

Assessing The Economic Impact Of The Value Chain Development Program Intervention On Rice Farmers In Ebonyi State

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Abstract

Developing countries have continuously been involved in programs of agricultural development, and one of such intervention was implemented for Ebonyi State a dedicated agrarian part of Nigeria. It becomes imperative to assess if the realisations of these interventions are fit for purpose. This study sets out to evaluate the impact of the rice value chain development program (VCDP) on the income and productivity of rice farmers in Ebonyi State. A combination of stratified and simple random sampling techniques was used to obtain data from 214 rice farmers – the farmer program participants and non-participants - through a well-structured questionnaire instrument. The dataset was analysed using the treatment effect model – inverse probability weighted regression adjustment. The findings revealed that the farmers made a positive net income and productivity from rice farming, however the program participants made higher net income and productivity than the non-participants. This was further confirmed by the regression which showed that the rice program intervention had positive impact on the income (1.79%) and total factor productivity (1.014) of rice farmers in the study area. Different key factors, farm size, age, marital status, car/asset ownership, extension services, household size, transportation costs, loan patterns and membership in agricultural associations affected the income and productivity of the farmers, whereas membership in agricultural associations, extension access, inputs access and agricultural training, influenced farmer participation in the VCDP intervention. It is recommended that the intervention is sustained, and that such programs which promotes the combination of extension & training services, input access, credit facilitation and market linkages be domesticated at the community levels by local government.

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I. Introduction

Growing rice, as a component of staple cereal agriculture, is vital for boosting economies, cutting poverty, and securing food supplies in Sub-Saharan Africa. Increases in agricultural activity—especially rice—produce strong ripple effects on rural incomes and disproportionately help the poorest households, with larger benefits seen in rural areas than in cities (Sassi, 2023). Staples such as rice therefore remain a key channel for turning productivity improvements into better welfare for vulnerable people, making sustained investment in the sector necessary. Many countries, including Nigeria, are now focusing on rural transformation by developing agri-food value chains and tapping demand for higher-value goods to stimulate growth (Ukeje, 2021).

Nigeria faces significant economic strains because domestic supply cannot keep pace with growing demand for staple foods like rice, largely due to poor product quality, unreliable supply chains, and weak market linkages for smallholder producers (Chiaka et al., 2022; Odewole et al., 2024). Consumer preference is strongly influenced by differences in quality between imported and locally milled rice, highlighting shortcomings in production techniques, value addition, and processing standards (Odewole et al., 2024). Other barriers—such as restricted access to inputs, finance, and markets, together with gender gaps in productivity and market information—further weaken the competitiveness of domestic rice (Chiaka et al., 2022; Ojo & Baiyegunhi, 2023). Recent studies emphasize the need for innovations and improved infrastructure across the rice value chain to raise productivity, expand market access, and increase transparency, while calling for policies that specifically support smallholder farmers (Odewole et al., 2024; Ojo & Baiyegunhi, 2023).

Tackling these structural problems through modern technologies, value-chain optimization, and inclusive policy measures is essential if Nigeria is to meet growing demand and reduce its dependence on imported rice (Chiaka et al., 2022; Odewole et al., 2024; Ojo & Baiyegunhi, 2023). It is believed that targeted poverty-reduction programs—such as those embedded in Value Chain Development Programs (VCDPs)—can create a reinforcing cycle in which decreasing poverty further stimulates economic growth, particularly when interventions are specifically designed to meet the needs of the poor (Thorbecke & Ouyang, 2022). One of such rice VCDP interventions was initiated and implemented within the last decade for Ebonyi State. Hence, this study aims to evaluate the impact of the rice VCDP intervention on the income and productivity of rice farmers, as key actors in rice production and the agricultural development drive.

II. Methodology

Study Area and Sampling

The study was conducted in Ebonyi State, one of the pilot states for the rice VCDP intervention and a southeastern state of Nigeria. Given that the rice VCDP was initially implemented in five out of the thirteen local government areas (LGAs) in the State, the research design was made to include rice farmers in both LGAs that received the VCDP intervention and others that did not receive the VCDP intervention.

