EFFECT OF SHIRORO DAM PROJECT ON SUSTAINABLE LIVELIHOOD AND POVERTY STATUS OF FARMERS IN NIGER STATE, NIGERIA

BY

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ABSTRACT

Crop production in Nigeria is plagued by frequent and unpredictable climatic conditions such as drought, torrential rainfall and flooding. Using farming households' survey data from a sample of 165 each from Shiroro dam (SD) participating and non-participating farmers, this paper assesses the effect of the dam on sustainable livelihood and poverty status of farmers in Niger state, Nigeria. Foster-Greer-Thorbeecke (FGT) index, Tobit regression, Propensity Score Matching (PSM) and Z-test models were used to achieve the objectives of the study. The regression coefficients estimated revealed that the farm size (0.009), extension contact (0.300), level of investment (-0.511), level of training (0.005), per capita expenditure (0.490) and market access (0.286) were statistically significant factors affecting livelihood security status of Shiroro dam farmers (SDF) at different levels of probability. Likewise, the regression result of poverty status showed that farm size (-0.1e-4), extension contact (-0.641), level of investment (0.008), household size (0.412), per capita expenditure (-0.008) and market access (-0.344) were statistically significant factors affecting the SDF at different levels of probability. In line with *a priori* expectation, the impact analysis using Z-test, PSM and LATE models indicated a statistically significant and positive impact of the project on livelihood and poverty alleviation of farmers that are utilizing Shiroro dam for farming activities. It is suggested that more irrigation facilities should be built to guarantee agricultural production in both wet and dry seasons to encourage all year farming and to catalyze statistically significant socio-economic variables, and transformation of rural masses and alleviate their poverty status.

Key words: Crop production, Poverty alleviation, Shiroro dam, Sustainable livelihood, Nigeria

INTRODUCTION

Food production in Nigeria is mostly rainfed. Nigeria has abundant water supply and reservoir but uses less than 2 % of its total renewable water resources (Van Der Wijngaart et al., 2019). Only 4 % (6 million ha) of the whole Sub Saharan Africa (SSA) region's total cultivated area is equipped for irrigation. It is far from achieving the irrigation potential, which is estimated at over 42.5 million ha (Kadigi, Tesfay, Bizoza, and Zinabou, 2012). Crop production in Nigeria is plagued by frequent and unpredictable climatic conditions such as drought, torrential rainfall and flooding. These peculiarities attached to crop production in Nigeria are closely linked to the persistence of food and livelihood insecurity and poverty among its small scale farmers. This is also not unconnected to food demand-supply gaps that have been lingering on in Nigeria from 1980s till now in 2020.

The climatic variation of Nigeria has a distinct wet and dry season. Most small scale farmers engage in crop production during the wet season which has a short life cycle in some regions, though could extend to 7 - 8 months in other areas. Nigeria has abundant land area of 98.3 million ha, out of which 79 million ha are arable land, and untapped water resource of about 214 billion m^3 of surface water and 87 km^3 of ground-water both of which can be used for irrigation (Food and Agricultural Organisation [FAO], 2013; Oladimeji and Abdulsalam, 2014). Therefore, it has resource for a massive expansion of agricultural production, eradication of poverty and unemployment, reduction of inequality, and transformation of its production and export structure to reduce over dependence on oil (Oladimeji et al., 2019).

In a bid to achieve livelihood security and end hunger both of which are in tandem to poverty reduction or alleviation, there is a need to re-emphasize irrigation agriculture and exploit its use for livelihood sustainability. The need for continuous cultivation to escape the hardship of food shortage and livelihood insecurity led to emphasis on irrigation projects (Uduma, Samson, and Mure, 2015). Hence, irrigation practice in Nigeria is vital to successful green revolution all year round to achieving sustainable development goals (SDGs) of complete eradication of hunger, food insecurity and is expected to expand farmers' production parameters, mitigates production risks and encourages farmers to make more intensive use of inputs and land (Shah, Verma, and Pavelic, 2013) and sustain their livelihood as full time farmers.

Irrigation is a science of planning and designing a water supply system, usually man-made, for agricultural land to produce crops where there is virtually little or no precipitation, and to protect the crops from bad effect of drought or low rainfall (Oladimeji and Abdulsalam, 2014). An ideal irrigation effort aims to cover the deficit between a crop’s optimal water needs and what it can take up through natural means. Increased irrigation access is linked to higher productivity and important nutritional outcomes through improvements in food availability and dietary diversification that is embedded in SDG goal one: end extreme poverty in all forms by the year 2030 and two: end hunger and improved nutrition and promote sustainable agriculture.

