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LEARNING-ORIENTED REAL-TIME IMPACT ASSESSMENT (LORTA)

Impact evaluation baseline report for FP072: Strengthening climate resilience of agricultural livelihoods in agro-ecological regions I and II in Zambia

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GREEN CLIMATE FUND
INDEPENDENT EVALUATION UNIT

Learning-Oriented Real-Time Impact Assessment (LORTA)

IMPACT EVALUATION BASELINE REPORT FOR FP072: STRENGTHENING CLIMATE RESILIENCE OF AGRICULTURAL LIVELIHOODS IN AGRO-ECOLOGICAL REGIONS I AND II IN ZAMBIA

11/2022

PREFACE

This report presents the baseline data for “Strengthening climate resilience of agricultural livelihoods in agro-ecological regions I and II in Zambia” (SCRALA), a project funded by the Green Climate Fund and implemented by the United Nations Development Programme in Zambia. The report includes descriptive statistics collected for the baseline phase of the SCRALA impact evaluation.

The baseline data are instrumental in assessing the average value of demographic and other variables of interest, determining baseline similarities and significant differences between the treatment and comparison groups and verifying key assumptions regarding the impact evaluation.

This baseline report is intended for the SCRALA project impact evaluation team and involved stakeholders as a basis for the impact evaluation.

ACKNOWLEDGEMENTS

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INTRODUCTION ABOUT LORTA

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. The programme aims to strengthen the capacity of accredited entities, implementing partners and project staff in conducting impact evaluations of GCF supported climate change adaptation and mitigation projects.

LORTA is based on three pillars:

Learning-oriented: The programme provides lessons for GCF, stakeholders and the international community about what works and how in climate change adaptation and mitigation. Through the technical assistance they receive in impact evaluation, GCF-funded project teams build the knowledge and skills essential for rigorous impact assessment, such as developing and using theories of change, outcome indicators and data collection tools. This capacity-building also helps the accredited entities to apply a more efficient monitoring system and improve their understanding of the project.

Real-time: LORTA seeks to learn the real-time impact of projects by integrating implementation tracking with impact assessment. LORTA's capacity-building is expanded to implementation tracking or monitoring, which help to inform a project's impact evaluation. Tracking outcome indicators that reflect a project's objectives may provide real-time learnings for the teams, the GCF and the broader community about the progress and impact trajectory of the project's outcomes.

Impact assessment (or impact evaluation): Impact assessment/evaluation captures the extent to which changes in outcome indicators can be attributed to a particular intervention. This focus on attribution is a hallmark of impact evaluation. Impact evaluation empirically measures the effects caused by intervention and the statistical significance of those effects.

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ABBREVIATIONS

C4ED	Center for Evaluation and Policy Development
COVID-19	Corona virus disease of 2019
CSI	The coping strategies index
DiD	Difference-in-differences
DP	Data processing
FAO	Food and Agriculture Organization of the United Nations
FCS	Food consumption score
FISP	Farmer input support programme
FRA	Food reserve agency
GCF	Green Climate Fund
GPS	Global positioning system
HDDS	Household dietary diversity score
HH	Household
ICC	Inter-cluster correlation
IE	Impact evaluation
IEU	Independent Evaluation Unit
LCSI	Livelihoods and asset-based coping strategy index
LORTA	Learning-Oriented Real-Time Impact Assessment
MDES	Minimum detectable effect size
RCT	Randomized control trial
SCRALA	Strengthening climate resilience of agricultural livelihoods in agro-ecological regions I and II in Zambia
ToC	Theory of change
UNDP	United Nations Development Programme
ZMW	Zambian Kwacha

EXECUTIVE SUMMARY

Zambia is one of the lowest ranked countries for inequality and poverty. The agricultural sector is mainly characterized by low productivity subsistence agriculture, with limited access to productive assets and market opportunities. Zambian agriculture is also characterized by limited crop diversity, with maize being the predominant crop. Food security is primarily affected by the lack of access to inputs, markets, post-harvest management information and climate variability.

The "Strengthening climate resilience of agricultural livelihoods in agro-ecological regions I and II" project (SCRALA) is financed by the GCF, the Government of Zambia, and the United Nations Development Programme, and implemented by the Zambian Ministry of Agriculture. SCRALA strengthens the capacity of smallholder farmers to plan for climate risks, improving food security and income generation by promoting climate-resilient farming and diversification practices, enhancing access to markets and fostering the commercialization of climate-resilient agricultural commodities. It aims to achieve increased resilience by taking a value chain approach, addressing barriers to climate-resilient agriculture across key stages of the value chain – planning, inputs, production, and post-production – through various activities such as input support, training, and infrastructure development. To achieve this, the project is implementing interventions that strengthen and promote viable climate-resilient value chains relating to smallholder agriculture, specifically targeting gender-sensitive value chains that provide viable economic opportunities for women.

As part of SCRALA, an evaluation strategy was implemented to measure the impact of the distribution of beehives and goats among the proposed interventions. This report presents the results of the household baseline survey that was conducted among eligible households from all the 15 districts in agro-ecological zones I and II. Due to sampling frame related challenges, the final survey population list was produced by combining separate lists of beneficiaries and pass-on households receiving inputs in the near future. In addition, the comparison group included a stratified random sample of households from the farmer listing who were neither goat nor beehive beneficiaries and are not expected to be beneficiaries in the future. The final sample comprised 1,251 treatment households and 1,231 control households. However, due to challenges in the field, the survey team interviewed 1,218 households in the treatment group and 1,290 in the control group.

Findings

The baseline survey highlighted a wide range of socioeconomic characteristics of beneficiaries and control households. We summarize these here before outlining some of the challenges for the evaluation design and endline survey.

The baseline data showed that 74 per cent of the sampled households were male-headed. The household heads in the treatment group had lower educational levels than those in the control group, and treatment households had a higher number of disabled people and orphans on average.

The food groups mostly consumed by households included cereals (90 per cent), orange-fleshed fruits (85 per cent), other vegetables (75 per cent), meat and eggs (66 per cent), oils/fats (66 per cent), and green leafy vegetables (62 per cent). Vitamin A-rich vegetables (12 per cent), roots and tubers (19 per cent), other fruits (17 per cent), and milk and dairy products (39 per cent) were the least consumed. A higher proportion of treated households consumed meat and dairy products compared to control households.

More than half of the treatment (60 per cent) and control households (70 per cent) reported "own production" as their primary food source in the last 12 months.

Climatic and economic shocks aggravate food insecurity and severely impact livelihoods, especially for poor households. The major climatic/environmental shock experienced by the majority of the households were crop diseases and pests (67 per cent), followed by drought (49 per cent). Sharp food price increases were the most severe economic shock (53 per cent) households experienced in the past 12 months, followed by high agricultural input prices (33 per cent). About 18 per cent of the households reported income loss due to the COVID-19 pandemic.

The dominant strategy for coping with shocks employed by about a third (33 per cent) of the treatment and control households was the use of savings to buy food. These coping strategies fall under the "stress" or "neutral" strategies with low severity weights. Leasing land to buy food (2 per cent) and selling productive assets to buy food (4 per cent) were the livelihood and asset coping strategies used least by sampled households.

Food production and sales were highlighted as the dominant cash source in the last 12 months by about 30 per cent of treatment and 22 per cent of the control households.

The dominant sources of household income for the treatment group during the last month before the survey were pension (Zambian Kwacha [ZMW] 1592), salary (ZMW 1150), loans (ZMW 918), income from own business (ZMW 916), and crop sales (ZMW 808).

Household expenditures in the last month before the survey on food items showed that the highest expenditures were allocated to maize meal (ZMW 183) and maize grain (ZMW 169). Household expenditures on non-food items showed that the highest expenditures were allocated to education (ZMW 31845), followed by agricultural inputs (ZMW 1397), construction (ZMW 1290), and business-running costs (ZMW 1175). Treatment households incurred significantly lower expenditure on agricultural inputs (ZMW 1040) compared to control households (ZMW 1733).

Regarding agricultural production technologies, over three-quarters of the entire sample was familiar with crop rotation (84 per cent) and organic fertilizers (79 per cent) in the past 12 months. More than half of all households were familiar with intercropping (73 per cent), adapted and drought-tolerant crops and varieties (70 per cent), composting (54 per cent), and minimum/zero tillage (54 per cent) and less than a fifth (24 per cent) of the households were familiar with animal fodder production. Regarding the seeds used in the farms, about 44 per cent of the plots in the entire sample used improved seeds, while 30 per cent relied on local seeds purchased from fellow farmers and local markets. About 27 per cent of the plots were planted with recycled seeds. About 39 per cent of the household's crop plots in the entire sample relied on retained seed (from their harvest) for their planting requirements. Farmer Input Support Programme (FISP) and shops/traders were the second and third most dominant sources used on 15 per cent and 11 per cent of the plots, respectively. Concerning the method of acquiring seeds, survey results show that cash purchases (60 per cent) dominated for the entire sample and across treatment and control households' plots.

On average, the mean total land size of a household was four and a half hectares, which includes about two owned agricultural fields. Almost all households (94 per cent) grew maize. Sorghum was the second dominant cereal crop, grown by about a third of the households. A higher proportion of treatment households grew sorghum than control households. Most of the cultivated plots (81 per cent) were owned by the households, and less than 2 per cent of the plots for treatment and control households were rented in, rented out, or borrowed in and out. Customary land without titles was the dominant tenure system for most household fields (91 per cent). About 7 per cent of the plots had customary land titles.

As regards the seeds used in the farms, about 44 per cent of the plots in the entire sample used improved seeds, while 30 per cent relied on local seeds purchased from fellow farmers and local markets. About 27 per cent of the plots were planted with recycled seeds. About 39 per cent of the household's crop plots in the entire sample relied on retained seed (from their harvest) for their planting requirements. FISP and shops/traders were the second and third most dominant sources used on 15 per cent and 11 per cent of the plots, respectively. On the method of acquiring seeds, survey results show that cash purchases (60 per cent) dominated for the entire sample and across treatment and control households' plots.

As to land tillage, conventional ploughing was the dominant tillage method used on slightly over half of the plots (54 per cent). A higher proportion of plots for treatment households (63 per cent) compared with control households' plots (46 per cent) were conventionally ploughed, while hand hoeing was the second most common tillage method used. Ripping and ridging before planting was used on about 8 per cent of the plots.

Manual household labour was the primary source of power used for tillage on 45 per cent of the plots. A higher proportion of plots (50 per cent) among control households relied on manual labour for tilling compared to 39 per cent of the plots among treatment households. Over 70 per cent of treatment and control households' fields were tilled after the onset of rain, and only 20 per cent were tilled during the dry season.

On access to climatic and agricultural information from all sources (multiple responses possible), about 45 per cent of households used early warnings regarding natural hazards (e.g., drought, heavy rains), while 42 per cent got information on crop pests and diseases, including the fall armyworm (which is discussed later). About 84 per cent of the sampled household accessed information on COVID-19 (including causes and prevention methods).

The productive assets owned by most households include hand hoe (98 per cent), axe (92 per cent), spade or shovel (54 per cent), and ox-drawn plough (44 per cent). More treatment households owned ox-drawn ploughs and shovels. The other productive assets owned by the majority of households include a mobile phone (82 per cent) and a bicycle (45 per cent), followed by a wheelbarrow (11 per cent) and a stone grinding mill (44 per cent).

The average number of cattle and draught cattle owned was nine and five, respectively, with no differences between the treatment statuses. Regarding livelihoods diversification, results show that about 9 per cent of treatment households depend on agriculture as their sole source of income. This is significantly lower compared to 12 per cent of the control households. This implies that about 91 per cent of treatment households have diversified livelihoods. About 54 per cent of the treatment household used climate information for farm decisions, which was significantly higher compared to 50 per cent among control households. Treatment households had higher knowledge levels about climate information and climate-resilient agriculture.

Regarding the interventions, 35 per cent of the sampled farmers reported participating in goat rearing, representing 58 per cent of the beneficiaries, while 15 per cent reported having received training in beekeeping. However, only around 4 per cent were keeping bees.

While the evaluation strategy used was deemed to be the most appropriate, as it targeted all farmers in the intervention districts and used the sampling framework drawn from the farmer listing, some constraints need to be addressed in future sampling and evaluation design. First, the farmer listing had not been completed by the time the sampling design was finalized. Second, some farmers listed as control were revealed as treatment farmers who had benefited from the project. Input distribution, especially seeds and other planting inputs, was being conducted in some areas during the time of the data collection. This also meant that farmers who had previously been listed as control became

beneficiaries after receiving the inputs. Third, the administration of the public lottery, which was held to select beneficiaries to receive inputs, did not keep a record of the non-selected participants. This indicates a loss of information on the control group, as there might be a selection bias in the pool of the lottery participants. Lastly, the planting period and rainy season adversely affected the logistical planning and the duration of fieldwork, as farmers were busy and some camps were inaccessible.

The aforementioned difficulties raise the need to further discuss and develop the evaluation design, which was initially planned for a randomized control trial (RCT). Difference-in-differences (DiD) with matching, RCT with recall data in the endline survey, or other quasi-experimental designs are being considered.

Chapter 1. CONTEXT

Zambia ranks among the countries with the highest levels of inequality and poverty (de la Fuente, Rosales and Jellema, 2017). In 2015, the Gini index[1] was estimated at 57 (World Bank, 2015), and 16.6 million Zambian people earned less than the international poverty line of USD 1.90 per day (World Bank, 2019c). The poverty rate in urban areas fell from 25.7 per cent in 2010 to 23.4 per cent in 2015, whereas the poverty rate in rural areas increased from 73.6 per cent to 76.7 per cent over the same period (World Bank, 2020). A transition from a low-income to a lower-middle-income country occurred in 2011. Still, the country remains under-developed, and its middle-income status masks its social and economic vulnerabilities (Organisation for Economic Co-operation and Development, 2019).

The agricultural sector accounts for a small percentage of gross domestic product (8.2 per cent in 2017, World Bank, 2019a) and includes 1.5 million smallholder farmers. Smallholder production is characterized by low productivity, subsistence agriculture and limited access to productive assets and market opportunities. In addition, the sector is also characterized by limited crop diversity. Maize production alone accounts for 70 per cent of all crops grown, which increases vulnerability to both environmental and market shocks (World Bank, 2019a).

Food security is affected mainly by the lack of access to inputs, markets, post-harvest management[2] information and climate variability (Mulenga, Ngoma and Tembo, 2015). The frequency and intensity of climate hazards, such as higher temperatures and heatwaves, are becoming more common and pervasive. Such hazards impact smallholder production and the economy at large (Faramarzi and others, 2013), for instance, by causing internal displacement and reducing labour productivity. During the *hunger season*, from December to March,[3] 60 to 80 per cent of rural households report running out of food, and only 36 per cent report having enough food to eat all year round (Bhorat and others, 2017). With a score of 38.1, the Global Hunger Index (2019) ranked Zambia the fourth-lowest country among the 117 surveyed countries.

Given these challenges, a number of initiatives and techniques have been introduced across the country. For example, the *Climate-Smart Agriculture Investment Plan* is a collaborative project between the World Bank and the Government of Zambia, with the overarching objective of identifying and prioritizing "policy actions, investments, and knowledge gaps" for promoting cost-effective climate-smart agriculture approaches (World Bank, 2019b). Another example is the *Conservation Agriculture Scaling-Up* project which was funded by the European Union and was implemented across the four agro-ecological regions (AER I, IIa, IIb, and III) in nine provinces and 48 districts (Food and Agriculture Organization of the United Nations (FAO), 2018).

Conservation agriculture practices include minimal soil disturbance, a permanent cover of the soil through the use of mulch,[4] and frequent crop rotation (FAO, 2017b). Climate-smart agriculture aims

[1] The Gini index measures the extent to which the distribution of income (or, in some cases, consumption expenditure) among individuals or households within an economy deviates from a perfectly equal distribution. A Gini index of 0 (zero) represents perfect equality, while an index of 100 implies perfect inequality (World Bank, Poverty and Inequality Platform: pip.worldbank.org).
[2] Post-harvest management includes all transportation, storage, processing, packaging, and marketing processes and measures that contribute to the flow of agricultural products (crops) which have been harvested, or are suitable for harvesting (van Gogh and others, 2017).
[3] During these months the farmers in Zambia and elsewhere struggle to make their harvest last the full year; they run out of food in the months leading up to the next maize harvest.
[4] A technique that uses crop and other plant residues spread around the base of the crops.

to achieve the sustainable enhancement of agricultural productivity, improve climate resilience, and reduce greenhouse gas emissions through expanding carbon storage (FAO, 2017a).

The "**Strengthening climate resilience of agricultural livelihoods in agro-ecological regions I and II in Zambia" (SCRALA)** project aims to strengthen the capacity of farmers to plan for climate risks, promote climate-resilient agricultural production and diversification practices to improve food security and income generation, improve access to markets, and foster the commercialization of climate-resilient agricultural commodities. The project is financed by the Government of Zambia, the Green Climate Fund, and the United Nations Development Programme (UNDP). It is implemented by the Zambian Ministry of Agriculture and will support the Government of Zambia in building climate-resilient food security and poverty reduction measures for approximately 940,000 people. The project is slated to reach over three million indirect beneficiaries, that are expected to benefit from the project while not being the targeted beneficiary of the intervention, who account for approximately 18 per cent of the total population and who are located in 16 Zambian districts.[5]

[5] These districts are Mambwe, Nyimba, Chongwe, Luangwa, Chirundu, Rufunsa, Chama, Mafinga, Kazungula, Siavonga, Gwembe, Namwala, Sioma, Senanga, Sesheke and Mulobezi.

Chapter 2. PROJECT DESCRIPTION

The SCRALA project focuses on regions I and II of the three major agro-ecological regions in Zambia. Region I spans the southern parts of the southern and western provinces and is one of the hottest, driest and poorest regions in Zambia. It is categorized as a low rainfall area with sandy soils and poor fertility. Cultivation of maize, sorghum, groundnuts, sunflower, cowpeas, and fishing are the main activities practised in the region. It is particularly vulnerable to climate change and is categorized as a drought-prone area. Region II includes three subregions (IIa1 and IIa2, and IIb) and is a medium-rainfall belt extending from east to the west through the centre of the country. It has relatively fertile soils and receives more rainfall than Region I. It has the most favourable agro-ecological conditions regarding rainfall, soil quality, an absence of the tsetse fly[6] and high irrigation potential. This allows for a diverse mix of crops and livestock enterprises.

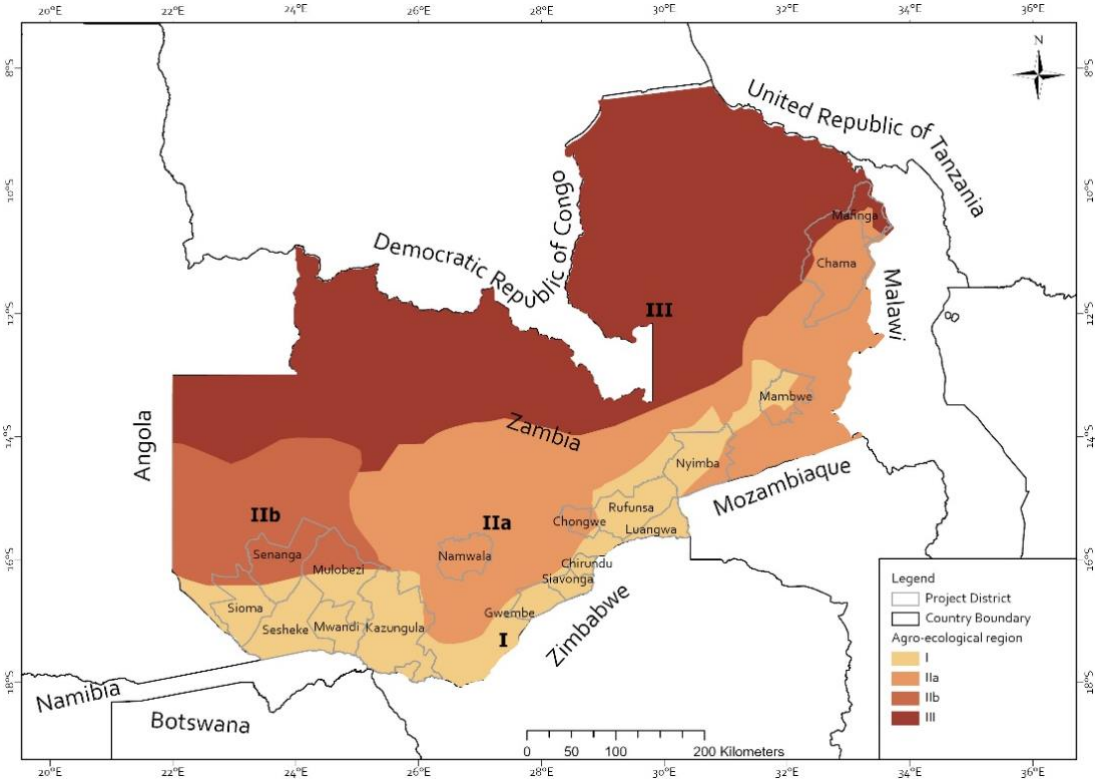
Region IIb is different from the other subregions. It can be characterized as a low rainfall area in the western part of the country, which corresponds mainly to the central/northern parts of the Western province. This region has lower rainfall, sandier soils, poorer road and market infrastructure, and high drought risk. Sorghum and millet are mainly grown as staple crops alongside cassava and some maize. This drought-prone area is also suitable for extensive livestock production, cashew and timber.

Regions I and II are highly exposed to climatic hazards due to frequent drought and flood events and the lack of adaptive capacity[7] (NAPA, 2007). Furthermore, these regions have a very high poverty incidence. Rain-fed agriculture is predominant and there is a lack of crop diversity. Maize, which is not very resistant to climate change and is considered vulnerable to climate change impacts, is the most grown crop in regions I and II. Drought-resistant crops such as cassava are grown to a limited extent.

The project aims to achieve increased resilience by taking a value chain approach and addressing barriers to climate-resilient agriculture across key value chain stages – planning, inputs, production, and post-production – through input support, training, and infrastructure development. To achieve this, the project is implementing targeted interventions to strengthen and promote viable climate-resilient value chains relating to smallholder agriculture by targeting gender-sensitive value chains and providing viable economic opportunities for women. This includes the three interrelated project components presented in Figure 2.

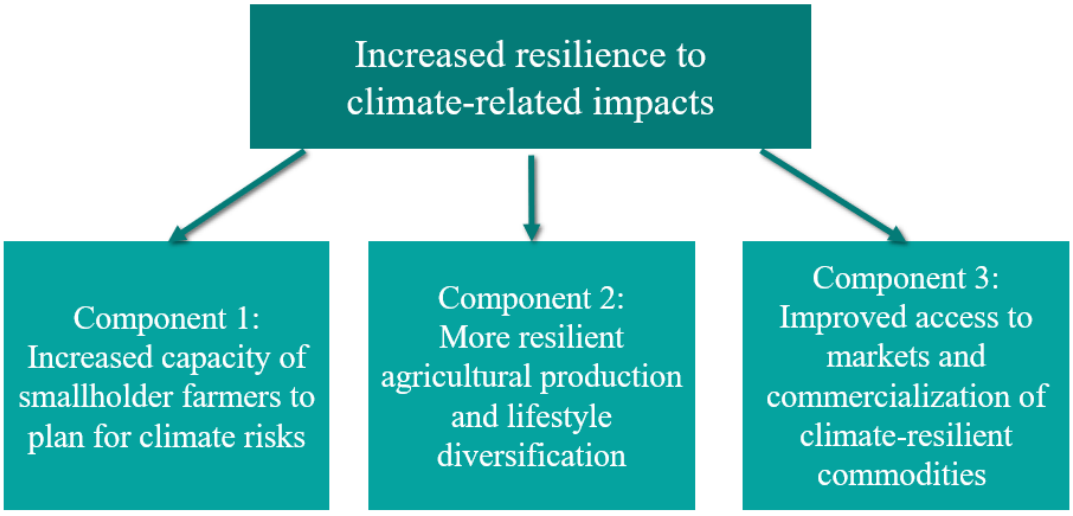
[6] Tsetse fly (*Glossina sp.*) transmits *Trypanosoma globans* a parasite that causes sleeping sickness in humans and livestock (Durocher-Granger and others, 2021)
[7] Communities in these agro-ecological regions are generally dependent on rainfed agriculture and have low coping mechanisms to adjust and respond to the effects of droughts and flash floods on their livelihoods.

Figure 1. Map of major agro-ecological regions in Zambia



Source: Adapted from UNDP (2018)

Figure 2. Components of the project strengthening climate resilience of agricultural livelihoods in agro-ecological regions I and II



Source: Adapted from UNDP (2018)

The first component aims to increase the quality of weather/climate-based information and its dissemination. The second component is mainly directed at irrigation and input support, mostly from the FISP. The third component on markets and commercialization will drive the production of resilient agricultural commodities and ensure the sustainability of the first two components, directly reaching over 157,000 farming households.

A total of 940,000 people will directly benefit from the project across 220 agricultural camps in 16 districts, and the indirect beneficiaries will be over 3 million, comprising 18 per cent of the total population. The 16 districts are in five provinces spread across agro-ecological regions I and II (namely, Eastern, Lusaka, Muchinga, Southern and Western provinces).[8] The project officially started in October 2018 and is planned to be implemented for seven years. The LORTA impact evaluation inception workshop took place at the beginning of 2019. The central executing entity is the Zambian Ministry of Agriculture. The Ministry partners with a range of organizations and government bodies, including the Zambian Water Resources Management Authority, the Zambia Meteorological Department, the FAO, and the World Food Programme. Further support for the project and quality assurance is undertaken by the UNDP, which is also the accredited entity of the GCF.

A. IMPLEMENTATION PLAN

The project targets over 150,000 farming households (50.2 per cent female) in 220 camps in 16 districts in the agro-ecological regions I and II. It consists of three main components.

For component 1, the installation of manual rain gauges in every camp is planned as well as the installation of automated weather stations in selected sites within the targeted districts. These stations are being installed to increase the density of the weather observation network.[9]

Component 2 involves introducing water storage and irrigation equipment, constructing boreholes, weirs, and irrigation canals, and training smallholder farmers and district officers in implementing and maintaining irrigation infrastructure.[10]

One critical activity of component 2 is the distribution of seeds, soil kits, and tools. Like many other smallholder farmers, SCRALA project beneficiaries receive benefits through FISP. Through this programme, seeds will be distributed mainly through cooperatives in one of two ways. A farmer can get a bag of seeds directly (direct input support), or the farmer can get an e-voucher to purchase seed or other agricultural input of their choice. Farmers face a dilemma in choosing between open-pollinated seed varieties and hybrid types. The former has the advantage of only needing to be bought about once every three years, while the latter is more climate-resilient and higher yielding but needs to be bought every 12 months. Additionally, the project will distribute improved seeds, particularly for more drought-tolerant crops than maize, such as soybeans.

Another key activity of component 2 will be to introduce and strengthen farmer field schools, which will serve as demonstration sites for training sessions on sustainable agricultural practices and improved seeds. Farmer field schools have between 20 and 30 members and are managed by extension workers (participants will be the same for components 1 and 2). These schools will also receive seeds, but in small quantities and only for training purposes. In addition to the farmer field schools, a learning centre of excellence will be established in each district to scale up and disseminate good practices on climate-resilient agriculture. At these learning centres, training will be first delivered to the community's leading farmers who will set the example for others to follow.

[8] The districts are Mambwe, Nyimba, Chongwe, Luangwa, Chirundu, Rufunsa, Chama, Mafinga, Kazungula, Siavonga, Gwembe, Namwala, Sioma, Senanga, Sesheke and Mulobezi.
[9] To further increase the availability and usability of data, hard-copy historical data will be digitized. Furthermore, training and university cooperation will strengthen the capacity of Zambia Meteorological Department staff to generate, analyze and model climate information. To disseminate the improved weather- and climate-related information, various channels will be used such as radio, television, field extension services, and print media. However, the main channel will be SMS text messages. To increase the capacity of farmers to use the improved and disseminated information, trainings at farmer field schools will be held in every camp.
[10] The selection of sites for the installation of irrigation systems has been completed. To finalize the construction plans, a mapping of the sites is necessary and has been started. The construction has not yet been completed.

Each of the camps will receive training and inputs to adopt alternative livelihoods, which includes the distribution of 68,000 fishponds, 1,520 beehives and 14,000 goats. The beehives and goats will benefit up to 50,000 households. The impact evaluation particularly focuses on the beehive and goat components. Public lotteries for the random selection of beneficiaries to receive goats and beehives, took place in 2020, with a possible second round of lotteries of beehives for upscaling purposes to be held in 2022 (see section Chapter 4.E).

Component 3 will be mostly delivered through cooperatives. Across the 16 districts, 71 multipurpose processing centres will be established and training on post-harvest crop processing (such as drying and milling of cassava) will be provided by cooperatives. Storage and transport facilities will be strengthened – for example, by making toyo cycles (tractor-cycles with 0.5-ton cargo capacity) available on a loan basis. Furthermore, a marketing platform will be established and access to finance and insurance products will be strengthened.

