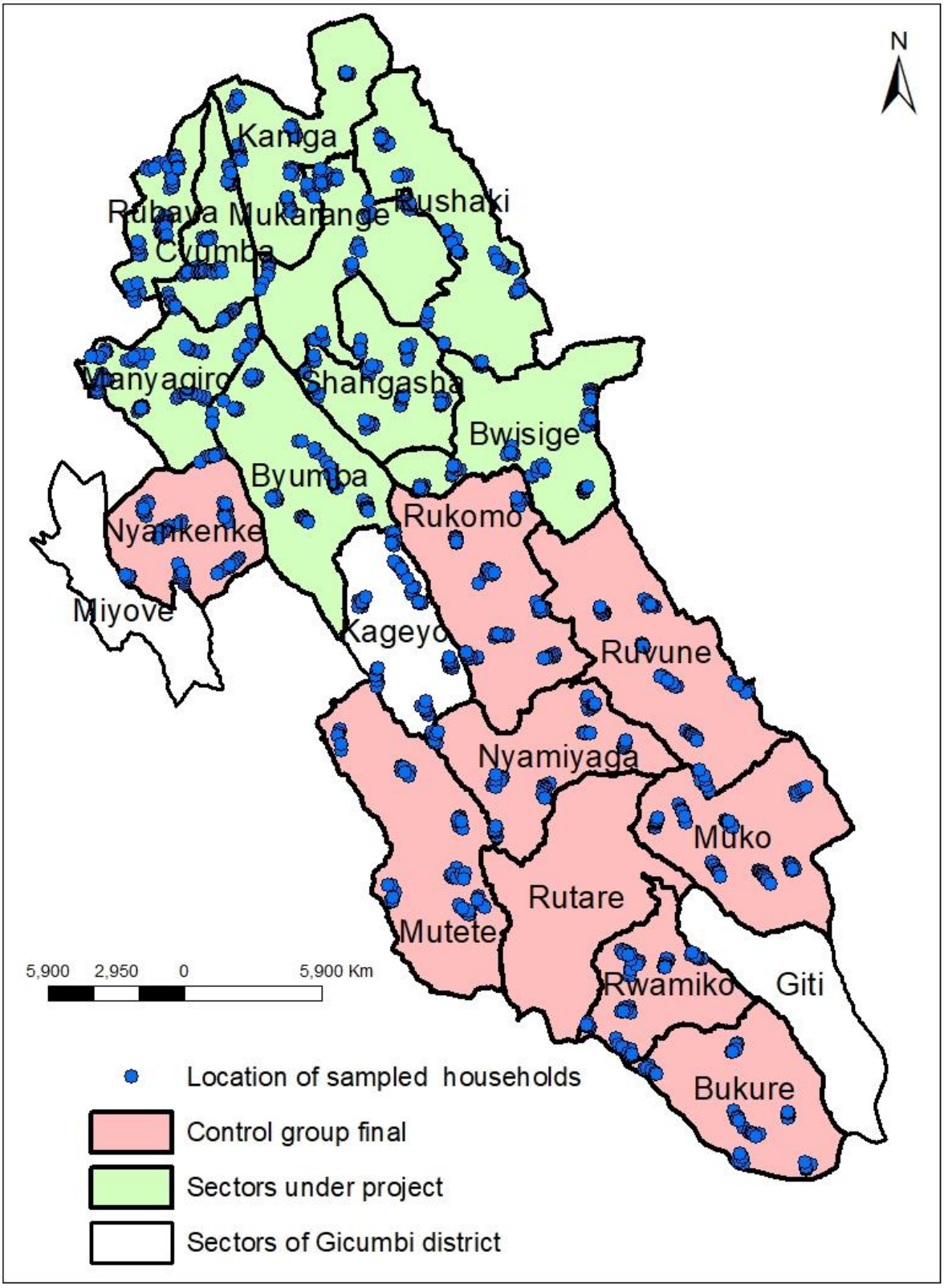
Outcome Group	Indicators and Variable of interest	Baseline data
2. Communities supported to implement sustainable forest management and adopt fuel efficient cooking methods	Area (ha) of seed stands established and managed	maize: 5798.5 ha, wheat: 5134 ha, Irish potatoes: 1379.1 ha, beans: 36168 ha, cassava: 1011.9 ha
	No. of high quality seedlings raised in time for the start of planting season	maize: 113,631kg, wheat: 59,533kg
	Using firewood for cooking food	88%
	Community members trained in tree nursery management	3.4%
	Community members trained in agroforestry planting	9.5%
	Beekeeping cooperatives or associations operational	0
	No. of households or institutions installing and operating efficient energy technologies for cooking (stoves tier 1 and 2; domestic biogas units; institutional biogas units, gasifier stoves tier ¾; large stoves for institutions)	Biogas 611
3. Human settlements developed and/or modified to increase climate resilience	House ownership	96.5%
	Households living in developed settlements	84.4%
	Rainwater harvesting tanks, cisterns and ponds installed	10.3%
	Settlements in flat areas that did not experience any damage	47.5%
	No. of low carbon social housing units developed and occupied by climate vulnerable families (disaggregated by women headed households)	43 households in Kabeza village (Rubaya sector) 33 households in Ruzizi village (Giti sector)
	Constructed latrine by government support	2,532 in 2019
	Rehabilitated toiles by government support	16,910 in 2019
	No. of stormwater management structures installed (gully plugs/check dams, infiltration ditches, channels planted with trees/shrubs/bamboo)	0
	Construction of terraces	8.653.5 ha

