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The role of NEAZDP on social mobility of poverty in Yobe State of Nigeria

El papel del NEAZDP en la movilidad social de la pobreza en el estado de Yobe, Nigeria

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Abstract

Yobe State in Nigeria, marked by socio-economic challenges such as climate variability and poor infrastructure, provides a compelling context for assessing poverty reduction strategies. This study evaluates the effectiveness of the Northeast Arid Zone Development Program (NEAZDP) as a poverty alleviation strategy using 2023 cross-sectional household survey data from 322 households selected through a multi-stage sampling technique. Data collection was carried out using a well-structured questionnaire coupled with interview schedules. The analysis employed both the Foster-Greer-Thorbecke (FGT) poverty index and the Alkire-Foster multidimensional poverty index (MPI) to measure poverty. Results reveal that NEAZDP has had a significant impact on reducing both unidimensional and multidimensional poverty among participants. The proportion of beneficiaries below the poverty line decreased substantially during the program, although a slight increase was noted toward the program's conclusion. Furthermore, multidimensional poverty levels among NEAZDP beneficiaries were significantly lower compared to those in spill-over and control groups, indicating improvements in access to education, healthcare, and income-generating opportunities. Despite these successes, the study identified persistent challenges in areas such as standard of living, empowerment, and environmental sustainability. In conclusion, NEAZDP has made notable progress in enhancing socio-economic conditions and social mobility in Yobe State. However, for its impact to be sustained, there is a need for continuous, targeted interventions and better policy integration. Strengthening these areas can help ensure the long-term success of poverty alleviation efforts and promote inclusive development across the region.

Keywords: Development, Intervention, Poverty Alleviation, Sustainability, Nigeria.

Resumen

El estado de Yobe, en Nigeria, caracterizado por diferentes desafíos socioeconómicos como la variabilidad climática y la infraestructura deficiente, ofrece un contexto relevante para evaluar las estrategias de reducción de la pobreza. Este estudio analiza la efectividad del Programa de Desarrollo de la Zona Árida del Noreste (NEAZDP) como estrategia de mitigación de la pobreza, utilizando datos de una encuesta transversal realizada en 2023 a 322 hogares, seleccionados mediante una técnica de muestreo en varias etapas. La recolección de datos se efectuó mediante cuestionarios estructurados y entrevistas programadas. El análisis empleó tanto el índice de pobreza Foster-Greer-Thorbecke (FGT) como el índice de pobreza multidimensional Alkire-Foster (MPI) para medir la pobreza. Los resultados revelan que el NEAZDP tuvo un impacto significativo en la reducción de la pobreza tanto unidimensional como multidimensional entre los participantes. La proporción de beneficiarios por debajo de la línea de pobreza disminuyó sustancialmente durante la ejecución del programa, aunque se observó un ligero incremento hacia su finalización. Además, los niveles de pobreza multidimensional entre los beneficiarios del NEAZDP fueron significativamente menores en comparación con los grupos de desbordamiento y de control, evidenciando mejoras en el acceso a la educación, la atención médica y las oportunidades de generación de ingresos. A pesar de estos avances, el estudio identificó desafíos en aspectos como el nivel de vida, el empoderamiento y la sostenibilidad ambiental. En conclusión, el NEAZDP ha logrado avances importantes en la mejora de las condiciones socioeconómicas y en la promoción de la movilidad social en el estado de Yobe. Sin embargo, para mantener su impacto, hay que implementar intervenciones continuas y específicas, así como una mejor integración de las políticas públicas. El fortalecimiento de estos aspectos puede garantizar el éxito a largo plazo de los esfuerzos de mitigación de la pobreza y fomentar un desarrollo inclusivo en toda la región.

Palabras clave: Desarrollo, intervención, alivio de la pobreza, sostenibilidad, Nigeria.

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1 Introduction

Yobe State, located in northeastern Nigeria, remains entrenched in poverty exacerbated by its arid and semi-arid climate, limited infrastructure, and long-standing socio-economic challenges (Gadzama, 2017; Umar, 2024; Madaki et al., 2024). In response, the Northeast Arid Zone Development Program (NEAZDP) was implemented to promote economic empowerment and sustainable development among vulnerable rural populations (Mukhtar et al., 2017; Galadima and Isa, 2020). While the program has made notable investments in agriculture, entrepreneurship, and rural infrastructure, its effectiveness in driving social mobility and sustainable poverty reduction remains underexplored.

Despite NEAZDP's interventions, key questions persist about the extent to which it has improved livelihoods, income levels, and access to essential services, and whether it has succeeded in fostering long-term economic resilience in the face of persistent climate and security challenges. The unique socio-economic and environmental context of Yobe State—characterized by desertification, food insecurity, and conflict—poses distinct implementation challenges that may limit program impact compared to other regions.

A global comparative lens further enriches discourse. For instance, Brazil's Bolsa Família and India's Mahatma Gandhi National Rural Employment Guarantee Act (MGNREGA) have demonstrated how integrated social protection and livelihood programs can uplift households from chronic poverty through conditional cash transfers, job creation, and access to services. In Ghana, the Livelihood Empowerment Against Poverty (LEAP) program also mirrors NEAZDP's focus on vulnerable groups but integrates more targeted health and education incentives (Schotte, 2023; Woode, 2024). These international programs highlight the importance of monitoring, adaptability, and policy integration, which are crucial for replicating success in Nigeria's fragile contexts.

Moreover, studies in sub-Saharan Africa suggest that the effectiveness of poverty alleviation programs is context-dependent, with success hinging on community participation, environmental adaptability, and inclusive governance (Ncube et al., 2024; Wudil et al., 2022). As such, Yobe State presents a unique case for evaluating the impact of rural development programs in conflict-prone, ecologically fragile environments.

Therefore, this study seeks to bridge empirical gaps by assessing the role of NEAZDP in enhancing social mobility and reducing poverty—both unidimensional and multidimensional—among its beneficiaries in Yobe State. Specifically, it evaluates the program's impact compared to non-beneficiary groups (spillover and control) using quantitative metrics and qualitative insights. Findings from this research aim to inform evidence-based policymaking, enhance program effectiveness, and contribute to broader strategies for sustainable development and inclusive growth in Nigeria and across sub-Saharan Africa (Orunbon and Adeleke, 2024; Kabari and Nwogo, 2021; Ogbari et al., 2024; Kolawole and Samuel, 2024). Succinctly, the specific objectives are to assess the role of NEAZDP on unidimensional poverty among the beneficiary group and multidimensional poverty status of the beneficiary group against the non-beneficiary group.

2 Theoretical Framework

The foundation of this study is grounded in established poverty and development theories that explain the mechanisms through which development interventions like the Northeast Arid Zone Development Program (NEAZDP) influence poverty reduction and social mobility in fragile contexts like Yobe State, Nigeria.

2.1 Capability Approach (Amartya Sen)

Sen's Capability Approach redefines poverty beyond income deficiency, framing it as a deprivation of basic capabilities such as education, health, and living standards (Sen, 1999). This theoretical lens is crucial in understanding how NEAZDP interventions in agriculture, education, and infrastructure affect not just income but broader well-being. The approach has been effectively used in rural development studies in sub-Saharan Africa (Mak et al., 2023).

2.2 Social Mobility Theory

Rooted in the work of Blau and Duncan (1967), this theory explains how individuals or households change their socio-economic position over time. NEAZDP's emphasis on skill acquisition, entrepreneurship support, and infrastructural access can influence vertical mobility among previously marginalized rural dwellers (Lembi and Yahaya, 2023).

2.3 Growth and Redistribution Theory

As highlighted by Bourguignon (2004), growth alone is insufficient to combat poverty unless accompanied by equitable redistribution. This theory aligns with studies indicating that NEAZDP's redistributive components, such as subsidized agricultural inputs and financial empowerment schemes, play a central role in reducing rural inequality (Sadiq et al., 2024).

2.4 Multidimensional Poverty Framework (Alkire & Foster, 2011)

This model emphasizes simultaneous deprivations across various domains—education, health, and standard of living—and supports the use of the Multidimensional Poverty Index (MPI) in evaluating the NEAZDP. Empirical applications of this approach in Nigeria have revealed disparities that income-based metrics overlook (Naibbi, 2023; Jellason, 2018).

2.5 Demographic Transition Theory

According to Notestein (1945), shifts in population structure influence development outcomes. Large household sizes, rural-urban migration, and dependency burdens in Yobe State may dilute the impact of NEAZDP unless interventions are designed with demographic realities in mind (Cinjel and Kefas, 2024).

3 Conceptual Framework

The conceptual framework illustrates the logical relationships between NEAZDP interventions and the study's dependent variables: unidimensional and multidimensional poverty, and social mobility. It is structured around three main pathways:

Input: NEAZDP Interventions

- Agricultural support (tools, seeds, irrigation)
- Infrastructure development (boreholes, roads)
- Vocational training and skills acquisition
- Micro-credit and entrepreneurship support

Mediating Variables

- Household Demographics (size, dependency ratio, education level)
- Access to Services (schools, healthcare, markets)
- Environmental Conditions (aridity, displacement, insecurity)

These factors influence the rate and depth of poverty reduction.

Outcome Variables

- Unidimensional Poverty (measured by income thresholds using FGT index)
- Multidimensional Poverty (MPI domains: education, health, standard of living)
- Social Mobility (changes in income class, occupational shift, education level over time)

This framework allows a structured analysis of how development programs produce variable poverty outcomes depending on demographic and structural factors. It also guides the use of both FGT and Alkire-Foster methodologies for analyzing poverty levels and program impact.

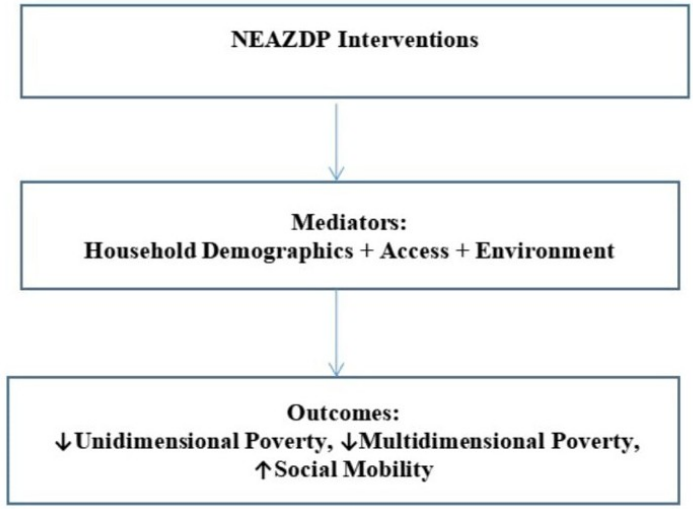

Figure 1. Conceptual framework.

