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Behavioural drivers of agricultural resilience: Evidence from Nigeria's NG-CARES social protection programme in Zamfara State

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Abstract

This study applies a theory-driven approach to assess the impact of Nigeria Community Action for Resilience and Economic Stimulus (NG-CARES) programme, focusing on result area 2 (RA 2), which targets agricultural productivity and food security among smallholder farming households in Zamfara State, northwestern Nigeria. Implemented in response to pandemic-induced disruptions, RA 2 aimed to improve on-farm productivity and food access through the provision of agricultural inputs, climate-smart technologies, and extension services. A mixed-methods approach was employed using a quasi-experimental design based on cross-sectional household survey data from 723 respondents across four Local Government Areas. The analytical framework integrates the theory of planned behaviour (TPB), social cognitive theory (SCT), and the NG-CARES theory of change to examine behavioural, institutional, and economic pathways linking programme participation to welfare outcomes. Programme impacts were estimated using endogenous treatment effect (ETE) and augmented inverse probability weighting (AIPW) models. Results show that NG-CARES participation significantly increased yield by 34–37 % (kg ha^{-1}), farm income by 86–87 % (₦ ha^{-1}), and reduced household food insecurity scores by 0.64 points on the household food insecurity access scale (HFIAS), with all effects statistically significant at the 1 % level. The study provides empirical evidence of the behavioural impact of NG-CARES in fragile rural contexts. It emphasises the importance of incorporating behavioural insights into programme design, highlights the usefulness of integrated econometric tools for evaluating non-randomised interventions and stresses the need for gender-sensitive strategies to enhance inclusion. The policy recommendations are to scale up behavioural-informed input support systems, enhance extension platforms, institutionalise routine impact evaluations and target female farmers more effectively in order to inform adaptive programme design.

Keywords: agricultural productivity, behavioural theory, food security, mediation analysis, rural resilience.

1 Introduction

Agricultural productivity and food security remain central development challenges in Nigeria, particularly in rural and agrarian states such as Zamfara. Although agriculture employs over 70 % of the rural workforce, farming households frequently encounter limited access to quality inputs, advisory services, and functional markets (Udoh & Adelaja, 2021; Sennuga *et al.*, 2023). These constraints contribute to persistently low yields, seasonal income volatility, and chronic food insecurity (Babatunde & Qaim, 2010; FAO, 2020). In Zamfara State, located in north-western Nigeria, more than one million individuals are classified as food insecure – a condition compounded by internal displacement, climate variability, and economic marginalisation (Sanchi, 2022; World Bank, 2020).

Building on these pre-existing vulnerabilities, the COVID-19 pandemic further disrupted agricultural value chains, restricted market access, and drove up input costs. Both globally and nationally, food systems became increasingly fragile, while smallholder farmers in Nigeria faced supply chain breakdowns, income shocks, and rising food prices (Castaneda *et al.*, 2021; Clapp & Moseley, 2020). In response, the Nigerian government – working in partnership with the World Bank – launched the Nigeria Community Action for Resilience and Economic Stimulus (NG-CARES) programme in 2020. This initiative was designed to mitigate the socio-economic impacts of external shocks,

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safeguard livelihoods, and strengthen community resilience through targeted, inclusive interventions.

This study focuses on Result Area 2 (RA 2) of the NG-CARES programme, which supports smallholder farmers through a suite of measures including subsidised agricultural inputs (such as certified seeds, fertilisers, and agrochemicals), improved production technologies, extension services, and training via demonstration activities. These services are delivered through cooperative groups and institutional platforms to encourage adoption, enhance productivity, and improve food access. Participation is voluntary and primarily directed at economically vulnerable farmers operating on a small scale.

Despite its inclusive aims, programme participation has remained heavily skewed toward male farmers, with only 91 female participants out of 361 in our sample. This gender imbalance underscores the structural, cultural, and logistical barriers that limit women's access to agricultural support programmes. Our analysis acknowledges this limitation and proposes gender-sensitive strategies such as tailored extension services, women-focused group delivery models, and childcare support during training sessions to enhance female participation.

Empirical evidence on the actual impact of NG-CARES remains limited. This study seeks to address that gap by rigorously evaluating the programme's effects on agricultural yield (kg ha^{-1}), income (₦ ha^{-1}), and household food security, measured using the Household Food Insecurity Access Scale (HFIAS), among participating farmers in Zamfara State.