Outcome Group	Indicators and Variable of interest	Baseline data
4. Successful adaptation and mitigation approaches communicated and mainstreamed at the national level	Website developed, maintained and promoted to users	*www.gicumbi.gov.rw*
	Access to weather/climate information	82%
	Members of forest management cooperatives	1%
	People trained in climate resilient forestry, watershed management and green settlements	11.3%
	People (women, men) trained in rainwater harvesting technologies	7.4%

Appendix 2. DISTRIBUTION OF HOUSEHOLDS VISITED BY EACH ENUMERATOR

LIST OF ENUMERATORS	INTERVIEWS UNDERTAKEN	%
Enumerator 1	99	7.6
Enumerator 2	110	8.5
Enumerator 3	113	8.7
Enumerator 4	110	8.5
Enumerator 5	109	8.4
Enumerator 6	109	8.4
Enumerator 7	110	8.5
Enumerator 8	108	8.3
Enumerator 9	116	8.9
Enumerator 10	111	8.5
Enumerator 11	99	7.6
Enumerator 12	105	8.1
Total	*1,299*	*100.0*

Appendix 3. LOCATION OF SAMPLED VILLAGES



Appendix 4. SAMPLED VILLAGES

Table 22. Distribution of targeted sampled villages

PROVINCE	DISTRICT	SECTORS	CELLS	VILLAGES	SAMPLED HOUSEHOLDS
Northern Province	Gicumbi intervention area	Kaniga	Bugomba	Gatare	10
			Bugomba	Ryakabanda	10
			Gatoma	Nyakibande	10
			Mulindi	Gisunzu	10
			Mulindi	Taba	10
			Nyarwambu	Nyamabare	10
			Rukurura	Kabare	10
		Rubaya	Gihanga	Gomba	10
			Gihanga	Kirimbi	10
			Gishambashayo	Gashiru	10
			Gishari	Kabaya	10
			Muguramo	Mabare	10
			Muguramo	Ngange	10
			Nyamiyaga	Kabeza	10
		Cyumba	Gasunzu	Mugera	10
			Muhambo	Nyamabare	10
			Nyakabungo	Remera	10
			Nyambare	Burambira	10
			Nyambare	Gipandi	10
			Nyaruka	Murore	10
			Rwankonjo	Kagera	10
		Rushaki	Gitega	Karambi	10
			Gitega	Rubyiro	10
			Gitega	Ryaruganzu	10
			Kamutora	Kamutora	10
			Kamutora	Mabare	10
			Karurama	C. Rushaki	10
			Karurama	Nyaruhanga	10
		Shangasha	Bushara	Gasura	10
			Kitazigurwa	Iharama	10
			Nyabishambi	Gasiza	10

