Food and Agriculture Organization of the United Nations

Evaluating the impacts of in-kind productive transfers and extension training in Zambia

Baseline analysis of the integration of the Food Security Pack programme and farmer field schools

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Juan Sebastian Correa and Nicholas Sitko

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Abbreviations and acronyms

CWAC	Community Welfare Assistance Committee
ESP	Inclusive Rural Transformation and Gender Equality Division
FAO	Food and Agriculture Organization of the United Nations
FSP	Food Security Pack
ha	hectares
HH	household
IAPRI	Indaba Agricultural Policy Research Institute
MCDSS	Ministry of Community Development and Social Services
MDE	minimum detectable effect
PEA	participatory extension approaches
PWAS	public welfare assistance scheme
SERA	Socio Economic Research and Analysis
ZIPAR	Zambia Institute for Policy Analysis and Research
ZMW	Kwacha

Executive summary

The "Building Back Better and Greener: Integrated Approaches for an Inclusive and Green COVID-19 Recovery in Rural Spaces" project has three primary objectives:

1. Strengthen the capacity of key stakeholders in providing advisory and extension services.
2. Integrate social protection measures with complementary extension advice focused on climate-adaptive agriculture.
3. Generate evidence through an impact evaluation, to assess the effectiveness of climate-adaptive agricultural training and the distribution of input packages in enhancing rural incomes, food security, and resilience in the face of persistent climate-related challenges.

While existing literature suggests that adopting climate-adaptive agricultural practices can mitigate production losses, enhance farmer resilience, and improve overall welfare, a key challenge lies in determining the most efficient methods for promoting such practices. Climate adaptation requires farmers to adopt new technologies and management approaches, which necessitate knowledge, skills, and investments. However, knowledge and liquidity constraints, common in rural communities in Sub Sharan Africa, alongside uncertainty in investment returns, often hinder the adoption of these practices.

To address these challenges effectively, the project combines extension advice through farmer field schools with the transfer of input packages provided to beneficiaries through the government's Food Security Pack programme (FSP) in Zambia. The impact evaluation is structured to provide causal evidence on the varying impact of the extension advice and input packages on project outcomes. In the context of this impact evaluation, this report serves three interconnected objectives:

1. It outlines the experimental design of the evaluation and offers comprehensive details about the baseline survey instrument.
2. It provides in-depth information on programme outcomes, demonstrating the effectiveness of the randomization procedure and the absence of systematic differences across treatment groups, which is critical for generating evidence on the causal effects of programme components.
3. It conducts policy-relevant descriptive and econometric analyses of the baseline data, highlighting concerns related to food insecurity, gender disparities, and the benefits of climate-adaptive practices.

Analysis of the baseline data highlights substantial challenges related to poverty and food insecurity in the study region. Moreover, it uncovers specific gender-related disparities, such as differences in income and food security, when comparing households with a male main respondent to those with a female main respondent. These disparities also manifest in variations in participation and confidence in decision-making, often leading to the marginalization of females within the household. However, it also establishes a positive mediating role of perceived resilience between climate-adaptive agricultural practices and household food security and income. This analysis provides preliminary evidence that promoting climate-adaptive practices and increasing household resilience can effectively enhance household welfare in the face of adverse climate conditions. Nonetheless, further investigation is needed to determine the most effective combination of policies to promote climate adaptation and increased wellbeing.

Introduction

Globally, poverty disproportionately burdens rural communities, with the majority of their inhabitants relying on agriculture for both their livelihoods and sustenance. This challenge is acutely pronounced in sub-Saharan Africa, where over half of the region's population resides in rural areas. Despite sustained economic growth experienced until the pandemic, more than 60 percent of the nation's populace in Zambia still lives below the international poverty line, set at USD 2.15 a day, in contrast to the regional average of 35 percent for sub-Saharan Africa (IMF, 2023). Notably, the incidence of poverty is even higher in rural areas. In light of these stark disparities, achieving the global objectives of poverty reduction and food security, as outlined in the Sustainable Development Goals 1 and 2, necessitates precise, targeted interventions tailored to the unique challenges faced by impoverished farmers. These interventions must equip rural households with the tools they need to attain agricultural growth and foster an inclusive transformation of rural areas.

Pandemics and climatic disasters have exacerbated the difficulties of rural poverty in recent years. These events disrupt the flow of the agricultural value chain, hamper transportation, harm farming output, and weaken job prospects and income potential within the rural non-farm sector (Blanc and Schlenker, 2017; Sitko *et al.,* 2022). As a consequence, these challenges directly impact the livelihoods, incomes, and food and nutrition security of the rural poor, who rely on agriculture and related activities for their well-being. In Zambia for example, exposure to droughts has been shown to affect maize yields and income (Alfani *et al.*, 2021) and poverty (Ngoma *et al.,* 2019).

Immediate measures are necessary to address the threats to the livelihoods of rural communities stemming from these challenges. Prior research has shown that the provision of agricultural technology transfers and extension services can enhance the income and overall well-being of farming households (Tirivayi *et al.,* 2016; Larsen and Lilleør, 2014; Davis *et al.,* 2012). As a result, this project incorporates the transfer of agricultural technologies (the Food Security Pack) to equip beneficiary rural households in Zambia with the resources they need for the upcoming agricultural season, thereby allowing them to allocate their resources more effectively to manage risks and financial constraints. Additionally, it integrates extension advice through farmer field schools (FFS), which is designed to disseminate knowledge on the sustainable use of the transferred inputs by promoting conservation agricultural practices. The articulation of extension advice around the transferred input package aims to enhance food security and farm productivity, contributing to inclusive rural transformation.

Moreover, the analytical component of the project, which is structured around experimental and quasi experimental techniques, allows to address critical questions concerning the most efficient methods for promoting climate adaptive practices and improving productivity, and, consequently, enhancing food security and resilience among farming households. The evaluation is structured to assess two policy-relevant aspects: (a) the varying impacts of the Food Security Pack (FSP) on the livelihoods of beneficiaries; and (b) the differential impacts of the Food Security Pack programme vs the Food Security Pack programme plus extension advice in the form of FFS. Collectively, these two estimates offer valuable information into the effectiveness of these strategies in enhancing the well-being of beneficiaries. They also shed light on the complementarity of these approaches and offer a deeper understanding of the mechanisms through which these programmes influence the overall welfare of households. Additionally, the Government of Zambia stands to gain a deeper understanding of this approach as it seeks to scale up and enhance the programme's efficiency.

This report offers a comprehensive overview of the project's evaluation design and the baseline survey instrument. It presents detailed insights into the baseline data collection process, including balance tests linked to randomization into the FFS and the construction of a pure counterfactual, along with a policy-relevant analysis of the baseline data. Section 2 of the report provides essential context, outlining the project's objectives, targeting criteria, and the underlying theory of change. In Section 3, the evaluation design of the project is expounded upon, including in-depth information about the intervention itself. Sections 4 and 5 offer a meticulous examination of data collection processes and the survey instrument used. Section 6 delivers summary statistics and balance tests to evaluate the efficacy of the randomization procedure employed and the construction of a pure counterfactual. Section 7 furnishes econometric estimates of the effect of the adoption of climate-adaptive practices on farmer’s wellbeing that passes through resilience using mediation analysis. Section 8 compares male and female-headed households, examining various outcomes. It also delves into the differences in intrahousehold decision-making between spouses in male-headed households. Section 9 concludes.

Context

Description of the Food Security Pack programme

The Food Security Pack (FSP) is a social safety net programme implemented by the Department of Community Development of the Ministry of Community Development and Social Services (MCDSS) since 2000. The programme provides agricultural inputs (seeds, fertilizers, fungicide, and insecticide) and livelihood skills, and initially targeted farmer households who had been affected by increased unfavourable climatic conditions and whose productivity had been compromised due to the structural adjustment reforms in the 1990s (Muyenga, 2021).

The FSP intends to achieve the following goals:

- improve nutrition and food security at household level;
- increase agricultural output and productivity;
- promote conservation farming/ climate smart agriculture;
- increase household incomes; and
- promote community food banks and management, and marketing hubs.

In 2021, the FSP expanded from 36 300 to 263 700 beneficiaries, and for 2022 it expected to reach more than 300 000 beneficiaries. To roll out the programme, the MCDSS uses Community Welfare Assistance Committees (CWAC), which are groups that consist of volunteer members elected from the community/communities they cover that help identify potential beneficiaries. The committees were initially part of the structure of the public welfare assistance scheme (PWAS), which aimed at supporting the most disadvantaged members of the population to enable them to fulfil their essential requirements and fostering community resilience in tackling poverty and vulnerability.

To be eligible for participation in the programme, there are specific primary selection criteria that must be met. These criteria include:

- The household must be able to provide sufficient labour resources.
- The household should have access to land ranging in size from half a hectare to two hectares.
- The household head or primary breadwinner should not be engaged in gainful employment.

The project focuses on a sub-programme of the FSP targeting households that have access to wetlands areas, known locally as *dambos*. Hence, beneficiaries must have access to this type of land.

In addition to the primary selection criteria, there are several secondary criteria that are also considered for eligibility in the programme. Some of these secondary criteria include households headed by females, children, or individuals with disabilities. There are other secondary criteria related to various vulnerabilities that are also taken into account for programme eligibility.

Evaluation objective

A critical challenge affecting the effective implementation of the FSP lies in the difficulties of connecting programme beneficiaries with the necessary extension support. Zambia has a high farmer-to-extension officer ratio, causing these officers to prioritize larger, more resource-rich producers for extension support (FAO, 2022). Consequently, FSP beneficiaries often lack essential information on how to make the most of the FSP input package, hindering their progress towards higher agricultural production and economic independence.

As a response to this challenge, the “Building Back Better and Greener: Integrated Approaches for an Inclusive and Green COVID-19 Recovery in Rural Spaces" project in Zambia is strategically geared toward enhancing the availability of extension services, with a particular focus on promoting conservation agricultural practices among FSP beneficiaries in districts where programme expansion is underway. To achieve this, beneficiaries will actively engage in FFS to acquire valuable knowledge and adopt best practices associated with the FSP package.

The impact evaluation will enable a comparison of outcomes between a subset of beneficiaries who receive the FSP pack along with additional extension advice (referred to as the "FSP plus" group) and those who solely receive the FSP programme. Moreover, data will be gathered on prospective beneficiaries from CWACs without prior exposure to the programme, who were not chosen to benefit from the 2022 expansion. This data collection will facilitate an assessment of the isolated impact of the FSP programme.

The assessment of the impacts for both the FSP and FSP plus interventions will focus on outcomes aligned with the objectives of the FSP programme. These outcomes encompass:

- Climate-resilient Agricultural Practices: Climate-resilient agricultural practices have shown promise to enhance overall farm productivity, mitigate production-related risks, and elevate the well-being of smallholder households (Di Falco *et al.,* 2011; Scognamillo *et al.*, 2022). Nevertheless, factors such as information gaps and financial limitations often impede the widespread adoption of these productive practices (Mobarak and Sanldanha, 2022). In response, this project integrates agricultural extension advice with input transfers designed to alleviate these constraints. The impact evaluation will furnish valuable evidence regarding the effectiveness of these strategies in encouraging the adoption of climate-resilient agricultural practices. This adoption is considered a crucial step towards establishing resilient and transformative food production systems.

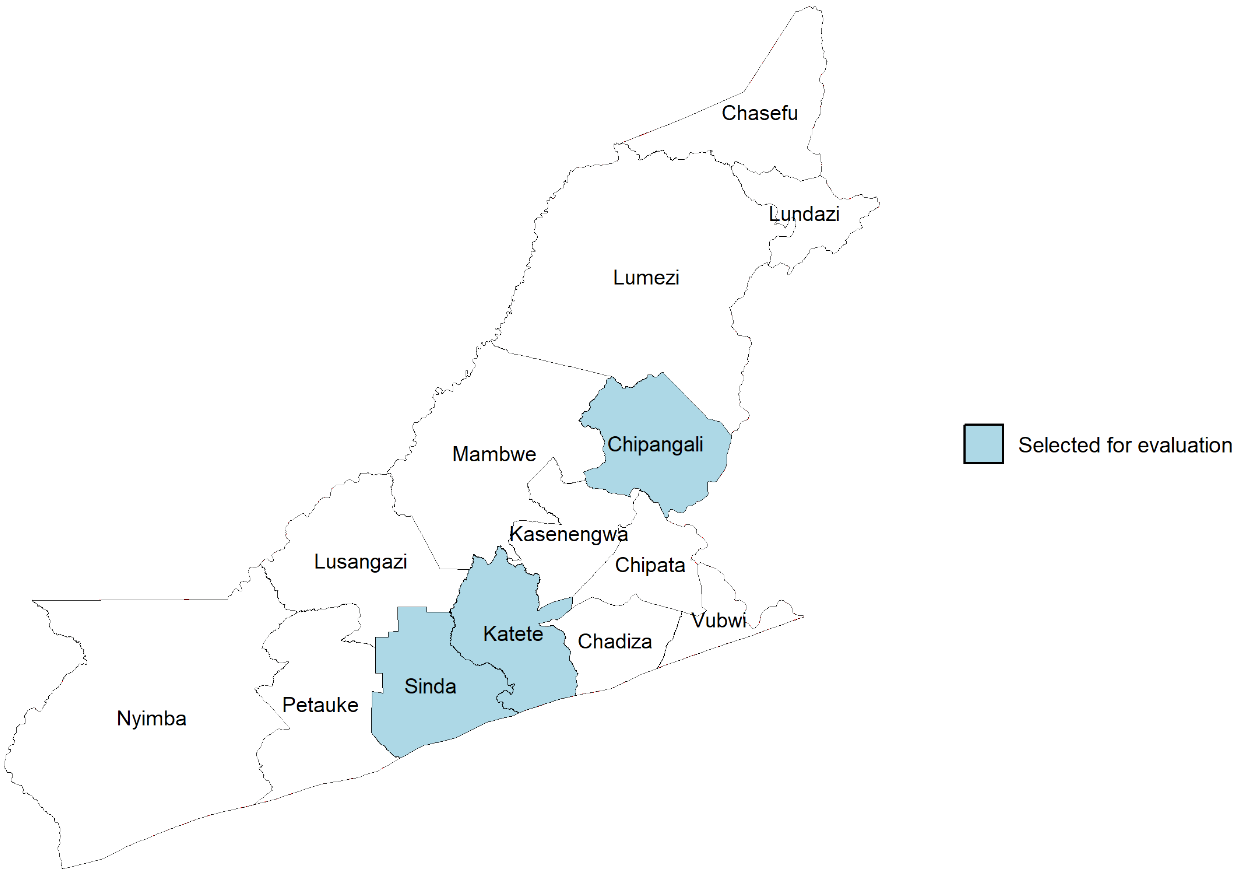
- Income diversification: Income and livelihood diversification represent vital strategies in rural areas for mitigating production risks and improving welfare, as underscored in the literature (Asfaw *et al.,* 2019; Mohammed *et al.,* 2021). However, constraints related to credit access and liquidity, as documented in prior studies (Macours *et al.,* 2012; Pace *et al.,* 2022), can limit the diversification of income and livelihoods. We postulate that the intervention will not only enhance climate-resilient practices and elevate agricultural productivity but also empower farmers to generate income from various farm and off-farm sources.
- Crop diversification: Crop diversification has the potential to stabilize the productivity of cropping systems while simultaneously mitigating adverse environmental impacts and preserving biodiversity (Hufnagel *et al.,* 2020). At the same time, increased diversification may increase yields, leading to reduced food insecurity (Makate *et al.,* 2016). We posit that the extension advice and training initiatives and input transfers will lead farmers to plant crops of increased market value, ultimately fostering a more robust and diversified portfolio on their farms.
- Food security: An essential goal of the programme is to enhance food consumption and security. The intervention, accomplished through increased adoption of climate-resilient practices, income diversification, as well as increased access to community food banks, aims to address and overcome the food security challenges confronting rural population in Zambia.
- Enhanced resilience: This project is dedicated to bolstering the overall resilience of rural households, which is a multifaceted concept with various definitions and econometric measurement approaches available in the literature (Barrett *et al.,* 2021). Following Ahmed *et al.,* (2023) we present it as the household's capacity to rebound, adapt their farming and livelihood strategies, and transform their production system in response to adverse shocks. These dimensions of resilience are expected to be fortified through the promotion of climate-resilient agricultural practices, increased income and crop and income diversification.