4 Empirical Review

This section synthesizes empirical evidence on the effectiveness of the Northeast Arid Zone Development Program (NEAZDP) in promoting poverty alleviation and social mobility among beneficiaries in Yobe State, Nigeria, using current and context-relevant studies from 2019 to 2024.

4.1 Poverty Reduction and Livelihood Enhancement

Studies indicate that NEAZDP has been instrumental in providing sustainable livelihoods for rural communities in Yobe State by promoting agricultural support, water supply, and environmental conservation (Mukhtar et al., 2017). The program's success in mitigating soil degradation and desertification has contributed to improved food security, which directly impacts poverty reduction (Danjuma and Daura, 2014). A study by Mukhtar et al. (2017) found that while NEAZDP interventions have improved access to essential services in northern Yobe, sustainable poverty reduction remains a challenge. The authors argue that limited government funding and policy inconsistencies hinder long-term impact.

4.2 Social Mobility through Economic Empowerment

Lembi and Yahaya (2023) examined the link between NEAZDP's rural development efforts and upward social mobility. Their study found improvements in occupational standing and educational attainment among participants, especially women and youth, because of interventions in agriculture and entrepreneurship. Yet, they reported limited spillover effects on non-beneficiaries in the same communities.

4.3 Multidimensional Poverty Dynamics

According to Naibbi (2023), spatial disparities in access to services such as clean water and education continued to affect multidimensional poverty. His spatial mapping analysis across Yobe State revealed that although NEAZDP beneficiaries had better MPI (Multidimensional Poverty Index) scores than control groups, infrastructural inequality and population pressure diluted these gains in more remote LGAs.

4.4 Environmental and Institutional Challenges

Jellason (2018) critically examined environmental challenges such as desert encroachment, land de-

gradation, and food insecurity—factors that undermine long-term NEAZDP success. The study suggested integrating sustainable environmental management into program design, especially for agricultural resilience.

4.5 Gendered and Community-Specific Outcomes

Studies by Cinjel and Kefas (2024) explored how cultural and gender norms shape NEAZDP outcomes in different communities. Their research in Mangu and Potiskum LGAs found that men dominated access to capital inputs while women benefited more from vocational training components, pointing to the program's uneven impact.

4.6 Policy Implementation and Governance Gaps

Wrona et al. (2023) emphasizes weak institutional capacity and lack of data harmonization as major bottlenecks affecting NEAZDP's efficiency. The study underscores the importance of coordinated monitoring and community engagement for long-term program effectiveness in the region.

5 Research Methodology

Yobe State, located in northeastern Nigeria, spans about 45,502 km^2 and shares borders with Niger Republic and several Nigerian states (Figure 2). It lies within the Sudano-Sahelian zone, featuring flat terrain and high temperatures, with frequent droughts and desertification risks (Naibbi, 2023; Jellason, 2018). Agro-ecologically, Yobe is a semi-arid region with a short rainy season and poor soil fertility. Farming, primarily rain-fed, focuses on crops like millet and cowpea, alongside livestock rearing. However, low agricultural productivity persists due to environmental constraints (Gadzama, 2017). Economically, the state is largely agrarian, with over 70 % of residents engaged in subsistence farming. Challenges such as insecurity, poor infrastructure, and limited market access have intensified poverty. The region experiences high unidimensional and multidimensional poverty rates (Mak et al., 2023).

The Northeast Arid Zone Development Program (NEAZDP) is operational in the northern part of the state, targeting nine (9) Local Government Areas (LGAs): Bade, Jakusko, Bursari, Geidam, Yunusari, Yusufari, Nguru, Karasuwa, and Machina. For this study, a multi-stage sampling technique was employed to select respondents across three strata: treated (project participants), spill-over (non-beneficiaries in proximate communities), and control groups (distant non-beneficiaries).

In the first stage, four LGAs were randomly selected from the treated group: Bade, Jakusko, Bursari, and Geidam. In the second stage, four LGAs each were purposively selected for the spill-over and control groups, respectively:

Spill-over LGAs: Tarmuwa, Nangere, Fune, and Fika, all located within a 20–50 km radius of the intervention sites.

Control LGAs: Damaturu, Potiskum, Gujba, and Gulani, situated at distances $\geq$100 km from the intervention areas, following the approach adopted by Sadiq et al. (2020).

From each selected treated LGA, one Development Area (DA) was identified. Subsequently, three clusters were randomly drawn from each DA, resulting in a total of twelve clusters. Within these clusters, two villages were randomly selected, leading to a total of 40 villages across all strata (treated, spill-over, and control).

Using a sampling frame obtained from NEAZDP and validated through a reconnaissance survey (see Table 1), five beneficiaries were randomly selected from each of the 24 treated villages (3 clusters $\times$ 4 LGAs $\times$ 2 villages), yielding a total of 120 respondents for the treated group.

For the non-beneficiary groups (spill-over and control), where no finite sampling frame existed, sample sizes were determined using the Bartlett et al. (2002) formula for sample size calculation (Equation 1). Accordingly, 138 respondents were randomly selected for each of the spill-over and control groups.

In total, the study included 396 respondents, distributed as follows: 120 in the treated group, 138 in the spill-over group, and 138 in the control group.

These groups form the basis for comparative analysis of NEAZDP's impact on poverty and social mobility (Table 1).

Furthermore, a cross-sectional dataset was collected in 2023 using the easy-route cost approach. Data collection was conducted by trained enumerators through a well-structured questionnaire, which was further complemented by an interview schedule to enhance data depth and reliability. Moreover, the objective related to the economic/income (unidimensional) aspect of poverty was achieved using a Foster-Greer-Thorbecke (FGT) index (Equation 2–15) while the objective related to social (multidimension) aspect of poverty was achieved using Alkire and Foster multidimensional poverty index (MPI).

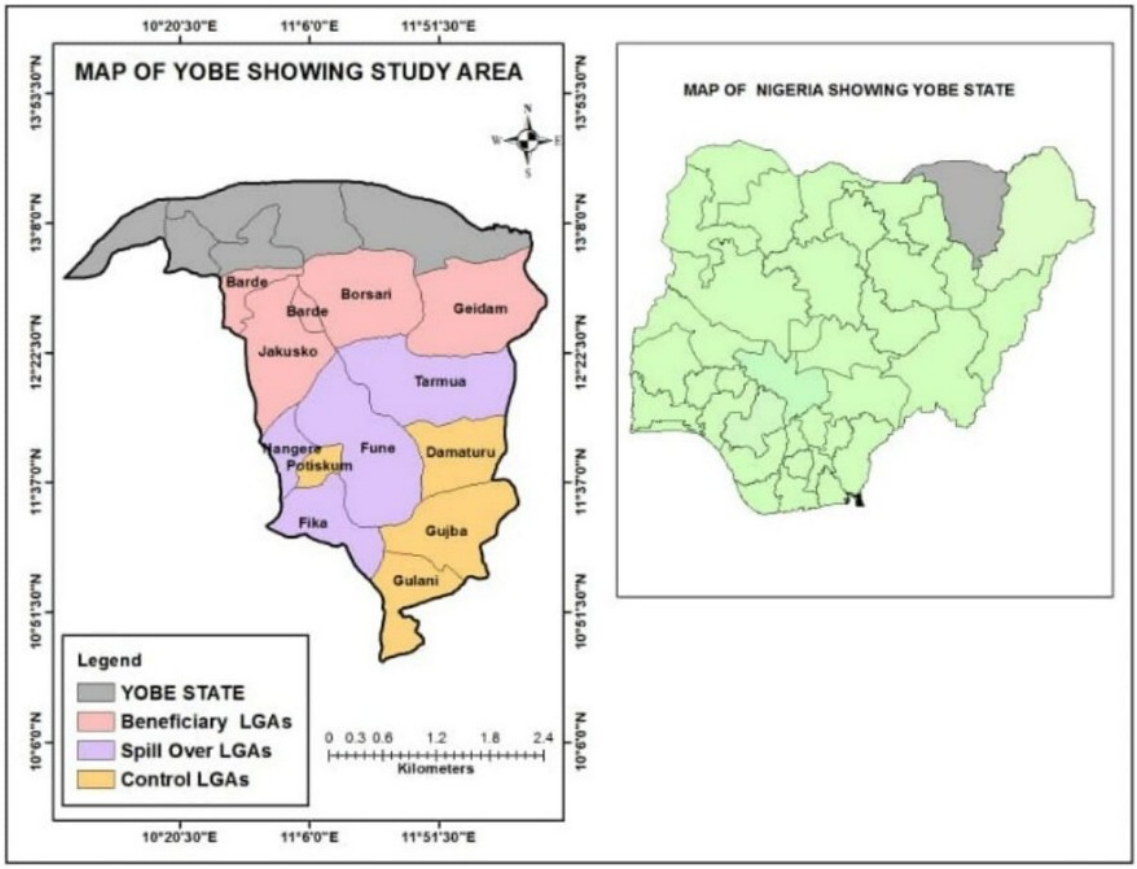

Figure 2. Map of the study area.

According to Bartlett's formula, the sample size of the unknown can be generated using the following formula:

$$N_{nb} = \frac{Z^2 * P(1-P)}{e^2} \quad (1)$$

Where, N_{nb} is the sample size of the non-beneficiaries, Z is the Z-statistic at 5 % probability level (1.96), P is the sample proportion (10 %), and e is the error gap at 5 %.

Table 1. Sampling frame of both the beneficiaries and non-beneficiaries.

