Building Resilience through Integrated Assistance: Evidence from the Democratic Republic of the Congo.

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Abstract

Despite growing investment in resilience-building programs in conflict zones, limited empirical evidence exists on the effectiveness of integrated interventions in such contexts. This study examines the impact of a comprehensive resilience-building program in North Kivu, Democratic Republic of the Congo (2017-2019), focusing on community infrastructure, farmer associations, and land access. Using propensity score matching and difference-in-differences analysis of primary panel data from 1,643 households, our research reveals that integrated interventions significantly improved households' resilience capacity, primarily through enhanced market access and strengthened collective marketing systems. The program yielded a statistically significant positive impact on beneficiaries' access to land and participation in community associations, though impacts on agricultural production and food security were limited. These findings highlight the importance of context-specific, multifaceted approaches in enhancing resilience in areas facing protracted crises, particularly emphasizing market access and social cohesion. Our results provide valuable empirical evidence for policymakers and development practitioners, suggesting that resilience-building in conflict zones requires sustained, locally-adapted interventions that prioritize market linkages and community networks alongside traditional agricultural support.

Keywords: resilience; food security; impact evaluation; North Kivu; shock; conflict, community
JEL Classification Codes: C01; C23; D04.

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1 Context

The concept of resilience is gathering momentum in fostering the agenda of international agencies. This is evidenced by large-scale resilience-oriented food-security initiatives led by major donors, including the United States Agency for International Development (USAID), the United Kingdom's Foreign, Commonwealth & Development Office (FCDO), and the European Union (EU) (Constas 2023). Constantly swinging between humanitarian and development domains, resilience gained sensible space in the agenda and portfolio of every development agency and donors. The World Bank invests about 6 billion dollars in urban development and resilience projects every year (GFDRR, 2022). FAO dedicated almost 1.5 billion to Better Life in its 2022-23 Strategic Framework. Hallegatte *et al*. (2019) argue that investing in more resilient infrastructure in low- and middle-income countries would create $4.2 trillion savings.

The popularity of resilience programs is also due to the perceived correlation between building resilience in crisis-prone countries and achieving the Sustainable Development Goals (SDGs). Resilience can be understood as the ability of systems, communities, households, and individuals to prepare for, respond to, and recover from shocks and stresses in a manner that does not compromise long-term development. Addressing and improving resilience is crucial for advancing the SDGs, particularly in countries that face chronic stresses or acute shocks. Crisis-prone regions face setbacks in development gains due to repeated shocks, making it harder for these populations to lift themselves out of poverty (SDG 1). Investments in resilience can help protect achieved gains and provide safety nets (Hallegatte *et al*., 2017). Agricultural resilience ensures food security (SDG 2) in the face of adverse weather events, pests, or economic crises. Ensuring that farming systems can bounce back from shocks is crucial for sustained food availability. A resilient health system can maintain functionality and services when faced with shocks, directly contributing to health and well-being (SDG 3) (Kruk *et al*., 2015). Building resilience is intrinsically linked to preparing for and mitigating the effects of climate change. As crisis-prone countries are often the most vulnerable to climate impacts, resilience-building directly contributes to the SDG 13.

The design and implementation of resilience programs often suffer from a lack of evidence-based insights. This affects the efficacy, relevance, and impact of such programs, especially in regions most prone to food insecurities. A significant amount of research on food security comes from specific regional case studies. While these studies offer valuable insights, their results might not be generalizable across different socio-economic, cultural, and ecological contexts (Barret, 2010). Many studies focus on post-crisis immediate relief, but fall short in offering insights into long-term resilience-building strategies that prevent or mitigate the impacts of future food crises (Maxwell *et al*., 2014). The absence of robust, comprehensive, and generalizable evidence to guide the design of food resilience programs poses significant challenges. It underscores the need for interdisciplinary, long-term, and context-specific research to ensure that interventions are not just well-intentioned but also effective and impactful.

In this paper, we use data collected before and after the implementation of an integrated assistance project in the North Kivu region, implemented by FAO (Food and Agriculture Organisation), WFP (World Food Program), and IFAD (International Fund for Agricultural Development). The program intended to increase households' food security and resilience, with a special focus on women and children, by targeting three primary outcomes: i) increased availability and equitable

access to nutritious, diversified, and stable food supply; ii) Improving sustainable gender-sensitive governance of collective productive resources; and (iii) Improvement of essential nutritional, dietetic and family practices[1]. The objectives of the intervention directly addressed various Sustainable Development Goals of the United Nations (SDG).

The contribution of this paper to the literature is therefore in a) providing evidence of an integrated resilience intervention in humanitarian context; b) in conflict prone context such as the Democratic Republic of the Congo, and c) making use of a unique panel data that captures changes over time. Overall, the paper provides a comprehensive understanding of "resilience" within the context of crisis-prone areas, setting the stage for how resilience can be measured, fostered, and sustained. Moreover, by identifying areas and people that are particularly vulnerable to crises – whether due to natural disasters, conflict, economic volatility, or other factors – the paper can help refine interventions targeting. A paper on "building resilience in crisis-prone areas" could belong to multiple strands of literature due to the interdisciplinary nature of resilience, especially when it comes to crisis management. However, in the context of our study, the paper aligns with humanitarian and emergency response, socio-ecological systems and, conflict and peace studies literature.

Food insecurity in the Democratic Republic of the Congo has been a persistent problem for decades. The country has experienced conflicts, political instability, and economic crises, which have contributed to high levels of poverty, malnutrition, and hunger. According to the latest data from the Food and Agriculture Organization (FAO, 2022), around 21.8 million people in the Democratic Republic of the Congo are experiencing food insecurity, with 5.2 million of them in a state of severe food insecurity. This represents around one-fifth of the population and is one of the highest levels of food insecurity in the world.

Conflict and displacement have been major drivers of food insecurity in the Democratic Republic of the Congo (Mercy Corps, 2021; ReliefWeb, 2022). Armed groups have been fighting for control over natural resources and territories, leading to displacement, destruction of infrastructure, and disruption of agriculture and trade. A recent study by the World Food Programme (WFP 2021) found that areas affected by conflict have higher levels of food insecurity than areas that are relatively stable.

In addition to conflict, other factors contributing to food insecurity in the Democratic Republic of the Congo include low agricultural productivity, limited access to markets, weak governance, and inadequate social protection (World Bank, 2019). Climate change is also affecting food security in the Democratic Republic of the Congo, with increasing frequency and intensity of droughts, floods, and other extreme weather events.

Several interventions have been implemented to address food insecurity, including emergency food assistance, agricultural support, and social protection programs (Musumari *et al*., 2014). However, these interventions face numerous challenges, such as inadequate funding, logistical difficulties, and insecurity. According to the WFP report (WFP, 2022), the Democratic Republic of the Congo is one of the largest hunger crises in the world. Indeed, hunger and conflict fuel one

[1] including the detection and treatment of moderate acute malnutrition

another, with armed conflict and widespread displacement prevailing for the past 25 years and multiple other crises compounding the Democratic Republic of the Congo's humanitarian challenges. For that reason, the east of the Democratic Republic of Congo has remained volatile for the last 20 years. As a result, populations in eastern Democratic Republic of the Congo have been living with conflict and displacement for much of the past two-and-a-half decades. The conflict often takes the form of fragmented armed groups preying on civilians and preventing them from accessing their fields. North Kivu, South Kivu, and Ituri are the provinces where conflicts and unrest have been the most protracted.

Given its moderate climate and frequent precipitation, agroecological conditions in this region are favourable to various forms of agriculture, including livestock and horticulture (Marivoet *et al.*, 2020). However, large shares of the population suffer from various forms of malnutrition; more than 40% of children under the age of five years are stunted and have anaemia. Figure A1 (in the annex) illustrates the agricultural paradox faced by most of the 33 territories in Eastern Democratic Republic of the Congo; except in the region's major cities where potential agricultural production mostly falls below 2,500 kilocalories per day, all areas in Greater Kivu (North and South Kivu) and Tanganyika can easily produce the required amounts of food. However, stunting rates of children below the age of five years are alarmingly high throughout the region; especially in various territories in Nord-Kivu where they exceed 55%. The paradox between existing agricultural potential and prevailing food insecurity may be in most part due to recurring conflicts in the region.