Using a combination of simple random sampling and stratified random sampling techniques, 24 communities were sampled from 6 LGAs (comprising of 3 LGAs with the rice VCDP intervention and another 3 without the rice VCDP intervention). Using a well-structured questionnaire, a total of 214 responses of sampled rice farmer data was obtained from these communities.

Data Collection and Data Analysis

Data collected involved farmers from the rice VCDP participating areas and the non-participating areas. This was done to provide a basis for comparison to estimate the impact of the VCDP intervention. Such methods are employed in the absence of requisite quality data collected on the units of analysis (the rice farmers) before and after the implementation of the intervention. Hence, post-intervention survey collection of the same information on participants and non-participants, mimics the treatment and control technique used in experimental procedures, considering that such experimental approaches is difficult actualize with human subjects.

The Net Farm Income and Total Factor Productivity was employed to compute the farmers' income and productivity measures from their rice farming, whereas a treatment effects regression model the Inverse Probability Weighted Regression Adjustment (IPWRA) was used to estimate the impact of the rice VCDP intervention on the participating rice farmers.

To determine an intervention's treatment effect, evaluators must estimate the outcome that would have been observed had participants not been exposed to the program — the counterfactual — because it is impossible to observe the same subjects in both treated and untreated states. Consequently, impact assessment hinges on constructing a control group that is comparable to the treated group in every respect except for receipt of the intervention. The principal challenge in evaluating the rice VCDP is endogeneity stemming from differences in both measured and unmeasured covariates that correlate with how treatment was allocated. Given these selection biases and the program's delivery mechanisms, applying a treatment-effect framework is essential to obtain valid estimates of the rice VCDP's effects on the different outcome measures for farming households.

The IPWRA is a double robust model which has the advantage of providing consistent estimates of the treatment effect (or impact of the intervention) even when there is misspecification in the either treatment or outcome regression model. The choice of the IPWRA model was also informed by the confirmation of no endogeneity using the Wald test, allowing us to assume the conditional mean independence which was further tested following (Imai & Ratkovic, 2014) test for balancing of covariates by the treatment model. In other words, the IPWRA estimators used the weighting method to ensure that the outcome is conditionally independent of the treatment by conditioning on the covariates.

III. Results And Discussions

The Net Farm Income and Total Factor Productivity of the Rice Farmers

The income of the rice farmers was estimated using the net farm income computed by deducting the total cost incurred in rice production from the total revenue generated by farmers from the sale of the rice produce. The total factor productivity was also estimated by computing the ratio of the total revenue from rice production to the total variable cost of the rice production. The values of these estimates are both presented in Table 1 which presents a cost and returns analysis for rice production in the study area, disaggregated into the VCDP participant and non-participants.

Table 1: Costs and Returns of Rice Farming in the Study Area

Items	Participant farmer	Non-participant farmer	Pooled farmers
Variable cost	(₦)	(₦)	(₦)
Seeds	99136.36	137243.90	113738.32
Fertilizer	207916.67	191454.27	201608.64
Agrochemicals	51133.33	65301.59	56562.29
Labour cost	553711.37	453376.84	515265.43
Facilitating costs	74068.56	51056.10	65250.70
Interest on loan	21285.61	37006.33	27171.56
Rent on land	88083.33	76893.90	83795.79
A. Total variable cost (TVC)	1095335.23	1012332.93	1063392.73
Fixed cost	(₦)	(₦)	(₦)
Depreciation on farm implements	9948.44	4650.61	7918.43
B.Total fixed cost	9948.44	4650.61	7918.43
C. Total Cost (A+B)	1105283.67	1016983.54	1071311.16
Returns			
i. Rice output (kg)	3989.77	2485.67	3413.43
ii. Price/kg	812.15	885.15	832.52
D. Total Revenue (TR = i * ii)	₦3240310.61	₦2200185.98	₦2841758.18
E.Net Farm Income (D-C)	₦2135026.94	₦1183202.44	₦1770447.02
Total Factor Productivity (TR/TVC)	2.96	2.17	2.67

Source: Author's computation from 2024 survey data

The mean net farm income (NFI) for rice growers in the study area was approximately N1,770,447 for the season, reflecting the enterprise's profitability. Table 1 shows that farmers who participated in the rice VCDP earned higher annual net farm income (N2,135,026.94) than non-participants (N1,183,202.44). The overall total factor productivity (TFP) for rice producers was 2.67, indicating that each naira invested in production inputs yielded output valued at about 2.67 naira. The TFP breakdown in Table 1 further indicates that VCDP participants had a slightly higher TFP (2.96) than non-participants (2.17).

