THE IMPACT OF VALUE CHAIN DEVELOPMENT PROJECT ON RICE PRODUCTION AND PRODUCTIVITY IN ANAMBRA STATE, NIGERIA

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Abstract

Anambra State is one of the 6 states participating in the Value Chain Development Programme implemented by IFAD and FGN for 6 years in six participating states of Taraba, Ogun, Niger, Ebonyi, Benue and Anambra. The main objective of this study was to determine the impact of Value Chain Development Project on the productivity (Mt/Ha) and production (Mt) of rice in Nigeria during the 2017 cropping season. This study applied the random triangular subplot crop cutting methodology to estimate rice productivity and production in Anambra state; and estimated the "average treatment effect" using the Propensity Score Matching (PSM) evaluation technique to determine the impact of VCDP intervention on rice production and productivity in Anambra state. It also estimated the overall production level from VCDP farmers as a representation of the contribution of VCDP in Anambra State to national domestic rice supply in Nigeria. The sample size for the survey was based on stratified sample design and a sample of 63 farmers was selected for study. Field work was achieved using multi-visit interview techniques with the farmers and actual measurements on the farmers' plots. The estimated mean age of the sample farmers was 46.8 years. The estimated yield from the sample was 5.8 Mt/Ha. The VCDP participating farmers obtained a yield of 6.17 Mt/Ha. The non-participant farmers obtained a yield rate of 5.03 Mt/Ha. The rice yield of the participants was 23 percent higher than that of the non-participants. In Anambra State the rice productivity of VCDP farmers in the 2017 cropping season was 18.4 percent higher than that of 2016 cropping season and the productivity of VCDP participants in 2017 cropping season was higher than that of the non VCDP participants by 23 percent. The month for planting rice in Anambra State is July. Transplanting of seedlings is the most popular method for planting rice in the state. Weeding and pest control on rice in Anambra State is by the use of agrochemicals. The major natural hazard during the cropping season was flood. Most of the VCDP farmers sourced their inputs and also sold their output in the open market. The use of credit facilities is low among the VCDP farmers. The estimated rice outputs of the VCDP participants and the non-participants farms were 10,433.47 and 8,505.73 Mt respectively. The difference between the participants' production and that of the non-participants was 1927.74 Mt. The rice production of the participants was 23 percent higher than that of the non-participants. The VCDP intervention impacted positively in the productivity and production of rice in Anambra State. For each participant in the project the VCDP intervention caused the rice yield and output to increase (increment) by 1.53 Mt/Ha and 1.8 Mt respectively. These increments were additional to the average yields and outputs of the non-participants in the project. Efforts should be geared at stimulating youths to take up rice production as a means of livelihood and the VCDP should disseminate production strategies that would attract youths into rice production. The VCDP should capacitate the farmers on techniques of flood, pests and birds management. The VCDP should capacitate the farmers on the use of better and more reliable sources of inputs and disposal of output to guarantee high quality produce and improved farm income. The VCDP should build the capacity of the farmers to source credits from better dependable and reliable financial markets like the Bank of Agriculture and commercial banks.

Key words: Propensity Score Matching, Impact, Rice, Production, Productivity

Introduction

Rice (Oryza sativa) is one of the oldest cereal grains (grown for at least 5000 years) taken as staple food for more than half of the world's population. It is the most important human food *crop* in the world, directly feeding more people than any other *crop* and an agricultural commodity with the third-highest worldwide production. The health benefits of *rice* include its ability to provide instant energy, regulate and improve bowel movements, stabilize blood sugar levels, and slow down the aging process. It also plays a role in providing vitamin B1 to the human body. Rice production in Anambra State, Nigeria is still in the hands of small producers who cultivate on the average 1 Ha using traditional tools and methods which are very labour intensive and fraught with drudgery. The International Fund for Agricultural Development (IFAD) and the Federal Government of Nigeria (FGN) are implementing 6 years Value Chain Development Programme (VCDP) in six participating states of Ogun, Niger, Benue, Taraba, Ebonyi and Anambra. The goal of the VCDP is reduction of rural poverty, improvement of incomes of the rural poor and attainment of food security on sustainable basis. Using the overall strategy of market-led and value enhancement approach, the VCDP targeted the small scale and poor rural households for inclusion into the programme. The VCDP in Anambra State supported rice farmers through: production support, value addition, co-financing matching grant support. Under production support, the VCDP supported farmers in Anambra State in land development by providing power tillers, harvesters, planters, threshers, knapsack sprayers and water pumps. Under value addition, the VCDP provided rice processing equipment including millers, parboilers, destoners and packaging materials. It provided the farmers with 50 percent of farm inputs for 2 years; 30 percent of equipment and 10 percent of the cost of demanded infrastructure. It provided matching grants for improved rice seeds, fertilizers, herbicides, and insecticides.