The irrigation potential of Niger river basin is estimated at 1,678,510 hectares (ha) from which 885,510 ha represent the potential for public schemes development while the balance of 793,000 ha represent the potential for ‘*Fadama’* development out of which a total of 670 000 ha is already under irrigation (FAO, 1997). The total irrigation potential is large, about 3.14 million ha comprising of 2.04 million ha for formal farmer owned and managed schemes based on conjunctive rise of surface water and shallow ‘*Fadama’* aquifers; and 1.1 million ha for formal public irrigation projects, which are under government control (National Water Policy, NWP, 2004). The flood plain of the river Niger and its tributaries is also regarded as the largest untapped potential area for irrigation development in Nigeria. According to Zarma (2004), about two-third of Nigeria lies in the watershed of the river Niger, which empties into the Atlantic at the Niger Delta, with its major tributaries and it suffices to note that river Niger is African's third longest river and fifth largest in term of discharge.

Nigerian farmers gain access to irrigation from two sources: surface water: and groundwater. Shiroro hydroelectric dam is one example of dam that farmers benefit immensely as a surface irrigation system. The Shiroro Dam Project (SDP) has one major product component, hydroelectricity and two old sub-components or multiplier effects: artisanal fishing and irrigation which has been boosting the socio-economic activities of the rural settlements before the dam.

However, while irrigation is not a cure-all for poverty, food insecurity and malnutrition as well as livelihood sustainability, it has great potential to drive the development of increased agricultural productivity. Dananto and Alemu (2014) stated that irrigated agriculture can reduce poverty through increased production and income, and reduction of food prices, that help vulnerable and poor farming households to meet the basic needs by improving their overall economic welfare, protect them against risks of crop loss due to insufficient rain water supplies and promote their use of yield enhancing farm inputs which in the long run enable them to move out of the poverty trap. Recognizing that the full potentials of Nigeria agriculture could not be realized without the development of her water resources for irrigation, successive administrations in Nigeria have adopted various irrigation development policies (Oladimeji et al., 2019).

One of such is Shiroro dam water shed in Niger state that drains about 27% of the total land mass of the State. The reservoir created by the dam has a tremendous storage capacity of 605 billion cubic metres which is a potential reservoir of valuable renewable agricultural resources in the semi-arid zone ecosystem of the country (NWP, 2004; Zarma, 2004). The rich soil deposits and abundant water supply of Shiroro Lake basin ha.ve brought about increased agricultural and fisheries activities in the basin.

However, past empirical studies on effect of dam projects on sustainable livelihood and poverty status of farmers in Nigeria especially Niger state is rare in literature. The few empirical studies such as Adie et al. (2012), Nkhata (2014), Oladimeji and Abdulsalam (2014) that are available failed to examine the causal effect using Propensity Score Matching (PSM) and Local Average Treatment Effect (LATE) models both of which established an appropriate counterfactual situation that could facilitate the true identification of the causes of effect and eliminate prejudice of pseudo impact or at worst overestimated or underestimated change. Hence, the broad objective of this study was to assess the effect of Shiroro dam project (SDP) on sustainable livelihood and poverty status of farmers in Niger State, Nigeria. The specific objectives were to: enumerate livelihood activities engaged in by Shiroro dam farmers (SDF); estimate the poverty status of SDF; determine the effect of Shiroro dam on livelihood and poverty status of SDF and, assess the impact of Shiroro dam on livelihood sustainability and poverty status of SDF.

THE STUDY AREA

This study was conducted in Niger State, North central Nigeria. The State is located between Latitudes 8° 22' and 11° 30' N and Longitudes 3° 30' and 7° 20' E and covers a land area of about 74, 244 square km, or about 8 % of Nigeria’s total land area (Figure 1). Specifically, the populations of Shiroro and Muya LGAs which are the main beneficiaries of Shiroro irrigation farming activities are projected in 2020 to 322,918 and 141,767 people respectively using recommended 3.2% growth rate and the population of the two LGAs in 2006 census (NPC, 2009). The climate, edaphic features and hydrology of the state permit the cultivation of most of Nigeria’s staple crops such as maize (*Zea mays*), yam (*Discorea spp*), rice (*Oryza sativa*), millet (*Pennisetum glaucum*) and sorghum (*Sorghum bicolor*) among others, and allows sufficient opportunities for harvesting fresh water fish such as *Alestes spp, Bagrus spp, Clarias spp, Gymnarchus niloticus, Heterotis spp, Labeo spp, Mormysus spp, Lates niloticus*.