Province	District	Sectors	Cells	Villages	Sampled households
			Nyabishambi	Kagali	10
			Nyabubare	Karuhanga	10
			Shangasha	Kajyanjyali	10
			Shangasha	Runaba	10
		Mukarange	Cyamuganga	Ndarama	10
			Gatenga	Nyacyoroma	10
			Kiruhura	Burembo	10
			Kiruhura	Nyamutoko	10
			Mutarama	Kaziba	10
			Rugerero	Munyege	10
			Rusambya	Rusambya	10
		Manyagiro	Kabuga	Gabiro	10
			Nyiragifumba	Rwamazi	10
			Nyiravugiza	Rusebeya	10
			Remera	Sangano	10
			Rusekera	Kavure	10
			Rusekera	Rebero	10
			Ryaruyumba	Gatsyata	10
		Byumba	Gacurabwenge	Gacurabwenge	10
			Gisuna	Rebero	10
			Kivugiza	Mugandu	10
			Murama	Gacaca	10
			Nyakabungo	Gacyamo	10
			Nyamabuye	Gatete	10
			Nyarutarama	Mukeri	10
		Bwisige	Bwisige	Kavuruga	10
			Bwisige	Ndoha	10
			Gihuke	Nyakagera	10
			Gihuke	Nyamugari	10
			Mukono	Rwebisheke	10
			Mukono	Rwondo	10
			Nyabushingitwa	Warufu	10
Total beneficiaries					*630*
		Bukure	Rwesero	Gicaca	10

Province	District	Sectors	Cells	Villages	Sampled households
Northern Province	Gicumbi (Control group)		Rwesero	Mugorore	10
			Kivumu	Karambo	10
			Kivumu	Butare	10
			Karenge	Kabuga	10
			Kigabiro	Kanyogote	10
			Kigabiro	Gabiro	10
		Kageyo	Gihembe	Munini	10
			Gihembe	Nyaruvumu	10
			Horezo	Kigoma	10
			Kabuga	Maya	10
			Muhondo	Mwange	10
			Nyamiyaga	Kageyo	10
			Nyamiyaga	Rukomo	10
		Muko	Cyamuhinda	Ntonyanga	10
			Kigoma	Cyerere	10
			Kigoma	Karambi	10
			Mwendo	Gikumba	10
			Nyange	Gasharu	10
			Rebero	Gasizi	10
			Rebero	Mayogi	10
		Mutete	Gaseke	Runyinya	10
			Gaseke	Gasharu	10
			Kabeza	Busabira	10
			Musenyi	Gataba	10
			Musenyi	Rurama	10
			Mutandi	Karama	10
			Nyarubuye	Kavumu	
		Nyankenke	Butare	Gikombe	10
			Kigogo	Gakoma	10
			Kinishya	Gashiru	10
			Rusasa	Birumba	10
			Rutete	Kabingo	10
			Rwagihura	Mwendo	10
			Yaramba	Nturo	10

Province	District	Sectors	Cells	Villages	Sampled households
		Nyamiyaga	Gahumuriza	Maya	10
			Jamba	Byimana	10
			Kabeza	Karambo	10
			Kabuga	Mubuga	10
			Mataba	Mataba	10
			Karambo	Gaseke	10
			Kiziba	Karambi	10
		Rukomo	Cyeya	Birambo	10
			Cyuru	Kabuga	10
			Cyuru	Sabiro	10
			Gisiza	Gatare	10
			Gisiza	Rusumo	10
			Kinyami	Gahondo	10
			Mabare	Mburamazi	10
			Munyinya	Mataba	10
		Ruvune	Cyandaro	Karambo	10
			Gasambya	Kirara	10
			Gashirira	Nyarurama	10
			Kabare	Murehe	10
			Rebero	Taba	10
			Rebero	Gatare	10
			Ruhondo	Kirwa	10
		Rwamiko	Cyeru	Bugararura	10
			Cyeru	Gabiro	10
			Kigabiro	Cyiri	10
			Kigabiro	Kanyove	10
			Nyagahinga	Kigaga	10
			Nyagahinga	Kabusunzu	10
			Nyagahinga	Ntaremba	10
Total control group					*630*
General total					***1,260***

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