Research Problem

In Anambra State amongst others, the VCDP supported the production of rice farmers through land development by providing power tillers, harvesters, planters, threshers, knapsack sprayers and water pumps. It provided rice processing equipment including millers, parboilers, destoners and packaging materials. It also provided the farmers with matching grant supports for farm inputs equipment and demanded infrastructure, improved rice seeds, fertilizers, herbicides, and insecticides. In spite of these supports, the results and emerging outcomes of the project were not fully appreciated by supervision and eyeball analysis. If the results in terms of emerging outcomes and impact of the intervention were not adequately known the same will happen to the benefits and it will be difficult to justify the cost of the intervention. There will neither be sufficient basis to replicate the intervention elsewhere nor learn lessons from it. This study seeks to determine the impact of the VCDP intervention on the production and productivity of rice in Anambra State. The knowledge will provide the information on the extent to which the VCDP intervention is contributing to the import substitution and the food security policies of Anambra State and the FGN.

Objectives of the Study

The main objective of this study was to determine the impact of the VCDP on production and productivity of rice in Anambra State, Nigeria during the 2017 cropping season.

Specific objectives

The specific objectives of the study were to:

i. Estimate the plot areas of a selected sample of rice farmers under VCDP in Anambra State using the Geographic Positioning System (GPS).
ii. Estimate the productivity and production of rice for a selected sample of rice farmers under VCDP in Anambra State using the triangular subplot crop cut methodology.
iii. Apply the logit regression model to determine the propensity (probability) scores of the participating and non-participant farmers using relevant covariates of rice yield.
iv. Estimate the Average treatment Effects (ATE) on production and productivity between participating and non-participant farmers by using the estimated propensity (probability) scores to match the rice production and productivity across the two groups.
v. Determine the implication of the estimate on the output of rice in Anambra State in the 2017 cropping season

Scope and Limitations

The study was limited to the VCDP intervention in Anambra State. Rice farmers outside the LGAs under the VCDP intervention in the State were not involved. The production and productivity of rice from irrigation agriculture or dry season rice farming were not involved. The time period covered by the study is 2017 rain-fed cropping season.

Literature Review

This study reviewed recent literature on: (a) agricultural production data; (b) methods of estimating crop production (c) estimation of rice productivity by VCDP; and (d) the conduct of impact evaluation using matching methodology.

Overview of Agricultural Production Data

Many scholars have studied the collection and uses of agricultural production data. They included, Bradbury (1996), Fielding and Riley (1997), Kelly et al. (1995), Murphy, Casley, and Curry (1991), Poate (1988), Sawasawa (2003), Sempungu (2010), Wairegi, Tenywa, and Bekunda (2009). They indicated that agricultural production data are important for monitoring of agricultural production changes, planning of agricultural interventions and development projects; development of early warning systems; and preparation of macroeconomic accounts. They stated that poor agricultural data can lead to misallocation of scarce resources and policy formulations that fail to resolve critical development problems. The need for accurate and precise production data for rice in Anambra State can never be overemphasized.

Methods of Estimating Crop Production

A plethora of scholars had studied the methods of estimating crop production. There are several methods of estimating crop production in literature. They include mainly the subplot crop cut and farmer's estimate and others which include daily recording, whole plot harvesting, sampling of harvest units, expert assessments, crop cards, crop modelling, purchase records, allometric models, and remote sensing. The most popular method which has found worldwide application is the Estimation of Crop Yield Using the Subplot Crop Cut.