Evaluation design

To evaluate the impact of the FSP package and the FSP with an additional extension advice component, we employ a combination of experimental and quasi-experimental designs. The MCDSS initiated the expansion of the project across all ten provinces in 2022. However, due to budgetary limitations, the evaluation efforts, conducted in collaboration with FAO, were confined to the Eastern province, specifically in three districts: Sinda, Katete, and Chipangali. These districts share the same agroecological zone, characterized by a rainy season typically occurring from November to April, with peak rainfall between December and February. Local farmers rely on rainfed agriculture, using the rainfall patterns to determine planting and harvesting seasons, making them particularly vulnerable to climatic fluctuations (Arslan *et al.,* 2015).

Figure 1 provides a visual representation of the geographical locations of these three districts within the Eastern Province. A total of 141 CWACs within the three districts met the criteria for participation in the programme's expansion. These CWACs had not previously received programme benefits, and a majority of their members had access to wetlands. However, due to administrative challenges, we were unable to employ a randomized selection process for inclusion in the FSP programme. Instead, the MCDSS chose 42 CWACs from the three districts to be recipients of the programme. The selection process was primarily influenced by prior commitments made with local authorities before the possibility of an impact evaluation was discussed.

Figure 1. Districts in the eastern province, Zambia



Note: Authors' own elaboration with information of the FMM/GLO/166/MUL project
Source: **Grid3.** 2023. *Zambia - Administrative District Boundaries 2022.* Cited 25 July 2023. https://data.grid3.org/datasets/GRID3::zambia-administrative-district-boundaries-2022/explore

From the 42 CWACs selected to benefit from the FSP expansion, we randomly selected 21 to benefit from the additional extension advice, while the remaining 20 would only receive the FSP programme.

To construct a control group, we first calculated the geographical distances in kilometres between all the 99 remaining eligible CWACs[1] and each of the CWACs chosen for the FSP intervention within the same district and ward. Focusing on the nearest treated neighbouring CWAC, we excluded those that were either in overly close or excessively distant proximity[2]. Following this step, the number of eligible CWACs was reduced to 55. Subsequently, we conducted random selection, opting for either one or two CWACs from each ward. This oversampling approach was taken to account for the non-experimental nature of the control group's formation. Consequently, we arrived at a total of 26 control CWACs that would not be recipients of the FSP expansion. Table 1 below shows the number of CWACs across treatment arms and districts. Figure 2 provides a closer view of the Eastern Province, illustrating the location of CWACs within the selected districts, categorized by their respective treatment arms.

Table 1. Number of CWACS by treatment arms and districts

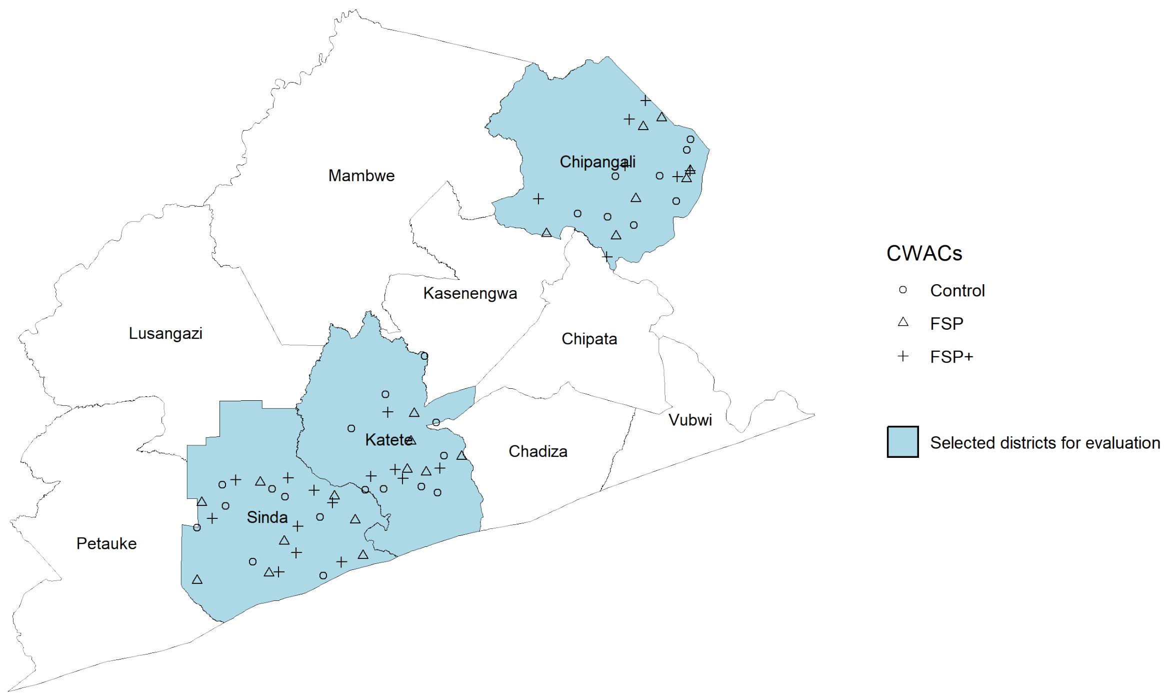
	Treatment arms			
District	**Control**	**FSP**	**FSP plus**	**Total**
Sinda	9	8	9	26
Katete	8	5	5	18
Chipangali	9	7	7	23
Total	26	20	21	

Source: Authors' own elaboration.

[1] 141 eligible minus 42 selected for treatment

[2] We retained unselected CWACs located within a range of 4 to 15 kilometres from the nearest treated CWAC. These distance criteria were deliberated with the MCDSS, and their officials concurred that the distances were sufficient to prevent contamination and not so far as to significantly differentiate them from the CWACs chosen for treatment.

Figure 2. Control, FSP, and FSP plus treatment CWACs



Note: Authors' own elaboration with information of the FMM/GLO/166/MUL project
Source: **Grid3.** 2023. *Zambia - Administrative District Boundaries 2022.* Cited 25 July 2023. https://data.grid3.org/datasets/GRID3::zambia-administrative-district-boundaries-2022/explore

This design allows calculating the following types of impacts at the project level in relation to the outcomes and outputs of interest:

1. The differential impact of the FSP programme on livelihoods of beneficiaries (FSP vs. control).
2. The differential impact of additional extensions services vs only receiving the FSP programme (FSP plus vs. FSP).

The FSP beneficiaries will receive 50 kilograms of compound D, 50 kilograms of Urea, and different types of seeds depending on the specific area, including maize (5 kilograms), rape seed (50 grams), butternut (400 grams) and okra (1 kilogram).

The FFS within the project comprises groups of approximately 30 farmers who gather regularly to study specific crops, meeting once a week. In total, 59 FFS have been established — 33 from January to May and 26 from August to December 2023. These schools offer farmers valuable opportunities through hands-on learning, emphasizing principles of adult and non-formal education, and experiential learning. Adult education is seamlessly integrated into community-level agricultural extension programs through participatory extension approaches (PEA).

FFS plays a multifaceted role in society, extending beyond its primary function as a catalyst for agricultural development. It serves as a platform not only for validating established, research-based technologies but also as an arena where farmers actively contribute recommendations and modifications to enhance the adaptability of the studied technology. Acting as a hub for adult education, FFS addresses crucial gaps in societies with lower education levels. Additionally, FFS creates an optimal learning environment, facilitating collaboration among researchers, extension workers, and farmers to jointly explore and test innovative climate-smart agricultural practices and technologies.

In addition to participants, each FFS requires a skilled facilitator, which is an employee of the Ministry of Agriculture, a designated plot, and clearly defined objectives. These components collectively guarantee a dynamic and focused learning environment, promoting the practical application of agricultural and technological knowledge.

Farmers convene at agreed intervals, typically meeting weekly throughout the growing period for most crops. In the case of vegetables, smaller groups are formed, with members alternating and tending to the crops more regularly. A typical cycle of the FFS focuses on one or two crops, such as okra, onion, maize (orange and white), rape, cabbage, and butternut, under the FSP wetland component. Adherence to recommended agricultural practices is crucial, emphasizing the empowerment of farmers to independently implement decisions in their own fields. The overarching goal is to foster a sense of ownership and autonomy among farmers in the cultivation process.

Data collection

The FAO Zambia country office with the support of the Socio-Economic Research and Analysis team (SERA) of the Inclusive Rural Transformation and Gender Equality Division (ESP) signed a Letter of Agreement for the data collection with the Zambia Institute for Policy Analysis and Research (ZIPAR). The MCDSS provided us with rosters of beneficiaries, encompassing both those in the FSP and FSP plus treatment groups, as well as individuals who could potentially qualify for the programme for the control treatment arm. These rosters served as the basis for the random household selection process for our surveys within the designated CWACs.

Data collection was completed between mid-October and early December 2022 involving a team of six supervisors and 30 enumerators. Table 2 provides a breakdown of the surveys conducted, number of CWACs, the supervisors, and the enumerators in each district. Out of the 3 001 surveys collected, five were excluded, leaving a total of 2 996 surveys for the current analysis. The number of observations in all the analysis presented in Section 0, 0, and 0 is 2 996 unless explicitly stated.

Table 2. Surveys, supervisors, and enumerators by district

District	Actual respondents	Total CWACs	Field supervisors	Enumerators
Chipangali	1 012	23	2	10
Katete	804	18	2	10
Sinda	1 185	26	2	10
Total	3 001	67	6	30

Source: Authors' elaboration from survey data.

As stated earlier, the randomization was done at the CWAC level. Before knowing the number of CWACs the 2023 expansion of the project would cover, we calculated the minimum detectable effect size (MDEs) for some important outcomes: agricultural income, household dietary diversity, number of agricultural practices adopted, and maize yields. To carry out this power analysis, we assumed 25 clusters per treatment arm, which is slightly higher than the actual number for two out of the three treatment arms (20 CWACs for the FSP only arm, 21 CWACs for the FSP plus arm) and marginally lower for the other (26 CWACs for the control arm). We also varied the size of the cluster and used 20, 25, and 30 households to do the power calculations. Ultimately, the average size of the cluster in the sample is 44, implying that the power calculations are conservative in what respects to this parameter.

The MDEs are estimated using the 2015 wave of the rural agricultural livelihood survey (RALS) which is carried out by the Central Statistical Office in collaboration with the Ministry of Agriculture and the

Indaba Agricultural Policy Research Institute (IAPRI). The analysis concluded that while the number of clusters may not be powerful enough to distinguish effects on variables with high variance such as total income, the study can credibly distinguish even relatively small effects on indices associated with adoption of climate adaptive practices, household dietary diversity, and even maize yields.

The baseline data capture the living conditions of the project participants before the start of the training activities and before any input packages have been delivered. Further, these data allow the evaluation team to assess whether any systematic differences across the treatment groups exist at baseline, so that we can control for them in the analysis.

Survey

The baseline data collection for the impact evaluation of the project employed a single survey instrument, the household questionnaire, with a reference period spanning from May 2021 to April 2022 for all questions, unless otherwise explicitly indicated. The development of this household instrument was guided by three fundamental principles:

- The instrument must contain the key list of indicators presented in the project's log frame that will allow the programme to be assessed against its stated objectives. These core indicators include land management and agricultural practices, crop production, climate shocks, climate information and coping strategies, food security, access to markets and savings, although the final instrument contains many more relevant indicators.
- Where possible, indicators are measured using the questions and approaches that have already been field tested in similar surveys in the country, thus ensuring that they are appropriate for local conditions. For example, to measure food insecurity, we used food insecurity experience scale (FIES) and food consumption scores (FCS), which are commonly used in the literature (e.g. Saint Ville *et al.,* 2019; Muthini *et al.,* 2020). Similarly, to measure perceived resilience capacity of the households, we used the conceptual framework put forth by Meuwissen *et al.,* (2019) and adapted it to farm-household setting.
- The survey instrument must be a manageable length to avoid interviewer or respondent fatigue. Table 3 provides a list of topics covered in the instrument. The questionnaire took approximately an average 55 minutes.

Table 3. Household survey

Sections:
Roster
Land
Crop production and use (rainfed and wetlands)
Vegetable production and sale (rainfed and wetlands)
Fruit production and sales
Livestock holding
Livestock by-products
Agricultural assets
Agricultural inputs expenses
Non-farm enterprises
Hired labour
Transfers
Decision-making
Access to information
Climate
Food consumption
Food insecurity
Housing
Credit
Perceived resilience

Source: Authors' elaboration from survey data.

Analysis

Methodology

This report presents a description of the sociodemographic characteristics and livelihoods of eligible households of the FSP programme prior to the start of the activities. We describe demographic features of the sample and several characteristics that relate to either the goals of the project or potential mediators.

To check that the three treatment arms are comparable in terms of the main outcome variables, outputs and observed characteristics, we carry out one-way analysis of variance (ANOVA) for each variable. ANOVA is used to determine whether there are any statistically significant differences between the means of three or more independent groups. Specifically, we test the null hypothesis:

$$H_0: \mu_C = \mu \quad = \mu \qquad (1)$$

where μ_C, μ_{FSP}, and $\mu_{FSPplus}$ are the group means for the control group, the group receiving only the FSP transfer, and the group that receives the FSP transfer plus the additional extension advice, respectively. ANOVA uses F-tests to statistically test the equality of means. The F statistics are based on the ratio of the between-groups variability (numerator) and the within-group variability (denominator). If the one-way ANOVA returns a statistically significant result, we accept the alternative hypothesis that there are at least two group means that are statistically significantly different from each other.

Because of their random allocation, we expect to find minimal differences across households included in the FSP and FSP-plus groups. Given that the Control group was not randomly established, we additionally test whether there are differences across the considered variables between the Control group and the FSP-all group, which includes all households receiving the FSP transfer (the FSP group and the FSP-plus group). Since all the households in the Control groups belong to eligible CWACs for the FSP transfer, we expect this comparison to result in differences in limited number of variables. To test for statistical differences, we carry out simple t-tests of the mean difference between the control group and the FSP-all group. This analysis complements the ANOVA approach previously described, and checks whether the non-experimental assignment to the Control group was successful.

The tables with the baseline comparisons across the treatment groups for the demographic variables, the main outcomes of interest and the transfer variables are organized as follows, from left to right. The first three columns present the average for the Control, FSP, and FSP-plus groups, respectively. The fourth column shows the p-value of the F-statistic associated to the null hypothesis of equality of the means for the control, only FSP and FSP plus households stemming from the ANOVA. The fifth column shows the average value for each variable for the FSP-group (only FSP group and FSP-plus group). Sixth column shows the p-value of the t-statistic associated to the null hypothesis of equality of the means for the Control and FSP-all groups.

Additionally, the estimated standard errors are clustered at the CWAC level. This same procedure will be used for the analysis of the impact of the programme after the endline survey is collected.

Demographics

Table 4 provides information on the households' demographics for the full sample. The mean age of the main respondent is approximately 40 years, 35 percent are female. and 19 percent are single. On average, the main respondents did not finish primary school and only completed around five years of education. This contrasts with the maximum years of education attained by any household member which is equal to eight on average. Regarding the household, the average size is 5.47 members, with the biggest household having 18 members. Most of the household members are adults, and on average there is 1.18 members between the ages of 6 and 12, while the number of children between zero and five and between 13 and 17 is equal to 0.75 and 0.8 respectively. For every five households, the is around one with a member older than 60 years and with a disabled member.