B. THEORY OF CHANGE

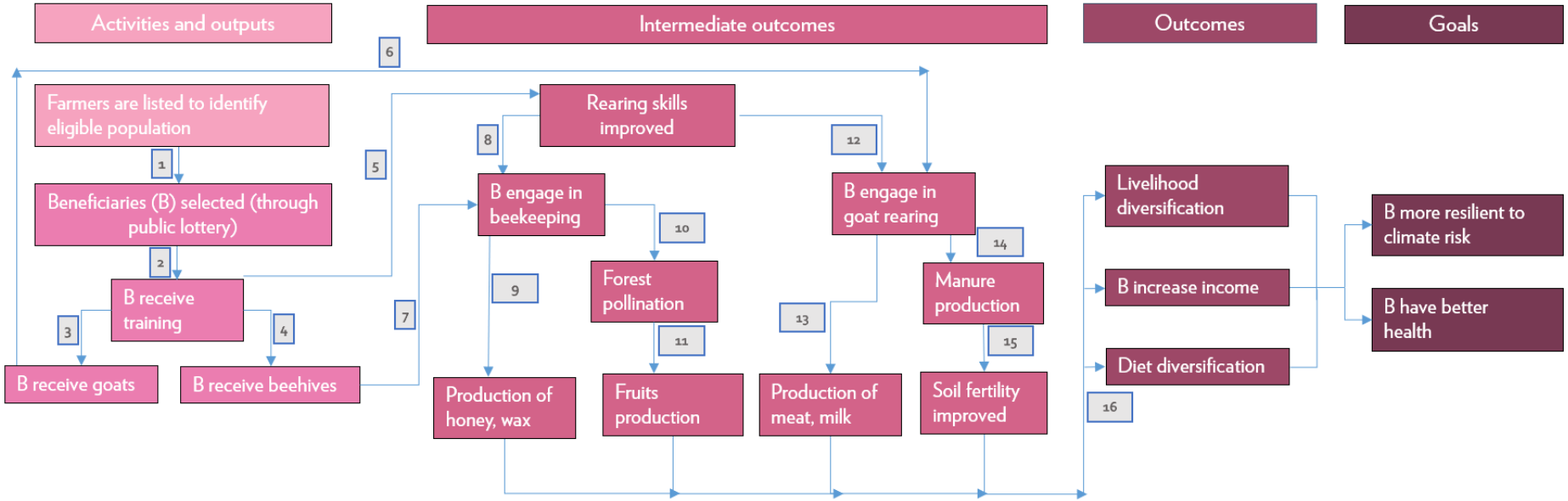
The theory of Change (ToC) for the SCRALA project is presented in Figure 3. We focus on the distribution of goats and beehives as part of component 2, as these are part of the impact evaluation strategy (see section Chapter 4). The ToC shows the causal pathway of how the provision of goats and beehives may ultimately contribute to better health and higher resilience to climate risk.

The ToC stipulates those beneficiaries were identified from a listing and were selected via a public lottery. Those selected to receive goats and beehives participate in additional training to improve farmers' beekeeping and goat rearing skills to farm products like goat meat, goat milk, honey and wax more successfully.[11] These intermediate outcomes can lead to a more diversified livelihood and increased income from selling goat and bee products. If households consume parts of their produce, it may also lead to diet diversification. Collectively, these outcomes can contribute to the goals of better health and increased resilience to climate risks.

The development of the questionnaire was guided by the ToC and the specific indicators outlined in Table 1, Table 2, and Box 1.

[11] Beekeeping may then have an effect on forest pollination, which has a positive impact on fruit production. Goat rearing can also have a positive effect on soil fertility since goats produce manure.

Figure 3. Theory of change



Source: Adapted from UNDP (2018)

The key indicators and assumptions of the ToC is presented in Table 1.

Table 1. Indicators and assumptions

NODE	INDICATORS	ASSUMPTIONS
1	Number of farmers listed Number of farmers attending public lotteries	The listing targets a sufficient number of farmers for selection.
2	Number of farmers attending public lotteries Number of farmers attending training	The public lotteries are organized and training is conducted.
3	Number of goats received by every farmer	Selected farmers receive a sufficient number of goats.
4	Number of beehives received by every farmer	Selected farmers receive a sufficient number of beehives
5	Trainers' qualifications and years of experience in training beekeeping and goat rearing Number of sessions of beekeeping Number of sessions of goat rearing Length of each session	The training has to contain modules on how to manage beehives and goat rearing. The training needs to contain practices with sufficiently skilled trainers.
6	Number of farmers engaged in goat rearing	Farmers have access to water and grazing land.
7	Number of farmers engaged in beekeeping	Farmers have easy access to beehives. Water is well-drained. Existence of a nearby water source for the bees, dappled sunlight, and minimal wind.
8	Training evaluation after training	Farmers have good skills from the training to handle beekeeping.
9	Amount of honey and wax in kg	Farmers follow all necessary instructions for good beekeeping.
10	Number of different types of trees and flowers around the vicinity	Forest (trees) exist in the neighbourhood of beehives place.
11	Amount of fruits produced in kilograms (kg)	There is sufficient water and manure for soil fertility.
12	Training evaluation after training	Farmers have acquired good skills from their training and can handle goat rearing.
13	Amount of milk and meat produced in l and kg	Farmers follow all necessary instructions to ensure good goat rearing.
14	Number of goats received by every farmer	There is a sufficient number of goats to produce enough manure.
15	Amount of manure produced in kg/hectare	Farmers are willing to collect and distribute manure.
16	Time left between the reception of beehives and the first bee product (honey, wax) sold Time left between the reception of goats and the first goat selling (meat or alive) Number of kilometres (km) from the beekeeping production location to the nearest market Number of km from goat rearing production location to the nearest market	Farmers are diligent and patient enough to wait until they reach a level of production that can be sold. Farmers have market access.

Source: LORTA team

Chapter 3. EVALUATION QUESTIONS AND INDICATORS

Table 2 and Box 1 below show the project and impact indicators, respectively, which guided the formulation of research questions for this baseline report. From these, the following evaluation questions were included:

- What is the food security status of farmers based on food consumption score, dietary diversity, and coping strategy index?
- What is the income level, its volatility, and stability between treatment and control farmers?
- What is the percentage of farmers with agriculture as the only source of income and who diversified their livelihoods (apart from subsistence agriculture)?
- What is the number of distinct income generating activities that farmers are engaged in?
- What is the percentage of farmers who declare using climate information and what is the knowledge level of climate information and climate-resilient agriculture among farmers?
- What percentage of farmers adopted sustainable and climate-resilient agricultural practices, including intercropping, crop rotation, organic manure application, composting, leguminous cover cropping, minimum tillage and agroforestry?[12]

The project indicators guided the development of the survey tools. Table 2 presents details of the project indicators. The last column labelled "tracker" identifies the questionnaire number in the household survey tool or source of information for the particular indicator.

Table 2. Project indicators and source of information

FROM FUNDED ACTIVITY AGREEMENT SCHEDULE 8 (REVISED AND APPROVED)		TRACKER
Excepted result	Indicator	Questionnaire number
	Total number of direct and indirect beneficiaries; Number of beneficiaries relative to the total population	Project documents
Al.0 Increased resilience and enhanced livelihoods of the most vulnerable people, communities, and regions	Indicator 1.2: Number of males and females benefiting from adopting diversified, climate-resilient livelihood options.	Module C and project documents
A2.0 Increased resilience of health and well-being, and food and water security	Indicator 2.2: Number of food-secure households (in areas/ periods at risk of climate change)	Module B - Food consumption score (FCS) and Dietary diversity (HDDS)
A7.0 Strengthened adaptive capacity and reduced exposure to climate risks	Indicator 7.1: The extent to which target beneficiaries (vulnerable households, communities, businesses, and public-sector services) adopt climate-resilient technologies (improved tools, instruments, strategies, and activities to respond to climate variability and climate change)	Module C101 and Module D103 Module C – C101a and b

[12] Sustainable and climate resilient agricultural practices employ minimum tillage (restricted only to planted areas) to reduce soil moisture loss, improve soil nutrients and reduce erosion through mixing of conventional crops with nitrogen fixing crops (legumes) and trees in the case of agroforestry and plant residues and animal manure in place of synthetic fertilisers.

FROM FUNDED ACTIVITY AGREEMENT SCHEDULE 8 (REVISED AND APPROVED)		TRACKER
1. Smallholder farmers can plan for and manage climate risk to support resilient agricultural production	(1a) Percentage of smallholder farmers demonstrating knowledge to plan for and manage climate risk to support resilient agricultural production (disaggregated by gender)	Module C – C101a and b
	(1b) Percentage of population with access to improved climate information, weather, and agricultural advisories (disaggregated by gender)	Module F - F601 Module G2
	(1c) Perception of targeted populations on the timeliness, content, and reach of weather, agricultural, and water advisories	Module F - F603
2. Resilient agricultural livelihoods are promoted in the face of changing rainfall, increasing drought, and occasional floods	(2a) Area (ha)of agricultural land made more resilient to climate change through changed agricultural practices (e.g., planning times, new and resilient native varieties, efficient irrigation systems adopted)	Module C – C101c
	(2b) Number of farmers adopting new agricultural practices and alternative livelihoods	Module C – C101a and b
	(2c) Percentage increase in agricultural incomes in the project sites	Module D – D102 Module B – B203 and B205
3. Increasing farmers' access to markets and commercialization or resilient agricultural products	Percentage of resilient commodities produced by target farmers that are sold on the markets	Module D104 Module H101C
	Percentage of households accessing financial education programmes related to credit and insurance schemes	F6f, F6j, and F9

Source: LORTA team

The main key impact indicators included in the survey tools, based on information from UNDP, are shown in Box 1 below. At the end of each indicator, we list the module/questionnaire number in the household survey tool that tracks the particular indicator:

Box 1. Key SCRALA impact indicators

- Food security index - We use the below FCS as a food security indicator.
- Food Consumption Score and Food Consumption Groups – Module B: b101
- Food expenditure shares – Module B: b205
- Coping Strategies Index (CSI) -Module B: Asset and food-based coping strategies b201 and b202
- Income stability per agricultural season and per year
- Volatility of income level – Module E – Shock impacts to income – E105, 106 and 107. Measuring ability to recover from shock.
- Number of months without income –This is covered by expenditure component.
- Average level and volatility of yields -Module D – D104. Measuring average yields. Volatility measured in follow-up surveys.

- Percentage of farmers who diversified their livelihoods (e.g., who diversify from maize and who have started new activities other than subsistence agriculture) – Module D – D102, Module B – B203 and B205
- Percentage of farmers with agriculture as only source of income - Module D – D102, Module B – B203 and B205
- Number and type of different income generating activities farmers engage - Module B – B203 and B205
- Number and type of different seeds planted -Module D – D102

Source: LORTA team

The following briefly describes the indices used to analyse the coping strategies and food security. These indices were used as part of the key impact indicators, mentioned in Box 1, before presenting the results. It shows how the specific indicators used for the analysis were computed. These indicators are based on the standard indicators developed by the FAO and the World Food Programme, among others. Their choice was guided by the SCRALA project and impact indicators.

- **The Livelihoods and asset-based coping strategy index score (LCSI)** measures households' coping capacities, i.e., how they respond to recent crises (such as lack of food or money). The index gives an understanding of the behaviours that households engage in to adapt to these (such as begging for food and selling productive assets) and assesses their situation's difficulty. Households were asked a set of 10 questions about selling or making changes to assets or livelihoods in the past 30 days due to the lack of food or money to buy food. The answer to these questions was either 'yes' or 'no'. The 10 coping strategies were categorized into four groups and their weights are in parenthesis:
  - Emergency strategies: These affect future productivity and are the most difficult to reverse (4). These include leasing out land to buy food, selling last female breeding livestock to buy food, begging for food.
  - Crisis strategies: These are difficult to reverse and reduce human capital formation, for example, selling productive assets or means of transport (plough, wheelbarrow), withdrawing children from school because of hunger, reducing non-food expenses, for example, spending on clothes, medicine, and education to buy food (3).
  - Stress strategies: These indicate a reduced ability to deal with future shocks and can lead to a current reduction in resources, such as borrowing money from formal and informal sources to buy food, purchasing food using savings and selling household assets and goods to buy food (2), for example, a radio or table.
  - Neutral strategies: These indicate an improved ability to cope with shocks and include selling more non-productive animals than usual to buy food (1).

  For each household in our study, an LCSI score was computed by multiplying and summing (i) the occurrence of each strategy and (ii) their weight based on whether it is an emergency, crisis, stress, or neutral strategy. Higher LCSI scores indicate a worse livelihood situation and vice versa.
- **Food based coping strategy index (CSI)** indicates a household's food security by assessing its use of harmful coping strategies when it lacks sufficient food or enough money to buy food. The CSI index was computed using the information on how often a household used a set of 12 short-term (last 30 days) food-based coping strategies. The possible responses for each of the 12 coping strategies (frequency of occurrences) in a month/or in a week in the past 30 days

were: 0 = never; 1 = seldom (1–3 days per month); 2 = sometimes (1–2 days per week); 3 = often (3 days per week) and 4 = daily (Belachew and others, 2013; Murendo and others, 2021; Saaka and others, 2017). For each household in our study, a CSI score was computed by multiplying (i) the frequency of each strategy (how many times each strategy was adopted?); and (ii) their severity (how serious is each strategy?) (Saaka and others, 2017). A higher CSI indicates a worse food security situation and vice versa and helps monitor the same households over time.

- **Household dietary diversity (HDDS)** was calculated for each household using recall data on the consumption of foods over the previous 24 hours (Kennedy and others, 2010; Kennedy, Ballard and Dop, 2011). The food items were categorized into eight different food groups. The food groups used to calculate the HDDS included: cereals, roots and tubers, pulses and nuts, vegetables, fruits, meat (including eggs, fish, and seafood), milk and milk products, oils, and fats (Swindale and Bilinsky, 2006). After computing the HDDS, we categorized households into two levels to understand the proportions of household dietary diversity. There are no universal cut-offs for categorizing households according to their HDDS. Therefore, the sample distribution was divided into HDDS categories based on the number of food items consumed: low (0-5) and acceptable (6-8) dietary diversity (Kennedy, Ballard and Dop, 2011; Pauzé and others, 2016).
- **Food consumption score (FCS)** was computed as a composite score based on dietary diversity, food frequency, and relative nutritional importance of different food groups (Kennedy and others, 2010; Kennedy, Ballard and Dop, 2011; Swindale and Bilinsky, 2006). The FCS is calculated using the frequency of consumption of different food groups consumed by a household during the seven days before the survey. The consumption frequency of eight food groups is multiplied by a group-assigned nutrient weight, and the resulting values are summed to obtain the FCS, which is a count variable (Kennedy and others, 2010). The assigned weights for each food group are based on their respective energy, protein, and micronutrient densities. We used the FCS to determine household food consumption status based on the following thresholds: 0-21 (poor), 21.5-35 (borderline), and greater than 35 (acceptable food consumption) (Kennedy and others, 2010; Kennedy, Ballard and Dop, 2011).

Chapter 4. EVALUATION STRATEGY AND DESIGN

A. IMPACT EVALUATION DESIGN

This section presents the preliminary impact evaluation (IE) strategy. The IE design focuses on the impacts of the alternative livelihoods activities as part of component 2: specifically, the distribution of 1,520 beehives and 14,000 goats. Initially, the evaluation strategy was to evaluate the impact of improved seeds as well as beehives and goats. At the time of sampling for the baseline data collection (in November 2020), the beneficiaries of improved seeds had not been selected, nor was the selection procedure decided. Therefore, the evaluation strategy focused solely on beehive and goat recipients.

The initial choice of the IE design was an RCT. A well-implemented RCT only requires one round of data collection (at endline) to measure effects. However, randomization may often be imperfect in practice and outside academic research projects. For example, the lottery may go wrong, or the two groups selected randomly may be different based on certain common characteristics. Therefore, baseline data collection is still beneficial as it can test the balance between treatment and control farmers. It can also be used to conduct more precise power calculations for the endline survey, possibly improving the RCT design's statistical power. In addition, it allows backup IE options in case the randomization is not conducted as planned. A more extensive tool kit of IE methods becomes available with baseline data: quasi-experimental designs. As explained in the following sections, the availability of baseline data became very important due to the challenges encountered during implementation, sampling and data collection.

The LORTA team agreed on employing DiD (with or without matching) as a backup IE strategy. This strategy may allow us to eliminate observed and unobserved differences at baseline. The choice of the IE strategy will be defined in mid-2022.

B. SAMPLING STRATEGY

This section presents key factors considered for the sampling strategy. We focus first on the practicalities and constraints of the sampling frame and then turn to the sampling frame definition. Finally, we discuss limitations.

Constraints and final sample size

The target sample size was 3,000 households, equally distributed between a treatment and a control group. During the preparation of the data collection, after discussions between a research company Ipsos, contracted by the UNDP, which provided baseline data collection and analysis services to the project and LORTA teams, the sample size was refined to account for technical and logistical constraints.

Rains were the major constraint. Zambia, especially in the south, was heavily affected by seasonal rains in November and December, when the data collection took place. Lists of inaccessible camps, when available, were provided by the UNDP and accounted for in the sampling frame. A total of 24 camps with beneficiaries, distributed between seven different districts (namely Chirundu, Gwembe, Kazungula, Mambwe, Namwala, Nyimba and Siavonga), were known to be inaccessible and were discarded from the sampling frame.

To ensure comparable control households, these were sampled from the same camps as the households in the treatment groups. In addition, to ensure that the sample size could be reached despite the time and weather constraints, it was agreed to prioritize the data collection in zones and camps where the most households could be found. Thus, all camps with less than 10 households were discarded from the sampling frame.

The final sample size reached 1,251 households in the treatment group and 1,232 in the control group. Details are presented in Table 5.

Sampling frame

The population of interest for the household survey corresponded to all eligible households from the 16 districts in agro-ecological zones I and II.

Household eligibility was defined as a household being part of smallholder farming and matching any of the following:

- Female-headed household
- Household affected by drought or flood in the last five years
- Household faced with a loss of assets due to adverse weather and disease in the past five years
- Household with a young unemployed female
- Household with a disabled person
- Household with an underweight woman or children
- Household with an orphan

While the listing of households was initially planned to cover the population of eligible households in the 16 districts, the final listing exercise did not fully cover the population by the time the data collection was started. Although the representativeness of the farmer listing compared to the population could not be assessed precisely,[13] the farmer listing approximated the population of interest.

Before sampling, we attempted to merge the beneficiary lists with the farmer listing based on their names, location, and National Registration Card numbers. Strict and fuzzy matching was used to avoid the same farmer being sampled twice and to assess the characteristics of the beneficiaries. While we were able to match many beneficiaries with households from the farmer listing, some beneficiaries could not be matched.[14] As such, the final population list combined the distinct beneficiary lists (households who have already benefited from the programme and pass-on households who will receive it in the near future), with the list of 497 farmers within the crop-cut survey (both beneficiaries and non-beneficiaries), and the farmer listing.

Table 3 provides some background information on the project according to the abovementioned categories. This table shows, for each district, how many households benefit from each project intervention. The final sampling frame created for the survey is presented in Table 3.

[13] In some districts, most of the eligible households were listed in the farmer listing, while in other districts only a small proportion of households were listed. However, we do not have sufficient information to assess potential selection effect. In the interest of the data collection, we had to assume that the farmer listing and the total population of interest had similar characteristics.

[14] A total of 1,722 beneficiaries could be matched with households from the farmer listing. More specifically, this corresponded to 566 pass-on beneficiaries who could be matched with the farmer listing, 65 beehive beneficiaries, and 1,101 goat beneficiaries. A total of 1055 beneficiaries could not be matched with the farmer listing (448 pass-on beneficiaries, 127 beehive beneficiaries, and 480 goat beneficiaries.

Table 3. Distribution of beneficiaries among the different districts

District	Number of camps	Pass-on beneficiaries	Beehive beneficiaries	Goat Beneficiaries	Surveyed with crop-cut	Number of planned boreholes
Chama	25	0	0	47	119	2
Chirundu	8	0	0	98	0	10
Chongwe	17	0	0	92	0	14
Gwembe	15	60	0	100	0	4
Kazungula	19	380	0	180	0	2
Luangwa	9	0	0	100	0	4
Mafinga	18	0	0	132	242	0
Mambwe	14	0	0	85	0	10
Mulobezi	8	80	0	86	136	0
Namwala	15	100	0	85	0	10
Nyimba	16	100	0	90	0	6
Rufunsa	12	0	192	0	0	10
Senanga*	19	0	0	100	0	6
Sesheke	13	94	0	94	0	11
Siavonga	10	200	0	192	0	12
Sioma	9	0	0	100	0	4

Source: LORTA and project teams
Note: *Senanga district is not in the final sample because it did not have any pass-on or beehive farmers, nor any beneficiaries in camps with boreholes, and thus did not meet the selection criteria.

Based on the population obtained after merging the different data sets, we present our strategy to build a sampling frame below.

Beneficiary households

The treatment group consists of different types of beneficiaries. Beneficiaries had already been selected before data collection, after a public lottery organized by the camp officers among eligible households only. The lists of beneficiaries were then shared with the field teams and used as a basis for establishing the treatment group.

The following are the three types of beneficiaries that were considered for sampling:[15]

- Pass-on beneficiaries, i.e., farmers selected for receiving goats but who have not yet received them (1,014 farmers listed as pass-on beneficiaries)
- Other goat beneficiaries, i.e., farmers who have already received goats (1,614 farmers)
- Beehive beneficiaries, i.e., farmers who have already received beehives (192 farmers)

Pass-on beneficiaries are the ideal candidates for the treatment groups compared to other beneficiaries who have already received goats or beehives. Indeed, any IE that depends on baseline data will be more reliable if both the control and the treatment groups have not received any benefits at the time of the baseline data collection. That way we can ensure that household characteristics and

[15] Beneficiaries from improved seeds were not considered because the seeds had not been distributed by the time of the data collection. It was also impossible to develop a list of future seed beneficiaries as the raffle for selecting beneficiaries will be conducted in the field by camp officers immediately before seed distribution.

outcomes are not yet affected by the programme and that the evaluated impact is the impact of benefiting from the programme. For this reason, to sample the treatment group, we prioritized the 1,014 pass-on farmers and beneficiary farmers who were also part of a UNDP crop-cut survey conducted before collecting baseline data at the end of the harvest period, mainly from April to June.[16] Given that the 1,014 pass-on farmers and the 36 beneficiaries in the crop-cut survey were insufficient to reach the targeted sample size for treatment, we completed the treatment group with beehive beneficiaries (all 192 farmers) and a random selection of goat beneficiaries.

For the random selection of goat beneficiaries, we prioritized districts without pass-on farmers, beehive beneficiaries, and crop-cut to sample from all districts under the SCRALA programme. Within those districts, we prioritized camps where boreholes are planned to be installed. This way, we achieve some variation in whether farmers also benefit from boreholes as most camps with beehives and pass-on farmers are not planned to receive boreholes. At the level of the individual farmers, we prioritized goat beneficiaries who could be matched with the farmer listing. Finally, we completed it with a stratified random selection of goat beneficiaries among those neither matched with the crop-cut survey nor with the farmer listing.

We also had to account for the constraint of camp inaccessibility due to the rainy season. Some camps were not accessible at the time of the data collection, forcing us to remove households from inaccessible camps from the sampling.

Comparison (control) group

The comparison group comprises a similar number of observations as the treatment group. All farmers who were part of the crop-cut survey but were not beneficiaries of any of the previously mentioned beneficiary groups were included in the comparison group. They accounted for 461 farmers (out of 497 farmers from the crop-cut survey, including the beneficiaries).

The comparison group was completed with a stratified random sampling of households from the farmer listing who were neither goat nor beehive beneficiaries and were not expecting to be a beneficiary in the future. The sampling was done within the same camps as in the treatment camps. Households from inaccessible camps were again not considered for sampling. Table 4 presents the overall sample size before data collection with details of each category.

Table 4. Final sample by categories after removing the inaccessible camps

GROUP	CATEGORY	SAMPLE (EXCLUDING FARMERS FROM INACCESSIBLE CAMPS)	NOTES
Treatment group (N=1251)	Pass-on goat beneficiaries	774 farmers	Including: • 14 farmers who were also part of the crop-cut survey (and who could also be matched with the farmer listing) • 530 farmers without being part of the crop-cut survey (and who could be matched with the farmer listing)
	Beehive beneficiaries	188 farmers	-

[16] The UNDP undertook a maize crop-cut study to assess maize crop productivity, as part of the SCRALA project. The survey consisted of gathering relevant socio-demographics from farmers, GPS mapping of maize fields, and weighting dry grains harvested from the subplots identified for the crop cut survey, as well as assessment of the harvest's volume. Crop cuts allow to monitor agricultural yields on a frequent basis, accounting for seasonal and yearly fluctuations. Crop cuts are generally considered as a more robust measurement for yields than recall data.

GROUP	CATEGORY	SAMPLE (EXCLUDING FARMERS FROM INACCESSIBLE CAMPS)	NOTES
	Goat beneficiaries	289 farmers	Including: 22 farmers who were also part of the crop-cut survey
Control group (N=1232)	Farmers from the crop-cut survey	461 farmers	Excluding the farmers from the crop-cut survey who were also pass-on, beehive, or goat beneficiaries
	Households from the farmer listing	771 farmers	Excluding the households from the farmer listing who were also pass-on, beehive or goat beneficiaries, and those already counted in the crop-cut group
Replacement for the treatment group	Goat beneficiaries	366 replacement[17] farmers	-
Replacement for the control group	Households from the farmer listing	500 replacement farmers	-

Source: LORTA and project teams

Limitations

The sampling frame is at risk of sampling bias. Several factors account for this risk: time constraints, the rainy season, the inability to finalize baseline data collection before the distribution of beehives and goats, and the fact that the farmer listing did not include information of the entire eligible population. This can reduce the representativeness or external validity of the results for the overall intended population.

C. DESCRIPTION OF UNITS FOR DECISION-MAKING, THE INTERVENTION, AND ANALYSIS

The main unit of observation for this baseline study is the household. The recipient of goat and beehives should be the household head. This will ensure a household does not receive programme benefits twice through different household members.

Consequently, sampling was done at the household level, and the analysis below is presented mainly at the household level. Sometimes information is presented at the plot level for better clarity.

[17] A set of households were randomly selected to serve as replacements in case treatment or control households could not be interviewed in the field. However, the field teams also used households from outside the sampling frame to replace sample households. While some of those out-of-sample replacements can be explained by the constraints imposed by the rainy season and some locations not being accessible (with sometimes no possibility to anticipate them prior to being in the field), there was no communication regarding those replacements during the fieldwork. This issue was identified after fieldwork, when the data was shared. This explains why the actual number of interviewed households does not perfectly match with the targets from the sampling frame. It is not possible with the current data to identify exactly which interviewed households were not originally from the sampling frame. A* unique ID was created during the sampling phase to facilitate tracking sampled households over the data collection phase. The unique ID is considered best practice to allow identifying immediately the type of household that was interviewed (treatment group, control group, replacement, or not originally in the sample), even in the case of typos in the names or if the respondent is not the same household member as expected. Unfortunately, this unique ID was discarded during fieldwork and considering the respondent names (shared after fieldwork was over) did not allow us to track exactly how many households originated from the sample list and how many were replaced in the field with non-sampled households.

D. SAMPLE SIZE AND POWER CALCULATIONS

Power calculations enable us to determine the minimum sample size needed to detect with high probability a meaningful impact, also known as the desired minimum detectable effect size (MDES), if there is one. Which impact can be considered meaningful is highly context-specific and may require extensive discussions between the project funders and the evaluation team. Conventions on standardized effect sizes, distinguishing small, medium, and large, provide helpful starting points. It was agreed through discussions between the LORTA and UNDP teams that an MDES of around 0.2, the lower threshold of a small effect, would be desirable.

For an RCT, the power calculations refer to the required sample size of the endline survey. Given that at the time of the sampling, it was not clear to what extent beneficiaries were randomly sampled, it was agreed that the baseline survey should have the same sample size as required for the endline survey. Therefore, the starting point for the power calculations is an RCT's assumption. Before the endline survey, power calculations should still be adjusted once further discussions on minimum acceptable levels of impacts have taken place. Baseline data provide better estimates of the variability in outcomes.

The power calculations are based on a cluster design, as the sampling is done at a village level. We assume an average of 10 farmers per village. The next crucial ingredient is the intra-cluster correlation (ICC).[18] We estimated the ICC for several variables available in the data set from the Zambia Integrated Agriculture Management Information System. Because the village coding seems to have many mistakes, the results should be viewed cautiously. The ICC is very low (below 0.1) for "household income", high (0.3) for "cultivated farmland" and fairly low (0.15) for "household expenditure". From previous experience, an assumption is made that 0.2 is reasonable. - Aiming for an MDES of 0.2 and an assumed ICC of 0.2 would require around 2,700 farmers in approximately 270 villages (assuming no attrition) to the endline.

