

THE IMPACT OF SHIRORO DAM PROJECT ON PRODUCTIVITY AND LIVELIHOOD DIVERSIFICATION OF RURAL FISHERFOLKS IN NIGER STATE, NIGERIA

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Abstract: The interdependence of water, food and energy are widely recognized as important drivers of socioeconomic development. The objective of the study was to assess the impact of Shiroro Dam Project (SDP) on productivity and livelihood diversification of rural fisherfolks in Niger state, Nigeria. Primary data were collected from the fisherfolks with the aid of structured questionnaires. A multistage sampling procedure was used to select 363 fisherfolks from two LGAs, twelve villages and 1,210 sample frames. Two hundred and sixty (267) fisherfolks who are non-beneficiaries of SDP were also selected as counterfactual to examine the impact. The data were analyzed using descriptive statistics, Tobit regression, Propensity Score Matching (PSM) and the Local Average Treatment Effect (LATE) models. Result revealed that fishery activities were the most important source of income (68.3%) among the fisherfolks. The coefficients of length of fishing gears (-0.400), capacity of outboard engine (-0.005), household size (0.008), credit accessed for fishery (0.052) and per capita expenditure (0.306) were statistically significant factors influencing the extent of livelihood diversification of Shiroro dam fisherfolks. There was statistically significant difference between the mean income of fisherfolks (₦56,119.06 per annum) who benefitted from SDP and counterfactual (₦37,876.80). Similarly, the results of impact of SDP on productivity of fisherfolks revealed that the treatment effect on the treated (ATT) increases productivity of the benefitted fisherfolks by 2.8273 (38.1%), that ATU had a significant and positive impact (0.1282) on productivity, and the average effect of the treatment (ATE) for SDP fisherfolks has a positive difference of 0.6654 compared to the treated category. Fisherfolks should form a formidable social organization to benefit from economy of bulk purchase of farm inputs especially fishing gears and outboard engine, farm advisory services, increased access to credit, and access to other modern fishing techniques.

Keywords: *Fisherfolks, impact, income, Shiroro dam project, Nigeria*

<http://dx.doi.org/10.21776/ub.agrise.2020.020.3.2>

Received 10 February 2020

Accepted 11 April 2020

Available online 29 July 2020

INTRODUCTION

The interdependence of water, food and energy are widely recognized as important drivers of socioeconomic development. This importance is embedded in the United Nations 2030 Agenda for Sustainable Development Goals Report as Nigerian population is expected to increase to 262, 599 000 people by 2030 ((UN SDG, 2016; ICSU-ISSC, 2015, UNDESA, 2015). The economic benefits of dams outweigh the costs, thus providing rationale for construction of dams around the world (Philip *et al.*, 2008). Dams are important means of meeting water; energy and food need in the long-term, strategic investments with many additional benefits. Some of these benefits include projects or regional

development, employment generation, and fostering of local industry (World Commission on Dam, 2000). Impacts of dams can be involuntarily imposed on rural farming households whose livelihoods are dependent on riverine resources through contributions to economic growth while the services they provide may come at a cost (Skinner *et al.*, 2009, Oladimeji and Abdulsalam, 2014).

Similarly, large dams by increasing irrigation and hydroelectricity production, can stimulate development and reduce poverty has led developing countries and international agencies such as the World Bank to undertake major investments in dam construction. By implication, dams generated 19 % of the world's electricity supply and irrigated over

CITATION: Oladimeji, Y., U., Abubakar, B., A., Y., Abdulsalam, Z. (2020). The Impact of Shiroro Dam Project on Productivity and Livelihood Diversification of Rural Fisherfolks In Niger State, Nigeria, Agricultural Socio-Economics Journal, 20(3), 191-200 DOI: <http://dx.doi.org/10.21776/ub.agrise.2020.020.3.2>

30 % of the 271 million hectares irrigated worldwide (World Commission on Dam, 2000). Dams often transformed surrounding communities positively (Skinner *et al.*, 2009). Irrigation practice across the world is vital to successful green revolution all year round to achieving sustainable development goals in food security, socio-economic and rural development. However, irrigation practice in Nigeria has not achieved the set goals despite the huge investment involved. Moreover, the level of investment and abundant water resources ought to have expedited the goals of food self-sufficiency and socio-economic development in the country (Bashir Adelodun and Kyung-Sook Choi 2018).