Subplot crop cutting methodology involves randomly locating prior to the harvest of one or more small subplots of known area, usually in form of squares or triangles, within the farmer's

plot. At the time of harvest, the subplot is harvested by the survey enumerator, the crop is dried and processed, and then it is weighed. Crop yield is calculated as total production divided by total harvested area in the crop cut plot or sub-plots. This method has a very strong advantage that the area of the subplot cut is known and thus does not introduce an error into the final yield computation (Poate 1988). With the inception of the Agricultural Development Projects (ADPs) in Nigeria in 1975, triangular subplot crop cut has been the most commonly approach adopted by the ADPs to estimate the national yield of various crops. Since the 1950s, subplot crop cut has been the standard method recommended by the Food and Agriculture Organization of the United Nations (FAO) to measure crop production (FAO 1982; Murphy, Casley, and Curry 1991). This study adopted the subplot crop cutting methodology to estimate the yield and output of rice in the study area.

Estimation of Rice Productivity by VCDP

The VCDP has several reports and time series data on rice production and productivity about Anambra State. The report on the productivity of rice in 2016 cropping season under VCDP in Anambra State, Nigeria (VCDP, 2017) estimated the State's yield rate at 4.91Mt per hectare with a standard deviation of 1.92 metric tonnes per hectare. This study used the data to assess the realism of its estimates and determined the corresponding incremental changes.

Choice of Crop Yield Estimation Approach

It was evident from the literature review that the subplot crop cut is the most popular and most widely used approach for estimating crop yield worldwide. It is also the most popular method applied in Nigeria. The National Bureau of Statistics (NBS), the national agricultural agencies, the universities, research organizations in the country and all the Agricultural Development Projects in the country have been using it since the 1970s for estimating crop yields in the country. This survey also adopted this methodology. The subplot crop cut is associated with some biases. The sources of these biases as indicated by Fielding and Riley 1997; Murphy, Casley, and Curry 1991; Casley and Kumar 1988; Poate 1988; David 1978 were noted as follows: edge effect; border effect; non-random location of subplots; and weighing problems. Most of these effects result in an upward bias of results, and the overestimation bias increases with decreasing plot size. Although individual errors may be small, the combination of errors can be significant (Murphy, Casley, and Curry 1991). In addition to the above sources of bias, various authors (Casley and Kumar 1988; Diskin 1997) reported other problems associated with crop cuts. These include: heterogeneous crop performance; costly and time consuming; and one point in time observation. Since most of these errors arise from enumeration, this study employed very rigorous training of enumerators; strict supervision and meticulous measurement techniques to mitigate their effects.

Impact Evaluation Using Matching Methodology

Several authors have elaborate discussion on impact evaluation using matching methodology. Notable ones included: Khandker et al (2010); Lechner (1999); and Rosenbaum and Rubin (1983). The general notion is that the main problem associated with impact evaluation is the determination of the counterfactual. They agreed that there are two broad approaches that are used to mimic the counterfactual of a treated group. The first one is to create a comparator group through a statistical design and the second is to modify the

targeting strategy of the programme itself to wipe out differences that would have existed between the treated and non-treated groups before comparing outcomes across the two groups. They concluded that depending on the assumptions made about the nature of potential selection bias in project targeting and participation, the following methods are employed in impact evaluation studies namely; (i) Randomized evaluations; (ii) Matching methods, specifically propensity score matching (PSM); (iii) Double-difference (DD) methods; (iv) Instrumental variable (IV) methods; (v) Regression discontinuity (RD) design and pipeline methods; (vi) Distributional impacts; and (vii) Structural and other modelling approaches. Since the VCDP intervention in Anambra State was not randomly distributed across candidate participants rather some levels of selection and targeting of small scale and poor rural households were applied to determine participants and non-participants in the programme, propensity score matching evaluation approach would be the most appropriate method to be applied in determining the average treatment effect (ATE) of the VCDP.

Analytical Framework

The framework for the impact evaluation of the VCDP intervention in Anambra State is the Propensity Score Matching (PSM) technique. The core theory in the analysis is hinged on the logit and comparison models. The generalized logit model which estimates the propensity (probability) score is specified as follows:

$$\boldsymbol{p_{ij}} = \frac{\boldsymbol{exp}(\boldsymbol{X_i^{/}B_j})}{\mathbf{1}+\sum_{\boldsymbol{k=1}}^{\boldsymbol{j-1}} \boldsymbol{exp}(\boldsymbol{X_i^{/}B_k})}$$

Where:

