Food Assistance and Resilience to Food Insecurity in Malawi: A Gender Analysis

by Monserrath Ximena Lascano Galarza

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Abstract:

This research investigates the impact of food assistance programmes on the resilience to food insecurity levels of rural agricultural households headed by females that are beneficiaries of the project "The R4 Rural Resilience Initiative" of the World Food Programme and Oxfam America's. This analysis uses a balanced panel dataset containing information of 216 households for the years 2015(baseline) and 2016. In the first part of the empirical analysis, resilience and food security levels are estimated using the Resilience Index Measurement and Analysis II methodology of the Food and Agriculture Organization. Second, using a naïve approach, a reflective and reflexive method are used for a descriptive performance assessment of key R4 indicators of female vs male-headed households before and after the project implementation. Finally, matching and difference-in-difference techniques, with an emphasis on gender, were used for impact evaluation. The performance analysis shows positive and significant effects of the project participation on male and female-headed households, being these effects on male-headed larger than in their counterparts. The impact evaluation shows a negative and significant relationship between female-headed households' programme participation and the variation of the outcome variables, but a positive and significant relationship between program participation and the levels of resilience and food security of female-headed households.

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Keywords: resilience, food security, food assistance, Malawi, female-headed households, impact evaluation

JEL code: Q18, O19, J16

1. INTRODUCTION

Although resilience has an ecological and engineering origin (Holling, 1973; Walker *et al.*, 1981; Pimm, 1984; O'Neill *et al.*, 1987; Levin *et al.*, 1998), it has been adapted and applied to various disciplines, and more recently, it has been used in the assessment of more complex ecological and socioeconomic systems (i.e. agri-food systems in developing countries) (Folke, 2006; d'Errico, Romano and Pietrelli, 2018). Resilience is most commonly understood as *the capacity that ensures adverse stressors and shocks do not have long-lasting adverse development consequences* (Constas, Frankenberger and Hoddinott, 2014), and it could be determined by tangible and subjective factors (Maxwell *et al.*, 2015; Béné *et al.*, 2016), for instance, information about risks or shocks, individuals' self-assessments or perceptions of their capacities to deal with stressful situations that could explain their short and long term coping strategies or wiliness to engage in different types of shock responses. Food security has often been studied from a vulnerability's perspective; thus, humanitarian and development interventions commonly focus on relief rather than on a long-term objective to decrease peoples' vulnerabilities to shocks.

The last decades have been characterised by an increment of the frequency and intensity of climatic shocks that exacerbate already vulnerable communities, heavily dependent on agriculture. Consequently, humanitarian and development actors have intensified their efforts to deliver more efficient and comprehensive interventions to the affected populations, aiming at providing the tools to prevent harmful impacts, preparing for shocks, and avoiding harmful coping mechanisms, building on peoples' ability to adapt and reorganise, looking for a prompt recovery that allows them to bounce back better (Pingali, Alinovi and Sutton, 2005). To successfully targeting populations and designing customised interventions, it is essential to understand the context and the beneficiaries' characteristics, as, for instance, the factors that conditions a community's resilience to adverse shocks (Caldera Sánchez, Rasmussen and

Röhn, 2015). International Organizations, Governments, Non-Governmental Organisations, and different Institutions have been more frequently using resilience as a core approach for policies and programme design, mainly due to this concept's dynamic nature that allows its use as a process and an outcome (Sturgess, 2016). Despite the greater interest in the topic and the spread of the use of resilience as a focal concept or as a long-run objective in policies and programs, no agreements on definitions, frameworks, or common robust tools have yet been made, mainly due to its unobservability and ex-ante characteristic, resulting in theoretical and empirical constraints (von Grebmer *et al.*, 2013; Alfani *et al.*, 2015; Cisse and Barrett, 2015; Béné *et al.*, 2016; Sturgess, 2016).

Most of the contemporary literature on resilience to food insecurity tries to overcome the empirical limitations of resilience measurement and focuses on understanding the determinant of resilience to food insecurity. Different measurement methods centred in the estimation of attributes, dimensions, and capacities, using ex-ante and ex-post effects of a shock, have been proposed (Vaitla *et al.*, 2012; FAO, 2013, p. 213, 2016; Hughes and Bushell, 2013; von Grebmer *et al.*, 2013; Constas *et al.*, 2014; IIED, 2014; Béné *et al.*, 2016; Sturgess, 2016). A body of literature looks for a rigorous approach that could smoothly be applied in practice (Béné *et al.*, 2017), while other authors look at operationalising the concept of resilience (Alinovi, Mane and Romano, 2008; Alinovi *et al.*, 2010; Tefera and Demeke, 2011; Ciani and Romano, 2013; Smith *et al.*, 2014; Alfani *et al.*, 2015; Cisse *et al.*, 2015; Kimetrica, 2015; Tefera and Kayitakire, 2015; Constas *et al.*, 2016; d'Errico and Di Giuseppe, 2016; Cissé and Barrett, 2018).

However, just a limited part of the literature studies the links between resilience and food insecurity from a clear gender perspective. The existing literature focuses on understanding the factors that trigger women's vulnerabilities and lower levels of food security or women's contribution to their households' food security levels. For instance, Babatunde *et al.*, (2008)

studied the determinants of vulnerability to food insecurity by households heads' gender in rural Nigeria. This analysis showed that vulnerability to food insecurity among female-headed households is triggered by resource availability inequalities, frequent and severe adoption of detrimental coping strategies, and household heads' characteristics such as age, level of education, and off-farm income. Mallick and Rafi, (2010) studied indigenous and ethnic Bangladeshi households' food security based on their heads' gender. Authors found no significant differences among the households studied, mainly due to women greater freedoms to participate in labour and contribute to their family's food security levels. In Ibnouf, (2013), the author used a qualitative-quantitative approach to assess rural Sudanese women's role in reducing hunger and malnutrition and their contribution to their households' food security levels. This research showed that women play an essential role in improving their food security regarding food availability, use and allocation. More recently, Perez *et al.*, (2015) performed, from a gender-based perspective, a quantitative and qualitative analysis to assess the conditions that trigger vulnerability and resilience among households and communities of nine African countries facing and responding to climate changes. The authors compared agricultural and livelihood systems, productive resources, organisation, and access to services and found that women have access to less quality and quantity of resources and that response programmes in the area mainly support men. Similarly, Kassie *et al.*, (2015) applied a counterfactual analysis to investigate the underlying causes of the food security gap between female and male-headed households. Authors found that greater access to resources and the adoption of sustainable agricultural practices would significantly improve the female-headed households' level of food security; however, due to their chronic levels of food insecurity and the disparities in the returns of resources, the gap existing between both types of households wouldn't close.

To the best of the author's knowledge, no gender-based investigation has been made on the effects of assistance programmes on the levels of resilience to food insecurity among the

beneficiary population. The linkages between resilience, food security, nutrition security, climate shocks and their connotations in designing policies and interventions are complex. This research is based on the framework represented in Figure 1, which attempts at linking resilience, food and nutrition security and programming assistance. For this study's aim, we assume that nutrition security can be considered at the same time, an *input to* and an *outcome of* strengthened levels of resilience and food security. External shocks/stresses exacerbate already vulnerable populations, reducing their nutrition security levels and affecting their food security. Subsequently, their resilience levels would decrease, pushing households to adopt coping strategies that provide immediate relief but can be detrimental in the long run (Maxwell, 1996; Ciani and Romano, 2013; Béné *et al.*, 2014; Frankenberger *et al.*, 2014).