The region is also known for its abundant mineral resources such as gold, diamonds, and coltan with the potential to serve as a catalyst for economic development but instead has been used to fuel the conflict by financing a myriad of armed groups, hence further exacerbating food insecurity. It is critical to understand how conflict could affect some of the determinants of food security and hence, impact the speed and sustainability of recovery and resilience. Often, the impact of conflict on food security will depend on the magnitude of damage to physical, human, financial, social, and political capital, all of which affect the households' access to resources (including food) needed to ensure resilience. Furthermore, since conflict affects in a disproportionate manner particular household members (e.g. women and children) or groups (e.g. the poor, those from a particular ethnic group, displaced people), to achieve increased resilience to future conflicts, it is important to identify the most in need for social protection programs and understand the social transformation generated by past conflict events.

Often overlooked, the ability of local communities to cope with the consequences of conflict on food security depends on the level of social capital but also on how much this social capital has been altered by the conflict (possibly through the social transformation mentioned above). The question becomes even more complex when considering how change in social capital influences the community resilience capacity to future conflicts. On the one hand, conflict experiences may indeed increase the willingness of people to cooperate with each other, but, on the other hand, violent acts have the potential to significantly disrupt existing social networks. Therefore, particular attention should be given to the reintegration of refugees or internally displaced people and the opportunities or threats their return or permanent displacement may represent for the ability of communities to contribute to the provision of key public goods.

Finally, in the context of North Kivu, the management of natural resources is likely to be an important determinant of both food security and resilience building. For example, the security of land tenure and the production of particular crops need to be further investigated to assess how agricultural development could provide a promising alternative to more conflict-fuelling mining activities.

According to the latest Integrated Food Security Phase Classification (IPC, 2023) analysis, the eastern region is experiencing high levels of food insecurity. Specifically, the following IPC phases were identified:

- Phase 1: Minimal: This phase is observed in parts of North Kivu and South Kivu, where there are no significant food security concerns.
- Phase 2: Stressed: This phase is observed in the majority of North Kivu and South Kivu, as well as in parts of Ituri and Tanganyika. In this phase, households are facing reduced food access and/or consumption, with moderate to high acute malnutrition among children.
- Phase 3: Crisis: This phase is observed in some areas of Ituri, North Kivu, and Tanganyika. In this phase, households are experiencing high levels of acute food insecurity, with severe acute malnutrition among children.
- Phase 4: Emergency: This phase is observed in some areas of Ituri, North Kivu, and Tanganyika. In this phase, households are facing extreme food gaps, with very high acute malnutrition and excess mortality.

Overall, the IPC analysis suggests that food insecurity in the eastern Democratic Republic of the Congo is a serious concern, with many households facing high levels of acute malnutrition and limited access to food. The ongoing conflict and displacement, combined with economic challenges and climate change, are major drivers of food insecurity in the region. Addressing these underlying factors is critical to improving food security and reducing the risk of further crises.

The remainder of this study is organised as follows. Section 2 puts integrated assistance in context. Section 3 describes the data used in this study. Section 4 presents the methodology. Section 5 reports the estimated results. Section 6 dwells on discussion of the findings. Section 7 concludes.

2 Integrated assistance in crisis context

Rural households, and particularly poor and ultra-poor, have low access to adequate sanitation, health services, education, information, social protection, and public infrastructure. They typically earn money from small-scale farming or casual labour, while both financial and human capital constraints keep them from investing in and expanding into more lucrative activities (Chowdhury et al. 2017). This is particularly true for the most vulnerable population groups, such as female headed households, elders, and orphans. For instance, a combination of increased care responsibilities and economic crisis may reduce female participation in the labour force.

With these considerations in mind, projects and programs that aim to simultaneously alleviate different constraints have been developed and implemented. Integrated assistance programs are intended to address multiple needs. They often include provision of seeds and training; provision of transfers and training; a significant transfer of food and productive assets, followed by training, productive asset transfer, and ongoing support. There is evidence on the effectiveness of those programs; especially, in countries such as Bangladesh, Ethiopia, Ghana, India, Honduras, Pakistan,

and Peru. However, these countries, while facing multiple threats to food security, are all mostly stable (Brune *et al*., 2022; Banerjee *et al*., 2015).

There are also studies focusing on unstable areas such as Yemen (Brune *et al*. 2022); Kenya (Suri *et al*., 2021; MacPherson and Sterck, 2021); or Turkey (Özler *et al*., 2021). However, little is known on the effect of integrated assistance on resilience in protracted crisis countries (with few exceptions, such as Malik *et al*. 2020 in Somalia; d'Errico *et al.* 2021 in South Sudan). Understanding what works well and what does not in those contexts is key to designing adequate policy interventions. Additionally, and given the nature of resilience, this gap has important consequences for both Humanitarian and Development interventions.

The impact evaluation of a multi-faceted program in a fluid and conflict prone contest is limited by many factors. Treated population might become even more vulnerable (Brune *et al.* 2022). If, for instance, the program promoted market-oriented enterprises, and markets failed because of the conflict; participants might have invested in business destroyed or threatened by the shocks; fidelity to the program or the actual implementation may fail for security constraints (see Murphy *et al.* 2015).

There are also data collection issues, because of insecurity, program rigorous implementation and termination, and recurrent violence events. This is particularly true for North Kivu, in the Democratic Republic of the Congo (Muyingi, 2013). As a result, there are extremely limited examples of impact evaluation from the Democratic Republic of the Congo. In 2015 Aker compared cash and voucher transfers in the context of humanitarian intervention in the Democratic Republic of the Congo. Humphreys *et al*. (2019) investigated the partial failure to export democratic practices to local communities. In particular, they found out that short run exposure to those practices does not lead to subsequent adoption.

van der Windt et al. (2019) examined the gender quotas in development programming in Congo. They attributed the failure of the attempts to the lack of engagement generated and to the short time horizon of the intervention. Ainembabzi *et al.* (2017) examined whether the membership in farmer groups is correlated with the adoption lag of agricultural technologies and farm performance in Burundi, Democratic Republic of the Congo, and Rwanda. They discovered that the longer the duration of membership in farmer groups, the shorter the adoption lag and much more so if combined with extension service delivery. Doocy *et al.* (2017) assesses the impact on farmer field schools on food security and nutrition outcomes in the Eastern Democratic Republic of the Congo. The lack of sustainable effects on children's nutrition is attributed to the complex relationship between agriculture, food security, and nutrition and the difficulties of achieving sustained changes in health status in low-resource settings.

Extremely limited examples exist of impact evaluation of integrated assistance on women and children. For example, access to credit provides women with the opportunity to invest in income-generating assets and activities, and thus, has the potential to increase earnings (Hillesland *et al.* 2021). Moreover, greater earnings also grant more empowerment and, consequently, a larger role in the decision making for women. Collectively, being part of self-helps groups can build trust and confidence. However, mixed findings are reported when looking at the effect of microcredit on women's empowerment (Hillesland *et al.,* 2021). Krenz *et al*. (2014), otherwise, suggest that a

microfinance "plus" programme may be more effective at empowering women instead of a programme that offers microfinance only.