P = the probability of response category j at subpopulation i:
This is the propensity score P(X) = Pr(T=1/X).
The last category J is assumed to be the reference category
X = matrix with element (n x k) of the covariates
i=1,..., n are the observations in the covariates
j=1,...,k are the parameters of the covariates
B =vector of the coefficient for the *j*th parameter
When J = 2 this model becomes equivalent to the binary logistic regression model. Thus the model can be thought of as an extension of the binary logistic regression model from binary response to polytomous nominal response. The outcomes of participating and non-participant sample rice farmers with similar propensity scores are compared to obtain the project effect denoted by:

$$ATE = E[Y_i(1)|T_i = 1] - E[Y_i(0)|T_i = 0]$$

The propensity score matching (PSM) mimics the randomized design by adopting an observational analogue. The application of PSM involved constructing a statistical comparison group that is based on a model of the probability (propensity) of participating in the treatment (VCDP), using observed characteristics. Participants are then matched on the basis of this probability, or propensity score, to nonparticipants. The average treatment effect of the intervention is then calculated as the mean difference in outcomes across these two groups. Two conditions must be satisfied prior to the application of the PSM namely:

i) Conditional independence which implies that the unobserved factors (error term in econometric parlance) do not affect participation. This is denoted as $(Y_i^T Y_i^c) \perp T_i / X_i$; and

ii) Sizable common support or overlap in propensity scores across the participant and non-participant samples which implies that the probabilities or propensity score are bounded away from zero and one : 0 < P(Ti = 1|Xi) < 1. This condition ensures that treatment observations have comparison observations "nearby" in the propensity score distribution (Heckman, LaLonde, and Smith 1999).

These conditions were met in this study. The limitations of the model include that:

(i) t-statistics and the adjusted R^2 are not informative and may be misleading;

(ii) Over-specification (including too many X) leads to higher standard errors for $\hat{P}(X)$ and may result $\hat{P}(X) = 1$ thus falling outside the region of common support and consequently the case will be dropped.

Methodology

This study conducted a farm survey using a sample of farmers to track and establish the production and productivity level of rice farmers under the VCDP intervention in the State. The study collected primary data from a cross section of farms and farming households under the VCDP intervention in the State. A multistage stratified sampling design was applied to determine the sample size and select the sample. A pre-survey training was conducted for the enumerators and supervisors. Preparation of the survey instrument used for collecting the data was part of the pre-survey training. Enumeration was accomplished through scheduled multiple visit interviews with the farmers at home and in their farms. Firstly, the enumerators visited the farmers to estimate their farm sizes using the geographical positioning system (GPS) and also collect information on their agronomic details and inputs' application. Secondly the enumerators visited the farmers' farms with the farmers to lay random triangular subplot of 0.01Ha. Thirdly, at harvest time, and on an agreed date with each farmer the enumerators accompanied the farmer to his farm to harvest and weigh the output of rice from the triangular subplots. A sample of the harvest was threshed and the enumerator recorded the threshing percentage from the plots. The data collected with the survey instruments were keyed into the computer using the Microsoft Excel Spread Sheet software. Data cleaning and management were also achieved using the Microsoft Excel Spread Sheet. The descriptive analysis of the data was accomplished with the Statistical Package for the Social Sciences (SPSS Version 22) and propensity score matching was carried out using Stata Package Version 14. Results of the analysis are presented and discussed in simple prose aided by tables and charts that are understandable by both professionals and laymen alike.

Sample Size Selection

The frame work for determining the sample size (n) for estimating the yield per hectare of rice in the project areas was the stratified sample design. The sample size was determined by applying the total sample size formula for equal size subsamples selected from each stratum as detailed in Daniel and Terrell (1975) pp.388-389. The formula is as follows:

$$n = \frac{z^2 L \sum_{L=1}^{L} N_h^2 S_h^2}{N^2 d^2 + z^2 \sum_{L=1}^{L} N_h S_h^2}$$

Legend

S/No	Variable symbol	Descriptive meaning	Values applied in the formula
1	z	Reliability coefficient	1.96
2	L	Number of strata (states)	6
3	N_h	Size of h^{th} Stratum	200
4	N	Population size (VCDP) Baseline survey data)	1200
5	d	Maximum desirable sampling error	50 Kg
6	S_h^2	Variance of rice yield	330625 Kg

The variance of rice yield estimates in Nigeria was from generic sources. This was determined using the approximation that variance $=\left[\frac{range}{6}\right]^2$. Range of rice F44 yield in Nigeria as published by International Institute of Tropical Agriculture (IITA) is from about 2.5 Mt to 6.0 Mt. per hectare.

