

Impacts of Agricultural Interventions and Projects (2005-2025) on Agribusiness Participation and Income-Generating Ability of Farmers in Nigeria

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Abstract

Despite numerous programs implemented in Nigeria in the past, questions remain regarding their effectiveness in enhancing farmers' agribusiness participation (ABP) and income-generating capacity (IGC). This study assessed interventions for 2005-2025 period on ABP and IGC in twelve states of Nigeria. Data from 1,544 farmers, collected with structured questionnaire, were analysed using descriptive statistics and ordered logit model. The results show that participation contributed to improvements in farmers' livelihoods, i.e., 42.12% reported improved livelihood, while 30.36% indicated very substantial improvements in food security, housing, education, healthcare, and social obligations. Regarding IGC, above 62% reported high capacity, suggesting that most interventions contributed to improved economic outcomes. Training and input support were the most common forms of assistance received by farmers, while credit facilities, grants, and machinery support were less prevalent. However, the regression results are at variance with much of the claims above, revealing that years of formal education, age, and access to no extension services positively influenced IGC, while high dependence on other income sources and limited access to affordable credit were negative. The findings suggest that the effectiveness of agricultural interventions in Nigeria is less constrained by their design and more by weaknesses in complementary institutions, particularly credit delivery, extension services, and technology implementation frameworks. Therefore, agricultural interventions will not improve farmers' income unless they are supported by functional systems for skills development, effective credit utilization, contextual technology adoption framework, and high-quality extension services.

Keywords: *knowledge co-creation, technology adoption ecosystem, self-selection bias, diminishing marginal returns to intervention participation*

JEL Q16, O13, R28

Introduction

Agriculture is a critical sector for economic growth, poverty reduction, and livelihood sustainability in sub-Saharan Africa where smallholder farmers dominate food production systems. The sector provides employment for a substantial proportion of the rural population and contributes to national income and food security. However, agricultural productivity and farmer income in many of the countries remain relatively low due to limited access to modern technologies, inadequate credit facilities, weak extension systems, and climate-related risks, Nigeria inclusive (Sithole & Olorunfemi, 2024; Temesgen & Aweke, 2023). These structural challenges have prompted governments and development partners to implement various agricultural interventions. Over the past, Nigeria has witnessed the implementation of numerous agricultural interventions and development programs designed to enhance farmers' access to productive resources, strengthen institutional support systems, and promote ABP. These include input subsidy schemes, credit programs, extension services, capacity-building initiatives and technology dissemination projects. They are expected to stimulate farm productivity, increase market participation and improve the income of the farmers. Evidence suggests that well-designed agricultural interventions can enhance farm output and household welfare by improving access to inputs, knowledge, and markets (Alawode, 2025; Ayanwale et al., 2023). Also, access to extension services positively influences farm productivity, income levels, and food security among

smallholder farmers (Baylie & Pércsi, 2025; Danso-Abbeam et al., 2018). But the effectiveness of these programs often varies depending on implementation quality, institutional capacity, and farmer characteristics even as access to extension services remains uneven, and the quality-of-service delivery is often constrained by inadequate funding, poor infrastructure, and limited human resources. In the view of Alawode (2025), farmers in Nigeria face barriers to accessing formal credit due to high interest rates, collateral requirements, and weak financial institutions, therefore, the potential benefits of agricultural interventions may not be fully realized. In recent years, the focus of agricultural development programs has shifted from production-oriented interventions to integrated approaches that emphasize ABP, value addition, and market integration. These approaches recognize that sustainable income growth among farmers depends not only on increased production but also on improved participation in agribusiness activities (AGA) such as processing, marketing, and distribution. Innovation platforms, digital agriculture initiatives, and capacity-building programs have emerged as important tools for enhancing farmers' participation in value chains and improving income distribution (Muromba et al., 2025; Ayanwale et al., 2023). Despite the proliferation of these interventions, concerns persist regarding their actual impact on farmers' ABP and income-generating activities (IGA). Many programs have reported positive outcomes in terms of productivity and income; however, evidence remains limited, scanty, inconsistent and fragmented, and questions remain about their sustainability and long-term effectiveness. The studies focus primarily on productivity without adequately examining the broader economic and institutional factors influencing farmer participation in the interventions. In addition, existing research often evaluates individual programs rather than assessing the cumulative impact of multiple interventions over time. Factors such as institutional weaknesses, inadequate monitoring systems, limited farmer participation, and socio-economic constraints have been identified as major challenges affecting program performance (Sithole & Olorunfemi, 2024). Given these concerns, there is need for a comprehensive assessment of the types of support received by farmers, the level of participation in AGA, and the socio-economic and institutional factors influencing income generation among participants of these agricultural interventions and determining their effectiveness in improving farmers' livelihoods and welfare as well. Therefore, the goal of this study is to assess the impacts of agricultural interventions and projects implemented between 2005 and 2025 on ABP and IGC of farmers in Nigeria. The objectives are to:

- i. describe the level of ABP, livelihood improvement and IGC among farmers involved in the agricultural interventions,
- ii. describe the factors promoting the effectiveness, success or failure of the interventions in the study area,
- iii. determine the factors affecting IGC of the participants, and
- iv. assess the constraints faced by the participants in the interventions and programs.

The findings provide evidence-based insights for policymakers, development agencies, and agricultural stakeholders seeking to design more effective intervention programs that promote sustainable rural development.

Conceptual Framework

The conceptual framework for this study (Fig. 1) is grounded in agricultural development theory, livelihood enhancement models, and institutional support theory, which collectively posit that targeted agricultural interventions improve farmers' productivity, participation in AGA, and income generation through enhanced access to resources, knowledge, and markets (Udemezue & Osegbue, 2018; Omorogbe et al., 2014; Hayami & Ruttan, 1985; Ruttan, 1977).

Empirical evidence shows that agricultural interventions like credit schemes, extension services, technology adoption programs and contract farming arrangements increase farmers' productivity and income by improving access to inputs, markets and financial services (Bichi et al., 2025; Ikuemonisan, 2024). For example, Bichi et al. (2025) observed that participation in agricultural credit programs increased farm yield and income among Nigerian farmers, demonstrating the direct link between intervention participation and income. Similarly, interventions that promote technology adoption and digital agriculture enhance productivity, reduce post-harvest losses, and improve IGC among farmers (Alih, 2025). However, participation in agribusiness and IGA is not determined by interventions alone (Fig. 1). Socioeconomic characteristics, institutional factors, and environmental conditions play moderating roles. For instance, insecurity, climate variability, and limited access to finance reduce agricultural productivity and income even when interventions are present (Ijirshar et al., 2025; Nwanojuo et al., 2025).