Category	LGAs	DAs	Cluster villages	Villages	SF	SS
Beneficiary (Treatment)	Bade	Dagona	Dala	Gabarwa	15	5
				Mainiya	15	5
		Tagali	Lafiyami	Madamuwa	15	5
		Bizi	Murza	Misilli	15	5
	Bursari	Dumburi	Dadigar	Baya Mallum	15	5
				Diga	15	5
		Gadine	Gamsa West	Gamsa East	15	5
		Daskum	Gangawa	Kagadama	15	5
	Geidam	Balle	Bayamari	Malango	15	5
				Kelluri	15	5
		Damaya	Mobarti	Gallaba	15	5
		Ajiri Dapchi	Ajiri Geidam	Matakuskum	15	5
	Jakusko	Muguram	Jaba	Dagayak	15	5
				Garin Maji	15	5
		Gamjam	Nasari	Garin Tsaiha	15	5
		Lafiya Loiloi	Buduwa	Gamya	15	5
	Sub-total	**4**	**12**	**24**	**360**	**120**
Non-Beneficiary	*Spill-over*					
	Tarmuwa	–	–	Lantewa	–	17
		–	–	Biriri	–	17
	Nangere	–	–	Dawasa	–	17
		–	–	S/Gari Nangere	–	17
	Fune	–	–	Dogon Kuka	–	17
		–	–	Damagum	–	17
	Fika	–	–	Janga	–	18
		–	–	Gadaka	–	18
	Sub-total	**4**	–	**8**	–	**138**
	Control					
	Damaturu	–	–	Maisandari	–	17
		–	–	Dukumari	–	17
	Gujba	–	–	Katarko	–	17
		–	–	Kasesa	–	17
	Gulani	–	–	Bara	–	17
		–	–	Shishiwaji	–	17
	Potiskum	–	–	Mamudo	–	18
		–	–	Garin Jaji	–	18
	Sub-total	**4**	–	**8**	–	**138**
Total	**12**	**4**	**12**	**40**		**396**

Source: NEAZDP report (2022) and Reconnaissance survey (2022)

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5.1 Empirical model

5.1.1 Economic/Income (unidimensional) approach of poverty measurement

a. The decomposition of the FGT index across growth and redistribution effects

Datt and Ravallion (1992) decompose the change in the FGT index between two periods, t_1 and t_2, into growth and redistribution components as follows (Urban et al., 2024; Rebechi and Rohde, 2023):

$$\mathrm{P}_2 - P_1 = [P(\mu^{t_2}, \pi^{t_1}) - P(\mu^{t_1}, \pi^{t_1})] + [P(\mu^{t_1}, \pi^{t_2}) - P(\mu^{t_1}, \pi^{t_1})] + R \quad /\text{ref} = 1 \tag{2}$$

$$\mathrm{P}_2 - P_1 = [P(\mu^{t_2}, \pi^{t_2}) - P(\mu^{t_1}, \pi^{t_2})] + [P(\mu^{t_2}, \pi^{t_2}) - P(\mu^{t_2}, \pi^{t_1})] + R \quad /\text{ref} = 2 \tag{3}$$

Where, $P_2 - P_1$ represents the difference (variation) in poverty between periods t_1 and t_2. Component 1 (C1) refers to the growth component or growth effect, whereas Component 2 (C2) denotes the redistribution component or redistribution effect. The term R represents the residual component, and Ref. indicates the reference period.

$\boldsymbol{P(\mu^{t1}, \pi^{t1})}$: the FGT index of the first period.
$\boldsymbol{P(\mu^{t2}, \pi^{t2})}$: the FGT index of the second period.
$\boldsymbol{P(\mu^{t2}, \pi^{t1})}$: the FGT index of the first period when all incomes y_i^{t1} are multiplied by μ^{t2}/μ^{t1}.
$\boldsymbol{P(\mu^{t1}, \pi^{t2})}$: the FGT index of the second period when all incomes y_i^{t2} are multiplied by μ^{t1}/μ^{t2}.

The Shapley value decomposes the variation in the FGT Index between two periods, t_1 and t_2, into growth and redistribution components as follows (Aristondo and Onaindia, 2020; Fosu and Gafa, 2022):

$$P_2 - P_1 = C_1 + C_2 \tag{4}$$

$$C_1 = \frac{1}{2}\left([P(\mu^{t_2}, \pi^{t_1}) - P(\mu^{t_1}, \pi^{t_1})] + [P(\mu^{t_2}, \pi^{t_2}) - P(\mu^{t_1}, \pi^{t_2})]\right) \tag{5}$$

$$C_2 = \frac{1}{2}\left([P(\mu^{t_1}, \pi^{t_2}) - P(\mu^{t_1}, \pi^{t_1})] + [P(\mu^{t_2}, \pi^{t_2}) - P(\mu^{t_2}, \pi^{t_1})]\right) \tag{6}$$

b. Pro-poor curves

Pro-poor curves can be drawn using either the primal or the dual approach (Rehman et al., 2024; Fatima et al., 2024). The former uses income levels. The latter is based on percentiles.

The change in the distribution from state 1 to state 2 is s-order absolutely pro-poor with standard *cons* if:

$$\Delta(z, s) = (P_2(z + cons, \alpha = s - 1)) < 0 \quad \forall z \in [0, z^+] \tag{7}$$

The change in the distribution from state 1 to state 2 is s-order relatively pro-poor if:

$$\Delta(z, s) = (P_2(z + cons, \alpha = s - 1)) < 0 \quad \forall z \in [0, z^+] \tag{8}$$

5.2 Impact of demographic changes

This application computes the impact of a change (by a given percentage) in the proportion of a group t. That change is accompanied by an exact offsetting change in the proportion of the other groups (Ha, 2024; Septya et al., 2024).

If the population proportion of group t increases by pc percent, such that $\phi(t) \rightarrow (\phi(t)(1 + pc))$, the total estimated impact on poverty is as follows:

$$\Delta P = \left[\phi(t) * P(t; z, \alpha) - \sum_{k \neq t}^{K} \frac{\phi(t)}{1 - \phi(t)} * \phi(k) * P(k; z, \alpha)\right] * pc \tag{9}$$

If the population proportion of group s increases by absolute pc percent of the total population, such that $\phi(t) \rightarrow (\phi(t)(1+pc))$, the total estimated impact on poverty is as follows:

$$\Delta P = \left[P(t; z, \alpha) - \sum_{k \neq s}^{K} \frac{\phi(k)}{1 - \phi(t)} * P(k; z, \alpha)\right] * pc \tag{10}$$

Where $P(t; z, \alpha)$ is the FGT poverty index for subgroup k and $\bar{\phi}(k)$ is the proportion of the population found in that subgroup.

5.3 FGT Poverty: decomposition by population subgroups

This decomposition takes the form:

$$\hat{P}(z;\alpha) = \sum_{g=1}^{G} \hat{\phi}(g)\hat{P}(z;\alpha;g) \tag{11}$$

Where G denotes the number of population subgroups. The results provide the estimated FGT index for each subgroup g, $\hat{P}(z;\alpha;g)$, as well as the estimated population share of subgroup g, $\hat{\phi}(g)$. In addition, the absolute contribution of subgroup g to total poverty is given by $\hat{\phi}(g)\hat{P}(z;\alpha;g)$, while its relative contribution to total poverty is computed as $(\hat{\phi}(g)\hat{P}(z;\alpha;g))/\hat{P}(z;\alpha)$.

5.4 Decomposition of change in FGT poverty by poverty and population group components – sectoral decomposition

Additive poverty measures, like the FGT indices (Ogwang and Mwabu, 2024; Bossert et al., 2022), can be expressed as a sum of the poverty contributions of the various subgroups of population (Bárcena-Martín and Cantó, 2025). Each subgroup contributes by its population share and poverty level. Thus, the change in poverty across time depends on the change in these two components. Denoting the population share of group k in period 1 by $\phi_1(k)$, the change in poverty between two periods can be expressed as follows (Huppi and Ravallion, 1991; Duclos and Araar, 2006):

$$\begin{aligned} P_2 - P_1 = &\left[\sum_{k=1}^{K} \phi_1(k)(P_2(k;z;\alpha) - P_1(k;z;\alpha))\right] + \\ &\left[\sum_{k=1}^{K} P_1(k;z;\alpha)(\phi_2(k) - \phi_1(k))\right] + \\ &\left[\sum (P_2(k;z;\alpha) - P_1(k;z;\alpha))(\phi_2(k) - \phi_1(k))\right] \end{aligned} \tag{12}$$

Where $P_2 - P_1$ represents the change in poverty between periods 1 and 2. Component C1 captures the intra-sectoral or intra-group effects (i.e., changes occurring within the group itself), whereas C2 reflects the impact of changes in subgroup proportions, associated with demographic or sectoral shifts. Finally, C3 denotes the interaction effect.

This decomposition uses the initial period as the reference. If the reference period is the final one, the decomposition takes the form:

$$\begin{aligned} P_2 - P_1 = &\left[\sum_{k=1}^{K} \phi_2(k)(P_2(k;z;\alpha) - P_1(k;z;\alpha))\right] + \\ &\left[\sum_{k=1}^{K} P_2(k;z;\alpha)(\phi_1(k) - \phi_2(k))\right] + \\ &\left[\sum (P_2(k;z;\alpha) - P_1(k;z;\alpha))(\phi_1(k) - \phi_2(k))\right] \end{aligned} \tag{13}$$

To remove the arbitrariness in selecting the reference period, we can use the Shapley decomposition approach, finding:

$$\begin{aligned} P_2 - P_1 = &\left[\sum_{k=1}^{K} \bar{\phi}(k)(P_2(k;z;\alpha) - P_1(k;z;\alpha))\right] + \\ &\left[\sum_{k=1}^{K} \bar{P}(k;z;\alpha)(\phi_2(k) - \phi_1(k))\right] \end{aligned} \tag{14}$$

Where $\bar{\phi}(k)$ is the average population share $= 0.5(\phi_1(k) + \phi_2(k))$ and $\bar{P}(k;z;\alpha) = 0.5(P_1(k;z;\alpha) + P_2(k;z;\alpha))$.

5.5 Poverty dominance

Distribution 1 dominates distribution 2 at order s over the conditional range $[Z^-, Z^+]$ if only:

$$P_1(\xi;\alpha) > P_2(\xi;\alpha) \quad \forall \xi \in [Z^-, Z^+] \quad \text{for } \alpha = s - 1 \tag{15}$$

This involves comparing stochastic dominance curves at order s or FGT curves with $\alpha = s - 1$. This application checks for the points at which there is a reversal of the dominance conditions. Hence, it provides the crossing points of the dominance curves, i.e., the values of ξ and $P_1(\xi;\alpha)$ for which $P_1(\xi;\alpha) = P_2(\xi;\alpha)$ when sign $(P_1(\xi - \eta;\alpha) - P_2(\xi - \eta;\alpha)) =$ sign $(P_2(\xi - \eta;\alpha) - P_1(\xi - \eta;\alpha))$ for a small η.

The crossing points of ξ can also be referred to as "critical poverty lines".

5.6 Multidimensional poverty index (MPI)

The MPI is a composite indicator of poverty that accounts for both the distribution of deprived areas and their prevalence (Appendix 1) (Tigre, 2020; Sadıq and Sani, 2022; Salari et al., 2024). The following are the indexes involved in the measurement:

Multidimensional headcount ratio (H): Is the proportion of people who have been classified as multidimensionally poor, i.e., those who fall below the poverty line (Bhuiyan et al., 2023), and is expressed as:

$$H = q(k)/n \tag{16}$$

The number (or headcount) of multidimensionally poor people according to parameter k is $q(k)$.

$$q(k) = \sum_{i=1}^{n} p_k(x_i; z) \tag{17}$$

The average deprivation share across the poor is defined as the intensity of poverty A, often known as the breadth of poverty (Marcelino and Cunha, 2023). This is presented as:

$$A = \sum_{i=1}^{q} C_i(k)/q(k) \tag{18}$$

The percentage of the d indicators in which the average multidimensionally poor person is deprived is the intensity of poverty (Li and He, 2024).