The formula above was applied to arrive at a sample size of 60 for Anambra state or 10 per Local Government Area (LGA) including the control LGAs. An additional number of 3 respondents were added to allow for data cleaning and elimination of outliers.

Presentation of Results and Discussion

This study applied the frequency procedure of the SPSS to analyse most of the categorical variables in the data (ii) it applied the descriptive procedure of the SPSS to analyse the continuous variables in the data; (iii) thirdly, randomized design was mimicked by adopting an observational analogue namely the propensity score matching (PSM) to determine the impact of VCDP intervention on rice productivity and output.

Descriptive Analysis of the Data

This study determined the frequencies of response in the categories of the following variables: Local Government Areas (LGAs), category of respondents, gender; role in the household; marital status; educational level; receipt of extension services, number of extension visits received, variety of rice planted, planting month, whether rice seedlings were transplanted, weeding method, type of pesticides applied, irrigation farming, source of rice variety, source inputs, method of output disposal, form of produce at sale and source of credit. It estimated the mean values and standard deviation of the following variables: the plot area; yield; number in the household; ages of respondents; farming experience number of years of using current variety of rice seed, number of extension visits had and amount of credit assessed. Detailed analysis and description of these variables were beyond the scope of this study; suffice it to present brief summaries of their results.

Local Government Areas (LGAs) involved in the study

Six LGAs contributed a total of 63 respondents to the sample for study as follows: Ten respondents each were selected from Anambra East; Anambra West; Awka North; Orumba North and Orumba South; and 13 respondents were selected from Ayamelum LGAs.

Category of Respondents

Of the 63 respondents in the sample, 44No or 70 % were participants of the VCDP while 30% were not.

Gender of the Respondents

The gender of the respondent determines to a large extent his/her access to crucial farm inputs such as land in the rural areas of Anambra State. Out of the 63 respondents in the sample 84 percent were males and 16 percent were females.

Role of the Respondent in the Household

A household head in rural areas of Anambra State is responsible for taking the important decisions that will be binding to all household members; what crops should be planted to each family plot, when and how to plant the crops. The household head is also responsible for taking decision on where and how to source farm inputs and also where and how to dispose of farm produce. Out of the 63 respondents in the survey 84 percent were household heads, 16 percent were non household heads.

Marital Status of the Respondents

Out of the 63 respondents in the sample 94 percent were married and only 6 percent were single.

Highest Educational Level Attained by the Respondents

The highest educational level of the respondents determines their level of exposure and indicates the literacy level that will be applied in preparing extension manuals and disseminating extension messages to the respondents. Out of the 63 respondents in the study about 48 percent completed primary, 33 percent completed secondary and 19 percent completed tertiary school education.

Receipt and Number of Extension Service

Receipt of extension service improves the technological knowhow of the farmers. It is through extension visits and services that technological packages are disseminated to the respondents. The adoption of the extension messages will lead to improvement in their farm management practices and subsequently increased yield and output. Out of the 63respondents in the study 97 percent received extension services during the farming season and 3 percent did not receive. The order of visiting the farmers by Extension Agent were as follows: 22 respondents or 35% were visited 8 times; 16 respondents or 25% were visited 4 times; 15 respondents or 24% were visited 2 times; and 9 respondents or 14% were visited 3 times.

Variety of Rice Planted

The VCDP recommended FARO 44 rice seed variety for the farmers. Of the 63 respondents in the study, 55No or 87% planted FARO 44 rice variety and 8 or 13% planted FARO 52 rice variety. Most of respondents 48 or 76% planted rice in July and 11% of the respondents planted in June. Negligible number of respondents planted in the other months of the year. About 49 respondents or 78 % of the sample transplanted their rice seedlings while 13% planted rice by broadcasting the seeds. The general method of weeding adopted by the respondents was the use of agrochemicals as indicated by 95% of the respondents and the general type of pesticides adopted by all the respondents was the use of agrochemicals.

Natural Hazard

The natural hazards encountered by the respondents during the farming season were as follows: 42 No or 67% experienced flood; 17No or 27% had pest attacks and 4 percent had

attacks from birds. The VCDP should capacitate the farmers on techniques of flood, pests and birds management.