Analysing the experiences of Afghanistan, Somalia, and Yemen in building resilience in the face of conflict, natural disasters, and other shocks, Khimi *et al.* (2020) identify common challenges and opportunities for building resilience in fragile states, including the need for better governance, community participation, and capacity-building. Hegre *et al.* (2019) provide a comprehensive review of the literature on building peace in war-prone countries, with a focus on the role of local actors and institutions in promoting resilience and reducing conflict. The findings suggest that building peace requires a bottom-up approach that engages with local communities and supports their capacity to manage conflict and build resilience. Using a comparative analysis of different approaches to building resilience in conflict-affected countries, drawing on case studies from Africa, Asia, and Latin America, Garcia (2019), highlight key challenges and opportunities for building resilience, including the need for inclusive governance, community participation, and innovative financing mechanisms.

3 Data

The panel data used in this paper comes from a combination of program baseline and follow-up datasets. A stratified sampling approach was adopted, where each stratum represented a health zone proportionally to the population. The final sample was increased by 20 percent to anticipate the attrition rate due to the hardship and conflict context of the intervention areas and the repetitive movement of the population.

Table 1: Sampling

	Beneficiaries	**Non beneficiaries**	**Additional areas**
Baseline	380	534	793
Follow up	359	483	801

Source: Authors' elaboration.

Baseline data were collected between July and August 2017 in the health zones of Bambo, Binza, Birambizo, Kibirizi, Rutshuru, and Rwanguba in Rutshuru territory and in Kirotshe, Masisi and Mweso health zones in Masisi territory. Stratified population-proportional sampling was adopted to ensure the representativeness of the sample in each health zone. The questionnaire was administered to 1,707 households. Households are randomly selected using the Expanded program on immunisation as reference. Households in Rutshuru and Rwanguba health zones are the beneficiary group, while households in the three Masisi territory health zones are the control group.

The follow-up survey was carried out in 2019 over the same period July-August as the baseline survey to avoid seasonality bias in the measurement of indicators. Data are collected from 1,643 households including 933 households found (56.8%), 206 new households (12.5%) and 504 households replaced (30.7%). The high attrition rate (43.2%) is due to conflict and prevalence of acts of violence (kidnapping) that have forced households to move to other territories or to join refugee camps in neighbouring countries, particularly Uganda. The replacement of households was based on the principle that the head of the replacement household must have the same main activity as the replaced household. Details of the distribution of observations collected are reported in Table 2.

Table 2: Sample sizes of households of baseline and mid-term surveys

Households	Baseline	Midterm	Tracked	Replace	Tracked (%)	Attrition (%)	Attrition effective
Beneficiaries	380	359	238	120	62.63	37.37	17.37
NB Masisi	534	483	272	187	50.94	49.06	29.06
4 NB Rutshuru	793	801	423	197	53.34	46.66	26.66
NB & 4NB	1327	1284	695	384	52.37	47.63	27.63
Total	**1707**	**1643**	**933**	**504**	**54.66**	**45.34**	**25.34**

Note Non-beneficiaries (NB), non-beneficiaries in Masisi, and non-beneficiaries in Rutshuru (NB & 4NB).
Source: Authors' elaboration.

The Resilience Capacity Index (RCI), the food consumption score, the food diversity score, the wealth index, the agricultural wealth index, access to land, participation in the community association, access to training serve as outcome variables. We chose these variables as they reflect the theory of change and logical framework adopted by the integrated assistance strategy (see description of key variables in Table A1).

4 Methodology

4.1 Analytical framework

A theoretical framework for resilience analysis in the presence of shocks provides a structured approach to understanding how different factors can influence a system's ability to recover from shocks and maintain its functionality. One such framework is the Panarchy model (Gunderson and Holling, 2002), which describes the interactions between different levels of a system, including individuals, communities, ecosystems, and larger social and economic systems. The model suggests that a resilient system has the capacity to adapt to changes and maintain its structure and function over time, even in the face of disturbances or shocks.

Moreover, the Adaptive Cycle model (Allison and Hobbs, 2004; Pelling and Manuel-Navarrete, 2011; Walker *et al.*, 2004), which describes the stages of growth, consolidation, crisis, and reorganisation that a system may go through over time. The model emphasises the importance of learning and adaptation during times of crisis, as well as the need to balance exploitation and conservation of resources to maintain long-term resilience.

Other frameworks that can be used for resilience analysis include the Social-Ecological Systems (SES) framework, which emphasises the importance of understanding the interactions between social and ecological systems; and the Resilience Assessment Workbook (RAW), which provides a structured approach to assessing the resilience of a system based on its capacity to absorb, adapt, and transform in response to shocks (Adger, 2000; Berkes *et al*., 2003).

In this paper, we use a theoretical framework that accounts for the presence of shocks while considering the complex interactions between different factors, including social, economic, and ecological systems, as well as the different stages of the adaptive cycle. It provides a more comprehensive understanding of a system's resilience and help identify strategies to strengthen its capacity to recover from shocks and maintain its functionality over time.

4.2 Resilience and Food Security Indicators

Resilience is not new in the literature and is often adopted to design interventions on humanitarian and development nexus. This paper makes use of the FAO Resilience Index Measurement and

Analysis (RIMA) methodology (FAO, 2016). This approach has been widely adopted to measure the impact of social protection (d'Errico *et al.,* 2020), assistance (d'Errico *et al.,* 2021a), conflicts (Brück *et al.,* 2019; von Uexkull *et al.,* 2020), climatic shocks (d'Errico *et al.,* 2019), and many agricultural interventions. There is quite limited literature on estimating the impact of integrated assistance on resilience. d'Errico *et al. (*2020) measure the impact of social protection interventions in Lesotho, showing that cash transfers increased resilience by providing larger access to food and greater financial support. Malik *et al.* (2020) showed the effect of a joint resilience strategy in Somalia that led to an increase of diversification of income sources and greater access to training and basic services. d'Errico et al. (2021a) measured the effect of integrated assistance in South Sudan, showing the difficulties in reaching out the right target of beneficiaries, due to elite power and other social inclusion limits. d'Errico *et al.* (2021b) look at the effects of conflict on resilience, showing that in Gaza Strip the exogenous support provided by international assistance and remittances was effectively smoothing the negative consequences of the conflict. Lain and Bishop (2018) showed that an integrated assistance package increased resilience of Arid and Semi-Arid zones in Kenya, through Community-Managed Disaster Risk Reduction (CMDRR) and integration of community-level plans and committees into the work of the county government. Consistently, Fuller and Lain (2018) showed positive effects of a similar intervention in Zambia. Quattrochi et al. (2020) showed that the provision of Essential Household Items via vouchers and fairs causes substantial improvement in adults' mental health and moderate improvement in resilience and social cohesion.

RIMA is specified using a Multiple Indicator Multiple Causes (MIMIC) model. In this specification, the determinant part is made of the four pillars of resilience (Asset – AST; Adaptive Capacity – AC; Social Safety Nets – SSN; Access to Basic Services – ABS). The outcome part is represented by the achievement of the resilience capacity, i.e., food security.

As food security indicators, Food Consumption Score (FCS) (Wiesmann *et al.,* 2009) and Household Dietary Diversity Score (HDDS) (Swindale and Bilinsky, 2006; Kennedy *et al.,* 2011) were adopted. The FCS is a food security indicator based on the frequency, diversity, and significant nutritional value of the food groups consumed by the household during the seven days preceding the interviews. The HDDS is an indicator of access to food. An increase in the average number of different food groups consumed is associated with improved household food access.
The Resilience Capacity Index (RCI) is specified against this set of equations:

$$[\ Dietary\ Diversity\ FCS\ ] = [\Lambda_2, \Lambda_3] \times [RCI] + [\varepsilon_2, \varepsilon_3] \quad (1)$$

$$[RCI] = [\beta_1, \beta_2, \beta_3, \beta_4] \times [ABS\ AST\ SSN\ AC\ ] + [\varepsilon_1] \quad (2)$$

Where the Food Security indicators are specified in (1) against the RCI (plus error terms); and the RCI is identified as the result of the combination of the four pillars (plus error term).

In table A2 in the annex, we report the descriptive statistics for variables involved in the estimation of the resilience capacity index. We also present both the matched and unmatched statistics.