Table 4. Household demographics

	Mean	SD
Main respondent		
Age	39.78	13.81
Single(=1)	0.19	0.39
Female(=1)	0.35	0.48
Years of education	5.33	3.81
Household		
# members in the hh	5.47	2.11
# members 0 –5 years	0.75	0.81
# members 6 –12 years	1.18	1.09
# members 13 –17 years	0.80	0.90
# female members 18+ years	1.36	0.75
# male members 18+ years	1.38	0.88
# members 60+ years	0.21	0.51
# disabled hh members	0.21	0.55
highest # of years of education by any member	8.00	3.08

Note: *SD* stands for standard deviation.
Source*:* Authors' elaboration from survey data.

Table 5 provides disaggregated demographic information for the three groups and for all the beneficiaries of the FSP transfer. For most of the demographic variables considered, the null hypothesis of equality among the means cannot be rejected at a 5 percent significance level (column

4). Only the average number of members aged 13–17 years exhibited a significant difference among the groups, suggesting that households may differ in terms of their teenage population. When comparing the Control group with FSP-all group (column 6), this difference disappears. Notably, the p-value for age in the comparison between FSP-all and the Control group showed significance at a 5 percent level. This difference shows that the main respondents of the FSP-all group appear to be older by around two years on average.

Table 5. Household demographics by treatment group

	Control	FSP	FSP plus	p-value H_0: $H_C=H_{FSP}=H_{FSPplus}$	FSP-all	p-value H_0:$H_C=H_{allFSP}$
Main respondent						
Age	38.59	40.79	40.67	0.075	40.73	0.027
Single(=1)	0.19	0.20	0.18	0.720	0.19	0.857
Female(=1)	0.32	0.36	0.38	0.420	0.37	0.247
Years of education	5.26	5.63	5.16	0.471	5.39	0.655
Household						
# members in the hh	5.43	5.43	5.56	0.400	5.50	0.470
# members 0–5 years	0.78	0.76	0.69	0.075	0.72	0.125
# members 6–12 years	1.14	1.16	1.25	0.089	1.21	0.168
# members 13–17 years	0.77	0.75	0.88	0.007	0.82	0.277
# female members 18+ years	1.34	1.37	1.37	0.646	1.37	0.356
# male members 18+ years	1.39	1.39	1.38	0.969	1.38	0.833
# members 60+ years	0.19	0.23	0.22	0.174	0.22	0.085
# disabled hh members	0.20	0.19	0.24	0.286	0.22	0.494
highest # of years of education by any member	7.92	8.07	8.07	0.841	8.07	0.568

Notes: Errors are clustered at the CWAC level. First, second, and third column, show the average value for each variable for control, only FSP and FSP plus households, respectively. Fourth column shows the p-value of the F-statistic associated to the null hypothesis of equality of the means for the control, only FSP and FSP plus households. Fifth column shows the average value for each variable for FSP-all group (only FSP and FSP plus). Sixth column shows the p-value of the t-statistic associated to the null hypothesis of equality of the means for the Control and FSP-all (FSP and FSP plus) households.
Source*:* Authors' elaboration from survey data.

Summary indices of outcome variables

In this section we describe a list of indicators that corresponds to the goal and outcomes included in the projects log frame, which are described in Section 0. Designing and implementing the survey instrument for this evaluation is complex due to the various domains affected by the interventions, both FSP and FSP plus. The challenge lies in measuring multidimensional concepts and choosing appropriate indicators that appropriately represent these. Testing the relationship between the interventions and each indicator poses two problems: a) the risk of multiple comparison issues (see Haushofer and Shapiro, 2016), and b) the inability to make broader statements about the program's effects on specific outcome areas.

For these reasons, we chose to use a summary index approach following Anderson (2008) for the main outcome variables. This approach allows us to conduct a single hypothesis test while still obtaining general insights into the program's effectiveness. Some critics argue that summary indices are too simplistic and do not reveal the program's mechanisms (Schwab *et al.,* 2020). However, this approach doesn't prevent researchers from delving into the details and discussing individual indicators. Recent development literature, such as Haushofer and Shapiro (2016), Janzen *et al.,* (2018) and Bandiera *et al.,* (2020) has successfully disentangled the findings of summary indices. In this section of the baseline study, we present the balance for the summary indices, while discussing their individual components in separate sections.

We calculate summary indices by adopting the standardized weighted mean approach of Anderson (2008), where we use the control group as the default reference group for the standardization. These standardized summary indices à la Anderson do not have a specific meaning as they merely reflect deviations from the reference group and can be thus interpreted as effect sizes.

We construct the following index variables:

I. The food security index is a standardized weighted average of the (negatively coded) indicators for whether during the recall period (May 2021 to the end of April 2022) there was a time when, because of lack of money or resources, the main respondent: was worried about not having enough food to eat, was unable to eat healthy and nutritious food, ate only a few kinds of foods, had to skip a meal, ate less than they thought they should, thought their household ran out of food, was hungry but did not eat, went without eating for a whole day; and the (positively coded) number of meals, including breakfast, eaten per day by the household members and the number of months the maize currently in the granary is expected to last.

II. The agricultural practices index is a standardized weighted average of the following indicators: dummy variables for whether any land was left fallow for more than one year in the last five years, land has been irrigated, crop residue used to cover land, zero/minimum tillage has been practiced in available land, manure fertilizer is applied on land, no use of pesticides on land, land subject to crop rotation, two or more crops are intercropped in land, any water conservation structure has been applied, and whether trees have been planted on farmland.

III. The income diversification index is a standardized weighted average of the (positively coded) number of income sources, a Simpson index of income concentration (Simpson, 1949) and a Shannon index of income diversity (Shannon and Weaver, 1948).

IV. The crop diversification index is a standardized weighted average of the (positively coded) number of crops planted, a Simpson index of farmland distribution and a Shannon index of farmland diversity by crop.

V. The perceived resilience index is a standardized weighted average of the positively and negatively coded Likert-scale items, extending and adapting the resilience framework of Meuwissen *et al.,* (2019) to a farm-household setting in a developing country. The index relies on eliciting farm-household's ability to (a) bounce back from a shock (robustness), (b) adapt farming practices through management and adoption of technologies in face of a shock (farm adaptability), (c) transform production (transformability), and (d) adapt and diversify their livelihoods (livelihood adaptability). The same Likert-scale items were used to elicit resilience to droughts and floods. Section 0 provides more details about the Likert-scale items used to elicit aspects of perceived resilience.

In Table 6 we describe the main outcome variables by treatment group. Because the summary indices are standardized relative to the Control group, the mean for each variable of this group equals zero (and the unreported standard deviation equals to one). While the reported mean values do not have an immediate interpretation, a positive (negative) sign is indicative of larger (smaller) values of the index relative to the control group. For example, the summary food security index for the FSP group equals -0.11, meaning that this index is 0.11 standard deviations (SD) smaller than in the Control group. The three groups are perfectly balanced as shown by the p-values in column 4 and there are no statistical differences at a 5 percent significance level between the control group and the FSP-all group.

Table 6. Means of summary indices by treatment group

	Control	FSP	FSP plus	p-value H_0: $H_C=H_{FSP}=H_{FSPplus}$	FSP-all	p-value H_0: $H_C=H_{FSP-all}$
Food security index	0.00	-0.11	-0.12	0.447	-0.12	0.207
Agricultural practices index	0.00	-0.00	0.05	0.735	0.02	0.683
Crop diversity index	-0.00	-0.05	-0.06	0.629	-0.06	0.349
Income diversification index	0.00	-0.11	-0.09	0.236	-0.10	0.110
Subjective resilience index, drought	-0.00	-0.14	-0.12	0.199	-0.13	0.079
Subjective resilience index, flood	-0.00	-0.08	-0.09	0.528	-0.08	0.270

Notes: Errors are clustered at the CWAC level. First, second, and third column, show the average value for each variable for control, only FSP and FSP plus households, respectively. Fourth column shows the p-value of the F-statistic associated to the null hypothesis of equality of the means for the control, only FSP and FSP plus households. Fifth column shows the average value for each variable for FSP-all group (only FSP and FSP plus). Sixth column shows the p-value of the t-statistic associated to the null hypothesis of equality of the means for the Control and FSP-all (FSP and FSP plus) households.
Source*:* Authors' elaboration from survey data.

Income sources and diversification

As mentioned in section 0, the summary index of income diversification is a standardized weighted average of the shares of different income sources and of both a Simpson and a Shannon index of income diversity. In this study we consider the following income sources: crop production, vegetables production, fruits production, livestock production, livestock-by-products, non-farm businesses, private transfers, which includes both remittances from abroad and within the community/village, public transfers, and off-farm wage income. The general formula of a Simpson index is the following:

$$Simpson = 1 - \sum_{i=1}^{I} sh_i^2 \qquad \textbf{(2)}$$

where sh_i is the income share of source i, calculated over total household gross income. The Simpson index ranges between zero and one; a value of zero implies that the household relies only on one income source while a value closer to one reflects a more even distribution of income by source.

The general formula of a Shannon index is instead:

$$Shannon = -\sum_{i=1}^{I} sh_i \log(sh_i) \qquad \textbf{(3)}$$

Where again sh_i is the income share of source i. Values for the Shannon index can range from zero to the value of the log of the highest number of income sources of the household. The Shannon index ranges from 0, which flags households relying on one income source only, to a maximum of log I (when all shares equal 1/n). Considered together, the Simpson and Shannon indices identify the distribution or "evenness of income" by source. In so doing, they add granularity to the number of income sources, which captures only the raw diversity of livelihoods.

Table 7 provides an overview of the indices mentioned above and all the sources of income of the households, including the total gross and the agricultural gross monetary income in Kwacha (ZMW) for all the sample. For each income source, we provide the share of households and the average earnings. Overall, the number of income sources is 3.45 and annual gross income is ZMW 22 182 (~ PPP USD[3] 3 430). Most households engage in market participation by selling crops and vegetables (82 and 85 percent, respectively), while livestock by-products sales, private transfers, and fruit sales are present in much smaller proportions (3, 7, and 12 percent, respectively).

[3] The purchasing power parity (PPP) conversion factor is ZMW 6.47 per international USD for 2022 (World Bank, 2023).

Table 7. Sources of income

	Mean	SD
Indices, income sources and gross income:		
Summary index of income diversification	-0.06	1.06
Shannon income diversity index	0.72	0.36
Simpson income diversity index	0.42	0.20
# income sources	3.45	1.26
hh gross income, ZMW	22 182	54 960
hh agricultural gross income, ZMW	13 140	43 525
Crops		
hh has crop sales	0.82	0.38
total value of hh crop sales	5 359	8 355
total value of harvest, ZMW	10 771	40 322
Vegetables		
hh sold vegetables	0.85	0.36
value of vegetable sales, ZMW	1 956	3 956
Fruits		
hh sold fruit	0.12	0.33
value of fruit sales, ZMW	653	2 240
Livestock and livestock by-products		
hh has livestock sales	0.19	0.39
value of livestock sales, ZMW	4 045	35 786
hh has livestock by-products sales	0.03	0.16
value of livestock by-products sales, ZMW	565	1 208
Non-farm business		
hh has revenues from non-farm business	0.39	0.49
non-farm business revenues, ZMW	17 186	38 426
Wage work		
hh has at least a member with a wage work	0.41	0.49
hh total annual wage	3 994	12 470
Transfers		
Household received private transfers	0.07	0.25
Value of private transfers, ZMW	769	1 199
Household received public transfers	0.43	0.49
Value of public transfers, ZMW	1 358	2 160

Source*:* Authors' elaboration from survey data.

Table 8 compares the indices and the sources of income across groups. The means for all variables across the three groups are not statistically different, except for one. The mean of the value of livestock by-products sales statistically different for the three groups. Given that only three percent of the sample sell these products, it is expected some variability in the value of the sales. When comparing the Control group to the FSP-all group, the difference is no longer significant. Moreover, no difference is statistically significant between the control group and the FSP-all group.

Table 8. Sources of income by treatment group

	Control	FSP	FSP plus	p-value H_0: $H_C=H_{FSP}=H_{FSPplus}$	FSP-all	p-value H_0:$H_C=H_{allFSP}$
Indices, income sources and gross income:						
Summary index of income diversification	-0.00	-0.13	-0.08	0.207	-0.10	0.094
Shannon income diversity index	0.75	0.70	0.72	0.193	0.71	0.187
Simpson income diversity index	0.43	0.40	0.41	0.298	0.41	0.176
# income sources	3.55	3.41	3.41	0.142	3.41	0.128
hh gross income, ZMW	21 578	24 626	21 682	0.757	23 117	0.480
hh agricultural gross income, ZMW	12 441	15 071	12 942	0.668	13 980	0.352
Crops:						
hh has crop sales	0.84	0.83	0.82	0.786	0.83	0.625
total value of hh crop sales	5 373	5 490	5 212	0.931	5 348	0.970
total value of harvest, ZMW	10 220	11 950	10 515	0.824	11 215	0.593
Vegetables:						
hh sold vegetables	0.87	0.83	0.84	0.414	0.83	0.207
value of vegetable sales, ZMW	1 831	1 796	2 299	0.495	2 056	0.477
Fruits:						
hh sold fruit	0.13	0.15	0.10	0.071	0.12	0.665
value of fruit sales, ZMW	455	681	1 040	0.168	829	0.110
Livestock and livestock by-products:						
hh has livestock sales	0.18	0.19	0.20	0.775	0.19	0.621
value of livestock sales, ZMW	3 060	7 987	1 953	0.312	4 828	0.513
hh has livestock by-products sales	0.03	0.03	0.03	0.922	0.03	0.695
value of livestock by-products sales, ZMW	778	650	189	0.030	410	0.203
Non-farm business:						
hh has revenues from non-farm business	0.41	0.39	0.38	0.687	0.38	0.430
non-farm business revenues, ZMW	17 145	18 845	16 133	0.868	17 472	0.849
Wage work:						
hh has at least a member with a wage work	0.44	0.38	0.38	0.271	0.38	0.097

	Control	FSP	FSP plus	p-value H_0: $H_C=H_{FSP}=H_{FSPplus}$	FSP-all	p-value H_0:$H_C=H_{allFSP}$
hh total annual wage, ZMW	3 375	4 162	5 142	0.134	4 668	0.060
Transfers:						
hh received private transfers	0.08	0.05	0.06	0.137	0.06	0.053
value of private transfers, ZMW	737	847	762	0.897	800	0.727
hh received public transfers	0.43	0.42	0.44	0.829	0.43	0.774
value of public transfers, ZMW	1281	1487	1381	0.676	1431	0.358

Notes: Errors are clustered at the CWAC level. First, second, and third column, show the average value for each variable for control, only FSP and FSP plus households, respectively. Fourth column shows the p-value of the F-statistic associated to the null hypothesis of equality of the means for the control, only FSP and FSP plus households. Fifth column shows the average value for each variable for FSP-all group (only FSP and FSP plus). Sixth column shows the p-value of the t-statistic associated to the null hypothesis of equality of the means for the Control and FSP-all (FSP and FSP plus) households.

Source*:* Authors' elaboration from survey data.

Crop diversification and production

Table 9 shows the number of crops produced by the households in the sample, the indices of crop diversification, the share of crop growers for the five main crops, and their yields. 89 percent of households cultivate maize and the second most widely spread crop is soya beans (57 percent), followed by sunflower (26 percent), green maize (25 percent), and groundnuts (19 percent). The yields for white maize are 1 455 kilograms per hectare, which are lower than the national average of 2 570 kilograms per hectare reported for 2021 (FAO, 2023).