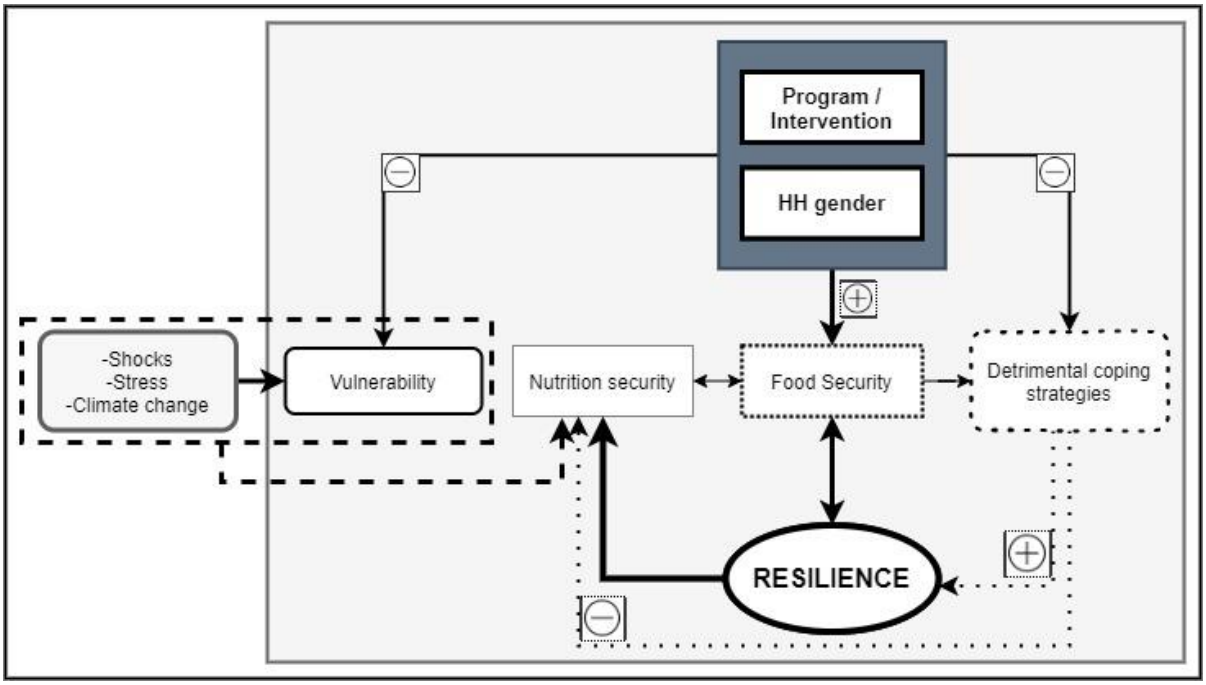

Figure 1 Resilience, nutrition and food security, and intervention links
Source: Authors' representation based on (Lascano G., 2020)

Dynamic policies and programmes that adapt to the context of implementation and consider specific needs and characteristics of the beneficiary households (i.e., gender of the household head) would reduce beneficiaries' vulnerabilities and the adoption of negative coping strategies. Reduced vulnerabilities would translate into higher nutrition and food security levels, contributing to better coping with external shocks, resulting in improved well-being and

resilience levels (IISD *et al.*, 2013; Fan, Pandya-Lorch and Yosef, 2014).

This research investigates the impact of food assistance programmes on the resilience and food security levels of rural agricultural households' beneficiaries of the project "The R4 Rural Resilience Initiative" of the World Food Programme and Oxfam America's, implemented during the period 2015-2016, using a gender-based approach. The dataset was obtained from the *R4 and Food for Assets (FFA) baseline and outcome survey*. To improve the analysis's external validity, the R4 dataset was pooled with data obtained from the *Malawi 2010-2016 Living Standards Measurement Study of the World Bank*. The empirical part of this research was performed in three stages. In the first part of the empirical analysis, resilience (R) and food security (FS) indexes were estimated using the Resilience Index Measurement and Analysis II (RIMA-II) methodology. The second part of the analysis used a reflexive method to track the changes of the outcome indicators of resilience and food security before and after the project's programme implementation while using a reflective approach to compare the results between female-headed households (FHH) and male-headed households (MHH). Finally, nearest-neighbour matching techniques were used to pool the panel data with a control group to perform a difference in difference (DID) model for impact evaluation with a gender focus. Academically, this research contributes to the existing literature regarding the relationship between gender, food insecurity, and resilience-building by using primary data collected from beneficiary populations benefiting from food assistance. From a practitioner's point of view, it contributes to a better understanding and a more rigorous analysis of the impacts of this kind of programmes on the beneficiary population levels of resilience and food security.

2. CONTEXT

Sub-Saharan African countries are among the most vulnerable to climatic change due to their high vulnerabilities and dependence on climate-vulnerable activities. Malawian rural households are characterised for having widespread levels of poverty, especially those headed

by females. Most Malawian rural households' economy depends on agriculture, resulting in households highly vulnerable to the effects of natural and climate disasters. Severe droughts and flooding have hit one-quarter of Malawian people during the last decade (World Bank, 2016; Ministry of Finance, Economic Panning & Development, 2017). For instance, the year 2015 marked record levels of flooding that resulted in damaged agricultural assets and infrastructure and shortages in production with severe consequences to food and nutritional levels, which triggered a national emergency that affected the most vulnerable households, especially those headed by females, depriving them of adequate time to recover.

The R4 Rural Resilience Initiative (R4) is a comprehensive risk management initiative first implemented in Malawi in 2015 as a three-year pilot project that targeted 500 participants (WFP and OXFAM, 2016). This initiative targets vulnerable households that experience seasonal food gaps and have the labour capacity to engage with the project. This project aims to build resilience among participants by reinforcing their abilities to withstand and recover from shocks while maintaining their essential functions to go back to a previous or stronger state. The R4 builds resilience grounded in five strategies: risk reserve (savings promotion), prudent risk-taking (credits facilitation and access), risk transfer (access to weather, livestock and yield index insurance), risk reduction (access to climate-resilient assets, conservation agriculture, climate services and community risk management), and social safety nets (food and cash assistance) (WFP, 2017).

3. METHODS AND DATA

This research used information on rural farming Malawian households from the Balaka district, obtained from the WFP's R4 and FFA Baseline, Midterm, and Outcome Household Monitoring Survey in Malawi. The survey includes information regarding households' demographics, assets, agricultural inputs and production, shocks and coping strategies, food and non-food consumption and expenditure, income sources, credit, savings, social networks, associations,

safety nets, and participation in assistance programmes. The empirical analysis is based on a two-years balanced panel dataset for the period 2015 (baseline) and 2016, formed by 216 households (432 observations) distributed among four Group Village Heads (GVHs) (Mtumbwe, Pongolani, Zalengera, and Hambahamba). Most of the households (HH) are conformed by 4 (19.9%) or 5 (16.6%) members, 74.4% of the households are male-headed (MH), and 25.6% have a female head (FH). Male heads (MH) are, on average, 48 years old, and female heads (FH) 42 years old. Most of the household heads (HHH) attended primary school: 67% male heads and 65.5% female heads. However, while 22% of MH attended secondary school, only 8% of FH attended secondary school; the remaining heads never attended school. While 95% of MH were married, 46% of FH were widowed, 24% divorced, 18% married, 10% separated, and 2% were single. All 216 households are R4 beneficiaries, which supposed an empirical constraint and allowed only a longitudinal analysis without a control group. To improve the external validity of this study, we extracted information of 930 rural agricultural Malawian households from the *Integrated Household Panel Survey of Malawi's 2010-2013-2016 Living Standards Measurement Study of the World Bank*. Afterwards, we matched the extracted data with our panel dataset to control the effects of the R4 Initiative on the beneficiary group against a non-beneficiary one.