E. CHALLENGES ENCOUNTERED WITH THE RESEARCH DESIGN AND DATA COLLECTION

Challenges with the research design

As outlined above, the evaluation has encountered diverse challenges. The three principal challenges are (i) the lack of a sampling frame for the entire eligible population, (ii) the use of a lottery to select the first wave of beneficiaries, and (iii) the merging of treatment and control groups.

The lack of a sampling frame: The farmer listing was only completed in fragments, with large differences in completion between different camps. Furthermore, information on treatment farmers was only available late and may not have been complete, which led to delays in the onset of the baseline data collection. Therefore, the sampling and the evaluation questions to which the baseline data could speak were limited to goat and beehive farmers.

The use of a lottery to select beneficiaries: The Ministry of Agriculture, with the project team's support, created a listing of all eligible farmers and used a lottery to select the first wave of beneficiaries. The farmer registry information of the Zambia Integrated Agriculture Management Information System was updated in hard copy during the listing. Unexpectedly, the project team used a lottery to select the first wave of beneficiaries for inputs provided under component 2

[18] The intracluster correlation coefficient, or ρ, is a measure of relatedness of responses within a cluster. In our case, the cluster is a village. The lower the correlation, the more similar the households between the villages are.

simultaneously with the listing. Specifically, the lottery was done at the level of agricultural camps or villages (in case these were large). Among all eligible farmers who came to a meeting with the project staff, 20 farmers were selected to receive benefits. The benefits are mostly goats but also beehives. This process of randomization most likely led to an unrepresentative sample. The farmers who attended the meetings might be systematically different from those who did not.

The merging of treatment and control groups: A third challenge became clear during data collection. Many control group respondents reported that a household member had been selected to receive project benefits. Details are elaborated in the results section of this report. The possible contamination of the control group may considerably shrink the size of the unaffected control group, negatively affecting the statistical power of any IE design that relies on baseline data.

At the time of the baseline data collection, some beneficiaries had already received inputs while others had only been selected for future inputs. The first group consists of those who received beehives and goats. The latter group consists of farmers selected to receive goats through the pass-on mechanism. The baseline survey should have taken place for the former group before receiving any inputs. In contrast, for the latter, it is an accurate baseline – with the caveat of potential anticipation effects. As the baseline data collection also provided the backup option of a DiD or a matching design and monitoring approach, the latter group was prioritized in the sampling as much as possible.[19] This was described in detail in the preceding section. The erroneous listing of treatment and control households caused delays and considerable confusion during data collection.

Logistical challenges

The biggest constraint experienced in the data collection was logistical: since the data collection was conducted a few weeks after the start of the rainy season, movement during this period was constrained by poor and waterlogged roads, flooding, and washed-away bridges. This situation made accessing some camps challenging and delayed data collection in some districts. The specific challenges encountered are listed in Appendix 1.

F. DATA AND QUALITY ASSURANCE

Data quality assurance stands for the process of quality control that starts with the design of data collection tools, which are followed by the selection of the field team, data collection, and processing. This process follows prescribed rules about the design of the tools, selection of the field team, and the value of data elements. The latter include data type, range of values, missing values, completeness, and consistency. The quality control protocols are described under the following headings:

Design of data collection tool

The questionnaires were designed in English and translated into Lozi, Nyanja, and Tonga, the local languages spoken in the survey districts in the western, eastern and southern provinces. The evaluation team then reviewed the questionnaire to ensure that all questions were logical, coherent and framed in a manner that was easy for the respondents to understand. The pilot was conducted in the districts of Rufunsa and Chongwe located within the Lusaka province. The pilot verified the accuracy of the translated survey tool, identified questions that were difficult to understand and identified where improvements were needed to the questionnaire design, flow, and translation.

[19] Anticipation effects could include income- or wealth effects in case farmers want to smoothen their consumption based on a possible increase in permanent income and future wealth.

Programming of data collection tools into computer-assisted personal interviews

This process involved scripting the data collection tools into an electronic version accessible via smartphones or tablets. Quality checks, as part of bench-testing, were performed to ensure that the computer-assisted personal interviewing script mapped the designed data collection tool. The logical skips and verifications were functional including a range-check to ensure the interviews were conducted in the right location and the Global Positioning System (GPS) coordinates were recorded. Ipsos iField software, which incorporates project management and data quality control, was used for the scripting.

iField is an integrated system covering all aspects of face-to-face data collection for efficient and faster delivery. IField offers a high-quality, full Field Management Systems search platform. Its key strengths are its inclusion of configuration databases of interviewers, enumerator allocations by sampling point, quota definition and real-time monitoring and quality control through back-checking.

Selection of data collection team

The data collection team went through a rigorous recruitment process, to ensure that those selected were best suited to the task. Items considered included qualifications, experience and the ability to speak and write the local language in areas surveyed fluently. For this survey, the minimum qualification for the team was a post-secondary school diploma, proficiency in either of the three local languages (Nyanja, Tonga, and Lozi), and experience in conducting similar household surveys. Priority was given to the interviewers with a background in agriculture. The enumerators were drawn from the Ipsos pool of "field ready" enumerators with experience in data collection.

Training

To ensure quality control, the data collection team delivered theoretical and practical training involving a pilot over five days. An additional 10 interviewers were trained as a contingency measure to replace any dropouts. The training was conducted in a central location to ensure it was uniform.

Data collection verification

Data accuracy and consistency were checked throughout the data collection process using the following methods:

Interview check: Data quality was checked after completion of the interviews by checking GPS location, duration of the interview, and length of time between two interviews by the same interviewer. Enumerators were only allowed to visit households from 9 am to 6 pm. Working outside these agreed time frames was not allowed for ethical reasons. The starting and ending times of the interviews were reviewed to ensure adherence to the authorized working hours.

Call-back checks: At least 30 per cent of the interviews conducted by each interviewer were randomly selected and the corresponding participants were re-contacted to respond to some validation questions. This was conducted to determine the validity of the responses provided during the main interview. An independent quality control team at the Ipsos office in Lusaka conducted the checks.

Accompaniment and spot-checks: Supervisors, independent back-checkers,[20] the field coordinator, and the Ipsos field manager conducted impromptu visits to observe enumerators during the

[20] "Back checks are an important tool that allows the research team to verify the quality and validity of survey data. Throughout the duration of the fieldwork, a back check team returns to a randomly selected sub-sample of households that enumerators have already surveyed. The back check team re-interviews these respondents, using a much smaller set of questions from the actual survey instrument (or questionnaire). This is known as a back check survey and allows the research team to modify certain aspects of the data collection to improve data quality." (https://dimewiki.worldbank.org/Back_Checks)

interviews. This ensured the data collection process was implemented according to the survey methodology and protocols.

Data checks for all incoming data: Back-checkers checked all the incoming data for completeness, interview duration, GPS recordings, location, and logic. Instant, remedial action was taken when quality issues were noted. The action taken varied depending on the nature of the issue and involved de-briefing the interviewer and the entire team, back-checking the case with the issue, and back-checking all cases for the interviewer concerned. If the commission of malpractice such as not adhering to study protocols were identified, the interviewer would have been dismissed, and replacement interviews would have been conducted. This survey identified no malpractices, and the debriefing exercises focused on discussing experienced challenges during the fieldwork.

Screening out duplicate respondents: This corresponds to the checks for duplicates of respondents' mobile phone numbers, biodata, and location. If the quality control team identified any duplication of respondents, a mechanism for discarding data from the additional interviews was employed. No cases of duplicate respondents were identified for this survey.

Data processing and verification

Due to the stringent data quality control mechanism before and during the data collection, the final data was about 95 per cent usable. However, quality checks were still employed during the data processing. Firstly, the Ipsos Data Processing (DP) team checked the data for completeness. Thereafter, they ensured that the collected data matched the questionnaire sequence and followed up on any missing responses. Afterwards, the logic of the given responses was checked, such as whether the respondent's age fell within the natural demographic curve or the figures entered were out of range. Identified issues were flagged by alerting the project manager, who then verified the information with the data collection team. To address all data quality issues, the DP team processed the data according to the data processing instructions.

G. SOFTWARE AND CODE

Android system based iField software was used for the data collection. The evaluation team reviewed and approved the final versions of the survey tools. The survey tools included the household (Appendix 1) and community questionnaire (Appendix 2). The survey tools were designed to collect information on responses to all the questions according to the appropriate skip logic; GPS coordinates and interview start time and end times; interviewers' route path when in the field; duration of the interview; and interview gaps if the interviewer paused during the interview. Once an interview was completed, the application prompted the interviewer to upload the data. This happened immediately after GSM network connectivity became available. Data collected in areas without internet connectivity was uploaded immediately after gaining internet access. The data was uploaded to a secure cloud server with restricted access. The data quality control team ensured all the interviewers did this every day.

Once the data collection was completed, the project manager alerted the DP team to download the data for cleaning and processing. The DP team downloaded the data in Excel, cleaned it in SPSS and finally converted it to a statistical software application, STATA, for delivery to the data analysis team. Ipsos created a codebook presenting the variable names, labels, and descriptions of the values. Following data cleaning, all the statistical analysis was run using STATA-16. Additional cleaning and scripting of the analysis were done using a STATA do-file. The script was organized and annotated so the code could be understandable and easily replicable. All corresponding data, code, and codebook are available on request.

The table below (Table 5) presents all the software used for this baseline survey and analysis.

Table 5. Software used for data collection and analysis

SOFTWARE	PURPOSE	PROJECT OBJECTS DERIVED
Ipsos iField	Tablet-based data collection	Household and Community survey answers on the server
Microsoft Excel	Data export from the server	Raw data sets
SPSS	Data cleaning	Cleaned data sets and codebook
STATA	Data analysis	Indicators and results

Source: LORTA and project teams

H. ETHICS

Ethical absence

The baseline survey was ethically cleared before the commencement of the survey in accordance with the regulations concerning local research in Zambia. Ipsos ensured all necessary clearances and permissions were obtained and retained the services of a private firm, ERES Converge. Ipsos was responsible for liaising with the government to acquire the facilitative role of the relevant government departments in conducting activities (for example, the Ministry of Agriculture during farmer listing). To obtain the necessary Institutional Review Board clearance for the project, the project team provided a basic research protocol, data collection tools in English and local languages and informed consent forms.

Coronavirus disease strategy

Ipsos adhered strictly to all Zambian Ministry of Health guidelines on the coronavirus disease (COVID-19) throughout the data collection process. Before the training began, all enumerators, supervisors, and coordinators were made aware of COVID-19 transmission and prevention. All training participants undertook temperature checks and hand sanitization before entering the training venue, maintained a distance of one metre between each other and wore face masks at all times. The training venue was equipped with well-ventilated and disinfected handwashing stations. Participants with a body temperature above normal were not allowed into the venue. Furthermore, all parties involved in the field had hand sanitizers and face masks. Field teams were provided with a field protocol to follow in case enumerators showed COVID-19 symptoms.

Data protection

The baseline phase for this IE followed strict data protection policies. Ipsos and C4ED have strict data protection guidelines and followed the pre-established protocols for the SCRALA survey. Respondents were informed before starting the survey that their data would be strictly confidential and anonymous, and no answer would be recorded without explicit consent. Any personally identifiable information was only accessible to a strict number of persons defined as the survey team and only shared between the survey team through encryption. Ipsos removed any personable identifiable information before data analysis to minimize the data breach risks. All the data shared between the survey team after data anonymization was distributed through internal servers with access restricted to a limited number of individuals from the survey team. Ipsos used an encrypted iField software application where data was stored in a cloud server with restricted access.

Chapter 5. PRESENTATION OF RESULTS

This baseline report presents statistics on the households sampled for the baseline survey. The results presented here should be seen as a screenshot of the household characteristics at baseline.

The results presented here can identify pre-existing patterns and possible differences between the households selected as beneficiaries (T) and the control households (C). The results generally present overall figures for the whole sample, for the treatment group only, and the control group only. The results are presented with the same structure as the questionnaire modules (as presented in Table 6), each module corresponding to a set of related analyses. The statistical tests used for the comparison of the means are standard t-tests. We indicate the statistical significance levels based on the following thresholds: * $p < 0.05$, ** $p < 0.01$, *** $p<0.001$.

Table 6. Survey questionnaire modules

MODULE	
A1	Household demographics
A2	SCRALA project participation
A3	Bee keeping and honey project production
B1	Household diet diversity
B2	Livelihood, assets, and food based coping strategies
C	Agricultural production technologies practices
D	Crop production for all crops grown by the household during the 2019/20 production year
E	Shocks, stress, and resilience
F	Social capital
G	Access to extension services and household assets
H	Livestock assets

Figures usually give a visual representation of the difference between the treatment and the control groups. Tables are either presented in the text or are included in Appendix 4.

A. MODULE A1: HOUSEHOLD DEMOGRAPHICS

This section presents general information on household demographics. Community characteristics are described in Appendix 3. It also presents a summary of the households' participation in SCRALA activities, with details of activities in which they had already participated.

Table A - 3 in Appendix 4 presents household characteristics for the overall treatment and control sample. Overall, 74 per cent of sample households were male-headed with an average age of 49 years, an average household size of almost six and only 10 per cent of household members was formally employed at the time of the survey. Almost all (97 per cent) of household heads were involved in agriculture. Household heads in the treatment group were significantly older than their counterparts in the control group and had slightly lower educational levels (although this difference was not significant). On average, treatment households had a significantly higher number of orphans.

B. Module A2: Summary of participation in SCRALA activities

Table A - 4 in Appendix 4 presents what the head of households declared during the survey regarding participation in SCRALA activities. Households were categorized between treatment and control groups based on their status according to sampling. Respondents from both treatment and control households were asked if they were currently or will in future be participating in SCRALA activities.

The table shows that 98 per cent of the treatment group and 43 per cent of the control group stated that at least one household member had been chosen to or already participated in some SCRALA activity.

According to the design, no households from the control group were expected to indicate participating in SCRALA activities or having benefited by receiving goats or beehives. However, the following factors may have led to control households declaring their participation in SCRALA:

- The head of household misunderstood the question and confused SCRALA with other programmes.
- The head of household attended a SCRALA meeting and raffle, was not selected as a beneficiary but may have understood that they would be a beneficiary shortly.
- The head of household is registered as control, while one of their spouses may have participated in SCRALA.
- Some control households may have received some goats or beehives, while the survey team was not aware of those changes to the beneficiary lists.
- Challenges were encountered during the sampling, data collection or listing phases as discussed above.

Table A - 4 provides some details to further clarify the possible explanations for those results within the control group. When only considering the households who received at least one goat or one beehive, only 4 per cent of the control households declared having received something from SCRALA (with 47 of the 50 households receiving a goat). This allows us to formulate some hypotheses for why 43 per cent of the control households have declared participating in SCRALA activities. Given that only a few of them effectively received at least one goat or beehive from SCRALA, it is likely that the question regarding participation was misunderstood or that SCRALA was confused with another programme.

Additional analysis showed that most control households receiving goats or beehives from SCRALA were concentrated in given areas, particularly in the district of Chama.

As for the treatment group, the questions on SCRALA participation suggest that most treatment households (98 per cent) have either already participated in SCRALA activities or have already been selected. That is consistent with the sampling design, as the treatment group gathers households that had already received goats or beehives and households already selected to receive goats or beehives soon. In total, 60 per cent of the households from the treatment group have already received at least one goat or one beehive. However, this figure may also be inflated by confusion on the part of households between SCRALA and similar previous projects (as for the control group).

Table A - 5 presents further details for the treatment group by gender of the head of the household. Within the female-headed households that received a goat or beehive from SCRALA, 89 per cent of the households reported that the goat or beehive was given to a female household member alone. Within the male-headed households who received a goat or beehive from SCRALA, the recipient

was a man alone for about half of the households (51 per cent). In comparison, in 47 per cent of households, the recipient was either a woman alone or both men and women as joint recipients. Again, this finding is supported by Table A - 3, which shows almost all (95 per cent) male-headed households were married.

C. MODULE A3: BEE KEEPING AND HONEY PROJECT PRODUCTION

Table A - 6 in Appendix 4 shows that four per cent of households are involved in beekeeping and production. More control households (five per cent) undertake this livelihood activity and have done so for longer, on average, for over four years (with both differences significant at the 0.1 per cent level). However, more households in the treatment groups have received training on beekeeping and are also using modern beehives compared to those in the control group (at the one per cent and 0.1 per cent levels, respectively). Modern beehives are recommended because they are expected to produce up to triple the volume of honey compared to traditional beehives and positively contribute to the quality of the honey produced. However, no significant difference in the quantity of honey produced was observed between modern and traditional beehives.

D. MODULE B1: HOUSEHOLD DIET DIVERSITY

Table A - 7 in Appendix 4 shows the consumption of different food groups. Considering the entire sample, food groups that were consumed mainly by households included cereals (90 per cent), orange-fleshed fruits (85 per cent), other vegetables (75 per cent), meat and eggs (66 per cent), oils/fats (66 per cent) and green leafy vegetables (62 per cent). Milk and dairy products (39 per cent), vitamin A-rich vegetables (12 per cent), roots and tubers (19 per cent), and other fruits (17 per cent) were the least commonly consumed. A significantly higher proportion of households in the control group consumed root and tubers, pulses/legumes, green leafy vegetables, and vitamin A-rich fruits.[21] These food groups are typically consumed more by poorer households. On the other hand, a slightly higher proportion of treated households consumed meat and dairy products, food groups which are typically eaten by wealthier households.

E. MODULE B2: LIVELIHOOD, ASSETS, AND FOOD BASED COPING STRATEGIES

This section presents the results on food security, livelihood, and coping strategies. The indicators used in the tables below are discussed in detail in section Chapter 3.

Table A - 8 in Appendix 4 shows the livelihood and asset-based coping strategies for entire, treatment and control samples. The dominant coping strategy employed by about a third (33 per cent) of the treatment and control households was the use of savings to buy food. The other strategies utilized by about a fifth of the entire sample included begging to get food (20 per cent), borrowing money from financial institutions (20 per cent), and reduction of non-food expenses (17 per cent). These coping strategies fall under the “stress” or “neutral” strategies with low severity weights. Leasing land to buy food (two per cent) and selling productive assets to buy food (four per cent) were the livelihood and asset coping strategies used least by households.

[21] One of the reasons for this could be that the treatment group may have attracted wealthier households and control group households are, on average, poorer.

Only two variables showed significant differences between treatment and control groups: more treatment households borrowed money from a formal lender/bank to buy food, and more treatment households sold animals to buy food (both at the five per cent significance level). The average LCSI for the overall sample is 3.6 (minimum 0 and maximum 27). The average LCSI score for the treatment households (3.8) was not statistically different from control households (3.5) based on an independent samples t-test. Regarding gender, the average LCSI for male-headed households (3.7) is not significantly different from female-headed households (3.5).

Table 7 shows that the average CSI was 5.52 for the entire sample (minimum 0 and maximum 24), and there were no significant differences between treatment and control households. Households with an average food CSI score of less than 10 are considered to have an acceptable level of food-based coping strategies. Overall, more than half (81 per cent) of the households were found to have an acceptable level of CSI score, and 19 per cent were food insecure.

Table 7. Food based coping strategies

VARIABLES	ENTIRE SAMPLE (N=2508)	TREATMENT(T) (N=1218)	CONTROL(C) (N=1290)	T-C	[P-VALUE]
Food based coping strategy index	5.5 (4.6)	5.5 (4.6)	5.5 (4.7)	- 0.02	0.9233

Source: LORTA and project teams
Note: * p < 0.05, ** p < 0.01, *** p<0.001

Sources of monetary income in the past 12 months for treatment and control households are shown in Figure A - 1 in Appendix 4. Food production and sales are highlighted as the most frequent source of income by about 30 per cent of treatment and 22 per cent of the control households. Casual labour and cash crop production were the second and third frequent sources of income among the two household categories. Having their own business was noted as the source of cash income by about 10 per cent of households, while about five per cent relied on livestock production and sales for income. Overall, these results suggest that most households in the project district rely on agricultural production as a major source of cash income.

Source: LORTA and project teams

in Appendix 4 highlights the household food sources differentiated by treatment status. Results show that overall, a household's own production was the most important household food source over the last 12 months. More than half of the treatment (60 per cent) and control households (70 per cent) reported own production as their primary food source. Approximately one-tenth (10 per cent) of treatment and control households reported that income from casual labour was their primary means of acquiring food. Around 10 per cent of control households and 15 per cent of treatment households, respectively, reported that their main source of food was derived from cash income.

Table A - 9 in Appendix 4 shows the specific sources of income that the households reported in the last month before the survey, categorized by treatment status. In terms of value per source without consideration of the frequency, the largest sources of income ranging from highest to the lowest were salaries (ZMW873), income from own businesses (ZMW723), loans (ZMW675), crop sales (ZMW579), livestock sales (ZMW520), and from pensions (ZMW520). Income from sales of livestock products and social transfers was the lowest. Despite salaries, loans, and pensions being the primary source in terms of value, these were only confined to less than five per cent of the sample (see Figure A - 1 in Appendix 4). While crop sales were ranked fourth in value, these were the dominant sources of income relied upon by about a third (33 per cent) of the sampled households

(see Figure A - 1 in Appendix 4). Differences in petty trading (including cross-border trade) and fishing and gathering natural products such as firewood and fruits were observed between treatment and control households. The collection of natural resources as a source of income is typically practised by poorer households and supports the narrative that control households display characteristics of poorer rural dwellers.

Household expenditures in the last calendar month before the survey are shown in Table A - 10 (in Appendix 4). Concerning food items, the highest expenditures were allocated to maize meal (ZMW183) and maize grain (ZMW169) for the entire sample. This is expected, considering maize is the staple food for rural households and all significant food policies are centred on maize (Chisanga and Zulu-Mbata, 2018). The next most important expenditure costs were transport (ZMW193), cooking fuel (ZMW89), and domestic services (ZMW75). None of these showed significant differences between treatment and control households. However, treatment households incurred significantly higher expenditure levels (at the 10 per cent level) on wheat flour (ZMW76) compared to control households (ZMW50). This more expensive food group was more common among the treatment group. Other expenditure lines that treatment households spent significantly more on included tea leaves and coffee (five per cent), peanut butter, jam, and margarine (five per cent), and soya mince/soya chunks (five per cent). All these products are relatively luxurious commodities in rural Zambia. In contrast, other products that treatment households spent significantly more on include staple food crops: sweet potatoes and other tubers (both significant at five per cent). Control households may spend less on these items because they grow more (see Table A - 10 in Appendix 4). The one product control on which households spent significantly more was salt/soup (five per cent).

Household expenditures in the 12 months before the survey are shown in Table A - 11 (in Appendix 4). The highest expenditures were allocated to agricultural inputs (ZMW1151) and education (ZMW1149), followed by construction (ZMW1028) and business-running costs (ZMW966). Treatment households incurred significantly lower expenditure on agricultural inputs (ZMW918) compared to control households (ZMW1371). There were no significant differences between treatment and control households regarding education and construction expenditures. The other notable expenditures were allocated to loan repayments (ZMW461), clothing (ZMW437) as well as agricultural labour and tillage (ZMW433). Treatment households spent significantly less on clothing/footwear (excluding school uniforms) and agricultural services in the form of labour and tillage (five per cent). That treatment households are spending less on agricultural inputs and services suggests they are making more use of other forms of fertilizer and conservation agriculture. This interpretation of these findings is underpinned by Table A - 12 in Appendix 4, illustrating that treatment households are more familiar with zero or minimum tillage agriculture. Table A - 12 in Appendix 4 further shows that they used more organic fertilizer and manure.

F. Module C: Agricultural production technologies

Table A - 12 in Appendix 4 shows that over three-quarters of the entire sample was familiar with crop rotation (84 per cent) and organic fertilizers (79 per cent) in the past 12 months. More than half of all households were familiar with intercropping (73 per cent), adapted and drought-tolerant crops and varieties (70 per cent), composting (54 per cent), and minimum/zero tillage (54 per cent). Less than a quarter (24 per cent) of the households were familiar with animal fodder production. In addition to zero or minimum tillage agriculture, organic fertilizer, and manure, treatment households were significantly more familiar with adapted and drought-tolerant crops and varieties.

While more than three-quarters of the households were familiar with crop rotation and organic fertilizers, only about 57 per cent and 41 per cent used these techniques in the past 12 months, respectively (see Table A - 13 in Appendix 4). About 40 per cent of all households adopted intercropping and used adaptable and drought-tolerant crops and crop varieties. The least-adopted technologies in the past 12 months were animal fodder, micro-irrigation, agroforestry, and homemade livestock feeds. Less than a fifth (20 per cent) of households adopted these technologies. A significantly higher proportion of control households adopted intercropping compared to treatment households.

On the other hand, a significantly greater number of treatment households adopted organic fertilizers compared to control households. What is clear from these results is that higher levels of knowledge about agricultural technologies do not necessarily translate into higher adoption rates. There could be other underlying factors constraining the adoption of climate-smart agricultural technologies. This is an area of further research.

G. Module D: Crop production for all crops grown by the household during the 2019/20 production year

Overall, the mean total owned land size was 4.5 hectares with 3.7 hectares of cultivated land (Table 8). The mean arable land planted within the sample was 2.2 hectares; households held 1.8 fields on average. The distance between the homestead and agricultural land was 2.2 kilometres. Treatment households held significantly more land (4.7 hectares) than control households (4.2 hectares) at the five per cent level.

Table 8. Summary statistics for agricultural land variables

Variables	Entire sample (N=2508)	Treatment (T) (N=1218)	Control (C) (N=1290)	T-C	[p-value]
Total household landholding in hectares	4.5 (6.1)	4.7 (4.7)	4.2 (4.2)	0.51*	0.0353
Number of fields owned per household	1.8 (1.0)	1.8 (1.0)	1.8 (1.1)	0.01	0.7413
Area of cultivated fields in hectares	3.7 (5.0)	3.8 (4.8)	3.5 (5.3)	0.31	0.1233
Area planted in hectares	2.2 (2.9)	2.2 (2.2)	2.2 (2.2)	0.01	0.9450
Distance between the field and homestead in km	2.2 (10.8)	2.0 (2.0)	2.3 (2.4)	- 0.37	0.3866

Source: LORTA and project teams
Note: * p < 0.05, ** p < 0.01, *** p<0.001

Table A - 14 in Appendix 4 shows the proportion of households that grew different types of crops. Almost all households (94 per cent) grew maize. Sorghum was the second most frequent cereal crop, grown by about a third (27 per cent) of households. A significantly higher proportion of treatment households grew sorghum compared to control households. Sorghum is drought-tolerant and thus suited for farming in arid areas. It is widely used for brewing local beer. A significantly higher proportion of treatment households also grew sunflower compared to control households.

Groundnuts are the most frequently grown legume, grown by slightly over a third of the households (36 per cent), followed by mixed beans (11 per cent). A significantly higher proportion of control households grew groundnuts and mixed beans compared to treatment households. As mentioned above, significantly more control households grew cassava and sweet potatoes than treatment households.[22] No households grew kenaf, paprika, sesame, red sunhemp and black sunhemp.

Most plots cultivated (72 per cent) are owned by households (Table 9). Less than 2 per cent of the plots for treatment and control households were rented in, rented out, borrowed in and out. The literature highlights that households tend to have a propensity to invest in land development (e.g. soil and water conservation technologies, fencing, etc.) if they own that land (de Graaff and others, 2008).

Table 9. Main land use of agricultural fields

VARIABLES	ENTIRE SAMPLE (N=4537)	TREATMENT (T) (N=2212)	CONTROL (C) (N=2325)	T-C	[P-VALUE]
Own cultivated field	3268 (72%)	1608 (72%)	1660 (71%)	- 1.80*	0.0294
Rented in	38 (1%)	22 (1%)	16 (1%)	0.36	0.3089
Borrowed in	53 (1%)	22 (1%)	31 (1%)	- 0.50	0.2304
Garden	32 (1%)	25 (1%)	7 (0.3%)	1.04**	0.0012
Fallow	57 (1%)	37 (2%)	20 (1%)	0.99*	0.0204
Rented out	6 (0.1%)	0 (0%)	6 (0.3%)	- 0.34*	0.0148
Borrowed out	1 (0.02%)	1 (0.1%)	0 (0%)	0.06	0.3143
Orchard	29 (1%)	14 (1%)	15 (1%)	- 0.05	0.8789
Virgin land	6 (0.1%)	5 (0.2%)	1 (0.04%)	0.23	0.0990

Source: LORTA and project teams
Note: * p <.05, ** p < 0.01, *** p<0.001

Table 10 shows the land tenure and mode of acquisition used by households. Customary tenure without titles was the dominant tenure system for most household fields (91 per cent). About 7 per cent of the fields had customary land titles. The lower panel of the table shows households' land acquisition mode. The majority of the land was acquired through being allocated and inherited. This is plausible given that most of the land is under customary land tenure and is passed to ensuing generations through inheritance and allocation by traditional local leadership.

[22] Significant differences were also observed for crops such as rice, sugarcane and pigeon peas but the sample size was too small to for reporting these differences.