2 Theoretical and conceptual framework

This study integrates the Theory of Planned Behaviour (TPB), Social Cognitive Theory (SCT), and the NG-CARES Programme Theory of Change (ToC) to explain how the intervention fosters technology adoption and improves welfare outcomes. According to TPB, behavioural intentions depend on attitudes, subjective norms, and perceived behavioural control (Ajzen, 1991). In our context, a farmer's decision to adopt improved practices hinges on their beliefs about benefits, perceived community expectations, and confidence in accessing inputs and services. SCT highlights the roles of self-efficacy, observational learning, and social reinforcement in behaviour change (Bandura, 1986). Here, farmers gain skills and confidence by observing peers on demonstration plots, engaging with extension agents, and receiving ongoing social support. The NG-CARES ToC links programme inputs such as improved seeds, fertilisers, training, and institutional support to intermediate outputs like the uptake of improved practices and ultimately to final outcomes including yield, income, and food security. It provides the causal backbone that connects behavioural drivers to agricultural resilience. Fig. 1 synthesises these models into a unified conceptual framework, illustrating pathways from NG-CARES participation through behavioural constructs to productivity and welfare gains. This framework guided indicator selection and informed our empirical strategy.

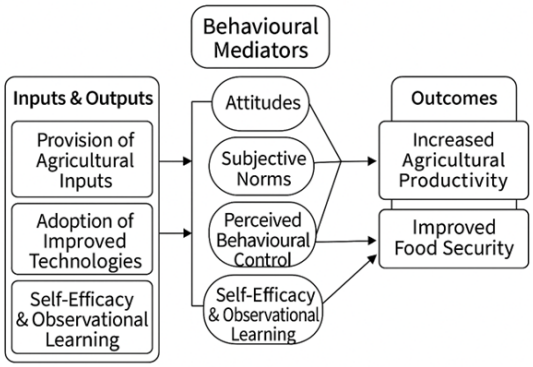

Fig. 1: *Conceptual framework – Adapted from NG-CARES ToC, Ajzen (1991) and Bandura (1986).*

Gender considerations run throughout the framework. Structural and cultural barriers may constrain women's perceived control and access to extension services – critical mediators of adoption. We therefore identify gender-sensitive delivery strategies alongside behavioural drivers.

To operationalise TPB and SCT, we mapped each theoretical construct to survey-based proxies (Table 1). This mapping underpins our quantitative analysis of how attitudes, norms, perceived control, learning, and self-efficacy influence participation and outcomes.

Table 1: *Operationalisation of theoretical constructs from theory of planned behaviour and social cognitive theory.*

Construct	*Proxy variable*	*Data source*
Attitude	Prior programme awareness, adoption history	Field survey
Subjective norm	Membership in farmer cooperative	Field survey
Perceived behavioural control	Access to inputs, extension visits	Field survey
Self-efficacy	Technical efficiency, advisory use	DEA results, survey
Observational learning	Peer learning, demo plot exposure	Group-level indicators

DEA = data envelopment analysis.

3 Materials and methods

This study adopts a quasi-experimental approach interpreted through a behavioural lens. We frame programme participation as a behavioural outcome influenced by attitudes, norms, and perceived control, as specified in TPB. Specifically, perceived behavioural control increases the likelihood of enrolling in the programme, while subjective norms and prior awareness (attitudes) further shape engagement.

3.1 Study area

The research was conducted in Zamfara State, northwestern Nigeria. The state lies within the Sudan Savannah agro-ecological zone, characterised by a distinct wet and dry season with annual rainfall ranging between 675 mm and 1,000 mm. The population is predominantly agrarian, with most residents engaged in the cultivation of rice, sorghum, maize, and vegetables. The state was selected due to its vulnerability to food insecurity and its high level of participation in the NG-CARES programme.

3.2 Sampling procedure

A multi-stage sampling technique was adopted. First, four Local Government Areas (LGA: Gusau, Bungudu, Bakura, and Talata-Mafara) were purposively selected based on NG-CARES implementation intensity and accessibility. In the second stage, 30 % of the participating and non-participating Farmer Community Associations (FCAs) in each LGA were randomly selected to ensure fairness and transparency in the selection process. This was based on the assertion made by Leedy & Ormrod (2010), that a sample size of 30 % is commonly employed in practical research when high precision is required, and the population is not too large. In the final stage, stratified random sampling was used to select 723 households, comprising 361 programme participants and 362 non-participants. Data were collected from September to December, 2024 using a structured questionnaire administered by trained enumerators.