The Shiroro hydropower reservoir is a storage based hydroelectric facility located in Niger State at the Shiroro Gorge which is approximately between Latitudes 9° 46' 35" and 10° 08' 36" N and

Longitudes 6° 50' 51" and 6° 53' 14" E. It is located approximately 90 km southwest of Kaduna on River Dinya. The facility has an initial installed capacity of 600 MW, surface area of about 320 km^2 with a maximum length of 32 m and a total storage capacity of 7 billion m^3 of water (Suleiman and Ifabiyi, 2015; Adegun, Ajayi, Badru, and Odunuga, 2018). About 70 % of inflows into the reservoir are from river Kaduna, with lateral contributions from rivers Dinya, Guni, Sarkin-Pawa, Erena and Muyi. Annual temperature around the reservoir varies between 27 and 35.The catchment has an annual rainfall of about 1,300 mm with an annual evaporation loss of between 2.48 x10^8 and 4.35x10^8 m^3 (Adie, Ismail, Muhammad, and Aliyu, 2012).

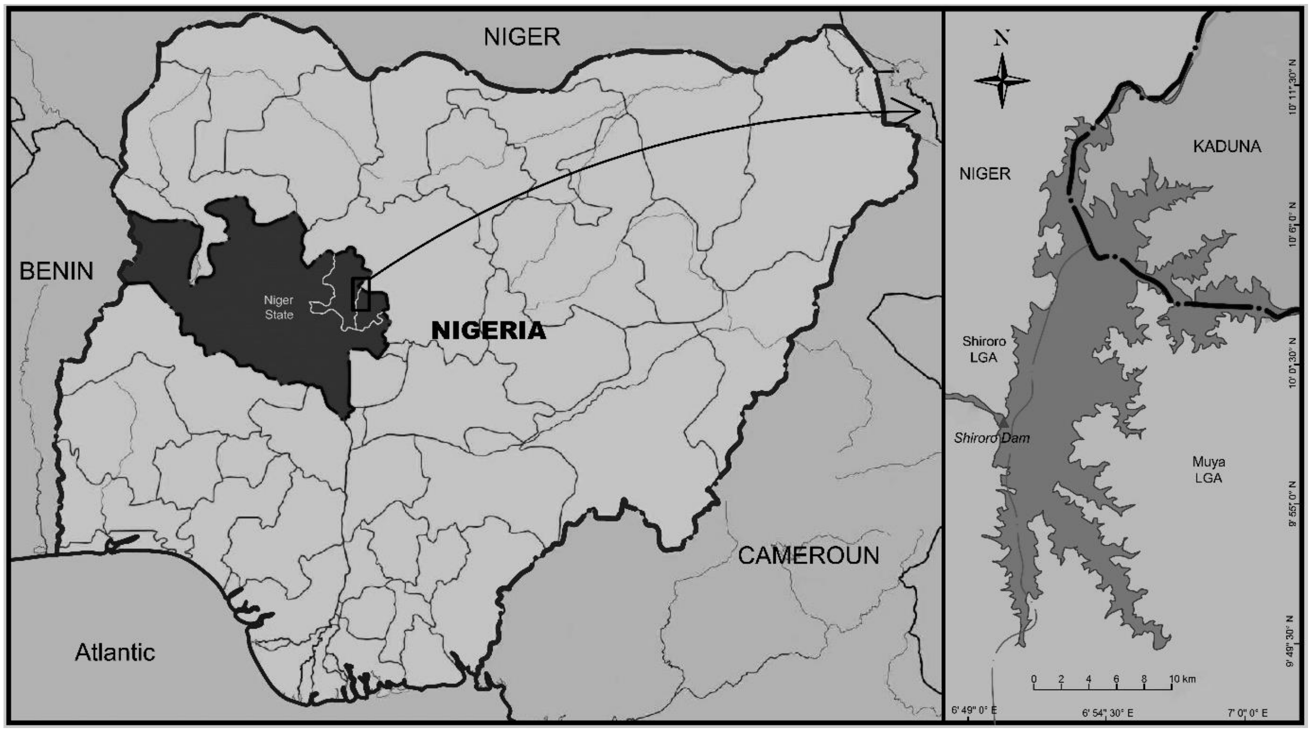

Figure 1: Nigeria showing Niger State and the study area
Source: Adopted and modified from Google map

MATERIALS AND METHODS

Data Collection and Sampling Procedure

Primary data were collected in 2019 farming season, with the aid of a structured questionnaire and trained field enumerators for the study. Information collected include: socio-economic characteristics such as age, farming experience, level of education and credit access, and production inputs include fertilizer, seed, agrochemical and labour. Data on income and expenditure from crop production, and income earned from other sources were also collected.