Non-farm earnings account for a considerable share of farm household income in rural farming Africa household (Reardon, 1997; Barrett *et al.*, 2001). Rural farm household diversify into non-farm income earning due to the activities diminishing or time-varying returns to labour or land, market failures (example for credit) or frictions, risk management, and to be able to cope with adverse shocks.

Based on the foregoing, policy makers at national regional and household levels should focus on increasing agricultural productivity and farm income so as to attain food self-sufficiency. Although, substantial resources have been spent on agricultural research and extension to alleviate food shortage in the nation, issues related to off or non-farm diversification with regards to dam should be adequately looked into. In spite of this fact, farmers are engaged in a variety of off and / or non-farm activities to diversify their income with a view to feed and sustain themselves during crop failures. Moreover, the contribution made by livelihood diversification to rural livelihoods is significant and has often been ignored by policy makers who have chosen to focus their activities on agriculture (Ellis, 1998 Oladimeji *et al.*, 2015).

In developing countries fish is an important source of both food and income to many people. According to FAO (2012), fish contribute more than 60 % of the world supply of protein, especially in the developing countries. The global fish production was estimated to about 171 million tonnes in 2016, valued at USD 362 billion. Between 1961 and 2016, the average annual increase in global food fish consumption, 3.2 % outpaced population growth, 1.6 % and exceeded that of meat from all terrestrial animals combined, 2.8 % (FAO, 2018). In per capita terms, food fish consumption grew from 9.0 kg in 1961 to 20.2 kg in 2015, at an average rate of about 1.5 percent per year. New Partnership for African Development (2005) state that, in Africa the fisheries sector provides income for over 10 million people engaged in fish production, processing and trade. Fish has also become a leading export commodity for Africa with an annual export value over USD 2.7 billion (FAO, 2007, FAO, 2018).

Policy makers and researchers have often ignored the contribution made by rural livelihood diversifications focusing attention on agriculture (Carswell, 2000) especially artisanal fishery. It is pertinent to note that research works on the impact of dam on productivity and livelihood diversification of rural fish farming household are scanty. This study therefore examines the impact of Shiroro dam on productivity and livelihood diversification of rural fisherfolks. Consequently, the study seeks to provide answers to the following research questions:

- a. what are the level of livelihood diversification among artisanal fisherfolks?
- b. which factors influence the extent of livelihood diversification of fisherfolks?
- c. are there impact of Shiroro dam project on the livelihood diversification?
- d. are there impact of Shiroro dam project on the productivity of fisherfolks?
- e. what are the constraints encountered by the rural fisherfolks in the study area?

METHODOLOGY

Description of the Study Area

This study was conducted in Shiroro, Munya and Gurara Local Government Areas (LGAs) of Niger state. The State is located between Latitude 8° 22' N and 11° 30' N and Longitude 3° 30' N and 7° 20' E and covers a land area of about 74,244 sq. km, or about 8 % of Nigeria's total land area. The climate, soil and hydrology of the state permit the cultivation of most of Nigeria's staple crops such as maize, yam, rice millet, sorghum, and allows sufficient opportunities for grazing, fresh water fishing and forestry development.

