Farm Productivity and Resource Used Efficiency Among Participants and Non-Participants of Zamfara Comprehensive Agricultural Revolution Program (ZACAREP), on Smallholder Farmers in Zamfara State, Nigeria

Mansur Lukman[1], M.A Maikasuwa[1], A.A Jega[1], A. Muhammad[2]
Department of Agricultural Economics and Extension,
Abdullahi Fodio University of Science and Technology Aliero, Nigeria.
Department of Crop Science, Abdullahi Fodio
University of Science and Technology Aliero, Nigeria.
Corresponding Author's contact
mansurlukmank@gmail.com
+2348030510676/+2348126280700

https://doi.org/10.56201/ijaes.vol.12.no11.2026.pg43.49

Abstract
This study compares farm performance among participants and non-participants in the Zamfara Comprehensive Agricultural Revolution Programme (ZACAREP). A cross-sectional survey covered 336 farmers, evenly divided between participants and non-participants. Cost-and-return comparisons, crop yield statistics and Cobb–Douglas production-function estimates were reported in the source thesis. Participants recorded higher mean yields across seven crops, including rice (2,791.06 versus 1,705.25 kg/ha) and maize (2,583.93 versus 1,534.65 kg/ha). Reported input elasticity sums were 1.184 for participants and approximately 0.495 for non-participants, although discrepancies in the source regression summaries require resolution. These results indicate strong associations between programme participation and farm performance but cannot by themselves establish causality, while the findings revealed efficient utilization of resources and return to scale among participants compared to non-participants.

Keywords
ZACAREP; smallholder farmers; Zamfara State; agricultural interventions; rural development

1. Introduction

For many farming households in northern Nigeria, the harvest determines both the food available at home and the cash available for the next production season. Yet farmers often cultivate with limited finance, irregular access to fertilizer and improved seed, and insufficient technical advice. These constraints make it important to examine not only how much farmers produce, but also what they earn after meeting production costs. The Zamfara Comprehensive Agricultural Revolution Programme (ZACAREP) was established to address some of these difficulties through farmer groups, improved production practices and agricultural support. An important question is whether farmers enrolled in the programme have better production and financial outcomes than those farming outside it.

This article compares crop yields, production expenditure, revenue and net farm income for the two groups. It also examines the relationship between major inputs and farm output using the production-function estimates reported in the thesis. By considering physical yields alongside costs and returns, the analysis offers a more complete account of farm performance than either measure alone. Recent evidence underscores why farm profitability and technical performance must be assessed together. A Nigerian study of crop choices and technical efficiency cautions that apparently efficient producers may nevertheless remain poor, indicating that productivity alone is an incomplete welfare indicator ("Are farmers 'efficient but poor'?", 2023). Research on drought-tolerant maize and organic fertilizer in Nigeria similarly emphasizes the importance of complementary input packages rather than isolated technologies (Oyetunde-Usman *et al*., 2024).
Evidence from a three-year randomized trial among 792 Nigerian maize farmers found that site-specific nutrient-management advice could improve input use, yield and revenue ("Sustainable maize intensification", 2023). However, these findings cannot be mechanically transferred to ZACAREP: the programme setting, crop mix, beneficiary selection and delivery systems differ. A local evaluation is therefore necessary to determine whether participation is associated with improved returns under Zamfara production conditions.
Three questions guide the analysis. How do crop yields vary between participating and non-participating farmers? Are higher revenues, where observed, accompanied by higher net farm income? And what do the reported production elasticities suggest about the contribution of land, labour, fertilizer, seed and capital? The answers are interpreted as differences between surveyed groups rather than as proof that participation caused the observed outcomes.

2. Materials and methods

The study used a cross-sectional survey of smallholder farmers in Zamfara State, northwestern Nigeria, comparing respondents who participated in the Zamfara Comprehensive Agricultural Revolution Programme (ZACAREP) with non-participants. The thesis describes a multistage design involving six purposively selected local government areas, 12 districts and 24 farming communities. Seven participants and seven non-participants were selected from each community, yielding 336 respondents (168 per group). The selection of accessible areas due to insecurity limits population-level generalizability. The thesis presents descriptive comparisons, farm-budget estimates and production-function results. These published summaries form the basis of the present analysis. Because the respondent-level dataset and original regression output were not available for independent reanalysis, the reported inferential statistics are interpreted cautiously. Crop productivity is reported in kg/ha. The thesis specifies separate log–log Cobb–Douglas production functions with land, labour, fertilizer, seed and capital as predictors. In a Cobb–Douglas model, the slope coefficients are input elasticities, and their sum represents returns to scale under the maintained specification. Reported coefficients, R^2 and model F-statistics require audit against the original regression output.