A multistage sampling procedure was used to obtain the respondents. Two Local Government Areas (LGAs): Shiroro and Muya out of the twenty-five LGAs in Niger state were purposefully selected because of location of Shiroro dam and the fact that households from the two LGAs are those mostly utilizing the water from the dam for livelihood improvement. With the assistance of extension agents of Niger State Agricultural Development Program (NSADP) during reconnaissance survey, 21 villages adjacent to the Shiroro dam were listed and 13 villages were purposefully selected due to intensity of households' involvement in Shiroro dam farming. The villages selected were Chiri, Zumba, Kwata, Shiroro, Shakwana, Kam, Galadimakogo, Guni, Tungalemu, Tungaalhaji, Gwada, Bakko and Dangunu. The list of farming households in each village was compiled with the assistance of NSADP extension agents in collaboration with village heads. It is pertinent to mention that sampling intensity adopted by Diaw, Blay, and Adu-Anning, (2002) was used to select respondents for the study. The Diaw et al. (2002) indicated that a minimum of 10 % sampling intensity can be used for population below 500, 5 % sampling intensity for population between 500 and 1000, and 2.5 % sampling intensity for the population above 1000. Two hundred and thirty nine (239) participating and 366 non-participating farmers in Shiroro dam project were identified from the NASDP list. In arriving at the equal sample size for participant and non-participant though not sacrosanct, account was taken basically of the paired Z-statistic employed in the analysis which required equal sample size aside ensuring that the control groups generated through random assignment serve as a perfect counterfactual, free from the problem of selection bias that exists in all evaluations. Therefore, 56.7 % of the Shiroro dam FP (165) and 45% of NP (165) were randomly chosen totaling 330 farmers.

Data Analysis

Descriptive statistics such as percentages, frequency, minimum, maximum and coefficient of variation were used to achieve part of the objectives. Foster-Greer-Thorbeecke (FGT) index, Tobit regression, propensity score matching (PSM) and Z-test models were also used to analyse the data obtained. The FGT (1984) poverty index was used to determine poverty status among the farmers. It is generally given as:

$$p_{ai} = \frac{1}{n}\sum_{i=1}^{q}\left(\frac{z-y_i}{z}\right)^{\alpha} \quad (1)$$

(Adopted from FGT, 1984; Oladimeji, Adepoju, Galadima, and Fagge, 2018)

Where: P = FGT index, n = total number of respondents, q = number of farmers below the poverty line, qi = per capita household expenditure / income of the farmers, z = the poverty line, α is a non-negative poverty aversion parameter decomposed into three indicators: poverty incidence (P_0), poverty depth (P_1) and severity of poverty (P_2). From the mean of per capita household expenditure / income, poverty line was drawn as two thirds of the mean per capita household income and global $1.9 per day. The results of poverty measures were tested for robustness to the changes in the estimated poverty line with the use of stochastic dominance. The estimated poverty line, 2/3 of mean per adult equivalent income or expenditure obtained from the survey was varied at interval of 15 % to determine stochastic dominance analysis.

The effect of Shiroro dam project on the sustainable livelihood security and poverty status of farmers were achieved using Tobit regression model. The model measures not only probability that the respondent is poor but also the intensity of poverty (Oladimeji et al., 2018).
Explicitly, the effect of Shiroro dam on the poverty status of farmers is postulated as follows:

$$Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \mu_i \quad (2)$$

Where: Yi = ratio of income realized from Shiroro farm to total income / expenditure of ith Shiroro farmers; Where: X_1 = farm size (ha); X_2 = extension contact (number); X_3 = non-farm income; X_4 = level of investment, (₦); X_5 = household size (number of persons per farmers); X_6

= level of education (years); X_7 = credit accessed (₦); X_8 = per capita expenditure (₦); X_9 = market access (access =1 and 0 otherwise), μ_i= residual error.

Similarly, the effect of Shiroro dam project on the livelihood security status of farmers is postulated as follows:

$$Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \mu_i \qquad (3)$$

Where: Yi = livelihood composite index (ratio) of the following indicators: income realized from Shiroro dam farm (₦), income realized from secondary occupation (₦), income realized by other member of household or remittance (₦), current value of irrigation and farm equipment (₦), current savings (₦), current value of improvement in house and land, current loan obtained (deducted, ₦). A standardized indicator j of a farmer livelihood composite index is given by:

$$\text{Yi} = \frac{\text{total income of a farmer from Shiroro dam}j - \text{Min}j \text{ value}}{\text{Max}j \text{ value} - \text{Min}j \text{ value}} \qquad (4)$$

(Adopted and modified from Lindenberg (2012) and CARE (2014). X_1 to X_9 are defined above.