Research on comparable agricultural initiatives such as the Anchor Borrowers' Program in Nigeria have been shown to boost participant productivity and welfare relative to non-participants, largely by improving access to modern agronomic practices, credit facilities, and extension support (Chima, Gberevbie, Duruji, Osimen, & Abasilim, 2024; Daudu, Abdoulaye, Bamba, Shuaib, & Awotide, 2023). In Ebonyi State, the adoption of contemporary farming equipment and novel financing mechanisms has helped smallholder farmers scale up production and raise their living standards (Chima et al., 2024).

Determinants of Rice Farmer VCDP Participation and Production Outcomes

Table 2 shows the result of the logit regression estimates of the treatment effect regression. The regression output shows the results of the farmer and farm characteristics important in determining the outcome means for the rice VCDP participant farmers (OME1) and rice VCDP non-participant farmers (OME0). The table 2 also reported the treatment model part of the regression (TME1), showing the factors used to determine selection into treatment (i.e. the determinants of participation in the rice VCDP).

Table 2: Logit Estimates from the Treatment Effects Results of the Factor Determinants

Variable	Log NFI Coef	TFP Coef
OME (0)		
Farm size	0.790*** (0.236)	0.179*** (0.018)
Married (yes)	11.463*** (1.266)	
Household size	-0.439*** (0.095)	
Rice farming experience	0.001 (0.040)	-0.062*** (0.022)
Ownership of car (yes)	2.090* (1.085)	
Duration of membership in Agric. Assoc.	-0.220* (0.127)	-0.109*** (0.023)
Number of visits of extension	0.109 (0.141)	-0.090** (0.043)
Age		0.055*** (0.019)
Cost to output market		-0.0003* (0.0002)
Cost to input market		-0.0003* (0.0002)
Loan from friend (yes)		-0.866** (0.433)
Constant	4.837** (2.139)	1.876*** (0.328)
OME (1)		
Farm size	0.115*** (0.020)	0.048 (0.044)
Married (yes)	0.384 (0.255)	
Household size	0.012 (0.025)	
Rice farming experience	-0.005 (0.006)	-0.020 (0.016)

Ownership of car (yes)	0.206* (0.111)	
Duration of membership in Agric. Assoc.	-0.014 (0.012)	-0.048** (0.024)
Number of visits of extension	0.085*** (0.029)	0.104 (0.069)
Age		0.006 (0.017)
Cost to output market		0.0001 (0.0004)
Cost to input market		0.0001 (0.0003)
Loan from friend (yes)		-0.928*** (0.227)
Constant	14.009*** (0.295)	2.928*** (0.850)
TME (1)		
Membership in Agric. Assoc. (yes)	1.855*** (0.698)	1.855*** (0.698)
Attend agricultural training (yes)	1.663*** (0.632)	1.663*** (0.632)
Inputs from Agric. Assoc. (yes)	1.808*** (0.690)	1.808*** (0.690)
Extension services visit	1.840*** (0.504)	1.840*** (0.504)
Constant	-3.525*** (0.652)	-3.525*** (0.652)
Observations	214	214

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

The findings indicated that an extra hectare of farm land had the likelihood of raising the net farm income by 79 percentage points for VCDP non-participants and by 11.5 percentage points for VCDP participants. Among non-participants, married rice farmers were inclined to earn 11.5 percentage points more in net farm income compared to the unmarried farmers. Owning a car had the probability of increasing the net farm income by 2.1 percentage points for non-participants and by 0.21 percentage points for participants. An increase in the number of extension services visit had the likelihood of increasing the net farm income for VCDP participants by 8.5 percentage points. On the other hand, an increase in the household size was associated with a reduction in net farm income for VCDP non-participating farmers by 43.9 percentage points. Similarly, an additional year of membership in agricultural associations was associated with 22 percentage points reduction in net farm income for the VCDP non-participants.