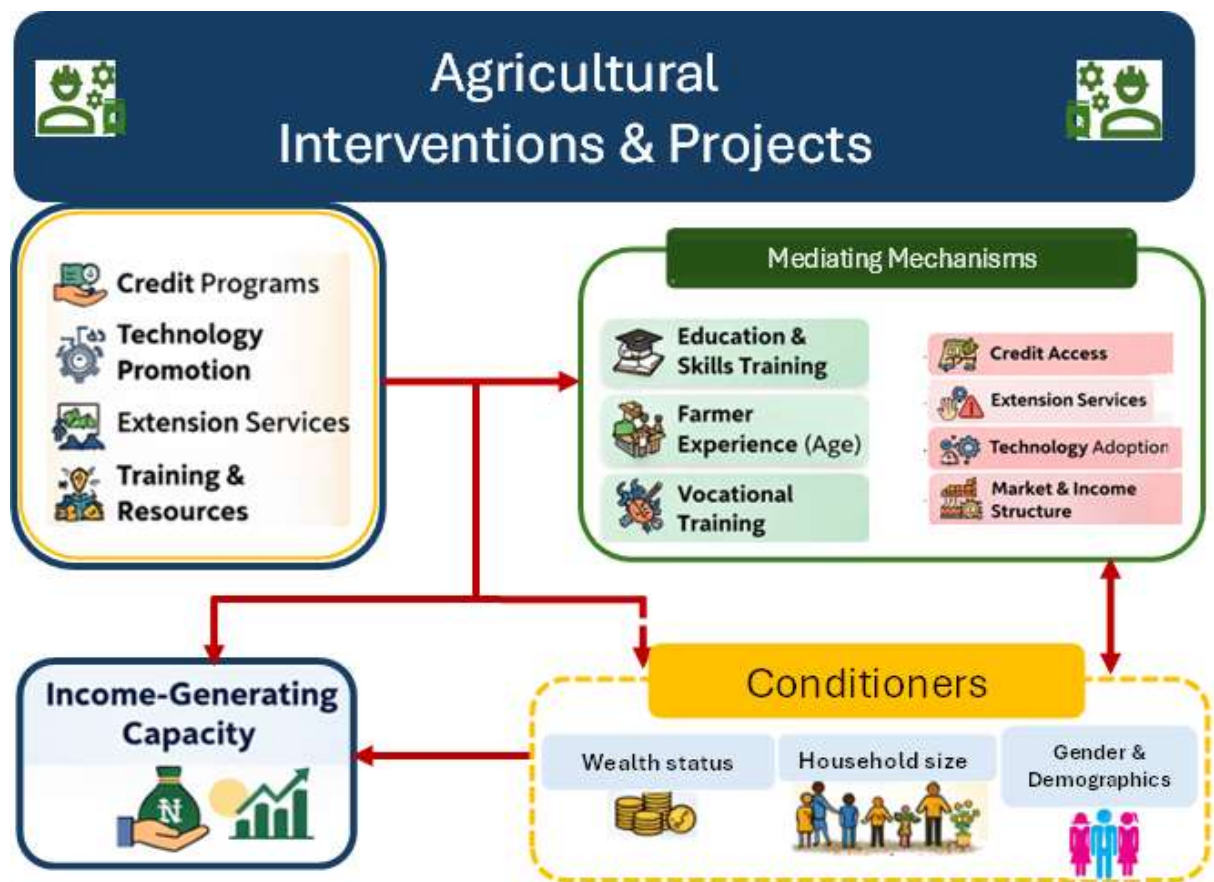


Fig. 1 Conceptual framework on the impact of interventions on IGC of participants
Source: Authors construct

Literature review

Agricultural interventions refer to organized programs, policies, or projects designed to improve productivity, enhance farmer welfare, and promote rural development through the provision of inputs, training, financial support, and institutional services. These interventions remain central to agricultural development strategies in developing countries, where smallholder farmers face persistent constraints related to limited access to resources, markets, and technology (Abraham & Pingali, 2020; Jellason et al., 2021). Recent evidence shows that targeted agricultural and rural development interventions can improve agricultural yields, strengthen food security, and enhance household resilience when appropriately designed and implemented (Cordonnier et al., 2024). Furthermore, agricultural interventions have been shown to contribute to poverty reduction and long-term well-being by improving access to finance, extension services, and market opportunities among smallholder farmers (Adenle et al., 2019). Agricultural interventions play a critical role in improving rural livelihoods and food security. For instance, Temesgen and Aweke (2023) found that smallholder agricultural production contributes to household food security and income generation in rural communities. Similarly, Sithole and Olorunfemi (2024) reported that adoption of sustainable agricultural practices through intervention programs enhances farm productivity and resilience to climate variability in sub-Saharan Africa. These findings highlight the importance of well-designed interventions in promoting sustainable agricultural development.

In the same vein, Baylie and Pércsi (2025) have documented the positive impact of extension services on agricultural productivity and income generation and found that farmers with access to extension services achieved higher crop yields compared to those without such access. Similarly, Ogola et al. (2023) reported that extension services improved milk productivity among smallholder dairy farmers by providing timely information on feeding practices, disease management, and market opportunities. Access to extension services has also been linked to increased adoption of improved farming technologies and better farm management practices (Argaw et al., 2023). Studies have also shown that participation in agribusiness activities improves farmers' IGC. Ayanwale et al. (2023) reported that participation in agricultural innovation platforms increased income distribution among maize farmers in Nigeria by improving access to market information and production technologies. Similarly, digital agricultural services have been found to enhance farmers' access to market information, reduce transaction costs, and improve income opportunities (Muromba et al., 2025). However, recent evidence shows that insecurity reduces agricultural output and household income in farming communities (Ijirshar et al., 2025). Nevertheless, ABP is influenced by several socio-economic and institutional factors, including education level, access to credit, market infrastructure, and government policies. In addition, external factors such as insecurity and climate variability can negatively affect agricultural production and income levels.

These findings underscore the need for integrated intervention strategies that address both economic and institutional constraints affecting farmers.

Overall, the reviewed literature demonstrates that agricultural interventions and ABP are critical drivers of improved productivity, income generation, and livelihood outcomes among smallholder farmers. However, the effectiveness of these interventions depends largely on the enabling socio-economic and institutional environment within which farmers operate.

Methodology

Cross-sectional data, collected from 12 randomly selected states of Nigeria (Fig. 2) were utilized in this study. From each selected state, two LGAs were randomly selected, and two village areas were randomly selected from each LGA, a total of 25 LGAs and 50 villages were involved. The respondents were randomly selected from farming households who have either benefited or participated in any of the projects or intervention from the villages. At least 10 respondents were selected from each village and a total of 1544 respondents were enumerated for the data. The data collected included socio-economic characteristics, wealth change, present state of income generating capacity, environmental and climatic variables as well as assets and social capital. The instrument for the data collection was open-source data kit-powered structured questionnaire (www.kobotoolbox.org, 2024) simultaneously administered by trained enumerators via interview schedules in a cordial atmosphere between June and October 2025.