Specifically, the Shiroro hydropower reservoir is a storage based hydroelectric facility located in Niger State at the Shiroro Gorge with approximately between Latitude 9° 46' 35 and 10° 08' 36 N and Longitude 6° 50' 51 and 6° 53' 14 N. It is located approximately 90 km southwest of Kaduna on River Dinya. The facility has an installed capacity of 600 MW (Kolo, 1996). The reservoir has a surface area of about 320 km² with a maximum length of 32 m and a total storage capacity of 7 billion m³ of water (Usman and Ifabiyi, 2012). About 70 % of inflows into the reservoir are from river Kaduna, with lateral contributions from rivers Dinya, Guni, Sarkin-Pawa, Erena and Muiy. Annual temperature around the reservoir varies between 27 and 35 °C. (Abayomi *et al.*, 2015)

Method of data Collection and Sampling Procedure

Primary data was collected in 2019 fishery season, with the aid of a structured questionnaire and trained field enumerators for the study. Information

collected includes: socio-economic characteristics, livelihood diversification activities, fishery inputs such as size of canoes in meters; length of fishing gears (nets) in meters; fuel gasoline and diesel oil in litres; number of plastic container, hand paddlers and baits and capacity of outboard engine in horse power.

A multistage sampling procedure was used to obtain the sampled 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 in the vicinity of villages in the two LGAs and concentration of fisherfolks in the villages. The list of beneficiary villages was listed and a total of a dozen villages were randomly selected through balloting from the two LGAs proportionate to size. The list of fisherfolks in each village was compiled and 30 % of the sampling frame (1, 210) was randomly selected through balloting totaling 363 fisherfolks.

On the other hand, two hundred and sixty (267) fisherfolks who are non-beneficiaries of Shiroro dam fishery expedition but engage in fishing nearby communities in Kebbi and Kwara states with similar socio-economic characteristics were randomly selected from a sample frame of nine hundred and sixty two (962) fisherfolks (Oladimeji, 2018) as counterfactual to examine the impact of the dam on productivity of the fisherfolks.

Analytical techniques

Descriptive statistics and the mean of income shares approach were used to estimate the level of livelihood diversification by the fisherfolks in Niger state, Nigeria. The general mean of income shares (MIS) formula is given as:

$$MS_i = \frac{\sum_{h=1}^n y_{ih}/Y_h}{n} \dots \dots \dots (1)$$

(Bernard *et al.*, 2014; Oladimeji *et al.*, 2018)

Where I = the income source (naira, ₦), Y = total Income (naira, ₦), y = income from particular activity (naira, ₦), h = the household (number of persons), n = the number of fisherfolks. Equation (1) was applied in this study as:

The sum of total household income (THI) is given as:

$$THI = \sum_{j=1}^{16} Y_j \dots \dots \dots (2) \quad (\text{Schwarze and Zeller, 2005; Bernard } et al., 2014)$$

Where: THI=Total Household Income, thus income coming from all sources j
 $j=1, 2, 3, 4, \dots, 16$, fish, off-fish and non-fish income.

Factors influencing diversification of fisherfolks to non-fishery activities were determined using Tobit model. This was measured by the share of fishery income (from all activities) in total

fisherfolks' income. The diversity index of zeros indicated no diversification in the dependent variable for some respondents necessitated the use of the censored and truncated Tobit regression. Thus:

$$Y_i^* = \sum X_i \beta + \mu_i \dots \dots \dots (3)$$

Where: Y_i^* is the vector of variables indicating the dependent variables in the model;

$$Y_i = P_i = (X_i \beta, \mu_i), \text{ if } P_i > P_i^* \dots \dots (4)$$

$$0 = (X_i \beta, \mu_i), \text{ if } P_i \leq P_i^* \dots \dots (5)$$

$i = 1, 2, \dots, 363$

(Equations 3 -5: Tobin, 1958 adopted by Schwarze and Zeller, 2005; Bernard *et al.*, 2014; Femi and Adelomo, 2016, Oladimeji, 2018)

Where: Y_i^* is the vector of variables indicating the share of income in fishery from total household income. β is a vector of unknown co-efficient and μ_i is an independently distributed error term. X_i is a vector of explanatory variables stated explicitly in equation 6 below. P_i is the diversification depth or intensity defined as $(Z - Y_i)/Z$ and P_i^* is the diversification intensity, when the diversification line (Z) equals the $Z - Y_i$. The model was estimated using maximum likelihood estimation (MLE) procedure.