Given that this paper aims at measuring the effect of the intervention on resilience, the RCI is calculated twice, at *time 0* and at *time 1*. The estimation is done separately; the two distributions are then used in the impact evaluation equation mentioned below.

4.3 Main specification

Considering the nature of the data used, a rotating panel (2017, 2019), and the limitations of the data (non-randomized assignment of treatment), we opted for the quasi-experimental methods: matching method (propensity score matching – PSM) and double-difference method (DID).

The advantage of these two combined approaches is the correction of the selection bias on observables (PSM) and on time-invariant unobservable characteristics (DID) (Hechman *et al*., 1997; Smith and Todd, 2005; Binci *et al*., 2018). The PSM matches beneficiaries and non-beneficiaries' probability of taking part in the program according to their observable characteristics (Hechman *et al.*, 1997; Smith and Todd, 2005; Caliendo and Kopeinig, 2008; Binci *et al.*, 2018). The propensity score matching considers the conditional independence assumption (CIA), i.e., that given a set of observable covariates not affected by treatment, potential outcomes are independent of treatment assignment.

Two algorithms were used to estimate the propensity score matching, the Nearest Neighbour (5-NN) and the Kernel matching approaches[2]. The set of variables used in the matching do not include any of those used in the estimation of the resilience capacity index. In particular, gender of household head, membership to local association, and occurrence of shocks have been employed. Different specifications of the Propensity scores are reported in Annex Figure A3. To assess the matching quality, Rosenbaum, and Rubin's (1985) methodology was applied.The DID differentiates the imbalances between beneficiaries and non- beneficiaries on two waves of data to isolate the attributable impact. The following formula gives the double-difference estimator:

$$DD = \left[\left(E[Y_{i1}^{T}|T_i = 1] - E[Y_{i0}^{T}|T_i = 1]\right) - \left(E\left[Y_{i1}^{C}|T_i = 0\right] - E\left[Y_{i0}^{C}|T_i = 0\right]\right)\right] \quad (3)$$

where $E[Y_{i1}^{T}|T_i = 1]$ et $E[Y_{i0}^{T}|T_i = 1]$ are respectively the average values expected at times 1 (mid-term) and 0 (baseline study) of the group of beneficiary households, and $E\left[Y_{i1}^{C}|T_i = 0\right]$ and $E\left[Y_{i0}^{C}|T_i = 0\right]$ the expected average values of non-beneficiary households at times 1 and 0, respectively. The DID controls for observed and unobserved time-invariant heterogeneity. Drawing on most of the empirical applications of the DID evaluation method, we adopt the linear regression model to estimate the change induced by the program in the outcome and impact indicators.

$$Y_{it} = \alpha_0 + \alpha_1 T_i + \alpha_2 time_t + \delta T_i * time_t + \beta X_{it} + \varepsilon_{it} \quad (4)$$

We use household characteristics and household shocks as control variables in the estimation of equation (4). Where Y_{it} is the variable of interest on which the impact of the intervention is measured (resilience capacity index); T_i is the variable participation in the program which takes

[2] Nearest Neighbour is the most straightforward matching estimator (Caliendo and Kopeinig, 2008); while Kernel matching (KM) is a non-parametric matching estimator that uses weighted averages of all households in the control group to construct the counterfactual outcome providing the lower variance, achieved by using more information.

the value 1 if household *i* is a beneficiary of the program and 0 otherwise; Y_{it} is a binary variable which takes the value 0 if the household is in baseline survey (t = 2017) and 1 in the mid-term study (t = 2019); X_{it}, the vector of control variables; and ε_{it} the error term with mean 0 and constant variance. The coefficient δ of the interaction variable between the treatment or program participation (T) and time (time) variables is the difference in differences estimator (DID) and represents the average effect of the intervention on the variable of interest.

4.4 Robustness checks

The inverse probability weighting method is used to correct attrition bias on the impact of interventions (Fitzgerald *et al.,* 1998; Baulch and Quisumbing, 2011). The approach first tests whether attrition is random or not through the Wald statistical test. Afterward, we test the random attrition hypothesis using the BGLW test (Becketti, Gould, Lillard, and Welch, 1988). The test results indicate that attrition is not random for all the outcome indicators, including resilience capacity index, household dietary diversification score, and food consumption score. Therefore, inverse probability weights are estimated to correct the attrition bias (Fitzgerald *et al.,* 1998; Baulch and Quisumbing, 2011).

To assess the robustness of our results and to control for unobserved time variation heterogeneity, we adopt a placebo test as in Gertler et al. (2016) and Del Prete *et al.* (2019). The testing process consists of randomly assigning the program participation status to a subgroup of households in the comparison group and estimating through the PSM-DID model by comparing the fictitious group of beneficiaries to the rest of the comparison group. This simulation was repeated 5,000 times for three leading indicators: the resilience capacity index, the food consumption score, and the dietary diversity score[3]. All the distributions indicate that the unobserved heterogeneity features do not affect the effectiveness of the intervention on outcome indicators[4]. Consequently, we concluded that there was no bias in the estimation of the program effects.

To further assess the robustness of our results, we run the same DID specification presented in the previous section, against another set of Ys: the two food security indicators, and the entire array of variables that compose the Resilience capacity index. We do so, to investigate the effect of the intervention on individual variables, and, therefore, disentangling the transmission channels induced by increase in resilience.

5 Results

Results of the changes over time of the resilience capacity index and its pillars and components are shown in Table A3. Resilience has largely increased, especially for the beneficiaries. Significant increases in resilience pillars are reported for social safety nets, adaptive capacity, and access to basic services, while assets record a minor increase only. We also notice a substantial increase in the production of legumes and food security.

[3] If the distribution of the estimated average effects for each variable of interest is centred on 0, indicating that the fictitious treatment group does not affect the results, then the analysis is not affected by the unobserved heterogeneity.
[4] Distributions are centred at 0 for each comparison group and each outcome indicator.

Table 3: The average effect of the intervention (propensity score matching and difference – in difference with inverse probability weights)

Outcome	Model 1		Model 2		Model 3		Model 4	
	Impact	SE	Impact	SE	Impact	SE	Impact	SE.
Resilience capacity index	4.560***	1.170	3.396**	1.391	4.098**	1.723	3.246**	1.517
Food consumption score	1.885*	1.068	1.252	1.255	1.544	1.533	1.313	1.364
Dietary diversification score	0.143	0.109	0.087	0.130	0.156	0.158	0.068	0.141
Access to basic service (ABS)	4.659***	1.265	2.999*	1.61	3.520*	1.802	2.903	1.773
Assets (AST)	-0.925	0.968	-2.015*	1.187	-2.428*	1.458	-1.904	1.273
Social safety nets (SSN)	0.203	0.836	0.096	1.023	-0.783	1.223	0.306	1.126
Adaptive capacity (AC)	0.443	1.138	-0.587	1.391	-1.381	1.499	-0.41	1.554
Distance to market, inverse	0.020*	0.012	0.030**	0.014	0.031**	0.015	0.027*	0.015
Livestock (TLU (Tropical Livestock Unit))	0.001	0.015	-0.011	0.02	0.007	0.022	-0.019	0.021
Wealth index	0.032***	0.012	0.001	0.015	-0.006	0.017	0.002	0.016
Agricultural wealth index	-0.031***	0.010	-0.031***	0.011	-0.032**	0.014	-0.028**	0.011
Land (hectare)	0.996*	0.536	1.795**	0.862	1.443*	0.863	1.919**	0.904
Association	0.066*	0.035	0.109**	0.045	0.033	0.053	0.143***	0.049
Access to credit	0.015	0.034	0.049	0.041	0.044	0.047	0.047	0.045
Income diversification index (#)	-0.086	0.086	0.003	0.106	-0.083	0.119	0.035	0.116
Crops diversification index (#)	0.071	0.097	0.085	0.111	-0.021	0.129	0.133	0.120
Training on agricultural techniques	0.048*	0.025	0.099***	0.032	0.05	0.038	0.120***	0.033
Cereal's production (kg)	-7.186	10.951	2.684	12.254	-3.153	11.505	3.451	13.514
Legume's production (kg)	-7.683	8.967	7.107	11.809	-23.846**	10.902	20.731	13.67
Tuber's production (kg)	-21.274**	9.142	-17.979*	10.779	-39.770***	13.858	-8.847	11.427
Coping strategy index, inverse	-0.004	0.003	-0.005	0.003	-0.008*	0.005	-0.004	0.003
Number of households	3350		2627		1423		1820	
Control variables	Sex of household head, household size, and shocks							