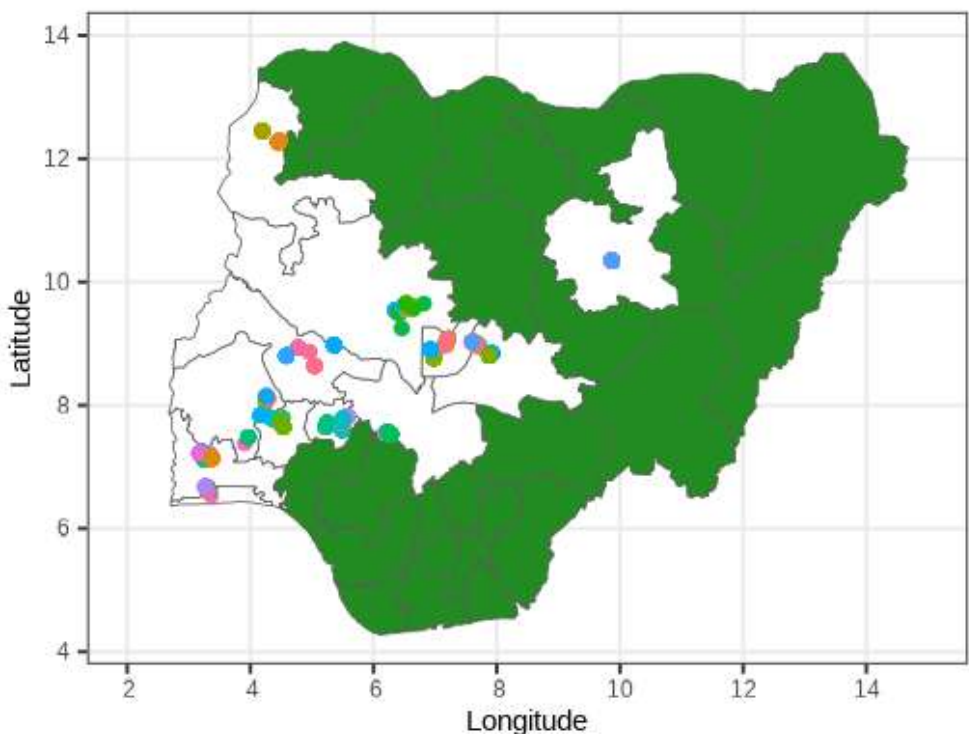


Fig. 2 Map of Nigeria showing the states in the study and the LGAs in colours
Source: Survey data, 2025.

The data collected were analysed using descriptive and inferential (ordered logit model, OLM) statistical tools. OLM was used in this study because the dependent variable, IGC, is ordinal and consists of ranked categories with a natural order but unequal intervals between them. Linear regression models are unsuitable for such data because they assume continuous outcomes and equal spacing between values. The underlying assumption is that an unobserved continuous latent variable (Y_i^*) is related to the observed ordinal outcome (Y). The model posits an unobserved continuous latent variable Y_i^* for everyone is determined by a linear combination of predictor variables (x_{ij}) and a random error term (ϵ_i). The OLM estimates the probability of a farmer belonging to a higher or lower income category while preserving the ordinal structure of the response variable. The model also allows for identification of threshold effects between income levels and accommodates both continuous and categorical explanatory variables. Therefore, the OLM provides a statistically appropriate and theoretically consistent approach for analysing the determinants of IGC among farmers participating in agricultural interventions. The full model is specified in eq. 1 and the description of the covariates is presented in Table 1.

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \beta_{10} X_{10} + \beta_{11} X_{11} + \beta_{12} X_{12} + \beta_{13} X_{13} + \beta_{14} X_{14} + \beta_{15} X_{15} + \beta_{16} X_{16} + \beta_{17} X_{17} + \beta_{18} X_{18} + \beta_{19} X_{19} + \epsilon_i \text{ eq. 1}$$

Y is a categorized version of Y_i^* which are defined by a set of cut points or thresholds (κ_c) as $Y=1$ if $Y_i^* \leq \kappa_1$, $Y=2$ if $\kappa_1 < Y_i^* \leq \kappa_2$, $Y=C$ if $Y_i^* > \kappa_{C-1}$ where C is the number of categories in the ordinal,

β_0 = intercept/constant, β_1 - β_{26} = Parameters to be estimated, ϵ_i = Error term variable and other variables are as defined in Table 1.

Table 1 Variables in the ordered logit regression and their units of measurements

Variab le	Description	Unit	Remark	Apriori expectatio n
Y	IGC (Income generating capacity)	factor	Very high, High, Neutral, Low, Very low	+
X ₁	Age	Integer		+
X ₂	Family size	Integer		+
X ₃	Farm size	Numeri c		+
X ₄	Income from primary occupation	NGN		+
X ₅	Income from secondary occupation	NGN		+
X ₆	Years in formal education	Integer		+
X ₇	Credit access	factor	Less than 1M Naira, 1M-5M Naira, 5M-10M Naira, 10M-50M Naira, Above 50M	+
X ₈	Sex	Dumm y	Male, Female	±
X ₉	Gender	factor	Adult male, adult female, elderly male, elderly female, youth	±
X ₁₀	Marital status	factor	Married, Single, Widow(er), Divorced, Separated, Co-habiting, In a relationship	±
X ₁₁	Educational level	factor	Tertiary, Secondary, Primary. Qur'anic. Adult/In service, Vocational/Skills acquisition, None	+
X ₁₂	Diversification	Dumm y	If the respondent has diversified from agriculture (Yes, No)	+
X ₁₃	Cooperatives membership	Dumm y	Yes, no	+
X ₁₄	Access to extension	factor	Always accessible, often accessible, sometimes accessible, rarely accessible, never accessible	+
X ₁₅	Distance to extension services	factor	any time, within a day, within a week, within a month, occasionally reached, Hard to reach	±
X ₁₆	Status in the family	factor	Household head ONLY, Breadwinner ONLY, Household head and breadwinner, Member	±
X ₁₇	Level of technology	factor	Manual/physical means only, Traditional technology only, Improved manual or traditional technology, New/modern technology, Mix of manual/traditional/modern technologies	+
X ₁₈	Wealth change (Five years ago, 2020-2025)	factor	100% increase, 50% increase, 20% increase, Decrease, No change	+
X ₁₉	Wealth change (Ten years ago, 2015-2025)	factor	100% increase, 50% increase, 20% increase, Decrease, No change	+

Source: Survey data, 2025

All the computations, estimations were carried with R Programming (vers. 4.5.1, R Core Team, 2025) using various packages and codes developed by Nmadu (2025) and Wickham (2016).

Results and discussion

The results are presented in Tables 2-10. Table 2 shows the livelihood improvements from participation in the interventions while Table 3 represents the respondents' assessment of their IGC as well as participation in produce processing and agribusiness. Table 4 shows the types of support received alongside participation in the interventions while Table 5 is the OLM's estimates of the factors affecting IGC of the participants. Table 6 presents the awareness, participation and effectiveness of the projects and interventions while Table 7 presents factors motivating participation in the interventions. Table 8 shows the factors contributing to the Success of the interventions while Table 9 presents factors contributing to the failure of the interventions and Table 10 presents the constraints faced in participation in the interventions.