$$Y_i = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \beta_{10} X_{10} + \beta_{11} X_{11} + \varepsilon_i \quad (6)$$

(Equation 6 adopted from Oladimeji, 2018)

Where: X_1 = size of canoes in meters; X_2 = length of fishing gears (nets) in meters; X_3 = capacity of outboard engine in horse power; X_4 = level of investment, (₦); X_5 = age (years); X_6 = household size (number of persons per fisherfolks); X_7 = level of education (years); X_8 = credit accessed (Naira); X_9 = cooperative society (years); X_{10} = per capita expenditure (naira); X_{11} = market access (access =1 and 0 otherwise); β_0 = constant; β_1 - β_{11} are coefficients to be estimated and ε = error term.

The challenge in impact evaluation based on observational data lies on the estimation of the counterfactual of the treated group based on the observations on the untreated group. This is because beneficiaries and non-beneficiaries are very unbalanced; that is, they are different socially, economically and psychologically. The impact of Shiroro dam project on the productivity of fisherfolks were achieved using the propensity score matching (PSM) and Local Average Treatment Effect (LATE) models. The method of propensity score matching (PSM) allows this matching problem to be reduced to a single dimension: that of the propensity score. PSM is defined as the conditional probability that a unit in the full sample receives the treatment, given a set of observed variables (Rosenbaum and Rubin, 1983). It entails computation using either Probit or Logit regression models. Thus:

$$p(X_i) = P(d=1|X_i) \dots \dots \dots (7)$$

Where $p(X_i)$ is a consistent estimate of the propensity score evaluated at X_i while X_i were the variables used for the matching. P score was estimated in the first stage and computed for each fisherfolks, the actual matching was carried out after p score was computed. The estimated propensity scores were used to estimate the Average Treatment Effect on the Treated (ATT) which was the parameter of interest as

$$\delta = E\left(\frac{Y_{i1} - Y_{i0}}{D_{i1} = 1}\right) = E\left\{\frac{E\left(\frac{Y_{i1}}{D_{i1} = 1} \mid P(Z_i)\right) - E\left(\frac{Y_{i0}}{D_{i1} = 0} \mid P(Z_i)\right)}{D_{i1} = 1}\right\} \dots \dots \dots (8)$$

(Adopted from Idi *et al.*, 2019)

Where: $P(Z_i)$ is the P-Score, Y_i and Y_i are the Shiroro dam fisherfolks beneficiaries and non-beneficiaries respectively in the two counterfactual situations of receiving treatment (fisherfolks income benefit from Shiroro dam and non-treatment (non-beneficiaries of Shiroro dam. Two important properties of the PSM are the balancing property and conditional independence assumption (CIA). Testing for this property is important to ascertain if fisherfolks behavior within each group is actually similar. Related to the balancing of P-score is CIA, which states that participating in fishery in Shiroro dam is random and uncorrelated with the fish output by the fisherfolks from the dam, once the set of observable characteristics, Z are controlled. A further requirement is the common support condition, which requires that persons with the same values of covariates Z have positive possibilities of being both beneficiaries and non-beneficiaries (Heckman *et al.*, 1999, Idi *et al.*, 2019).

Furthermore, Heckman and Hotz, (1989), Hünermund and Czarnitzki, (2016) adopted from Imbens, and Angrist (1994), opined that Local Average Treatment Effect (LATE) estimator could be used to remedied the noncompliance problems experienced in estimation of the average treatment effect (ATE) for the population. LATE estimation was achieved using equation 9 below:

$$E[Y^1 - Y^0 \mid T = C] = \frac{E[Y \mid Z = 1] - E[Y \mid Z = 0]}{E[D \mid Z = 1] - E[D \mid Z = 0]} \dots \dots \dots (9)$$