The measure M_0 is the so-called adjusted headcount ratio when $\alpha = 0$.

$$M_0 = H \times A \tag{19}$$

When $\alpha = 1$, the measure M_1, adjusted poverty gap, defined as the weighted average of indicator-specific poverty gaps is used. G is poverty gap.

$$M_1 = H \times A \times G \tag{20}$$

$$G = \frac{\sum_{i=1}^{n}\sum_{j=1}^{d} g_{ij}^{1}(k)}{\sum_{i=1}^{n}\sum_{j=1}^{d} g_{ij}^{0}(k)} \tag{21}$$

Finally, when $\alpha = 2$, the adjusted squared poverty gap (M_2) is calculated as the weighted average of the indicator-specific squared poverty gaps. S is poverty severity.

$$M_2 = H \times A \times S \tag{22}$$

$$S = \frac{\sum_{i=1}^{n}\sum_{j=1}^{d} g_{ij}^{2}(k)}{\sum_{i=1}^{n}\sum_{j=1}^{d} g_{ij}^{0}(k)} \tag{23}$$

Seth and Alkire (2014) as reported by Sadıq and Sani (2022) suggested an additively decomposable inequality measure that is a positive multiple of "variance" and has within-group and between-group components. The inequality measure I^q employs the vector of deprivation scores of the q impoverished people $c_i(k)$ to quantify inequality among the poor at the national or sub-national level.

$$I^q = \frac{\tilde{\beta}}{q}\sum_{i=1}^{q}[c_i(k) - A]^2 \tag{24}$$

To calculate the measure of inequality, the difference between each poor person's deprivation score and average intensity is squared, then the squared distances are added together and multiplied by a constant $\tilde{\beta}$. We set $\tilde{\beta} = 1/49$ since the poor's deprivation ratings vary from $1/7$ to 1. This is the greatest permissible number for the inequality gauge, guaranteeing that the inequality gauge is constrained between zero and one, given the spectrum of deprivation scores. Nevertheless, a lower degree of poverty or a decline in poverty does not necessarily mean that every region or demographic category has experienced an equal reduction in poverty (Sadıq and Sani, 2022; Sadiq and Grema, 2024; Sadiq et al., 2025).

6 Results and Discussion

6.1 The Role of NEAZDP on Social Mobility of Poverty among the Beneficiary Group

A perusal of Table 2 revealed the unidimensional social and economic mobility of poverty for the beneficiary group as the program transitioned through the initial period to the final period. The matrix showed that in the first quarter phase of the program, 24.17 % of the beneficiaries were significantly below the poverty threshold. Subsequently,

as the program passed to the second quarter phase, the proportion of the beneficiaries below the poverty threshold significantly declined to 16.67 %. This significant reduction in the proportion of the beneficiaries that were below the poverty threshold persisted until the third quarter phase (15.83 %) of the program implementation.

Conversely, in the last (fourth-quarter) phase of the program implementation, there was a sudden reversal in the trend of poverty proportion (increase) among the beneficiaries in the study area, i.e., 20.83 % of the beneficiaries were significantly below the poverty threshold. The initial decline in poverty levels across the phases indicates positive economic mobility for the beneficiaries. They were initially moved towards improved economic conditions, potentially finding better employment opportunities or increasing their income through the program's support.

The increase in poverty levels in the last phase signifies a reversal in economic mobility. It could imply that the economic gains achieved earlier were not sustained or that external factors such as economic downturns, changes in policy, or programmatic issues have caused deterioration in economic status. Fluctuations in poverty levels can affect social stability. A sudden increase in poverty levels, as seen in the last phase, might lead to social unrest or dissatisfaction among beneficiaries. Therefore, policymakers should consider the factors that contributed to the increase in poverty in the last phase. This might involve addressing systemic issues, enhancing program monitoring and evaluation, or providing longer-term support to ensure sustained economic and social improvements.

In summary, while the NEAZDP program initially showed positive impacts on reducing poverty and enhancing mobility among beneficiaries, the increase in poverty levels in the last phase highlights challenges in achieving sustained social and economic mobility. Addressing these challenges is crucial for ensuring that interventions lead to lasting improvements in the lives of beneficiaries.

Table 2. Unidimensional social mobility of poverty for the beneficiary group

	Final period (AMI)				
Initial period (BMI)	**0.0 – 0.25**	**0.25 – 0.5**	**0.5 – 0.75**	**0.75 – 1.0**	**Total**
0.0 – 0.25	**0.241667** **(-0.01342)** **[-18.0073]**$^{\wedge}$	0.091667 (-0.01447) [-6.33674]$^{\wedge}$	0.008333 (-0.00845) [-0.9857]^{NS}	0.008333 (-0.00827) [-1.00753]^{NS}	0.291667 (-3.6E-05) [-8172.22]$^{\wedge}$
0.25 – 0.5	0.108333 (-0.0145) [-7.46882]$^{\wedge}$	**0.166667** **(-0.01986)** **[-8.39025]**$^{\wedge}$	0.091667 (-0.01846) [-4.96439]$^{\wedge}$	0.041667 (-0.017) [-2.45069]$^{\wedge}$	0.35 (-3.9E-05) [-8995.12]$^{\wedge}$
0.5 – 0.75	0.008333 (-0.00815) [-1.02304]^{NS}	0.15 (-0.01669) [-8.98535]$^{\wedge}$	**0.158333** **(-0.02017)** **[-7.85053]**$^{\wedge}$	0.058333 (-0.0151) [-3.86247]$^{\wedge}$	0.333333 (-2.6E-05) [-12679.1]$^{\wedge}$
0.75 – 1.0	0 (-0.00033) [0]^{NS}	0.033333 (-0.00986) [-3.3823]$^{\wedge}$	0.125 (-0.01581) [-7.90809]$^{\wedge}$	**0.208333** **(-0.02311)** **[-9.01317]**$^{\wedge}$	0.35 (-2.3E-05) [-15125.3]$^{\wedge}$
Total	0.266667 (-3.1E-05) [-8672.09]$^{\wedge}$	0.316667 (-2.5E-05) [-12586.1]$^{\wedge}$	0.258333 (-3.9E-05) [-6591.82]$^{\wedge}$	0.266667 (-2.8E-05) [-9379.76]$^{\wedge}$	1 0 -

Note: Values in ( ) and [ ] are standard errors and t-statistics, respectively; $^{\wedge}$ & NS mean significant at 1 % and non-significant, respectively. Source: Field survey, 2023

6.2 Impact of Growth and Redistribution on Poverty of NEAZDP Beneficiaries

Furthermore, in assessing the effects of income growth and redistribution on poverty reduction among the beneficiary group (Table 3 and Figure 3), after program intervention, due to growth in the economy (i.e., economic growth), poverty declined by 6.20 %. Conversely, income redistribution increased poverty among the beneficiaries after program intervention, an indication of a poor system of tax administration; likewise, the social safety measure(s) are not pro-poor, i.e., they favor the non-poor against the poor in the beneficiary group.

Despite the program's impact on economic growth, the poor state of public expenditure (i.e., subsidies, social safety measures) and the presence of an ineffective progressive tax administration system constitute a clog in the wheel of the program's success and long-term sustainability in the study area. In other words, despite the NEAZDP's positive impact on economic growth and poverty reduction, the ineffective income redistribution, inadequate public expenditure, and flawed tax administration undermine its success and sustainability, necessitating targeted reforms in tax policy, public expenditure, and social safety measures to better support the poor.

Put differently, the results indicate that while NEAZDP-induced economic growth reduced poverty by 6.20 %, flawed income redistribution increased poverty among beneficiaries, highlighting issues in tax administration. This suggests that the benefits of economic growth are not reaching the poorest members of the community, potentially exacerbating inequality. For the NEAZDP to achieve its poverty reduction goals sustainably, it is crucial to reform tax policies to ensure a more equitable distribution of income, so that the poorest beneficiaries are effectively supported and can share in the program's benefits.

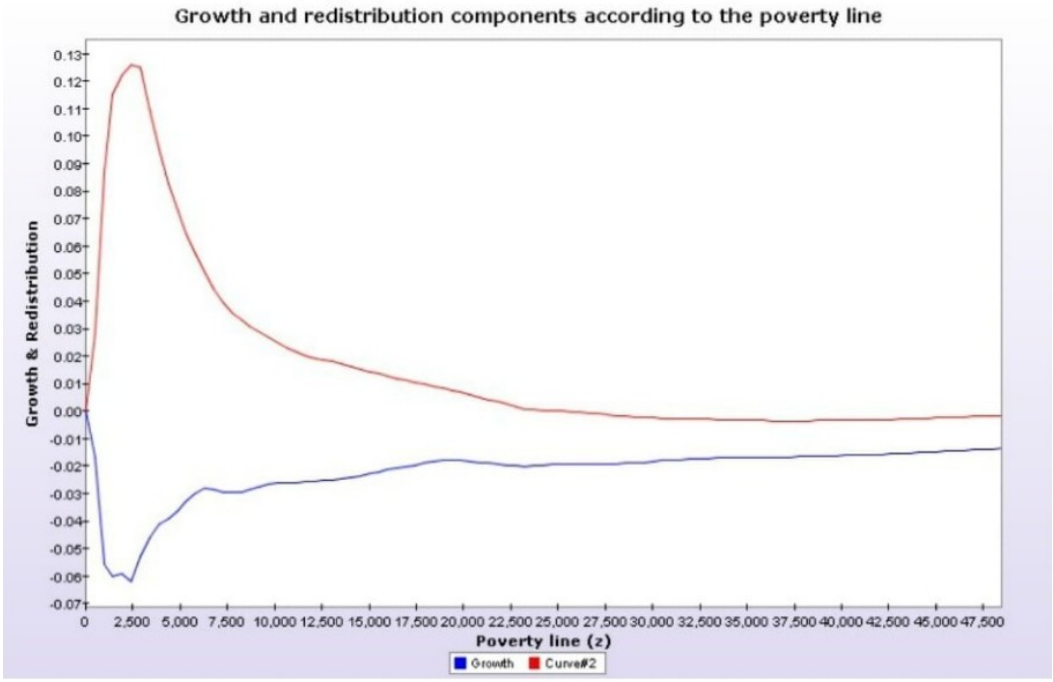


Figure 3. Growth and redistribution effects on poverty of NEAZDP

Table 3. Impact of growth and redistribution on poverty of the beneficiary group

I. Poverty indices			
Items	**Initial**	**Final**	
	Reference 2		
Datt & Ravallion (1992) approach			
Estimate	0.36166427	0.42506710	
	(0.02728206) 13.2565***	(0.02850802) 14.9104***	
Difference Index1–Index2	0.06340283 (0.03962348) 1.60013^{NS}		
Covariance Index1–Index2	-0.00000650		
Shapley approach			
Estimate	0.36166427	0.42506710	
	(0.02728206) 13.2565***	(0.02850802) 14.9104***	
Difference Index1–Index2	0.06340283 (0.03962348) 1.60013^{NS}		
Covariance Index1–Index2	-0.00000650		
	Reference 1		
Datt & Ravallion (1992) approach			
Estimate	0.36166427	0.42506710	
	(0.02728206) 13.2565***	(0.02850802) 14.9104***	
Difference Index1–Index2	0.06340283 (0.03962348) 1.60013^{NS}		
Covariance Index1–Index2	-0.00000650		
Shapley approach			
Estimate	0.36166427	0.42506710	
	(0.02728206) 13.2565***	(0.02850802) 14.9104***	
Difference Index1–Index2	0.06340283 (0.03962348) 1.60013^{NS}		
Covariance Index1–Index2	-0.00000650		
Poverty line	2417.78002930 (0.00000000)		
II. Decomposition (Contribution)			
Contribution of:	**Growth**	**Redistribution**	**Residue**
NEAZDP	**Reference 2**		
	-0.06196356	0.12571451	-0.00034812
	(0.06077006)	(0.12385039)	N.A
	1.01964^{NS}	1.01505^{NS}	–
	-0.06213762	0.12554045	0.00000000
	(0.07908917)	(0.07908917)	(0.0)
	0.785665^{NS}	1.58733^{NS}	–
	Reference 1		
	-0.06231168	0.12536639	0.00034812
	(0.09838520)	(0.05125128)	N.A
	0.633344^{NS}	2.44611**	–
	-0.06213762	0.12554045	0.00000000
	(0.07908917)	(0.07908917)	(0.0)
	0.785665^{NS}	1.58733^{NS}	–