Table 9. Crop diversification, production and yields

	Mean	SD
Household produced crops	0.99	0.12
# crops planted	2.36	0.78
Simpson crop diversity index	0.73	0.09
Shannon crop diversity index	1.42	0.31
Household grows:		
White Maize (dry)	0.89	0.32
Green Maize	0.25	0.43
Sunflower	0.26	0.44
Groundnuts	0.19	0.39
Soya beans	0.57	0.50
Crop productivity		
White Maize (dry), kg/ha	1 455	3403.16
Green Maize, kg/ha	1 529	2191.76
Sunflower, kg/ha	1 112	1196.49
Groundnuts, kg/ha	1 131	1986.88
Soya beans, kg/ha	1 120	1388.19

Source*:* Authors' elaboration from survey data.

Table 10 shows the crop diversification variables, the share of crop growers for the five main crops, and their yields for each treatment group. We cannot reject the null hypothesis of equality of the means across the three groups at a 5 percent significance level for all variables except one. The mean of the value of green maize productivity is the only variable that is statistically different across the three groups. When comparing the Control group to the FSP-all group for this variable, the difference is significant at a one percent significance level, revealing that the FSP-all group has a higher productivity relative to the Control group.

Table 10. Crop diversification, production and yields by treatment group

	Control	FSP	FSP plus	p-value H_0: H_C=H_{FSP}=$H_{FSPplus}$	FSP-all	p-value H_0:H_C=H_{allFSP}
Household produced crops	0.99	0.98	0.98	0.147	0.98	0.156
# crops planted	2.37	2.37	2.34	0.814	2.35	0.663
Simpson crop diversity index	0.73	0.73	0.73	0.695	0.73	0.459
Shannon crop diversity index	1.43	1.41	1.42	0.776	1.41	0.495
Household grows:						
White maize (dry)	0.89	0.88	0.88	0.780	0.88	0.533
Green maize	0.25	0.26	0.24	0.875	0.25	0.952
Sunflower	0.23	0.29	0.27	0.501	0.28	0.242
Groundnuts	0.19	0.20	0.17	0.773	0.19	0.841
Soya beans	0.60	0.50	0.58	0.384	0.55	0.369
Crop productivity						
White maize (dry), kg/ha	1 380	1 373	1 653	0.429	1 517	0.336
Green maize, kg/ha	1 280	1 669	1 792	0.018	1 730	0.005
Sunflower, kg/ha	1 082	1 155	1 108	0.768	1 132	0.607
Groundnuts, kg/ha	1 141	957	1 307	0.224	1 123	0.918
Soya beans, kg/ha	1 109	1 092	1 160	0.865	1 129	0.866

Notes: Errors are clustered at the CWAC level. First, second, and third column, show the average value for each variable for control, only FSP and FSP plus households, respectively. Fourth column shows the p-value of the F-statistic associated to the null hypothesis of equality of the means for the control, only FSP and FSP plus households. Fifth column shows the average value for each variable for FSP-all group (only FSP and FSP plus). Sixth column shows the p-value of the t-statistic associated to the null hypothesis of equality of the means for the Control and FSP-all (FSP and FSP plus) households.
Source*:* Authors' elaboration from survey data.

Table 11 shows in Panel A the crop diversification variables, the share of crop growers for the five main crops overall, and their yields for each treatment group for rainfed plots, while Panel B for wetland plots. The table reveals that although wetland plots are mostly used for vegetable production, more than one fifth of the households grow maize on them. Again, the table reveals an almost perfect balance across treatment groups. As in Table 10, green maize productivity is the only variable where we reject the null hypothesis of equality of means across groups but only for the wetland plots. When comparing the Control group to the FSP-all group for this variable, the difference is significant at a one percent significance level, revealing that the FSP-all group has a higher green maize productivity relative to the Control group in the wetland plots.

Table 11. Crop diversification, production and yields by treatment group for rainfed and wetland plots

	Control	FSP	FSP plus	p-value H_0: $H_C=H_{FSP}=H_{FSPplus}$	FSP-all	p-value H_0:$H_C=H_{allFSP}$
Panel A: Rainfed plots						
Household grows:						
White maize (dry)	0.85	0.85	0.84	0.991	0.84	0.989
Green maize	0.04	0.05	0.05	0.694	0.05	0.414
Sunflower	0.22	0.28	0.27	0.522	0.28	0.256
Groundnuts	0.19	0.20	0.17	0.734	0.18	0.856
Soya beans	0.59	0.50	0.58	0.427	0.54	0.409
Crop productivity						
White maize (dry), kg/ha	1 405	1 375	1 472	0.570	1 425	0.855
Green maize, kg/ha	1 478	1 117	1 376	0.274	1 247	0.259
Sunflower, kg/ha	1 087	1 155	1 115	0.805	1 135	0.622
Groundnuts, kg/ha	1 138	912	1 312	0.162	1 100	0.824
Soya beans, kg/ha	1 091	1 090	1 149	0.864	1 123	0.788
Panel B: Wetland plots						
Household grows:						
White maize (dry)	0.21	0.20	0.20	0.827	0.20	0.647
Green maize	0.23	0.23	0.22	0.844	0.22	0.759
Sunflower	0.00	0.00	0.00	0.568	0.00	0.721
Groundnuts	0.00	0.00	0.00	0.701	0.00	0.964
Soya beans	0.01	0.00	0.01	0.289	0.01	0.270
Crop productivity						
White maize (dry), kg/ha	1 236	1 373	2 404	0.410	1 886	0.207
Green maize, kg/ha	1 293	1 816	1 967	0.002	1 891	0.001

Notes: Errors are clustered at the CWAC level. First, second, and third column, show the average value for each variable for control, only FSP and FSP plus households, respectively. Fourth column shows the p-value of the F-statistic associated to the null hypothesis of equality of the means for the control, only FSP and FSP plus households. Fifth column shows the average value for each variable for FSP-all group (only FSP and FSP plus). Sixth column shows the p-value of the F-statistic associated to the null hypothesis of equality of the means for the Control and FSP-all (FSP and FSP plus) households.
Source*:* Authors' elaboration from survey data

Vegetable production

Table 12 illustrates the percentage of households cultivating the five primary vegetables, in addition to okra and butternut, across both wetland (Panel A) and rainfed (Panel B) plots. Okra and butternut have been incorporated due to the FSP programme's objective to promote the expansion of these two vegetable varieties. In wetland plots, rape is grown by nearly 80 percent of the households within the sample, while tomato is grown by over 50 percent. Approximately one fifth of the sample cultivates cabbage and pumpkin leaves, and 17 percent of the households grow onion. The presence of okra cultivation exists, albeit not extensively, at 16 percent. Conversely, the cultivation of butternut squash is limited, involving only 1 percent of the farmers. In general, fewer farmers engage in vegetable cultivation on their rainfed plots. Among the vegetables, pumpkin leaves exhibit the highest prevalence, being cultivated by nearly 30 percent of the farmers. This could potentially signify the implementation of intercropping techniques aimed at preserving soil moisture and suppressing weed growth, thus facilitating the flourishing of maize plants. Conversely, the remaining primary vegetables are cultivated by fewer than 8 percent of the farmers.

Table 12. Vegetable production

	Mean	SD
Wetland plots: *Household grows:*		
Rape	0.79	0.41
Tomato	0.53	0.50
Pumpkin Leaves	0.21	0.41
Cabbage	0.21	0.41
Onion	0.17	0.38
Okra	0.16	0.36
Butternut Squash	0.01	0.11
Rainfed plots: *Household grows:*		
Rape	0.05	0.22
Tomato	0.03	0.17
Pumpkin Leaves	0.28	0.45
Cabbage	0.01	0.11
Onion	0.01	0.11
Okra	0.08	0.28
Butternut Squash	0.02	0.12

***Source**:* Authors' elaboration from survey data

Table 13 shows the percentage of households cultivating the five primary vegetables, in addition to okra and butternut, across both wetland (Panel A) and rainfed (Panel B) plots for each treatment group. The table below shows perfect balance across all groups, meaning that there are no statistical differences for the means across the groups at a 5 percent significance level.

Table 13. Vegetable production by treatment group

	Control	FSP	FSP plus	p-value $H_0:H_C=H_{FSP}=H_{FSPplus}$	FSP-all	p-value $H_0:H_C=H_{allFSP}$
Panel A: Wetland plots						
Household grows:						
Rape	0.85	0.81	0.80	0.156	0.80	0.055
Tomato	0.59	0.52	0.55	0.195	0.53	0.082
Pumpkin Leaves	0.22	0.22	0.22	1.000	0.22	0.987
Cabbage	0.25	0.21	0.18	0.211	0.20	0.115
Onion	0.20	0.16	0.17	0.295	0.17	0.122
Okra	0.17	0.15	0.17	0.610	0.16	0.674
Butternut Squash	0.01	0.02	0.01	0.055	0.02	0.032
Panel B: Rainfed plots						
Household grows:						
Rape	0.05	0.07	0.04	0.275	0.05	0.989
Tomato	0.03	0.05	0.02	0.286	0.03	0.711
Pumpkin leaves	0.28	0.32	0.29	0.707	0.31	0.489
Cabbage	0.01	0.01	0.01	0.428	0.01	0.462
Onion	0.02	0.02	0.00	0.045	0.01	0.596
Okra	0.10	0.08	0.08	0.136	0.08	0.052
Butternut squash	0.01	0.02	0.01	0.693	0.02	0.677

Notes: Errors are clustered at the CWAC level. First, second, and third column, show the average value for each variable for control, only FSP and FSP plus households, respectively. Fourth column shows the p-value of the F-statistic associated to the null hypothesis of equality of the means for the control, only FSP and FSP plus households. Fifth column shows the average value for each variable for FSP-all group (only FSP and FSP plus). Sixth column shows the p-value of the t-statistic associated to the null hypothesis of equality of the means for the Control and FSP-all (FSP and FSP plus) households.
Source*:* Authors' elaboration from survey data.

Land management and agricultural practices

Table 14 provides a comprehensive summary of the key attributes associated with the plots managed by the households included in the surveyed sample. Overall, households in the study area have access to more than two plots (2.25 on average), and the cultivated area is equal to 2.23 hectares (ha) on average. Within the last five years, only 30 percent of the households have allowed at least one plot to remain fallow. Moreover, the average irrigated area amounts to 0.44 hectares, constituting around 25 percent of the available land designated for crop and vegetable production. This proportion reflects the accessibility that farmers in this sample have to wetlands areas.

The data presented in the table highlights that over half of the farmers utilize crop residues for compost production (55 percent), with a slightly lower portion using them as plot cover (45 percent). 30 percent of farmers burn or remove some of the crop residues. Zero/minimum tillage techniques are embraced by nearly two-thirds of the farmers (62 percent), while the remainder employ traditional ridging techniques. The land allocation for these two practices amounts to 1 and 0.64 hectares, respectively. Furthermore, almost two-thirds of the farmers use basal (62 percent) and top-dressing fertilizers (63 percent), applying them at rates averaging 43 and 36 kilograms per hectare, respectively. In contrast, close to 90 percent of farmers in the sample utilize manure as a form of fertilizer.

The prevalence of erosion emerges as a crucial aspect to consider among the surveyed households, given the promotion of soil conservation practices in extension activities. Farmers indicate that the majority of their land (61 percent) demonstrates a low level of erosion. However, approximately 16 percent of the land is categorized as experiencing high levels of erosion.

Table 14. Land management

	Mean	SD
Land destined for crop or vegetable production		
Number of plots	2.25	0.77
Total cultivated land, ha	2.23	2.41
Left plot fallow:		
at least once in past 5 years	0.29	0.45
Irrigation:		
Land area irrigated, ha	0.44	0.60
% operated land area that is irrigated	0.25	0.23
Crop residue:		
Used to cover land	0.45	0.50
Is burnt or removed	0.30	0.46
Used to produce compost	0.55	0.50
Land preparation		
zero/minimum tillage	0.62	0.49
minimum/zero tillage, ha	1.01	1.76
traditional ridging	0.37	0.48
traditional ridging, ha	0.64	1.79
Crop rotation		
Crop planted different from previous season	0.36	0.48
Land area subject to crop rotation, ha	0.55	1.39
Fertilizer use		
Basal fertilizer is used by household	0.62	0.49
Basal fertilizer used, kg/ha	43.03	244.58
Top-dressing fertilizer is used by household	0.63	0.48
Top-dressing fertilizer used, kg/ha	35.90	69.11
Manure is used by household	0.89	0.31
Land erosion		
Land area operated under low erosion, ha	1.36	1.94
% operated land area under low erosion	0.61	0.42
Land area operated under high erosion, ha	0.36	1.47
% operated land area under medium/high erosion	0.16	0.32

***Source**:* Authors' elaboration from survey data.

Table 15 illustrates the land management practices observed among different treatment groups. For the majority of the variables, we fail to reject the null hypothesis of mean equality across the three groups at a 5 percent significance level. This implies that these variables are well balanced across the different treatment groups. Only two variables exhibit a p-value lower than 0.05, and hence the null hypothesis of equality of the means is rejected. These variables correspond to the proportion of farmers employing zero/minimum tillage techniques for land preparation and the proportion of farmers utilizing manure as a fertilizer.

Upon comparing these variables between the Control and FSP-all groups, it becomes apparent that a greater number of farmers in the FSP-all group utilize zero/minimum tillage techniques for land preparation, while more farmers in the Control group employ manure as fertilizer. Nevertheless, the discrepancies in magnitude for either of these two variables are not substantial.

Table 15. Land management by treatment group

	Control	FSP	FSP plus	p-value H_0: H_C=H_{FSP}=$H_{FSPplus}$	FSP-all	p-value H_0:H_C=H_{allFSP}
Land destined for crop or vegetable production						
Number of plots	2.24	2.23	2.29	0.715	2.26	0.736
Total cultivated land, ha	2.25	2.39	2.05	0.161	2.22	0.819
Left plot fallow:						
at least once in past 5 years	0.28	0.31	0.28	0.584	0.29	0.663
Irrigation:						
Land area irrigated, ha	0.45	0.44	0.44	0.876	0.44	0.626
% operated land area that is irrigated	0.25	0.24	0.26	0.619	0.25	0.810
Crop residue:						
Used to cover land	0.42	0.47	0.49	0.187	0.48	0.075
Is burnt or removed	0.33	0.28	0.29	0.221	0.28	0.091
Used to produce compost	0.58	0.52	0.53	0.207	0.52	0.078
Land preparation						
zero/minimum tillage	0.58	0.63	0.67	0.017	0.65	0.021
minimum/zero tillage, ha	0.90	1.19	1.00	0.183	1.09	0.074
traditional ridging	0.40	0.35	0.35	0.102	0.35	0.044
traditional ridging, ha	0.70	0.66	0.54	0.194	0.60	0.209
Crop rotation						
Crop planted different from previous season	0.33	0.37	0.38	0.356	0.38	0.181
Land area subject to	0.54	0.61	0.52	0.750	0.57	0.732

	Control	FSP	FSP plus	p-value H_0: $H_C=H_{FSP}=H_{FSPplus}$	FSP-all	p-value H_0:$H_C=H_{allFSP}$
crop rotation, ha						
Fertilizer use						
Basal fertilizer used by household	0.59	0.66	0.63	0.447	0.64	0.233
Basal fertilizer used, kg/ha	35.51	46.53	51.45	0.235	49.06	0.149
Top-dressing fertilizer used by household	0.60	0.66	0.64	0.399	0.65	0.190
Top-dressing fertilizer used, kg/ha	32.05	39.85	38.18	0.271	38.99	0.112
Manure is used by household	0.92	0.88	0.86	0.013	0.87	0.005
Land erosion						
Land area operated under low erosion, ha	1.34	1.48	1.28	0.476	1.38	0.693
% operated land area under low erosion	0.60	0.63	0.62	0.664	0.62	0.462
Land area operated under high erosion, ha	0.35	0.45	0.30	0.222	0.37	0.730
% operated land area under medium/high erosion	0.16	0.16	0.16	0.985	0.16	0.917

Notes: Errors are clustered at the CWAC level. First, second, and third column, show the average value for each variable for control, only FSP and FSP plus households, respectively. Fourth column shows the p-value of the F-statistic associated to the null hypothesis of equality of the means for the control, only FSP and FSP plus households. Fifth column shows the average value for each variable for FSP-all group (only FSP and FSP plus). Sixth column shows the p-value of the t-statistic associated to the null hypothesis of equality of the means for the Control and FSP-all (FSP and FSP plus) households.
Source*:* Authors' elaboration from survey data.