T-statistics was used to determine the impact of Shiroro dam project on the livelihood

diversification of fisherfolks. This was achieved to test whether there is significant difference between returns from fisheries from dam versus other activities of fisherfolks in the study area. It is a useful technique for comparing mean values of two sets of numbers. The formula is given by:

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{\sigma_1^2}{n_1} + \frac{\sigma_2^2}{n_2}}} \dots \dots \dots (10)$$

(Adopted from Oladimeji *et al.*, 2016)

Where: \bar{X}_1 = average return from fisheries for beneficiaries' fisherfolks (\bar{X}) \bar{X}_2 = average return from non- beneficiaries' fisherfolks (\bar{X}), σ_1^2 = variance from return of beneficiaries, σ_2^2 = variance for return from non-beneficiaries, n_1 and n_2 = sample size of beneficiaries and non-beneficiaries fisherfolks.

RESULTS AND DISCUSSION

Classification of Livelihood Diversification

The shares of incomes from different livelihood activities are summarized by sectors in Table 1. Although the activities were important sources of income for all the fisherfolks sampled, fishing activities were the most important source of income (68.3%) which is in tandem with study of Oladimeji (2018) on determinants of livelihood diversification among rural artisanal fisherfolks in north-central and north-western Nigeria. However, off-fish activities which accounted for 22.66 % of total fisherfolks' income were largely made up of crop production which constitutes about 65.5 % of off-fish sectorial activities. Others such as livestock / poultry (2.98 %), agric. wage labour (2.26 %) and agriculture input or output items (1.49%) were also captured but of lesser important.

Factors Influencing Extent of Livelihood Diversification among Fisherfolks

Table 2 shows the factors influencing extent of livelihood diversification among Fisherfolks in Shiroro dam. In the regression model, the coefficients of length of fishing gears (-0.400), capacity of outboard engine (-0.005), household size (0.008), credit accessed for fishery (0.052) and per capita expenditure (0.306) were statistically significant factors influencing the extent of livelihood diversification of Shiroro dam fisherfolks.

Table 1. Summary of average income earnings by activities per annum (n=363)

Activities	Amount per season	%	Sector ranking	Pooled ranking
Fishery income				
Share of fishery income	0.684			
actual fishing	73,007.60	43.51	1 st	1 st
canoe building	18,005.50	10.73	2 nd	3 rd
canoe transportation	11,530.91	6.87	3 rd	4 th
fish processing & marketing	6,980.04	4.16	4 th	6 th
fish net making & repairs	2,620.00	1.56	5 th	11 th
engine services	2,600.75	1.55	6 th	12 th
sub-total	114,744.80	68.38		
Off-fish income				
Share of fishery income	0.227			
crop production	25,005.00	14.9	1 st	2 nd
Livestock / poultry	5,003.06	2.98	2 nd	7 th
agric. wage labour	3,800.05	2.26	3 rd	8 th
agric. input or output marketing	2,500.08	1.49	4 th	13 th
apiculture / beekeeping	1,720.90	1.02	5 th	14 th
sub-total	38,029.09	22.66		
Non-farm income				
Share of fishery income	0.089			
commercial motorcycle	7,540.05	4.49	1 st	5 th
wood carving / carpentry	3,650.00	2.18	2 nd	9 th
non-farm rural wage	2,800.00	1.67	3 rd	10 th
remittance & gifts	1,050.00	0.63	4 th	15 th
sub-total	15,040.05	8.96		
Total		100		

Source: Field survey, 2019.