Note: Values in parentheses ( ) are standard errors; ***, **, * and NS indicate statistical significance at the 1 %, 5 %, and 10 % levels, and non-significance, respectively. Source: Field survey, 2023

6.3 Pro-Poor Curve of NEAZDP Beneficiaries

Moreover, in assessing the pro-poor growth, after program participation, the results in Table 4 (depicted in Figure 4) showed a decline in the growth incidence (18.75 %) of poverty and a significant decline in the growth severity (17.22 %) of poverty. Succinctly, it can be inferred that the policies of the program directly targeted the poorest of the poor; in other words, the policies of the program are more generally aimed at poverty alleviation. Likewise, it can be concluded that the incomes of poor households in the beneficiary group grow faster than that of the whole population of the non-beneficiary group.

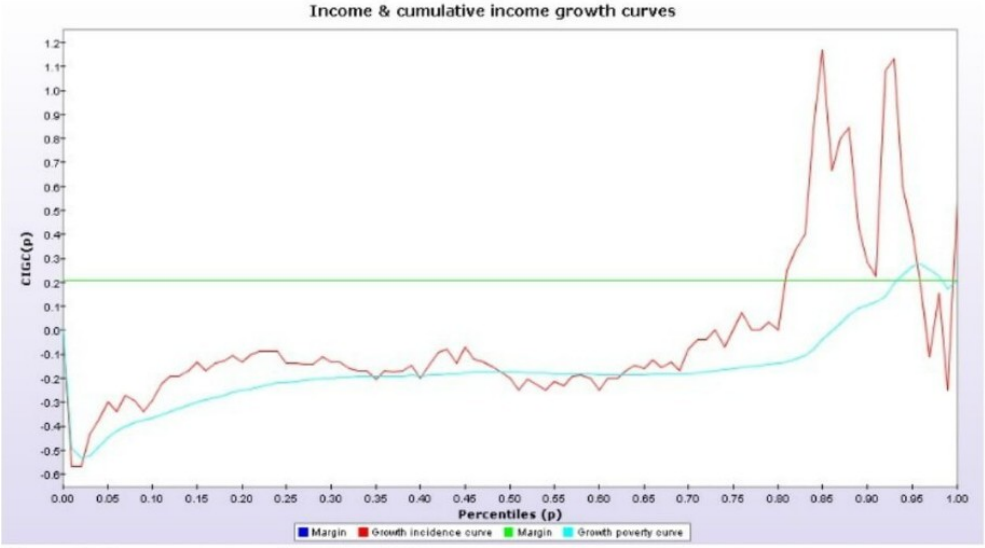


Figure 4. Pro-poor curve of the beneficiary group

Table 4. Pro-poor curve of beneficiary group

Items	Estimated Value
Growth Incidence Curve	-0.18750001 (0.15652524) 1.19789^{NS}
Growth Poverty Curve	-0.17221867 (0.08624621) 1.996826**

Note: Value in ( ) is standard error; ***, **, * & NS mean significant at 1, 5, 10 % and non-significant respectively. Source: Field survey, 2023

Succinctly, for growth to be pro-poor, it means there is a fall in income inequality of the beneficiary group compared to the non-beneficiary group. Noteworthy, pro-poor growth is the type of growth that enables the poor to actively participate in economic activities and benefit proportionally more than the non-poor from overall income increase. This suggests that the program has effectively targeted and benefited the poorest individuals within the beneficiary group, leading to meaningful improvements in their living conditions. The significant decline in poverty severity also implies that the most vulnerable members are experiencing less extreme poverty, which is a positive outcome for long-term poverty reduction and improved well-being in the region.

In other words, the NEAZDP has effectively targeted the poorest households, leading to significant reductions in poverty incidence and severity,

and ensuring that poor households benefit more proportionally from economic growth compared to the non-beneficiary group. Therefore, to enhance its impact, the program should continue focusing on equitable income growth and implement measures to further reduce income inequality.

6.4 Impact of Demographic Change on Poverty of NEAZDP Beneficiaries

In assessing the impact of demographics on poverty (relative to group) (Table 5), between beneficiary and spill-over groups respectively, for a 10 % change (increase) in the size of each group, poverty will significantly decline by 0.64 % and increase by 0.86 %, as evident by their respective impact coefficient at 10 % degree of freedom. Besides, the results showed a decrease (28.03 % to 26.21 %) in the proportion of poor in the beneficiary group against an increase (39.40 % to 43.34 %) in the proportion of poor in the spill-over group.

Moreover, relative to population, the results showed that a 10 % increase in each of the population of the beneficiary and spill-over groups, respectively, will significantly make poverty to decline and increase by 1.63 % and 2.18 %. On the other hand, relative to group, between beneficiary and control groups respectively, a 10 % increase in the size of each group will significantly plummet and increase poverty by 0.44 % and 1.63 %. Nevertheless, relative to population, for a 10 % increase in the group size of the beneficiary group, poverty will significantly plummet by 1.34 % whereas relative to the control group, poverty will significantly surge by 5.01 %.

Table 5. Impact of demographic change on poverty

Items	Poverty Before	Poverty After	Total Impact
Beneficiary vs. Spill-over			
Relative to Group (RG)	0.34835789	0.33988169	-0.00847619
	(0.07950081)	(0.08708012)	(0.01028815)
	4.38182***	3.90309***	0.823879^{NS}
Relative to Population (RP)	0.34835789	0.32684656	-0.02151132
	(0.07950081)	(0.06844059)	(0.00779362)
	4.38182***	4.77562***	2.760119***
Poverty line		11021.84	
Beneficiary vs. Control			
Relative to Group (RG)	0.33328196	0.34139459	0.00811263
	(0.08290117)	(0.08831333)	(0.00637910)
	4.02023***	3.86572***	1.27175^{NS}
Relative to Population (RP)	0.33328196	0.35819332	0.02491135
	(0.08290117)	(0.06957350)	(0.00721471)
	4.02023***	5.14842***	-3.45286***
Poverty line		10733.72	
Beneficiary vs. Spill-over and Control			
Relative to Group (RG)	0.31974724	0.32697389	0.00722665
	(0.07714256)	(0.08159047)	(0.00567126)
	4.14489***	4.0075***	1.27426^{NS}
Relative to Population (RP)	0.31974724	0.34193803	0.02219079
	(0.07714256)	(0.06287188)	(0.00710749)
	4.14489***	5.43865***	3.12217***
Poverty line		10550.48	

Table 5: Continued .....

Group	Estimate	Proportion Before	Proportion After	Impact
		Beneficiary vs. Spill-over		
1 (RG)	0.35214436	0.28030601	0.26207889	-0.00641858
	(0.05010282)	(0.33943272)	(0.33590802)	(0.00837355)
	7.02843***	0.82581^{NS}	0.78021***	0.76653^{NS}
2	0.21800661	0.39403409	0.43343750	0.00859020
	(0.00966169)	(0.38837504)	(0.42721254)	(0.00808642)
	22.564***	1.01457^{NS}	1.01457^{NS}	1.0623^{NS}
1 (RP)	0.35214436	0.28030601	0.23404829	-0.01628939
	(0.05010282)	(0.33943272)	(0.30205948)	(0.01392726)
	7.02843***	0.82581^{NS}	0.77484^{NS}	1.169605^{NS}
2	0.21800661	0.39403409	0.49403409	0.02180066
	(0.00966169)	(0.38837504)	(0.38837504)	(0.00096617)
	22.564***	1.01457^{NS}	1.27205^{NS}	22.564***
		Beneficiary vs. Control		
1 (RG)	0.32265320	0.28030601	0.26676916	-0.00436771
	(0.04848970)	(0.33943272)	(0.33022633)	(0.00669527)
	6.65406***	0.82581***	0.80784^{NS}	0.652358^{NS}
3	0.50126922	0.32565993	0.35822592	0.01632433
	(0.04570181)	(0.32955313)	(0.36250844)	(0.01503607)
	10.9683***	0.98819^{NS}	0.98819^{NS}	1.08568^{NS}
1 (RP)	0.32265320	0.28030601	0.23873856	-0.01341187
	(0.04848970)	(0.33943272)	(0.29634706)	(0.01360754)
	6.65406***	0.82581^{NS}	0.8056^{NS}	0.98562^{NS}
3	0.50126922	0.32565993	0.42565993	0.05012692
	(0.04570181)	(0.32955313)	(0.32955313)	(0.00457018)
	10.9683***	0.98819^{NS}	1.29163^{NS}	10.9683***
		Beneficiary vs. Spill-over and Control		
1 (RG)	0.32265320	0.28030601	0.26676916	-0.00436771
	(0.04848970)	(0.33943272)	(0.33022633)	(0.00669527)
	6.65406***	0.82581^{NS}	0.80784^{NS}	0.652358^{NS}
2	0.19400491	0.39403409	0.37500495	-0.00369175
	(0.00931401)	(0.38837504)	(0.38642935)	(0.00458291)
	20.8294***	1.01457^{NS}	0.97044^{NS}	0.805547^{NS}
3	0.46938863	0.32565993	0.35822592	0.01528611
	(0.04114868)	(0.32955313)	(0.36250844)	(0.01413320)
	11.4071***	0.98819^{NS}	0.98819^{NS}	-1.08157^{NS}
1 (RP)	0.32265320	0.28030601	0.23873856	-0.01341187
	(0.04848970)	(0.33943272)	(0.29634706)	(0.01360754)
	6.65406***	0.82581^{NS}	0.8056^{NS}	0.98562^{NS}
2	0.19400491	0.39403409	0.33560154	-0.01133620
	(0.00931401)	(0.38837504)	(0.34767237)	(0.00878248)
	20.8294***	1.01457^{NS}	0.96528^{NS}	1.290774^{NS}
3	0.46938863	0.32565993	0.42565993	0.04693886
	(0.04114868)	(0.32955313)	(0.32955313)	(0.00411487)
	11.4071***	-0.98819^{NS}	1.29163^{NS}	11.4071***

Source: Field survey, 2023

Note: Value in ( ) is standard error; ***, **, * & ^{NS} mean significant at 1, 5, 10% and non-significant respectively; 1 = Beneficiary, 2 = Spillover, 3 = Control.