The regression results provided insights on how the different factors may have affected the income of farmers who were part of the VCDP and those who were not. It revealed that having more land for farming was more beneficial for farmers who did not participate in the VCDP, perhaps given that they did not have the improvement of the VCDP they were less efficient, thus needing more resources to increase income (Daudu et al., 2023). Married VCDP non-participants were likely to earn more probably because they may have had better access to household labour, capital pooling from household members, stronger networks or larger market access than the unmarried (single) ones with limited reach. This is consistent with (Ayanwale, Ojo, & Adekunle, 2023; Daudu et al., 2023) argument that this challenge is less for the participants who already enjoy the VCDP support. Car ownership tended to improve the capacity to increase net farm income for both but more for the VCDP non-participants probably because, although that means of transportation improves market access, owning a car would have improved the plight of the VCDP non-participant farmers more since the VCDP participants were already benefiting from the program intervention of market linkages (Daudu et al., 2023). More extension visits raised income for VCDP participants due to the improved knowledge gains, the complementarity with VCDP program deliverables, and the farmer motivation. Larger household size was attributed to lower net farm income for VCDP non-participants which may be related to resource dilution due to higher dependency ratios in the household, meanwhile the VCDP participants' program support may have helped offset the burden (Daudu et al., 2023; Wudil, Aderinoye-Abdulwahab, Raza, Mehmood, & Sannoh, 2023). The associated decrease in net farm income with more years of agricultural association membership for the VCDP non-participants, may be related to the benefits they failed to take advantage of given that agricultural association was one of the criteria for selection into the VCDP (Daudu et al., 2023; Kehinde, Shittu, Awe, & Ajayi, 2024).

From the findings presented in Table 2, each additional hectare of farmland had the likelihood of raising the total factor productivity (TFP) for VCDP non-participants by 0.18. A year increase in the age of farmers was associated with a total factor productivity increase of 0.06 for VCDP non-participant rice farmers. However, an extra year of experience in rice-farming was associated with a 0.062 reduction in total factor productivity for non-participants. An additional year of membership in agricultural associations was likely to reduce the total factor productivity by about 0.05 for participants and about 0.11 for non-participants. An increased number of extension visits was associated with reduced total factor productivity for non-participants by 0.09. Expectedly, the higher the transportation costs to input and output markets the more the probability of a reduced non-participants' productivity by 0.0003. Borrowing from friends was linked to large drops in productivity, decreasing TFP by 0.93 for participants and by 0.87 for non-participants in comparison to those not taking the loans. These results highlight important determinants of input-use efficiency among rice farmers in the study area.

The result reveals that larger farm size increases may have provided the farmers the advantage of economies of scale in production to increase their market share and obtain resources to improve efficiency,

especially for the VCDP non-participants with less market linkages, hence the positive association with productivity for program non-beneficiaries (Daudu et al., 2023; Omotilewa et al., 2021). The older farmers tend to be more risk averse hence employ more resource conservative practices which improves efficiency. This may be peculiar to the VCDP non-participants who are not exposed to the innovative ideas from the program, hence the more time needed to improve productivity. Conversely, more farming experience reduced the TFP for the VCDP non-participants perhaps due to their suboptimal routines such that long-tenured farmers may resist new, higher-efficiency practices unlike their VCDP participant counterparts (Daudu et al., 2023; Wudil et al., 2023). Association membership duration was adjudged to reduce TFP probably because the membership years captured the older, less-adaptive farmers or it might be related to a substantial diversion of resources to association activities by poorer farmers (Daudu et al., 2023). More extension visits associated with lower TFP for non-participants may be related to the implementation burden which comes with the advice that increases risky experimentation costs especially for these VCDP non-participant farmers who are not benefiting from the program assistance (Daudu et al., 2023; Wudil et al., 2023). Higher transport costs reduced TFP as expected due to the input/output price wedge whereby transport raises effective input prices and lowers net output prices, squeezing margins and discouraging optimal input use (Ukpe & Ilu, 2024). Borrowing from friends was strongly associated with TFP drops because such informal loan arrangements signal liquidity stress resulting in distress sales or underinvestment owing to the reduced capacity to invest productively accustomed with unchecked loans (Daudu et al., 2023; Ukpe & Ilu, 2024).