Z-statistics was used to determine the hypothesis that SDP had no impact on poverty and sustainable livelihood security status of farmers. This was achieved to test whether there is significant difference between income with and without involvement in Shiroro irrigation farming. The formula is given by:

$$Z = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}} \qquad (5)$$

(Adopted from Oladimeji, Abdulsalam, Muhammed-Lawal, Adefalu, Adepoju, 2016)

Where: $\bar{X}_1$ = average return from combined other income and irrigation farming for Shiroro farmers (₦), X_2 = average return from only non- irrigated farming (₦), σ_1^2 = variance from return of X_1, σ_2^2 =variance for return from X_2, n_1 and n_2 = sample size of X_1 and X_2.

The impact of Shiroro dam project on the sustainable livelihood and poverty status of farmers were achieved using the propensity score matching (PSM) and Local Average Treatment Effect (LATE) models. It entails computation using estimating propensity scores from Logit model, matching estimators and thereafter estimates the Average Treatment Effect on the Treated (ATT) which is the parameter of interest as

$$\delta \equiv E\{Y_i^1 - Y_i^o / D_i = 1\} = E\,\{E\,\{Y_i^1 / D_i = 1, P\,(Z_i)\} - E\,\{Y_i^o / D_i = 0, P\,(Z_1)\} / D_i = 1\} \qquad (6)$$

(Adopted from Nkhata (2014), Idi, Damisa, Ahmed, Edekhogregor, and Oladimeji (2019).

Y_i and Y_i are the potential outcomes (sustainable livelihood and poverty status) in the *two* counterfactual situations of receiving treatment (Shiroro dam farmers) and no treatment (non-participant). Where: P (Z_i) is the P-Score, Furthermore, Heckman and Hotz (1989), Hünermund and Czarnitzki (2016) and Oladimeji (2020) adopted from Imbens and Angrist (1994), opined that LATE estimator could be used to remedy the noncompliance problems experienced in estimation of the average treatment effect (ATE) for the population. LATE estimation was achieved using equation 7 below:

$$E\lfloor Y^1 - Y^0 \mid T = C \rfloor = \frac{E\lfloor Y \mid Z=1\rfloor - E\lfloor Y \mid Z=0\rfloor}{E\lfloor D \mid Z=1\rfloor - E\lfloor D \mid Z=0\rfloor} \quad (7)$$

RESULTS AND DISCUSSION

Classification of Farmers' Livelihood Diversification

The shares of incomes from different livelihood activities are summarized by sectors in Table 1. Although all activities were important sources of income for the SDF sampled, farming activities were the most important source of income cumulated to 79.30 % comprising of the share of income from Shiroro dam irrigation and rainfed farming amount to 57.4 % and 45.52 % of farm income and total income respectively. Off-farm incomes play a lesser role as a source of livelihood with a proportion of 14.68 % from the pooled activities.

Table 1: Summary of livelihood activities and income earnings by SDF per season (n=165)

Activities (₦)	Amount per season	Sector data %	Sector data Ranking	Pooled data %	Pooled data ranking
Share of farm income	0.793				
Shiroro dam irrigation	88,907.05	57.40	1st	45.52	1st
Rainfed	52,002.08	33.57	2nd	26.62	2nd
farm processing & others	13,990.05	9.03	3rd	7.16	3rd
sub-total	154,899.18	100		79.30	
Share of off-farm income	0.147				
Fishery	10,090.00	35.21	1st	5.17	4th
Livestock / poultry	9,540.02	33.29	2nd	4.88	5th
agric. wage labour	4,231.27	14.77	3rd	2.17	7th
agric. input / output marketing	3,005.00	10.49	4th	1.54	8th
apiculture / beekeeping /others	1,790.06	6.25	5th	0.92	11th
sub-total	28,656.35	100		14.68	
Share of non-farm income	0.062				
commercial motorcycle	5,982.50	50.82	1st	3.06	6th
non-farm rural wage	2,753.00	23.39	2nd	1.41	9th
remittance & gifts	2,500.00	21.24	3rd	1.28	10th
Artisans &others	536.84	4.5601	4th	0.27	12th
sub-total	11,772.34	100		6.02	
Total	195,327.87				

Source: Field survey, 2019.

However, fishery and livestock were the most important in off-farm sector and took a portion of 35.21 and 33.29 % in the sub-sector and 5.17 and 4.88 % in the pooled data. It suffice to note that non-farm income share a paltry of 6.02 % from the pooled data. The result demonstrated that income from Shiroro dam can significantly make impact on the livelihood of the farmers in the study area. This is comparable to the study of Eneyew, Alemu, Ayana, and Dananto (2014) that irrigation use has a positive impact on households earning from crop and livestock in rural area of Ethiopia.