3.3 Analytical techniques

Impact estimation employed econometric models to correct for selection bias and ensure credible counterfactuals. The quasi-experimental design enabled causal inference by comparing matched groups of participants and non-participants, while also taking into account behavioural variables. This approach facilitated the identification of direct effects on productivity and food security, as well as indirect behavioural pathways through which the programme influences participants.

To address potential selection bias from unobserved heterogeneity, the endogenous treatment effect (ETE) model was applied. This involves estimating both a selection (participation) equation and an outcome equation. The general specification is:

$$Y_i = \alpha + \tau D_i + \beta X + \lambda\, IMR + \varepsilon_i$$

where Y_i is the outcome variable (yield in kg ha^{-1}, income in ₦ ha^{-1}, food security score); D_i is participation in NG-CARES (1 if participant, 0 otherwise); X is a vector of covariates (age, gender, education, household size, etc.); IMR is the inverse Mills ratio from the selection model; and ε_i is the error term.

The augmented inverse probability weighting (AIPW) model was employed to validate the ETE results. This doubly robust model adjusts both the treatment assignment and the outcome regression models using propensity scores to estimate the average treatment effect (ATE). Standard errors, p-values, and 95 % confidence intervals were reported for all estimates to enhance interpretability.

To examine how behavioural and institutional factors mediate programme outcomes, the causal mediation analysis (CMA) was conducted. Mediators included seed use, fertiliser use, and access to advisory services, consistent with the study's theoretical framework, allowing estimation of both direct and indirect effects.

Key outcome variables were measured as follows: yield was estimated in kg ha^{-1} and complemented by DEA-based technical efficiency scores; income was measured as gross margin per hectare (₦ ha^{-1}); and food security was assessed using the Household Food Insecurity Access Scale (HFIAS).

4 Results

The results are presented in four parts. First, socio-economic characteristics of NG-CARES participants and non-participants are compared to highlight baseline differences. Next, programme impacts on yield, farm income, and household food security are examined using endogenous treatment effect (ETE) and augmented inverse probability weighting (AIPW) models. Qualitative evidence from household interviews is incorporated where relevant to contextualise the quantitative findings.

4.1 Socio-economic differences

Table 2 shows significant socio-economic differences between NG-CARES participants and non-participants. Participants were younger, from smaller households, and cultivated less land, suggesting that the programme targeted or

appealed to more dynamic smallholders operating at modest scales. The age disparity indicates a generational tilt, with younger household heads more open to innovation and support.

In contrast, dependency ratios did not differ significantly, implying similar demographic burdens across groups despite differences in age and household size. Categorical attributes reveal gender and education disparities. While male-headed households dominated both groups, female-headed households were more likely to participate, though they remained a minority overall. This suggests that women readily engage when given access, but structural barriers such as limited land rights and restrictive norms continue to constrain their representation. Educational attainment was also higher among participants, which may have facilitated programme awareness and engagement. Addressing these barriers is essential for ensuring equitable access to agricultural support.

Table 2: *Mean differences in socio-economic characteristics and categorical variables between participants (N=361) and non-participants (N=362).*

Variable	*Non-part.*	*Participants*	*p-value*
Age (Years)	58 (11.47)	45 (10.67)	***
Household size	13 (4.23)	8 (4.52)	***
Dependency ratio	144.6 (84.82)	145.3 (92.68)	n.s.
Land cultivated (ha)	1.17 (0.52)	0.50 (0.00)	***
Gender			***
Female	4	91	
Male	356	270	
Education			***
Primary	160	162	
Secondary	47	91	
Tertiary	8	17	
No formal	145	91	

Note: Standard deviation (SD) in parantheses; *** $p < 0.01$, n.s. = not significant.

4.2 Yield effects

Table 3 shows that NG-CARES participation significantly increased yields (kg ha^{-1}), with consistent results across both ETE and AIPW models. These productivity gains are notable given the rain-fed, resource-constrained conditions of Zamfara State. Beyond input provision, advisory services and demonstrations appear to have strengthened technical competence, enabling more efficient agronomic practices. Behaviourally, the yield effect reflects stronger perceived control and self-efficacy, consistent with the theory of planned behaviour and social cognitive theory. The robustness of findings across models indicates a genuine programme impact on productivity.