Note: *** P<0.01; ** P<0.05; * P<0.1.
Source: Authors' own elaboration

Table 3 reports estimation results. Model 1 shows the results of the naïve estimation considering replaced households. Models 2, 3, and 4 present the results of PSM-DID estimation combined with inverse probability weights with respectively non-beneficiaries' households from Masisi and Rutshuru territories, non-beneficiaries' households from Masisi territory, and non-beneficiaries' households from Rutshuru territory.

The results in Table 3 show a positive and statistically significant impact of the program on the resilience capacity index of beneficiaries. The program improved the capacity of beneficiary households to cope with shocks and stressors. Results indicate that the program's positive impact on household resilience capacity is induced by a significant improvement in households' access to essential services (ABS). Indeed, one of the goals of the program was to promote market access for smallholder farmers. The rehabilitation and construction of community warehouses; and the training and support of farmers' organisations in the collective marketing of their agricultural products have certainly eased access to the market for beneficiary households. This significantly improved access to essential services (Table 3), which subsequently increased their resilience capacity.

The program provides activities to improve household livelihoods through food assistance by building community assets, agricultural production and processing of agricultural products, and post-harvest management. According to the theory of change, by carrying out these activities, beneficiary households should have better food production systems, diversification of sources of income and savings/credit, access to social safety nets, and promotion of production. This should also lead to the improvement of various aspects of resilience. However, the results (Table 3) show non-significant impacts of the program on improving household assets, Adaptive capacity, and access to social safety nets.

The estimation of the direct effects of these activities on the various indicators shows that participation in the program has improved, in addition to market access, access to land; asset holdings in households (wealth index); building social capital through the participation of beneficiary households in community and village associations. The intervention had a significant positive impact on the participation of beneficiaries in training in agricultural techniques.

The results also indicate that non-beneficiary households are significantly more endowed with agricultural equipment than beneficiary households of the program. The program did not have a significant and positive effect on crop diversification. On average, beneficiary households grew two crops in 2019 and 1.40 in 2017, while the non–beneficiaries grew 1.60 in 2019 and 1.04 in 2017. The poor crop diversification makes agricultural households more vulnerable to climate chocs.

The program had no significant effects on the production of cereals and pulses but it had a statistically significant negative effect on the production of tubers. Any positive change in the production of cereals and pulses is associated with the time effect. On the other hand, the low production of tubers (cassava, potato) by beneficiary households is justified because these speculations are produced less by nature in the intervention areas of the program. Also, it is a perverse effect of participation in the program since it targets the production of cereals and pulses.

As a result, beneficiary households may have cut tubers from their production systems, favouring products prioritised by the program, notably soybeans, corn, and beans.

Impact on food security

The program's impact on beneficiaries' food security is assessed by considering two indicators: household food consumption score (FCS) and household dietary diversity score (HDDS).

The results in Table 3 show that the program had no significant positive effects on the food consumption score and the dietary diversity score. This might be the result of the program's short time horizon: two full years have passed between the start of the project and the collection of data for its evaluation. This might not suffice to see the effects of the intervention on food security. Also, the purpose of the intervention was to increase many aspects of resilience and not food security per se; therefore, this result can be a direct consequence of the design of the intervention.

6 Discussion

Despite the limitations of the method used, especially with small sample sizes or in case of misspecification of the propensity score models (Cesnaye *et al* 2022), our results are technically sound given the large sample size and the results of robustness checks conducted. Moreover, the placebo tests adopted wipe out the uncertainties on the parallel trend assumption that might derive from the high attrition test (Gertler et al., 2016). However, our results are context-specific, especially considering the peculiarities of the socio-economic characteristics of North Kivu, and the structural and multifaceted causes of conflicts.

Our findings indicate that the program significantly improved the resilience capacity of beneficiaries through improvement in smallholders' access to market and collective marketing systems. This is consistent with previous findings on the relevance of access to the market (Markelova *et al.*, 2009; Tesso *et al.*, 2012, Barua *et al.*, 2012, Barua *et al.*, 2013). Tesso et al. (2012) indicate that in Ethiopia farmers with better access to the market and better social networks are more resilient during and after climate change-induced shocks. Oparinde and Hodge (2011) found that social capital and market access significantly strengthen farmers' coping capacities and maintain livelihood resilience in rural areas. The program in North Kivu organised farmers in peasants' organisations and cooperatives and set up a collective marketing system through these organisations. These activities increase the social network.

The collective marketing of agricultural products enabled producers to have higher bargaining power over the selling prices to buyers (high price for producers), and therefore increase their agricultural incomes, as confirmed by Markelova *et al*. (2009). The participation of small farmers in markets can contribute to higher productivity and income growth, which in turn can improve food security, poverty reduction efforts, and overall economic growth (Markelova and Mwangi, 2010). With support in collective marketing, the beneficiaries sold more than 1,000 tonnes of their agricultural products through the collective market system implemented by the program. This development comes with farmers' income increase; income diversification; enhanced resilience to food insecurity; and rural development Yaro (2013). Market access improves livelihood opportunities in both the farm and non-farm sectors (Barua *et al.*, 2014). Investment in human capital, infrastructure and land is needed for enhancing households and communities' resilience (Barua *et al.*, 2014). Increased resilience means increased resources and adaptive capacity that a community can use to overcome future shocks (Barua *et al.*, 2012). For instance, Mishra *et al.*

(2017) shows that farmers from mountain communities in Nepal are not engaged in vegetable farming because of a lack of access to the market.

Our findings also suggest that the program significantly improves beneficiaries' access to land for agricultural production, while there is no significant impact on agricultural production. This is consistent with the chronic conflict context in the areas of intervention, where nacts of violence can have significant adverse effects on the activities of smallholder farmers. Conflicts and the recurrence of violence induce sub-optimal use of productive resources such as land and investment (Aria *et al.,* 2019). Faced with the recurrence of these conflicts and the permanent presence of armed actors, farmers are turning to activities with short-term returns and low profitability (Aria *et al.,* 2019). For example, Adelaja and George (2019) have shown that the Boko Haram conflict in Nigeria has reduced total production and productivity of farm households but not land use, reduced yields of staple crops such as sorghum, soy, cassava; and negatively affects the supply of paid agricultural labour for men and women. Conflicts can disrupt agricultural production, trade, food systems, market structures, and supply chain mechanisms, thereby intensifying conditions of food insecurity and causing future conflicts (Eme *et al.,* 2014). Investing in coalitions for peace that will help prevent the escalation of violence, promote social cohesion and reconciliation is essential for households' resilience building and sustainable livelihood development.

7 Conclusion

This study provides critical insights into building resilience in conflict-affected areas, demonstrating that market access and social cohesion are fundamental drivers of household resilience. Our analysis of integrated interventions in North Kivu reveals that improving households' market access through collective marketing systems and strengthening community networks significantly enhances resilience, even in chronically unstable environments. However, the limited impact on agricultural production and food security underscores the complex challenges posed by persistent conflict.

These findings have important implications for policy and practice. First, resilience-building programs in conflict zones should prioritize market linkages and collective marketing systems alongside traditional agricultural support. Second, interventions must account for the destabilizing effects of chronic conflict on agricultural production and investment decisions. Third, strengthening social cohesion and community networks appears crucial for sustainable resilience outcomes.