Table 10. Field tenure and mode of acquisition

VARIABLES	ENTIRE SAMPLE (N=4537)	TREATMENT (T) (N=2212)	CONTROL (C) (N=2325)	T-C	[P-VALUE]
Tenure					
State land-titled	69 (2%)	33 (1.5%)	36 (2%)	- 0.06	0.8765
State land not titled	44 (1%)	29 (1%)	15 (1%)	0.67*	0.0222
Former customary land-titled	300 (7%)	165 (7.5%)	135 (6%)	1.65*	0.0251
Customary no title	4124 (91%)	1985 (90%)	2139 (92%)	- 2.26**	0.0081
Acquisition					
Purchased	157 (3.5%)	71 (3.2%)	86 (4%)	- 0.49	0.3677
Inherited	1617 (36%)	805 (36%)	812 (35%)	1.47	0.3023
Allocated / Given	2262 (50%)	1140 (51.5%)	1122 (48%)	3.28*	0.0272
Rented / Borrowed	119 (3%)	53 (2%)	66 (3%)	- 0.44	0.3511
Just walked in	377 (8%)	140 (6%)	237 (10%)	- 3.86***	<0.0001
Other	5 (0.1%)	3 (0.1%)	2 (0.1%)	0.05	0.6148

Source: LORTA and project teams
Note: * p < 0.05, ** p < 0.01, *** p<0.001

Table 11 shows the type of seeds predominantly used by households on their plots. Improved seeds consist of hybrids and open-pollinated seeds that have been formally certified. Recycled is the retained grain from previous harvests that were selected as seeds. Local seeds refer to local landraces.[23] About 44 per cent of the plots in the sample used improved seeds, while 30 per cent relied on local seeds purchased from fellow farmers and local markets. About 27 per cent of the plots were planted with recycled seeds. A higher proportion of plots among treatment households (32 per cent) used local seed compared to plots for control households (27 per cent).

[23] Seeds native to the area.

Table 11. Type of agricultural seed used

VARIABLES	ENTIRE SAMPLE (N=4537)	TREATMENT (T) (N=2212)	CONTROL (C) (N=2325)	T-C	[P-VALUE]
Seed used					
Improved seed	1987 (44%)	961 (43%)	1026 (44%)	- 0.68	0.6425
Local	1346 (30%)	708 (32%)	638 (27%)	4.57***	0.0008
Recycled	1204 (27%)	543 (25%)	661 (28%)	- 3.88**	0.0031

Source: LORTA and project teams
Note: * p < 0.05, ** p < 0.01, *** p<0.001

Table 12 shows the seed sources used by the household for all the crops. About 39 per cent of the household's crop plots in the entire sample relied on retained seed (from their harvest) for their planting requirements. FISP and shops/traders were the second and third most dominant sources of seed used – on 15 per cent and 11 per cent of the plots, respectively. Retained seeds, FISP, and shops/traders were the dominant seed sources used by households in the year before the survey. The FISP and shops tend to be the major suppliers of improved seeds. However, the shops/traders that supply improved seeds tend to have a poor network in the rural areas and programmes that work on upgrading and expanding them are crucial. Local varieties are better known for their adaptability and ability to produce good yields without using fertilizer. The fact that recycled/retained seed is coming from their stock means that farmers can be trained in the best methods of producing and preserving their seed.

Table 12. Main source of agricultural seeds used

VARIABLES	ENTIRE SAMPLE (N=4537)	TREATMENT (T) (N=2212)	CONTROL (C) (N=2325)	T-C	[P-VALUE]
Own saved seed from own harvest	1760 (39%)	828 (37%)	932 (40%)	- 2.65	0.0667
Seed saved from last season's purchase	114 (3%)	37 (2%)	77 (3%)	- 1.64***	0.0004
FISP	683 (15%)	358 (16%)	325 (14%)	2.21*	0.0378
Trader/shopkeeper	511 (11%)	251 (11%)	260 (11%)	0.16	0.8611
Private seed suppliers/companies	230 (5%)	95 (4%)	135 (6%)	- 1.51*	0.0203
Gift from family/neighbour	188 (4%)	112 (5%)	76 (3%)	1.79**	0.0024
Farmer to the farmer seed exchange	83 (2%)	52 (2%)	31 (1%)	1.02*	0.0106
Local market/open-air	79 (2%)	38 (2%)	41 (2%)	- 0.05	0.9067

VARIABLES	ENTIRE SAMPLE (N=4537)	TREATMENT (T) (N=2212)	CONTROL (C) (N=2325)	T-C	[P-VALUE]
On-farm trials	5 (0.1%)	0 (0%)	5 (0.2%)	- 0.22*	0.0291
Extension demo plots	2 (0.04%)	0 (0%)	2 (0.1%)	- 0.09	0.1677
Farmer groups/Coops	166 (4%)	112 (5%)	54 (2%)	2.74***	<0.0001
Local seed producers	40 (1%)	23 (1%)	17 (1%)	0.31	0.2665
Provided free by NGOs/govt	64 (1%)	40 (2%)	24 (1%)	0.78*	0.0267
Research centres	3 (0.1%)	3 (0.1%)	0 (0%)	0.14	0.0757
Agrovets	241 (5%)	93 (4%)	148 (6%)	- 2.16**	0.0012
Farmer-to-farmer trading	117 (3%)	54 (2%)	63 (3%)	- 0.27	0.5686
Other	251 (6%)	116 (5%)	135 (6%)	- 0.56	0.4077

Source: LORTA and project teams
Note: * p < 0.05, ** p < 0.01, *** p<0.001

Regarding methods of acquiring seeds, survey results show that cash purchases (60 per cent) dominated the entire sample and across treatment and control households' plots (Table 13). These findings show that farmers are willing to pay for seeds when the crop is an important means of livelihood. Seed delivery mechanisms that motivate farmers to buy seeds should be encouraged, and seed aid should only be confined to vulnerable population groups. The second dominant mode of seed acquisition was social networks, which included informal seed exchanges between family, friends, and fellow farmers.

Table 13. Agricultural seed acquisition

VARIABLES	ENTIRE SAMPLE (N=4537)	TREATMENT (T) (N=2212)	CONTROL (C) (N=2325)	T-C	[P-VALUE]
Main method of payment for seed					
Own cash	2719 (60%)	1293 (58%)	1426 (61%)	- 2.88*	0.0479
Money received as a gift from relatives and non-relatives	65 (1%)	39 (2%)	26 (1%)	0.64	0.0677
Credit from a money lender	5 (0.1%)	1 (0.1%)	4 (0.2%)	- 0.13	0.1982
Credit from seed dealers	29 (0.6%)	11 (0.5%)	18 (0.8%)	- 0.28	0.2422

VARIABLES	ENTIRE SAMPLE (N=4537)	TREATMENT (T) (N=2212)	CONTROL (C) (N=2325)	T-C	[P-VALUE]
Credit from relative /neighbour /friend	19 (0.4%)	7 (0.3%)	12 (0.5%)	- 0.20	0.2980
Credit from micro-finance	3 (0.1%)	1 (0.1%)	2 (0.1%)	- 0.04	0.5931
Credit from NGO	14 (0.3%)	6 (0.3%)	8 (0.3%)	- 0.07	0.6585
Credit from coops	13 (0.3%)	5 (0.2%)	8 (0.3%)	- 0.12	0.4573
Other	1670 (37%)	849 (38%)	821 (35%)	3.07*	0.0321

Source: LORTA and project teams
Note: * p < 0.05, ** p < 0.01, *** p<0.001

Table 14 shows the main tillage methods used by households. Conventional ploughing was the dominant tillage method used by slightly over half of the plots (54 per cent). A higher proportion of plots for treatment households (63 per cent) compared to control households' plots (46 per cent) were conventionally ploughed. Conventional hand hoeing was the second most common tillage method used. Ripping and ridging before planting was used on about 8 per cent of the plots.

Table 14. Main tillage methods implemented

VARIABLES	ENTIRE SAMPLE (N=4537)	TREATMENT (T) (N=2212)	CONTROL (C) (N=2325)	T-C	[P-VALUE]
Conventional hand hoeing	998 (22%)	422 (19%)	576 (25%)	- 5.70***	<0.0001
Planting basins (potholes)	117 (3%)	53 (2%)	64 (3%)	- 0.36	0.4488
Zero tillage excluding shifting cultivation (chitemene)	106 (2%)	43 (2%)	63 (3%)	- 0.77	0.0879
Ploughing	2463 (54%)	1387 (63%)	1076 (46%)	16.42***	<0.0001
Ripping	325 (7%)	181 (8%)	144 (6%)	1.99**	0.0094
Ridging (before planting)	368 (8%)	33 (1.5%)	335 (14%)	- 12.92***	<0.0001
Bunding	8 (0.2%)	3 (0.1%)	5 (0.2%)	- 0.08	0.5240
Mounding	14 (0.3%)	11 (0.5%)	3 (0.1%)	0.37*	0.0254
Did not till (broadcasted seed)	16 (0.4%)	3 (0.1%)	13 (0.6%)	- 0.42*	0.0162
No other tillage method	122	76	46	1.46**	0.0024

VARIABLES	ENTIRE SAMPLE (N=4537)	TREATMENT (T) (N=2212)	CONTROL (C) (N=2325)	T-C	[P-VALUE]
	(3%)	(3%)	(2%)		

Source: LORTA and project teams
Note: * p < 0.05, ** p < 0.01, *** p<0.001

Table 15 shows the source of power used for tillage on household crop plots. Manual household labour was the main source of power used for tillage on 45 per cent of the plots. A higher proportion of plots (50 per cent) among control households relied on manual labour for tilling compared to 39 per cent of the plots among treatment households. The second major source of power for tillage were the household's own animals. This was significantly higher among treatment compared to control households. The use of borrowed animals and household labour was reported for 11 per cent of the plots in the entire sample. The least-used source of power reported by the sampled households was tractors for mechanized tillage. The over-reliance on manual power for tillage is negatively associated with drudgery and time poverty. The use of tractors tends to be associated with faster and timely completion of tillage.

Table 15. Main type and source of power used for the main type of tillage

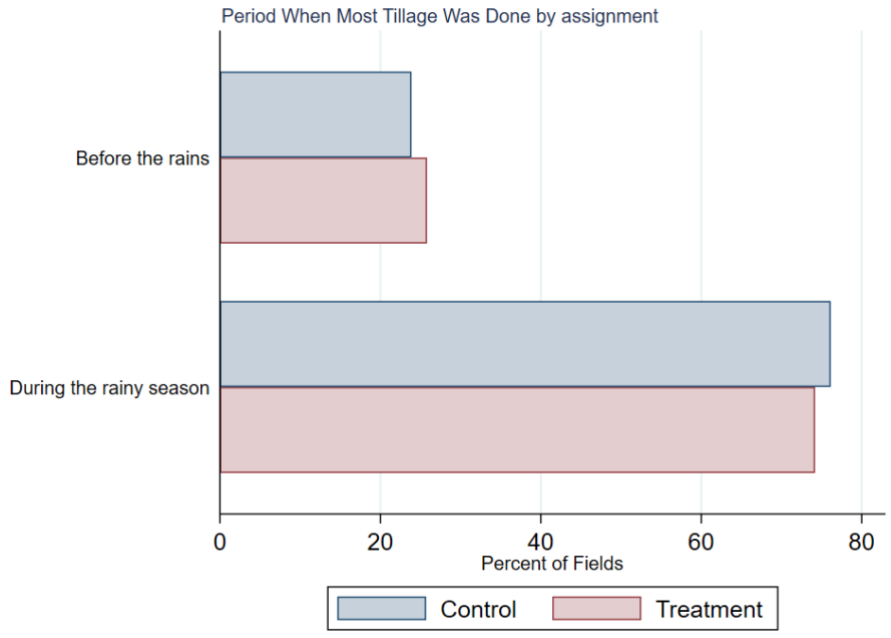
VARIABLES	ENTIRE SAMPLE (N=4537)	TREATMENT		GENDER		T - C	[P-VALUE]
		TREATMENT (T) (N=2212)	CONTROL (C) (N=2325)	MALE (N=3488)	FEMALE (N=1049)		
Manual household labour	2021 (45%)	863 (39%)	1158 (50%)	1558 (45%)	463 (44%)	- 10.79***	<0.0001
Manual hired labour	247 (5%)	93 (4%)	154 (7%)	183 (5%)	64 (6%)	- 2.42***	0.0003
Own animals with household (HH) labour	1153 (25%)	642 (29%)	511 (22%)	988 (28%)	165 (16%)	7.05***	<0.0001
Own animals with hired labour	125 (3%)	58 (3%)	67 (3%)	78 (2%)	47 (4.5%)	- 0.26	0.5934
Hired/borrowed animals with HH labour	503 (11%)	276 (12.5%)	227 (10%)	350 (10%)	153 (15%)	2.71**	0.0036
Hired/borrowed animals with hired labour	287 (6%)	162 (7%)	125 (5%)	176 (5%)	111 (11%)	1.95**	0.0071
Own mechanical with HH labour	15 (0.3%)	10 (0.5%)	5 (0.2%)	13 (0.4%)	2 (0.2%)	0.24	0.1645
Own mechanical with hired labour	4 (0.1%)	2 (0.1%)	2 (0.1%)	1 (0.03%)	3 (0.3%)	0.00	0.9603
Hired/borrowed mechanical with HH labour	11 (0.2%)	7 (0.3%)	4 (0.2%)	11 (0.3%)	0 (0%)	0.14	0.3229

VARIABLES	ENTIRE SAMPLE (N=4537)	TREATMENT		GENDER		T - C	[P-VALUE]
		TREATMENT (T) (N=2212)	CONTROL (C) (N=2325)	MALE (N=3488)	FEMALE (N=1049)		
Hired/borrowed mechanical with hired labour	9 (0.2%)	5 (0.2%)	4 (0.2%)	6 (0.2%)	3 (0.3%)	0.05	0.6829
None	162 (4%)	94 (4%)	68 (3%)	124 (4%)	38 (4%)	1.32*	0.0162

Source: LORTA and project teams
Note: * p < 0.05, ** p < 0.01, *** p<0.001

Figure 4 shows the time when most tillage was done. Over 70 per cent of treatment and control households' fields were tilled after the onset of rain, and only 20 per cent were tilled during the dry season. Most households practice hand cultivation and wait for the onset of rains for the ground to be wet. Yet, early tillage in the dry season is advisable to allow proper decomposition of organic matter and destruction of weed seeds.

Figure 4. Period when most tillage was done by assignment



Source: LORTA and project teams

Table 16 shows the other agricultural practices implemented in the study area by treatment status. About 2 per cent of the household plots had gravity/flood irrigation practices, and there are no differences by treatment status. As concerns residue management, about 41 per cent of the entire sample left them in the fields for animal grazing, and 25 per cent ploughed them into the ground to decompose and add organic matter.

Table 16. Other agricultural practices implemented

VARIABLES	ENTIRE SAMPLE (N=4537)	TREATMENT		GENDER		T - C	[P-VALUE]
		TREATMENT (T) (N=2212)	CONTROL (C) (N=2325)	MALE (N=3488)	FEMALE (N=1049)		
Other agricultural practices							
Inter cropping	1208 (27%)	538 (24%)	670 (29%)	921 (26%)	287 (27%)	-4.50***	0.0006
Irrigation	115 (3%)	69 (3%)	46 (2%)	97 (3%)	18 (2%)	1.14	0.0145
Irrigation type							
Gravity/flood	76 (2%)	49 (2%)	27 (1%)	64 (2%)	12 (1%)	12.32	0.1746
Sprinkler	1 (0.02%)	0 (0%)	1 (0.04%)	1 (0.03%)	0 (0%)	- 2.17	0.2222
Drip	17 (0.4%)	8 (0.4%)	9 (0.4%)	15 (0.4%)	2 (0.2%)	- 7.97	0.2418
Others specify	21 (0.5%)	12 (0.5%)	9 (0.4%)	17 (0.5%)	4 (0.4%)	- 2.17	0.7700
Applied herbicides and/or pesticides	714 (16%)	400 (18%)	314 (13.5%)	588 (17%)	126 (12%)	4.58***	<0.0001
Applied manure	940 (21%)	520 (23.5%)	420 (18%)	732 (21%)	208 (20%)	5.44***	<0.0001
Applied compost	461 (10%)	255 (12%)	206 (9%)	361 (10%)	100 (10%)	2.67**	0.0029
Disposal of crop residues from the previous season							
Left in the field then ploughed/incorporated into the field	1153 (25%)	506 (23%)	647 (28%)	868 (25%)	285 (27%)	-4.95***	0.0001
Left in the field and grazed by animals	1854 (41%)	1079 (49%)	775 (33%)	1407 (40%)	447 (43%)	15.45***	<0.0001
Burned on field	690 (15%)	225 (10%)	465 (20%)	537 (15%)	153 (15%)	-9.83***	<0.0001
Cut and spread on the field	385 (8.5%)	192 (9%)	193 (8%)	323 (9%)	62 (6%)	0.38	0.6472
Cut and removed from field and fed to animals	57 (1%)	31 (1%)	26 (1%)	49 (1%)	8 (1%)	0.28	0.3921
Cut and removed from the field for other household use	24 (1%)	10 (0.5%)	14 (1%)	16 (0.5%)	8 (1%)	- 0.15	0.4862
The new field cleared later	35 (1%)	15 (1%)	20 (1%)	25 (1%)	10 (1%)	- 0.18	0.4836

Variables	Entire sample (N=4537)	Treatment		Gender		T - C	[P-value]
		Treatment (T) (N=2212)	Control (C) (N=2325)	Male (N=3488)	Female (N=1049)		
Left in the field or did nothing	339 (7%)	154 (7%)	185 (8%)	263 (8%)	76 (7%)	- 0.99	0.2027

Source: LORTA and project teams
Note: * p < 0.05, ** p < 0.01, *** p<0.001

Table 17 presents details regarding production decisions and production stresses that have affected the households, by treatment status, and by gender of the household head.

Households headed by males or females present different patterns regarding who is responsible for the decisions on when to harvest the crop. In female-headed households, the female head more often makes the decisions alone (79 per cent of the female-headed households). But in only 26 per cent of male-headed households is the decision taken exclusively by the male head. Again, this must be seen from the perspective of previous results that have shown that only a few of the female-headed households have spouses.

The major production stresses experienced by the households are insects/pests (48 per cent); in particular, 19 per cent of households were affected by the fall armyworm). There is no significant difference in the production stresses experienced depending on the treatment status or the gender of the head of the household. Female-headed households reported higher levels of stress. For instance, 21 per cent of female-headed households declared that stress has had a catastrophic impact on their household, against 17 per cent for male-headed households.

Table 17. Decisions on production and production stress

Variables	Entire sample (N=2508)	Treatment		Gender		T - C	[P-value]
		Treatment (T) (N=1218)	Control (C) (N=1290)	Male (N=1864)	Female (N=644)		
Who decided when to harvest the crop							
Self	998 (40%)	466 (38%)	532 (41%)	490 (26%)	508 (79%)	- 3.39	0.0797
Spouse	157 (6%)	70 (6%)	87 (7%)	141 (8%)	16 (2.5%)	- 1.08	0.2782
Self and spouse jointly or another household member	1159 (46%)	585 (48%)	574 (45%)	1092 (59%)	67 (10%)	3.41	0.0820
Self and another household member (s) or Spouse and another household member (s)	72 (3%)	42 (3.5%)	30 (2%)	35 (2%)	37 (6%)	1.06	0.1206

VARIABLES	ENTIRE SAMPLE (N=2508)	TREATMENT		GENDER		T - C	[P-VALUE]
		TREATMENT (T) (N=1218)	CONTROL (C) (N=1290)	MALE (N=1864)	FEMALE (N=644)		
Major stresses experienced							
Insects/pests	1204 (48%)	608 (50%)	596 (46%)	906 (49%)	298 (46%)	1.88	0.3656
Disease	50 (2%)	19 (2%)	31 (2%)	43 (2%)	7 (1%)	- 1.25	0.1335
Waterlogging	55 (2%)	23 (2%)	32 (2.5%)	42 (2%)	13 (2%)	- 0.98	0.2676
Drought	210 (8%)	120 (10%)	90 (7%)	141 (8%)	69 (11%)	4.15**	0.0084
Frost	1 (0.04%)	0 (0%)	1 (0.1%)	0 (0%)	1 (0.2%)	- 0.08	0.5935
Hailstorm	24 (1%)	4 (0.3%)	20 (2%)	19 (1%)	5 (1%)	- 1.73**	0.0023
Animal trampling	18 (1%)	7 (1%)	11 (1%)	14 (1%)	4 (1%)	- 0.19	0.7109
Fall armyworm	474 (19%)	230 (19%)	244 (19%)	345 (19%)	129 (20%)	- 1.23	0.5627
Other	20 (1%)	11 (1%)	9 (1%)	13 (1%)	7 (1%)	0.41	0.4493
Level of stress							
Moderate	395 (16%)	195 (16%)	200 (16%)	312 (17%)	83 (13%)	- 0.32	0.8719
Severe	727 (29%)	347 (28.5%)	380 (29.5%)	531 (28.5%)	196 (30%)	- 3.55	0.1207
Catastrophic	453 (18%)	238 (20%)	215 (17%)	318 (17%)	135 (21%)	3.87	0.0644

Source: LORTA and project teams
Note: * p < 0.05, ** p < 0.01, *** p<0.001

Table 18 shows the input costs and maize yield by treatment status. Households realized an average yield of 1.5 tonnes per hectare; no significant differences existed between treatment and control. The yields obtained are slightly lower than the national average of 2.6 tonnes per hectare. This is expected given that the project is being implemented in arid regions of the country. The major cost drivers of maize production in decreasing order of cost were basal fertilizer, top-dressing fertilizer, and seeds.

Table 18. Maize production values and variables cost

VARIABLES	ENTIRE SAMPLE (N=2508)	TREATMENT (T) (N=1218)	CONTROL (C) (N=1290)	T-C	[P-VALUE]
Yield (kgs/hectare)	1520.78 (3187.07)	1494.17 (3440.43)	1546.76 (2919.86)	- 52.59	0.6866
Gross Value of Production in ZMW per hectare	2247.18 (2821.30)	1977.41 (2631.19)	2507.78 (2971.44)	- 530.36***	0.0000
Cost of seed planted in ZMW per hectare	474.05 (1016.22)	420.39 (480.59)	519.88 (1309.35)	- 99.48	0.1028
Cost of basal dressing fertilizer in ZMW per hectare	939.45 (3263.39)	761.57 (3022.59)	1094.39 (3454.57)	- 332.82	0.0891
Cost of top-dressing fertilizer in ZMW per hectare	849.03 (2211.34)	747.62 (3023.36)	936.32 (1106.37)	- 188.70	0.1566
Cost of hired oxen in ZMW per hectare	456.30 (2289.59)	596.29 (3236.14)	321.76 (453.34)	274.53	0.2299
Cost of a hired tractor in ZMW per hectare	479.64 (407.02)	484.03 (369.72)	474.78 (455.00)	9.25	0.9439
Cost of hiring manual labour in ZMW per hectare	524.36 (2286.29)	634.59 (3484.02)	445.09 (521.97)	189.49	0.4119

Source: LORTA and project teams
Note: * p < 0.05, ** p < 0.01, *** p<0.001

Table 19 shows the marketing outlets for all agricultural products. Farmers rely on multiple market outlets when selling their produce. Sales to the small-scale trader (16 per cent) are commonly followed by sales to other households (12 per cent) and direct sales to food reserve agency (FRA)d (nine per cent).

Table 19. Market for agricultural output

VARIABLES	ENTIRE SAMPLE (N=3287)	TREATMENT		GENDER		T - C	[P-VALUE]
		TREATMENT (T) (N=1563)	CONTROL (C) (N=1724)	MALE (N=2484)	FEMALE (N=803)		
Small-scale trader	518 (15.76%)	236 (15.10%)	282 (16.36%)	395 (15.90%)	123 (15.32%)	2.45	0.2533
Large-scale trader/wholesaler	70 (2.13%)	28 (1.79%)	42 (2.44%)	61 (2.46%)	9 (1.12%)	- 0.54	0.5521
Retailer/market	218 (6.63%)	85 (5.44%)	133 (7.71%)	178 (7.17%)	40 (4.98%)	- 2.19	0.1563
Other households	389 (11.83%)	210 (13.44%)	179 (10.38%)	297 (11.96%)	92 (11.46%)	9.20***	<0.0001
A direct sale to FRA	293 (8.91%)	77 (4.93%)	216 (12.53%)	234 (9.42%)	59 (7.35%)	- 11.31***	<0.0001

Variables	Entire sample (N=3287)	Treatment		Gender		T - C	[P-value]
		Treatment (T) (N=1563)	Control (C) (N=1724)	Male (N=2484)	Female (N=803)		
Sale to FRA through a coop	16 (0.49%)	8 (0.51%)	8 (0.46%)	13 (0.52%)	3 (0.37%)	0.24	0.5961
NGO/faith-based organization/church	2 (0.06%)	2 (0.13%)	0 (0.00%)	2 (0.08%)	0 (0.00%)	0.25	0.1066
Cooperative (not destined for FRA)	6 (0.18%)	2 (0.13%)	4 (0.23%)	4 (0.16%)	2 (0.25%)	- 0.14	0.6166
Directly to miller/ processor delivered	42 (1.28%)	26 (1.66%)	16 (0.93%)	37 (1.49%)	5 (0.62%)	1.74*	0.0147
To miller/processor through agent or delivery	32 (0.97%)	18 (1.15%)	14 (0.81%)	24 (0.97%)	8 (1.00%)	0.92	0.1409
Out grower	3 (0.09%)	2 (0.13%)	1 (0.06%)	3 (0.12%)	0 (0.00%)	0.16	0.4173
COMACO (Community Markets for Conservation	8 (0.24%)	2 (0.13%)	6 (0.35%)	6 (0.24%)	2 (0.25%)	- 0.33	0.2915
Schools, hospitals, or health centres	2 (0.06%)	0 (0.00%)	2 (0.12%)	2 (0.08%)	0 (0.00%)	- 0.20	0.2150
Export trading group	20 (0.61%)	2 (0.13%)	18 (1.04%)	16 (0.64%)	4 (0.50%)	- 1.50**	0.0024
Others	192 (5.84%)	89 (5.69%)	103 (5.97%)	149 (6.00%)	43 (5.35%)	1.25	0.3919

Source: LORTA and project teams
Note: * p < 0.05, ** p < 0.01, *** p<0.001

H. Module E: Shocks, stress and resilience

Climatic and economic shocks aggravate food insecurity and severely impact livelihoods, especially in poor households. One of the SCRALA objectives is to build household resilience capacities to cope with shocks or stresses and early recovery for better livelihoods and food security. Household level information was collected for a 12-month recall period to better understand the types of shock exposures, household level impacts, and coping strategies utilized. The major climatic / environmental shock experienced by the majority of the households were crop diseases and pests (67 per cent), followed by drought (49 per cent) (Table 20). A higher proportion of treatment households experienced drought than control households, suggesting a geographical difference between control and treatment. The major crop pest that has caused considerable yield losses in Southern Africa is the African armyworm. Sharp food price increases were the top-most economic shock (53 per cent) that households experienced in the past 12 months, followed by high agricultural input prices (33 per cent). Theft of livestock was highlighted by 21 per cent of the sampled households. About 18 per cent of the households reported income loss due to COVID-19, and the proportion of treatment households reporting this shock was higher compared to control households.