Practice of Irrigation Farming

Out of 63 respondents in the study 84 percent practiced irrigation (dry season) farming while 16 percent did not. With irrigation farming the output of rice could be doubled or tripled in the study area. The VCDP should strengthen the capacity of the farmers to practice irrigation farming.

Sources of Inputs and outlets of Produce

The main source of current seed variety by the respondents was from VCDP beneficiaries as indicated by 41No respondents or 65% and 13No respondents or 21% bought from the open market. The selling outlet for produce was mainly the open market as indicated by 53No respondents or 84%; 6No respondents or 10% sold at the farm gate and 2No respondents or 3% sold at home. About 54No respondents or 86% sold their rice to wholesalers and 9No or 14 % sold to retailers. About 57No respondents or 90% sold their rice in milled form and only 10% sold rice as paddy.

Credit Source and amount

The main source of credit for the respondents was the local money lenders as indicated by 32No respondents or 51 %; 2No respondents or 3 % of the sample sourced credit from commercial banks and 29No respondents or 46% of the sample did not use credit. The average amount of credit collected by those who took credit was ₦ 106,788.7. See table 1for details. The VCDP should build the capacity of the farmers to source credits from better dependable and reliable financial markets like the Bank of Agriculture and commercial banks.

Plot Area and Yield

The cultivated plot area is a measure of the status of the farmer and an indicator of expected total out. The estimated mean plot area from the sample survey was 0.7 Ha. The mean plot yield was 5.8 Mt/Ha. The estimated mean plot yield in 2016 was 4.91Mt. (VCDP, 2016). There was an increase of 18.4% in yield relative to 2016 estimate. The estimated mean plot output was 4.2 Mt. The details are in table 1.

Household Size

The household size is an estimator of the size of family labour available for farm work. It is also an estimator of the consumption burden on the farm output. The estimated mean household size from the sample survey was 7 members. The details are in table 1.

Age

The age of the farmer is an indicator of potential energy for farm work. It is also an indicator of the farmer's potential capacity to learn and take up other commitments apart from farm work. The estimated mean age of the sample farmers was 46.8 years. The details are in table 1. Younger people between the ages of 20 and 35 years will be more vigorous at work and has better capacity to adopt new rice production technologies. The VCDP should disseminate production strategies that would attract youths into rice production.

Number of Years of Planting Improved Variety of Rice

The length of time in years during which the farmers had been planting the current improved variety of rice would enable assessment whether the practice was due to VCDP or it could be attributed to other interventions in the past which exposed the farmers to the variety. The estimated number of years during which the farmers had been planting the current improved variety of rice in the sample survey was 3.1 years. This agrees with 2015 when VCDP came into operation in the State. To this end planting of the current improved varieties of rice could be attributed to the VCDP intervention. The mean farming experience of the respondents was 14 years.

Table 1:The Mean, Standard Deviation and Maximum Values of Key Variables

Variables	Mean	Std. Deviation	Maximum
Plot Area in Ha.	0.7	0.6	3.9
Plot Yield in Mt/Ha	5.8	1.2	8.4
Plot Output in Mt	4.2	4.7	32.3
Household Size	7	2	17.0
Age	46.8	10.7	60.0
Farming Experience in years	14.1	7.8	47.0
Years of planting current variety	3.1	1.3	6.0
Credit Amount	106788.7	156988.2	750000.0

Productivity Level of Rice Farmers in Anambra State

In order to estimate the yield of a hectare, the weight of paddy rice obtained from the 0.01 Ha triangular subplot was multiplied by the threshing percentage to obtain the threshed weight of the rice. The threshed weight from the subplot was multiplied by 100 to express it in terms of kilogram per hectare (Kg/Ha). The estimated output in kilograms per hectare (Kg/Ha) was divided by 1000 to express it in terms of metric tonnes (Mt) per hectare. The summary of the estimated rice yield (Mt/Ha) is presented in table 2. The estimated yield for the state was 5.83 Mt per hectare. Compared with the estimated yield in 2016, the estimated yield in 2017 for Anambra state increased by 18 percent

Productivity Level of Rice Farmers by Farm Category

The estimated rice productivities were analysed by farm categories and the result was presented in table 2. From the table, it was evident that the VCDP participating farmers obtained a yield rate of 6.17 Mt/Ha. The non-participating farmers obtained a yield rate of 5.03 Mt/Ha. The rice yield of the participants was 23 percent higher than that of the non-participants. This result was not unexpected considering the improved inputs and management practices that the VCDP farmers benefitted from.