The results in Table 2 show that participation in agricultural interventions produced substantial improvements in farmers' livelihoods. A total of 42.12% of respondents reported improved livelihood conditions, while 30.36% reported very significant improvements, particularly in food security, housing quality, education of children, healthcare access, and the ability to meet social obligations. Only 5.09% indicated unimproved or very unimproved conditions, suggesting that most intervention beneficiaries experienced measurable welfare gains. Food security recorded one of the strongest improvements, with 642 farmers reporting improved conditions and 625 reporting very improved conditions. This indicates that agricultural interventions contribute to strengthening household food availability and economic stability. Table 3 presents farmers' perceptions of the effect of interventions on IGC and ABP. The results revealing the dominance of high responses and high ABP suggest that agricultural interventions generally contribute to improved IGA and strong engagement in processing and AGA (65.03%) among participating farmers. Meanwhile, 34.97% of respondents are not ABP, suggesting that although those participating are the majority, a large minority remains outside agribusiness involvement.

Table 4 highlights the types of support received by farmers under the various agricultural interventions. Training constituted the most common form of support, accounting for 44.23% of all interventions, but technology packages accounted for only 2.42%, indicating relatively low

Table 2 Livelihood improvements from participation in the interventions

Variable	Improved	Neither improved or unimproved	Unimproved	Very improved	Very unimproved
Food Security status of the family	642	228	38	625	11
Housing style of the family	665	385	49	428	17
Education of your children	643	323	61	499	18
Healthcare of your family	709	386	50	384	15
Sustainability of family status	648	320	65	496	15
Meeting your social and cultural obligations	595	436	109	381	23
Total	3902	2078	372	2813	99
%	42.12	22.43	4.02	30.36	1.07

Source: Survey data, 2025

Table 3 Respondents' Assessment of Their IGC

IGC	Frequency	%	Rank
High	633	41	1
Neutral	466	30.18	2
Very high	338	21.89	3
Low	89	5.76	4
Very low	18	1.17	5
Total	1544	100	

Source: Survey data, 2025

Table 3a Distribution of Respondents by Processing activities and Business participation

Description	Processing business	Business participation	Total	%
Yes	1003	1005	2008	65.03
%	64.96	65.09	65.03	
No	541	539	1080	34.97
%	33.62	33.50	33.56	
Total	1608.96	1609.09	3088	

Source: Survey data, 2025

Table 4 Types of Supports received by the participants

Type of support	Frequency	%	Rank
Training	1042	44.23	1
Inputs	661	28.06	2
Credit	230	9.76	3
Grants in cash or kind	204	8.66	4
Equipment and Machinery	162	6.88	5
Technology package	57	2.42	6
Total	2356	100.01	

Source: Survey data, 2025

Table 5 Estimates of the model on IGC of participants in the interventions

Variables	Ordered Logit			Stepwise Ordered Logit		
	Estimate	Odds ratio	%	Estimate	Odds ratio	%
Very high High	3.196* (1.27)	24.442* (1.27)	2,34 0	3.299** (1.23)	27.08** (1.23)	2,610
High Neutral	5.857*** (1.28)	349.654* (1.28)	34,9 00	5.953** (1.24)	385.023*** (1.24)	38,400
Neutral Low	8.959*** (1.29)	7774.531 (1.29)	777, 000	9.05*** (1.25)	8516.805*** (1.25)	852,00 0
Low Very low	11.118*** (1.30)	67379.04 (1.30)	6,74 0,00 0	11.21** (1.27)	73857.517** (1.27)	7,390, 000
Numeric						
Age	0.012 (0.00800)	1.012 (0.00800)	1.17	0.013* (0.00600)	1.013* (0.00600)	1.26
Family size	-0.017+ (0.00900)	0.983+ (0.00900)	-1.6 6	-0.017+ (0.00900)	0.983+ (0.00900)	-1.66
Years in formal education	0.036* (0.0160)	1.037* (0.0160)	3.67	0.04* (0.0160)	1.04* (0.0160)	4.04
Farm size	0.029 (0.0260)	1.03 (0.0260)	2.95	-		
Income from primary occupation	-0.059** (0.0220)	0.943** (0.0220)	-5.7 2	0.056** (0.0210)	0.945** (0.0210)	-5.49
Income from secondary occupation	-0.056** (0.0220)	0.945** (0.0220)	-5.4 5	0.057** (0.0220)	0.945** (0.0220)	-5.52
Sex						
Male	-0.059 (0.488)	0.943 (0.488)	-5.6 9	0.266+ (0.136)	1.305+ (0.136)	30.5
Gender						

Variables	Ordered Logit			Stepwise Ordered Logit		
	Estimate	Odds ratio	%	Estimate	Odds ratio	%
Adult male	0.331 (0.504)	1.393 (0.504)	39.3			
Elderly female	-0.662 (0.956)	0.516 (0.956)	-48.4			
Elderly male	0.292 (0.572)	1.339 (0.572)	33.9			
Youth	-0.024 (0.446)	0.977 (0.446)	-2.33			
Marital status						
Divorced	0.956 (0.992)	2.601 (0.992)	160	0.978 (0.981)	2.66 (0.981)	166
In a relationship	1.092 (1.04)	2.979 (1.04)	198	1.116 (1.03)	3.054 (1.03)	205
Married	1.085 (0.971)	2.959 (0.971)	196	1.127 (0.961)	3.085 (0.961)	209
Separated	-1.535 (1.37)	0.215 (1.37)	-78.5	-1.404 (1.35)	0.245 (1.35)	-75.5
Single	1.44 (0.973)	4.222 (0.973)	322	1.433 (0.963)	4.193 (0.963)	319
Widow(er)	1.153 (1.02)	3.168 (1.02)	217	1.158 (1.01)	3.183 (1.01)	218
Education level						
None	1.713* (0.796)	5.544* (0.796)	454	1.872* (0.788)	6.501* (0.788)	550
Primary	1.331+ (0.748)	3.784+ (0.748)	278	1.432+ (0.744)	4.188+ (0.744)	319
Qur'anic	1.326 (0.848)	3.765 (0.848)	277	1.413+ (0.843)	4.109+ (0.843)	311
Secondary	1.502* (0.717)	4.49* (0.717)	349	1.581* (0.714)	4.857* (0.714)	386
Tertiary	1.502* (0.712)	4.491* (0.712)	349	1.573* (0.709)	4.821* (0.709)	382
Vocational/Skills acquisition	2.268** (0.796)	9.658** (0.796)	866	2.283** (0.794)	9.808** (0.794)	881
Credit access						
1M - 5M Naira	-0.517* (0.262)	0.596* (0.262)	-40.4	-0.563* (0.259)	0.57* (0.259)	-43.0
5M - 10M Naira	-0.478+ (0.276)	0.62+ (0.276)	-38.0	-0.489+ (0.275)	0.613+ (0.275)	-38.7
Above 50M	0.45 (0.364)	1.569 (0.364)	56.9	0.397 (0.360)	1.488 (0.360)	48.8
Less than 1M Naira	-0.296 (0.267)	0.744 (0.267)	-25.6	-0.331 (0.265)	0.718 (0.265)	-28.2
None	0.35 (0.321)	1.42 (0.321)	42.0	0.303 (0.318)	1.354 (0.318)	35.4
Level of technology						
Manual/physical means only	0.719*** (0.158)	2.052*** (0.158)	105	0.751** * (0.156)	2.12*** (0.156)	112
Mix of manual/traditional/modern technologies	-0.106 (0.171)	0.899 (0.171)	-10.1	-0.11 (0.170)	0.896 (0.170)	-10.4
New/modern technology	-0.157 (0.199)	0.854 (0.199)	-14.6	-0.151 (0.198)	0.86 (0.198)	-14.0
Traditional technology only	0.328* (0.167)	1.388* (0.167)	38.8	0.328* (0.166)	1.388* (0.166)	38.8
Wealth change (Five years ago, 2020-2025)						