Our research contributes to the broader understanding of resilience-building in crisis-prone settings, particularly relating to the Sustainable Development Goals. The findings demonstrate clear pathways to achieving SDG 1 (No Poverty) and SDG 2 (Zero Hunger) through enhanced market access, while supporting SDG 16 (Peace, Justice, and Strong Institutions) through community cohesion building. However, the challenges identified in our study emphasize the need for sustained, context-specific interventions that acknowledge the complex interplay between conflict, food security, and community resilience.

Study limitations include the context-specificity of our findings and the challenges of data collection in conflict zones. Future research should examine: (1) the role of income diversification in building resilience, (2) gender-specific impacts of market-focused interventions, (3) the

relationship between social cohesion and sustained resilience, and (4) innovative approaches to maintaining program effectiveness during active conflicts.

In conclusion, while our findings demonstrate the potential of integrated interventions to build resilience in conflict zones, they also highlight the need for sustained, locally-adapted approaches that prioritize market systems and social networks. These insights can inform more effective programming in similar contexts, ultimately contributing to more resilient communities in crisis-prone regions.

Conflict of Interest

The authors declared that they have no conflict of interest

References

Adger, W.N., (2000). "Social and ecological resilience: Are they related?" *Progress in Human Geography*, 24(3), pp.347-364.

Ainembabazi, J.H., van Asten, P., Vanlauwe, B., Ouma, E., Blomme, G., Birachi, E.A., Nguezet, P.M.D., Mignouna, D.B. and Manyong, V.M., (2017). "Improving the speed of adoption of agricultural technologies and farm performance through farmer groups: evidence from the Great Lakes region of Africa." *Agricultural Economics*, 48(2), pp.241-259.

Aker, J.C., (2017). "Comparing cash and voucher transfers in a humanitarian context: Evidence from the Democratic Republic of Congo." *The World Bank Economic Review*, 31(1), pp.44-70.

Allison, H.E. and Hobbs, R.J., (2004). "Resilience, adaptive capacity, and the "Lock-in Trap" of the Western Australian agricultural region." *Ecology and Society*, 9(1), p.3.

Bandiera, O., Burgess, R., Das, N., Gulesci, S., Rasul, I. and Sulaiman, M., (2017). "Labor markets and poverty in village economies." *The Quarterly Journal of Economics*, 132(2), pp.811-870.

Banerjee, A., Duflo, E., Goldberg, N., Dean, K., Osei, R., Pariente, W., Shapiro, J., Thuysbaert, B. and Udry, C., (2015). "A multifaceted program causes lasting progress for the very poor: evidence from six countries." *Science*, 348(6236), pp.1260799.

Barrett, C.B., (2010). "Measuring food insecurity." *Science*, 327(5967), pp.825-828.

Barua, A., Katyaini, S. and Mili, B., (2012). "Reducing the vulnerability of the poor by building resilience: a case study from South Sikkim." *In: Climate Change in Sikkim Patterns, Impacts, and Initiatives. Gangtok: Information and Public Relations Department*, Government of Sikkim.

Barua, A., Katyaini, S., Mili, B. and Gooch, P., (2014). Climate change and poverty: building resilience of rural mountain communities in South Sikkim, Eastern Himalaya, India. *Regional Environmental Change*, 14(1), pp.267-280.

Baulch, B. and Quisumbing, A., (2011). Testing and adjusting for attrition in household panel data. London: Chronic Poverty Research Centre.

Berkes, F., Colding, J. and Folke, C. eds., (2003). *Navigating social-ecological systems: building resilience for complexity and change.* Cambridge: Cambridge University Press.

Binci, M., Hebbar, M., Jasper, P. and Rawle, G., (2018). Matching, differencing on repeat. *Working Paper* Oxford Policy Management.

Brück, T., De Groot, O.J. and Bozzoli, C., (2012). "How many bucks in a bang: on the estimation of the economic costs of conflict." In: M.R. Garfinkel and S. Skaperdas, eds. *The Oxford Handbook of the Economics of Peace and Conflict*, Oxford University Press, pp.252-274.

Brück, T. and De Groot, O.J., (2013). "The economic impact of violent conflict." *Defense and Peace Economics*, 24(6), pp.147-159.

Brück, T., Cuesta, J., De Hoop, J., Gentilini, U. and Peterman, A., (2019). "Social Protection in Contexts of Fragility and Forced Displacement: Introduction to a Special Issue." *The Journal of Development Studies*, 55(sup1), pp.1-6.

Brück, T., d'Errico, M. and Pietrelli, R., (2019). "The effects of violent conflict on household resilience and food security: Evidence from the 2014 Gaza conflict." *World Development*, 119, pp.203-223.

Caliendo, M. and Kopeinig, S., (2008). "Some practical guidance for the implementation of propensity score matching." *Journal of Economic Surveys*, 22(1), pp.31-72.

Chesnaye, N.C., Stel, V.S., Tripepi, G., Dekker, F.W., Fu, E.L., Zoccali, C. and Jager, K.J., (2022). "An introduction to inverse probability of treatment weighting in observational research." *Clinical Kidney Journal*, 15(1), pp.14-20.

Chowdhury, R., Collins, E., Ligon, E. and Sulaiman, M., (2017). Valuing Assets provided to Low-Income Households in South Sudan. BRAC Ultra poor graduation initiative.

d'Errico, M., Garbero, A., Letta, M. and Winters, P., (2020). "Evaluating program impact on resilience: Evidence from Lesotho's Child Grants Programme." *The Journal of Development Studies*, 56(12), pp.2212-2234.

d'Errico, M., Ngesa, O. and Pietrelli, R., (2021). "Assistance in chronic conflict areas: evidence from South Sudan." *Journal of Development Effectiveness*, 13(2), pp.145-165.

d'Errico, M., Mariani, R.D., Pietrelli, R. and Rosati, F.C., (2021). "Refugee-host proximity and market creation in Uganda." *The Journal of Development Studies*, pp. 213-233.

Del Prete, D., Ghins, L., Magrini, E. and Pauw, K., (2019). "Land consolidation, specialization, and household diets: evidence from Rwanda." *Food Policy*, 83, pp.139-149.

Doocy, S., Cohen, S., Emerson, J., Menakuntuala, J. and Rocha, J.S., (2017). "Food security and nutrition outcomes of farmer field schools in the Eastern Democratic Republic of the Congo." *Global Health: Science and Practice*, 5(4), pp.630-643.

Eme, O.I., Onyishi, A.O., Uche, O.A. and Uche, I.B., (2014). Food insecurity in Nigeria: A thematic exposition. *Arabian Journal of Business and Management Review (OMAN Chapter)*, 4(1), p.1-14

Food and Agriculture Organization (FAO), (2016). Resilience Index Measurement and Analysis – II. Rome: FAO.

FAO, (2019). Analyse de la Résilience au Nord Kivu, République Démocratique du Congo. Rome: FAO.

FAO, (2022). Democratic Republic of the Congo: FAO in emergencies. Rome: FAO.

Fitzgerald, J., Gottschalk, P. and Moffitt, R., (1998). "An Analysis of Sample Attrition in Panel Data: The Michigan Panel Study of Income Dynamics." *The Journal of Human Resources*, 33(2), pp.251-299.

Foster, J., Greer, J. and Thorbecke, E., (1984). "A class of decomposable poverty measures." *Econometrica*, 52(3), pp.761-766.

Foster, J., Greer, J. and Thorbecke, E., (2010). "The Foster-Greer-Thorbecke (FGT) poverty measures: 25 years later." *The Journal of Economic Inequality*, 8(4), pp.491-524.

FSIN (Food Security Information Network), (2014). Qualitative data and subjective indicators for resilience measurement. Technical Series No. 4. Rome: FSIN.