Table 2. Estimate of factors influencing extent of livelihood diversification of fisherfolks

Variable	Parameter	Coefficient	Std Error	T-value	P > Z
Constant	β_0	0.203*	0.115	1.76	0.062
size of canoes	β_1	0.076	0.106	0.72	0.209
length of fishing gears	β_2	-0.400**	0.196	-2.04	0.037
capacity of outboard engine	β_3	-0.005***	0.001	-5.00	0.000
investment	β_4	0.002	0.002	1.00	0.168
Age	β_5	-0.105	0.300	-0.35	0.421
household size	β_6	0.008***	0.003	2.67	0.001
level of education	β_7	0.016	0.025	0.65	0.250
credit accessed for fishery	β_8	0.052*	0.028	1.87	0.051
cooperative society	β_9	-0.006	0.007	-0.85	0.163
per capita expenditure	B_{10}	0.306**	0.148	2.07	0.030
market access	B_{11}	-0.001	0.001	-1.06	0.156
Diagnostic statistics					
Number of observation	363				
Log likelihood ratio	-72.09				
Restricted log likelihood ratio	-91.01				
Chi square (χ^2)	14.07				
Pseudo R ²	0.185				
Probability > Chi ²	0.000				

Source: Field survey, 2019; Note: *** P<0.01 and **<0.05 level of probability.

The coefficients of length of fishing gears (-0.400) and capacity of outboard engine (-0.005) were statistically significant at 5 and 1 % respectively which implies that fisherfolks without improved fishing gears and employ manual outboard such as paddle tend to have an array of livelihood sources and their distribution is more uneven. The availability of modern fishing gears

enable the fisherfolks to rely more on actual fishing and exploit distance fishery resources which invariably increase their income. In remote areas there are no income possibilities outside self-employment within agriculture.

Conversely, the coefficients of household size (0.008) and per capita expenditure (0.306) were

positive and statistically significant at 1 and 5 % level of probability respectively.

This suggests that fisherfolks with large family size tend to diversify more to cater for the member of household and improve their per capita expenditure. This result is consistent with several studies: Schwarze and Zeller, (2005), Oladimeji *et al.* (2015), Femi and Adelomo, (2016), Oladimeji, (2018), that fisherfolks with large household size and dependents have likelihood to engage in supplementary earnings aside their main occupation. This could be for either consumption or to foster education of their wards and family health care or to minimize income fluctuation or shocks as experienced by the sampled fisherfolks. In addition, credit had significant positive effect on livelihood diversification of the sampled fisherfolks in line with Schwarze and Zeller, (2005) and Oladimeji, (2018) suggesting that better-off households through credit diversify more out of the fishery

sector than less privilege ones. Credit seems to enable household members to extend their participation to fishery and new activities.

Impact of Shiroro dam project on the livelihood diversification of fisherfolks

The result of impact of Shiroro dam on the income accrued to fisherfolks was achieved through t-test as depict in Table 3. The result showed that the mean income of fisherfolks who benefitted from Shiroro dam project (₦56,119.06 per annum) for fisheries activities is greater than that of counterfactual (₦37,876.80). The t-statistics was statistically significant at 1 % which implies that there is a significant difference between the accrued incomes of fisherfolks that participated in fishing enterprise compared to non-participants. Therefore it can be concluded that the Shiroro dam project impact on the livelihood of fisherfolks.

Table 3. t-test of the impact of the Shiroro dam project on the fisherfolks' income

Variables	Beneficiaries	Non-beneficiaries
Mean (₦)	56,119.062	37,876.800
Variance	39.0085	45.752
Observation	363	267
Hypothesized mean difference	0	
Df	628	
t-statistics	5.770081***	
P(T≤t) one tail	0.200827E-03	
t critical one tail	1.8608275	
P(T≤T) two tail	0.4973341E-04	
t critical two tail	2.28342	

*** denote statistically Significant at 1%

Impact of Shiroro dam on Productivity of fisherfolks

The impact of Shiroro dam on fisherfolks' productivity was achieved through Propensity Score Matching (PSM) and Local Average Treatment Effect (LATE) model. The two analytical tools concurrently tackled the problem of selection bias and particularly non-compliance or problem of endogeneity.