In the ***first part*** of our empirical analysis, resilience was estimated using the RIMA-II model of FAO that uses a mixed-methods approach and allows for context adaptation, rigorous analysis and comparison of the households, and the effects of shocks on the households' resilience and food security (FAO, 2013). The Resilience Capacity Index (RCI) estimation relies on four pillars: AST, ABS, SSN, and AC. Productive and non-productive *Assets* (**AST**)[1] as an indicator of households' living conditions and shocks' effects on households' behaviour

[1] See information on RIMA-II's variables and indexes in Annex 1.

and coping strategies. Proxies may include wealth index, land owned extension, agricultural expenditure. **ABS** represents the HHs' ability to meet its basic needs, quality and use and *access to basic services*. An example of ABS is the access or the monetary cost of health services. A household's (HH) ability to access formal and informal assistance is represented by *Social Safety Nets* (**SSN**) (i.e., support groups, informal loans). *Adaptive capacity* (**AC**) describes a HH's ability to face and adapt to a new situation after a shock; it can be estimated from a HH's income sources, education level, among others (FAO, 2016). The RIMA-II model considers Food security (FS) as a well-being indicator closely linked to resilience. Here, resilience is the ex-ante link between well-being and shocks and the ex-post capacity to preserve well-being after the shock (Constas, Frankenberger and Hoddinott, 2014). In this research, FS was measured using two proxies: a weighted value estimated by weekly frequency of different food groups consumption, known as Food Consumption Score (**FCS**) (WFP, 2008), and the monetary value of food consumption, known as food expenditure (**FX**), which is an indirect measure of food caloric intake and is expressed in Malawian kwacha[2] (includes bought, self-produced, received in-kind or in-cash as part of food assistance programmes, and stored foods). The RIMA-II model supposed a descriptive and a causal analysis. During the first part of the **descriptive analysis**, the FS proxies are estimated, and the four pillars of resilience constructed from observed variables through the Iterated Principal Factor Analysis (IPF). The factors considered for each pillar are those able of explaining at least 95% of the variance. More specifically, three factors are retained for ABS, three factors for AST, three factors for SSN and one factor for AC. In the second stage of the descriptive analysis, the RCI is estimated using Multiple Indicators Multiple Causes (MIMIC) model. The MIMIC model belongs to the Structural Equation Model (SEM) class and is characterised by one underlying latent variable

[2] 1 United States Dollar equals 796.058 Malawian Kwacha. 5/24/2021 12:00:00 AM (Reserve Bank of Malawi, 2021)

with multiple indicators and multiple causes. A system of equations is constructed specifying the relationships between the unobservable latent variable (RCI), a set of outcome indicators (FS indicators), and a set of covariates (pillars). The two components of the MIMIC model are represented by equation (1), which is the measurement component of the model (where observed indicators of FS are assumed to be imperfect indicators of resilience capacity), and equation (2) that represents the structural component of the model (it correlates the pillars to resilience capacity):

$$\begin{bmatrix} FCS \\ FX \end{bmatrix} = [\Lambda_1, \Lambda_2] \times [\eta = RCI] + [\varepsilon_2, \varepsilon_3] \quad (1)$$

$$[\eta = RCI] = [\beta_1, \beta_2, \beta_3, \beta_4] \times \begin{bmatrix} ABS \\ AST \\ SSN \\ AC \end{bmatrix} + [\varepsilon_3] \quad (2)$$

The coefficient of *FX* (Λ_1 loading) is restricted to unity and is not estimated, which means that one standard deviation increase in *RCI* results in a single unit increase in the standard deviations of *FX* (FAO, 2016). This defines the unit of measure for Λ_2 and the variance of both *FX* and *FCS*, as represented in equation (3) and (4):

$$FCS = \Lambda_1 RCI + \varepsilon_2 \quad (3)$$

$$FX = \Lambda_2 RCI + \varepsilon_3 \quad (4)$$

RCI lacks a natural scale of unit or measurement, so, to ease the interpretation of the regressions, a 0 to 1 scale has been defined, using a min-max rescaling approach, as shown in equation (5):

$$X_{i^*} = (X - X_{min})/(X_{max} - X_{min}) \quad (5)$$

After resilience has been estimated, it is used in a **causal analysis** that aims at establishing a causal relationship between observed variables and well-being indicators (food security); shocks and coping strategies are included in the model for estimating their impact on resilience and food security indicators. The causal analysis model, represented in equation (6), contains

multiple js, or independent variables, to predict multiple Ys, or outcome variables ($Resilience, FCS, FX$), with each Y in a different formula, based on the same data. The model was applied to two subsamples according to the gender of the household head:

$$\boldsymbol{Y_{ikt} = \beta_{0kt} + \alpha_{jk} S_{ijt} + \delta_{jk} X_{ij} + \gamma_{jk} CS_{ijt} + \varepsilon_{ikt}} \quad (6)$$

For i {1, . . ., n} and k {1, . . ., m} where:

- Y_{ik} is the k-th real-valued response for the i-th observation: (k response for $Resilience, FCS, FX$);
- S_{ij} is the j-th predictor for the i-th observation for S$hock$: (the S predictor for $Weather\ Shock$);
- X_{ij} is the j-th predictor for the i-th observation for $HH\ characteristics$: (X predictor for households' characteristics $Elderly\ HHH,\ Education\ level\ HHH,\ Marital\ status\ HHH$);
- Cs_{ijt} is the j-th predictor for the i-th observation for $Coping\ strategies$: (Cs predictor for three coping strategies: Asset smoothing, Non-consumption Smoothing, and Adaptive capacity);
- ε_{ik} is a multivariate error vector.

The ***second part*** of the empirical analysis supposed a performance assessment of the key indicators[3] of the R4 initiative. We employed a reflective approach to compare results between female and male-headed households while comparing two points of the same observation of the treated group without any knowledge on the untreated group (reflexive method), as represented in equation (7):

$$\Delta Y = \frac{Y_1 - Y_0}{Y_0} \quad (7)$$

Where:

- Y_0 is the response for *Resilience* and *Food Security* indicators at t_0 (pre-intervention)
- Y_1 is the response for *Resilience* and *Food Security* indicators at t_1 (post-intervention)

[3] See information on Performance analysis' variables and indicators in Annex 2

- ΔY is the percentage of variation of the outcome variables (*R* and *FS*)

In the ***third and last part*** of the empirical analysis, we used propensity score matching to construct a control group based on a participation probability model. The probit model in equation (8) meets the underlying assumptions of conditional independence and common support and estimates the propensity score of the observations to be allocated into the treated group, where $\boldsymbol{T}$ represents the treatment or R4 participation and $\boldsymbol{X}$ the given pre-treatment characteristics that may affect the probability of the observations to be assigned into the treated group. Equation (9) represents a counterfactual situation. It compares the outcomes $\boldsymbol{Y}$ between the treated and control observations $\boldsymbol{T}$, using the propensity score to match observations with the nearest neighbour, and measuring the treatment effects:

$$p(X) = prob(T = 1|X) = E(T|X) \tag{8}$$

$$Y = \begin{cases} Y_1 \; if \; T = 1 \\ Y_0 \; if \; T = 0 \end{cases} \tag{9}$$

Subsequently, a difference-in-difference model was applied to assess the programme's effects[4] by comparing the outcomes across treatment and control units before and after the programme intervention and also implementing comparisons between female and male-headed households. Equation (10) estimates the average effects of the R4 initiative from pre- to post-treatment periods on the variation of the outcome variables $\Delta\boldsymbol{Y}$, between treated and controls $\boldsymbol{T}$, while controlling for pre-treatment characteristics $\boldsymbol{X}$, weather shocks $\boldsymbol{S}$, and coping strategies $\boldsymbol{CS}$:

$$\Delta \boldsymbol{Y_{ikt}} = \boldsymbol{\beta_{0kt}} + \boldsymbol{\alpha_{jk}} \boldsymbol{T_{ijt}} + \boldsymbol{\alpha_{jk}} \boldsymbol{S_{ijt}} + \boldsymbol{\delta_{jk}} \boldsymbol{X_{ij}} + \boldsymbol{\gamma_{jk}} \boldsymbol{CS_{ijt}} + \boldsymbol{\varepsilon_{ikt}} \tag{10}$$