García, B.M., (2019). "Resilient cultural heritage for a future of climate change." *Journal of International Affairs*, 73(1), pp.101-120.

Gertler, P.J., Martinez, S., Premand, P., Rawlings, L.B. and Vermeersch, C.M., (2016). Impact evaluation in practice. Washington, DC: World Bank.

Global Facility for Disaster Reduction and Recovery (GFDRR), (2022). Investing in a Resilient Future across The Globe. Washington, DC: World Bank.

Gunderson, L.H. and Holling, C.S., (2002). *Panarchy: understanding transformations in human and natural systems.* Washington, DC: Island Press.

Hallegatte, S., Rentschler, J. and Rozenberg, J., (2019). *Lifelines: The resilient infrastructure opportunity.* Washington, DC: World Bank.

Hallegatte, S., Vogt-Schilb, A., Bangalore, M. and Rozenberg, J., (2017). *Unbreakable: Building the resilience of the poor in the face of natural disasters.* Washington, DC: World Bank.

Hillesland, M., Kaaria, S., Mane, E., Alemu, M. and Slavchevska, V., (2021). "Did a microfinance 'plus' programme empower female farmers and pastoralists and improve intrahousehold equality in rural Ethiopia?" *IFPRI Discussion Paper 2037*. Washington, DC: International Food Policy Research Institute.

Humphreys, M., de la Sierra, R.S. and Van der Windt, P., (2019). "Exporting democratic practices: Evidence from a village governance intervention in Eastern Congo." *Journal of Development Economics*, 140, pp.279-301.

IPC, (2023). Democratic Republic of the Congo: Acute Food Insecurity Situation July - December 2022 and Projection for January - June 2023. Rome: IPC.

Kennedy, G., Ballard, T. and Dop, M.C., (2011). Guidelines for measuring household and individual dietary diversity. Rome: FAO.

Kimhi, S., Marciano, H., Eshel, Y. and Adini, B., (2020). "Community and national resilience and their predictors in face of terror." *International Journal of Disaster Risk Reduction*, 50, p.101746.

Krenz, K., Gilbert, D.J. and Mandayam, G., (2014). "Exploring women's empowerment through "credit-plus" microfinance in India." *Affilia*, 29(3), pp.310-325.

Kruk, M.E., Myers, M., Varpilah, S.T. and Dahn, B.T., (2015). "What is a resilient health system? Lessons from Ebola." *The Lancet*, 385(9980), pp.1910-1912.

Lain, J. and Bishop, D., (2018). Resilience in Kenya: Impact evaluation of the 'Building Resilience in the Arid and Semi-Arid Lands of Northern Kenya' project. Oxford: OXFAM.

Malik, A., d'Errico, M., Omolo, D. and Gichane, B., (2020). "Building resilience in Somalia; evidence from field data collection." *Journal of Development Effectiveness*, 12(4), pp.323-340.

Marivoet, W., Ulimwengu, J.M., Bugeme, D.M., Sanginga, B. and Thontwa, S., (2020). "Spatial food and nutrition security typologies for agriculture and food value chain interventions in Eastern DRC." *IFPRI Discussion Paper 1971*. Washington, DC: International Food Policy Research Institute.

Markelova, H., Meinzen-Dick, R., Hellin, J. and Dohrn, S., (2009). "Collective action for smallholder market access." *Food Policy*, 34(1), pp.1-7.

Markelova, H. and Mwangi, E., (2010). "Collective action for smallholder market access: evidence and implications for Africa." *Review of Policy Research*, 27(5), pp.621-640.

Maxwell, D., Vaitla, B. and Coates, J., (2014). "How do indicators of household food insecurity measure up? An empirical comparison from Ethiopia." *Food Policy*, 47, pp.107-116.

Mercy Corps, (2021). DRC: High levels of food insecurity pushing communities to breaking point. Portland: Mercy Corps.

Mishra, A., Ghate, R., Maharjan, A., Gurung, J., Pathak, G. and Upraity, A.N., (2017). "Building ex-ante resilience of disaster-exposed mountain communities: Drawing insights from the Nepal earthquake recovery." *International Journal of Disaster Risk Reduction*, 22, pp.167-178.

Murphy, E., Glaeser, L., Maalouf-Manasseh, Z., Collison, D.K. and Sethuraman, K., (2015). USAID Office of Food for Peace Food Security Desk Review for Katanga, North Kivu, and South Kivu, the Democratic Republic of the Congo. Washington, DC: FANTA.

Musumari, P.M., Wouters, E., Kayembe, P.K., Kiumbu Nzita, M., Mbikayi, S.M., Suguimoto, S.P. and Kihara, M., (2014). "Food insecurity is associated with increased risk of non-adherence to antiretroviral therapy among HIV-infected adults in the Democratic Republic of Congo: a cross-sectional study." *PloS One*, 9(1), p.e85327.

Oparinde, A. and Hodge, I., (2011). "Building livelihood resilience: a case study of factors affecting farm households' adoption of coping and adaptive strategies in rural Nigeria." *MPRA Paper 39162*. Munich: University Library of Munich.

Pelling, M. and Manuel-Navarrete, D., (2011). "From resilience to transformation: the adaptive cycle in two Mexican urban centers." *Ecology and Society*, 16(2), p.11.

Quattrochi, J., Bisimwa, G., Thompson, T., Van der Windt, P. and Voors, M., (2020). The effects of vouchers for essential household items on child health, mental health, resilience, and social cohesion among internally displaced persons in the Democratic Republic of Congo. Working Paper 107. New Delhi: International Initiative for Impact Evaluation.

ReliefWeb, (2022). Democratic Republic of the Congo: Humanitarian needs overview 2022. New York: United Nations Office for the Coordination of Humanitarian Affairs.

Smith, J. and Todd, P., (2005). "Does matching overcome LaLonde's critique of nonexperimental estimators?" *Journal of Econometrics*, 125(1-2), pp. 305-353.

Swindale, A. and Bilinsky, P., (2006). Household dietary diversity score (HDDS) for measurement of household food access: indicator guide. Washington, DC: Food and Nutrition Technical Assistance Project, Academy for Educational Development.

Tesso, G., Emana, B. and Ketema, M., (2012). "Analysis of vulnerability and resilience to climate change-induced shocks in North Shewa, Ethiopia." *Agricultural Sciences*, 3(06), pp.871-888.

Van der Windt, P., Humphreys, M. and de la Sierra, R.S., (2018). "Gender quotas in development programming: Null Results from a field experiment in Congo." *Journal of Development Economics*, 133(C), pp.326-345.

Vansteelandt, S., Carpenter, J. and Kenward, M.G., (2010). "Analysis of incomplete data using inverse probability weighting and doubly robust estimators." *Methodology: European Journal of Research Methods for the Behavioral and Social Sciences*, 6(1), pp.37–48.

Uexkull, N.V., d'Errico, M. and Jackson, J., (2020). "Drought, resilience, and support for violence: household survey evidence from DR Congo." *Journal of Conflict Resolution*, 64(10), pp.1994-2021.

Walker, B., Holling, C.S., Carpenter, S.R. and Kinzig, A., (2004). "Resilience, adaptability and transformability in social-ecological systems." *Ecology and Society*, 9(2), p.5.

Wiesmann, D., Basset, L., Benson, T. and Hoddinott, J., (2009). "Validation of the World Food Programme's Food Consumption Score and Alternative Indicators of Household Food Security." *IFPRI Discussion Paper 00870*. Washington, DC: International Food Policy Research Institute.

World Bank, (2019). Democratic Republic of Congo poverty assessment. Washington, DC: World Bank.

