International Journal of Agricultural Science, Research and Technology in Extension and Education Systems (IJASRT in EESs)
Available online on: http://ijasrt.iau-shoushtar.ac.ir
ISSN: 2251-7588 Print
ISSN: 2251-7596 Online
2023: 13(3):165-177, DOR: 20.1001.1.22517588.2023.13.3.4.4

Received: 07 July 2023
Reviewed: 01 August 2023
Revised: 06 August 2023
Accepted: 20 September 2023

Is Off-Farm Work Impacting Productivity-Enhancing Inputs? Evidence from Arable Crop Farmers

Lawrence Olusola Oparinde[1*], Olaniran Anthony Thompson[1], Oluyede Adeleke Aturamu[2] and Adekunle Isaac Adetula[1]

[1]*Department of Agricultural and Resource Economics, Federal University of Technology, Akure, PMB 704, Akure, Nigeria.*
[2]*Department of Agricultural Science and Technology, Bamidele Olumilua University of Education, Science and Technology, Ikere-Ekiti, Nigeria.* [*]*Corresponding Author Email: looparinde@futa.edu.ng*

Abstract

This study examined the impact of off-farm work adoption on productivity-enhancing inputs (fertilizer and herbicide) in Southwest, Nigeria. Treatment effects model which addresses selection bias issue while considering observed and unobserved factors was used in the analysis of the data collected from sampled respondents. Endogenous Switching Regression (ESR) Model was also employed for the purpose of carrying out a robustness check. Empirical findings from the study showed that years of formal education and membership of cooperative society increased the likelihood of adopting off-farm work. Also, the study confirmed the positive role of extension services in investing in productivity-enhancing inputs as number of extension visits increased level of fertilizer expenditure in the study area. Furthermore, the study clearly showed that off-farm work adoption had direct and significant impact on both fertilizer and herbicide expenditures with the marginal effects of 6.1300 and 3.1023, respectively. Therefore, policies that promote off-farm work adoption should be put in place by all the concerned authorities in the study area. The findings that emanate from this research exercise give valuable supports to the policy architects in coming up with social and agri-environmental policies.

Keywords:
Off-farm work, fertilizer, herbicide, arable crop, treatment effects model

1. Introduction

Most studies on off-farm revenue from developing countries have shown that revenue from off-farm activities constitute significant and growing percentage of total revenue of farming households (Haggblade et al., 2010; Shittu, 2011). Haggblade et al., (2010) reported that 35% -50% of total revenue of farming households is from non-farm activities. In spite of the rising population growth and low productivity in Sub-saharan Africa (SSA), it is expected that the contributions of rural households to total income will significantly rise in the coming years. More than 96% of farms earned income from off-farm economic activities and income from off-farm sources constitutes 86% of the total household income (Key, 2020). Ogbanje et al., (2015) reported that about 50.3% of the total household income came from earnings from off-farm activities. Hou et al., (2023) also stated that the desired increase in income of the farming households can be achieved through off-farm employment. Any activity undertaken by members of the farming household outside the farm is referred to as off-farm work. This includes labour activities undertaken within or outside individual village or location (Wang et al., 2016).

Rapid industrial and urban development has caused an increase in off-farm employment generation for farming households, which has increased off-farm employment. Therefore, there exist unparalleled variations in the distribution of farming households' labour between farming and non-farming economic activities. Numerous studies documented that labour meant for agricultural related activities have been reduced by off-farm engagements (Pfeiffer et al., 2009; de Brauw, 2010). Also, revenue generated from off-farm activities can be used to employ labour, invest in farm equipment and access agricultural services. The added farm inputs can further raise the amount of revenue realized by members of the farming households from off-farm economic activities in relation to the revenue realized from the farm. Hence the reduction in the request for labour inputs on the farm (Su et al., 2016).

There is an increase in the campaign in favour of off-farm participation in developing countries such as Nigeria because of the vital role off-farm activities play in the welfare status of farming households. For example, Hoang et al., (2014), Mishra et al., (2015) stated that income from non-farm work boosts food security as farming households take care of food consumption instabilities better than farming households without non-farm employment. Involvement in off-farm economic activities makes farmers to be self-insured (Alasia et al., 2009) and empower them to invest in risky but high-yielding agricultural related businesses. Earnings from off-farm activities can also improve farm production by calming liquidity and credit problems to buy farm technologies that are productivity-enhancing (for example, machinery, fertilizer, improved seed and hiring labour (Anríquez and Daidone, 2010).