Production of VCDP Farmers as a Contribution to National Domestic Rice Supply in Nigeria

In order to establish the production level from VCDP farmers the estimated yield rates were used to multiply the area cultivated to rice in the state to obtain the rice output of the VCDP participants and that of non-participants farms. Baring non-inclusion of dry season rice output, this may be construed as a representation of the contribution of the programme to national domestic rice supply in Nigeria. The estimated rice outputs of the VCDP participants and the non-participants farms were 10,433.47 and 8,505.73 Mt respectively. The difference between the participants' production and that of the non-participants was 1927.74 Mt. The rice

production of the participants was 23 percent higher than that of the non-participants. See table 2.

Table 2: Production Estimates of VCDP Participants and Non-participants in Anambra State

Variable Description	Value
Participant Yield in Mt/Ha	6.17
Non-participant Yield in Mt/Ha	5.03
Area Cultivated With Rice for Anambra State In Ha (VCDP Records)	1691
Participant Production 2017 in Mt	10433.47
Participant Production 2016 in Mt	8301.78
Diff. B/W 2017 Vs 2016 Participants	2131.7
% Diff. B/W 2017 Vs 2016 Participants	26
Non-participant Production	8505.73
Diff b/w participants and non-participants	1927.74
% Diff B/W participants & non-participants	22.66
Source: VCDP-CAYS 2017 Survey Data and VCDP-M&E records December, 2016	

Impact of the VCDP intervention on Rice Production and Productivity

This study applied Propensity Score Matching (PSM) to determine the impact of VCDP intervention on the productivity (yield) and production (output) of rice in Anambra State. Application of the PSM was informed by the fact that the project's background information, indicated that the VCDP did not select participant randomly, rather selection of LGAs and targeting of participants were based on some criteria, including poverty level and past records on rice production. Since selection and targeting was used in the determination of participants, non-participants would not be regarded as adequate counterfactual of the participants. This study constructed a statistical comparison group (counterfactual) based on a model of the probability of participating in the VCDP intervention using observed characteristics (covariates) of farmers that were participating and not participating in the VCDP project. It applied the logit model for estimating the probabilities or propensity scores. In doing so the specified number of near neighbour matching was 5. The continuous outcome dependent variables used were yield in Mt/Ha and output in Mt. The bivariate treatment variable was the category of respondents (1 or 0). The number of covariates was 8 namely: (i) gender of the respondent (ii) role in the household (iii) marital status (iv) household size (v) age of respondent (vi) education level attained (vii) number of years of farming rice, and (viii) operation of dry season farming. The software package used in the PSM analysis was Stata Version 14. Participants were matched on the basis of the probability or propensity score to nonparticipants. The average treatment effect of the VCDP intervention was calculated as the mean difference in outcomes (productivity or production) across the two groups (participants and nonparticipants). The requirements of (a) conditional independence (namely, that unobserved factors do not affect participation) and (b) sizable common support or overlap in propensity scores across the participant and nonparticipant in the sample were satisfied (Khandker et al, 2010). The results are presented in box 1.

From the results of the PSM analysis it was evident that the "Average Treatment Effect " of the VCDP intervention were 1.53 Mt/Ha for yield and 1.8 Mt for output of rice in the Anambra State. It implied that the VCDP intervention impacted positively in the productivity and production of rice in Anambra State. For each participant in the project the VCDP intervention caused the rice yield and output to increase (increment) by 1.53 Mt/Ha and 1.8 Mt respectively. These increments were additional to the average yields and outputs of the non-participants in the project. The 95 percent confidence interval for the estimates did not include zero and the z-statistics were quite high 26.7 for ATE of the rice yield estimate and 2.3 for ATE of the output of rice estimate. The details are in Box 1.

Box 1: VCDP Impact on Rice Production and Productivity

Number of observations = 63
The Estimator = Propensity-Score Matching
Matches: requested = 5
Outcome model = Matching
Minimum matching = 5
Treatment model = logit maximum = 5
Treatment dependent variable = participant in VCDP (1); Non-participant in VCDP (0).
Treatment independent variables or covariates (8) namely: gender of the respondent; head of household; marital status; household size; age of respondent; education level attained; number of years in rice farming; and operation of dry season farming.