Table 20. Shocks/stress

VARIABLES	ENTIRE SAMPLE (N=2508)	TREATMENT (T) (N=1218)	CONTROL (C) (N=1290)	T-C	[P-VALUE]
Climatic/environmental					
Excessive rains	607 (24.20%)	195 (16.01%)	412 (31.94%)	- 15.98***	<0.0001
Flood/flash flood	283 (11.28%)	115 (9.44%)	168 (13.02%)	- 3.60**	0.0044
Variable/infrequent rainfall	729 (29.07%)	432 (35.47%)	297 (23.02%)	12.49***	<0.0001
Drought	1238 (49.36%)	671 (55.09%)	567 (43.95%)	11.10***	<0.0001
Crop diseases or pests	1683 (67.11%)	834 (68.47%)	849 (65.81%)	2.56	0.1733
Reduced soil productivity	300 (11.96%)	151 (12.40%)	149 (11.55%)	0.91	0.4874
Deforestation (less firewood available)	211 (8.41%)	112 (9.20%)	99 (7.67%)	1.54	0.1660
Frost	134 (5.34%)	79 (6.49%)	55 (4.26%)	2.25*	0.0131
Destructive shocks					
Crop damage/destruction by wildlife	533 (21.25%)	267 (21.92%)	266 (20.62%)	1.26	0.4428
Theft of livestock (raids)	516 (20.57%)	263 (21.59%)	253 (19.61%)	1.92	0.2352
Economic shocks					
Sharp food price increase	1338 (53.35%)	676 (55.50%)	662 (51.32%)	4.65*	0.0201
The increased price of agricultural / livestock input	821 (32.74%)	393 (32.27%)	428 (33.18%)	- 0.14	0.9418
Reduced price of agricultural (including cash crops) or livestock products	233 (9.29%)	121 (9.93%)	112 (8.68%)	1.42	0.2411
Death of a household member	273 (10.89%)	127 (10.43%)	146 (11.32%)	- 0.90	0.4716
Death of livestock (cattle, donkeys, or goats) due to disease or lack of food or water (poverty deaths)	950 (37.88%)	541 (44.42%)	409 (31.71%)	12.78***	<0.0001

VARIABLES	ENTIRE SAMPLE (N=2508)	TREATMENT (T) (N=1218)	CONTROL (C) (N=1290)	T-C	[P-VALUE]
Serious/chronically ill household member (s)	459 (18.30%)	232 (19.05%)	227 (17.60%)	1.43	0.3558
COVID-19 illness of household member (s)	24 (0.96%)	7 (0.57%)	17 (1.32%)	- 0.74	0.0559
COVID-19 death of a household member (s)	9 (0.36%)	3 (0.25%)	6 (0.47%)	- 0.22	0.3600
COVID-19 related loss of income	459 (18.30%)	241 (19.79%)	218 (16.90%)	3.04	0.0501
Large/unusual expense on medical treatment (T) of a family member(s)	273 (10.89%)	151 (12.40%)	122 (9.46%)	2.99*	0.0164

Source: LORTA and project teams
Note: * p < 0.05, ** p < 0.01, *** p<0.001

Table 21 shows access to climatic and agricultural information from all sources, with multiple responses possible. About 45 per cent of the households accessed early warnings of natural hazards (e.g., drought, heavy rains), while 42 per cent got information regarding crop pests and diseases, including the fall armyworm. Other information types accessed by over a third (33 per cent) of the households included information on animal diseases, weather patterns, crop production improvement methods, and crop prices. About 84 per cent of the sampled household accessed information on COVID-19 (including causes and prevention methods). About half (50 per cent) of the sampled households accessed child nutrition and health information.

Table 21. Access to information and perception of usefulness

VARIABLES	ENTIRE SAMPLE (N=2508)	USEFULNESS	TREATMENT (T) (N=1218)	CONTROL (C) (N=1290)	T-C	[P-VALUE]
Early warning for natural hazards (drought, flooding, heavy rain, hailstorm, etc.) – Disaster Risk Reduction	1141 (45.49%)	33.65%	552 (45.32%)	589 (45.66%)	- 0.26	0.8969
Threats to crop health (e.g., pest, disease including Fall Army Worms (FAW))	1060 (42.26%)	40.79%	503 (41.30%)	557 (43.18%)	- 2.01	0.3084
Threats to animal health (e.g., disease,	878 (35.01%)	34.25%	456 (37.44%)	422 (32.71%)	4.64*	0.0151

VARIABLES	ENTIRE SAMPLE (N=2508)	USEFULNESS	TREATMENT (T) (N=1218)	CONTROL (C) (N=1290)	T-C	[P-VALUE]
epidemic)						
Rainfall/weather prospects for the coming growing season, including Seasonal climate forecasting (Meteorology and Indigenous)	841 (33.53%)	25.04%	423 (34.73%)	418 (32.40%)	2.34	0.2165
Long-term changes in weather patterns	642 (25.60%)	24.56%	336 (27.59%)	306 (23.72%)	3.82	0.0295
Insurance (including weather and yield insurance)	301 (12.00%)	10.61%	173 (14.20%)	128 (9.92%)	4.33***	0.0009
Methods to improve crop production	986 (39.31%)	38.56%	492 (40.39%)	494 (38.29%)	2.22	0.2571
Methods for improved animal health/husbandry	729 (29.07%)	28.55%	390 (32.02%)	339 (26.28%)	5.79**	0.0015
Business and investment opportunities	475 (18.94%)	18.02%	240 (19.70%)	235 (18.22%)	1.59	0.3112
Financial education and credit opportunities	418 (16.67%)	15.67%	218 (17.90%)	200 (15.50%)	2.43	0.1050
Information on crop prices	789 (31.46%)	30.02%	355 (29.15%)	434 (33.64%)	- 4.51*	0.0154
Current market prices of live animals and animal products	425 (16.95%)	16.43%	195 (16.01%)	230 (17.83%)	- 1.84	0.2227
Grazing conditions in a nearby area	304 (12.12%)	11.96%	186 (15.27%)	118 (9.15%)	6.17***	<0.0001
Child nutrition and health information	1275 (50.84%)	50.16%	634 (52.05%)	641 (49.69%)	2.42	0.2261
COVID-19	2116 (84.37%)	82.42%	1067 (87.60%)	1049 (81.32%)	6.23***	<0.0001

Source: LORTA and project teams
Note: * p < 0.05, ** p < 0.01, *** p<0.001

Table 22 shows the proportion of households belonging to different groups. The dominant group was goat keeping, where 47 per cent of households belonged to a goat keeping group. A higher

proportion of households in the treatment category (66 per cent) had membership in the goat keeping group compared to 30 per cent of households in the control category. This is expected as the SCRALA project promotes goat production among its beneficiaries. The other dominant groups were the lead farmer group (26 per cent) and the savings group (23 per cent). A higher proportion of treatment households belonged to farmer field schools and poultry groups compared to those in the control groups. There is scope for the SCRALA project to deliver training and promote resilience interventions to the groups. Training groups on governance, leadership, and cohesion is also imperative to ensure efficient group management and sustainability.

Table 22. Group participation

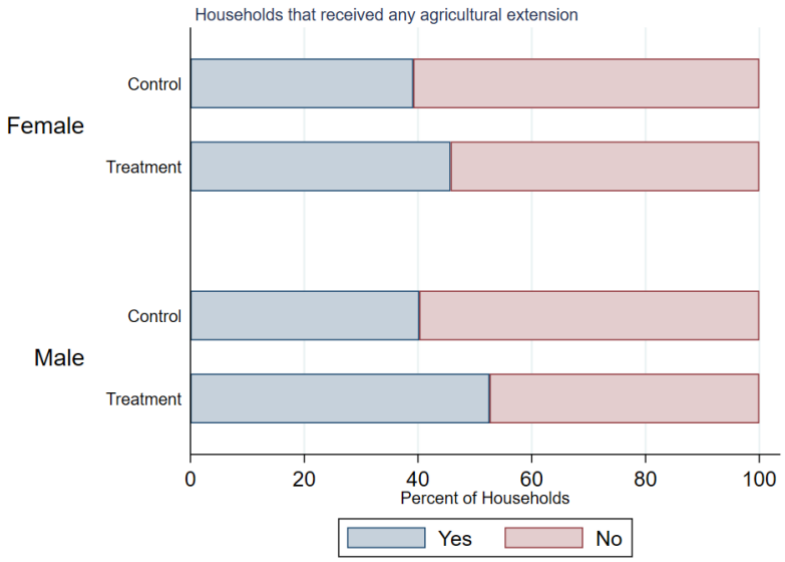
GROUP MEMBERSHIPS	ENTIRE SAMPLE (N=2508)	TREATMENT (T) (N=1218)	CONTROL (C) (N=1290)	T-C	[P-VALUE]
Lead farmer or model farmer's group	657 (26.20%)	352 (28.90%)	305 (23.64%)	5.19**	0.0033
Farmer field school (FFS)	290 (11.56%)	160 (13.14%)	130 (10.08%)	3.09*	0.0164
Demo plots or crop and livestock innovation centre (CLICs)	415 (16.55%)	218 (17.90%)	197 (15.27%)	2.66	0.0757
Cattle keeping group	176 (7.02%)	108 (8.87%)	68 (5.27%)	3.61***	0.0004
Goat keeping group	1188 (47.37%)	798 (65.52%)	390 (30.23%)	35.44***	<0.0001
Poultry keeping group	260 (10.37%)	146 (11.99%)	114 (8.84%)	3.15*	0.0100
Health clubs	263 (10.49%)	148 (12.15%)	115 (8.91%)	3.27**	0.0080
Natural resource management group	104 (4.15%)	65 (5.34%)	39 (3.02%)	2.34**	0.0036
Producer group / commodity association	90 (3.59%)	57 (4.68%)	33 (2.56%)	2.12**	0.0045
Vocational skills / enterprise group	108 (4.31%)	66 (5.42%)	42 (3.26%)	2.16**	0.0082
Youth forum	150 (5.98%)	103 (8.46%)	47 (3.64%)	4.85***	<0.0001
Fisheries group	138 (5.50%)	75 (6.16%)	63 (4.88%)	1.30	0.1569
Disaster response and management group	104 (4.15%)	67 (5.50%)	37 (2.87%)	2.61**	0.0011
Is any member of this household part of a savings group (ISAL/VSLA/SACCO)?	558 (22.25%)	262 (21.51%)	296 (22.95%)	- 1.44	0.3880

Source: LORTA and project teams
Note: * p < 0.05, ** p < 0.01, *** p<0.001

I. MODULE G: ACCESS TO THE EXTENSION SERVICES AND HOUSEHOLD ASSETS

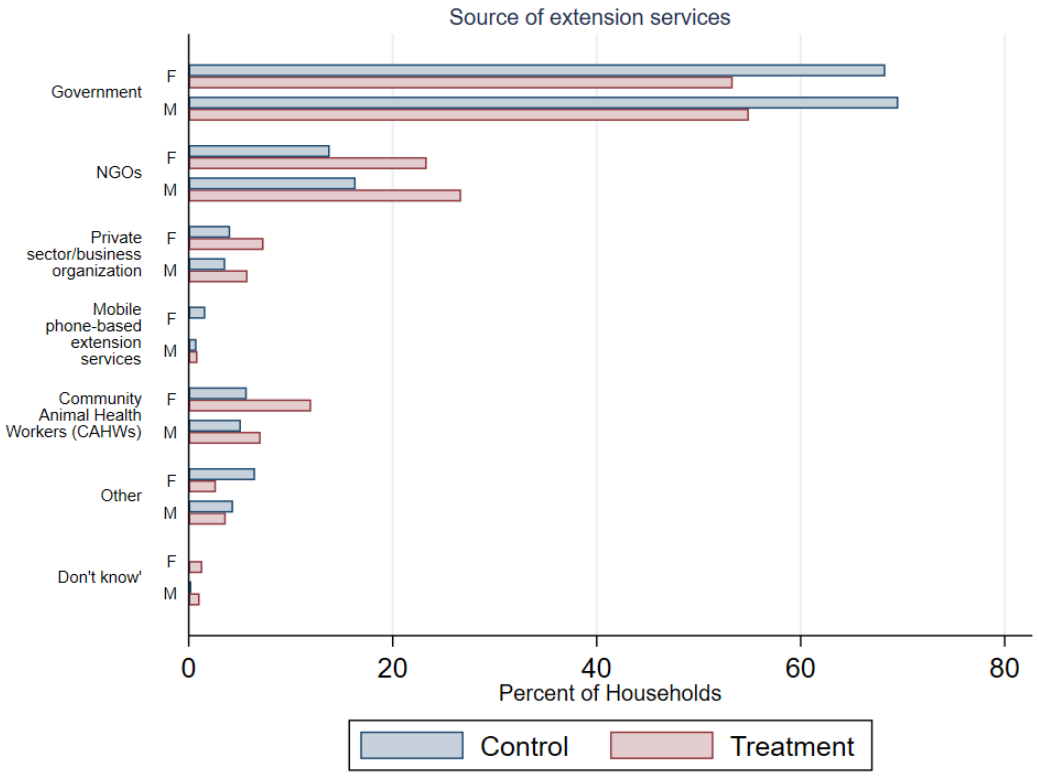
Figure 5 shows the proportion of households receiving any extension information broken down by the gender of the head of household. In total, 314 control households and 328 treatment households are headed by women, whereas men head 972 control and 890 treatment households. About 40 per cent of the control households and 52 per cent of the treatment households received any extension information. Figure 6 shows through what sources the extension information services were received.

Figure 5. Households that received any agricultural extension



Source: LORTA and project teams

Figure 6. Source of extension services (by gender)



Source: LORTA and project teams

Table 23 shows the proportion of households owning productive assets. The productive assets owned by most households include hand hoe (98 per cent), axe (92 per cent), spade or shovel (54 per cent), and ox-drawn plough (44 per cent). More treatment households owned ox-drawn ploughs and shovels. About 16 per cent of the treatment households owned modern beehives. This was significantly higher than 2 per cent for control households. Less than 2 per cent of the households owned labour-saving technologies (e.g., tractors, ridges, and planters). Using labour-saving technologies results in time savings, which may be converted into activities that enhance agricultural productivity (Mueller, Masias and Vallury, 2019).

Table 23. Ownership of household productive assets

Variables	Entire sample (N=2508)	Treatment		Gender		T - C	[P-value]
		Treatment (T) (N=1218)	Control (C) (N=1290)	Male (N=1864)	Female (N=644)		
Plough (oxen-pulled)	1101 (43.90%)	625 (51.31%)	476 (36.90%)	904 (48.50%)	197 (30.59%)	14.41***	<0.0001
Rippers	124 (4.94%)	90 (7.39%)	34 (2.64%)	107 (5.74%)	17 (2.64%)	4.75***	<0.0001
Scotch cart	453 (18.06%)	265 (21.76%)	188 (14.57%)	393 (21.08%)	60 (9.32%)	7.18***	<0.0001
Ridger/ weeder	67 (2.67%)	44 (3.61%)	23 (1.78%)	59 (3.17%)	8 (1.24%)	1.83**	0.0045
Planter	16	11	5	14	2	0.52	0.1052

Variables	Entire sample (N=2508)	Treatment		Gender		T - C	[P-value]
		Treatment (T) (N=1218)	Control (C) (N=1290)	Male (N=1864)	Female (N=644)		
	(0.64%)	(0.90%)	(0.39%)	(0.75%)	(0.31%)		
Tractor (Mechanical plough)	6 (0.24%)	4 (0.33%)	2 (0.16%)	6 (0.32%)	0 (0.00%)	0.17	0.3746
Sickle	987 (39.35%)	503 (41.30%)	484 (37.52%)	753 (40.40%)	234 (36.34%)	3.78	0.0530
Pick axe	707 (28.19%)	390 (32.02%)	317 (24.57%)	600 (32.19%)	107 (16.61%)	7.45***	<0.0001
Axe	2315 (92.30%)	1122 (92.12%)	1193 (92.48%)	1759 (94.37%)	556 (86.34%)	- 0.36	0.7337
Pruning/cutting shears	138 (5.50%)	80 (6.57%)	58 (4.50%)	103 (5.53%)	35 (5.43%)	2.07*	0.0229
Hoe	2468 (98.41%)	1202 (98.69%)	1266 (98.14%)	1835 (98.44%)	633 (98.29%)	0.55	0.2748
Spade or shovel	1359 (54.19%)	715 (58.70%)	644 (49.92%)	1122 (60.19%)	237 (36.80%)	8.78***	<0.0001
Traditional beehive	103 (4.11%)	37 (3.04%)	66 (5.12%)	97 (5.20%)	6 (0.93%)	- 2.08**	0.0087
Modern beehive	213 (8.49%)	189 (15.52%)	24 (1.86%)	171 (9.17%)	42 (6.52%)	13.66***	<0.0001

Source: LORTA and project teams
Note: * p < 0.05, ** p < 0.01, *** p<0.001

Table 24 shows the proportion of households owning other productive assets. The other productive assets owned by the majority of households include a mobile phone (82 per cent) and a bicycle (45 per cent), followed by a wheelbarrow (11 per cent) and a stone grinding mill (44 per cent). More treatment households owned a wheelbarrow compared to control households. Less than 2 per cent of the households owned water pumps and vehicles (e.g., a car and a motorcycle).

Table 24. Ownership of other household productive assets

Variables	Entire sample (N=2508)	Treatment		Gender		T - C	[P-value]
		Treatment (T) (N=1218)	Control (C) (N=1290)	Male (N=1864)	Female (N=644)		
Mechanical water pump	50 (1.99%)	33 (2.71%)	17 (1.32%)	44 (2.36%)	6 (0.93%)	1.39*	0.0127
Motorized water pump	31 (1.24%)	21 (1.72%)	10 (0.78%)	24 (1.29%)	7 (1.09%)	0.95*	0.0316
Stone grain mill	251 (10.01%)	113 (9.28%)	138 (10.70%)	186 (9.98%)	65 (10.09%)	- 1.42	0.2364
Motorized grain mill	57	29	28	46	11	0.21	0.7239

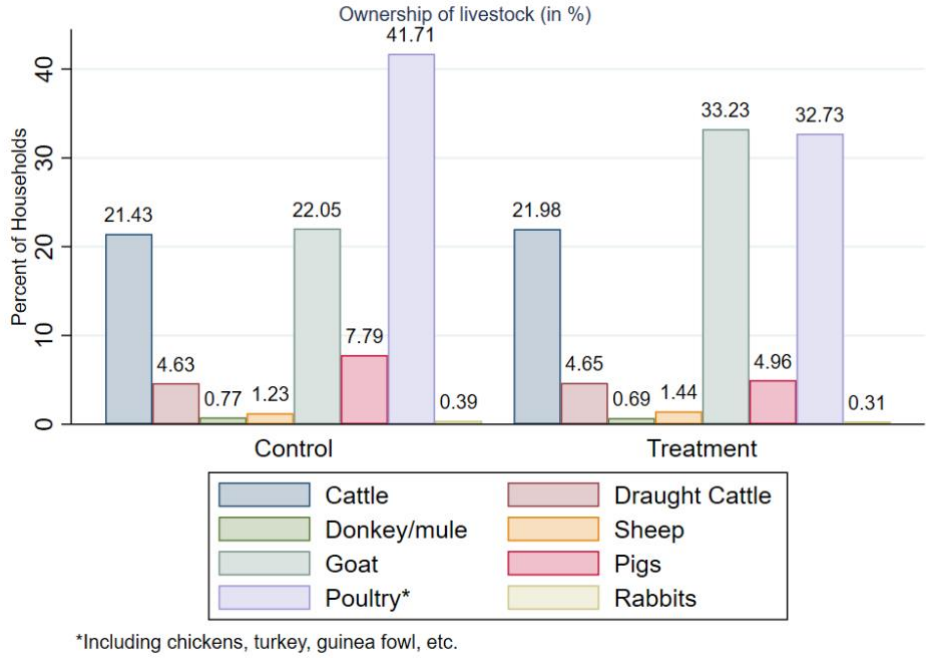
Variables	Entire sample (N=2508)	Treatment		Gender		T - C	[P-value]
		Treatment (T) (N=1218)	Control (C) (N=1290)	Male (N=1864)	Female (N=644)		
	(2.27%)	(2.38%)	(2.17%)	(2.47%)	(1.71%)		
Walking motorized tiller	31 (1.24%)	22 (1.81%)	9 (0.70%)	23 (1.23%)	8 (1.24%)	1.11*	0.0120
Cultivator/ridger/planter	26 (1.04%)	15 (1.23%)	11 (0.85%)	23 (1.23%)	3 (0.47%)	0.38	0.3494
Sewing machine	77 (3.07%)	45 (3.69%)	32 (2.48%)	54 (2.90%)	23 (3.57%)	1.21	0.0782
Wheelbarrow	275 (10.96%)	150 (12.32%)	125 (9.69%)	232 (12.45%)	43 (6.68%)	2.63*	0.0355
Borehole	86 (3.43%)	37 (3.04%)	49 (3.80%)	64 (3.43%)	22 (3.42%)	- 0.76	0.2956
Bicycle	1136 (45.30%)	556 (45.65%)	580 (44.96%)	979 (52.52%)	157 (24.38%)	0.69	0.7298
Motorcycle	64 (2.55%)	26 (2.13%)	38 (2.95%)	60 (3.22%)	4 (0.62%)	- 0.81	0.1981
Vehicle	45 (1.79%)	20 (1.64%)	25 (1.94%)	42 (2.25%)	3 (0.47%)	- 0.30	0.5770
Mobile phone	2051 (81.78%)	1011 (83.00%)	1040 (80.62%)	1592 (85.41%)	459 (71.27%)	2.38	0.1221

Source: LORTA and project teams
Note: * p < 0.05, ** p < 0.01, *** p<0.001

J. Module H: Livestock assets

Figure 7 presents the ownership of livestock by treatment status. Compared to the treatment group, a higher share of households in the control group have poultry (42 per cent instead of 33 per cent). More treated households have goats (33 per cent instead of 22 per cent), which is consistent with the fact that SCRALA has already distributed goats to the beneficiaries.

Figure 7. Ownership of livestock type



Source: LORTA and project teams

In Table 25, we show the number of livestock owned by type of livestock and treatment status. On average, the number of cattle and draught cattle owned was nine and five, respectively, with no differences between the treatment statuses. A higher proportion of treatment households owned more goats compared to control households. This is plausible considering the SCRALA project promotes goat production among its beneficiaries. The average poultry flock size was 16, with no difference between treatment and control households.

Table 25. Number of livestock owned

VARIABLES	ENTIRE SAMPLE (N=2508)	TREATMENT (T) (N=1218)	CONTROL (C) (N=1290)	T-C	[P-VALUE]
Cattle (for meat)	9.02 (13.91)	8.62 (11.21)	9.53 (16.68)	- 0.91	0.4111
Draught cattle/Oxen	5.11 (5.88)	4.81 (4.38)	5.47 (7.33)	-0.66	0.5037
Donkeys/ mule	2.78 (1.73)	3.09 (1.38)	2.50 (2.02)	0.59	0.4262
Sheep	6.56 (6.20)	6.31 (5.30)	6.94 (7.53)	- 0.63	0.7475
Goats	9.91 (9.27)	10.34 (9.50)	9.13 (8.77)	1.21	0.0711
Pigs	5.18 (5.32)	5.26 (5.85)	5.12 (4.90)	0.14	0.8573
Poultry*	15.97 (21.75)	15.97 (17.16)	15.97 (25.43)	- 0.00	0.9972

VARIABLES	ENTIRE SAMPLE (N=2508)	TREATMENT (T) (N=1218)	CONTROL (C) (N=1290)	T-C	[P-VALUE]
Rabbits	3.86 (4.13)	3.67 (3.01)	4.00 (5.01)	- 0.33	0.8881

Source: LORTA and project teams
Note: * p < 0.05, ** p < 0.01, *** p<0.001

K. MODULE I: IMPACT INDICATORS

Table 26 shows the differences in impact indicators by household beneficiary status. The upper part of the table shows the differences in food and nutrition security. The average FCS for treatment households (42.4) was significantly lower than for control households (44.2) using the independent samples t-test. A higher proportion of control households (62 per cent) had acceptable food consumption compared to 58 per cent among treated households. These results show that food insecurity was relatively pronounced among treated households and demonstrate that the SCRALA project efficiently targeted vulnerable households. The average CSI for the entire sample, treatment, and control households was less than 10, indicating food security. The average maize yield for the entire sample was 1.5 tonnes per hectare, and there were no significant differences between the treatment and control households.

Regarding livelihoods diversification, results show that about 9 per cent of treatment households solely depend on agriculture as their sole source of income. This is significantly lower compared to 12 per cent of the control households. This implies that about 91 per cent of treatment households have diversified livelihoods and the SCRALA project needs to promote both farm and non-farm livelihood activities. On average, the sampled households planted two crops. In most cases, this includes maize and another legume crop, showing low levels of crop diversification. The number of crops planted can be viewed as both risk management and nutrition diversification strategy in many ways. First, a farmer with a diversified crop mix can turn to other crops if one crop fails due to drought and other shocks. Second, higher crop diversification is important to ensure that households' production supplies carbohydrates, proteins, and micro-nutrients vital for nutrition security.

About 54 per cent of the treatment household used climate information for farm decisions, which was significantly higher than the 50 per cent among control households. In addition, treatment households had higher knowledge levels about climate information and climate-resilient agriculture. Our results show that most households (90 per cent) adopted at least one sustainable and climate-resilient agricultural practice.

Table 26. Differences in impact indicators by the beneficiary status

VARIABLES	ENTIRE SAMPLE (N=2508)	TREATMENT (T) (N=1218)	CONTROL (C) (N=1290)	T-C	[P-VALUE]
Food security					
Food consumption score	43.3 (21.1)	42.4 (21.2)	44.2 (21.0)	- 1.77*	0.0363
Acceptable household dietary diversity based on food consumption groups (%)	47.0 (50.0)	45.0 (50.0)	49.0 (50.0)	- 0.3	0.1084
Food expenditure shares	49.98%	51.24%	48.80%	2.43**	0.0054

VARIABLES	ENTIRE SAMPLE (N=2508)	TREATMENT (T) (N=1218)	CONTROL (C) (N=1290)	T-C	[P-VALUE]
	(21.73)	(21.90)	(21.51)		
Coping strategies index	5.52 (4.64)	5.51 (4.56)	5.53 (4.71)	- 0.02	0.9233
Income stability					
The volatility of income level	55.50% (49.71)	58.78% (49.24)	52.40% (49.96)	6.38**	0.0013
The average level of yields (Maize)	1520.78 (3187.07)	1494.17 (3440.43)	1546.76 (2919.86)	- 52.59	0.6866
Livelihood diversification					
Percentage of farmers with agriculture as the only source of income	10.37% (30.49)	8.54% (27.96)	12.09% (32.62)	- 3.55	0.0035
Number of different income generating activities farmers engage	1.97 (1.40)	2.03 (1.40)	1.90 (1.40)	0.13*	0.0197
Number of different crops planted	2.20 (1.14)	2.19 (1.12)	2.21 (1.16)	- 0.02	0.7325
Percentage of farmers who use climate information	52.11% (49.97)	54.11% (49.85)	50.23% (50.02)	3.87	0.0524
Knowledge level of climate information and climate-resilient agriculture (Number of known practices, out of 12)	6.47 (3.23)	6.59 (3.23)	6.36 (3.22)	0.23	0.0723
Percentage of farmers who adopt sustainable and climate-resilient agricultural practices	89.55% (30.59)	90.39% (29.48)	88.76% (31.60)	1.63	0.1812
Purchase decisions on agricultural inputs, seeds in particular (Women can decide alone or together with the husband or another adult)	60.25% (48.95)	60.43% (48.92)	60.08% (48.99)	0.35	0.8582

Source: LORTA and project teams
Note: * p < 0.05, ** p < 0.01, *** p<0.001

Chapter 6. DISCUSSION

Our evaluation sample consists of households in which 74 per cent of household heads are male at the average age of 49, who holds two fields and four hectares of the total land on average, of which 81 per cent of the cultivated plots are self-owned. Almost all households grow maize. Drought-tolerant sorghum was the second dominant crop, grown by 27 per cent. More than half of the households rely on their farming production as their main food source. The average number of cattle and draught cattle owned by a household was nine and five, respectively. Around 82 per cent of households have a mobile phone and 45 per cent a bicycle.

The baseline data has highlighted significant differences between treatment and control households. The treatment and comparison groups are generally similar regarding overall household characteristics such as household size and the proportion of females as head of a household. However, many results indicate that the treatment group is wealthier than the control group. A greater proportion of comparison households rely on fishing or gathering of natural products, purchase maize rather than more expensive products such as wheat flour and soya mince and hold smaller areas or plots of agricultural land. They also save seeds from one year to another, practice manual labour and hand hoeing for tillage, and have less income. The agricultural practices and knowledge also vary between the two groups. The treatment farmers display slightly higher familiarity with organic and conservation agriculture practices. A greater proportion of treatment farmers belong to agricultural organizations such as Lead Farmer or Model Farmer's groups, suggesting they have better access to social capital and more frequent training. Yet, not all results support the narrative that the treatment households have more wealth, knowledge and social capital. The number of disabled family members and orphans is, on average, higher in the treatment households, and food insecurity was relatively pronounced among the treatment group.

There are several possible explanations for these discrepancies. One is that the SCRALA project successfully targets the more vulnerable beneficiaries. Given that around 60 per cent of beneficiaries claim to have already received at least one goat or beehive at the time of the baseline survey, these inputs could have had an early impact on the wealth of beneficiary households. Beehives and goats are indeed considered to impact beneficiary households quickly. Farmers typically sign an arrangement with an off-taker for beehives and commit to selling their honey within six months, i.e., generally, two harvests per year. For goats, it is also expected that female goats have offspring twice a year, thus also having a relatively quick impact on the household. The second is that the beneficiary selection caused structural differences in the treatment and control groups. The lottery to select beneficiaries was not entirely random because only the farmers who showed up at the public lottery events could participate. The participants could have a better source of information, network, or be wealthier than the average farmers to join the event. Verifying this theory requires the information of the non-selected farmers at the lottery.

The early distribution of alternative livelihood inputs and the lack of control group data entails amendment in the evaluation strategy. The initial design was an RCT through a public lottery. Based on the information at the time of writing this report, there could be future rounds of lotteries for upscaling purposes in the distribution of beehives. The feasibility of an RCT hinges on receiving or collecting information on the lottery losers. If RCT remains the main evaluation strategy, extension officers should collect the information during routine field visits and the next lottery. There can be spill-overs at the village level because the selection of beneficiaries is at the individual level. Still, good record keeping of farmers' locations and variation in the distance between treatment and control farmers that comes from the random draw would allow quantifying any potential spillovers.