Poverty Status of Shiroro Dam and Control Farmers

The poverty status among the Shiroro dam farmers (SDF) and non-participants farmers were analyzed using FGT indices and presented in Table 2. The result revealed that the mean annual per capita income (mci) of SDF was ₦195,327.9 with a 2/3 poverty threshold of ₦130,218.6 and ₦13,860 using $693.5 per year of USA dollar respectively. The result showed that the poverty incidence for the SD farmers and non-participants (mci approach) was 0.378 and 0.504 implying that 37.7 and 50.4 % of the participants and non-participants respectively were poor. The poverty depth was 0.032 and 0.109 representing 3.2% and 10.9 % respectively for SDF and NPF whose average yearly per capita income was below the poverty line. This gap represents the income required to bring poor households below the poverty line up to the threshold. It can be inferred that poverty was more prevalent and severe among non-participants compared to SDF.

The result of decomposition of poverty status based on SDF and NPF was reinforcing in Figure 2. The Cumulative Distribution Function (CDF) of farmers with no access to Shiroro dam for farming stochastically dominated the CDF of farmers with access to the dam. This shows that the NPF will always be poorer than the SDF within the range of the specified poverty line. This implies that the head count ratio was robust to all possible choices of poverty lines within the specified range. The findings is in line with study Eneyew et al. (2014) who confirmed that irrigation contributed to poverty reduction among rural farmers in Ethiopia.

Table 2: Poverty status of Shiroro dam and control farmers per season

	Shiroro dam farmers		**Non-participants' farmers**	
Parameters	**M / CI[a]**	**$1.9 / day[a]**	**M / CI[b]**	**$1.9 / day[b]**
Non-poor	0.622	0.587	0.496	0.472
Poor	0.378	0.413	0.504	0.528
Poverty indices				
Poverty incidence (P_0)	0.378	0.413	0.504	0.528
Poverty gap (P_1)	0.032	0.070	0.109	0.127
Poverty severity (P_2)	0.002	0.002	0.010	0.058
Mean / capita income (m/ci)	195,327.9	-	150,300.05	-
Poverty threshold 2/3 of MPI	130,218.6	-	100,200.03	-
Poverty threshold 1.9 USD		₦20,790		₦20,790
2/ 3Poverty threshold 1.9 USD		₦13,860		₦13,860
t-value (M / CI[a] X M / CI[b])	**6.98*** **			
t-value ($1.9 / day[a] X $1.9 day[b])	8.45***			

Source: Field Survey, 2019

Note: $1.9 (USD) equivalent ₦693 in 2019, M / CI denote mean per capita income, *** *denote statistically significant at 1%*