Table 3: *Estimated treatment effects on yield (kg ha^{-1})*

Outcome	*Estimate*	*SE*	*p-value*	*95% CI*
ETE ATE	0.339	0.061	***	[0.219, 0.460]
AIPW ATE	0.372	0.017	***	[0.339, 0.405]
ETE ATET	0.312	0.121	**	[0.076, 0.549]

Note: ETE = endogenous treatment effect; ATE = average treatment effect; AIPW = augmented inverse probability weighting; ATET = average treatment effect on the treated. SE = Standard error; *** $p < 0.01$, ** $p < 0.05$; 95 % confidence intervals (CI) are shown for interpretability.

4.3 Income effects

Table 4 shows that NG-CARES participation significantly increased farm profitability (gross margin per hectare). Even with modest input investments, farmers achieved high marginal returns, suggesting that the programme effectively alleviated constraints related to input access and technical support. Household interviews confirmed that gains were linked to the adoption of improved seeds, fertiliser and herbicides in recommended quantities, and participation in advisory sessions on good agricultural practices, post-harvest handling, and storage. One beneficiary explained: "Before NG-CARES, we used old seeds and guessed at fertiliser use. Now, we know the right type and amount to use, and when to use it." These insights highlight that the programme's impact extended beyond inputs, fostering knowledge transfer and better farm-level decision-making.

Table 4: *Estimated treatment effects on income (gross margin in ₦ ha^{-1})*

Outcome	*Estimate*	*SE*	*p-value*	*95% CI*
ETE ATE	0.859	0.074	***	[0.715, 1.004]
AIPW ATE	0.873	0.020	***	[0.835, 0.910]
ETE ATET	0.817	0.137	***	[0.548, 1.086]

Note: ETE = endogenous treatment effect; ATE = average treatment effect; AIPW = augmented inverse probability weighting; ATET = average treatment effect on the treated. SE = Standard error; *** $p < 0.01$; 95 % confidence intervals (CI) are shown for interpretability.

From a behavioural perspective, the income effects align with enhanced self-efficacy and informed decision-making, reinforced by advisory services and group delivery mechanisms. The consistency of ETE and AIPW estimates supports the robustness of the findings, indicating genuine programme effects rather than selection bias.

4.4 Food security effects

Table 5 shows mixed but meaningful impacts on household food security, measured by HFIAS scores. The AIPW

Table 5: *Estimated treatment effects on food security (HFIAS Score)*

Outcome	*Estimate*	*SE*	*p-value*	*95% CI*
ETE ATE	-0.528	0.483	n.s.	[-1.476, 0.421]
AIPW ATE	-0.106	0.043	**	[-0.191, -0.022]
ETE ATET	-0.155	0.909	n.s.	[-1.938, 1.627]

Note: ETE = endogenous treatment effect; ATE = average treatment effect; AIPW = augmented inverse probability weighting; ATET = average treatment effect on the treated. SE = Standard error; $^{**}p < 0.05$, n.s. = not significant; 95 % confidence intervals (CI) are shown for interpretability.

model indicates a modest but significant reduction in food insecurity among participants, while ETE estimates were not statistically significant. Although smaller than yield or income effects, these gains are important in vulnerable rural settings, where incremental improvements in food access have substantial welfare implications.

These results suggest that NG-CARES improved household food security indirectly by enhancing access to inputs and knowledge, thereby stabilizing production and strengthening coping strategies. Behaviourally, the findings align with theories of planned behaviour and social learning, where advisory services and institutional support reinforce households' sense of control and planning capacity.

Table 6 decomposes the treatment effect into direct and indirect components. The NG-CARES programme improved income (₦ ha^{-1}) not only through direct effects but also via behavioural pathways. Seed use was the strongest mediator, followed by advisory services, indicating that resource access and guidance shaped farmer practices and outcomes.

From a TPB perspective, this reflects enhanced perceived behavioural control, while SCT underscores the role of advisory services and group-based learning in reinforcing self-efficacy. Thus, programme success depended on both inputs and the behavioural systems that supported their uptake.

Policy design should therefore integrate resource provision with behavioural mechanisms, such as group delivery, tailored advisory services (especially for women), and demonstration plots, to strengthen these mediation pathways and ensure sustainable impact.