Finally, we test the effects of treatment $\boldsymbol{T}$ on the households' resilience and food security indicators, considering the heads' gender. The model represented in equation (11) test the effects of treatment $\boldsymbol{T}$ on the variation of the outcome variables $\Delta\boldsymbol{Y}$. The model described in equation (12) tests the impact of treatment $\boldsymbol{T}$ on the total levels of resilience and food security

[4] See information on Impact evaluation's variables and indicators in Annex 3

indicators $\boldsymbol{Y}$. Interactions between project participation and households' heads gender were tested in both models:

$$\Delta \boldsymbol{Y_{ikt}} = \boldsymbol{\beta_{0kt}} + \boldsymbol{\alpha_{jk}} \boldsymbol{T_{ijt}} + \boldsymbol{\alpha_{jk}} \boldsymbol{FHH_{ijt}} + \boldsymbol{\alpha_{jk}} (\boldsymbol{T} \text{ X } \boldsymbol{FHH})_{ijt} + \boldsymbol{\alpha_{jk}} \boldsymbol{S_{ijt}} + \boldsymbol{\delta_{jk}} \boldsymbol{X_{ij}} + \boldsymbol{\gamma_{jk}} \boldsymbol{CS_{ijt}} + \boldsymbol{\varepsilon_{ikt}} \quad (11)$$

$$\boldsymbol{Y_{ikt}} = \boldsymbol{\beta_{0kt}} + \boldsymbol{\alpha_{jk}} \boldsymbol{T_{ijt}} + \boldsymbol{\alpha_{jk}} \boldsymbol{FHH_{ijt}} + \boldsymbol{\alpha_{jk}} (\boldsymbol{T} \text{ X } \boldsymbol{FHH})_{ijt} + \boldsymbol{\alpha_{jk}} \boldsymbol{S_{ijt}} + \boldsymbol{\delta_{jk}} \boldsymbol{X_{ij}} + \boldsymbol{\gamma_{jk}} \boldsymbol{CS_{ijt}} + \boldsymbol{\varepsilon_{ikt}} \quad (12)$$

4. RESULTS AND DISCUSSION

4.1. RIMA-II analysis

The first part of the RIMA-II model supposes estimating resilience pillars using factor analysis and principal component analysis of observable variables. Figure 2 illustrates the weights of the variables used to construct each resilience's pillar disaggregated by household head's gender.

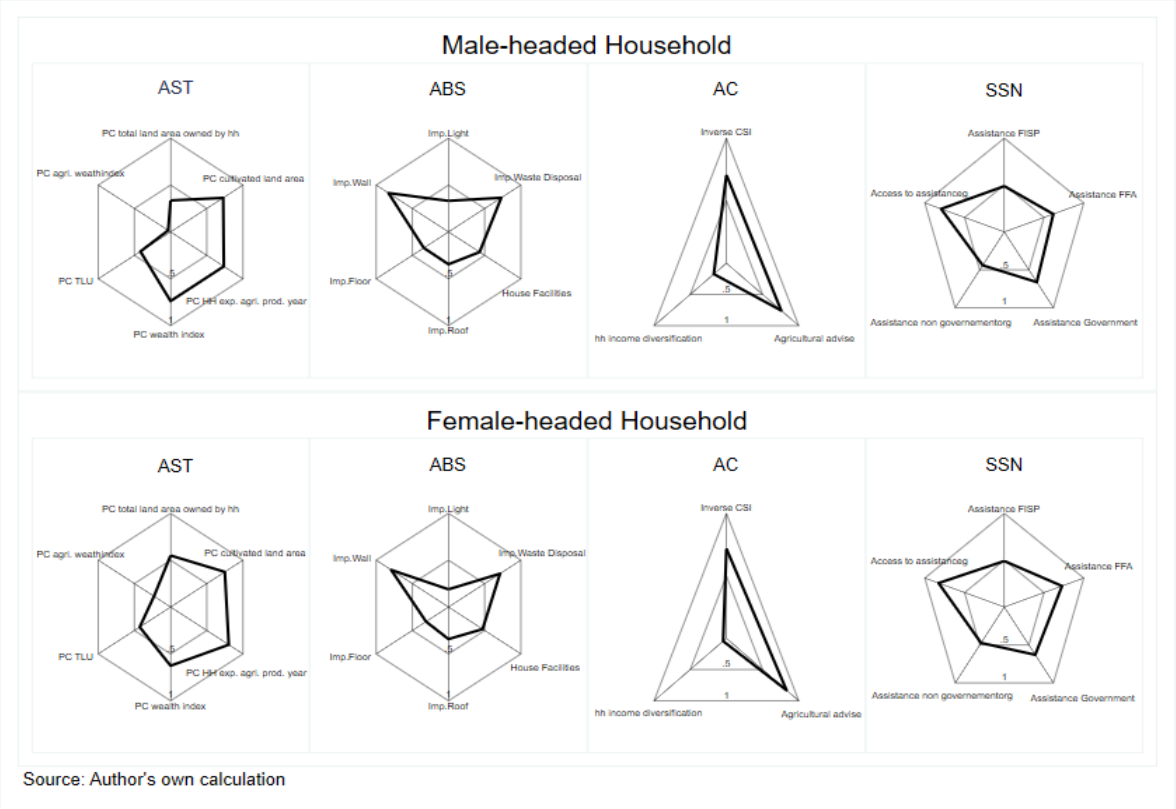

Figure 2 FHH vs MHH resilience structure by pillars disaggregation, Malawi panel dataset 2015 (pre-treatment) to 2016 (post-treatment)

The MIMIC model results, presented in Table 1 and shown in Figure 3, report the pillars weights in determining the resilience capacity index (RCI). These results indicate that although resilience and its pillars are similarly structured in FHH and MHH, there are some marked

differences in both groups, which show gender disparities or inequalities. For instance, SSN in both households' types is mainly explained by *access to assistance*; however, *government assistance* explains the FHH's resilience which suggests that government programmes focus on activities of difficult access for women.

Table 1
MIMIC model of RCI: coefficients of structural and measurement components

VARIABLES	(1) Female-headed households	(2) Male-headed households
Structural components		
Access to basic services	-0.0860	0.0115
	(0.867)	(0.817)
Assets	2.204***	2.643***
	(0.822)	(0.742)
Social safety nets	-1.682	-5.894***
	(1.036)	(1.086)
Adaptive capacity	-0.104	-0.927**
	(0.358)	(0.426)
Measurement component		
Food consumption score	1	1
	(0)	(0)
Food expenditure	468.3**	249.0***
	(182.5)	(36.93)
Goodness of fit statistics		
X^2	11.59	6.24
p value	0.0089	0.1006
RMSEA	0.158	0.059
Pr RMSEA	0.027	0.332
CFI	0.868	0.984
TLI	0.603	0.952
Observations	116	316

Note: Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
Source: Author's own calculation

At the same time, *Assistance from non-government institutions* and *Assistance in the shape of Food for Assets (FFA)* have less explanatory power in MHH than in FHH's resilience; these results suggest that FHH's SNN dependants more on international assistance than on government support. Another example is the lack of weight of *income diversification* on the FHH's AC; this suggests that female heads have less access to the labour market than male heads and that FHH are more labour insecure than MHH. Regarding AST, results show that the explanatory weights of *per capita agricultural wealth index*, *per capita expenditure in agricultural products*, *total land area owned*, and *cultivated land area* are higher in FHH than in MHH, while the AST of MHH is mainly explained by *per capita wealth index*. These result highlight that FHH's wealth is more dependent on agricultural-related activities than MHH,

and thus, FHH are more vulnerable to climate shocks.