Outcome variable	**Coefficient**	**Std Error**	**z-test**	$Prob. > \lvert z \rvert$	**95 % Conf. Interval**
Yield (Mt/Ha)	1.53	0.06	26.69	0.000	1.42 to 1.65
Production (Mt)	1.80	0.77	2.33	0.020	0.28 to 3.32

Summary and Conclusions

Anambra is one of the 6 states participating in the Value Chain Development Programme implemented by IFAD and FGN for 6 years in six participating states of Ogun, Niger, Benue, Taraba, Ebonyi and Anambra. The main objective of this study was to determine the impact of Value Chain Development Project on the productivity (Mt/Ha) and production (Mt) of rice in Nigeria during the 2017 cropping season. This study applied the random triangular subplot crop cutting methodology to estimate rice productivity and production in Anambra state; and estimated the "average treatment effect" using the PSM evaluation technique to determine the impact of VCDP intervention on rice production and productivity in Anambra state. It also estimated the overall production level from VCDP farmers as a representation of the contribution of the programme in Anambra State to national domestic rice supply in Nigeria. The sample size for the survey was based on stratified sample design and a sample of 63 farmers was selected for study. Field work was achieved using multi-visit interview techniques with the farmers and actual measurements on the farmers' plots. The estimated mean age of the sample farmers was 46.8 years. Younger people will be more vigorous at work and will have better capacity to adopt new rice production technologies. The VCDP should disseminate production strategies that would attract youths into rice production. The estimated yield from the sample was 5.8 Mt/Ha. The VCDP participating farmers obtained a yield of 6.17 Mt/Ha. The non-participating farmers obtained a yield rate of 5.03 Mt/Ha. The rice yield of the participants was 23 percent higher than that of the non-participants. In Anambra State the rice productivity of VCDP farmers in the 2017 cropping season was 18.4 percent higher than

that of 2016 cropping season and the productivity of VCDP participants in 2017 cropping season was higher than that of the non VCDP participants by 23 percent.

The month for planting rice in Anambra State is July as most of respondents 48 or 76% planted rice in July. Transplanting of seedlings is the most popular method for planting rice as about 49 respondents or 78 % of the sample indicated that they transplanted their rice seedlings. Weeding and pest control on rice in Anambra State is by the use of agrochemicals. The major natural hazard during the cropping season was flood. The VCDP should capacitate the farmers on techniques of flood, pests and birds management. Most of the VCDP farmers sourced their inputs and also sold their output in the open market. The VCDP should capacitate the farmers on the use of better and more reliable sources of inputs and disposal of output to guarantee high quality produce and improved farm income. The use of credit facilities is very low among the VCDP farmers: the VCDP should build the capacity of the farmers to source credits from better dependable and reliable financial markets like the Bank of Agriculture and commercial banks. The estimated rice outputs of the VCDP participants and the non-participants farms were 10,433.47 and 8,505.73 Mt respectively. The difference between the participants' production and that of the non-participants was 1927.74 Mt. The rice production of the participants was 23 percent higher than that of the non-participants.

The VCDP intervention impacted positively in the productivity and production of rice in Anambra State. For each participant in the project the VCDP intervention caused the rice yield and output to increase (increment) by 1.53 Mt/Ha and 1.8 Mt respectively. These increments were additional to the average yields and outputs of the non-participants in the project

Recommendations

This study recommended that:

(i) Efforts should be geared at stimulating youths to take up rice production as a means of livelihood and the VCDP should disseminate production strategies that would attract youths into rice production.

(ii) The VCDP should capacitate the farmers in Anambra State on techniques of flood, pests and birds management.

(iii) The VCDP should capacitate the farmers in Anambra State on the use of better and more reliable sources of inputs and disposal of output (rather than the open market) to guarantee high quality produce and improved farm income.

(iv) The VCDP should build the capacity of the farmers to source credits from better dependable and reliable financial markets like the Bank of Agriculture and commercial banks.

(v) The Propensity Score Matching should be used for assessing the impact of VCDP intervention in Anambra State and elsewhere in Nigeria.

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