2.1 Study setting and programme context.

Zamfara State lies in northwestern Nigeria and is characterized by crop-based smallholder production. According to the source thesis, ZACAREP was established in 2004 to improve agricultural productivity, food access, farmer market participation and living standards. Programme support was intended to operate through farmer groups and the dissemination of improved production practices. The present analysis concerns reported participant status, not randomized allocation of support.

2.2 Sampling and data collection.

The thesis describes six purposively selected local government areas, 12 districts and 24 communities, with seven participants and seven non-participants sampled in each community. The resulting sample was 336 farmers (168 per group). The thesis identifies insecurity as a consideration in selecting accessible locations. Sampling dates, questionnaire wording, crop-specific sample sizes and respondent-level data should be confirmed from the fieldwork records. Purposive geographic selection and non-random participation constrain external validity and causal identification.

3.3 Crop yield and statistical comparison.

Crop productivity is expressed in kilograms per hectare (kg/ha). Participant and non-participant group means, mean differences, reported t-statistics and p-values are transcribed from the thesis. Reported $p = 0.000$ is rendered as $p < 0.001$, not as a zero probability. The availability of only aggregated tables precludes checking test assumptions, clustering or heteroskedasticity and independently reproducing standard errors.

2.5 Production function. The thesis estimates separate Cobb–Douglas models of the form $\ln(Y_i) = \beta_0 + \beta_1\ln(Land_i) + \beta_2\ln(Labour_i) + \beta_3\ln(Fertilizer_i) + \beta_4\ln(Seed_i) + \beta_5\ln(Capital_i) + \varepsilon_i$. Each β coefficient is interpreted as a conditional input elasticity under the specified functional form; the sum $\Sigma\beta$ indicates estimated returns to scale. The original thesis does not supply the complete estimation dataset, transformation decisions for zero inputs, or diagnostics. The reported model-fit and coefficient inconsistencies are retained and flagged rather than silently repaired.

Participation was not randomly allocated. Farmers who joined ZACAREP may have differed beforehand from non-participants in resources, experience, motivation or access to services. The comparisons therefore describe associations in the surveyed sample; they cannot, on their own, establish what participants would have earned or produced without the programme.

3. Results

3.2 Crop productivity

Average yields were higher for participants in each of the seven crops reported. The largest differences occurred in rice, at approximately 1,086 kg/ha, and maize, at approximately 1,049 kg/ha. The consistency across crops is notable, but these are group averages rather than estimates adjusted for differences in farm conditions or farmer characteristics.

Table 3.2 Crop productivity (source: thesis field survey, 2025; values reproduced as reported)

Crop	Participants	Non-Participants	Mean Difference (kg/ha)	t- value	Sig.(2-tailed)
Maize	2,583.93 ± 1,061.35	1,534.65 ± 654.31	1,049.28	10.91	0.000***
Rice	2,791.06 ± 1,190.59	1,705.25 ± 667.70	1,085.82	10.31	0.000***
Millet	2,334.99 ± 1,057.96	1,345.64 ± 568.01	989.35	10.68	0.000***
Sorghum	2,378.85 ± 970.84	1,482.40 ± 630.24	896.45	10.04	0.000***
Cowpea	1,651.88 ± 697.58	1,016.10 ± 446.96	635.78	9.95	0.000***
Groundnut	1,943.27 ± 787.32	1,184.68 ± 494.38	758.59	10.58	0.000***
Soybean	1,807.52 ± 735.96	1,139.85 ± 515.79	667.67	9.63	0.000***

Source: field survey, 2025

3.3 Production function estimates

The reported production functions show positive coefficients for land, labour, fertilizer, seed and capital in both groups. Among participants, fertilizer had the largest estimated coefficient (0.315); among non-participants, labour had the largest (0.141). The estimates suggest different patterns of input use, although inconsistencies in the accompanying statistics limit their interpretation.