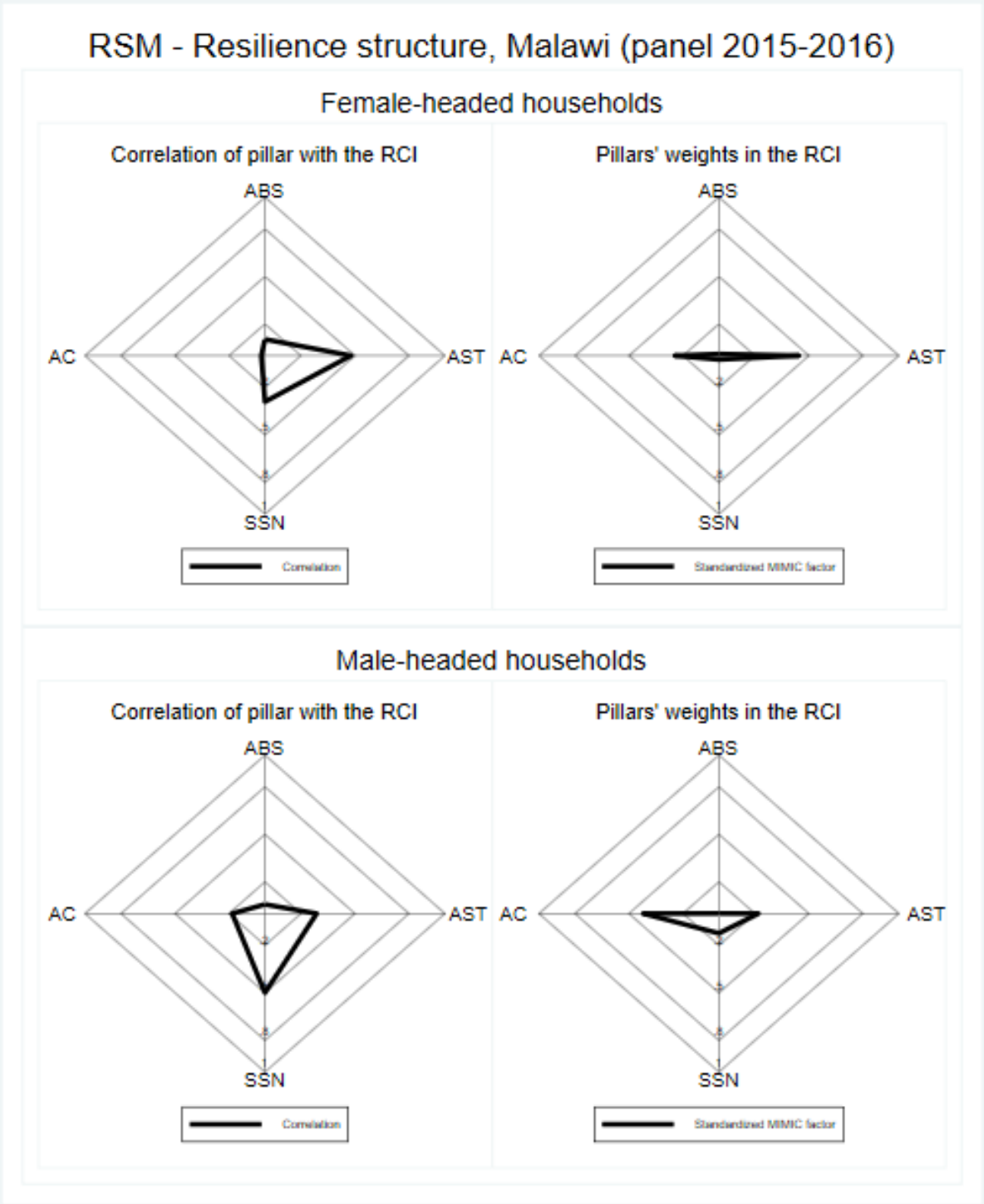

Figure 3 Pillars' correlation and significance to Resilience Capacity Index, distribution FHH vs MHH, Malawi panel data 2015 (pre-treatment) to 2016 (post-treatment)
Source: Author's own calculation

Regarding the relevance of the pillars on the households' resilience, results show a lack of AC's explanatory power and a lower relevance of SNN in FHH's resilience, while AST is the pillar that mainly explains their resilience. The results regarding AST and AC evidence the high

levels of dependency of FHH on agricultural-related activities. SSN's results suggest a lack of efficient and well-directed support tailored for FHH needs from the government and institutions.

The second part of the RIMA analysis looks at understanding the determinant of resilience. The panel data was divided into two subsamples, according to the household head gender. Subsequently, the model described in equation (6) was applied twice for every outcome variable (RCI, FX and FCS), first controlling for marital status (see Table 2) and then controlling for household head level of education (see Table 3).

Table 2
Effects of weather shocks and coping strategies on RCI and FS indicators

VARIABLES	(1) FHH-RCI	(2) FHH-FCS	(3) FHH-FX	(4) MHH-RCI	(5) MHH-FCS	(6) MHH-FX
Weather shock	-0.118***	-14.56***	-1,933***	-0.190***	-22.65***	-3,326***
	(0.0273)	(2.007)	(549.0)	(0.0145)	(1.548)	(284.6)
Adoption of coping strategies						
Adaptive capacity	-0.00223	1.593	-169.4	0.0561**	5.482**	1,014**
	(0.0362)	(2.779)	(726.3)	(0.0225)	(2.377)	(450.3)
Non-food consumption	-0.0416	-1.773	-710.4	-0.0150	-3.066*	-121.8
smoothing	(0.0276)	(2.113)	(555.0)	(0.0149)	(1.566)	(298.8)
Assets smoothing	-0.0594	-2.437	-1,345	-0.00612	-3.738	-70.27
	(0.0696)	(5.310)	(1,397)	(0.0268)	(2.825)	(535.4)
HH's characteristics						
Elderly household head	0.0555*	-3.288	1,139*	0.0422*	2.339	823.5
	(0.0322)	(2.730)	(647.1)	(0.0244)	(2.527)	(502.6)
HH's head level of education, in comparison to "attended secondary school."						
Never been to school	-0.0451	-4.309	-1,144	-0.0374	-3.096	-756.0
	(0.0537)	(4.465)	(1,078)	(0.0281)	(2.903)	(580.2)
Primary	-0.0957**	-1.429	-2,279**	-0.0178	-2.395	-274.6
	(0.0478)	(3.934)	(958.9)	(0.0185)	(1.906)	(381.2)
Constant	0.405***	41.97***	7,506***	0.324***	47.86***	5,334***
	(0.0506)	(4.104)	(1,015)	(0.0190)	(1.977)	(388.1)
Observations	116	116	116	316	316	316
Number of HH	74	74	74	174	174	174

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Source: Author's own calculation

The models presented in Table 2 and Table 3 show the effects of weather shocks and the adoption of coping strategies on the households' resilience and food security levels, considering the households' characteristics (households' heads' age, education, and marital status). The model's results on both types of households show a negative and significant relationship between weather shocks and the households' resilience and food security levels.

Regarding the households' adoption of coping strategies, results show that MHH's *Adaptive Capacity* has significant positive effects on their food security and resilience; these results were expected since adopting coping strategies supposed immediate relief and increased well-being levels. Contrary to the literature, *non-food consumption smoothing* has a significant negative impact on MHH's *food consumption score*.