The NEAZDP has effectively reduced poverty among beneficiaries compared to the spill-over and control groups, with a 10 % increase in the beneficiary group size leading to a significant 1.34 % decrease in poverty. Therefore, to maximize impact, the program should focus on expanding its reach while ensuring effective measures are in place to prevent increasing poverty in control and spill-over groups.

Put differently, the results indicate that the NEAZDP effectively reduces poverty within the beneficiary group, with a 10 % increase in group size leading to a 1.34 % decrease in poverty. However, the spill-over and control groups experience rising poverty with similar population increases. This suggests the program is successfully targeting the beneficiary group but may be contributing to increased inequality and poverty in surrounding areas. To enhance overall impact, the program may need to extend benefits to spill-over and control groups or address the negative effects on these non-beneficiary groups.

Furthermore, in assessing poverty decomposition for two groups, between the beneficiary and spill-over groups (Table 6), the empirical evidence showed that 28.34 and 9.87 % of the significant 35.21 % who were poor among the beneficiary group were relatively poor (have basic needs but face social exclusion) and absolutely poor (lack basic needs), respectively. Contrarily, of the significant 21.80 % who were poor among the spill-over group, 8.59 % faced relative poverty while 24.66 % faced absolute poverty. Further, between the beneficiary and control groups, of the 32.27 % who were significantly poor among the former, 27.15 % are challenged with relative poverty whereas 9.04 % are challenged with absolute poverty. Contrarily, of the significant 50.13 % who were poor among the control group, 48.98 % were relatively poor while 16.32 % were absolutely poor.

Nevertheless, in assessing poverty decomposition by groups (a broader perspective, i.e., overall), between beneficiary against spill-over and control groups, it was observed that of the significant 32.27 % who were poor among the beneficiary group, 28.29 and 9.04 %, respectively, were relatively and absolutely poor. Contrarily, of the significant 19.40 % who were poor among the spill-over group, 23.91 and 7.65 %, respectively, were relatively and absolutely poor. Likewise, of the significant 46.94 % who were poor among the control group, 47.81 and 15.29 %, respectively, were relatively and absolutely poor.

Table 6. FGT poverty decomposition (two groups and overall)

Items	Estimates
	Beneficiary vs. Spill-over
Poverty line	11021.84
Estimate	0.34835789 (0.07950081) 4.38182***
Abs. difference in contribution	0.13413775 (0.05648720) 2.37466**
Difference in % in contribution	0.03676145 (0.47523284) 0.07735^{NS}
	Beneficiary vs. Control
Poverty line	10733.72
Estimate	0.33328196 (0.08290117) 4.02023***
Abs. difference in contribution	-0.17861602 (0.07945089) 2.248131**
Difference in % in contribution	-0.21843864 (0.57176186) 0.382045^{NS}
	Beneficiary vs. Spill-over and Control
Poverty Line	10550.48046875 (0.00000000)
Estimate	0.31974724 (0.07714256) 4.14489***

Table 6: Continued .....

Group	Estimate	Population Share	Relative Contribution	Absolute Contribution
		Beneficiary vs. Spill-over		
1	0.35214436	0.28030601	0.28335276	0.09870818
	(0.05010282)	(0.33943272)	(0.30223390)	(0.10549074)
	7.02843***	0.82581^{NS}	0.93753^{NS}	0.9357^{NS}
2	0.21800661	0.39403409	0.24659131	0.08590204
	(0.00966169)	(0.38837504)	(0.28222683)	(0.08086418)
	22.564***	1.01457^{NS}	0.87373^{NS}	1.0623^{NS}
		Beneficiary vs. Control		
1	0.32265320	0.28030601	0.27136672	0.09044163
	(0.04848970)	(0.33943272)	(0.29265392)	(0.09593251)
	6.65406***	0.82581^{NS}	0.92726^{NS}	0.94276^{NS}
3	0.50126922	0.32565993	0.48980537	0.16324329
	(0.04570181)	(0.32955313)	(0.34020883)	(0.15036066)
	10.9683***	0.98819^{NS}	1.43972^{NS}	1.08568^{NS}
		Beneficiary vs. Spill-over and Control		
1	0.32265320	0.28030601	0.28285351	0.09044163
	(0.04848970)	(0.33943272)	(0.30035448)	(0.09593251)
	6.65406***	0.82581^{NS}	0.94173^{NS}	0.94276^{NS}
2	0.19400491	0.39403409	0.23907804	0.07644454
	(0.00931401)	(0.38837504)	(0.27542734)	(0.07167942)
	20.8294***	1.01457^{NS}	0.86803^{NS}	1.06648^{NS}
3	0.46938863	0.32565993	0.47806844	0.15286106
	(0.04114868)	(0.32955313)	(0.34060581)	(0.14133203)
	11.4071***	0.98819^{NS}	1.40358^{NS}	1.08157^{NS}
Total	—	1.0	1.0	0.31974724
		(0.00)	(0.00)	(0.07714256)
	-	-	-	4.14489***

Note: Value in ( ) is standard error; ***, **, * & ^{NS} mean significant at 1, 5, 10 % and non-significant respectively. Source: Field survey, 2023

The NEAZDP has been more successful in addressing absolute poverty among beneficiaries compared to the spill-over and control groups, significantly reducing absolute poverty while still encountering notable relative poverty. Thus, the program should continue focusing on reducing absolute poverty while also developing targeted interventions to address relative poverty and social exclusion. In other words, the results suggest that the NEAZDP has had a more substantial impact on reducing absolute poverty than relative poverty. The beneficiary group shows a higher proportion of individuals facing relative poverty compared to absolute poverty, indicating that while basic needs are generally met, issues of social exclusion persist. In contrast, both the spill-over and control groups experience higher rates of absolute poverty, especially the control group. This highlights the need for the NEAZDP to focus not only on reducing absolute poverty but also on addressing social exclusion and relative poverty to improve overall well-being.

Moreover, from a broader dimension, i.e., the sectoral decomposition of differences in poverty (natural), between the beneficiary versus the spill-over and control groups, the results showed a very drastic decline in the proportion of the beneficiary group that is challenged with absolute poverty against its counterparts in the spill-over and control groups (Table 7). Besides, due to program impact, as evident by the intra-group impact, the proportion of households in the beneficiary group that faces absolute poverty is 1.51 % against their counterparts in the spill-over group (2.40 %). Likewise, the proportion of households in the beneficiary group

challenged with absolute poverty is 1.085 % against their counterparts in the control group (2.09 %). Generally, it can be inferred that program impact plays a great role in minimizing absolute poverty among the beneficiaries against their counterparts in the spill-over and control groups. Nevertheless, the results obtained under Shapley's decomposition model exhibited a similar trend. Conclusively, the NEAZDP has significantly reduced absolute poverty among beneficiaries compared to both spill-over and control groups, demonstrating its effectiveness in addressing severe poverty. Therefore, to enhance overall impact, the program should continue its focus on absolute poverty reduction while also exploring strategies to mitigate relative poverty and ensure broader social inclusion.

Table 7. FGT poverty decomposition (sectoral decomposition).

Items	Distribution (1)	Distribution (2)	Difference P(2) - P(1)
	Beneficiary vs. Spill-over		
	Beneficiary	*Spill-over*	
Estimate (NA)	0.11783745	0.08572166	-0.03211579
	(0.03049792)	(0.02502065)	(0.00737291)
	3.86379***	3.42604***	4.355918***
Estimate (SA)	0.11783745	0.08572166	-0.03211579
	(0.03049792)	(0.02502065)	(0.00737291)
	3.86379***	3.42604***	4.355918***
	Beneficiary vs. Control		
	Beneficiary	*Control*	
Estimate (NA)	0.11783745	0.07124325	-0.04659420
	(0.03049792)	(0.02222445)	(0.01077736)
	3.86379***	3.20562***	4.323341***
Estimate (SA)	0.11783745	0.07124325	-0.04659420
	(0.03049792)	(0.02222445)	(0.01077736)
	3.86379***	3.20562***	4.323341***

Note: Values in parentheses represent standard errors; ***, **, * and NS indicate statistical significance at the 1 %, 5 %, and 10 % levels, and non-significance, respectively. NA = Natural approach; SA = Shapley approach.
Poverty line: 11788.41.
Source: Field survey (2023).

Table 7: Continued .....