Table 4: Comparison between NN, R and K algorithms

Algorithms by matching	T-value	Rubin's B	Rubin's R
Nearest neighbor (NN)	2.62***	12.83	1.08
Radius (R)	2.03**	21.7	1.09
Kernel (K)	2.00**	23.00	1.29
PSM Diagnostic statistics			
Observation	630		
Mean	0.549		
Standard deviation	0.251		
Minimum	0.0091		
Maximum	1.0000		

*** & ** denote statistically Significant at 1 and 5 % respectively

For propensity score, nearest neighbor (NN) matching algorithm was used to match the socio-economic characteristics between beneficiary and non-beneficiaries fisherfolks based on the t-value, Rubin B and Rubin R in Table 4. NN also uses the propensity score of individuals alike in the treated and control group to construct the counterfactual

outcome with its major advantage of having lower variance which is achieved because more information is used.

Propensity scores were obtained through Logit regression model and fisherfolks involved in the Shiroro dam were matched on the basis of the proximity of their propensity scores of participating

to fisherfolks in the counterfactual using individual socio-economic characteristics to form matched pairs of observational similar individual characteristics (Table 5). All other fisherfolks whose propensity scores for involvement in Shiroro dam fishing were different from the range of scores for the Shiroro fisherfolks were dropped from the analysis. The propensity score is a probability, so the average probability in the treatment for fisherfolks was 0.549.

The results of the impact of Shiroro dam on productivity of fisherfolks are presented in Table 6.

The result revealed that the average output per unit of inputs of the Shiroro fisherfolks was 6.0320 kg. This implies increasing return to scale, a unit increase in their inputs will lead to 6.032 units increase in the fish harvest. This result seems to be on high side simply because most fisherfolks committed little investment into artisanal fishery and take advantage of the opportunity of the dam for higher harvest. Therefore, the average impact estimation shows that involvement in Shiroro dam had a significant and positive impact on productivity of the fisherfolks.

Table 5: Maximum likelihood estimates of the propensity score for Shiroro dam

Variable	β	SE	T-value	P > Z	Marginal effect
Constant	-1.087***	-0.359	-3.03	0.000	0.0965
Age	0.321*	0.164	1.96	0.059	0.0063
Marital status	0.087	0.105	0.83	0.521	0.0732
Household size	-0.390**	0.188	-2.08	0.036	-0.04210
Cooperative	0.457	0.427	1.07	0.347	0.127
Education	0.521	0.521	1.00	0.357	0.0086
Credit	-0.076***	0.019	-3.91	0.000	-0.07231
LGA (dummy)	0.342*	0.195	1.75	0.072	0.214
LR Chi ² (7)	73.09				
Prob > chi ²	0.000				
Pseudo R ²	0.324				
Wald test	0.087				
Observations	630				

Note: *** P<0.01 and **<0.05 levels of probability.

Table 6: Impact of Shiroro dam on fisherfolks' productivity

Estimation by	Sample	Treated	Control	β	SE	T-value
Output-input ratio	Unmatched	6.0320	5.7002	0.3318***	0.0987	3.36
	ATT	7.9725	5.1452	2.8273***	0.8754	3.23
	ATU	3.4290	3.3008	0.1282**	0.0562	2.28
	ATE			0.6654		
WALD Chi ² test				0.50821	0.1965	2.58
Participant versus				1.9432	0.0976	19.91
Non-participant				1.0332	0.406	2.54
Observed diff.				0.9102	0.3908	2.33

Note: treated = beneficiaries and control = non-beneficiaries, Note: *** P<0.01 and **<0.05 levels of probability.

The Treatment Effect on the Treated (ATT) on the average also had a positive impact and increases productivity of the benefitted fisherfolks by 2.8273 (38.1%). This implies that Shiroro dam project positively impacted on the participants' productivity. The Treatment Effect on the Untreated (ATU) was estimated by matching a similar treated fisherfolks to each non-treated respondent. The result showed that ATU had a significant and positive (0.1282) impact on productivity, this is the counterfactual outcome of the treated had it been they were not treated. The Average Effect of the Treatment (ATE) for Shiroro dam fisherfolks has a positive difference of 0.6654 compared to the treated category. The positive impact of Shiroro dam

on fisherfolks' income and productivity is similar to the finding of Idi *et al.* (2019) on micro-credit utilization and its impact on farmers maize output and household food security in Kaduna state, Nigeria.