Table 3
Effects of weather shocks and coping strategies on RCI and FS indicators

VARIABLES	(1) FHH-RCI	(2) FHH-FCS	(3) FHH-FX	(4) MHH-RCI	(5) MHH-FCS	(6) MHH-FX
Weather shock	-0.125***	-13.72***	-2,135***	-0.187***	-22.61***	-3,258***
	(0.0293)	(2.112)	(589.1)	(0.0145)	(1.569)	(285.7)
Adoption of coping strategies						
Adaptive capacity	0.000742	1.484	-123.9	0.0557**	5.570**	998.3**
	(0.0363)	(2.765)	(729.8)	(0.0222)	(2.377)	(444.3)
Non-food consumption smoothing	-0.0358	-1.611	-564.4	-0.0149	-3.289**	-111.1
	(0.0283)	(2.135)	(568.2)	(0.0148)	(1.573)	(295.8)
Asset smoothing	-0.0380	-1.571	-965.8	-0.00430	-3.785	-26.01
	(0.0766)	(5.660)	(1,539)	(0.0265)	(2.831)	(529.2)
HH's characteristics						
Elderly household head	0.0568*	-5.346*	1,224*	0.0312	1.229	630.9
	(0.0337)	(2.798)	(678.1)	(0.0233)	(2.454)	(477.0)
HH's marital status in comparison to "single"						
married	-0.207**	2.384	-5,037**	0.0993	5.686	1,853
	(0.101)	(8.577)	(2,022)	(0.0917)	(9.633)	(1,887)
separated	-0.206**	-2.764	-4,667**	0.0773	10.10	1,264
	(0.104)	(8.889)	(2,097)	(0.110)	(11.59)	(2,244)
divorced	-0.212**	-3.509	-4,933**	0.228**	0.0838	5,113**
	(0.0989)	(8.500)	(1,988)	(0.110)	(11.59)	(2,245)
widowed	-0.181*	-0.877	-4,364**	0.216**	13.76	4,039*
	(0.0979)	(8.420)	(1,968)	(0.103)	(10.81)	(2,106)
Constant	0.520***	40.91***	10,224***	0.204**	40.31***	3,112
	(0.0971)	(8.317)	(1,952)	(0.0922)	(9.693)	(1,897)
Observations	116	116	116	316	316	316
Number of HH	74	74	74	174	174	174

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Source: Author's own calculation

The results regarding these two coping strategies could suggest that *adaptive capacity* actives, such as harvesting immature crops or eating the seeds that were supposed to be used in the following agricultural season, had an immediate positive effect on household well-being indicators. However, the activities related to *non-food consumption smoothing*, such as relocating money destined to education and health to increase food consumption, did not allow for adequate quality and quantity levels of the households' food consumed. Contrary to what could have been expected, having an elder head in the FHH had a positive and significant

impact on their *resilience* and *food expenditure* levels. Although advanced age could be understood as a negative factor for a household's well-being, it could be advantageous for resilience. Elder female and male household heads have accumulated (ancestral) knowledge and experiences regarding previous events and historical shocks in the zone where they live, giving their households and communities (Hartog, 2014) a fundamental advantage to strategise and prevent negative impacts and overcome the effects of such shocks.

Regarding food security, results show that despite the positive and significant relation between elder FHH and food expenditure, this kind of household has lower FCS levels than non-elder FHH. From these results, we could infer that elder FHH spend a higher percentage of their income on food, prioritising quantity rather than quality. This means lower adequacy of the diversity and frequency of the households' food consumption and reveals a lack of support from the government or institutions that contribute to improving the elder FHH purchase decision-making regarding food.

Regarding education levels, results show that FHH, whose heads have attended only primary school, have lower levels of resilience and food expenditure than FHH, whose heads have attended secondary school. Regarding marital status, results show in comparison to households that have a single female head, all other types of households have a significant negative relationship with resilience and food expenditure. These results suggest that single female household heads have more freedoms (than married or widowed women, for example) to participate in resilience-building activities or allocate money to purchase food. In contrast, in male-headed households, resilience and food expenditure are positively associated with the head being divorced or widowed.

4.2. Performance analysis

The performance assessment results presented in Table 4 show that FHH and MHH have more than doubled their levels of resilience and food security from 2015 to 2016. Although the

percentages of change of the outcome variables are lower in FHH, these changes are significantly similar among the three outcome variables.

Table 4
Resilience and food security indicators

	Indicator	2015	2016	Δ	%Δ
MHH	RCI	12.92	31.66	18.73	144.9%
	FX	2064	5309	3245	157.2%
	FCS	22.74	46.03	23.30	102.5%
FHH	RCI	18.93	32.28	13.35	70.5%
	FX	3356	5610	2254	67.2%
	FCS	24.02	38.78	14.76	61.5%

Source: Author's own calculation

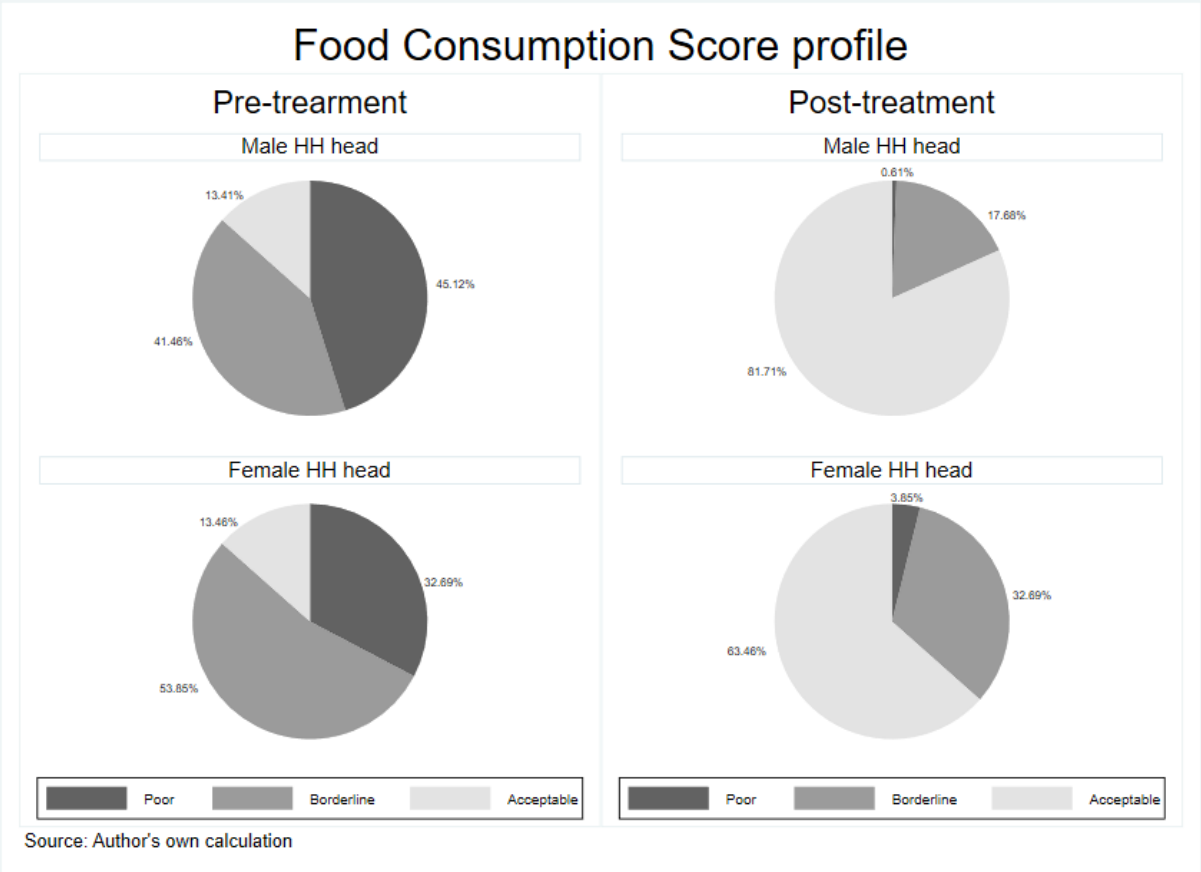

Figure 4 RCI by households' heads' gender, Malawi 2015-2016

Moreover, the results illustrated in Figure 4 show an improvement in the general levels of food consumption score and the quality and frequency of the food consumed by both types of households. FCS thresholds indicate that while most of the MHH have an acceptable food consumption after the project implementation, this percentage is lower in FHH. In comparison,

the latter type of households shows a higher rate of borderline food consumption.