Group	Estimate (1)	Proportion (1)	Abs. Contribution (1)	Estimate (2)	Proportion (2)	Abs. Contribution (2)	Difference in Cont. (2)-(1)
1 (NA)	0.09089787	0.28030600	0.02547922	0.05386852	0.28030600	0.01509967	-0.01037955
	(0.01259371)	(0.33943273)	(0.02732501)	(0.00743065)	(0.33943273)	(0.01620270)	(0.01112231)
	7.21772***	0.82581^{NS}	0.93245^{NS}	7.2495***	0.82581^{NS}	0.93192^{NS}	0.933219^{NS}
2	0.08015536	0.39403407	0.03158394	0.06097051	0.39403407	0.02402446	-0.00755949
	(0.00362057)	(0.38837504)	(0.02970480)	(0.00264210)	(0.38837504)	(0.02263913)	(0.00706566)
	22.1389***	1.01457^{NS}	1.06326^{NS}	23.0765***	1.01457^{NS}	1.06119^{NS}	1.069892^{NS}
1 (SA)	0.09089787	0.28030600	0.02547922	0.05386852	0.28030600	0.01509967	-0.01037955
	(0.01259371)	(0.33943273)	(0.02732501)	(0.00743065)	(0.33943273)	(0.01620270)	(0.01112231)
	7.21772***	0.82581^{NS}	0.93245^{NS}	7.2495***	0.82581^{NS}	0.93192^{NS}	0.933219^{NS}
2	0.08015536	0.39403407	0.03158394	0.06097051	0.39403407	0.02402446	-0.00755949
	(0.00362057)	(0.38837504)	(0.02970480)	(0.00264210)	(0.38837504)	(0.02263913)	(0.00706566)
	22.1389***	1.01457^{NS}	1.06326^{NS}	23.0765***	1.01457^{NS}	1.06119^{NS}	1.069892^{NS}
1 (NA)	0.09089787	0.28030600	0.02547922	0.03868928	0.28030600	0.01084484	-0.01463438
	(0.01259371)	(0.33943273)	(0.02732501)	(0.00479623)	(0.33943273)	(0.01178852)	(0.01553649)
	7.21772***	0.82581^{NS}	0.93245^{NS}	8.0666***	0.82581^{NS}	0.91995^{NS}	0.941936^{NS}
3	0.18661886	0.32565992	0.06077428	0.12230989	0.32565992	0.03983143	-0.02094285
	(0.01677674)	(0.32955313)	(0.05605531)	(0.01162652)	(0.32955313)	(0.03653385)	(0.01952147)
	11.1237***	0.98819^{NS}	1.08418^{NS}	10.5199***	0.98819^{NS}	1.09026^{NS}	1.072811^{NS}
1 (SA)	0.09089787	0.28030600	0.02547922	0.03868928	0.28030600	0.01084484	-0.01463438
	(0.01259371)	(0.33943273)	(0.02732501)	(0.00479623)	(0.33943273)	(0.01178852)	(0.01553649)
	7.21772***	0.82581^{NS}	0.93245^{NS}	8.0666***	0.82581^{NS}	0.91995^{NS}	0.941936^{NS}
3	0.18661886	0.32565992	0.06077428	0.12230989	0.32565992	0.03983143	-0.02094285
	(0.01677674)	(0.32955313)	(0.05605531)	(0.01162652)	(0.32955313)	(0.03653385)	(0.01952147)
	11.1237***	0.98819^{NS}	1.08418^{NS}	10.5199***	0.98819^{NS}	1.09026^{NS}	1.072811^{NS}

Source: Field survey, 2023

Poverty line = 11788.41

6.5 Poverty Dominance (Beneficiary versus Spill-over and Control Groups)

In assessing the poverty dominance between the beneficiary and spill-over groups, the results showed poverty to dominate in the spill-over group against the beneficiary group (Table 8). At cross 1 (case #1), the poverty crossing value for the beneficiary group out of the critical relative poverty line is ₦7,647.18, whereas the relative poverty crossing point for the spill-over group is ₦7,657.59 at cross 2 (case #2). Likewise, at cross 3 (case #2), the significant amount needed by the beneficiary group to cross over the line of relative poverty is ₦8,057.53, while the spill-over group needs a significant amount in the sum of ₦14,113.54 to cross over the relative poverty line at cross 4 (case #2). Comparatively, the margin of cross-over between the two groups is slight at cross 1 versus 2, while it is wide at cross 3 (case #1) versus cross 4 (case #2).

On the other hand, between the beneficiary and control groups, the poverty dominance of the latter is higher than that of the former as evident by case #1 versus case #2. Besides, the poverty crossing value of the beneficiary group is ₦46,296.82 against that of the control group (₦53,709.65). It is noteworthy that the poverty crossing values of both groups were significant thresholds; however, the marginal difference between the thresholds of the duo is mild.

The NEAZDP has effectively reduced poverty compared to the spill-over and control groups, with beneficiaries requiring significantly less to cross the relative poverty line, indicating better poverty alleviation. To further enhance its impact, the program should focus on deepening its interventions to address the remaining poverty gaps and reduce the disparities within the control group. In other words, the results indicate that while the NEAZDP has been somewhat effective, poverty remains more dominant in the spill-over group compared to the beneficiary group. The beneficiary group requires a smaller amount to move out of relative poverty compared to the spill-over group, but a larger amount compared to the control group. The control group faces higher poverty dominance overall. These findings suggest that the NEAZDP is moderately successful in reducing poverty but highlights the need for more targeted interventions to address the wider poverty gap and improve the situation of both spill-over and control groups.

Table 8. Poverty dominance between beneficiary vs. spill-over and control groups

Crossing	Value of Z	Standard Error	t-statistic	Case
Beneficiary vs. Spill-over				
1	7647.18310547	157.33786159	48.60358	1
2	7657.59179688	156.71906348	48.8619	2
3	8057.53173828	254.47420782	31.66345	1
4	14113.53808594	665.59058712	21.20453	2
Beneficiary vs. Control				
1	46296.81640625	409.09327366	113.1693	1
2	53709.64843750	6245.16691867	8.600194	2

Source: Field survey, 2023.
Note: Case #1 = Before, Distribution #1 Dominates Distribution #2; Case #2 = Before, Distribution #2 Dominates Distribution #1.

The Role of NEAZDP on Multidimensional Poverty Status of the Beneficiary against the Spill-over and Control Groups

A cursory review of the multidimensional poverty level showed that at the poverty threshold level ($k = 0.33$), a proportion of 28.21 % of the households in the beneficiary group were multidimensionally poor against that of the spill-over (61.51 %) and control (52.99 %) groups as indicated by their respective head count ratio index (Table 9 and Fi-

gure 5a). Comparatively, the incidence of poverty is low among the beneficiaries compared to the non-beneficiary group: the states of acute poverty in the spill-over and control groups are higher than that of the beneficiary group by 33.3 % and 24.78 %, respectively. This suggests that the intervention has been effective in reducing poverty among beneficiaries.

Besides, the average poor household of the beneficiary group is deprived of 36.64 % of the weighted indicators against that of the spill-over and control groups respectively that are deprived of 40.19 % and 38.68 % of the weighted indicators as evident by their respective intensity poverty index. Succinctly, the poor households in the beneficiary group experienced 10.34 % deprivation out of the total potential deprivations that could be experienced compared to the poor households in the spill-over and control groups respectively that experienced deprived share proportions of 24.72 % and 20.49 % from the total potential deprivation as evident from their respective MPI (multidimensional poverty index).

Nevertheless, as evident by the MPG (multidimensional poverty gap) index, the average indicator-specific gap between haves and non-haves of the beneficiary group is 17.87 % against that of the spill-over and control groups respectively that were 36.79 % and 32.49 %. By implication, if the poor households in the beneficiary, spill-over and control groups respectively become more deprived in the challenged indicator(s), poverty would surge by 17.87 %, 36.79 % and 32.49 %. Similarly, if the shortfall from the deprivation cutoff is reduced, the poverty levels of the beneficiary, spill-over and control groups respectively will go down by 17.87 %, 36.79 % and 32.49 %, even if a poor household remains poor. Besides, the average severity of the deprived indicator(s) for the beneficiary, spill-over and control groups were 11.34 %, 22.12 % and 20 % respectively as evident by their respective MPS (multidimensional poverty severity) indexes.

To sum up, the share contribution of the beneficiary group to poverty in the study area is 17 % against that of the spill-over (45 %) and control (38 %) groups. In the same vein, the share poverty population of the beneficiary group is 30.38 % compared to that of the spill-over (34.68 %) and control (34.94 %) groups. Nevertheless, among the poor households in the beneficiary group, standard of living ranked first as the major deprived indicator, followed by empowerment and then environment as evident in the dimension-wise distribution (Figures 5b and 5c). Comparatively, the contribution of groups to poverty exceeds that of the groups' poverty population share (Figure 5d). By implication, it entails that there is no serious unequal distribution of poverty within the beneficiary group while the reverse is the case for the spill-over and control (non-beneficiary) groups bearing a disproportionate share of poverty for each group. In addition, inequality in the poverty level of poor households across the targeted populations was low as evident by the inequality index value. However, according to Alkire and Foster (2011), as reported by Sadıq and Sani (2022); Sadiq and Grema (2024), a lower level of inequality among the poor or a drop in the degree of inequality among the poor does not always imply that poverty has decreased uniformly across demographic subgroups.

Noteworthy, the case of a severe poverty level ($k = 0.50$) was not established across the targeted groups. Generally, it can be inferred that the NEAZDP beneficiaries in the study area experienced lower multidimensional poverty compared to spill-over and control groups, with lower incidence, intensity, and severity of poverty. Despite these improvements, challenges remain in specific dimensions like standard of living, empowerment, and environment. The program's success in reducing poverty shares and severity underscores its potential to alleviate poverty further if targeted indicators are addressed. Effective policy adjustments could enhance impact, potentially reducing poverty by up to 17.87 % among beneficiaries. These findings underscore the program's positive impact while emphasizing areas for continued improvement and focused intervention.

Table 9. MPI distributions of beneficiary vis-à-vis spill-over and control groups

Items	Beneficiaries	Spill-over	Control
Head count (H)	0.282086	0.615061	0.529859
Intensity (A)	0.366389	0.401897	0.386753
MPI	0.103353	0.247191	0.204925
Gap	1.729339	1.488198	1.585633
MPG	0.178732	0.367869	0.324935
Severity (S)	1.097565	0.895027	0.975874
MPS	0.113437	0.221243	0.199981
Inequality (IE)	3.21E-05	9.44E-05	6.43E-05
CG	17	45	38
PS	30.38	34.68	34.94
Dimension			
Education (E)	0.008952 (8.662)	0.015704 (6.352877)	0.019007 (9.275217)
Health (H)	0.009 (8.708198)	0.020142 (8.148421)	0.020157 (9.836424)
Standard Living	0.025337 (24.51539)	0.058761 (23.77151)	0.04826 (23.55028)
Environment (EN)	0.018764 (18.15555)	0.028173 (11.39714)	0.034167 (16.67294)
Empowerment (EM)	0.019778 (19.13596)	0.036744 (14.8648)	0.026848 (13.10163)
Social capital (S)	0.008817 (8.531108)	0.043181 (17.46851)	0.020548 (10.02689)
Wealth (W)	0.012704 (12.29179)	0.044486 (17.99674)	0.035937 (17.53662)
MPI	0.103352 (100)	0.247191 (100)	0.204924 (100)

Source: Field survey, 2023.
Note: Value in ( ) is percentage; CG = contribution of group; PS = population share; Standard of living (SL).