Impact of the Rice VCDP on the Income and Productivity of Rice Farmers

Table 3 presents the result of the average treatment effect of the rice VCDP on the net farm income of participant rice farmers.

Table 3: Average Treatment Effect on the Treated Net Farm Income and Productivity

	Net Farm Income	Total Factor Productivity
ATET (VCDP participation (1 vs 0))	1.794*** (0.464)	1.014*** (0.237)
POMean (Rice VCDP)	12.992*** (0.469)	1.942*** (0.193)

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Source: Author estimation from the treatment effects model

The findings presented in Table 3 indicates that the rice VCDP produced a favourable and statistically significant effect on the net farm income. Specifically, the net farm income of participants in the rice VCDP was 1.79 percentage points higher than it would have been in the absence of their participation. The affirmative and significant effects of the rice VCDP intervention were further corroborated by the positive magnitude of the potential outcome mean.

Participation in the VCDP significantly and positively increased net farm income just as in similar agricultural programs. Evidenced by an above average ROI for rice farmers in Anambra and supported by similar West African interventions for instance in Ghana where the program provided improved varieties and fertilizer which raised net revenue and reduced income inequality, indicating gains attributable to program participation rather than chance (Addison, Ohene-Yankyera, Acheampong, & Wongnaa, 2022; Obianefo, Okoroji, Obiekwe, Osuafor, & Shah, 2022).

The result of the treatment effects estimates presented in Table 3 indicates that the rice VCDP intervention produced a beneficial impact on the total factor productivity of rice farmers. Specifically, participant farmers in the rice VCDP by virtue of their participation amassed a TFP that was 1.014 units greater than that of non-participants. In essence, the total factor productivity of the rice farmers engaged in the VCDP is approximately 2.956, attributable to their involvement in the program. This suggests that due to their participation in the VCDP, these rice farmers experience an additional margin of 1.014 in terms of output for the factor inputs utilized, compared to what they would typically achieve in the absence of the program.

Rigorous treatment-effect studies show that participation in structured farming programs (e.g., VCDP) significantly raises productivity especially for participants who record higher TFP and outperform non-participants largely because of improved access to inputs, credit, training, extension services, and market linkages (Addison et al., 2022; Daudu et al., 2023).

IV. Conclusion

Participation in the rice Value Chain Development Program (VCDP) in Ebonyi State has a strong relationship with enhanced profitability and productivity for rice farmers, underscoring the significance of such interventions in ameliorating smallholder livelihoods and agricultural efficiency. The effectiveness of critical income determinants exhibits variability between VCDP participants and non-participants, emphasizing the

necessity for tailored interventions and the synergistic role of program support in augmenting farmer welfare. While larger farm size and advanced age may have enhanced efficiency for non-participants, resistance to innovation and resource limitations hinder potential gains. The VCDP participation alleviates these barriers, rendering extension services and associative benefits more impactful while diminishing the adverse effects of transportation costs and informal borrowing. Engagement in the rice VCDP engenders a distinct, favourable, and statistically significant augmentation in net farm income for Nigerian rice farmers, thereby affirming the program's pivotal role in bolstering rural livelihoods and agricultural profitability. The rice VCDP intervention manifests a pronounced, positive, and statistically significant influence on total factor productivity for participating rice farmers, accentuating the value of such programs in enhancing agricultural efficiency and rural livelihoods in Nigeria. It is recommended that such agricultural innovative programs which embodies the coordination of the extension services, associative support, input access, access to markets, credit facilitation and market linkages be domesticated and sustained at the community level to enable smallholder farmers grow their enterprise and foster agricultural transformation in the society.

Ethics and Conflicts of Interest

We hereby attest that all ethical guidelines and dignity of persons was observed in the process of obtaining data from the farmer respondents contacted for this study.

The authors declare that there is no conflict of interest whatsoever in the production and submission of this research article.

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