Variables	Ordered Logit			Stepwise Ordered Logit		
	Estimate	Odds ratio	%	Estimate	Odds ratio	%
20% increase	1.066*** (0.172)	2.903*** (0.172)	190	1.072** * (0.171)	2.922*** (0.171)	192
50% increase	0.498** (0.157)	1.646** (0.157)	64.6	0.503** (0.157)	1.653** (0.157)	65.3
Decrease	0.761** (0.248)	2.14** (0.248)	114	0.767** (0.247)	2.154** (0.247)	115
No change	1.629*** (0.193)	5.097*** (0.193)	410	1.61*** (0.192)	5.004*** (0.192)	400
Wealth change (Ten years ago, 2015-2025)						
20% increase	1.033*** (0.244)	2.81*** (0.244)	181	0.964** * (0.238)	2.623*** (0.238)	162
50% increase	0.399 (0.257)	1.49 (0.257)	49.0	0.342 (0.251)	1.407 (0.251)	40.7
Decrease	1.542*** (0.263)	4.673*** (0.263)	367	1.497** * (0.259)	4.466*** (0.259)	347
No change	1.387*** (0.252)	4.003*** (0.252)	300	1.317** * (0.246)	3.732*** (0.246)	273
Access to extension services						
Never accessible	2.526*** (0.277)	12.507** * (0.277)	1,150	2.557** * (0.276)	12.899*** (0.276)	1,190
Often accessible	0.494* (0.204)	1.639* (0.204)	63.9	0.499* (0.204)	1.647* (0.204)	64.7
Rarely accessible	1.702*** (0.217)	5.484*** (0.217)	448	1.716** * (0.217)	5.562*** (0.217)	456
Sometimes accessible	0.991*** (0.203)	2.694*** (0.203)	169	1.009** * (0.202)	2.744*** (0.202)	174
Distance to extension services						
Hard to reach	0.286 (0.229)	1.331 (0.229)	33.1	0.274 (0.228)	1.315 (0.228)	31.5
Occasionally reached	-0.67* (0.274)	0.512* (0.274)	-48.8	-0.65* (0.273)	0.522* (0.273)	-47.8
within a day	0.184 (0.146)	1.202 (0.146)	20.2	0.186 (0.146)	1.204 (0.146)	20.4
within a month	0.103 (0.265)	1.108 (0.265)	10.8	0.084 (0.263)	1.087 (0.263)	8.71
within a week	-0.513** (0.189)	0.599** (0.189)	-40.1	-0.533** (0.187)	0.587** (0.187)	-41.3

+ p < 0.1, * p < 0.05, ** p < 0.01, *** p < 0.001
Source: Survey data, 2025

Table 6 Awareness, participation and effectiveness of the projects and interventions

Project	Aware	Availability	Affordability	Accessibility	Beneficial	Adequacy	Use	Effective	Total
FADAMA Development Program (I, II, III, AF)	0.11	0.13	0.13	0.13	0.13	0.13	0.15	0.13	1.04
N-Power Agro Program	0.11	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.95
Agricultural Transformation Agenda (ATA)	0.1	0.1	0.1	0.11	0.11	0.11	0.11	0.11	0.85
National Special Program for Food Security (NSPFS)	0.07	0.07	0.08	0.08	0.07	0.08	0.08	0.08	0.61
Anchor Borrowers' Program (ABP)	0.04	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.39
Commercial Agriculture Development Program (CADP)	0.05	0.04	0.04	0.05	0.05	0.05	0.05	0.05	0.38
Nigeria Rural Access and Agricultural Marketing Project (RAAMP)	0.03	0.04	0.03	0.03	0.03	0.04	0.04	0.03	0.27
Ogun State Economic Transformation Project (OGSTEP)	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.24
Growth Enhancement Support Scheme (GESS)	0.02	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.23
National Agricultural Technology and Innovation Policy (NATIP)	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.16
One Acre Fund – Nigeria Program	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.16
International Institute of Tropical Agriculture (IITA) – Youth Agripreneur & eAgri Projects	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.16
Agricultural Promotion Policy (APP) – “The Green Alternative”	0.01	0.01	0.02	0.01	0.01	0.01	0.02	0.01	0.1
Nigeria Farmers' Soil Health Card Scheme	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.08
Nigeria Incentive-Based Risk Sharing System for Agricultural Lending (NIRSAL)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.08
Nigeria Strategy Support Program	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.08
Livelihood Improvement Family Enterprises Program (LIFE)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.08
International Fund for Agricultural Development Program (IFAD)-Value Chain Development Program (VCDP)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.08
Nigeria Agro-Processing Productivity Enhancement and Livelihood Improvement Support (APPEALS)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.08
Women Farmers Advancement Network (WOFAN) – AGRIC Projects	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.08
Rural Development Initiative Nigeria (RDI)	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.08
UN Women Programs and Projects	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.08
Alliance for a Green Revolution in Africa (AGRA)	0	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.07
Oyo State Agribusiness Development Agency (OYSADA)	0.01	0.01	0.01	0	0	0.01	0	0	0.04
Special Agro-Industrial Processing Zones (SAPZ)	0	0	0	0	0	0	0	0	0
Presidential Fertilizer Initiative by Nigerian and Moroccan Governments	0	0	0	0	0	0	0	0	0
Kano State Agro-Pastoral Development Project (KSADP)	0	0	0	0	0	0	0	0	0
Kaduna State Agricultural Development Project (KADP)	0	0	0	0	0	0	0	0	0
Heifer International – Nigeria Projects	0	0	0	0	0	0	0	0	0
Digital Green – Agricultural Extension in Nigeria	0	0	0	0	0	0	0	0	0
GAIN – Nutrition-Sensitive Agriculture Projects	0	0	0	0	0	0	0	0	0
Synergos Nigeria – Agricultural Development Programs	0	0	0	0	0	0	0	0	0