The importance of livelihood diversification as one of the risk management strategies is shown in the existence of an association between revenue from non-farm activities and the adoption of risk management strategies (Oparinde, 2019). Also, Ullah and Shivakoti (2014) reported that revenue from off-farm activities can support farmers' investment in risk management choices which can lessen other risks on the farm, while Seng (2015) stated that involvement in off-farm activities also empowers farm households to lessen susceptibility. Off-farm activities supply tools for risk management which reduce revenue inconsistency particularly when there is a failure of farm production resulting from climate change or other shocks (El-Osta et al., 2008). Participation in off-farm activities is driven by changes in the encouragement given to producers and engagement openings outside the farm. Households could see off-farm economic activities as more interesting than on-farm economic activities provided the incentives for involving in the off-farm sector surpass the gains from the on-farm sector (Anang, 2019).

It has been established in the literature that there are two major possible direct income effects from off-farm activities (Babatunde, 2015) and they are liquidity-relaxing effect and lost-labour effect. Liquidity-relaxing is about possible rise in farm investment, while lost-labour effect is about possible labour distribution outside the farm. The direct influence of revenue from off-farm economic activities on hired labour, inputs and productivity were pointed out by Ellis and Freeman (2004); Mitiku et al., (2012). Also, more hired labour and mineral fertilizers were used by farmers who were involved in off-farm economic activities in Nigeria (Oseni and Winters, 2009). According to Pfeiffer et al., (2009), off-farm activities had a direct effect on request for farm inputs, while a negative effect on production and use of family labour was reported. In the case of farm investment, household revenue from off-farm economic activities had a negative association with farm investment (Davis et al., 2009).

There are significant number of studies on the impact of off-farm employment on efficiency and productivity, food security, poverty status and food expenditure (for example, Babatunde and Qaim, 2010; Zhu and Luo, 2010; Shittu, 2014; Mishra, et al., 2015) where majority of the findings revealed that off-farm activities had direct impact on the listed outcomes. Also, there are studies that examined the impact of off-farm work on inputs (for example, Phimister and Roberts, 2006; Pfeiffer et al., 2009; Feng et al., 2010; Shi et al., 2011; Chang and Mishra, 2012; Babatunde, 2015; Mathenge, et al., 2015; Kousar and Abdulai, 2015; Ma et al., 2017) but there have been elements of inconclusiveness in their findings.

Findings from Ma et al., (2017) revealed that the revenue from off-farm activities encourages farm production by growing productivity-enhancing inputs' investment. Pfeiffer et al., (2009) reported that revenue from off-farm activities inversely affected household labour in production of crops, but it had a direct influence on the usage of bought inputs (such as fertilizer and pesticides). Babatunde (2015) reported that income from off off-farm activities leads to increased farm output and more investment on inputs. Mathenge et al., (2015) stated that income from off-farm economic activities meaningfully lessens the fertilizer quantity applied in high farming areas of Kenya. According to the investigation by Feng et al., (2010), involvement in indigenous off-farm activities wields an inverse and weighty impact on the likelihoods of financing soil-improving inputs like organic manure.

Shi et al., (2011) reported that off-farm economic activities reduced the use of chemical fertilizer. Phimister and Roberts (2006) reported that level of fertilizer use may reduce as labour in off-farm sector rises, while the usage of ecologically damaging crop protection rises as off-farm economic activities increase. Kousar and Abdulai (2015) showed that partaking in off-farm activities have a tendency to increase the level of investment in long-term land-improving measures like organic and green manure, but reduced the spending on synthetic fertilizer in Pakistan. Chang and Mishra (2012) concluded that off-farm activities of farm operatives decrease the level of fertilizer/chemical use, which is capable of contributing to the improvement in the quality of the environment.

It is sufficed to state that studies on impact of off-farm work on productivity-enhancing inputs have provided mixed evidence. Also, there is scarceness of empirical evidence with respect to the degree of farmers' adjustment to the use of productivity-enhancing inputs in reaction to labour loss to off-farm activities in Nigeria. This, therefore, calls for further research work that will assist in giving better understanding of how off-farm work adoption impacts productivity-enhancing inputs among arable crop farmers in Nigeria. The findings that emanate from this research exercise will give valuable supports to the policy architects in coming up with social and agri-environmental policies.