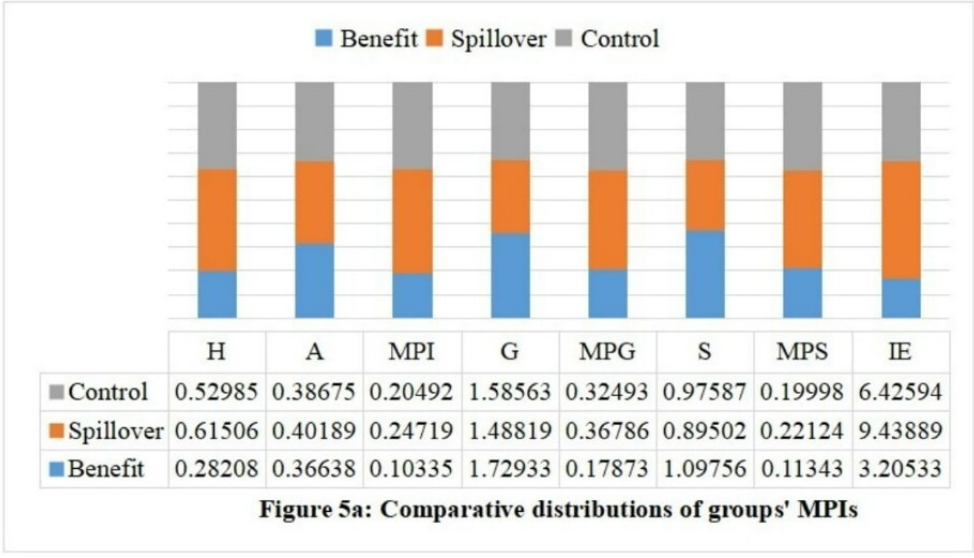
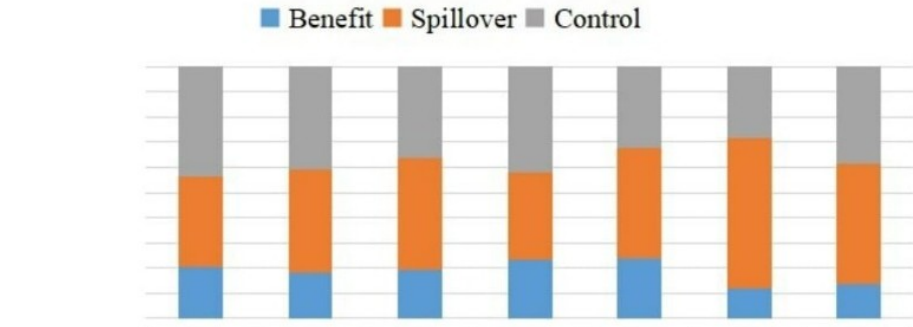


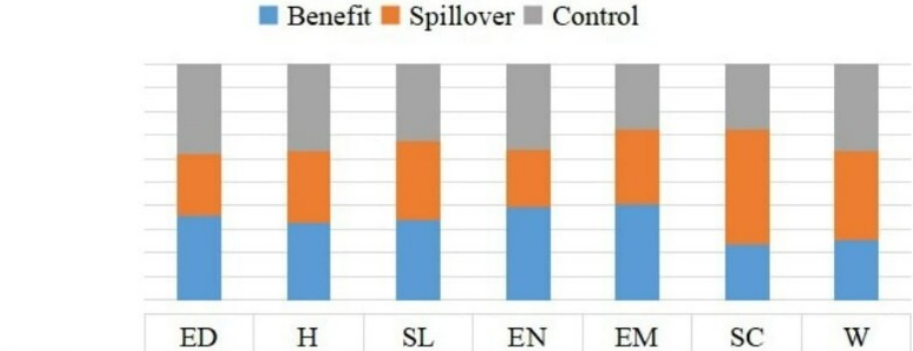
Figure 5a. Comparative distributions of groups' MPIs



	ED	H	SL	EN	EM	SC	W
Control	0.01900	0.02015	0.04826	0.03416	0.02684	0.02054	0.03593
Spillover	0.01570	0.02014	0.05876	0.02817	0.03674	0.04318	0.04448
Benefit	0.00895	0.00900	0.02533	0.01876	0.01977	0.00881	0.01270

Figure 5b: Index comparative distributions of groups' dimensions to MPI

Figure 5b. Index comparative distributions of groups' dimensions to MPI



	ED	H	SL	EN	EM	SC	W
Control	9.27521	9.83642	23.5502	16.6729	13.1016	10.0268	17.5366
Spillover	6.35287	8.14842	23.7715	11.3971	14.8648	17.4685	17.9967
Benefit	8.66200	8.70819	24.5153	18.1555	19.1359	8.53110	12.2917

Figure 5c: % comparative distributions of groups' dimension

Figure 5c. % comparative distributions of groups' dimension

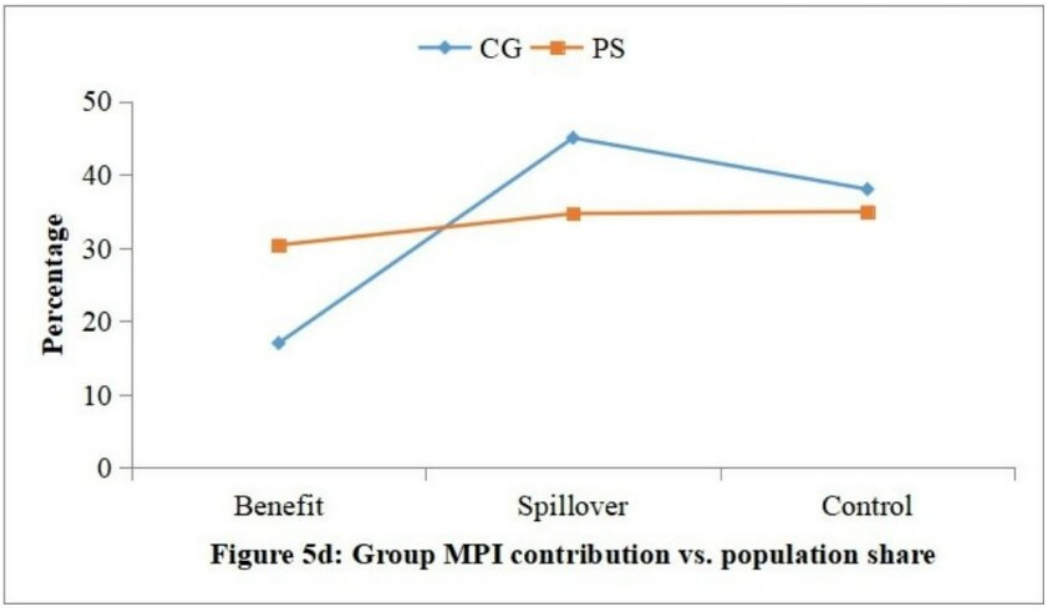


Figure 5d. Group MPI contribution vs. population share

Conclusions and Recommendations

The Northeast Arid Zone Development Program (NEAZDP) has shown significant effectiveness in reducing poverty among beneficiaries in Yobe State. The study reveals a consistent decline in the proportion of beneficiaries below the poverty threshold over time, with a notable improvement observed until the third quarter phase of the program. The program has successfully reduced the incidence, intensity, and severity of poverty among its participants, particularly in dimensions related to standard of living, empowerment, and environment. Despite improvements, challenges persist in specific dimensions of poverty, highlighting the need for targeted interventions. Inequality within the beneficiary group remains low, but disparities are evident between beneficiaries and non-beneficiaries, emphasizing the importance of equitable distribution and inclusive growth strategies. Consequently, the present study offered the following recommendations for inclusivity and comprehensive growth among the beneficiaries in the study area:

It is imperative for the program to focus on addressing specific dimensions of poverty identified in the study, particularly improving quality education, healthcare, and sustainable livelihoods.

The program should strengthen environmental conservation efforts and promote sustainable agricultural practices to ensure long-term resilience and reduce vulnerability to climate risks.

The program should implement rigorous monitoring mechanisms to track poverty reduction indicators continuously and adjust programs based on real-time data.

The program should integrate poverty alleviation strategies with broader development policies at local, regional, and national levels to ensure comprehensive and inclusive growth (i.e., inclusivity and equity in resource distribution).

The program advises investing in capacity-building initiatives to empower local communities and institutions to sustain poverty reduction efforts independently.

Authors' contributions

M.S.S.: Conceptualization, data processing, results and discussion (60 %). **I.J.G.:** Introduction, methodology, results and discussion (40 %).

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Appendix

Appendix 1: Dimensions, indicators, cut-off points and relative weight (RW) of MPI

Dimensions	Indicators	Deprivation cut-off	RW
Education	School	No child (≥ 10 years) has completed five years of schooling.	1/28
	School	No school age child (1–6 years) is attending school.	1/28
	Literacy	The primary household has no formal education.	1/28
	Literacy	The secondary household head has no formal education.	1/28
Health	Nutrition	Any family member that is underweight (slim) (BMI < 18.5) or overweight (≥ 23) / obesity (≥ 25).	1/28
	Immunization	Any family member not immunized/vaccinated to prevent any type of communicable diseases.	1/28
	Ante-natal care	Any pregnant women in the household with less than four (4) antenatal care.	1/28
	Morbidity	Any household member being sick in the last 5 months prior to survey.	1/28
Standard of living	Housing	Household living in an inadequate housing condition.	1/63
	Insurance	No family member is insured under any type of health insurance scheme.	1/63
	Electricity	No access to electricity.	1/63
	Water	No access to safe drinking water.	1/63
	Mobility	Doesn't own any type of motor vehicle for transportation purpose.	1/63
	Financial institution	Doesn't possess a savings bank account.	1/63
	Residential plot	Doesn't own any $100m^2$ of residential land other than where he/she is residing.	1/63
	Food security	Household is below food security threshold (2/3 of food expenditure).	1/63
	Over population	Household is overcrowded.	1/63
Empowerment	Health decision	Unable to take healthcare decision.	1/63
	Domestic violence	Unable to prevent domestic violence.	1/63
	Instability	Problem of social/political unrest.	1/63
	Self-defense	Problem of personal security.	1/63
	Job	Doesn't take any type of employment decision(s) for himself other than farming activities.	1/63
	Diversification	Doesn't participate in off-farm activities.	1/63
	Credit	No access to credit facilities in the last production season prior to the survey.	1/63
	Facilities	Doesn't belong to any co-operative organisation.	1/63
	Advisory services	Doesn't have access to extension service in the last production season prior to the survey.	1/63
Environment	Toilet	Household still practicing open defecation.	1/14
	Energy	Using dirty fuel as primary energy for cooking (e.g. firewood, dung & charcoal).	1/14
Social connection	Community service	Household head has not participated in any type of community-level activities.	1/21
	Co-operate responsibility	The household has not been involved in organizing any type of community-level activities.	1/21

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Appendix 1: Continued

Dimensions	Indicators	Deprivation cut-off	RW
	Social safety net	Doesn't trust government social investment programme (e.g. farmers/traders monie etc.).	1/21
Wealth	Agricultural land	Household doesn't own any agricultural land.	1/28
	Livestock	Livestock ownership (deprived if TLU is less than average).	1/28
	Dead stock (agric.)	Doesn't possess agricultural dead stocks.	1/28
	Dead stock (non-agric.)	Doesn't possess non-agricultural dead stocks.	1/28

Source: Modified from Sadıq and Sani (2022); Sadiq and Grema (2024); Sadiq et al. (2024).