Table 16 and Table 17 present the same information as the previous table, disaggregated by plot type. Table 16 shows land management practices proportions and averages across treatment groups for rainfed plots and Table 17 for wetland plots. For rainfed plots, the same two variables as in Table 15, the proportion of farmers employing zero/minimum tillage techniques for land preparation and the proportion of farmers utilizing manure as a fertilizer, have a p-value lower than 0.05, and hence the null hypothesis of equality of the means is rejected. As for all plots when comparing the non-experimental Control group with the FSP-all group, it becomes apparent that a greater number of farmers in the FSP-all group utilize zero/minimum tillage techniques for land preparation, while more farmers in the Control group employ manure as fertilizer. Additionally, the comparison for these two groups reveals that more farmers in the FSP-all group use their crop residues to cover land relative to the Control group. The table also indicates that not all farmers within the sample possess access to at least one rainfed plot; however, a substantial majority of 95 percent do have such access.

Table 16. Land management by treatment group, rainfed plots

	Control	FSP	FSP plus	p-value H_0: H_C=H_{FSP}=$H_{FSPplus}$	FSP-all	p-value H_0:H_C=H_{allFSP}
Household has rainfed plot	0.95	0.95	0.94	0.841	0.94	0.641
Land destined for crop or vegetable production						
Number of plots, rainfed plots	1.22	1.26	1.29	0.589	1.28	0.339
Total cultivated land, rainfed plots, ha	1.74	1.91	1.56	0.115	1.73	0.942
Left plot fallow:						
at least once in past 5 years	0.19	0.22	0.20	0.541	0.21	0.349
Irrigation:						
Land area irrigated, ha, rainfed plots	0.01	0.02	0.01	0.358	0.02	0.306
Crop residue:						
Used to cover land	0.38	0.45	0.45	0.077	0.45	0.024
Is burnt or removed	0.26	0.22	0.25	0.382	0.24	0.257
Used to produce compost	0.39	0.36	0.34	0.387	0.35	0.210
Land preparation						
Minimum/zero tillage	0.42	0.47	0.51	0.025	0.49	0.017
Minimum/zero tillage, ha	0.68	0.91	0.75	0.244	0.83	0.126
Traditional ridging	0.36	0.32	0.30	0.199	0.31	0.109
Traditional ridging, ha	0.61	0.60	0.46	0.230	0.53	0.334
Crop rotation						
Crop planted different from previous season	0.30	0.33	0.34	0.458	0.34	0.233
Land area subject to crop rotation, ha	0.47	0.55	0.45	0.651	0.50	0.745
Fertilizer use						
Basal fertilizer used by household	0.55	0.60	0.56	0.577	0.58	0.447
Basal fertilizer used, kg/ha	29.05	37.60	26.48	0.160	31.89	0.506
Top-dressing fertilizer used by household	0.56	0.63	0.60	0.363	0.61	0.207
Top-dressing fertilizer used, kg/ha	27.38	33.68	27.15	0.335	30.33	0.389
Manure is used by household	0.52	0.44	0.41	0.032	0.43	0.013
Land erosion						
Land area operated under low erosion, ha	0.96	1.12	0.93	0.427	1.02	0.561
Land area operated under high erosion, ha	0.31	0.41	0.26	0.223	0.34	0.678

Notes: Errors are clustered at the CWAC level. First, second, and third column, show the average value for each variable for control, only FSP and FSP plus households, respectively. Fourth column shows the p-value of the F-statistic associated to the null hypothesis of equality of the means for the control, only FSP and FSP plus households. Fifth column shows the average value for each variable for FSP-all group (only FSP and FSP plus). Sixth column shows the p-value of the t-statistic associated to the null hypothesis of equality of the means for

the Control and FSP-all (FSP and FSP plus) households.
Source: Authors' elaboration from survey data.

While most of the variables are balanced concerning the wetland plots, the outcomes presented in Table 17 reveal noteworthy statistical differences among the three treatment groups for four variables. This is evidenced by p-values lower than 0.05, prompting us to reject the null hypothesis pertaining to mean equality across the three treatment groups. First, a discernible variation emerges in the practice of burning or removing crop residues. Second, the employment of minimum/zero tillage techniques for land preparation exhibits noteworthy differentiation among the groups, although the mean number of hectares where the techniques are applied to remains consistent. Moreover, the extent of land prepared using traditional ridging techniques diverges across the treatment groups. Lastly, a distinct trend is observed in the utilization of manure as a household fertilizer, indicating group-specific differences. Column 6 confirms that these differences relate to differences between the non-experimental Control group and the FSP-all group. Additionally, these two groups also present statistically significant differences in the proportion of farmers that use crop residue to cover land and in the kilograms of top-dressing fertilizer used per hectare.

Table 17.Land Management by Treatment Group, Wetland Plots

	Control	FSP	FSP plus	p-value H_0: $H_C=H_{FSP}=H_{FSPplus}$	FSP-all	p-value H_0:$H_C=H_{allFSP}$
Household has wetland plot	0.97	0.93	0.95	0.280	0.94	0.159
Land destined for crop or vegetable production						
Number of plots	1.01	0.97	1.00	0.172	0.98	0.175
Total cultivated land, ha	0.51	0.49	0.49	0.767	0.49	0.487
Left plot fallow:						
at least once in past 5 years	0.19	0.20	0.18	0.708	0.19	0.839
Irrigation:						
Land area irrigated, ha	0.44	0.42	0.42	0.714	0.42	0.421
Crop residue:						
Used to cover land	0.29	0.36	0.37	0.089	0.36	0.030
Is burnt or removed	0.18	0.16	0.12	0.019	0.14	0.027
Used to produce compost	0.54	0.48	0.52	0.335	0.50	0.171
Land preparation						
Minimum/zero tillage	0.47	0.55	0.56	0.001	0.56	0.000
Minimum/zero tillage, ha	0.22	0.28	0.25	0.159	0.27	0.080

	Control	FSP	FSP plus	p-value H_0: $H_C=H_{FSP}=H_{FSPplus}$	FSP-all	p-value H_0:$H_C=H_{allFSP}$
Traditional ridging	0.15	0.12	0.14	0.423	0.13	0.261
Traditional ridging, ha	0.09	0.05	0.08	0.017	0.06	0.042
Crop rotation						
Crop planted different from previous season	0.12	0.15	0.15	0.464	0.15	0.241
Land area subject to crop rotation, ha	0.07	0.07	0.07	0.882	0.07	0.841
Fertilizer use						
Basal fertilizer used by household	0.30	0.34	0.37	0.304	0.36	0.130
Basal fertilizer used, kg/ha	6.46	8.93	24.97	0.355	17.17	0.188
Top-dressing fertilizer used by household	0.26	0.30	0.31	0.409	0.31	0.183
Top-dressing fertilizer used, kg/ha	4.67	6.17	11.03	0.122	8.66	0.045
Manure is used by household	0.91	0.88	0.87	0.023	0.87	0.007
Land erosion						
Land area operated under low erosion, ha	0.37	0.37	0.35	0.718	0.36	0.555
Land area operated under high erosion, ha	0.04	0.04	0.03	0.797	0.04	0.695

Notes: Errors are clustered at the CWAC level. First, second, and third column, show the average value for each variable for control, only FSP and FSP plus households, respectively. Fourth column shows the p-value of the F-statistic associated to the null hypothesis of equality of the means for the control, only FSP and FSP plus households. Fifth column shows the average value for each variable for FSP-all group (only FSP and FSP plus). Sixth column shows the p-value of the t-statistic associated to the null hypothesis of equality of the means for the Control and FSP-all (FSP and FSP plus) households.
Source*:* Authors' elaboration from survey data.

Food security and food consumption

Zambia is currently grappling with significant levels of food insecurity, impacting its population. According to the integrated food security phase classification (IPC) acute food insecurity scale, over one million individuals are undergoing a crisis situation. Additionally, more than six million people are categorized as being in a state of stress (IPC, 2022). Notably, the districts of Chipangali, Katete, and Sinda fall within the stressed category. For this study, we analyse the food security domain through the Food Insecurity Experience Scale (FIES). This measurement tool assesses household or individual food security based on personal experiences. Comprising of eight inquiries, the FIES delves into the accessibility of adequate food for individuals (Ballard *et al.,* 2013). The raw score derived from the FIES ranges from zero, indicating strong food security, to eight, indicating severe food insecurity.

Table 18 shows the summary statistics for food security, including the summary index presented in Section 0. Overall, the sample has a high level of food insecurity. The average FIES raw score is 6.15 for the Control group, 6.35 for the FSP group, and 6.44 for the FSP-plus group. We cannot reject the null hypothesis of equality of the means, implying the groups have the same level of food insecurity as measured by the FIES. The FIES methodology consists of a statistical model that assigns the probability to a household to be moderate or severe food insecure. According to this model, the probability of being moderately or severely food insecure ranges from 82 to 86 percent across the three experimental groups, and between 42 to 45 percent for being severely food insecure. None of the differences across the experimental groups are statistically significant.

We look at other two metrics used to measure food insecurity, i.e. the number of meals per day taken by the household and the number of months the maize currently stored in the granary is expected to last. For these indicators there are no statistical differences between the three treatment groups.

Table 18. Food Insecurity by Treatment Group

	Control	FSP	FSP plus	p-value H_0: H_C=H_{FSP}=$H_{FSPplus}$	FSP-all	p-value H_0:H_C=H_{allSP}
Summary index of food security	0.00	-0.10	-0.12	0.348	-0.11	0.156
Raw FIES score	6.15	6.35	6.44	0.454	6.39	0.213
FIES: probability (moderate + severe)	0.82	0.85	0.86	0.378	0.85	0.165
FIES: probability(severe)	0.42	0.43	0.45	0.561	0.44	0.369
Number of meals per day in HH	2.27	2.24	2.24	0.873	2.24	0.605
Months maize will last in the granary	3.77	3.65	3.77	0.731	3.71	0.715

Notes: Errors are clustered at the CWAC level. First, second, and third column, show the average value for each variable for control, only FSP and FSP plus households, respectively. Fourth column shows the p-value of the F-statistic associated to the null hypothesis of equality of the means for the control, only FSP and FSP plus households. Fifth column shows the average value for each variable for FSP-all group (only FSP and FSP plus). Sixth column shows the p-value of the t-statistic associated to the null hypothesis of equality of the means for the Control and FSP-all (FSP and FSP plus) households.
Source*:* Authors' elaboration from survey data

The food consumption index in this report is based on the food consumption score (FCS) that counts the number of days in the previous week a certain food group is consumed. This measure must be analysed with care, since the end of the recall period for the survey is almost six months before the date the survey took place. Hence seasonal variations in food consumption have to be considered. The FCS is calculated using the following equation:

$$FCS = [staples * 2] + [pulses * 3] + [meat, fish, milk * 4] + vegetables + fruit + [0.5 * (oil + sugar)] \qquad (\mathbf{3})$$

This equation allows us to calculate the FCS following WFP (2008) and comment on the percentage of households that are characterized as ‘poor’, ‘borderline’, or ‘acceptable’ in terms of their food consumption. As shown in Table 19, FCS in the sample ranges from 32.87 to 34.37 across the three treatment groups, and there are no statistical differences between them. According to the WFP (2008) definitions, between 19 and 20 percent of households are doing ‘poorly’ in terms of food consumption. Between 37 and 39 percent are in the ‘borderline’ range while between 40 and 44 percent are in the ‘acceptable’ range. There are no statistical differences across the three treatment groups for any of the ranges. These numbers illustrate that about 60 percent of the households are not consuming enough food and are in food insecure ranges requiring immediate interventions to ameliorate the hunger crisis in the region.

Table 19. Food consumption score by treatment group

	Control	FSP	FSP plus	p-value H_0: $H_C=H_{FSP}=H_{FSPplus}$	FSP-all	p-value H_0:$H_C=H_{allFSP}$
Food consumption score, raw	33.99	34.37	32.87	0.666	33.60	0.797
Food consumption status:						
Poor	0.20	0.19	0.20	0.909	0.20	0.964
Borderline	0.37	0.37	0.39	0.658	0.38	0.753
Acceptable	0.43	0.44	0.40	0.700	0.42	0.891

Notes: Errors are clustered at the CWAC level. First, second, and third column, show the average value for each variable for control, only FSP and FSP plus households, respectively. Fourth column shows the p-value of the F-statistic associated to the null hypothesis of equality of the means for the control, only FSP and FSP plus households. Fifth column shows the average value for each variable for FSP-all group (only FSP and FSP plus). Sixth column shows the p-value of the t-statistic associated to the null hypothesis of equality of the means for the Control and FSP-all (FSP and FSP plus) households.
Source*:* Authors' elaboration from survey data.

Productive inputs and assets

In this section we discuss agricultural assets ownership and productive inputs acquisition in the study sample. Table 20 reports the share of households owning various types of agricultural assets in working conditions. Overall farmers seem decently equipped with basic tools for crop production such as hand hoes (98 percent), axes (84 percent) and slasher (41 percent). However, the proportion of households owning more expensive, sizable, and capital-intensive assets such as tractors, generators, and water pumps plummets to zero. Table 21 shows that except for one asset, the null hypothesis of equality of the means across all treatment groups cannot be rejected. The sole exception lies in the ownership of sickles, where statistically significant differences among the three groups are observed at a 5 percent level of significance.

Table 20. Agricultural assets ownership

	Mean	SD
Assets Owned by Household	4.09	1.79
Household owns:		
Hand Hoe	0.98	0.13
Slasher	0.41	0.49
Axe	0.84	0.36
Ox Cart	0.19	0.40
Ox Plough	0.30	0.46
Generator Or Motorised Pump	0.01	0.11
Scotchcart	0.00	0.07
Cultivator	0.00	0.02
Tractor	0	
Sprayer	0.24	0.43
Panga Knife	0.22	0.42
Sickle	0.12	0.32
Treadle Pump	0.01	0.10
Micro-solar water pump	0	0
Watering Can	0.76	0.43

***Source**:* Authors' elaboration from survey data.

Table 21. Agricultural assets ownership by treatment group

	Control	FSP	FSP plus	p-value $H_0{:}H_C=H_{FSP}=H_{FSPplus}$	FSP-all	p-value $H_0{:}H_C=H_{allFSP}$
Assets owned by household	4.14	4.13	3.98	0.605	4.06	0.531
Household owns:						
Hand Hoe	0.98	0.99	0.98	0.690	0.98	0.486
Slasher	0.43	0.40	0.40	0.708	0.40	0.418
Axe	0.85	0.84	0.84	0.921	0.84	0.757
Ox Cart	0.19	0.21	0.18	0.633	0.20	0.914
Ox Plough	0.31	0.31	0.27	0.672	0.29	0.666
Generator Or Motorised Pump	0.01	0.01	0.01	0.510	0.01	0.640
Scotchcart	0.00	0.01	0.00	0.795	0.01	0.544
Cultivator	0.00	0.00	0.00	0.317	0.00	0.317
Tractor	0	0	0		0	
Sprayer	0.23	0.26	0.23	0.645	0.25	0.474
Panga Knife	0.23	0.21	0.22	0.678	0.21	0.419
Sickle	0.13	0.12	0.09	0.040	0.10	0.073
Treadle Pump	0.01	0.01	0.01	0.650	0.01	0.404
Micro-solar water pump	0	0	0		0	
Watering Can	0.76	0.77	0.75	0.873	0.76	0.910

Notes: Errors are clustered at the CWAC level. First, second, and third column, show the average value for each variable for control, only FSP and FSP plus households, respectively. Fourth column shows the p-value of the F-statistic associated to the null hypothesis of equality of the means for the control, only FSP and FSP plus households. Fifth column shows the average value for each variable for FSP-all group (only FSP and FSP plus). Sixth column shows the p-value of the t-statistic associated to the null hypothesis of equality of the means for the Control and FSP-all (FSP and FSP plus) households.
***Source**:* Authors' elaboration from survey data.