Annex

Table A1: Description of Indicators

Name of Indicator	Description
Resilience Capacity Index (RCI)	The RCI is computed through a two-steps procedure which entails the use of Factor Analysis and Structural Equation Models. More details can be found in FAO 2016. Its main pillars are Access to Basic Services (ABS); Adaptive Capacity (AC); Social Safety Nets (SSN); and Assets (AST). (FAO 2016)
Food consumption score (FCS)	FCS is normally calculated following the WFP indications. It employs the frequency of consumption of different food groups consumed by a household during the 7 days before the survey. There are standard weights for each of the food groups that comprise the food consumption score.[5]
Food diversity score (HDDS)	HDDS uses the sum of items groups consumed by the households during the seven days before the survey. [6]
Wealth index	Makes use of Factor Analysis to pool together indicators of (rural) wealth such as house, car, and other durable goods/items.
Agricultural wealth index	Makes use of Factor Analysis to pool together indicators of agricultural tools such as ox, how, and other agricultural activities tools
Access to land	Identifies if people have had access to usable land to cultivate.
Participation in the community association	It is a dummy variable reporting whether a household (or one member of the household) participates in association groups.
Access to training	It is a dummy variable reporting whether a household (or one member of the household) has received training or not.

Source: Authors' own elaboration

[5] INDDEX Project (2018), Data4Diets: Building Blocks for Diet-related Food Security Analysis. Tufts University, Boston, MA. https://inddex.nutrition.tufts.edu/data4diets. Accessed on 25 April 2023.

[6] FAO. 2021. Minimum dietary diversity for women. Rome. https://doi.org/10.4060/cb3434en. Accessed on 25 April 2023

Table A2 - Descriptive statistics

		Global				Rutshuru				Masisi			
Variable		**B**	**NB**	**% Bias**	**P-value**	**B**	**NB**	**% Bias**	**P-value**	**B**	**NB**	**% Bias**	**P-value**
HH size	U	6.729	7.023	-11.800	0.042	6.729	7.066	-13.200	0.036	6.729	6.961	-9.700	0.146
	M	6.729	6.670	2.400	0.733	6.729	6.750	-0.800	0.910	6.729	6.832	-4.300	0.553
Male-head HH	U	0.808	0.870	-16.800	0.003	0.808	0.855	-12.600	0.040	0.808	0.891	-23.500	0.000
	M	0.808	0.813	-1.400	0.853	0.808	0.797	2.800	0.716	0.808	0.788	5.600	0.499
Number of women 15-49 years	U	1.450	1.431	2.000	0.725	1.450	1.477	-2.700	0.660	1.450	1.363	9.700	0.143
	M	1.450	1.476	-2.800	0.713	1.450	1.482	-3.300	0.675	1.450	1.516	-7.300	0.337
Access to Drinking Water	U	0.934	0.920	5.400	0.363	0.934	0.897	13.500	0.036	0.934	0.955	-9.100	0.168
	M	0.934	0.949	-5.900	0.369	0.934	0.928	2.100	0.753	0.934	0.932	1.200	0.885
Electricity	U	0.253	0.133	30.500	0.000	0.253	0.144	27.500	0.000	0.253	0.118	35.100	0.000
	M	0.253	0.258	-1.300	0.868	0.253	0.271	-4.700	0.564	0.253	0.251	0.300	0.967
Close to School	U	0.145	0.146	-0.400	0.943	0.145	0.146	-0.500	0.934	0.145	0.146	-0.200	0.972
	M	0.145	0.151	-2.900	0.691	0.145	0.161	-8.400	0.255	0.145	0.130	8.400	0.223
Proximity to Public Transport	U	0.082	0.120	-20.400	0.001	0.082	0.111	-15.400	0.016				
	M	0.082	0.081	0.700	0.910	0.082	0.083	-0.500	0.940				
Improved Roof	U	0.937	0.650	75.800	0.000	0.937	0.702	64.000	0.000				
	M	0.937	0.932	1.400	0.770	0.937	0.929	2.200	0.664				
Dependency Ratio	U	1.244	0.938	26.100	0.000	1.244	1.047	16.100	0.007	1.244	0.775	43.100	0.000
	M	1.244	1.271	-2.300	0.795	1.244	1.351	-8.800	0.321	1.244	1.211	3.100	0.743
Average Number Years of Education	U	1.984	1.657	21.900	0.000	1.984	1.674	20.700	0.001	1.984	1.632	23.800	0.000
	M	1.984	1.920	4.200	0.566	1.984	2.029	-3.000	0.694	1.984	1.851	8.900	0.244
Drought Shock	U	0.242	0.166	19.000	0.001	0.242	0.195	11.300	0.067	0.242	0.122	31.600	0.000
	M	0.242	0.251	-2.100	0.788	0.242	0.246	-1.000	0.893	0.242	0.261	-4.800	0.559
Flood Shock	U	0.005	0.002	6.500	0.182	0.005	0.001	7.000	0.204	0.005	0.002	5.700	0.378
	M	0.005	0.001	8.200	0.225	0.005	0.003	3.700	0.655	0.005	0.003	4.400	0.564
Water Shortage Shock	U	0.003	0.002	2.500	0.645	0.003	0.001	3.100	0.595	0.003	0.002	1.600	0.809
	M	0.003	0.001	3.500	0.612	0.003	0.004	-2.400	0.796	0.003	0.004	-2.800	0.752
Confrontation Communities	U	0.008	0.043	-22.400	0.001	0.008	0.040	-21.300	0.002	0.008	0.047	-24.000	0.001
	M	0.008	0.011	-2.000	0.654	0.008	0.010	-1.400	0.758	0.008	0.008	0.000	1.000

Source Authors' own elaboration

Table A3 - Changes over time of RCI and variables

	Baseline				Midterm			
	Beneficiaries	**Non-Beneficiaries**			**Beneficiaries**	**Non-Beneficiaries**		
Outcome indicators	R	NBR&M	NBR	M	R	NBR&M	NBR	M
RCI	30.614	31.515	29.928	33.870	47.687	44.081	42.938	45.977
ABS	9.161	9.604	9.033	10.451	30.224	26.054	25.370	27.188
AST	23.789	17.938	17.593	18.450	24.990	20.384	19.993	21.032
SSN	7.847	9.173	9.076	9.317	22.460	23.606	23.433	23.893
AC	21.810	17.839	18.840	16.351	36.343	32.007	32.187	31.708
Distance to Market, inverse	0.087	0.115	0.108	0.124	0.066	0.074	0.070	0.080
Livestock (TLU)	0.056	0.028	0.022	0.037	0.085	0.057	0.051	0.068
Wealth Index	0.150	0.123	0.115	0.135	0.258	0.202	0.190	0.223
Agricultural Wealth Index	0.041	0.038	0.036	0.039	0.195	0.223	0.227	0.216
Land (hectare)	0.339	0.197	0.227	0.153	2.231	1.100	0.892	1.446
Association	0.147	0.099	0.116	0.075	0.460	0.349	0.335	0.373
Access to credit	0.250	0.341	0.340	0.341	0.797	0.873	0.874	0.872
Income Diversification Index (#)	2.000	2.059	2.061	2.056	1.930	2.085	2.082	2.089
Crops diversification Index (#)	1.392	1.064	1.194	0.871	1.986	1.598	1.724	1.389
Training on Agricultural Techniques	0.066	0.044	0.052	0.034	0.164	0.096	0.071	0.137
Coping Strategy Index, inverse	0.035	0.032	0.029	0.037	0.030	0.030	0.028	0.034
Cereal (kg)	42.262	27.598	39.550	9.848	50.425	44.080	47.447	38.497
Legumes (kg)	47.259	21.425	27.172	12.890	42.251	24.805	20.832	31.392
Tubers (kg)	21.350	29.617	27.807	32.304	21.894	52.091	38.165	75.186
FCS	27.325	27.878	26.443	30.008	31.194	29.895	28.818	31.682
HDDS	4.058	3.879	3.731	4.099	5.588	5.269	5.176	5.424
Observations	380	1327	793	534	359	1284	801	483

Source: Authors' own elaboration