Table 5
Variation of risk management indicators

	Female-headed households				Male-headed households			
Indicators	2015	2016	Δ	%Δ	2015	2016	Δ	%Δ
Households saving	29	57	28	97%	82	123	41	50%
Households accessing credits	24	34	10	42%	68	78	10	15%
Households accessing loans	0	3	3	*	21	51	30	143%
Income diversification = 0	0	2	2	*	4	4	0	0%
Income diversification = 1	9	24	15	167%	29	48	19	66%
Income diversification >1	43	38	-5	-12%	131	100	-31	-24%

Source: Author's own calculation

Table 5 provides information regarding the performance of the R4 initiative's objectives and strategies. Results show that households headed by women have benefited further from R4 participation, which is led by the higher increment of households saving and accessing credits. These results suggest that women, who are household heads, benefit more from the strategies "prudent risk-taking" and "risk reserve" than their counterparts. Results also show that some households (12% FHH and 24% MHH) had more than an income source before the project implementation, but they have only one income source after the project implementation. These results could be explained by the household engagement in the R4 project, which translates into a higher level of dedication to farming activities. In general, these results suggest that R4 allows households to build financial bases that would later allow them to access credit and improve their ability to cope with shocks.

4.3. Impact evaluation

To improve this analysis's external validity and impact evaluation purposes, we matched the *R4 and FFA survey* data with the *LSMS* dataset of the World Bank (see section 3). To do so, we applied the model represented in equation (8); the results of this model, reported in Table 6, show that the balancing property of the method is satisfied.

Table 7 shows the model's results represented in equation (10) and the robustness test that uses the direct nearest-neighbour matching method with no propensity score. Results suggest that the R4 initiative has positively impacted the beneficiaries' resilience and food security.

Table 6
Propensity score matching model

VARIABLES	Propensity Treatment WFP
Weather shocks	0.242***
	(0.0728)
Coping strategies	
Assets smoothing	-0.745***
	(0.218)
Non-food consumption smoothing	-1.428***
	(0.142)
Adaptive capacity	3.070***
	(0.192)
Households' characteristics	
Female-headed households	-0.110
	(0.150)
Elder headed households	0.0214
	(0.190)
Constant	-0.960***
	(0.121)
Observations	1,146
Standard errors in parentheses	
*** p<0.01, ** p<0.05, * p<0.1	
Notes: The region of common support is [.01204647, .9978722]	
The final number of blocks is 6	
The balancing property is satisfied	

Source: Author's own calculation

Table 7
R4 initiative ATT estimation and robustness check

VARIABLES	ATT on Δ RCI	ATT on Δ FCS	ATT on Δ FX
Nearest neighbour[1,2]	2.150***	2.178***	1.562**
	(0.195)[2]	(0.540)[2]	(0.659)[2]
Observations	1,146	1,146	1,146
n. treated	216	216	216
n. controls	513	513	513
Robustness check	SATT on Δ RCI	SATT on Δ FCS	SATT on Δ FX
Direct nearest-neighbour matching[3]	2.103***	2.143*	1.151
	(0.419)	(1.260)	(1.278)
Observations	1,146	1,146	1,146
n. matches (m)	1	1	1
*** p<0.01, ** p<0.05, * p<0.1			
Notes: [1] The numbers of treated and controls refer to actual nearest neighbour matches			
[2] Bootstrapped standard errors in parentheses			
[3] Standard errors in parentheses			

Source: Author's own calculation

Table 8 and Table 9 show the models' results of equation (11) and equation (12). Such models test the effects of the treatment on both the variation of the outcome variables and their total values, testing at the same time the interaction between participation in the R4 program and having a female household head. Results show that, although the *delta* R, FCS and FX have significant positive relationships with the participation in the R4 programme, the total resilience and food security levels are negatively related to the project participation; these results are consistent with the characteristics of the R4 participant households.

Table 8
Resilience and Food Security indicators variation, and treatment interaction with FHH

VARIABLES	(1) Δ RCI	(2) Δ FX	(3) Δ FCS
Treatment =1, yes	2.477***	2.658***	2.163***
	(0.274)	(0.969)	(0.426)
Female household head = 1, yes	0.0988	2.029	0.183*
	(0.0938)	(1.376)	(0.103)
Treatment=1# Female household head=1	-0.878**	-3.285**	-1.487**
	(0.345)	(1.585)	(0.723)
Shock			
HH suffered weather shock	0.0718	0.532	0.104
	(0.106)	(0.688)	(0.225)
Coping strategies			
Asset smoothing	0.0626	-0.301	-0.280
	(0.291)	(0.573)	(0.357)
Adaptive capacity	-0.942***	-1.369***	-1.514
	(0.276)	(0.421)	(0.951)
Non-consumption smoothing	0.0149	-2.151**	1.020
	(0.353)	(0.842)	(1.104)
HH characteristics			
Elderly household head	-0.163	0.355	-0.416*
	(0.191)	(1.138)	(0.245)
Constant	-0.0563	1.877***	-0.0802
	(0.0706)	(0.558)	(0.132)
Observations	430	430	430
R-squared	0.277	0.048	0.050

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Source: Author's own calculation

Table 9
Resilience and Food Security indicators levels and treatment interaction with FHH

VARIABLES	(1) RCI	(2) FCS	(3) FX
Treatment =1, yes	-0.0255**	-15.96***	-412.2
	(0.0123)	(1.518)	(424.0)
Female household head = 1, yes	-0.0325**	-6.657***	-238.9
	(0.0133)	(1.633)	(458.1)
Treatment=1# Female household head=1	0.0683***	4.063*	1,039
	(0.0188)	(2.315)	(644.5)
Coping strategies			
Asset smoothing	0.0227	0.976	607.8
	(0.0158)	(1.965)	(500.6)
Non-consumption smoothing	0.00576	-1.700	1,543***
	(0.00981)	(1.224)	(305.6)
Adaptive capacity	-0.0148	-0.661	-628.3*
	(0.0111)	(1.382)	(354.6)
Shock			
HH suffered weather shock	-0.115***	-14.12***	-2,094***
	(0.00865)	(1.082)	(265.3)
Constant	0.307***	57.30***	5,169***
	(0.00937)	(1.159)	(314.1)
Observations	860	860	860
Number of hh	430	430	430

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Source: Author's own calculation

On the other hand, the effects of the treatment on the FHH's *delta resilience* and *delta food*

security show a significant negative relationship (see Table 8). However, while FHH are generally negatively associated with the total levels of resilience and *food consumption score*, this relationship inverts when the FHH participates in the R4 project. These results suggest that FHH that are beneficiaries of the R4 initiative have higher levels of resilience and food security, even if the percentage of variation of the outcome variables are lower, in comparison to FHH that do not participate in the treatment.

5. CONCLUSIONS

The literature suggests that strategies to enhance resilience do not always result in improved well-being levels when referring to the linkages between resilience and food and nutrition security. The theory also acknowledges that, despite the greater levels of vulnerabilities, women have an essential role in the food security and resilience of their households and that if given the same access to resources and opportunities as men, the socioeconomic level of their households and nations could increase (Habtezion, 2017). Thus, to guarantee an efficient design and later implementation of programmes and policies, governments and institutions' initiatives to build resilience should consider all dynamics, timing, and context of the beneficiary households, especially if the household has a female head.

The analysis of this research evidences the extreme dependence of FHH on farming activities and assets. Moreover, we found evidence of gender disparities and inequalities, especially regarding AC, AST, and SSN. The performance assessment shows that among the R4 participants, the improvements of resilience and food security indicators of FHH were lower than in MHH. However, the impact assessment shows a positive and significant relationship between R4 participation and FHH compared to FHH that did not participate in the R4 project. These results suggest that despite the positive outcomes of the *R4 Rural Resilience Initiative* on the levels of resilience and food security of the total beneficiary population studied during the analysis period, the initiative's impacts are more significant in male than in female-headed

households. A possible explanation is that the R4's assistance and benefits are mainly directed to farming activities mostly carried out or controlled by men, which results in further challenges to female-headed households.