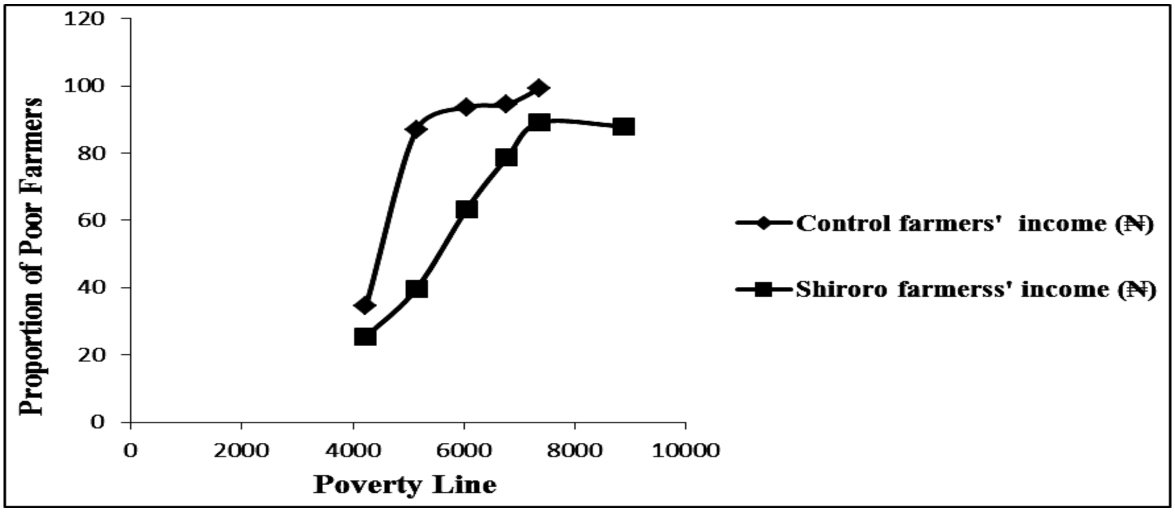

Figure 2: Distribution of dominance analysis by SDF and NPF farmers

Effect of Shiroro Dam on Livelihood and Poverty Status of Farmers

Table 3 shows the effect of Shiroro dam on livelihood and poverty status of Shiroro dam farmers using Tobit regression. The regression result of livelihood security status showed that the farm size (0.009), extension contact (0.300), level of investment (-0.511), level of training (0.005), per capita expenditure (0.490) and market access (0.286) were statistically significant factors affecting livelihood security status of Shiroro dam farmers at different levels of probability. The positive coefficients of all the variables except level of investment implies that a unit increase in these variables will increase the output of the farmers in Shiroro dam.

Table 3: Effect of shiroro dam on livelihood security and poverty status of farmers

Variable	Livelihood security status			Poverty status		
	β	SE	P > //Z//	β	SE	P > //Z//
constant	0.205**	0.107	0.064	0.100**	0.062	0.081
Farm size	0.009*	0.002	0.000	-0.1e-4*	3e-06	0.001
Extension contact	0.300*	0.087	0.000	-0.641*	0.121	0.000
Non-farm income	0.1e-07	0.1e-07	0.209	0.001	0.002	1.067
Level of investment	-0.511**	0.291	0.075	0.632*	0.237	0.008
household size	0.442*	0.100	0000	0.412*	0.099	0.000
level of training	0.005	0.006	0.454	0.211	0.237	0.621
credit accessed	0.065	0.073	0.461	0.187	0.175	0.498
per capita expenditure	0.490*	0.100	0.000	-0.008*	0.001	0.000
market access	0.286*	0.097	0.003	-0.344*	0.100	0.000
Diagnostic statistics						
No. of observation	165			165		
Log likelihood function	-101.072			-93.804		
LR Ratio	13.843			11.009		
Chisquare ($\chi2$)	7.95			5.05		
Pseudo R^2	0.195			0.276		
Probability > Chi^2	0.000			000		

* ; ** denote statistically significant at 1% and 5% respectively

Likewise, the regression result of poverty status revealed that farm size (-0.1e-4), extension contact (-0.641), level of investment (0.008), household size (0.412), per capita expenditure (-0.008) and market access (-0.344) were statistically significant factors affecting poverty status of Shiroro dam farmers at different levels of probability. The negative coefficients imply that a unit increase in Shiroro dam income would decrease poverty by corresponding units. Thus, the larger the farm output, the lower the probability of a farmers falling below the poverty line. Conversely, the coefficients that are positive suggest that a unit increase in the variables will lead to increase in poverty level.

Hypothesis

The result of hypothesis that state there is no significant difference between mean income of Shiroro dam farmers and control was achieved through Z-test as depicted in Table 4. The result showed that the mean income of farmers per annum that benefitted from Shiroro dam project (₦195,327.9) for all activities is greater than that of counterfactual (₦150,500.05). The Z-statistic was statistically significant at 1% which implies that there is a significant difference between the accrued incomes of farmers participating in Shiroro dam project compared to non-participants. Therefore it can be concluded that the Shiroro dam project impact positively on the livelihood and poverty status of participating farmers. Similarly, Eneyew et al. (2014) observed a statistically significant difference between income earned by households with and without irrigation in Ethiopia.

Table 4: Z-test of the impact of the Shiroro dam project on the farmers' income

Variables	Shiroro dam farmers	Non-beneficiaries
Mean (₦)	195,327.9	150,500.05
Variance	1,053.96	1,700.52
Observation	165	165
Hypothesized mean difference	0	
Df	328	
Z-statistic	2.9005***	

*** denote significant at 1%

Impact of Shiroro Dam on Livelihood Sustainability and Poverty Status of Participating Farmers

The impact of Shiroro dam on farmers' livelihood sustainability and poverty status was achieved through PSM and LATE models in Tables 5 and 6 respectively. The results of the impact of Shiroro dam on sustainable livelihood of Shiroro dam farmers presented in Table 5 revealed that per capita income of the Shiroro farmers was 0.194. This implies participating in Shiroro dam farming will lead to 0.194 units increase in farm income. In Table 6, household expenditure of farmers will increase by 0.237. The Treatment Effect on the Treated (ATT) on the average had a positive impact and increases participating farmers' income and expenditure by 0.065 and 0.135 units respectively. This implies that Shiroro dam project positively impacted on the participants' income hence household livelihood sustainability. Nkhata (2014) observed that growing rice under irrigation increases the average agricultural income of the participating households over those not engaging in any irrigated production by 51,440 units.