Table 22 shows instead the main summary statistics concerning productive inputs. The vast majority of the households has acquired inputs in the reference period prior to the survey and have spent close to ZMW 1 700 on average (~ PPP USD 260). Notably, improved maize seeds were secured by nearly 60 percent of households, while improved legume seeds were reported by only 27 percent. Other seed varieties, both improved and non-improved, were procured by nearly three-quarters of the farming population, establishing them as the most frequently acquired input. Pesticides are acquired by 56 percent of the farmers and herbicides only by 10 percent, while organic fertilizer by 67 percent, basal fertilizer by 64 percent, and top-dressing fertilizer by 61 percent of the farmers. Most households in this sample do not have problems in terms of access to farmland, so only a small share of them rented land (3 percent).

Table 23 shows that there are no statistical differences across the means of the three treatment groups. We cannot reject the equality of the means for any of the variables. Upon closer examination of potential differences between the Control group and the FSP-all group, we identify a noteworthy distinction: a higher number of farmers in the Control group acquire manure in comparison to the latter group. This difference is statistically significant at a 5 percent significance level. However, it is important to note that the extent of this difference is not particularly substantial.

Table 22. Acquisition of Productive Inputs

	Mean	SD
HH acquired any inputs	0.94	0.23
Total expenditure on inputs, ZMW	1 689	2 579
Household acquired:		
Improved maize seeds	0.59	0.49
Improved legume seeds	0.27	0.44
Other seeds	0.73	0.44
Pesticides	0.56	0.50
Organic fertilizer or manure	0.67	0.47
Basal fertilizer	0.64	0.48
Top dressing fertilizer	0.61	0.49
Herbicides	0.10	0.30
Land rent-in	0.03	0.18
Any crop inputs	0.94	0.24
Any livestock inputs	0.22	0.41

***Source**:* Authors' elaboration from survey data.

Table 23. Acquisition of productive inputs by treatment group

	Control	FSP	FSP plus	p-value H_0:H_C=H_{FSP}=$H_{FSPplus}$	FSP-all	p-value H_0:H_C=H_{allFSP}
HH acquired any inputs	0.95	0.94	0.94	0.552	0.94	0.279
Total expenditure on inputs, ZMW	1 522	1 878	1 771	0.222	1 823	0.094
Household acquired:						
Improved maize seeds	0.58	0.62	0.58	0.503	0.60	0.588
Improved legume seeds	0.29	0.26	0.24	0.170	0.25	0.097
Other seeds	0.74	0.72	0.73	0.720	0.72	0.473
Pesticides	0.56	0.56	0.57	0.935	0.57	0.841
Organic fertilizer or manure	0.70	0.63	0.66	0.116	0.64	0.046
Basal fertilizer	0.60	0.68	0.66	0.173	0.67	0.081
Top dressing fertilizer	0.57	0.64	0.63	0.229	0.64	0.102
Herbicides	0.10	0.10	0.09	0.984	0.10	0.907
Land rent-in	0.03	0.04	0.04	0.621	0.04	0.343
Any crop inputs	0.94	0.93	0.94	0.653	0.93	0.480
Any livestock inputs	0.22	0.22	0.20	0.617	0.21	0.700

Notes: Errors are clustered at the CWAC level. First, second, and third column, show the average value for each variable for control, only FSP and FSP plus households, respectively. Fourth column shows the p-value of the F-statistic associated to the null hypothesis of equality of the means for the control, only FSP and FSP plus households. Fifth column shows the average value for each variable for FSP-all group (only FSP and FSP plus). Sixth column shows the p-value of the t-statistic associated to the null hypothesis of equality of the means for the Control and FSP-all (FSP and FSP plus) households.
Source: Authors' elaboration from survey data.

Access to climate information

Getting early information on climate is an important strategy to implement prompt actions, provide support, and build resilience before future shocks occur (FAO, 2020). Table 24 provides an overview of the proportion of households within the sample that received various forms of information, encompassing sudden catastrophes, slow-onset disasters, pest outbreaks, rainfall details, and weather forecasts for both the short and medium-term. On average, households received fewer than three distinct types of information during the reference period. The most prevalent information accessible to farmers was related to pest outbreaks, accessed by 66 percent of the households. Following closely, 60 percent received updates on rainfall, while 39 percent and 37 percent received information on sudden catastrophes and slow-onset disasters, respectively. Short-term forecasts reached a larger proportion of farmers compared to medium-term forecasts, with percentages of 40 and 30 percent, respectively. Table 25 shows the for the variables considered, we cannot reject the hypothesis of equality of the means across all treatment groups, implying that this set of variables is balanced.

Table 24. Access to climate information

	Mean	SD
# of climate information received	2.77	2.19
Household received information about:		
sudden catastrophes	0.39	0.49
slow-onset disasters	0.37	0.48
pest outbreaks	0.66	0.47
rains	0.60	0.49
weather forecasts in 2/3 days	0.40	0.49
weather forecasts in 2/3 months	0.35	0.48

Source: Authors' elaboration from survey data.

Table 25. Access to climate information by treatment group

	Control	FSP	FSP plus	p-value $H_0{:}H_C{=}H_{FSP}{=}H_{FSPplus}$	FSP-all	p-value $H_0{:}H_C{=}H_{allFSP}$
# of climate information received	2.67	2.92	2.77	0.394	2.84	0.203
Household received information about:						
sudden catastrophes	0.38	0.42	0.36	0.248	0.39	0.898
slow-onset disasters	0.36	0.40	0.36	0.546	0.38	0.381
pest outbreaks	0.65	0.68	0.68	0.529	0.68	0.262
rains	0.58	0.61	0.61	0.580	0.61	0.311
weather forecasts in 2/3 days	0.37	0.45	0.41	0.154	0.43	0.073
weather forecasts in 2/3 months	0.34	0.37	0.35	0.689	0.36	0.475

Notes: Errors are clustered at the CWAC level. First, second, and third column, show the average value for each variable for control, only FSP and FSP plus households, respectively. Fourth column shows the p-value of the F-statistic associated to the null hypothesis of equality of the means for the control, only FSP and FSP plus households. Fifth column shows the average value for each variable for FSP-all group (only FSP and FSP plus). Sixth column shows the p-value of the t-statistic associated to the null hypothesis of equality of the means for the Control and FSP-all (FSP and FSP plus) households.
Source: Authors' elaboration from survey data.

Climate shocks

Shocks have the potential to result in significant livelihood losses for smallholder farmers in Zambia due to their heavy reliance on natural resources. In this section, we examine the various shocks that farmers claimed to have been exposed to. We present a summary of their exposure using two distinct indices: one that quantifies the occurrences of climatic shocks and another that encompasses three additional shocks unrelated to climate. Furthermore, we analyse the prevalence of each shock individually.

Given our focus on observing climate changes over the medium to long term, the survey incorporated questions about experiences with these events over an extended reference period. However, it is widely acknowledged that recalling events from a distant past can pose challenges, and as time passes, the accuracy of dating such events diminishes (Baddeley *et al.,* 1978; Janssen *et al.,* 2006).

To minimize errors stemming from telescoping, without reducing the survey's reference period, the field of psychometrics recommends introducing a highly salient landmark event that serves as the starting point for the reference period (Loftus and Marburger, 1983). In this survey, the designated landmark event is the passing of President Michael Sata, who died in office in October 2014. Given that the baseline survey was conducted between October and December 2022, this encompasses an eight-year recall period.

Over the past eight years, households, on average, have experienced around five different types of shocks. Nearly four of these shocks are linked to climate-related factors, as indicated in Table 26. The most prevalent types of shocks are droughts and insect pests, affecting 78 percent and 71 percent of households, respectively. As demonstrated in Table 27, for all indices and shocks, except for landslides, we do not find sufficient evidence to reject the null hypothesis, suggesting that the means across the three treatment groups are statistically equal. Specifically, when comparing the FSP-all group with the Control group in column 6, it is evident that the disparity in landslide shocks is not statistically significant.

Table 26. Climate and non-climate shocks experienced

	Mean	SD
Number shocks experienced by the hh in the last 8 years	5.21	3.15
Number climate shocks experienced by the hh in the last 8 years	3.72	2.40
Shock experienced:		
Drought	0.78	0.41
Fires	0.10	0.30
Flood	0.39	0.49
Windstorm	0.43	0.50
Hailstorm	0.19	0.39
Heavy rains	0.64	0.48
Sporadic rains	0.43	0.50
Erosion	0.59	0.49
Landslide	0.19	0.39
Heat wave	0.44	0.50
Cold wave	0.31	0.46
Insect pests / diseases	0.71	0.46
Shocks impact: big/very big	0.65	0.48

***Source**:* Authors' elaboration from survey data.

Table 27. Climate and non-climate shocks experienced by treatment group

	Control	FSP	FSP plus	p-value H_0: $H_C=H_{FSP}=H_{FSPplus}$	FSP-all	p-value H_0:$H_C=H_{allFSP}$
Number shocks experienced by the hh in the last 8 years	5.24	5.34	5.02	0.515	5.18	0.767
Number climate shocks experienced by the hh in the last 8 years	3.73	3.82	3.62	0.646	3.72	0.949
Shock experienced:						
Drought	0.77	0.78	0.80	0.561	0.79	0.356
Fires	0.11	0.11	0.07	0.144	0.09	0.365
Flood	0.38	0.41	0.39	0.700	0.40	0.499
Windstorm	0.42	0.46	0.41	0.413	0.44	0.651
Hailstorm	0.19	0.20	0.18	0.828	0.19	0.918
Heavy rains	0.65	0.64	0.61	0.380	0.62	0.313
Sporadic rains	0.45	0.42	0.41	0.465	0.41	0.232
Erosion	0.61	0.59	0.55	0.246	0.57	0.183
Landslide	0.21	0.21	0.14	0.024	0.17	0.120
Heat wave	0.43	0.45	0.44	0.836	0.45	0.591
Cold wave	0.31	0.34	0.30	0.465	0.32	0.701
Insect pests / diseases	0.69	0.72	0.71	0.618	0.72	0.329
Shocks impact: big/very big	0.64	0.65	0.67	0.859	0.66	0.673

Notes: Errors are clustered at the CWAC level. First, second, and third column, show the average value for each variable for control, only FSP and FSP plus households, respectively. Fourth column shows the p-value of the F-statistic associated to the null hypothesis of equality of the means for the control, only FSP and FSP plus households. Fifth column shows the average value for each variable for FSP-all group (only FSP and FSP plus). Sixth column shows the p-value of the t-statistic associated to the null hypothesis of equality of the means for the Control and FSP-all (FSP and FSP plus) households.
Source*:* Authors' elaboration from survey data.

Coping strategies

This section shows the negative coping strategies and the farm-level responses adopted by the households in the aftermath of a climate/weather shock (Table 28). Four negative coping strategies were identified in the questionnaire, which are here listed in order of rate of adoption: change in food habits, reduction of health and education expenses, distress sale of assets, and finally sending children to live elsewhere. There were no statistically significant differences observed among the treatment groups in terms of these negative coping strategies. Furthermore, the number of coping strategies utilized was found to be statistically consistent across the groups.

In the survey instrument we have also included questions concerning the farm-level response strategies adopted by households due to weather events. Among the eight potential strategies, the most widely adopted one in the sample is changing the sowing date, followed by altering the cropping pattern, increasing the use of organic compost, adopting improved seeds, and enhancing the utilization of chemical fertilizer. Notably, very few households chose to adopt crop insurance. Given the p-values in column 4, we cannot reject the hypothesis of equality of means across the treatment groups, meaning these changes in farm practices are well balanced.

Table 28. Coping strategies by treatment group

	Control	FSP	FSP plus	p-value H_0:H_C=H_{FSP}=$H_{FSPplus}$	FSP-all	p-value H_0:H_C=H_{allFSP}
Summary index of coping strategies	-0.00	0.03	0.07	0.519	0.05	0.391
Number of negative coping strategies to shocks	1.00	1.04	0.98	0.713	1.01	0.844
Due to weather events, the household:						
Changed food habits	0.64	0.65	0.64	0.977	0.65	0.875
Reduced health and education expenses	0.27	0.27	0.22	0.370	0.25	0.405
Sold assets	0.12	0.13	0.11	0.557	0.12	0.898
Sent children living elsewhere	0.06	0.06	0.06	0.968	0.06	0.899
Due to forecasts of any of these events, the household:						
Change in cropping pattern	0.71	0.70	0.73	0.674	0.72	0.873
Improved seeds adoption	0.58	0.60	0.60	0.879	0.60	0.614
Change in sowing date	0.74	0.79	0.78	0.395	0.78	0.176
Increased use of organic compost	0.64	0.60	0.58	0.270	0.59	0.136
Increased use of chemical fertilizer	0.32	0.42	0.32	0.069	0.37	0.161
Investment in irrigation	0.14	0.16	0.13	0.651	0.15	0.617
Greater diversification of crops	0.33	0.38	0.33	0.471	0.35	0.554
Crop insurance	0.03	0.05	0.04	0.678	0.04	0.381

Notes: Errors are clustered at the CWAC level. First, second, and third column, show the average value for each variable for control, only FSP and FSP plus households, respectively. Fourth column shows the p-value of the F-statistic associated to the null hypothesis of equality of the means for the control, only FSP and FSP plus households. Fifth column shows the average value for each variable for FSP-all group (only FSP and FSP plus). Sixth column shows the p-value of the t-statistic associated to the null hypothesis of equality of the means for the Control and FSP-all (FSP and FSP plus) households.
Source*:* Authors' elaboration from survey data

Credit and access to markets

Access to credit plays a crucial role in facilitating investments in modern inputs and promoting both farm and non-farm production. Nevertheless, in situations characterized by incomplete markets, which are frequently prevalent in rural areas of low- and middle-income countries, credit constraints often hinder investment opportunities. During the reference period, 28 percent of households sought financial assistance from either formal or informal lenders, as shown in Table 29. Additionally, 17 percent of households were part of savings groups. However, only 8 percent of households utilized the borrowed funds to acquire agricultural inputs. Table 30 shows that the variables are well balanced since we cannot reject the null hypothesis of equality of the means across the three treatment groups.

Table 29. Credit access

	Mean	SD
Household borrowed money	0.28	0.45
Household member belongs to savings group	0.17	0.38
Household used credit to buy inputs	0.08	0.26

Source*:* Authors' elaboration from survey data.