A quasi-experimental design like DiD could be one option. This method will need other non-beneficiaries to be sampled given that information on lottery losers is unavailable. In a DiD design, the difference in relevant indicators between the treatment and comparison group is calculated before and after the intervention and subtracted from each other. This "double differencing" eliminates initial and time-invariant observable and unobservable differences between the beneficiaries and the comparison group. The DiD design is valid as long as the "parallel trend assumption"—the initial differences are constant over time (i.e., similar trends in rainfall)—holds. To conduct placebo tests to check the plausibility of this assumption, the endline data collection would have to collect recall data from a point in time before the baseline.

An alternative strategy is to construct a comparison group through a matching technique, e.g., through propensity score matching, coarsened exact matching or inverse probability weighting. Matching attempts to mimic randomization by creating a sample of observations that did not receive the treatment and that is comparable on all observed characteristics to a sample of observations that did receive the treatment. Matching can potentially control the risk of selection bias if selection into SCRALA is based on observable variables. Any type of matching needs to be conducted on variables not affected by SCRALA, either because they are time-invariant or because they were collected before SCRALA was implemented. For the latter, the baseline data is very useful.

DiD and matching can combine their relevant strengths: DiD can control for time-invariant differences, whereas matching can control for selection bias based on observable variables. A greater similarity between the groups reinforces the validity of the parallel trend assumption. The intuition is that if the units of analysis in both groups are similar before the treatment, there is a higher likelihood that the outcomes of interest would follow a similar trend.

Overall, the baseline results illustrate that the SCRALA project's beneficiaries are well targeted regarding food insecurity and vulnerability, and the alternative livelihood inputs will enhance their climate resilience within a relatively short period. It is worth noting that the selection is at the individual level, meaning there can be spill-overs at the village level. However, good record keeping of farmers' locations and variation in the distance between treatment and control farmers that automatically comes from the random draw would allow quantifying any potential spillovers, which would be an important insight for the IE.

Chapter 7. CHALLENGES AND SHORTCOMINGS

This section will describe two types of challenges encountered in this evaluation: research design and logistical challenges. In the research design, the sampling frame was to be drawn from the farmer listing. However, the farmer listing was not fully completed at the time of the sampling frame development, having large differences between different camps. Furthermore, the beneficiary list was not available on time, which led to delays in the onset of the baseline data collection and was possibly not complete. The initial plan was to evaluate the impact of improved seeds and alternative livelihood inputs, particularly beehives and goats. However, beneficiary information was only available on beehive and goat recipients. Therefore, seed recipients could not be considered in the sampling. Consequently, the evaluation questions to which the baseline data could speak were limited to goat and beehive farmers.

In addition, a measurement challenge occurred during data collection where many control group respondents reported that a member of their household had been selected to receive benefits from the project (43.10 per cent). However, given the number of affirmative responses (3.88 per cent) to the follow-up question on how many had received at least a goat or a beehive dropped significantly, the results could still be trusted. This low figure could be because the listing exercise was at the individual level while the survey was at the household level. In other words, a marginal overlap could exist between a control individual and one of their spouses who may have been a beneficiary. Statistically, this issue would remain minor, given that the listing has about 100,000 individuals.

Nonetheless, other factors hamper the interpretation of the statistics based on the baseline data. Many treatment households reported that they had been treated before the baseline (60.34 per cent) and the record of public lottery participants was not kept. IEs generally involve comparing the treatment and control groups to see whether they are relatively similar. However, the early distribution of the inputs makes it difficult to distinguish the original characteristics of the treatment group from the short-term impact of the inputs. The lack of lottery losers' information precludes identifying self-selection bias in the beneficiaries.

Severe logistical challenges arose from the unfavourable weather. The aforementioned rainy seasons caused for a delay in sampling of the baseline data for a few weeks. Movement during this period was constrained by poor and waterlogged roads, washed-away bridges, and flooding in many areas, especially in the Southern province and Muchinga. This situation made accessing some of the camps difficult and thus altered the sample size slightly.

Chapter 8. CONCLUSION

The objective of this analysis has been to collect information at the beginning of the SCRALA project on the status of agricultural livelihoods in the agro-ecological regions I and II of Zambia. Results from the baseline survey will be used after the programme roll out and measured against the endline survey to see the project's impact, which is planned for the last quarter of 2025.

At the time of the baseline data collection, some SCRALA activities had already been ongoing. In particular, some households had already received goats or beehives. Consequently, the programme might have affected variables such as the number of livestock owned by a household. However, most descriptive analysis can still be used as a snapshot of the characteristics of smallholder households at the early phase of the project before we measure a project's direct impact.

The descriptive statistics from the baseline survey show that the SCRALA activities are effectively targeted at the most vulnerable households, such as households headed by a woman or which house orphans. The baseline results suggest that the treatment group tends to endure more acute food insecurity, with a lower diversity of food. They also tend to spend a higher share of their income on food, and their total income is also reported to be more volatile. The higher livelihood diversification for the treatment group suggests that those households may be affected by important push factors.

Knowledge and climate-smart practices are also of interest in this baseline study. In the treatment group, households displayed a slightly higher awareness of climate-smart practices. This may reflect the impacts of some of the early SCRALA activities related to information.

In conclusion, the statistical analysis suggests that gender aspects, different coping strategies, as well as the information and knowledge of climate-smart practices, are key elements to be monitored and emphasized throughout the programme.

The list below presents the recommendations drawn from the findings for policy, programme and monitoring and evaluation design:

- Consistent implementation tracking is key to designing a robust IE design for testing the programme's ToC along its causal chain. To ensure minimal burden on programme staff, we propose using simple surveys integrated into a data collection system with a dashboard for real-time monitoring from project and evaluation staff.
- If the lottery's recipients of improved seeds are selected at the level of lead farmers or follower farmers, we strongly suggest keeping records of the eligible population from which the lottery winners are drawn. For the distribution of beehives and goats, it was unclear who attended the public lottery and which households would be the right control group for the selected beneficiaries.
- Given the uncertainties around the treatment status of some control households, verifying the beneficiary status of households before conducting the endline survey and possibly adjusting the sample is strongly recommended.
- Farmers relied on improved seeds, local seeds purchased from fellow farmers and local markets, and recycled seeds. While programmes should promote access and availability of improved seeds, this should be promoted in tandem with informal seed sources (local and recycled) to maintain genetic biodiversity.

- Conventional ploughing and hand hoeing were the dominant tillage methods utilized. There is scope for piloting and promoting labour-saving mechanized conservation agriculture, which also eliminates drudgery and intense human labour.
- About half of the households used climate information for farm decisions. Treatment households had higher knowledge levels about climate information and climate-resilient agriculture. Therefore, there is a need to continue disseminating climate information to households using multiple extension methods, including Information Communication Technologies.
- Most households relied on agricultural production as a source of cash income. These interventions promote and upscale crop and livestock production and market linkages and are part of the SCRALA programme.
- Higher knowledge levels about agricultural technologies do not translate into higher adoption rates. Thus, it is recommended that SCRALA investigates the underlying factors constraining the adoption of climate-smart agricultural technologies. This is crucial to inform the entry points for promotion and upscaling technologies. We propose using diagnostic surveys to identify barriers, particularly those preventing behaviour change.
- The predominant cereal crops are maize and sorghum, while groundnuts dominate legumes. Promoting crop diversification strategies, including strategies for cereals and legumes, should be recommended as climate risk and nutrition-sensitive agriculture strategies.
- The major climatic shocks most households experienced were crop diseases, pests, and drought. In contrast, economic shocks were dominated by food price increases and higher agricultural input prices. Vulnerabilities were gendered and generally disadvantaged women as climate hazards disproportionately affect female-headed households' livelihoods. There is a need to ensure access to productive resources (e.g., land, agricultural, financial) and income opportunities by females in Zambia to enhance the shock-absorbing capacity of the female-headed households caused by climate shocks.
- There is a need for interventions that promote the production and consumption of legumes, green leafy vegetables, and vitamin A-rich fruits among the treated households. Promoting interventions that improve the production and productivity of crops and livestock are crucial for food security.

Appendix 1. LOGISTICAL CHALLENGES ENCOUNTERED DURING FIELDWORK

Kazungula district

En route to Kazungula, a survey team member was involved in a road traffic accident. Poor telecommunication networks in Kazungula made it difficult to reach some of the farmers referred to by the camp officers. Some of the initially sampled camps were inaccessible. The resampling of the camps contributed to delays in the data collection. Some of the selected farmers after the resampling could also not be reached.

Chama, Mambwe, and Nyimba districts

In Chama (Muchinga province) and Mambwe and Nyimba (Eastern Province) districts, some farmers moved to a new location and were absent. Some farmers had relocated to farming blocks away from the households, which meant walking long distances to reach the farms. Some farmers were not available for the interview, mostly because it was the farming season or they had gone to look for piece work. This led to the rescheduling of most of the interviews. Hence, the teams spent much more time in the camps than planned.

Rufunsa and Namwala districts

The team that conducted interviews in Namwala did not receive adequate support from the camp officers because they were new and unfamiliar with the farmers and the ongoing activities within the camp. In Rufunsa and Namwala, cases of farmer absenteeism were common. The field teams had to make several visits to one household just to make sure the interview was carried out. Most roads were not accessible due to heavy rains.

Mafinga district

The survey team that went to the Muyombe agricultural block experienced several challenges due to heavy rainfall. Conducting the survey along rain-affected gravel roads proved very challenging.

As with other districts, it was farming season and thus difficult to find and interview some respondents as they were working in their fields or doing piecework on other people's farms and therefore could not interview them at the planned time. Some farms could not be mapped using GPS units due to the long distances from the households to the farms – farming fields can be as far as 20 kilometres from homesteads.

Chongwe, Chirundu, Siavonga, Luangwa and Gwembe districts

In the southern districts of Chirundu, Siavonga, and Gwembe, relocation cases were common, as well as situations where some farmers were not known in the community and, therefore, challenging to locate.

Western province

The long distances between camps were the biggest challenge in the Western Province. Poor road networks and rough terrain exacerbated this challenge. Poor communication networks also presented challenges, making it difficult to communicate and coordinate with the camp officers, farmers, and the entire team, especially when there were vehicle breakdowns. In the western province, farmers usually relocate during the different seasons, and some were not available for interviews as they had relocated due to the heavy rains. For example, in Mulauli, the team could not find the farmers they sought because they had moved to other farming areas due to the rain. Some of the farmers listed were not beneficiaries as they mentioned that they have never participated in nor benefited from the programme in Nawinda and Bwina camps.

Appendix 2. LIST OF CAMPS NOT ACCESSIBLE DURING THE RAINY SEASON

Table A - 1. List of camps not accessible during the rainy season

District	Block	Camp	Number of Boreholes	Pass-on Beneficiaries	Goat Beneficiaries	Households in Farmer Listing
Chirundu	Siagweemu	Chikanzaya	4	0	0	1766
Chirundu	Siagweemu	Siangweemu	0	0	0	289
Gwembe	Bbondo	Bbondo	0	0	0	489
Gwembe	Bbondo	Chaamwe	0	0	0	132
Gwembe	Chipepo	Chisanga	0	0	0	520
Gwembe	Bbondo	Nakasiika	0	0	0	84
Gwembe	Chipepo	Siampande	0	0	20	679
Kazungula	Musokotwane	Kanchele	0	20	0	128
Kazungula	Nyawa	Kauwe	0	20	0	2129
Kazungula	Nyawa	Malimba	0	20	0	506
Kazungula	Sekute	Moomba	0	20	0	609
Kazungula	Nyawa	Nguba	0	20	0	2195
Kazungula	Sekute	Ngwezi	0	20	0	864
Kazungula	Nyawa	Siamundele	0	20	0	326
Mambwe	Masumba	Nsefu	0	0	0	318
Namwala	Mungaila	Chila	0	0	0	450
Namwala	Muchila	Kaabwe	0	20	9	270
Namwala	Muchila	Shimashikwe	0	0	0	472
Nyimba	Vizimumba	Mitilizi	2	20	20	432
Nyimba	Vizimumba	Mwape	0	0	0	230
Nyimba	Hofmyre	Ndake	0	0	0	670
Nyimba	Hofmyre	Nyalungwe	0	20	20	707
Siavonga	Lakeshore	Dambwe	0	20	20	61
Siavonga	Lakeshore	Munyama	0	20	20	187

Source: LORTA and project teams
Note: None of those camps had households for which the crop-cut survey was done, and neither did they have beehive beneficiaries (hence the columns do not appear here as they would only show zeros).

Appendix 3. COMMUNITY CHARACTERISTICS

Table A - 2. Community characteristics

ITEM	PERCENTAGE N=76
The main languages spoken	
Lozi	21%
Tonga	24%
Nyanja	12%
Bemba	3%
Chewa	1%
The average number of households per community	826
The type of main access road in the community	
Tar/Asphalt	11%
Graded gravel	21%
Dirt road	60.5%
Dirt track	8%
Percentage of communities with public buses	65%
Percentage of communities with the post office	3%
Percentage of communities with mobile network transmission booster	57%
Percentage of communities with child nursery school	63%
Percentage of communities with adult literacy centre	12%
Percentage of communities with electrified health centre	45%
Percentage of communities with designated COVID-19 quarantine and isolation centre	9%
Percentage of communities with a micro-finance institution	16%
Activities that are an important source of employment/income for individuals in communities	
Farming	84%
Fishing	3%
Firewood, charcoal selling	9%
Beer brewing and sale	1%
Percentage of communities where people leave temporarily during certain times of the year to look for work somewhere else	53%
Percentage of communities with the local warehouse where community members could store crops before sale	22%

Source: LORTA and project teams

Appendix 4. MAIN BASELINE DATA COLLECTION RESULTS

Table A - 3. Household demographics

VARIABLES	ENTIRE SAMPLE (N=2508)	TREATMENT (T) (N=1218)	CONTROL (C) (N=1290)	MALE (N=1864)	FEMALE (N=644)	T-C	[P-VALUE]
Male heads of household (%)	1864 (74%)	890 (73%)	974 (76%)			- 2.43	0.1634
Age of the household head in years	49	50	48	48	52	1.77**	0.0019
Marital status of the household head							
Married, living together (%)	1828 (73%)	869 (71%)	959 (74%)	1765 (95%)	63 (10%)	- 2.99	0.0918
Married, spouse living elsewhere (%)	36 (1%)	18 (1%)	18 (1%)	9 (0.5%)	27 (4%)	0.08	0.8623
Divorced/Separated (%)	196 (8%)	101 (8%)	95 (7%)	33 (2%)	163 (25%)	0.93	0.3871
Widowed (%)	396 (16%)	210 (17%)	186 (14%)	27 (1%)	369 (57%)	2.82	0.0527
Never married (%)	40 (2%)	16 (1%)	24 (2%)	19 (1%)	21 (3%)	- 0.55	0.2748
Highest education of the household head							
No education	48 (2%)	29 (2%)	19 (1%)	35 (2%)	13 (2%)	0.91	0.0972
Primary education	1259 (50%)	621 (51%)	638 (49%)	880 (47%)	379 (59%)	1.53	0.4446
Middle education	(571%) (23%)	261 (21%)	310 (24%)	484 (26%)	87 (14%)	- 2.60	0.1204
Secondary education	(373%) (15%)	180 (15%)	193 (15%)	321 (17%)	52 (8%)	- 0.18	0.8977
Upper education	(10.25%) (10%)	127 (10%)	130 (10%)	144 (8%)	113 (18%)	0.35	0.7732
The Head of household is formally employed (%)	161 (6%)	80 (7%)	81 (6%)	140 (8%)	21 (3%)	0.29	0.7679
The Head of household is involved in agricultural activities (%)	2431 (97%)	1175 (96%)	1256 (97%)	1813 (97%)	618 (96%)	- 0.89	0.1944
Average household size	6.0	6.0	5.9	6.3	5.1	0.05	0.6410
Number of female members	3.0	3.0	3.0	3.0	3.0	- 0.05	0.4226
Number of formally	0.1	0.1	0.1	0.1	0.1	0.01	0.7174

VARIABLES	ENTIRE SAMPLE (N=2508)	TREATMENT (T) (N=1218)	CONTROL (C) (N=1290)	MALE (N=1864)	FEMALE (N=644)	T-C	[P-VALUE]
employed household members							
Number of household members who contribute to farm activities	4.0	4.1	4.0	4.2	3.4	0.11	0.1742
Number of household members who have ever attended school	4.9	4.9	4.8	5.1	4.1	0.09	0.3278
Number of disabled household members	0.3	0.3	0.3	0.3	0.3	0.04	0.0901
The Head of a household has a disability (%)	231 (9%)	108 (9%)	123 (10%)	168 (9%)	63 (10%)	- 0.67	0.5634
Number of orphans in the household	0.2	0.3	0.2	0.2	0.4	0.06*	0.0245

Source: LORTA and project teams
Note: * p < 0.05, ** p < 0.01, *** p<0.001

Table A - 4. SCRALA project participation – improved inputs and alternative livelihoods

VARIABLES	ENTIRE SAMPLE (N=2508)	TREATMENT (T) (N=1218)	CONTROL (C) (N=1290)	T-C	[P-VALUE]
Total number of households interviewed during the survey	2508	1218	1290	-	-
Declared participation					
Households who declared that at least one member of the household had been chosen to or had already participated in some SCRALA activity	1748 (70%)	1192 (98%)	556 (43%)	54.76***	<0.0001
Households who declared that at least one member has been or is participating either in SCRALA goat rearing activities or in SCRALA beekeeping activities[24]	1061 (42%)	882 (72%)	179 (14%)	58.54***	<0.0001
Households who declared that at least one member has been or is participating in SCRALA goat rearing activities	886 (35%)	710 (58%)	176 (14%)	27.91***	<0.0001
Households who declared that at least one member has been or is participating in SCRALA beekeeping activities	196 (8%)	192 (16%)	4 (0.3%)	15.39***	<0.0001
Households who declared that at least one member has been or is participating in SCRALA improved seeds growing activities	78 (3%)	50 (4%)	28 (2%)	-0.84	0.4278
Declared goats and beehives received					

[24] 21 households reported participating in both activities.

Variables	Entire sample (N=2508)	Treatment (T) (N=1218)	Control (C) (N=1290)	T-C	[p-value]
Households who declared to have already received at least a goat or a beehive from SCRALA	785 (31%)	735 (60%)	50 (4%)	56.47***	<0.0001
Households who declared to have received at least one goat from SCRALA	611 (24%)	564 (46%)	47 (4%)	42.66***	<0.0001
Households who declared to have received at least one beehive from SCRALA	185 (7%)	182 (15%)	3 (0.2%)	14.71***	<0.0001

Source: LORTA and project teams
Note: * p < 0.05, ** p < 0.01, *** p<0.001

Table A - 5. Details by gender on the households who declared having received at least one goat or one beehive from SCRALA for the treatment group only

Variables	Total treatment (N=735)	By Gender of the Head of Household	
		Male-Headed Households (N=531)	Female-Headed Households (N=204)
Households who declared to have already received at least a goat or a beehive from SCRALA	735	531	204
Gender of the household member who received the goat or beehive			
Female only	363 (49%)	181 (34%)	182 (89%)
Male only	278 (38%)	273 (51%)	5 (2%)
Both female and male	83 (11%)	68 (13%)	15 (7%)
Unknown	11 (2%)	9 (2%)	2 (1%)

Source: LORTA and project teams
Note: * p < 0.05, ** p < 0.01, *** p<0.001

Table A - 6. Bee keeping and honey project production

Variables	Entire sample (N=2508)	Treatment (T) (N=1218)	Control (C) (N=1290)	T-C	[p-value]
Percentage involved in beekeeping and honey production, including non-SCRALA beneficiaries	4	2	5	-3.14***	<0.0001
Have you ever received any training in beekeeping? 1=yes	16%	22%	10%	11.83***	<0.0001
How long (years) have you been involved in beekeeping?	3	2	4	-2.50***	<0.0001

VARIABLES	ENTIRE SAMPLE (N=2508)	TREATMENT (T) (N=1218)	CONTROL (C) (N=1290)	T-C	[P-VALUE]
What kind of technology do you use for beekeeping and honey production?					
Traditional (Fixed comb-hives on tree barks/logs)	3%	2%	4%	-1.82**	0.0083
Modern (Movable Frame hives)	8%	16%	2%	14.13***	<0.0001
For the households involved in beekeeping					
How many beehives did you have in the last 12 months?	5	5	5	-0.07	0.9115
How much honey (litres) did you produce in the last 12 months?	13	10	23	-2.95	0.8326
What was the average price per litre of the honey produced and sold in the last 12 months (ZMW)?	22	25	11	58.25	0.3744

Source: LORTA and project teams
Note: * p < 0.05, ** p < 0.01, *** p<0.001

Table A - 7. Food consumption by food group in the past seven days before the survey interview

VARIABLES	ENTIRE SAMPLE (N=2508)	TREATMENT (T) (N=1218)	CONTROL (C) (N=1290)	T-C	[P-VALUE]
Cereals and grain	2253 (90%)	1104 (91%)	1149 (89%)	1.57	0.1935
Roots and tubers	465 (19%)	151 (12%)	314 (24%)	-11.94***	<0.0001
Beans	1077 (43%)	476 (39%)	601 (47%)	-7.51***	0.0001
Other legumes and nuts	1137 (45%)	483 (40%)	654 (51%)	-11.04***	<0.0001
Orange-fleshed vegetables (vitamin A-rich vegetables)	292 (12%)	150 (12%)	142 (11%)	1.31	0.3077
Green leafy vegetables	1547 (62%)	692 (57%)	855 (66%)	-9.46***	<0.0001
Other vegetables	1872 (75%)	903 (74%)	969 (75%)	-0.98	0.5737
Orange-fleshed fruits (vitamin A-rich fruits)	2126 (85%)	1012 (83%)	1114 (86%)	-3.27*	0.0228
Other fruits	419 (17%)	153 (13%)	266 (21%)	-8.06***	<0.0001
Meats/beef, fish, seafood, and eggs	1650 (66%)	833 (68%)	817 (63%)	5.06**	0.0076

VARIABLES	ENTIRE SAMPLE (N=2508)	TREATMENT (T) (N=1218)	CONTROL (C) (N=1290)	T-C	[P-VALUE]
Dairy products	981 (39%)	515 (42%)	466 (36%)	6.16**	0.0016
Oils, butter, and fats	1663 (66%)	792 (65%)	871 (68%)	-2.49	0.1866

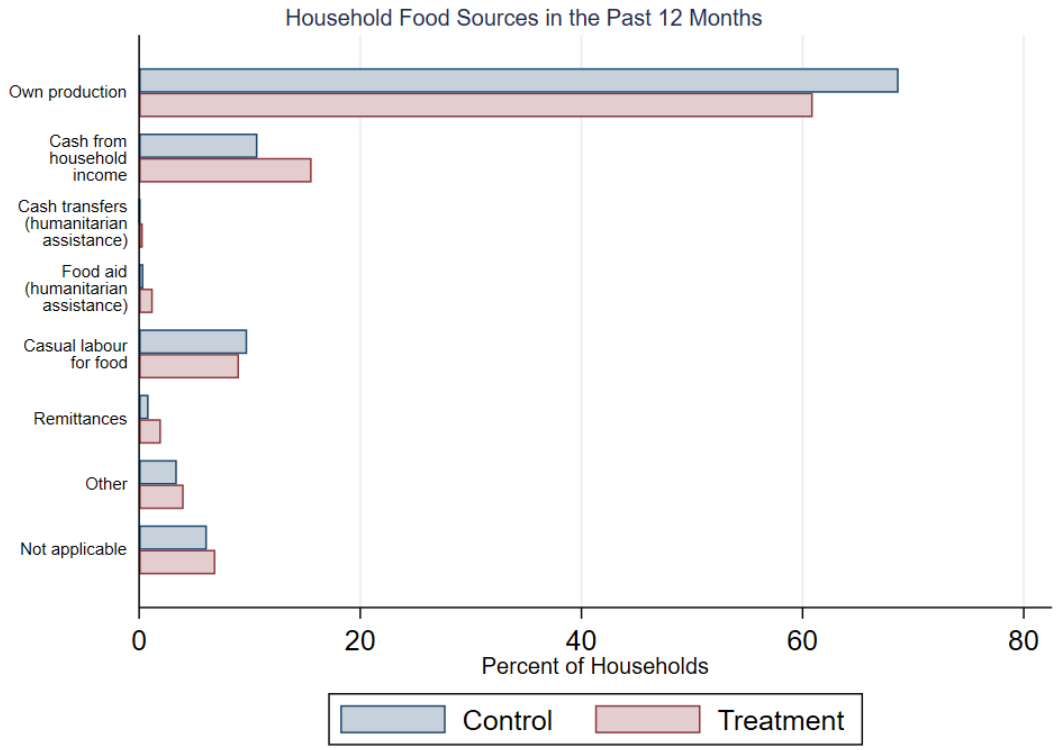
Source: LORTA and project teams
Notes: P-values computed on t-test for differences in means. T-C is given as percentage points. * p < 0.05, ** p < 0.01, *** p<0.001

Table A - 8. Livelihood and asset-based coping strategies

VARIABLES	ENTIRE SAMPLE (N=2508)	TREATMENT (T) (N=1218)	CONTROL (C) (N=1290)	T-C	[P-VALUE]
Sold household assets/goods to buy food	154 (6%)	74 (6%)	80 (6%)	-0.13	0.8955
Reduced non-food expenses to buy food	427 (17%)	209 (17%)	218 (17%)	0.26	0.8626
Sold productive assets or means of transport to buy food	99 (4%)	55 (5%)	44 (3%)	1.10	0.1557
Spent savings on buying food	828 (33%)	406 (33%)	422 (33%)	0.62	0.7415
Borrowed money from a formal lender/bank to buy food	497 (20%)	265 (22%)	232 (18%)	3.77*	0.0178
Leased out land to buy food	46 (2%)	27 (2%)	19 (1%)	0.74	0.1654
Withdrew children from school because of hunger or to help to work for food	157 (6%)	69 (6%)	88 (7%)	-1.16	0.2322
Sold last female breeding livestock to buy food	367 (15%)	180 (15%)	187 (15%)	0.28	0.8417
Begging to get food	509 (20%)	258 (21%)	251 (19%)	1.72	0.2833
Sold more animals (non-productive) than usual to buy food	324 (13%)	176 (14%)	148 (11%)	2.98*	0.0263

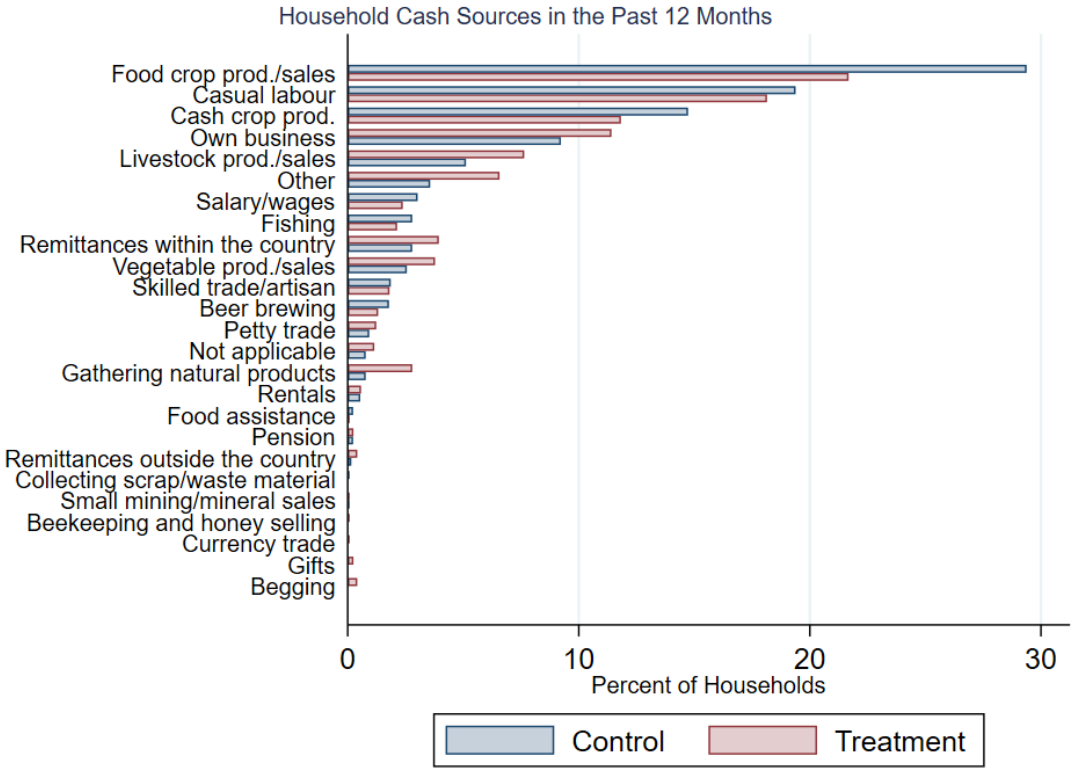
Source: LORTA and project teams
Note: * p < 0.05, ** p < 0.01, *** p<0.001

Figure A - 1. Household cash sources in the past 12 months



Source: LORTA and project teams

Figure A - 2. Household food sources in the past 12 months



Source: LORTA and project teams

Table A - 9. Income in the last calendar month (in ZMW)

VARIABLES	ENTIRE SAMPLE (N=2508)	TREATMENT (T) (N=1218)	CONTROL (C) (N=1290)	T-C	[P-VALUE]
Remittances outside/ Remittances within the country	393 (462)	379 (451)	409 (475)	-30.42	0.5101
Crops (food crop, cash crop) /vegetables sales	580 (952)	523 (867)	628 (1018)	-105.44	0.1521
Casual labour	279 (331)	270 (327)	288 (336)	-17.60	0.3715
Livestock sales	520 (774)	499 (723)	539 (820)	-39.61	0.4676
Sale of livestock products/ draught power hiring	173 (286)	135 (233)	221 (336)	-86.92	0.0633
Skilled trade/artisan	437 (630)	386 (616)	501 (644)	-114.15	0.2062
Own business/beer brewing	723 (1107)	684 (1094)	764 (1121)	-80.36	0.3835
Petty trade (including vending)/cross-border trade	518 (930)	366 (767)	718 (1083)	-351.75*	0.0173
Pensions	520 (1468)	521 (1715)	520 (1094)	1.13	0.9975
Salary/wages/earnings	873 (1295)	843 (1359)	896 (1246)	-52.77	0.7583
Fishing, gathering of natural products e.g., firewood, fruits	393 (574)	320 (507)	485 (638)	-165.00*	0.0200
Small-scale mining/ mineral sales	146 (480)	162 (560)	120 (331)	41.66	0.7544
Social Transfers (incl. cash and in-kind) from government or NGOs	239 (284)	235 (298)	248 (257)	-13.74	0.7414
Receipt of money owed	369 (566)	327 (525)	419 (610)	-91.99	0.2134
Loan received	675 (1100)	634 (960)	729 (1262)	-94.97	0.5616
Rental income	479 (748)	397 (640)	582 (861)	-184.93	0.1873
Other	275 (500)	283 (574)	263 (365)	19.78	0.8650

Source: LORTA and project teams
Notes: Amounts reported in ZMW. Amounts in USD were converted using an exchange rate of 1 ZMW = 0.0464984 USD and amounts in South African Rand (ZAR) were converted using an exchange rate of 1 ZAR = 0.0669350 USD. Both exchange rates are as of 05/02/2021 and are sourced from https://www.xe.com/currencyconverter. Standard deviations are reported in parenthesis. * $p < 0.05$, ** $p < 0.01$, *** $p<0.001$.