The Treatment Effect on the Untreated (ATU) was estimated by matching similarly treated farmers to each non-treated respondents. The result showed that ATU had a significant and positive impact on income and expenditure by 0.012 and 0.088 units in Tables 5 and 6 respectively. This implies the counter factual outcome of the treated had it been they were not treated. The Average Effect of the Treatment (ATE) for Shiroro dam farmers has a positive difference of 0.076 in Table 5 and 0.169 units in Table 6 compared to the treated category. The positive impact of Shiroro dam on farmers' income and household expenditure is similar to the finding of Adebayo Omonona, Abioye, and Olagunju, (2018) that estimated positive impact of irrigation technology use on crop yield, crop income and household livelihood security in Nigeria using PSM approach.

The LATE estimate was carried out for each of the two outcomes of interest (income and expenditure) a proxy of livelihood and poverty using WALD estimator proposed by Imbens and Angrist (1994). For the income, the result of its (LATE) mean difference depicted in Table 5 indicate a positive and statistically significant difference (P<0.10) of 0.107 in farmers' income between the Shiroro dam participants and non-participants. Similarly, the difference in household expenditure in Table 6 also showed a positive and statistically significant difference (P<0.10) between participants and non-participants. This is the average increase in both income and expenditure brought about by the participation in farming in the Shiroro dam project.

Table 5: Impact of Shiroro dam on farmers' livelihood security status

Estimation by	Sample	Treated	Control	B	SE	T-value
Per capita income	Unmatched	0.194	0.087	0.107**	0.047	2.28
(million '₦)	ATT	0.239	0.065	0.174***	0.031	5.61
	ATU	0.136	0.148	-0.012		
	ATE			0.076		
WALD Chi^2 test				0.054***	0.017	3.18
Participant versus				0.194***	0.075	2.59
Non-participant				0.087***	0.029	3.01
Observed diff.				0.107*	0.06	1.78

*Note: *** P<0.01, **<0.05 *<0.10 levels of probability.; treated = Shiroro famers and control = non-participant, Treatment Effect on the Treated (ATT), Treatment Effect on the Untreated (ATU), Average Treatment Effect (ATE)*

Table 6: Impact of Shiroro dam on farmers' poverty status

Estimation by	Sample	Treated	Control	B	SE	T-value
Household expenditure	Unmatched	0.237	0.175	0.062**	0.029	2.14
(million'₦)	ATT	0.259	0.135	0.124***	0.035	3.54
	ATU	0.014	0.102	0.088		
	ATE			0.169		
WALD Chi^2 test				0.006***	0.002	3.00
Participant versus				0.236***	0.079	2.99
Non-participant				0.175***	0.046	3.80
Observed diff.				0.061*	0.031	1.97

Heckman and Hotz (1989), Hünermund and Czarnitzki (2016) and Oladimeji (2020) opined that LATE model does not over-estimate or under-estimate the impact of participating or benefitting in a project because of its ability to estimate the actual impact of project in a situation of non-compliance irrespective of other factors that might influence the outcome of interest. This finding is in line with the results of Adebayo and Olagunju (2015) who found that there was impact of agricultural innovation on livelihood and productivity among smallholder farmers in rural Nigeria.

CONCLUSION

This study assesses the effects of Shiroro dam project on livelihood security and poverty status of crop farmers in Niger State, Nigeria. The regression results has substantiated that Shiroro dam irrigation in the study area has significantly affected the livelihood security and poverty alleviation of the farmers. The results showed that the dam impacted positively on livelihood security (income as a proxy) and poverty status (expenditure by proxy) of farmers that are participating in SD activities by dominating income earned, sustaining largely their livelihood and alleviate their poverty.

Irrigation enhance continuous farming throughout the year which is equally *sine qua non* to sustainable livelihood and improve standard of living as well as encouragement of full time farming activities, a significant acceleration of agricultural growth and development. It is suggested that more irrigation facilities should be built to guarantee agricultural production in both wet and dry seasons to catalyze statistically significant socio-economic and production variables (such as farm size, extension contact, credit, household size and market access) and transformation of rural masses and alleviation of poverty. Level of investment (irrigation machines) was also statistically significant, hence, improvements in the current irrigation infrastructure such as provision of pumping machines, access to underground water through well and boreholes, conserving surface run off during precipitation, improving water conveyance and distribution efficiency, upgrading irrigation efficiency and drainage systems, and enacting public law on industrial pollutants and dumping refuse near river bank are recommended to sustain agricultural production via irrigation and enhance sustainability of the farmers and environment.

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