This study evidences the need to reformulate food assistance programmes, eliminate all forms of discrimination, and appropriately understand and consider the FHH's needs, role, and activities inside their communities so equal opportunities of status strengthening may be offered. We could conclude this study by stating that a stronger focus on FHH's specific needs should be done to benefit all assistance beneficiaries at the same rate from the positive impacts of the programme participation.

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APPENDIX

Annex 1 RIMA-II's variables and indexes description

	Pillar	Variable	Description
Mimic model	AC	Inverse CSI	The Coping Strategy Index "CSI" refers to households' strategies to cope with acute food shortages and deals with severity and frequency of food consumption (e.g., reduced number or portions of meals eaten per day). It is a relative measure to compare food insecurity trends over time and cross-sectional differences in food insecurity among subgroups. The CSI is inverted for the estimation of SEM.
	AC	Agricultural advice	A dummy variable is constructed based on whether the household received advice on agriculture from the extension services of the WFP
	AC	Household income diversification	Number of different sources of households' income over a maximum of 6 activities: sale of crops, the sale of animals and animal products, casual labour, self-employment, remittances, other sources
	ABS	Improved lighting	The variable is a dummy equal to one if the household uses improved lighting (for instance: electricity, electricity generator) and zero otherwise (candle, torch, a lamp with batteries) or other
	ABS	Improved waste disposal	The variable is a dummy equal to one if the household uses improved waste disposals (for instance, close pit burying or open-pit deposit) and zero otherwise (waste burning, waste throw away) or other
	ABS	Improved house roof	Dummy variable equal to one if the household's house has a safe finished roof (finished: metal; wood; calamine/ cement fibre; ceramic tiles; cement; roofing shingles) and zero if the material of the dwelling roof is natural (no roof; thatch/ palm leaf; grass; sod), rudimentary (mat; palm/bamboo; wood planks; cardboard) or other
	ABS	Improved house floor	Dummy variable equal to one if the household's house has a safe finished floor (namely finished: parquet, vinyl or asphalt strips, ceramic tiles, cement, carpet) and zero if the material of the dwelling floor is natural (earth/sand; dung) or rudimentary (wood planks; palm/bamboo) or other
	ABS	Improved house wall	Dummy variable equal to one if the households' houses have safe finished walls (finished: cement; stone; bricks)
	ABS	Household's house facilities index	Index-based out of access to Safe Water, Sanitation and Cooking Energy
	SSN	Government assistance	Dummy variable equal to one if the household receives assistance from Government, zero otherwise
	SSN	Non-government assistance	Dummy variable equal to one if the household receives assistance from NGOs, zero otherwise
	SSN	Access to assistance	Dummy variable equal to one if the household receives assistance from any kind and source, zero otherwise
	SSN	FISP	Dummy variable equal to one if the household's main source of assistance comes from Farms Inputs Subsidy Programmes "FISP", zero otherwise
	SSN	FFA	Dummy variable equal to one if the household's main source of assistance comes from Food for Asset Programmes "FFA", zero otherwise
	AST	TLU	Tropical Livestock Units standardises different types of livestock into a single unit of measurement. The conversion factor adopted is: 0.7 cattle; 0.5 donkeys; 0.2 pigs; 0.1 sheep/goats; 0.01 chickens/guinea fowls / ducks/ pigeons
	AST	Land area owned	Per capita total agricultural land area owned by a household (acre) during the agricultural periods 2014-2015 and 2015-2016
	AST	Cultivated land area owned	Per capita total land area cultivated during the agricultural periods 2014-2015 and 2015-2016
	AST	Agricultural household expenditure	Per capita monthly household expenditure on agricultural products
	AST	Per capita wealth index	Index based on the possession of non-productive assets, domestic and personal appliances such as mosquito nets, blankets, lamps, TV, radio, mattresses, and vehicles
	AST	Per capita agricultural wealth-index	Index based on the possession or not of agricultural supplies, tools, vehicles, and productive assets
	AST	Conservation agriculture	Per capita total land area cultivated under conservation agriculture during the agricultural periods 2014-2015 and 2015-2016
	Food	Food Consumption score FCS	The food consumption score captures the quantity, dietary diversity and nutrient value of the food that the household consumes. It is calculated from the types of foods and the frequency with which they are consumed over seven days
	Food	Per capita monthly food expenditure	Monetary value, expressed in Kwacha, of monthly per capita food consumption, including bought, self-produced, received for free (as gifts or part of a conditional project) and stored food.
Causal analysis	Shock	Weather shock	Weather shocks faced by the household during the last six months (drought, dry spells/erratic rainfall, too much rain, floods, soil erosion, windstorms). This variable is represented in two ways, first as a dummy variable equal to one if the households faced weather shocks, second, as a variable representing the number of weathers shocks the households experienced
	Coping strategy	Asset smoothing	Dummy variable equal to one if the household has employed coping activities of asset smoothing (e.g., selling productive assets or means of transport, selling non-productive assets, selling more non-productive animals, sell last female animals)
	Coping strategy	Non-food consumption smoothing	Dummy variable equal to one if the household has employed coping activities of non-food consumption smoothing (e.g., lower expenditure for non-food expenditure: education, health)
	Coping strategy	Adaptive capacity	Dummy variable equal to one if the household has employed activities for adaptive capacities (e.g., consumption of seeds in stock, take out children from school, send household members to beg, harvest immature crops, increased causal labour)
	Control	Household head marital status	Categorical variable equal to one if the household is single, equal to two if married, three if separated, four if divorced, and five if widowed
	Control	Household head level of education	Categorical variable equal to zero if the household head never attended school, equal to one if the household head attended only primary school, and equal to two if the household head attended secondary school
	Control	Elderly-headed household	Dummy variable equal to one if the household's head is an elder (65 years old and over), zero otherwise

Annex 2 Performance analysis' variables and index description

Indicator		Description
Well-being indicator	RCI	Resilience Capacity Index, constructed over the pillars, ABS, AST, SSN, AC
	Household income diversification	Number of different sources of households' income over a maximum of 6 activities: sale of crops, the sale of animals and animal products, casual labour, self-employment, remittances, other sources
	Food Consumption score FCS	The food consumption score captures the quantity, dietary diversity, and nutrient value of the food that the household consumes. It is calculated from the types of foods and the frequency with which they are consumed over seven days
	Per capita monthly food expenditure	Monetary value, expressed in Kwacha, of monthly per capita food consumption, including bought, self-produced, received for free (as gifts or part of a conditional project) and stored food.
Households' characteristics	Female-headed household	Dummy variable equal to one if the household's head is female, zero otherwise
	Elderly-headed household	Dummy variable equal to one if the household's head is an elder (65 years old and over), zero otherwise

Annex 3 Impact evaluation's variables and index description

Variable		Description
Treatment "WFP"		Dummy variable equal to one if the household participated in the WFP's R4 Rural Initiative
Outcome	Delta resilience	It is the percentage change in resilience between 2015 and 2016
	Delta FCS	It is the percentage change in FCS between 2015 and 2016
	Delta FX	It is the percentage change in food expenditure between 2015 and 2016
Controls	Weather shock	Number of weather shocks faced by the household during the last six months (drought, dry spells/erratic rainfall, too much rain, floods, soil erosion, windstorms)
	Coping strategy: Asset smoothing	Dummy variable equal to one if the household has employed coping activities of asset smoothing (e.g., selling productive assets or means of transport, selling non-productive assets, selling more non-productive animals, sell last female animals)
	Coping strategy: Non-food consumption smoothing	Dummy variable equal to one if the household has employed coping activities of non-food consumption smoothing (e.g., lower expenditure for non-food expenditure: education, health)
	Coping strategy: Adaptive capacity	Dummy variable equal to one if the household has employed activities for adaptive capacities (e.g., consumption of seeds in stock, take out children from school, send household members to beg, harvest immature crops, increased causal labour)
	Female-headed household	Dummy variable equal to one if the household's head is female, zero otherwise
	Elderly-headed household	Dummy variable equal to one if the household's head is an elder (65 years old and over), zero otherwise