Table A - 10. Expenditure in the last calendar month (in ZMW)

VARIABLES	ENTIRE SAMPLE (N=2508)	TREATMENT (T) (N=1218)	CONTROL (C) (N=1290)	T-C	[P-VALUE]
Maize flour/Mealie meal	183 (321)	195 (355)	170 (282)	24.68	0.1715
Maize grain	169 (301)	178.62 (342)	159 (247)	20.01	0.2373
Wheat flour/ grain	64 (188)	76 (221)	50 (143)	25.66	0.0558
Bread, buns, and other confectionery	59 (186)	57 (135)	62 (226)	-5.11	0.6255
Millet (pearl millets/finger millet)	35 (141)	42 (174)	29 (100)	12.89	0.2127
Rice and pasta	49 (143)	51 (166.5)	47 (116)	3.87	0.6831
Sorghum (grain, flour)	42 (195)	54 (191)	29 (200)	24.80	0.0869
Sweet potatoes	34 (178)	50 (229)	18 (100)	32.69*	0.0141
Irish potatoes	36 (152)	42 (180)	30 (119)	11.51	0.2894
Other tubers (cassava, yams)	25 (143)	37 (184)	15 (90)	22.37*	0.0354
Milling costs	38 (108)	41 (140)	36 (65)	5.12	0.2581
Sugar and other sugar products/honey	52 (124)	54 (103)	50 (142)	3.58	0.5527
Salt/soups	23 (45)	20 (36)	25 (53)	-5.57**	0.0025
Milk (including powdered and formula)	33 (130)	37 (148)	29 (109)	7.61	0.3586
Tea leaves and coffee	23 (126)	33 (159)	14 (81)	18.97*	0.0226
Peanut butter, jam, and margarine	29 (146)	42 (184)	16 (93)	25.81*	0.0168
Cooking oil and fats	67 (87)	65 (78)	69 (94)	-4.09	0.2711
Meat (Beef, pork, chicken, including live chicken and other meats)	55 (133)	57 (141)	53 (124)	3.84	0.6337
Fish/Kapenta	49 (91.5)	48 (106)	50 (76)	-2.01	0.6747
Soya mince/Soya chunks	33	37	29	7.92*	0.0302

VARIABLES	ENTIRE SAMPLE (N=2508)	TREATMENT (T) (N=1218)	CONTROL (C) (N=1290)	T-C	[P-VALUE]
	(73)	(94)	(42)		
Vegetables (leaf, tomatoes, onions, etc.)	40 (67)	41 (79)	39 (53)	2.45	0.4388
Cooking fuel (paraffin, gel, gas, firewood, electricity, etc.)	89 (884)	74 (549)	104 (1131)	-30.56	0.6295
Matches/candles	6.4 (26)	6.9 (37)	6.0 (11)	0.81	0.5290
Washing and bathing Soap and other detergents	57 (113)	60 (149)	55 (63)	5.16	0.2639
Vaseline, toothpaste and other lotion	41 (53)	42 (61)	41 (43)	0.53	0.8145
Alcohol and cigarettes (including snuff)	42 (155)	50 (184)	34 (122)	16.82	0.1090
Transport (include bus fare, vehicle fuel, and services costs)	193 (393)	192 (394)	194 (392)	-2.02	0.9235
Domestic worker (including maid, herd boy)	75 (243)	87 (254)	62 (230)	24.57	0.1801
Communication (airtime/telephone bills/internet)	47 (95)	49 (112)	45 (75)	3.93	0.3509
Sanitary ware (including pampers and tissue paper)	29 (110)	33 (128)	24 (87)	9.46	0.1804
Other	42 (215)	56 (249)	28 (174)	28.23	0.0962

Source: LORTA and project teams
Note: Amounts reported in ZMW. Amounts in USD were converted using an exchange rate of 1 ZMW = 0.0464984 USD and amounts in South African Rand (ZAR) were converted using an exchange rate of 1 ZAR = 0.0669350 USD. Both exchange rates are as of 05/02/2021 and are sourced from https://www.xe.com/currencyconverter. Standard deviations are reported in parenthesis. * p < 0.05, ** p < 0.01, *** p<0.001.

Table A - 11. Expenditures in the last 12 months (in ZMW)

VARIABLES	ENTIRE SAMPLE (N=2508)	TREATMENT (T) (N=1218)	CONTROL (C) (N=1290)	T-C	[P-VALUE]
Education expenses (School fees and levies, uniforms, stationaries, and others)	1150 (2597)	1083 (2549)	1214 (2643)	-130.97	0.2460
Agricultural inputs (seed, fertilizers, chemicals, fuel)	1151 (1844)	918 (1358)	1371 (2184)	-453.04***	<0.0001
Agricultural services (Labour, tillage)	433 (1167)	344 (1136)	519 (1191)	-174.46*	0.0140
Veterinary chemicals and drugs	215 (507)	223 (481)	206 (537)	17.45	0.5636

VARIABLES	ENTIRE SAMPLE (N=2508)	TREATMENT (T) (N=1218)	CONTROL (C) (N=1290)	T-C	[P-VALUE]
Agricultural tools (include spare parts and maintenance)	181 (415)	187 (419)	175 (412)	12.27	0.5950
Business costs (running and investment costs)	966 (3232)	948 (3213)	984 (3253)	-35.81	0.8631
Health/medical	198 (507)	205 (528)	192 (486)	13.15	0.6439
Clothes/shoes (excluding school uniforms)	437 (778)	377 (688)	490 (849)	-112.33**	0.0027
Social occasions (weddings, parties)	157 (643)	149 (621)	165 (668)	-15.83	0.7278
Funeral expense	281 (590)	276 (586)	286 (594)	-10.02	0.7674
Loan repayment	461 (1898)	497 (2150)	423 (1597)	74.14	0.5946
Constructions expenses (including maintenance)	1028 (3470)	993.5 (3248)	1062 (3683)	-68.37	0.7639
Remittances out	270 (841)	238 (689)	303 (972)	-64.88	0.2563
Taxes (livestock, household, Government and council taxes, and any other taxes)	48 (262)	50 (284)	45 (239)	4.86	0.8134
Other	19 (172)	33 (239)	4.5 (45)	28.27*	0.0433

Source: LORTA and project teams
Note: * p < 0.05, ** p < 0.01, *** p<0.001

Table A - 12. Familiarity with agricultural production technologies

VARIABLES	ENTIRE SAMPLE (N=2508)	TREATMENT (T) (N=1218)	CONTROL (C) (N=1290)	T-C	[P-VALUE]
Adapted and drought-tolerant crops and varieties	1758 (70%)	886 (73%)	872 (68%)	5.15**	0.0049
Crop rotation	2099 (84%)	1028 (84%)	1071 (83%)	1.38	0.3509
Intercropping	1824 (73%)	867 (71%)	957 (74%)	-3.00	0.0915
Cover cropping (e.g., with legumes)	1075 (43%)	515 (42%)	560 (43%)	-1.13	0.5684
Mulching	1264 (50%)	637 (52%)	627 (49%)	3.69	0.0644
Agroforestry and planting of fodder trees	1062 (42%)	534 (44%)	528 (41%)	2.91	0.1403
Organic fertilizer or manure	1972	988	984	4.84**	0.0031

VARIABLES	ENTIRE SAMPLE (N=2508)	TREATMENT (T) (N=1218)	CONTROL (C) (N=1290)	T-C	[P-VALUE]
	(79%)	(81%)	(76%)		
Composting	1355 (54%)	652 (54%)	703 (55%)	-0.97	0.6278
Drip/Micro-irrigation	885 (35%)	437 (36%)	448 (35%)	1.15	0.5472
Zero or minimum tillage	1361 (54%)	715 (59%)	646 (50%)	8.63***	<0.0001
Animal fodder production for ruminants	594 (24%)	300 (25%)	294 (23%)	1.84	0.2789
Homemade animal feeds	987 (39%)	471 (39%)	516 (40%)	-1.33	0.4958

Source: LORTA and project teams
Note: * p < 0.05, ** p < 0.01, *** p<0.001

Table A - 13. Usage of agricultural production technologies

VARIABLES	ENTIRE SAMPLE (N=2508)	TREATMENT (T) (N=1218)	CONTROL (C) (N=1290)	T-C	[P-VALUE]
Adapted and drought-tolerant crops and varieties	997 (40%)	508 (42%)	489 (38%)	3.80	0.5947
Crop rotation	1426 (57%)	718 (59%)	708 (55%)	4.07	0.0667
Intercropping	1058 (42%)	466 (38%)	592 (46%)	-7.63***	0.0005
Cover cropping (e.g., with legumes)	556 (22%)	262 (22%)	294 (23%)	-1.28	0.5944
Mulching	756 (30%)	389 (32%)	367 (28%)	3.49	0.3585
Agroforestry and planting of fodder trees	303 (12%)	155 (13%)	148 (11%)	1.25	0.7196
Organic fertilizer or manure	1036 (41%)	544 (45%)	492 (38%)	6.52*	0.0244
Composting	488 (19%)	235 (19%)	253 (20%)	-0.32	0.9834
Drip/ micro-irrigation	211 (8%)	100 (8%)	111 (9%)	-0.39	0.5092
Zero or minimum tillage	769 (31%)	410 (34%)	359 (28%)	5.83	0.5111
Animal fodder production for ruminants	143 (6%)	66 (5%)	77 (6%)	-0.55	0.2330
Homemade animal fodder and feeds	420 (17%)	186 (15%)	234 (18%)	-2.87	0.0631

Source: LORTA and project teams
Note: * p < 0.05, ** p < 0.01, *** p<0.001

Table A - 14. Households growing each crop

VARIABLES	ENTIRE SAMPLE (N=2508)	TREATMENT (T) (N=1218)	CONTROL (C) (N=1290)	T-C	[P-VALUE]
Maize	2361 (94%)	1136 (93%)	1225 (95%)	-1.69	0.0712
Sorghum	676 (27%)	403 (33%)	273 (21%)	11.92***	<0.0001
Rice	27 (1%)	2 (0.2%)	25 (2%)	-1.77***	<0.0001
Millet	378 (15%)	189 (16%)	189 (15%)	0.87	0.5448
Sunflower	193 (8%)	118 (10%)	75 (6%)	3.87***	0.0003
Groundnuts	905 (36%)	411 (34%)	494 (38%)	-4.55*	0.0177
Soybeans	133 (5%)	64 (5%)	69 (5%)	-0.09	0.9161
Seed cotton	84 (3%)	33 (3%)	51 (4%)	-1.24	0.0836
Irish potato	2 (0.1%)	2 (0.2%)	0 (0%)	0.16	0.1455
Virginia tobacco	3 (0.1%)	0 (0%)	3 (0.2%)	-0.23	0.0922
Burley tobacco	1 (0.04%)	0 (0%)	1 (0.1%)	-0.08	0.3313
Mixed beans	276 (11%)	77 (6%)	199 (15%)	-9.10***	<0.0001
Bambara nuts	13 (1%)	8 (1%)	5 (0.4%)	0.27	0.3482
Cowpeas	167 (7%)	110 (9%)	57 (4%)	4.61***	<0.0001
Velvet beans	27 (1%)	18 (1%)	9 (1%)	0.78	0.0585
Coffee	1 (0.04%)	1 (0.1%)	0 (0%)	0.08	0.3035
Sweet potato, white or yellow-fleshed	87 (3.5%)	32 (3%)	55 (4%)	-1.64*	0.0252
Sweet potato, orange-fleshed	16 (1%)	7 (1%)	9 (1%)	-0.12	0.6992
Cassava	101 (4%)	23 (2%)	78 (6%)	-4.16***	<0.0001
Cashew nut	7 (0.3%)	3 (0.3%)	4 (0.3%)	-0.06	0.7623

VARIABLES	ENTIRE SAMPLE (N=2508)	TREATMENT (T) (N=1218)	CONTROL (C) (N=1290)	T-C	[P-VALUE]
Popcorn	49 (2%)	29 (2%)	20 (2%)	0.83	0.1332
Sugarcane	9 (0.4%)	1 (0.1%)	8 (0.6%)	-0.54*	0.0243
Pigeon peas	4 (0.2%)	4 (0.3%)	0 (0%)	0.33*	0.0394
Other	314 (13%)	170 (14%)	144 (11%)	2.79*	0.0346

Source: LORTA and project teams
Note: * p < 0.05, ** p < 0.01, *** p<0.001

Appendix 5. DATA DISAGGREGATED BY GENDER

MODULE A2: SCRALA PROJECT PARTICIPATION

Table A - 15. SCRALA project participation by gender

VARIABLES	ENTIRE SAMPLE (N=2508)	MALE (M) (N=1864)	FEMALE (F) (N=644)	M-F	[P-VALUE]
Total number of households interviewed during the survey	2508	1864	644		
Declared participation					
Households who declared that at least one member of the household had been chosen to or had already participated in some SCRALA activity	1748 (70%)	1286 (69%)	462 (72%)	-2.75	0.1910
Households who declared that at least one member has been or is participating either in SCRALA goat rearing activities or in SCRALA beekeeping activities	1061 (42%)	772 (41%)	289 (45%)	-3.46	0.1256
Households who declared that at least one member has been or is participating in SCRALA goat rearing activities	886 (35%)	633 (34%)	253 (39%)	-5.54*	0.0411
Households who declared that at least one member has been or is participating in SCRALA beekeeping activities	196 (8%)	154 (8%)	42 (7%)	2.88	0.0920
Households who declared that at least one member has been or is participating in SCRALA improved seeds growing activities	78 (3%)	55 (3%)	23 (4%)	-0.70	0.5313
Declared goats and beehives received					
Households who declared to have already received at least a goat or a beehive from SCRALA	785 (31%)	573 (31%)	212 (33%)	-2.18	0.3041
Households who declared to have received at least one goat from SCRALA	611 (24%)	436 (23%)	175 (27%)	-3.78	0.0539
Households who declared to have received at least one beehive from SCRALA	185 (7%)	146 (8%)	39 (6%)	1.78	0.1371

Source: LORTA and project teams
Note: * p < 0.05, ** p < 0.01, *** p<0.001

MODULE A3: BEE KEEPING AND HONEY PROJECT PRODUCTION BY GENDER

Table A - 16. Bee keeping and honey project production by gender

VARIABLES	ENTIRE SAMPLE (N=2508)	MALE (M) (N=1864)	FEMALE (F) (N=644)	M-F	[P-VALUE]
Percentage involved in beekeeping and honey production, including non-SCRALA beneficiaries	4%	5%	1%	3.26***	0.0001
Have you ever received any training in beekeeping? 1=yes	16%	17%	11%	5.52***	0.0009
How long (years) have you been involved in beekeeping?	2.5	2.6	1.9	0.77	0.2419
What kind of technology do you use for beekeeping and honey production?					
How many traditional (Fixed comb-hives on tree barks/logs?	3	4	1	2.25**	0.0043
How many modern (Movable frame) hives?	8	9	6	2.75*	0.0300
How many beehives did you have in the last 12 months?	5	5	5	-0.12	0.8626
How much honey (litres) did you produce in the last 12 months?	13.3	14.3	8.5	5.77	0.1962
What was the average price per litre of honey produced and sold in the last 12 months?	21.8	21.7	22.5	-0.75	0.9404

Source: LORTA and project teams
Note: * p < 0.05, ** p < 0.01, *** p<0.001

MODULE B1: HOUSEHOLD DIET DIVERSITY

Table A - 17. Food consumption by food group in the past seven days before the survey interview by gender

VARIABLES	ENTIRE SAMPLE (N=2508)	MALE (M) (N=1864)	FEMALE (F) (N=644)	M-F	[P-VALUE]
Cereals and grain	2253 (90%)	1669 (90%)	584 (91%)	-1.14	0.4075
Roots and tubers	465 (19%)	359 (19%)	106 (16%)	2.80	0.1151
Beans	1077 (43%)	821 (44%)	256 (40%)	4.29	0.0578
Other legumes and nuts	1137 (45%)	861 (46%)	276 (43%)	3.33	0.1430
Orange-fleshed vegetables (vitamin A-rich vegetables)	292 (12%)	226 (12%)	66 (10%)	1.88	0.2008

VARIABLES	ENTIRE SAMPLE (N=2508)	MALE (M) (N=1864)	FEMALE (F) (N=644)	M-F	[P-VALUE]
Green leafy vegetables	1547 (62%)	1131 (61%)	416 (65%)	-3.92	0.0778
Other vegetables	1872 (75%)	1417 (76%)	455 (71%)	5.37**	0.0069
Orange-fleshed fruits (vitamin A-rich fruits)	2126 (85%)	1597 (86%)	529 (82%)	3.53*	0.0315
Other fruits	419 (17%)	321 (17%)	98 (15%)	2.00	0.2401
Meats/beef, fish, seafood, and eggs	1650 (66%)	1281 (69%)	369 (57%)	11.43***	0.0000
Dairy products	981 (39%)	778 (42%)	203 (32%)	10.22***	0.0000
Oils, butter, and fats	1663 (66%)	1258 (67%)	405 (63%)	4.60*	0.0332

Source: LORTA and project teams
Note: * p < 0.05, ** p < 0.01, *** p<0.001

MODULE B2: LIVELIHOOD AND ASSET AND FOOD-BASED COPING STRATEGIES

Table A - 18. Livelihood and asset-based coping strategies by gender

VARIABLES	ENTIRE SAMPLE (N=2508)	MALE (M) (N=1864)	FEMALE (F) (N=644)	M-F	[P-VALUE]
Sold household assets/goods to buy food	154 (6%)	120 (6%)	34 (5%)	1.16	0.2914
Reduced non-food expenses to buy food	427 (17%)	339 (18%)	88 (14%)	4.52**	0.0085
Sold productive assets or means of transport to buy food	99 (4%)	90 (5%)	9 (1%)	3.43***	0.0001
Spent savings on buying food	828 (33%)	616 (33%)	212 (33%)	0.13	0.9526
Borrowed money from a formal lender/bank to buy food	497 (20%)	370 (20%)	127 (20%)	0.13	0.9435
Leased out land to buy food	46 (2%)	37 (2%)	9 (1%)	0.59	0.3383
Withdraw children from school because of hunger or to help to work for food	157 (6%)	110 (6%)	47 (7%)	-1.40	0.2073
Sold last female breeding livestock to buy food	367 (15%)	299 (16%)	68 (11%)	5.48***	0.0007
Begging to get food	509	351	158	-5.70**	0.0019

VARIABLES	ENTIRE SAMPLE (N=2508)	MALE (M) (N=1864)	FEMALE (F) (N=644)	M-F	[P-VALUE]
	(20%)	(19%)	(25%)		
Sold more animals (non-productive) than usual to buy food	324 (13%)	254 (14%)	70 (11%)	2.76	0.0722

Source: LORTA and project teams
Note: * p < 0.05, ** p < 0.01, *** p<0.001

Table A - 19. Food based coping strategies by gender

VARIABLES	ENTIRE SAMPLE (N=2508)	MALE (M) (N=1864)	FEMALE (F) (N=644)	M-F	[P-VALUE]
Food based coping strategy index	5.5 (4.6)	5.3 (4.6)	6.1 (4.8)	-0.70***	0.0009

Source: LORTA and project teams
Notes: Index range for entire sample: Min = 0, Max = 24. Standard deviations in parentheses. * p < 0.05, ** p < 0.01, *** p<0.001.

Table A - 20. Income in the last calendar month by gender

VARIABLES	ENTIRE SAMPLE (N=2508)	MALE (M) (N=1864)	FEMALE (F) (N=644)	M-F	[P-VALUE]
Remittances outside / Remittances within a country	393 (462)	414 (493)	349 (386)	65.47	0.1840
Crops (food crop, cash crop)/ vegetables sales	580 (952)	625 (988)	435 (813)	190.02*	0.0274
Casual labour	279 (331)	307 (356)	189 (209)	117.76***	0.0000
Livestock sales	520 (774)	548 (799)	413 (664)	134.80*	0.0445
Sale of livestock products/ draught power hiring	173 (286)	184 (297)	77 (120)	106.34	0.1724
Skilled trade/artisan	437 (630)	397 (550)	614 (895)	-216.48	0.0618
Own business/beer brewing	723 (1107)	777 (1152)	601 (990)	176.17	0.0788
Petty trade (including vending)/cross-border trade	518 (930)	491 (918)	620 (983)	-128.56	0.4809
Pensions	520 (1468)	575 (1543)	50 (87)	525.17	0.3746
Salary/wages/earnings	873 (1295)	876 (1277)	855 (1392)	21.74	0.9226
Fishing, gathering of natural products e.g., firewood, fruits	393 (574)	417 (605)	271 (354)	145.24	0.1332
Small-scale mining/ mineral sales	146	158	75	82.54	0.6568

VARIABLES	ENTIRE SAMPLE (N=2508)	MALE (M) (N=1864)	FEMALE (F) (N=644)	M-F	[P-VALUE]
	(480)	(514)	(175)		
Social transfers (incl. cash and in-kind) from government or NGOs	239 (284)	208 (271)	282 (297)	-74.51	0.0606
Receipt of money owed	369 (566)	355 (556)	417 (600)	-62.06	0.4744
Loan received	675 (1100)	658 (1108)	737 (1082)	-79.40	0.6873
Rental income	479 (748)	416 (643)	780 (1096)	-363.67*	0.0474
Other	275 (500)	277 (515)	266 (437)	10.13	0.9473

Source: LORTA and project teams
Note: * p < 0.05, ** p < 0.01, *** p<0.001

Table A - 21. Expenditure in the last calendar month by gender

VARIABLES	ENTIRE SAMPLE (N=2508)	MALE (M) (N=1864)	FEMALE (F) (N=644)	M-F	[P-VALUE]
Maize flour/Mealie meal	183 (321)	197 (353)	143 (202)	53.97**	0.0082
Maize grain	169 (301)	179 (324)	141 (219)	37.45	0.0510
Wheat flour/ grain	64 (188)	54 (166)	91 (240)	-36.87*	0.0167
Bread, buns, and other confectionery	59 (186)	59 (192)	60 (164)	-1.86	0.8805
Millet (pearl millets/finger millet)	35 (141)	26 (103)	61 (212)	-35.01**	0.0029
Rice and pasta	49 (143)	37 (96)	83 (227)	-45.79***	0.0000
Sorghum (grain, flour)	42 (195)	31 (173)	76 (248)	-44.79**	0.0068
Sweet potatoes	34 (178)	16 (93)	87 (305)	-70.91***	0.0000
Irish potatoes	36 (152)	21 (94)	77 (248)	-55.71***	0.0000
Other tubers (cassava, yams)	25 (143)	12 (87)	62 (235)	-49.52***	0.0000
Milling costs	38 (108)	38 (110)	39 (103.5)	-1.31	0.8023
Sugar and other sugar products/honey	52 (124)	54 (132)	45 (98)	8.56	0.2232

VARIABLES	ENTIRE SAMPLE (N=2508)	MALE (M) (N=1864)	FEMALE (F) (N=644)	M-F	[P-VALUE]
Salt/soups	22.5 (45)	24 (50)	17 (28.5)	7.13***	0.0007
Milk (including powdered and formula)	33 (130)	25 (96)	57 (201)	-31.73**	0.0010
Tea leaves and coffee	23 (126)	13 (77)	54 (213)	-41.02***	0.0000
Peanut butter, jam, and margarine	29 (146.5)	15 (86)	73 (249)	-58.66***	0.0000
Cooking oil and fats	67.5 (87)	70 (82)	61 (100)	8.62*	0.0452
Meat (beef, pork, chicken, including live chicken and other meats)	55 (132.5)	50 (115)	70 (176)	-20.24*	0.0311
Fish/Kapenta	49 (91.5)	50 (91.5)	44.5 (91)	5.88	0.2851
Soya mince/Soya chunks	33 (73)	32.5 (62)	36 (98)	-3.89	0.3599
Vegetables (leaf, tomatoes, onions, etc.)	40 (67)	41 (62)	36 (79)	5.13	0.1621
Cooking fuel (paraffin, gel, gas, firewood, electricity, etc.)	89 (884)	107 (1021)	35 (115)	71.85	0.3235
Matches/candles	6 (26)	6 (9)	8.5 (50)	-2.78	0.0596
Washing and bathing soap and other detergents	57 (113)	60 (119)	50 (95.5)	10.11	0.0565
Vaseline, toothpaste and other lotion	41 (53)	43 (50)	37 (60)	6.32*	0.0156
Alcohol and cigarettes (including snuff)	42 (155)	32 (105)	78 (263)	-46.08***	0.0003
Transport (include bus fare, vehicle fuel, and services costs)	193 (393)	201.5 (424)	166 (275)	35.85	0.1439
Domestic worker (including maid, herd boy)	75 (243)	59 (215)	120 (304)	-60.97**	0.0035
Communication (airtime/telephone bills/internet)	47 (95)	48 (91)	42.5 (107)	5.28	0.2983
Sanitary ware (including pampers and tissue paper)	28.5 (110)	19 (51)	57 (201)	-37.44***	0.0000
Other	42 (215)	29 (194)	79 (265)	-50.21**	0.0097

Source: LORTA and project teams
Note: * p < 0.05, ** p < 0.01, *** p<0.001

Table A - 22. Expenditure in the last calendar month by gender

VARIABLES	ENTIRE SAMPLE (N=2508)	MALE (M) (N=1864)	FEMALE (F) (N=644)	M-F	[P-VALUE]
Education expenses (School fees and levies, uniforms, stationaries, and others)	1150 (2597)	1246 (2830)	838 (1597)	407.94**	0.0021
Agricultural inputs (seed, fertilizers, chemicals, fuel)	1151 (1843)	1250 (1927)	817 (1485)	433.12***	0.0000
Agricultural services (Labour, tillage)	433 (1167)	456 (1207)	362 (1035)	93.99	0.2514
Veterinary chemicals and drugs	215.5 (507)	242 (552)	110 (227)	131.81***	0.0004
Agricultural tools (include spare parts and maintenance)	181 (415)	199 (444)	112 (269)	87.10**	0.0021
Business costs (running and investment costs)	966 (3232)	1044 (3443)	741 (2515)	302.52	0.2029
Health/medical	198 (507)	186 (440)	237 (678)	-50.54	0.1292
Clothes/shoes (excluding school uniforms)	437 (778)	484 (842)	287 (507)	197.16***	0.0000
Social occasions (weddings, parties)	157 (643)	176 (715)	94 (297)	81.65	0.1286
Funeral expense	281 (590)	292 (606)	247 (533)	45.43	0.2520
Loan repayment	461 (1898)	461 (1980)	458 (1620)	3.08	0.9849
Constructions expenses (including maintenance)	1028 (3470)	1182 (3808)	570 (2124)	612.06*	0.0193
Remittances out	270 (841)	306 (932)	142 (328)	164.00*	0.0179
Taxes (livestock, household, Government and council taxes, and any other taxes)	48 (262)	48 (273)	46 (225)	1.67	0.9446
Other	19 (172)	22 (196)	9 (58)	13.25	0.4143