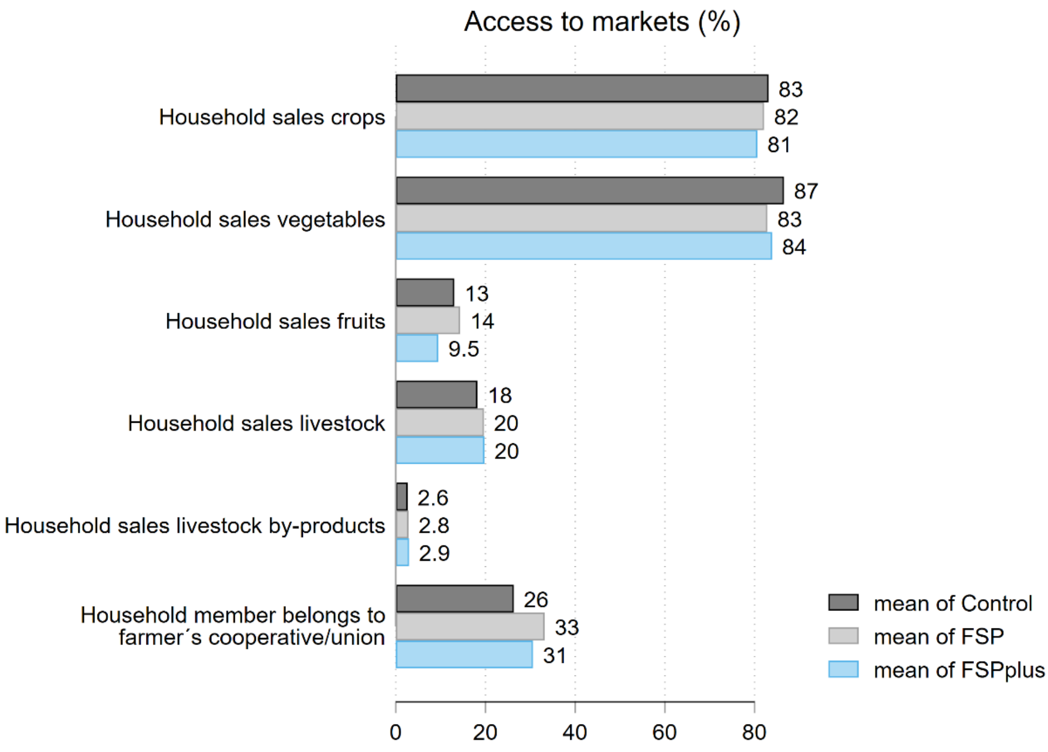
Table 30. Credit access by treatment group

	Control	FSP	FSP plus	p-value $H_0:H_C=H_{FSP}=H_{FSPplus}$	FSP-all	p-value $H_0:H_C=H_{allFSP}$
Household borrowed money	0.27	0.27	0.32	0.196	0.29	0.251
Household member belongs to savings group	0.17	0.18	0.18	0.957	0.18	0.768
Household used credit to buy inputs	0.07	0.10	0.06	0.308	0.08	0.780

Notes: Errors are clustered at the CWAC level. First, second, and third column, show the average value for each variable for control, only FSP and FSP plus households, respectively. Fourth column shows the p-value of the F-statistic associated to the null hypothesis of equality of the means for the control, only FSP and FSP plus households. Fifth column shows the average value for each variable for FSP-all group (only FSP and FSP plus). Sixth column shows the p-value of the t-statistic associated to the null hypothesis of equality of the means for the Control and FSP-all (FSP and FSP plus) households.
Source*:* Authors' elaboration from survey data.

We evaluate households' involvement in the market by examining their participation in crop, vegetable, fruit, livestock, and livestock by-products sales during the reference period, as well as their engagement in agricultural market groups (Figure 3). Across these variables, we find no differences between the means of the three treatment groups (p-values not shown, available upon request). The primary avenue for households to engage in the sales market is through the selling of crops and vegetables. Only approximately one-fifth of the farmers in our sample reported selling livestock during the reference period, and approximately one-tenth reported selling fruits. The sale of livestock by-products is relatively rare, with fewer than 3 percent of households participating in this activity. Furthermore, approximately 30 percent of the households indicated that at least one member of their household belonged to a farmer organization.

Figure 3. Market access by treatment group



Source: Authors' own elaboration.

Transfers

In Table 31 we provide descriptive evidence concerning the economic support received by the households in the reference period. Overall, 46 percent of the households received any type of transfer, with and average value of ZMW 1 367 (PPP USD 211) for the reference period. 43 percent of the households receive public transfers, while only 7 percent receive private ones. On average, public transfers amount to ZMW 1 358 (PPP USD 209) and private ones to ZMW 769 (PPP USD 119).

We additionally asked about the types of public transfers received by the respondents. Only 8 percent of the farmers in our sample reported that their households benefited from any form of cash transfers, including the social cash transfer programme. On average, the recipients of these cash transfers received ZMW 1 227 (PPP USD 189) over the course of the 12-month reference period. The School Meals Feeding Programme had a higher presence, with 27 percent of the farmers being recipients. On average, the value of these transfers amounted to ZMW 374 (PPP USD 58) for the reference period. A small fraction, 2 percent of the farmers, reported receiving in-kind transfers, which had an average value of ZMW 764 (PPP USD 118). Lastly, farmers that are eligible to benefit from the FSP programme should not benefit from the Farmer Input Support Programme (FISP). Nevertheless, 16 percent of the farmers of the sample claim to have benefitted during the reference period from this programme. This might be a result of households being excluded from the FISP programme due to their inability to meet the required farmer contribution or failing to meet other programme criteria, subsequently rendering them eligible for the FSP program.

Table 32 below shows that for all the considered variables, we cannot reject the null hypothesis of equality of the means across the three treatment groups. This implies that we find no statistical differences between the treatment groups.

Table 31. Transfers received by household

	Mean	SD
Household received transfers	0.46	0.50
Value of transfers, ZMW	1 367	2 156
Household received private transfers	0.07	0.25
Value of private transfers, ZMW	769	1 199
Household received public transfers	0.43	0.49
Value of public transfers, ZMW	1 358	2 160
Type of public transfer:		
Cash transfers beneficiary	0.08	0.27
Value of cash transfers, ZMW	1 227	1 244
School Meals Feeding Programme beneficiary	0.27	0.44
Value of School Meals Feeding Programme, ZMW	374	763
In-kind transfers beneficiary	0.02	0.13
Value of in-kind transfers, ZMW	764	904
FISP beneficiary	0.16	0.37
Value of FISP transfers, ZMW	2 164	1 967

Source: Authors' elaboration from survey data.

Table 32. Transfers received by household by treatment group

	Control	FSP	FSP plus	p-value $H_0:H_C=H_{FSP}=H_{FSPplus}$	FSP all	p-value $H_0:H_C=H_{allFSP}$
Household received transfers	0.47	0.45	0.47	0.832	0.46	0.761
Value of transfers, ZMW	1 280	1 490	1 394	0.619	1 440	0.347
Household received private transfers	0.08	0.05	0.06	0.131	0.06	0.053
Value of private transfers, ZMW	737	833	781	0.910	804	0.681
Household received public transfers	0.42	0.42	0.44	0.858	0.43	0.836
Value of public transfers, ZMW	1 276	1 481	1 371	0.675	1 423	0.407
Type of public transfer:						
Cash transfers beneficiary	0.06	0.10	0.09	0.030	0.09	0.024
Value of cash transfers, ZMW	1 179	1 074	1 438	0.277	1 250	0.711
School Meals Feeding Programme beneficiary	0.27	0.25	0.29	0.563	0.27	0.942
Value of School Meals Feeding Programme, ZMW	344	450.93	354	0.588	398	0.400
In-kind transfers beneficiary	0.02	0.02	0.02	0.804	0.02	0.618
Value of in-kind transfers, ZMW	765	1 065	546	0.174	764	0.998
FISP beneficiary	0.15	0.17	0.17	0.922	0.17	0.691
Value of FISP transfers, ZMW	2 216	2 292	1 966	0.482	2 125	0.694

Notes: Errors are clustered at the CWAC level. First, second, and third column, show the average value for each variable for control, only FSP and FSP plus households, respectively. Fourth column shows the p-value of the F-statistic associated to the null hypothesis of equality of the means for the control, only FSP and FSP plus households. Fifth column shows the average value for each variable for FSP households (only FSP and FSP plus). Sixth column shows the p-value of the t-statistic associated to the null hypothesis of equality of the means for the control and FSP (only FSP and FSP plus) households.
Source: Authors' elaboration from survey data

Perceived resilience index

The perceived resilience index is a standardized weighted average of the positively and negatively coded Likert-scale items, extending and adapting the resilience framework of Meuwissen *et al.,* (2019) to a farm-household setting in a developing country. Table 6 shows that descriptive statistics associated with perceived resilience index.

We use a novel subjective resilience measure developed by Ahmed *et al.,* (2023) based on the conceptual foundations of adaptive cycles in socioecological literature (Folke *et al.,* 2010; Bullock *et al.,* 2017). This stream of literature posits that a system's resilience is based on its ability to (a) bounce-back from a shock (robustness), (b) adapt to the shock (adaptability), and (c) transform production processes under pressure from external shocks (transformability). Meuwissen *et al.,* (2019) and Spiegel *et al.,* (2021) further develop this framework for assessing perceived resilience of farmers and farming systems in the EU.

Ahmed *et al.,* (2023) have further adapted this conceptual framework for the unique context of farm-households facing climate-related risks. They propose that these households must not only enhance the aforementioned capacities at the farm-level but also cultivate adaptive capabilities beyond on-farm activities. Consequently, by employing the methodology proposed by Ahmed *et al.,* (2023), we gauge households' abilities to bounce back (robustness), adapt at the farm-level (farm adaptability), transform production (transformability), and adjust their livelihoods (livelihood adaptability). These assessments are critical for evaluating their resilience to common shocks such as droughts and floods, prevalent in the study area.

Several ways to measure resilience exist, both objective and subjective, and each comes with its own strengths and limitations (Barrett *et al.,* 2021; Upton *et al.,* 2022). However, subjective measures have two notable advantages. Firstly, they can consider the knowledge and personal context of respondents regarding their well-being, which helps capture important psychological factors related to resilience (Marshall 2010; Jones and Tanner 2017; Jones and d'Errico, 2019). Additionally, subjective measures can complement traditional objective measures and don't require as much hard-to-obtain socio-economic data (Maxwell *et al.,* 2015).

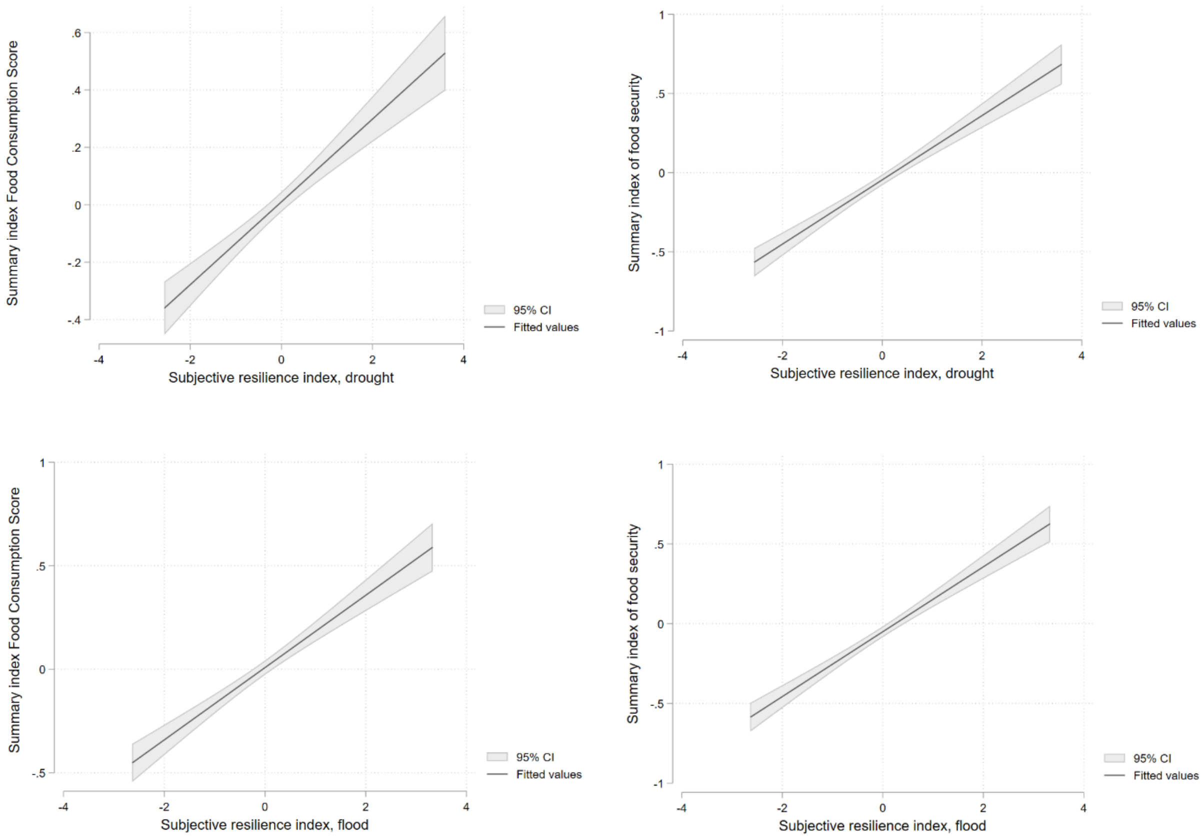
Table 33 displays the measurement scale used in our study. We calculated a scale reliability coefficient (Cronbach's α) of 0.81 for droughts and 0.84 for floods, indicating good reliability. Furthermore, we assessed the scale's predictive validity by examining its relationship with variables theoretically expected to be correlated with it. In our specific context, a strong measure of resilience should exhibit a positive correlation with food security indicators, as suggested by d'Errico *et al.,* (2018). Figure 4 illustrates that indeed, the summary food consumption index and the summary food security index are positively associated with the perceived resilience index, offering compelling evidence that our subjective resilience measure effectively captures the resilience of farm-households.

Table 33. Components of the perceived resilience index

		Drought	Flood
Robustness		**Mean (SD)**	**Mean (SD)**
After a *shock*, it is easy for my farm to recover to its previous profitability within a year	+	2.51 (1.22)	2.72 (0.96)
It is hard to manage my farm in a way that it recovers quickly from the *shock*	-	3.44 (1.08)	3.31 (1.09)
I consider myself well-prepared to protect my farm production in case there is a *shock*	+	2.43 (1.08)	2.62 (1.14)
Farm adaptability			
If needed, my farm can adopt new activities, varieties, or technologies in response to a *shock* within a year	+	3.07 (1.17)	3.18 (1.18)
I can adopt alternative management techniques and technologies to adapt quickly and successfully to a *shock*	+	3.09 (1.16)	3.21 (1.18)
It is difficult for my farm to adopt new practices and techniques in the short-term to minimize damages from a *shock*	-	3.37 (1.04)	3.26 (1.09)
Transformability			
My farm can easily transform to produce an alternative primary product and access different value chains when faced with a *shock* in the short-term	+	2.61 (1.06)	2.73 (1.11)
Due to circumstances not in my power (water availability, soil composition, markets, etc.), it is hard to quickly rearrange my farm especially when faced with a *shock*	-	3.52 (0.99)	3.44 (1.02)
Livelihood adaptability			
It is possible for me to get a job or start a business outside of farming when own-farm production declines due to a *shock*	+	2.96 (1.30)	2.93 (1.31)
It is possible for me to travel outside my village and earn money to support my family when a *shock* occurs	+	2.85 (1.31)	2.82 (1.29)
It is it very difficult for me to find a job or start a business outside my farm when a *shock* occurs	-	3.36 (1.18)	3.34 (1.20)

Notes: Cronbach's α of 0.81 for resilience against droughts and 0.84 for resilience against floods
Source: Authors' own elaboration.

Figure 4. Relationship between food security measures and subjective resilience measures



Source: Authors' own elaboration.

Male and female main respondents and intrahousehold decision-making

Table 34 presents a comparative analysis of households with the primary respondent identified as male and those with a female respondent, highlighting disparities in key project-related outcomes. We find that where there are male main respondents, income, food security, and the subjective resilience measures are higher compared to those where the main respondent is female. These differences are significant at a 1 percent significance level. This result is expected because households where the main respondent is female may face additional challenges in the event of divorce or the death of a male household member. However, we did not identify consistent differences in other additional outcomes between households with male and female main respondents.