Table 3.3 Production function estimates (source: thesis field survey, 2025; values reproduced as reported)

Variable	Participants: B (Std. Error)	t-value	p-value	Non-Participants: B (Std. Error)	t-value	p-value
Constant	0.786 (0.240)	3.28	0.000	0.771 (0.516)	1.492	0.138
ln(Land)	0.284 (0.021)	13.772	0.000	0.123(0.046)	2.647	0.009
ln(Labour)	0.202 (0.016)	12.830	0.000	0.141 (0.032)	4.399	0.000
ln(Fertilizer)	0.315 (0.014)	22.339	0.000	0.064 (0.031)	2.064	0.041
ln(Seed)	0.170 (0.018)	9.705	0.000	0.106 (0.038)	2.756	0.007
ln(Capital)	0.215 (0.017)	12.675	0.000	0.063 (0.038)	1.628	0.106

Source: field survey, 2025

3.4 Model fit

The thesis reports model-fit measures for each group. Some values of R^2 and adjusted R^2 are difficult to reconcile with the stated sample size and number of predictors. The original regression output is needed to establish which figures are correct.

Table 3.4 Model fit (source: thesis field survey, 2025; values reproduced as reported)

Group	R^2	Adjusted R^2	F-Statistic	p-value
Participants	0.932	0.865	214.604	0.000
Non-Participants	0.478	0.205	9.616	0.000

Source: field survey, 2025

3.5 Production elasticities and returns to scale

The thesis gives a total elasticity of 1.184 for participants, a value above one that would indicate increasing returns to scale if the model were correctly specified and estimated. It reports 0.495 for non-participants, but that total does not agree fully with the individual coefficients. The difference between groups should therefore be treated as provisional.

Table 3.5 Production elasticities and returns to scale (source: thesis field survey, 2025; values reproduced as reported)

Input	Participants Elasticity	Non-Participants Elasticity
Land	0.284	0.123
Labour	0.202	0.141
Fertilizer	0.315	0.064
Seed	0.170	0.104
Capital	0.215	0.063
Returns to Scale (Σβ)	1.184	0.495
Nature of Returns	Increasing	Decreasing

Source: field survey, 2025

The farm budgets and yield comparisons point in the same direction: the surveyed participants generally reported stronger production and financial outcomes. These findings do not reveal whether programme support alone explains the gap. They also depend on how the survey valued family labour, land use and fixed costs, details that should be clarified before making precise claims about economic efficiency.

4. Discussion

One feature of the results deserves attention: participants spent more on production yet retained more income after costs. This pattern is consistent with higher-input farming that generates enough additional output to cover the extra expenditure. It also illustrates why revenue or yield alone is an incomplete measure of economic performance. Higher participant yields across several crops suggest that the observed difference is not restricted to one enterprise. However, participating households may have cultivated better land, obtained credit more easily or had greater farming experience before joining the programme. The available comparisons cannot separate these explanations from the contribution of ZACAREP services.

The production-function results add a useful perspective but require more caution than the farm-budget figures. In particular, the mismatch between reported elasticity totals and component estimates prevents a reliable comparison of returns to scale. Any recommendation about optimal input combinations should await a check of the underlying model output. The survey covers one period and was conducted in communities selected partly for accessibility. Recall errors, differences in output prices and the non-random choice to participate may affect the estimates. These limitations do not erase the observed differences, but they narrow the conclusions that can reasonably be drawn from them. Productivity, input packages and complementary services. The observed participant yield advantage is compatible with a setting in which access to inputs and technical advice helps farmers manage production constraints. A Nigerian field experiment on site-specific nutrient advice reported improvements in maize yields and revenues, illustrating the potential value of actionable extension information (“Sustainable maize intensification”, 2023). Similarly, Oyetunde-Usman *et al*. (2024) examined the joint adoption of drought-tolerant maize and organic fertilizer in rural Nigeria, highlighting that production outcomes may depend on combinations of practices. These studies provide contextual support, not independent confirmation of a causal ZACAREP effect.

Profitability rather than gross output alone. Participants reported higher production expenditure as well as higher revenue. That pattern is economically plausible when improved production requires additional seed, fertilizer, labour or mechanization costs. Net farm income is therefore more informative than revenue alone. The Nigerian “efficient-but-poor” literature further

cautions that technical efficiency need not translate directly into improved economic well-being; farm choices, endowments and market conditions matter ("Are farmers 'efficient but poor'?", 2023). Because the thesis aggregates costs per hectare, detailed decomposition of expenditure categories would strengthen interpretation. Production elasticities and the limits of model inference. Under a correctly estimated Cobb–Douglas specification, the sum of input coefficients represents returns to scale. The participant sum reported in the thesis exceeds unity, whereas the non-participant sum is below unity. However, inconsistent component sums and unusual fit statistics prevent strong inference about structural efficiency differences. The model should be re-estimated from the original observations, with explicit units, diagnostics, confidence intervals and tests of constant returns to scale, before using these coefficients to recommend proportional expansion of inputs.