Source: LORTA and project teams
Note: * p < 0.05, ** p < 0.01, *** p<0.001

MODULE C: AGRICULTURAL PRODUCTION TECHNOLOGIES PRACTICES

Table A - 23. Familiarity with agricultural production technologies by gender

VARIABLES	ENTIRE SAMPLE (N=2508)	MALE (M) (N=1864)	FEMALE (F) (N=644)	M-F	[P-VALUE]
Adapted and drought-tolerant crops and varieties	1758 (70%)	1331 (71%)	427 (66%)	5.10*	0.0148
Crop rotation	2099 (84%)	1595 (86%)	504 (78%)	7.31***	0.0000
Intercropping	1824 (73%)	1369 (73%)	455 (71%)	2.79	0.1703
Cover cropping (e.g., with legumes)	1075 (43%)	829 (44.5%)	246 (38%)	6.28**	0.0055
Mulching	1264 (50%)	963 (52%)	301 (47%)	4.92*	0.0312
Agroforestry and planting of fodder trees	1062 (42%)	823 (44%)	239 (37%)	7.04**	0.0018
Organic fertilizer or manure	1972 (79%)	1489 (80%)	483 (75%)	4.88**	0.0092
Composting	1355 (54%)	1034 (55.5%)	321 (50%)	5.63*	0.0135
Drip/micro-irrigation	885 (35%)	678 (36%)	207 (32%)	4.23	0.0528
Zero or minimum tillage	1361 (54%)	1040 (56%)	321 (50%)	5.95**	0.0090
Animal fodder production for ruminants	594 (24%)	464 (25%)	130 (20%)	4.71*	0.0154
Homemade animal feeds	987 (39%)	751 (40%)	236 (37%)	3.64	0.1028

Source: LORTA and project teams
Note: * p < 0.05, ** p < 0.01, *** p<0.001

Table A - 24. Usage of agricultural production technologies by gender

VARIABLES	ENTIRE SAMPLE (N=2508)	MALE (M) (N=1864)	FEMALE (F) (N=644)	M-F	[P-VALUE]
Adapted and drought-tolerant crops and varieties	997 (40%)	763 (41%)	234 (36%)	4.60*	0.0398
Crop rotation	1426 (57%)	1086 (58%)	340 (53%)	5.47*	0.0157
Intercropping	1058 (42%)	782 (42%)	276 (43%)	-0.90	0.6888
Cover cropping (e.g., with	556	420	136	1.41	0.4566

VARIABLES	ENTIRE SAMPLE (N=2508)	MALE (M) (N=1864)	FEMALE (F) (N=644)	M-F	[P-VALUE]
legumes)	(22%)	(23%)	(21%)		
Mulching	756 (30%)	590 (32%)	166 (26%)	5.88**	0.0051
Agroforestry and planting of fodder trees	303 (12%)	238 (13%)	65 (10%)	2.68	0.0726
Organic fertilizer or manure	1036 (41%)	810 (43%)	226 (35%)	8.36***	0.0002
Composting	488 (19%)	375 (20%)	113 (18%)	2.57	0.1554
Drip/Micro-irrigation	211 (8%)	158 (8%)	53 (8%)	0.25	0.8460
Zero or minimum tillage	769 (31%)	597 (32%)	172 (27%)	5.32*	0.0116
Animal fodder production for ruminants	143 (6%)	115 (6%)	28 (4%)	1.82	0.0857
Homemade animal feeds	420 (17%)	317 (17%)	103 (16%)	1.01	0.5531

Source: LORTA and project teams
Note: * p < 0.05, ** p < 0.01, *** p<0.001

MODULE D: CROP PRODUCTION FOR ALL CROPS GROWN BY THE HOUSEHOLD DURING THE 2019/20 PRODUCTION YEAR

Table A - 25. Summary statistics for agricultural land variables by gender

VARIABLES	ENTIRE SAMPLE (N=2508)	MALE (M) (N=1864)	FEMALE (F) (N=644)	M-F	[P-VALUE]
Total household landholding in hectares	4.5 (6.1)	4.9 (4.9)	3.3 (3.3)	1.54***	0.0000
Number of fields owned per household	1.8 (1.0)	1.9 (1.1)	1.6 (0.9)	0.24***	0.0000
Area of cultivated fields in hectares	3.7 (5.0)	4.0 (5.5)	2.8 (3.3)	1.22***	0.0000
Area planted in hectares	2.2 (2.9)	2.2 (2.2)	2.0 (2.0)	0.21	0.1174
Distance between the field and homestead in km	2.2 (10.8)	2.2 (2.2)	2.2 (2.2)	-0.03	0.9539

Source: LORTA and project teams
Note: * p < 0.05, ** p < 0.01, *** p<0.001

Table A - 26. Households growing each crop by gender - Part A

VARIABLES	ENTIRE SAMPLE (N=2508)	MALE (M) (N=1864)	FEMALE (F) (N=644)	M-F	[P-VALUE]
Maize	2361 (94%)	1764 (95%)	597 (93%)	1.93	0.0718
Sorghum	676 (27%)	524 (28%)	152 (24%)	4.51*	0.0262
Rice	27 (1%)	24 (1%)	3 (0.5%)	0.82	0.0816
Millet	378 (15%)	289 (16%)	89 (14%)	1.68	0.3032
Sunflower	193 (8%)	165 (9%)	28 (4%)	4.50***	0.0002
Groundnuts	905 (36%)	671 (36%)	234 (36%)	-0.34	0.8778
Soybeans	133 (5%)	105 (6%)	28 (4%)	1.29	0.2097
Seed cotton	84 (3%)	75 (4%)	9 (1%)	2.63**	0.0014
Irish potato	2 (0.1%)	1 (0.1%)	1 (0.2%)	-0.10	0.4311
Virginia tobacco	3 (0.1%)	2 (0.1%)	1 (0.2%)	-0.05	0.7615
Burley tobacco	1 (0.04%)	1 (0.1%)	0 (0%)	0.05	0.5568
Mixed beans	276 (11%)	195 (10%)	81 (13%)	-2.12	0.1391
Bambara nuts	13 (0.5%)	10 (0.5%)	3 (0.5%)	0.07	0.8297
Cowpeas	167 (7%)	128 (7%)	39 (6%)	0.81	0.4768
Velvet beans	27 (1%)	21 (1%)	6 (1%)	0.19	0.6796

Source: LORTA and project teams
Note: * p < 0.05, ** p < 0.01, *** p<0.001

Table A - 27. Households growing each crop by gender - Part B

VARIABLES	ENTIRE SAMPLE (N=2508)	MALE (M) (N=1864)	FEMALE (F) (N=644)	M-F	[P-VALUE]
Coffee	1 (0.04%)	1 (0.1%)	0 (0%)	0.05	0.5568
Sweet potato, white or yellow-fleshed	87 (3%)	70 (4%)	17 (3%)	1.12	0.1824
Sweet potato, orange-	16	12	4	0.02	0.9504

VARIABLES	ENTIRE SAMPLE (N=2508)	MALE (M) (N=1864)	FEMALE (F) (N=644)	M-F	[P-VALUE]
fleshed	(1%)	(1%)	(1%)		
Cassava	101 (4%)	83 (4%)	18 (3%)	1.66	0.0651
Kenaf	0 (0%)	0 (0%)	0 (0%)	0.00	.
Cashew nut	7 (0.3%)	4 (0.2%)	3 (0.5%)	-0.25	0.2976
Paprika	0 (0.0%)	0 (0.0%)	0 (0.0%)	0.00	.
Popcorn	49 (2%)	38 (2%)	11 (2%)	0.33	0.6015
Sugarcane	9 (0.4%)	7 (0.4%)	2 (0.3%)	0.06	0.8122
Pigeon peas	4 (0.2%)	2 (0.1%)	2 (0.3%)	-0.20	0.2653
Sesame	0 (0%)	0 (0%)	0 (0%)	0.00	.
Black sunhemp	0 (0%)	0 (0%)	0 (0%)	0.00	.
Red sunhemp	0 (0%)	0 (0%)	0 (0%)	0.00	.
Other	314 (13%)	239 (13%)	75 (12%)	1.18	0.4371

Source: LORTA and project teams
Note: * p < 0.05, ** p < 0.01, *** p<0.001

Table A - 28. Main land use of agricultural fields by gender

VARIABLES	ENTIRE SAMPLE (N=4537)	MALE (M) (N=3488)	FEMALE (F) (N=1049)	M-F	[P-VALUE]
Own cultivated field	3268 (72%)	2546 (73%)	722 (69%)	0.46	0.6444
Rented in	38 (1%)	31 (1%)	7 (1%)	0.24	0.5753
Borrowed in	53 (1%)	39 (1%)	14 (1%)	-0.37	0.4544
Garden	32 (1%)	23 (1%)	9 (1%)	-0.32	0.4160
Fallow	57 (1%)	46 (1%)	11 (1%)	0.27	0.5979
Rented out	6 (0.1%)	5 (0.1%)	1 (0.1%)	0.05	0.7451
Borrowed out	1	1	0	0.04	0.5935

VARIABLES	ENTIRE SAMPLE (N=4537)	MALE (M) (N=3488)	FEMALE (F) (N=1049)	M-F	[P-VALUE]
	(0.02%)	(0.03%)	(0%)		
Orchard	29 (1%)	22 (1%)	7 (1%)	-0.09	0.7987
Virgin land	6 (0.1%)	3 (0.1%)	3 (0.3%)	-0.28	0.1007

Source: LORTA and project teams
Note: * p < 0.05, ** p < 0.01, *** p<0.001

Table A - 29. Field tenure and mode of acquisition by gender

VARIABLES	ENTIRE SAMPLE (N=4537)	MALE (M) (N=3488)	FEMALE (F) (N=1049)	M-F	[P-VALUE]
Tenure					
State land-titled	69 (2%)	48 (1%)	21 (2%)	-0.63	0.1465
State land not titled	44 (1%)	32 (1%)	12 (1%)	-0.23	0.5117
Former customary land-titled	300 (7%)	213 (6%)	87 (8%)	-2.19*	0.0124
Customary no title	4124 (91%)	3195 (92%)	929 (89%)	3.04**	0.0027
Acquisition					
Purchased	157 (3%)	116 (3%)	41 (4%)	-0.58	0.3653
Inherited	1617 (36%)	1209 (35%)	408 (39%)	-4.23*	0.0121
Allocated / Given	2262 (50%)	1766 (51%)	496 (47%)	3.35	0.0573
Rented / Borrowed	119 (3%)	92 (3%)	27 (3%)	0.06	0.9099
Just walked in	377 (8%)	303 (9%)	74 (7%)	1.63	0.0931
Other	5 (0.1%)	2 (0.1%)	3 (0.3%)	-0.23	0.0504

Source: LORTA and project teams
Note: * p < 0.05, ** p < 0.01, *** p<0.001

Table A - 30. Agricultural practices implemented by gender

VARIABLES	ENTIRE SAMPLE (N=4537)	MALE (M) (N=3488)	FEMALE (F) (N=1049)	M-F	[P-VALUE]
Seed used					
Improved seed	1987 (44%)	1551 (44%)	436 (42%)	2.90	0.0966

VARIABLES	ENTIRE SAMPLE (N=4537)	MALE (M) (N=3488)	FEMALE (F) (N=1049)	M-F	[P-VALUE]
Local	1346 (30%)	1032 (30%)	314 (30%)	-0.35	0.8297
Recycled	1204 (27%)	905 (26%)	299 (29%)	-2.56	0.1001

Source: LORTA and project teams
Note: * p < 0.05, ** p < 0.01, *** p<0.001

Table A - 31. Agricultural practices implemented by gender

VARIABLES	ENTIRE SAMPLE (N=4537)	MALE (M) (N=3488)	FEMALE (F) (N=1049)	M-F	[P-VALUE]
Main source of seed used					
Own saved seed from own harvest	1760 (39%)	1320 (38%)	440 (42%)	-4.10*	0.0169
Seed saved from last season's purchase	114 (3%)	86 (2%)	28 (3%)	-0.20	0.7119
FISP	683 (15%)	529 (15%)	154 (15%)	0.49	0.6998
Trader/shopkeeper	511 (11%)	421 (12%)	90 (9%)	3.49**	0.0017
Private seed suppliers/companies	230 (5%)	183 (5%)	47 (4%)	0.77	0.3214
Gift from family/neighbour	188 (4%)	131 (4%)	57 (5%)	-1.68*	0.0168
Farmer-to-farmer seed exchange	83 (2%)	66 (2%)	17 (2%)	0.27	0.5650
Local market/open-air	79 (2%)	56 (2%)	23 (2%)	-0.59	0.2026
On-farm trials	5 (0.1%)	5 (0.1%)	0 (0%)	0.14	0.2199
Extension demo plots	2 (0.04%)	2 (0.1%)	0 (0%)	0.06	0.4380
Farmer groups/Coops	166 (4%)	129 (4%)	37 (4%)	0.17	0.7957
Local seed producers	40 (1%)	36 (1%)	4 (0.4%)	0.65*	0.0481
Provided free by NGOs/govt	64 (1%)	46 (1%)	18 (2%)	-0.40	0.3390
Research centres	3 (0.1%)	3 (0.1%)	0 (0%)	0.09	0.3421
Agrovets	241 (5%)	188 (5%)	53 (5%)	0.34	0.6692
Farmer-to-farmer trading	117	96	21	0.75	0.1789

VARIABLES	ENTIRE SAMPLE (N=4537)	MALE (M) (N=3488)	FEMALE (F) (N=1049)	M-F	[P-VALUE]
	(3%)	(3%)	(2%)		
Other	251 (6%)	191 (5%)	60 (6%)	-0.24	0.7620

Source: LORTA and project teams
Note: * p < 0.05, ** p < 0.01, *** p<0.001

Table A - 32. Agricultural practices implemented by gender

VARIABLES	ENTIRE SAMPLE (N=4537)	MALE (M) (N=3488)	FEMALE (F) (N=1049)	M-F	[P-VALUE]
Main method of payment for seed					
Own cash	2719 (60%)	2149 (62%)	570 (54%)	7.27***	0.0000
Money received as a gift from a relative or non-relative	65 (1%)	42 (1%)	23 (2%)	-0.99*	0.0182
Credit from a money lender	5 (0.1%)	3 (0.1%)	2 (0.2%)	-0.10	0.3705
Credit from seed dealers	29 (1%)	22 (1%)	7 (1%)	-0.04	0.8964
Credit from relative/neighbour/friend	19 (0.4%)	14 (0.4%)	5 (0.5%)	-0.08	0.7407
Credit from micro-finance	3 (0.1%)	3 (0.1%)	0 (0%)	0.09	0.3421
Credit from NGO	14 (0.3%)	11 (0.3%)	3 (0.3%)	0.03	0.8805
Credit from coops	13 (0.3%)	11 (0.3%)	2 (0.2%)	0.12	0.5077
Other	1670 (37%)	1233 (35%)	437 (42%)	-6.31***	0.0002

Source: LORTA and project teams
Note: * p < 0.05, ** p < 0.01, *** p<0.001

Table A - 33. Main tillage methods implemented by gender

VARIABLES	ENTIRE SAMPLE (N=4537)	MALE (M) (N=3488)	FEMALE (F) (N=1049)	M-F	[P-VALUE]
Conventional hand hoeing	998 (22%)	731 (21%)	267 (25%)	-4.50**	0.0021
Planting basins (potholes)	117 (3%)	90 (3%)	27 (3%)	0.01	0.9909
Zero tillage excluding chitemene	106 (2%)	87 (2%)	19 (2%)	0.68	0.1992
Ploughing	2463 (54%)	1928 (55%)	535 (51%)	4.27*	0.0148

VARIABLES	ENTIRE SAMPLE (N=4537)	MALE (M) (N=3488)	FEMALE (F) (N=1049)	M-F	[P-VALUE]
Ripping	325 (7%)	254 (7%)	71 (7%)	0.51	0.5717
Ridging (before planting)	368 (8%)	278 (8%)	90 (9%)	-0.61	0.5262
Bunding	8 (0.2%)	6 (0.2%)	2 (0.2%)	-0.02	0.8996
Mounding	14 (0.3%)	13 (0.4%)	1 (0.1%)	0.28	0.1556
Did not till (broadcasted seed)	16 (0.4%)	10 (0.3%)	6 (1%)	-0.29	0.1718
No other tillage method	122 (3%)	91 (3%)	31 (3%)	-0.35	0.5434

Source: LORTA and project teams
Note: * p < 0.05, ** p < 0.01, *** p<0.001

Table A - 34. Maize production values and variables cost by gender

VARIABLES	ENTIRE SAMPLE (N=2508)	MALE (M) (N=1864)	FEMALE (F) (N=644)	M-F	[P-VALUE]
Yield (kgs/hectare)	1521 (3187)	1604 (3243)	1279 (3008)	325.26*	0.0293
Gross value of production in ZMW per hectare	2247 (2821)	2373 (2926)	1885 (2463)	487.91***	0.0003
Cost of seed planted in ZMW per hectare	474 (1016)	475 (1111)	471 (582)	4.46	0.9513
Cost of basal dressing fertilizer in ZMW per hectare	939 (3263)	962 (3650)	863 (1237)	99.11	0.6711
Cost of top-dressing fertilizer in ZMW per hectare	849 (2211)	836 (2430)	894 (1174)	-57.70	0.7175
Cost of hired oxen in ZMW per hectare	456 (2290)	518 (2825)	343 (484)	174.90	0.4648
Cost of a hired tractor in ZMW per hectare	480 (407)	543 (453)	349 (258)	193.83	0.1611
Cost of hire manual labour in ZMW per hectare	524 (2286)	566 (2612)	395 (551)	171.77	0.5167

Source: LORTA and project teams
Note: * p < 0.05, ** p < 0.01, *** p<0.001

MODULE E: SHOCKS, STRESS AND RESILIENCE

Table A - 35. Shocks/stress by gender

VARIABLES	ENTIRE SAMPLE (N=2508)	MALE (M) (N=1864)	FEMALE (F) (N=644)	M-F	[P-VALUE]
Climatic/Environmental					
Excessive rains	607 (24%)	456 (24%)	151 (23%)	0.88	0.6532
Flood/flash flood	283 (11%)	213 (11%)	70 (11%)	0.57	0.6939
Variable/infrequent rainfall	729 (29%)	542 (29%)	187 (29%)	-0.14	0.9463
Drought	1238 (49%)	910 (49%)	328 (51%)	-2.19	0.3381
Crop diseases or pests	1683 (67%)	1250 (67%)	433 (67%)	-0.10	0.9614
Reduced soil productivity	300 (12%)	232 (12%)	68 (11%)	1.88	0.2097
Deforestation (less firewood available)	211 (8%)	160 (9%)	51 (8%)	0.63	0.6239
Frost	134 (5%)	115 (6%)	19 (3%)	3.24**	0.0018
Destructive shocks					
Crop damage/destruction by wildlife	533 (21%)	415 (22%)	118 (18%)	3.89*	0.0385
Theft of livestock (raids)	516 (21%)	399 (21%)	117 (18%)	3.15	0.0896
Economic shocks					
Sharp food price increase	1338 (53%)	999 (54%)	339 (53%)	0.73	0.7500
Increase in price of agricultural/livestock input	821 (33%)	635 (34%)	186 (29%)	3.97	0.0754
Drop in price of agricultural (including cash crop) or livestock products	233 (9%)	186 (10%)	47 (7%)	2.42	0.0844
Death of a household member	273 (11%)	186 (10%)	87 (14%)	-3.58*	0.0124
Death of livestock (cattle, donkeys, or goats) due to disease or lack of food or water (poverty deaths)	950 (38%)	735 (39%)	215 (33%)	5.93**	0.0077
Serious/chronically ill household member (s)	459 (18%)	348 (19%)	111 (17%)	1.44	0.4163
COVID-19 illness of a household member (s)	24 (1%)	16 (1%)	8 (1%)	-0.38	0.3879

VARIABLES	ENTIRE SAMPLE (N=2508)	MALE (M) (N=1864)	FEMALE (F) (N=644)	M-F	[P-VALUE]
COVID-19 death of a household member (s)	9 (0.4%)	8 (0.4%)	1 (0.2%)	0.27	0.3170
COVID-19 related loss of income	459 (18%)	352 (19%)	107 (17%)	2.18	0.2195
Large/unusual expense on medical male care (M) of Family Member(s)	273 (11%)	207 (11%)	66 (10%)	0.85	0.5496

Source: LORTA and project teams
Note: * p < 0.05, ** p < 0.01, *** p<0.001

Table A - 36. Access to information and perception of usefulness by gender

VARIABLES	HAVE ACCESS-ENTIRE SAMPLE (N=2508)	FIND INFORMATION USEFUL§	MALE (M) (N=1864)	FEMALE (F) (N=644)	M-F	[P-VALUE]
Early warning for natural hazards (drought, flooding, heavy rain, hailstorm, etc.) – disaster risk reduction	1141 (45%)	34%	881 (47%)	260 (40%)	6.56**	0.0041
Threats to crop health (e.g., pest, disease incl. FAW)	1060 (42%)	41%	800 (43%)	260 (40%)	2.13	0.3490
Threats to animal health (e.g., disease, epidemic)	878 (35%)	34%	689 (37%)	189 (29%)	7.19**	0.0010
Rainfall/weather prospects for the coming growing season, including seasonal climate forecasting (meteorology and indigenous)	841 (34%)	25%	650 (35%)	191 (30%)	5.06*	0.0193
Long-term changes in weather patterns	642 (26%)	25%	499 (27%)	143 (22%)	4.30*	0.0325
Insurance (including weather and yield insurance)	301 (12%)	11%	236 (13%)	65 (10%)	2.45	0.1031
Methods to improve crop production	986 (39%)	39%	765 (41%)	221 (34%)	6.52**	0.0037
Methods for improved animal health/husbandry	729 (29%)	29%	570 (31%)	159 (25%)	5.60	0.0074
Business and investment opportunities	475 (19%)	18%	347 (19%)	128 (20%)	-1.45	0.4218
Financial education and credit opportunities	418 (17%)	16%	311 (17%)	107 (17%)	-0.09	0.9561
Information on crop prices	789 (31%)	30%	596 (32%)	193 (30%)	1.73	0.4179
Current market prices of live animals and animal products	425 (17%)	16%	332 (18%)	93 (14%)	3.19	0.0651

VARIABLES	HAVE ACCESS-ENTIRE SAMPLE (N=2508)	FIND INFORMATION USEFUL§	MALE (M) (N=1864)	FEMALE (F) (N=644)	M-F	[P-VALUE]
Grazing conditions in a nearby area	304 (12%)	12%	232 (12%)	72 (11%)	1.14	0.4502
Child nutrition and health information	1275 (51%)	50%	978 (52%)	297 (46%)	5.90*	0.0101
COVID-19	2116 (84%)	82%	1594 (86%)	522 (81%)	4.25*	0.0103

Source: LORTA and project teams
Notes: §usefulness: respondent has said to be useful or very useful. * p < 0.05, ** p < 0.01, *** p<0.001.

Table A - 37. Group participation and access to financial services by gender

VARIABLES	ENTIRE SAMPLE (N=2508)	MALE (M) (N=1864)	FEMALE (F) (N=644)	M-F	[P-VALUE]
Lead Farmer or Model farmer's group	657 (26%)	504 (27%)	153 (24%)	3.24	0.1089
Farmer Field School (FFS)	290 (12%)	217 (12%)	73 (11%)	0.30	0.8386
Demo Plots or Crop and Livestock Innovation Centre (CLICs)	415 (17%)	307 (16.5%)	108 (17%)	-0.24	0.8864
Cattle keeping group	176 (7%)	129 (7%)	47 (7%)	-0.39	0.7423
Goat keeping group	1188 (47%)	865 (46%)	323 (50%)	-3.63	0.1125
Poultry keeping group	260 (10%)	189 (10%)	71 (11%)	-0.88	0.5314
Health clubs	263 (10%)	189 (10%)	74 (11%)	-1.30	0.3566
Natural Resource Management Group	104 (4%)	75 (4%)	29 (5%)	-0.50	0.5863
Producer Group/Commodity Association	90 (4%)	61 (3%)	29 (5%)	-1.26	0.1422
Vocational skills/Enterprise group	108 (4%)	73 (4%)	35 (5%)	-1.55	0.0977
Youth Forum	150 (6%)	110 (6%)	40 (6%)	-0.36	0.7403
Fisheries group	138 (6%)	102 (5%)	36 (6%)	-0.11	0.9177
Disaster response and management group	104 (4%)	75 (4%)	29 (5%)	-0.50	0.5895

VARIABLES	ENTIRE SAMPLE (N=2508)	MALE (M) (N=1864)	FEMALE (F) (N=644)	M-F	[P-VALUE]
Is any member of this household part of a savings group (ISAL/VSLA/SACCO)?	558 (22%)	411 (22%)	147 (23%)	-0.78	0.6830

Source: LORTA and project teams
Notes: ISAL=internal savings and credit. VSLA=Village Savings and Loan Associations. SACCO=savings and credit cooperative organization. * p < 0.05, ** p < 0.01, *** p<0.001.

MODULE H: LIVESTOCK ASSETS

Table A - 38. Number of livestock owned by gender

VARIABLES	ENTIRE SAMPLE (N=2508)	MALE (M) (N=1864)	FEMALE (F) (N=644)	M-F	[P-VALUE]
Cattle (for meat)	9 (13.9)	9.7 (14.9)	5.7 (6.6)	3.96**	0.0069
Draught cattle/oxen	5.1 (5.9)	5.5 (6.2)	3.6 (3.9)	1.82	0.1484
Donkeys/mule	2.8 (1.7)	2.9 (1.7)	0 (0)	2.91	.
Sheep	6.6 (6.2)	6.9 (6.1)	4.5 (6.9)	2.39	0.3872
Goats	9.9 (9.3)	10.3 (9.7)	8.4 (7.5)	1.87*	0.0169
Pigs	5.2 (5.3)	5.4 (5.5)	3.9 (4.0)	1.51	0.1815
Poultry	16 (21.8)	17.1 (23.5)	12 (13)	5.04**	0.0017
Rabbits	3.9 (4.1)	4.3 (4.3)	1.5 (2.1)	2.75	0.4049

Source: LORTA and project teams
Note: * p < 0.05, ** p < 0.01, *** p<0.001

MODULE I: IMPACT INDICATORS

Table A - 39. Differences in impact indicators of the beneficiary status by gender

VARIABLES	ENTIRE SAMPLE (N=2508)	MALE (M) (N=1864)	FEMALE (F) (N=644)	M-F	[P-VALUE]
Food security					
Food consumption score	43.3 (21.1)	44.4 (21.2)	40.2 (20.7)	4.23***	0.0000
Acceptable Household Dietary Diversity based on Food Consumption Groups	0.5 (0.5)	0.5 (0.5)	0.4 (0.5)	0.10***	0.0000
Food expenditure shares	50%	49%	53%	-4.14***	0.0000

VARIABLES	ENTIRE SAMPLE (N=2508)	MALE (M) (N=1864)	FEMALE (F) (N=644)	M-F	[P-VALUE]
(percentage)	(22)	(22)	(22)		
Coping Strategies Index	5.5 (4.6)	5.3 (4.6)	6.1 (4.8)	-0.70***	0.0009
Income stability					
The volatility of income level	56% (50)	55% (50)	57% (50)	-2.21	0.3314
The average level of yields (Maize)	1521 (3187)	1604 (3243)	1279 (3008)	325.26	0.0293
Livelihood diversification					
Percentage of farmers with agriculture as the only source of income	10% (30.5)	11% (31)	10% (30)	0.79	0.5728
Number of different income generating activities farmers engage	2.0 (1.4)	2.0 (1.4)	1.9 (1.4)	0.11	0.0904
Number of different crops planted	2.2 (1.1)	2.3 (1.2)	2.1 (1.1)	0.19**	0.0003
Percentage of farmers who use climate information	52% (50)	53% (50)	48% (50)	5.35*	0.0191
Knowledge level of climate information and climate-resilient agriculture (Number of known practices, out of 12)	6.5 (3.2)	6.6 (3.2)	6 (3.3)	0.62***	0.0000
Percentage of farmers who adopt sustainable and climate-resilient agricultural practices	90% (31)	91% (28)	84.5% (36)	6.84***	0.0000
Purchase decisions on agricultural inputs, seeds in particular (Women can decide alone or together with a husband or other adult)	60% (49)	50% (50)	89% (31)	-39.07***	0.0000

Source: LORTA and project teams
Note: * p < 0.05, ** p < 0.01, *** p<0.001

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