Project	Aware	Availability	Affordability	Accessibility	Beneficial	Adequacy	Use	Effective	Total
Oxfam Nigeria – Livelihood and Agricultural Projects	0	0	0	0	0	0	0	0	0
SNV Netherlands Development Organisation – Opportunities for Youth Employment (OYE)	0	0	0	0	0	0	0	0	0
International Fertilizer Development Center (IFDC) – 2Scale, PAIRED, and other Nigeria-focused Projects	0	0	0	0	0	0	0	0	0
ActionAid Nigeria – Food Security and Climate Resilience	0	0	0	0	0	0	0	0	0
ProSAB – Promoting Sustainable Agriculture in Borno State	0	0	0	0	0	0	0	0	0
African Agricultural Technology Foundation (AATF) – Nigeria Projects (e.g., Striga, Cassava Mechanization)	0	0	0	0	0	0	0	0	0
Catholic Relief Services (CRS) – Agriculture & Resilience Projects	0	0	0	0	0	0	0	0	0
Practical Action – Agriculture Value Chain Projects	0	0	0	0	0	0	0	0	0
YIIFSWA (Yam Improvement for Income and Food Security in West Africa)	0	0	0	0	0	0	0	0	0
NGCare Agricultural Livelihood Program	0	0	0	0	0	0	0	0	0
HarvestPlus – Biofortification Projects (Vitamin A Cassava, Maize)	0	0	0	0	0	0	0	0	0
Sasakawa Africa Association – Nigeria Project (SG2000)	0	0	0	0	0	0	0	0	0
LEAD Farmers Nigeria – Local NGO Projects	0	0	0	0	0	0	0	0	0
YIAP (Youth Integrated Agripreneurs Project)	0	0	0	0	0	0	0	0	0
Aspire Coronation Trust (ACT) Foundation – Agriculture Grantees	0	0	0	0	0	0	0	0	0
AFOS Foundation Agricultural Interventions-German-Based	0	0	0	0	0	0	0	0	0
Foundation Thrive Agric’s Agroforestry Initiative	0	0	0	0	0	0	0	0	0
Bill & Melinda Gates Foundation Agricultural Grant	0	0	0	0	0	0	0	0	0
Oxfam’s Pro-Resilience Action (ProAct) Intervention	0	0	0	0	0	0	0	0	0
US African Growth and Opportunity Act (AGOA)	0	0	0	0	0	0	0	0	0
African Continental Free Trade Area (AfCFTA)	0	0	0	0	0	0	0	0	0
Total	0.73	0.79	0.8	0.8	0.79	0.82	0.84	0.8	6.37

Source: Survey data, 2025

Table 7 Factors motivating participation in the interventions and programmes

Description	Mean	Mean score	Garrett Relative index	importance	Rank
Assistance from relatives and friends	4.1	81	0.83		1
Pest and disease control	3.9	80	0.79		2
Change timing of crop planting	3.7	79	0.75		3
Using a diverse workforce	3.8	79	0.75		4
Farm waste disposal	3.7	79	0.73		5
Adding new crop/changing crop species	3.7	79	0.73		6
Soil and erosion control	3.6	79	0.73		7
Adoption of improved farming practices	3.6	79	0.73		8
Social networking and family support	3.6	78	0.72		9
Acquire awareness of local action on adaptation	3.5	78	0.70		10
Rainwater harvesting techniques, storage and conservation	3.5	78	0.70		11
Sharing of resources and technology	3.5	78	0.70		12
Participates in risk and vulnerability planning	3.4	78	0.69		13
Relocating to higher grounds, non-drought or unflooded area	3.4	78	0.69		14
Use of drought tolerant/resistance crop varieties/seeds	3.5	78	0.69		15
Prepares and trains for short-term changes	3.4	77	0.68		16
Collection of run-offs from flood	3.4	77	0.67		17
Participates in risk and vulnerability planning	3.3	77	0.67		18
Assess your early warning service/system to prevent water-related disasters	3.4	77	0.68		19
Seeking assistance from various organizations	3.4	77	0.67		20
Use of irrigation	3.3	77	0.65		21
Constructing flood dykes, control levees, flood retention areas, groynes, drainage canals, embankment/dam, river embankments.	3.1	76	0.62		22
Participating in governance	2.8	75	0.57		23

Source: Survey data, 2025

Table 8 Factors contributing to the Success of the interventions

Description	Mean	Mean score	Garrett Relative index	importance	Rank
Involvement of farmers, local leaders, and community-based organizations in planning and implementation	4.0	77	0.80		1
A bottom-up approach ensures programs address local needs and realities	3.9	77	0.78		2
Consistent and supportive agricultural policies	3.9	77	0.77		3
Reduces post-harvest losses and increases market access	3.8	76	0.77		4
Feedback mechanisms to incorporate lessons learned into ongoing projects	3.9	76	0.77		5
Regular training and technical support for farmers and extension agents	3.8	76	0.77		6
Adoption of climate-smart, affordable, and locally adaptable technologies	3.8	76	0.77		7
Financial inclusion through cooperatives, microfinance, and agricultural credit schemes	3.8	76	0.76		8

Description	Mean	Mean score	Garrett Relative index	importance	Rank
Deployment of skilled agricultural professionals at grassroots levels	3.8	76	0.77		9
Clear performance indicators, periodic evaluation, and adaptive management	3.8	76	0.76		10
Provision of soft loans, grants, and input subsidies (fertilizers, improved seeds)	3.8	76	0.76		11
Adequate budgetary allocation and political commitment to project goals	3.8	76	0.76		12
Good road networks, storage, processing, and irrigation facilities	3.8	76	0.76		13
ICT tools for market access, weather forecasting, and financial transactions	3.8	76	0.75		14
Partnerships with private agribusinesses and development partners (e.g., IFAD, FAO)	3.8	76	0.75		15
Co-financing and technical assistance enhance reach and impact	3.8	76	0.75		16