The LATE estimate was carried out for productivity using WALD chi square estimator proposed by Imbens and Angrist (1994) and adopted by Heckman and Hotz, (1989), Hünernmund and Czarnitzki, (2016). For the productivity, the result of its LATE mean difference as shown in Table 6 is that there was a significant difference of 0.9102 in fishery productivity between the beneficiaries and non-beneficiaries. This implies that the productivity of the participants of Shiroro dam fisherfolks were

0.9102 units higher when compare with the non-beneficiary's counterpart. Therefore, the LATE estimate analysis showed that Shiroro dam significantly and positively increase fisherfolks productivity by 0.50821 units. This is the average change in productivity brought about by the participation in Shiroro dam fisherfolks. LATE model does not over-estimate or under-estimate the impact of a project because of its ability to estimate the impact of project in a situation of non-compliance and ability to bring out the actual impact of the project irrespective of other factors that might influence the outcome of interest.

The hypothesis which stated that Shiroro dam utilization has no impact on fish caught of the

beneficiaries in the study area was conducted using T-test (Table 7). Fisherfolks output involved in Shiroro dam utilization after nearest neighbor matching was 32,980.07 kg while that of fisherfolks who were not involved in the dam utilization was 27,004.05 kg. Consequently, the impact of Shiroro dam utilization on fish harvest (ATT) was 5,976.02 kg. This was statistically significant at 1 % level of probability. This implies that the null hypothesis which state that Shiroro dam utilization has no impact on fish harvest of the beneficiaries in the study area was rejected at 1 % level of probability. In other words, there is a significant impact of Shiroro dam utilization on fish output of the beneficiaries in the study area.

Table 7. T-test of the impact of Shiroro dam accessibility on productivity of fisherfolks

Variables	Treated	Control	ATT	SE	T-statistics
Fish caught (kg)	32,980.07	27,004.05	5,976.02	901.41	3.00***

Source: Author's estimates, Note: **<0.01, ATT=Average Treatment Effect on the Treated (Impact)

The results of perception on constraints encountered by Shiroro dam fisherfolks presented in Table 8 indicates that inaccessibility of credit was perceived as the most critical with mean of 3.29. High cost of fish equipment (3.22), highest cost of hired labour (3.01) and Inadequate storage facilities (X=3.22)

were also critical constraints hindering fishery practices in the study area. The result corroborates the study of Oladimeji *et al.* (2013) on empirical analysis of artisanal fishery practices and constraints in North Central, Nigeria.

Table 8. Perception on severity of constraints encountered by Shiroro dam fisherfolks

Component	VH	H	L	N	WS	MS	Rank
inaccessibility of credit	852	228	80	34	1194	3.29	1 st
high cost of fish equipment	792	237	108	32	1169	3.22	2 nd
high cost of hired labour	668	255	116	53	1092	3.01	3 rd
inadequate storage facilities	348	555	104	39	1046	2.88	4 th
distance of markets	364	144	264	92	864	2.38	5 th
accessibility to fuel	180	228	354	65	827	2.29	6 th
infestation by hyacinth	168	135	156	197	656	1.81	7 th
climatic variability	216	66	84	245	611	1.68	8 th

VH= very high, H=high, L=low, N=not at all, WS= Weighted score, MS=mean score, %MS= percentage mean score

CONCLUSION

The study revealed that income from fishery was the most important source of income for fisherfolks in the study area. The key determinants of livelihood diversification among fisherfolks were the length of fishing gears, capacity of outboard engine, household size, credit accessed for fishery and per capita expenditure. Therefore, income from both artisanal fishery and non-farm could be combined to minimize income stress, fluctuation and shocks.

Fisherfolks should form a formidable social organization to benefit from economy of bulk purchase of farm inputs especially fishing gears and outboard engine, farm advisory services, increased access to credit, and access to other modern fishing techniques.

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