Table 34. Main outcomes, by sex of the main respondent

	Male, main respondent	Female, main respondent	p-value
Household gross income, ZMW	23 815	19 145	0.024
Food security index	0.02	-0.23	0.000
Agricultural practices index	0.03	-0.01	0.356
Crop diversity index	-0.00	-0.09	0.101
Income diversification index	-0.05	-0.08	0.483
Subjective resilience index, drought	-0.03	-0.16	0.009
Subjective resilience index, flood	0.00	-0.14	0.008
Observations	1953	1043	

Notes: Errors are clustered at the CWAC level. First and second column, show the average value for each variable for male and female-headed households, respectively. Third column shows the p-value of the t-statistic associated to the null hypothesis of equality of the means for the male and female-headed households.
Source*:* Authors' elaboration from survey data.

To better understand intra-household dynamics, we gathered responses from the spouse of the main respondent or another adult household member of the opposite sex. They answered a series of questions concerning participation and their confidence in making decisions across various domains, as outlined in Table 35. In total, we collected responses from both the main respondent and their spouse in 982 households. Subsequently, for the upcoming tables, we narrowed our focus to surveys where the main respondent was male, resulting in 703 observations.

Table 35. Activity type presented in survey

Getting inputs for agricultural production
The types of staple crops to grow in the fields in most fields or in the biggest field
Cultivation of vegetables in gardening plots
Raising livestock: poultry
Raising livestock: cattle and goats
Saving money and use of money from savings
Use of money from loans
Your own (singular) wage or salary employment
Major household expenditures (such as a large appliance like refrigerator)
Minor household expenditures (such as food for daily consumption)

Table 36 presents an overview of these differences. Male main respondents exhibit higher overall participation in the considered activities, express greater confidence in making decisions related to agricultural activities, and a larger proportion of them report feel being able to make at least two agricultural decisions compared to their spouses or another female adult household member. All the differences are significant at a 5 percent significance level.

Table 36. Intrahousehold participation in activities and decision-making, by sex

	Male, main respondent	Female spouse	p-value
Number of activities in which individual participates	7.14	6.37	0.000
Number of agricultural activities in which individual participates	4.03	3.42	0.000
Number agricultural domains individual feels can make decisions	4.56	3.81	0.000
Feels can make decisions in AT LEAST TWO agricultural domains	0.94	0.81	0.000
Observations	703	703	

Notes: Errors are clustered at the CWAC level. First and second column, show the average value for each variable for the main respondent and his spouse or another adult female, respectively. Third column shows the p-value of the t-statistic associated to the null hypothesis of equality of the means for main respondent and his spouse.
Source*:* Authors' elaboration from survey data

Table 37 presents the proportions of male main respondents and their respective spouses who assert their confidence in making decisions across five different agricultural topics within the household. For each domain, the proportion of males is statistically significantly greater than that of females at a 1 percent significance level. Even for activities traditionally associated with females, such as decisions concerning gardening plots and poultry raising, females report lower confidence in their decision-making abilities compared to the male respondents in their households.

Table 37. Feeling of ability to make agricultural decisions, by sex

	Male, main respondent	Female spouse	p-value
Feels can make decisions regarding:			
getting inputs for agricultural production	0.93	0.79	0.000
types of crops to grow	0.93	0.78	0.000
cultivation of vegetables in gardening plots	0.92	0.76	0.000
raising livestock: poultry	0.87	0.72	0.000
raising livestock: cattle and goats	0.91	0.76	0.000
Observations	703	703	

Notes: Errors are clustered at the CWAC level. First and second column, show the average value for each variable for the main respondent and his spouse or another adult female, respectively. Third column shows the p-value of the t-statistic associated to the null hypothesis of equality of the means for main respondent and his spouse.
Source*:* Authors' elaboration from survey data.

Econometric analysis

In this section, we explore the extent to which the impact of adopting climate-adaptive practices on well-being measures is mediated by the resilience channel. An augmented sense of resilience may be a proxy for an enhanced sense of self-efficacy, which represents an individual's belief in their ability to attain goals. In recent years, the field of economics has increasingly focused on comprehending how psychological or internal factors influence economic decision-making. Wuepper and Lybbert (2017) offer an overview of how self-efficacy has been integrated into economic analysis. One way in which this concept can influence economic well-being is by affecting perceived productivity, as discussed in Lybbert and Wydick (2017). The model proposed by the authors posits that a greater sense of self-efficacy results in a higher expected return for one's efforts. The ultimate economic outcome is influenced by one's exerted effort, inherent abilities, and random external factors. Individuals then solve an optimization problem: maximizing the difference between the expected payoff and the cost of exerting effort. When perceived self-efficacy is low, individuals either refrain from trying entirely or invest insufficient effort, missing the chance to discover their genuine capabilities. Conversely, those with accurate or overly high perceived self-efficacy both make the effort, leading to a convergence of their expectations with reality.

Specifically, we focus on the adoption of the following climate-adaptive practices: improved/hybrid seeds, crop diversification, off-farm diversification, and conservation agriculture (Table 38). To assess household well-being, we use two food security indicators: the food consumption index and the food security index. Additionally, we investigate how the adoption of climate-adaptive practices affects annual farm-related expenditures, farm income, and total household income (Table 39). We selected these variables following Ahmed *et al.,* (2023), which finds a positive impact of certain climate-adaptive practices on food security and income.

Table 38. Adoption variables

Variable	Description	Mean
Improved seed	Indicator variable = 1 if household has used improved and/or hybrid seeds in the previous year, 0 otherwise.	0.55
Crop diversification	Indicator variable = 1 if household has a summary crop diversification index a la Anderson (2008) larger than the median. The summary crop diversification index is a standardized weighted average of the number of cultivated crops and of both a Simpson and Shannon index of crop diversity.	0.53
Off-farm diversification	Indicator variable = 1 if any member of the household operates an enterprise outside the farm, 0 otherwise.	0.20
Conservation agriculture	Indicator variable =1 if household has adopted at least 3 out of 4 conservation agriculture practices (crop residue are spread over plot, zero tillage, crop rotation, intercropping), 0 otherwise.	0.40

Source: Authors' own elaboration.

Table 39. Outcome variables

Variable	Description	
Food consumption index	Standardized weighted average of the number of times a certain food group was consumed by the household in the last 7 days.	0 (1)
Food security index	Standardized (negatively) weighted average of 8 Likert-scale statements regarding experiencing food insecurity at various levels of intensity by the household in the last month.	0 (1)
Agricultural expenditure	Inverse hyperbolic sine of the total agricultural input expenditure from May 2021 to April 2022.	ZMW 1 689 [2 579]
Agricultural income	Inverse hyperbolic sine of the total agricultural income from May 2021 to April 2022.	ZMW 13 260 [43 582]
Gross income	Inverse hyperbolic sine of the total household income in the last 12 months.	ZMW 22 302 [55 010]

Note: N = 2 996. Standard deviation in brackets.
Source: Authors' own elaboration.

The decision to adopt climate-adaptive practices is influenced by a range of observed and unobserved factors. These factors are prone to systematic differences between those who adopt these practices and those who do not, and they may also be correlated with welfare outcomes. This presents a self-selection challenge in the estimation. In order to address this problem, Ahmed *et al.,* (2023) apply a doubly robust inverse probability weighted regression adjustment (IPWRA) following Wooldridge

(2010), using this same database. In the initial stage, inverse probability weights are computed based on the likelihood of being an adopter. To accomplish this, the authors determine propensity scores, as defined by Rosenbaum and Rubin (1983), employing a logistic regression model with various observable covariates. These weights are subsequently applied in a second stage to evaluate the impact of adoption on well-being outcomes. The approach assigns greater weight to observations less likely to have adopted and lesser weight to those more likely to have adopted, thereby achieving data balance. While this method leverages observable covariates to mitigate selection bias and confounding, it remains susceptible to potential heterogeneity arising from unobservable factors.

Mediation analysis is a tool that allows to break down the total effect of a treatment into distinct causal pathways and measuring their respective significance. The goal of this approach is to isolate a single mediating pathway represented by the indirect effect, while consolidating all other pathways into a unified direct effect. In our case, we wish to measure the indirect effect of the adoption of climate-adaptive practices on farmer's wellbeing that passes through resilience. To estimate this effect, we use a system of linear regressions, following Linden and Karlson (2013). To account for the observed factors that differ between those who adopt these practices and those who do not, and the potential correlation these may have welfare outcomes and resilience, we incorporate inverse probability weights to the system of linear regressions. Similar to the IPWRA approach described earlier, the weights are derived from an estimation of the probability of adopting each of the four climate-adaptive practices. This estimation accounts for various covariates, such as household and farm attributes, including household size, gender, age, and educational background of the primary respondent. It also considers factors like the household's labour availability, whether the household received extension guidance, and whether anyone in the household was provided with weather-related information.

Equations 4 and 5 show the system of linear equations that are used to estimate the indirect effect of the adoption of climate-adaptive practices on farmer's wellbeing that passes through resilience.

$$R_i = \beta_0 + \beta_A A_i + \beta_X \boldsymbol{X}_i + \varepsilon_i \qquad (\mathbf{4})$$

$$Y_i = \gamma_0 + \gamma_A A_i + \gamma_X \boldsymbol{X}_i + \gamma_R R_i + \nu_i \qquad (\mathbf{5})$$

R_i represents either the flood or drought perceived resilience measure for each household i, A_i denotes the climate-adaptive practices for each household, $\boldsymbol{X}_i$ encompasses the set of covariates described in the previous paragraph, and Y_i represents the different measures considered of farmer's wellbeing. The overall average indirect effect is equal to $\beta_A\gamma_R$, while the total causal effect is $\beta_A\gamma_R + \gamma_A$. The system of equations is weighted by the inverse of the adoption probability for each of the four practices, and it is estimated separately for each of the five outcomes. As a result, a total of 20 coefficients are obtained for each resilience measure, both for flood and drought.

Table 40 and Table 41 show the results for the indirect effect of the adoption of climate adaptive practices on wellbeing outcomes through perceived resilience to floods and droughts, respectively. The table shows the effect as a percentage of the total effect ($\beta_A\gamma_R / (\beta_A\gamma_R + \gamma_A)$). The signs in parenthesis represent the direction of the total effect of the adaptation on wellbeing, which are the same for both tables.

The tables show some mixed results. The first row in the two tables show the indirect effect of off-farm diversification on each of the five outcomes that passes through perceived resilience. Perceived resilience to floods has no statistically significant mediating effects on the wellbeing measures. Conversely, the effect of off-farm diversification on agricultural income, gross income, and inputs expenditure flows through changes in perceived resilience to droughts that amount to 5, 2.9 and 5.4 percent of the total effect, respectively. The effect of conservation agriculture on food security and food consumption is not statistically significant, and it is not economically significant on farm income (Ahmed *et al.,* 2023). Although there are three significant indirect effects on agricultural expenditure and income, one that flows through resilience to floods and the other two through droughts, these do not hold economic relevance.

As presented by Ahmed *et al.,* (2023) the adoption of improved and hybrid seeds leads to an increase in food security and food consumption indices of 0.31 and 0.27 standard deviations, and a 30, 7 and 7.4 percent increase in agricultural expenditure, gross and agricultural income, respectively. Table 40 and Table 41 present the indirect effects on these outcomes through perceived resilience, with all but one demonstrating statistical significance. However, it is worth noting that these indirect effects constitute a minor proportion of the overall effect. The most substantial indirect mediating effect, at 7.9 percent, is observed when considering perceived resilience to droughts in relation to the food security summary index. This implies that the effect of the adoption of improved and hybrid seeds increases the summary index of food security by 0.025[4] standard deviations through the indirect pathway associated with perceived resilience to droughts. This effect is small and not economically

[4] 0.079*0.31=0.025

relevant. Although statistically significant, the indirect effects that flow through perceived resilience account for marginal changes in the magnitude of the observed effects.

Lastly, the effects of crop diversification appear significant through the indirect channels of perceived resilience for all outcomes, except for agricultural income as indicated in Table 40. As highlighted in Ahmed *et al.,* (2023) the total effects for most outcome variables are statistically significant, although small in magnitude. Consequently, the indirect effects mediated through perceived resilience are likewise relatively modest in scale. The largest indirect effect as a proportion of the total effect is observed on the food security index through perceived resilience to droughts (Table 41). The total effect is equal to 0.114 standard deviations, with the indirect effect representing just 0.021[5] standard deviations of this total. As with the adoption of hybrid and improved seeds, the indirect effects remain relatively small and lack significant economic relevance.

This estimation method presented here is based on observable covariates to mitigate selection bias and confounding but does not account for heterogeneity that may be present due to unobservable factors. Consequently, these findings do not provide conclusive and unequivocal evidence of causation

Table 40. Indirect effect of adoption on outcomes through perceived resilience to floods, as a percentage of the total effect

	Agricultural Income	Gross Income	Inputs Expenditure	Summary index food consumption score	Summary index food security
Practices					
Off-farm diversification	1.3 (+)	0.8 (+)	2.3 (+)	-18.1 (-)	31.2 (+)
Conservation agriculture	-7.4 (+)	-22 (+)	24.4** (-)	-246 (+)	178(-)
Improved/hybrid seeds	0.6 (+)	1.8* (+)	3.2** (+)	7.1** (+)	7.7** (+)
Crop diversity	3.0 (+)	5.7*** (+)	13.7** (+)	11.5** (+)	17.4** (+)
Observations	2996				

Note: Total effect sign in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
Source: Authors' own elaboration.

[5] 0.183*0.114=0.021

Table 41. Indirect effect of adoption on outcomes through perceived resilience to droughts, as a percentage of the total effect

	Agricultural income	Gross income	Inputs expenditure	Summary index food consumption score	Summary index food security
Practices					
Off-farm diversification	5.0** (+)	2.9*** (+)	5.4*** (+)	42.3 (-)	99.2 (+)
Conservation agriculture	-14.8** (+)	-43.8 (+)	25.5*** (-)	263.0 (+)	222.0 (-)
Improved/hybrid seeds	1.3* (+)	2.7** (+)	2.7** (+)	5.5** (+)	7.9** (+)
Crop diversity	4.9** (+)	8.2*** (+)	10.0*** (+)	8.7** (+)	18.3*** (+)
Observations	2996				

Note: Total effect sign in parentheses
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$
Source: Authors' own elaboration.

Conclusion

The “Building Back Better and Greener: Integrated Approaches for an Inclusive and Green COVID-19 Recovery in Rural Spaces" project in Zambia is strategically geared toward enhancing the availability of extension services, with a particular focus on promoting conservation agricultural practices among FSP beneficiaries in districts where programme expansion is underway. To achieve this, beneficiaries engage in FFS to acquire valuable knowledge and adopt best practices associated with the FSP package.

The project aims to tackle a substantial challenge in the successful implementation of the FSP, which is the difficulty of connecting programme beneficiaries with crucial extension support. Zambia faces the issue of a significant farmer-to-extension officer ratio, which results in the prioritization of larger, more resource-endowed producers for extension assistance. Consequently, FSP beneficiaries often lack vital information on how to fully leverage the advantages of the FSP input package, hindering their progress towards increased agricultural production and economic self-sufficiency.

We employ both descriptive and econometric analyses to highlight three crucial aspects of our sample, which hold significant implications for effective programme design within the study area. First, the region is grappling with prolonged drought, resulting in a precarious food security situation. Our findings reveal that approximately 60 percent of the households in our sample exhibit food consumption scores below the 'acceptable' threshold. Second, our descriptive analysis underscores that male-headed households are better off in terms of income and food security than female-headed households and that decision-making authority are predominantly vested in male household members. Consequently, any poverty-alleviation and rural development programmes designed to be truly effective must address these prevailing gender disparities. Third, perceived resilience mediates the effect of certain climate adaptive practices on wellbeing measures. Increasing resilience may result in an amplification of the total effect of the adoption of climate-adaptive practices on wellbeing measures. It is important to note that these estimates represent strong correlations, and do not conclusively establish causality regarding the effectiveness of climate-adaptive practices.

Finally, the construction of the treatment arms was executed successfully, and no systematic differences were identified among the three groups. This ensures that any observed effects on the outcomes of interest, if present, can be attributed credibly to the programme itself rather than systematic disparities across the groups.

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