Source: Survey data, 2025

Table 9 Factors contributing to the failure of the interventions

Description	Mean	Mean score	Garrett Relative index	importance	Rank
Top-down approaches that ignore local realities	4.1	79	0.82		1
Lack of access to processing and storage facilities	4.0	79	0.81		2
Diversion of funds and inputs	4.0	79	0.81		3
Inadequate collateral for accessing formal financial services	4.0	79	0.81		4
Poor coordination among implementing agencies	4.0	79	0.80		5
Inadequate staffing, training, and logistics	4.0	79	0.80		6
Language and literacy barriers limit participation	4.0	78	0.80		7
Lack of policy continuity and institutional memory	4.0	78	0.80		8
Ghost beneficiaries and politicization of project implementation	4.0	78	0.80		9
Farmers are not adequately informed about opportunities and guidelines	4.0	78	0.80		10
Frequent changes in leadership and policies lead to project abandonment	4.0	78	0.80		11
Weak feedback mechanisms result in non-responsive programming	4.0	78	0.80		12
Inadequate needs assessment and feasibility studies	4.0	78	0.79		13
Poor rural roads, electricity, and water supply hinder logistics and production	4.0	78	0.79		14
Absence of real-time data for tracking progress	4.0	78	0.79		15
Displacement disrupts continuity and effectiveness of projects	3.9	78	0.79		16
Insecurity in rural areas is due to insurgency, banditry, and farmer-herder clashes	3.9	78	0.79		17

Description	Mean	Mean score	Garrett Relative index	importance	Rank
Land tenure issues, especially for women and youth	3.9	78	0.78		18

Source: Survey data, 2025

Table 10 Constraints faced in participation in the interventions

Description	Mean	Mean score	Garrett Relative index	importance	Rank
High interest rates on agricultural loans	4.1	84	0.82		1
Poor extension services result in limited awareness of available programs	4.1	84	0.82		2
Inconsistent government policies affecting program continuity	4.1	84	0.82		3
Corruption and favouritism in the selection of beneficiaries	4.1	84	0.81		4
Stringent loan conditions by banks and microfinance institutions	4.1	84	0.81		5
Inadequate rural roads, making access to project sites and resources difficult	4.1	84	0.81		6
Programs may not address the actual needs of local farmers	4.1	84	0.81		7
Poor monitoring and evaluation of programs	4.1	83	0.81		8
Targeting programs along political or ethnic lines	4.1	83	0.81		9
Limited access to ICT tools necessary for digitalized platforms and registration	4.1	83	0.81		10
Lengthy and complex application processes	4.1	83	0.81		11
Lack of synergy between research institutions, extension agents, and farmers	4.0	83	0.81		12
Excessive documentation and administrative procedures	4.0	83	0.81		13
Poor adaptation strategies incorporated into programs	4.0	83	0.81		14
Lack of collateral among smallholder farmers	4.0	83	0.80		15
Farmers are rarely involved in planning or decision-making processes	4.0	83	0.80		16
Lack of transparency and accountability in program implementation	4.0	83	0.80		17
Lack of electricity and storage facilities hampers the implementation of certain programs	4.0	83	0.80		18
Climate variability affects the implementation and sustainability of agricultural projects	4.0	83	0.80		19
Favouritism towards large-scale farmers or politically connected individuals	4.0	83	0.80		20
Inefficient communication channels between stakeholders and rural farmers	4.0	83	0.80		21
Women often have limited access to land, finance, and training	4.0	83	0.79		22
Duplication of efforts between government and NGOs	4.0	83	0.79		23
Farmer-herder clashes, banditry, and insurgency discourage participation in programs	3.9	83	0.79		24
Low literacy levels hinder comprehension of project requirements and benefits	3.9	83	0.78		25

Description	Mean	Mean score	Garrett Relative index	importance	Rank
Materials and training not delivered in local languages	4.0	83	0.79		26
Displacement of farming communities reduces program effectiveness	3.9	83	0.78		27
Cultural and societal norms restrict female farmers from participating fully in programs	3.9	83	0.78		28
Cultural practices may conflict with program guidelines	3.8	83	0.77		29

Source: Survey data, 2025

levels of technological transfer to farmers. Table 6 shows the level of awareness, accessibility, and effectiveness of various agricultural interventions in Nigeria indicating that FADAMA Development Program recorded the highest overall effectiveness score. Other programs such as the National Special Program for Food Security and the Anchor Borrowers' Program recorded lower levels of awareness and participation among farmers.

Table 7 presents the factors motivating farmers to engage in AGA following participation in intervention programs. Assistance from relatives and friends ranked highest with a relative importance index (RII) of 0.83. These findings suggest that social support networks and improved farm management practices are key drivers of farmers' participation in AGA. Table 8 identifies the key factors contributing to the success of agricultural interventions. The most important factor was the involvement of farmers, local leaders, and community organizations in program planning and implementation, with an RII of 0.80. Other important factors included bottom-up program design, consistent agricultural policies, improved market access, regular training, and financial inclusion mechanisms. Table 9 highlights the factors responsible for the failure of some of the agricultural interventions. The most significant factor was top-down implementation approaches that ignore local realities while Table 10 presents the major constraints faced by farmers in participating in agricultural interventions. The most critical constraints included high interest rates on agricultural loans, poor extension services, inconsistent government policies, corruption in beneficiary selection, and stringent loan conditions imposed by financial institutions. Other constraints included inadequate rural infrastructure, poor communication channels, lack of ICT access, and insecurity in rural areas. These findings correspond with studies in Nigeria and other African countries showing that agricultural development programs improve household welfare by increasing productivity and access to inputs. For example, participation in integrated agricultural support initiatives such as irrigation and input distribution programs increased food security and income among smallholder farmers in Nigeria (Liverpool-Tasie et al., 2021). Similarly, evaluations of rural agricultural interventions across sub-Saharan Africa demonstrate that development programs that combine input supply, extension services, and capacity building improve farmers' livelihoods and reduce poverty (Abate et al., 2022; Barrett et al., 2023). Globally, agricultural interventions have been identified as key instruments for achieving rural transformation and improving food security among smallholder households (Lowder et al., 2021; FAO, 2023). The results of the OLM (Table 5) provide important insights into the determinants of IGC among participants in agricultural interventions in Nigeria. Overall, the findings suggest that while agricultural interventions have the potential to enhance IGA, their effectiveness is highly conditional on human capital, prior wealth status, and institutional quality. A key finding of this study is the strong and consistent positive effect of human capital variables, particularly, years of formal education and vocational or skills acquisition, on IGC. The magnitude of the effect associated with vocational training is especially notable, indicating that farmers with practical, market-oriented skills are more likely to benefit from intervention programs. This aligns with evidence emphasizing the central role of knowledge and skills in enhancing agricultural productivity and income in developing countries (Abdulai & Huffman, 2022; FAO, 2023). The result reinforces the argument that interventions that fail to integrate capacity-building components are unlikely to achieve sustained income improvements.

In contrast, income from both primary and secondary occupations exhibits a negative relationship with IGC. This suggests diminishing marginal returns to intervention participation among relatively better-off farmers. In other words, interventions appear to have stronger impacts on lower-income participants, supporting the pro-poor impact hypothesis (Barrett et al., 2021; World Bank, 2022). However, this also raises concerns about targeting efficiency, as higher-income farmers may either be less responsive to interventions or already operate near their productive capacity.