5 Discussion

5.1 Socioeconomic characteristics and inclusivity

Differences in age, household size, and landholding highlighted the programme's targeting dynamics. Participants were younger, suggesting intentional engagement of innovation-prone farmers (Ajzen, 1991; Duflo *et al*., 2011; Asaleye *et al*., 2020). Smaller household sizes appeared to enhance responsiveness to interventions, reflecting adaptive potential (Babatunde & Qaim, 2010). Inclusion of marginal landholders indicated equity-oriented targeting, in line with broader subsidy initiatives (Adesina *et al*., 2017).

5.2 Gendered participation and barriers

Female-headed households were underrepresented (91 of 361 participants), reflecting barriers such as limited access to land, credit, and extension services, as well as cultural restrictions on group participation. To improve inclusion, NG-CARES could adopt:

- women-only farmer groups,
- childcare support during training,
- gender-tailored extension schedules
- improved access to credit and inputs.

These strategies are aligned with best practices in gender-responsive rural development and ensure more inclusive agricultural resilience.

5.3 Treatment effects on yield

Yield gains confirmed the programme's productivity objectives, driven by better input use and efficiency (Lu *et al*., 2021). From a TPB perspective, results reflected stronger behavioural control, while SCT highlighted peer learning and self-efficacy (Bandura, 1986). Similar outcomes have been documented in input–advisory interventions (Adesina *et al*., 2017; Udoh & Adelaja, 2021).

5.4 Treatment effects on income

Income improvements were driven by higher productivity, reduced transaction costs, and subsidised inputs. These reflected enhanced self-efficacy and deliberate decision-making (TPB), reinforced by group learning and demonstration effects (SCT; Bandura, 1986). Comparable findings were reported by Muth *et al*. (2020), underscoring financial viability and scalability potential.

5.5 Treatment effects on food security

ETE results were inconclusive, but AIPW estimates showed modest yet significant improvements in food security. Advisory support and planning behaviours likely contributed to stabilised access, echoing Babatunde & Qaim (2010). Even small gains are meaningful in fragile rural contexts.

Table 6: *Causal mediation pathway for yield, income (₦/hectare), and food security (HFIAS points)*

	Yield			*Income*			*Food security*		
Variable	*Direct*	*Indirect*	*Overall*	*Direct*	*Indirect*	*Overall*	*Direct*	*Indirect*	*Overall*
Programme participation	0.42	+0.11	0.53	0.37	+0.06	0.43	0.28	-0.22	0.06
Seed use	-	+0.15	+0.15	-	+0.10	+0.10	-	+0.08	+0.08
Fertiliser use	-	-0.05	-0.05	-	-0.03	-0.03	-	-0.02	-0.02
Herbicide use	-	-0.07	-0.07	-	-0.05	-0.05	-	-0.03	-0.03
Insecticide use	-	-0.04	-0.04	-	-0.05	-0.05	-	-0.03	-0.03
Advisory services	-	+0.12	+0.12	-	+0.09	+0.09	-	+0.06	+0.06
Income → food security	-	-	-	-	-	-	-	-0.28	-0.28

5.6 Mediation analysis

Causal mediation confirmed that seed adoption and advisory services were key behavioural channels linking programme participation to improved income. This supported behavioural impact theory and aligned with evidence from Adesina *et al*. (2017) and Muth *et al*. (2020). TPB and SCT explained these effects through enhanced knowledge, confidence, and decision environments.

5.7 Limitations and future directions

This study's cross-sectional design limited insights into behavioural dynamics over time. The low number of female participants restricted gender-disaggregated analysis, and reliance on self-reported yield and income data may have introduced recall bias. Findings from Zamfara may not generalise to other agro-ecological or socio-cultural contexts. Future work should adopt panel designs, integrate qualitative methods on gendered experiences, enlarge samples for subgroup analysis, and assess cost-effectiveness across regions.

6 Conclusion

The NG-CARES Result Area 2 programme significantly improved yields, income, and food security by combining input support with behavioural enablers such as seed adoption, advisory services, and peer learning. The findings emphasised the importance of perceived control, self-efficacy, and observational learning in technology adoption, with younger and smaller households showing the strongest gains. Persistent gender gaps, however, highlighted the need for tailored delivery mechanisms. Scaling strategies should integrate inputs with behavioural support systems to enhance resilience, inclusivity, and sustainability in rural communities.

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Conflict of interest

The authors declare no conflicts of interest related to this research.

Ethical compliance

This study adhered to ethical research standards, including obtaining informed consent from all participants.

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