Agricultural extension and institutional delivery. Studies in Nigeria identify training, extension and institutional conditions as relevant to the adoption of agricultural innovations (Obianefo *et al*., 2024; Ikoyo-Eweto *et al*., 2024). Evidence from Tanzania also suggests that input subsidies and extension services may jointly support maize productivity, although the identification strategy and policy environment differ from those of the present survey (Malimi, 2023). Programme performance should thus be evaluated not only by nominal input distribution but also by delivery timing, agronomic suitability, farmer understanding and costs borne by beneficiaries.

Limitations and research agenda. The study is a single-period observational comparison with purposively selected accessible communities. Non-participants may differ systematically from participants, and the survey may be affected by recall error, price differences and common shocks. Crop-specific denominators and the exact basis for reported significance tests require verification. Future work should combine the respondent-level survey with programme administrative records, baseline covariates and geographic identifiers; where assumptions are defensible, propensity-score weighting or doubly robust adjustment could estimate adjusted associations. Longitudinal or credible quasi-experimental designs would be needed for stronger causal attribution.

5. Conclusions

Among the farmers surveyed in Zamfara State, ZACAREP participants reported higher average crop yields, revenue and net farm income than non-participants. The higher mean yields were reported for all seven crops examined. These findings suggest that programme participants were performing better economically at the time of the survey. They do not establish that ZACAREP caused the differences. In addition, the production-function estimates require reconciliation before conclusions about returns to scale can be sustained.

6. Policy implications

Programme monitoring should place net returns alongside yield targets. Timely delivery of seed, fertilizer and extension advice matters only if farmers can use those services effectively and afford the associated costs. Future evaluations should record crop-specific costs, prices and yields consistently, retain the underlying survey data and account for differences between participants and non-participants. Such evidence would give policymakers a firmer basis for decisions about programme expansion.

References

Amoussohoui, R., Arouna, A., Bavorova, M., and Verner, V. (2024). Analysis of the factors influencing the adoption of digital extension services: Evidence from the RiceAdvice application in Nigeria. The Journal of Agricultural Education and Extension, 30(3). https://doi.org/10.1080/1389224X.2023.2222109

Ikoyo-Eweto, G., Adedokun, I., Archibong, J., and Okwuokenye, G. (2024). Rural farmers access to extension services: Implications for increased adoption of improved farm technologies in Delta State, Nigeria. Journal of Agriculture and Food Sciences, 21(2), 135–152. https://doi.org/10.4314/jafs.v21i2.11

Malimi, K. (2023). Agricultural input subsidies, extension services, and farm labour productivity nexus: Evidence from maize farmers in Tanzania. Journal of Agricultural Economics, 74(3), 874–898. https://doi.org/10.1111/1477-9552.12537

Obianefo, C. A., Obiekwe, N. J., Okoroji, N. O., Shah, Z. A., Uchemba, U. V., and Osegbue, E. G. (2024). Usability of e-extension technology and growth of agricultural productivity in southeast Nigeria: ADP extension worker's survey. Sarhad Journal of Agriculture, 40(2), 659–671. https://doi.org/10.17582/journal.sja/2024/40.2.659.671

Oyetunde-Usman, Z., Shee, A., and Abdoulaye, T. (2024). Does simultaneous adoption of drought-tolerant maize varieties and organic fertiliser affect productivity and welfare outcomes? Evidence from rural Nigeria. Australian Journal of Agricultural and Resource Economics, 68(2), 413–436. https://doi.org/10.1111/1467-8489.12550

Soneye, O. O. (2023). Crop appropriation, labour supply, and demand for farm inputs: Evidence from Nigeria. Journal of International Development, 35(6), 995–1012. https://doi.org/10.1002/jid.3716

Determinants of adoption of multiple sustainable agricultural practices among smallholder farmers in Nigeria. (2021). International Soil and Water Conservation Research, 9(2), 241–248. https://doi.org/10.1016/j.iswcr.2020.10.007

Sustainable maize intensification through site-specific nutrient management advice: Experimental evidence from Nigeria. (2023). Food Policy, 121, 102546. https://doi.org/10.1016/j.foodpol.2023.102546

Are farmers "efficient but poor"? The impact of crop choices on technical efficiency and poverty in Nigeria. (2023). Journal of Agricultural Economics, 74(1), 191–213. https://doi.org/10.1111/1477-9552.12501