The role of demographic variables such as age and household size is relatively weak, although the positive effect of age suggests that farming experience may modestly enhance the ability to translate interventions into income gains. Household size, on the other hand, shows a marginal negative effect, reflecting increased dependency burdens that dilute income gains. Gender-related variables are largely insignificant, implying that interventions may be broadly gender-neutral in their outcomes. This finding contrasts with global evidence highlighting persistent gender disparities in access to productive resources (Doss et al., 2021; UN Women, 2022) and may reflect limitations in variable measurement or contextual dynamics within the study area.

One of the more counterintuitive findings relates to education categories, where even farmers with no formal education exhibit positive and significant effects. This does not imply that lack of education enhances income capacity; rather, it likely reflects baseline effects, where less-educated farmers experience larger relative gains due to initially lower productivity levels. Similar patterns have been observed in impact evaluations where disadvantaged groups show higher marginal improvements following intervention exposure (Carter et al., 2021).

More concerning, however, are the results relating to credit access, technology adoption, and extension services. Access to credit, especially within the ₦1M–₦10M range, is associated with a reduction in IGC. This finding contradicts conventional expectations and global evidence that positions credit as a critical enabler of agricultural investment and productivity (Banerjee et al., 2021; World Bank, 2022). A plausible explanation is that credit in this context may be poorly structured, misallocated, or diverted toward non-productive uses, thereby increasing financial vulnerability rather than enhancing productive capacity. High interest rates, weak financial literacy, and inadequate monitoring mechanisms may further exacerbate this effect. Similarly, the results on technology adoption reveal an unexpected pattern, where reliance on manual or traditional technologies is positively associated with IGA, while modern technologies show no significant or even negative effects. This stands in contrast to a few global findings demonstrating the enhancing effects on productivity of improved technologies (Foster & Rosenzweig, 2022; FAO, 2024). The divergence observed in this study likely reflects implementation failures rather than theoretical inconsistencies. Specifically, the adoption of modern technologies without adequate training, maintenance support, or contextual adaptation may limit their effectiveness. This suggests that technology dissemination strategies in the study area may be insufficiently aligned with farmers' capacities and local production conditions.

The most striking anomaly in the results concerns access to extension services. Farmers who report never having access to extension services exhibit higher IGC compared to those with more frequent access. This finding contradicts extensive findings highlighting the positive role of extension services in improving agricultural outcomes (Anderson & Feder, 2021; FAO, 2023). The result may be driven by endogeneity issues, such as self-selection bias, where more capable farmers rely less on formal extension systems. Alternatively, it may reflect deficiencies in the quality, relevance, or delivery of extension services, rendering them ineffective or even counterproductive. This finding is further supported by the inconsistent effects of distance to extension services, suggesting that physical access alone is insufficient to guarantee impact.

Finally, the strong positive effects associated with wealth changes underscore the importance of initial conditions in shaping intervention outcomes. Farmers with prior improvements in wealth are more likely to experience enhanced IGC, indicating the presence of path dependency. This aligns with the broader evidence on poverty traps and cumulative advantage, where initial asset endowments influence the ability to benefit from development interventions (Carter et al., 2021; IFAD, 2023). Consequently, agricultural interventions may inadvertently reinforce existing inequalities if they do not explicitly account for differences in baseline conditions.

Conclusion

The findings of this study have important implications for the design and implementation of agricultural interventions in Nigeria and similar developing countries. The evidence suggests that the effectiveness of such interventions depends less on their existence and more on the strength of complementary systems, particularly human capital development, credit delivery mechanisms, extension services, and technology deployment frameworks.

First, the strong positive effects of education and vocational skills acquisition highlight the need to reposition agricultural interventions toward capacity-building rather than mere resource provision. Policies should prioritize the integration of practical, skills-based modules into all intervention schemes. This includes strengthening agricultural training institutes, promoting farmer field schools, and embedding continuous learning components within intervention programs. Without deliberate investment in human capital, the transformative potential of agricultural interventions will remain limited.

Second, the negative relationship between credit access and IGC raises serious concerns about the current structure and utilization of agricultural finance. Rather than expanding credit indiscriminately, policymakers must focus on improving the quality and targeting of credit delivery. This includes linking credit to specific productive activities, strengthening monitoring and accountability mechanisms, and promoting financial literacy among farmers. Blended finance models, input-tied loans, and performance-based lending frameworks may help ensure that credit translates into productive investment rather than increased financial burden.

Third, the findings on technology adoption point to a critical implementation gap in the promotion of modern agricultural technologies. The lack of positive impact from modern technologies suggests that access alone is insufficient; effective utilization requires complementary support systems. Policymakers should therefore shift from “technology distribution” to “technology adoption” ecosystem. This involves providing hands-on training, ensuring the availability of maintenance services, adapting technologies to local conditions, and facilitating access to complementary inputs such as credit and extension support. Without these enabling conditions, investments in modern technologies are unlikely to yield expected productivity gains.

Fourth, the paradoxical results on extension services indicate deep structural weaknesses in the agricultural extension system. The finding that farmers with little or no access to extension services perform better suggests that existing services may be ineffective, poorly targeted, or misaligned with farmers’ needs. Reform efforts should focus on improving the quality, relevance, and accountability of extension delivery rather than simply expanding coverage. This may include the use of performance-based evaluation systems for extension agents, greater involvement of private and digital extension platforms, and the knowledge co-creation with farmers to ensure contextual solutions. Fifth, the strong influence of prior wealth status on IGA underscores the need for more inclusive and differentiated intervention strategies. Uniform intervention designs are likely to disproportionately benefit already better-off farmers, thereby reinforcing existing inequalities. Policymakers should adopt targeted approaches that account for baseline differences among beneficiaries, such as providing additional support to resource-poor farmers, designing graduated intervention packages, and incorporating social protection measures to enhance resilience among vulnerable groups. Finally, the weak and inconsistent effects of demographic variables such as gender suggest that while interventions may not be explicitly exclusionary, they may also not be sufficiently responsive to structural inequalities. Policymakers should therefore ensure that intervention designs incorporate gender-sensitive components, including improved access to land, credit, and training for women, even in contexts where statistical differences are not immediately evident.

Limitations and Suggestions for Further Studies

This study is limited by the cross-sectional nature of the data and its reliance on self-reported farmer perceptions, even though efforts were made to ensure that the responses are as valid as possible. These may introduce response bias in assessing livelihood improvements and intervention effectiveness as well as to establish the causal relationships between intervention participation and IGC over time. Additionally, potential endogeneity issues like the paradoxical findings on extension services and credit access suggest that unobserved farmer characteristics such as motivation and managerial ability may confound the results, limiting the precision of the ordered logit estimates. Future studies should therefore employ longitudinal or panel data designs to better capture the dynamic effects of agricultural interventions, while also incorporating experimental or quasi-experimental approaches such as propensity score matching or instrumental variable estimation to address selection bias and provide more robust causal evidence on the role of credit delivery, technology adoption, and extension service quality in shaping farmers' IGC.

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Conflict of interest

No conflict of interest is declared by any of the authors.

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