There are two areas in which this study adds to the literature. To start with, the impact of off-farm work adoption on productivity-enhancing inputs expenditures, with interest on fertilizer and herbicide, was analyzed in Nigeria. Having known that different types of fertilizer and herbicides are applied concurrently or as alternatives by farmers, fertilizer and herbicide expenditures were used as proxies for the use of the two inputs following Jaraite and Kazukauskas (2012) and Ma et al., (2017). It is assumed that income from off-farm activities can be used to invest in farming activities in the area of purchase of inputs such as fertilizer and herbicide.

More so, the problem of sample selection was taken care of by employing a treatment effects model. Having known that it is the decision of the farmers to adopt off-farm work, unobserved (for instance, innate capabilities of the farmers) and observed factors may affect farmers' decision to be involved in off-farm activities and to finance productivity-enhancing inputs (that is, fertilizer and herbicide). It is possible to use ordinary least squares (OLS) method in the analysis of off-farm work adoption effect on fertilizer and herbicide expenditures, but it will lead to sample selection bias. Despite the fact that endogenous switching regression model also handles selection bias, it fails to estimate the marginal effect of the dependent variable in the selection equation on the outcome variables, which is done using treatment effects model (Ma et al., 2017).

2. Materials and Methods

2.1 Data and sampling

Well-structured questionnaire and pre-tested interview schedule were used to collect data from 240 sampled arable crop farmers in Southwest, Nigeria. The instrument for data collection was subjected to content validity by giving it to experts in the field of Agricultural Economics for critical review. The respondents understood and consented to the contents of the questionnaire as it was clearly stated that the exercise was for research purpose. The selection of the respondents was done using multistage sampling procedure. Two States (Ondo and Oyo) were chosen through random sampling technique in the first stage. Purposive selection of five Local Government Areas (LGAs) from each of the chosen States was carried out in the second stage. The selection was done based on the LGAs where cultivation of maize and cassava was prevalent. Random sampling technique was used to choose four communities from each of the selected LGAs in stage three. In stage four, six farmers were randomly picked from each of the selected communities using the list of maize and cassava farmers gotten from the State Agricultural Development Project Offices (SADPOs) in the chosen States. Hence, a total number of 240 respondents were chosen for the study. Well trained enumerators were deployed for the data collection on household characteristics, off-farm work adoption, production inputs expenditure and other farm related variables. It is worthy of note that only 226 copies of questionnaire were used for the analysis because of inadequate data supplied in the remaining 14 copies of questionnaire.

2.2 Theoretical framework

In this study, a time allocation model by Huffman (1991) is employed in the design of the link between adoption of off-farm work and expenditure on productivity-enhancing inputs like fertilizers and herbicides. It is assumed that the farm decision making unit is the household head and the production decision is seriously impacted on by the household heads' adoption of off-farm work. Also, it is assumed that utility U is maximized over consumption of commodities F and leisure time L_l by the household. The function for utility is therefore, specified as follows:

$$U_{max} = U(F. L_l. K) \quad (1)$$

Where U represents the utility function of the household, L_l stands for the allocated time to leisure by the farmer, F stands for the set of commodities consumed and K represents the characteristics of the household (for example, age and education). Farmers may decide to use his time L for farm work L_f and off-farm work L_{of} in addition to the time allocated to leisure by the farmers. Therefore, the time constraint is given as:

$$L = L_f + L_{of} + L_l \quad (2)$$

There is imposition of non-negativity constraints on farm work and off-farm work of the individual farmer which implies that $L_f \geq 0$ and $L_{of} \geq 0$. Household income constrains consumption of commodities. Household income may be farm profit, revenue from off-farm activities and other sources such as rents and remittances. Therefore, the income constraint is given as follow:

$$P_c F = P_Q Q - P_E E + W_{of} L_{of} + M \quad (3)$$

where P_c and F represent the prices and quantities of bought commodities for consumption, P_Q and Q stand for price and output quantity, P_E and E denote price and quantity vectors of production factors (for example, fertilizer and herbicide), W_{of} and L_{of} denote wage paid to the farmer for off-farm work and amount of time used for off-farm work, respectively and M represents other income (for example, private pension). Also, production technology constraint is faced by the household and it is presented as follow:

$$Q = Q(E.L_f.D) \quad (4)$$

where Q, E and L_f are already defined, while D stands for a vector of exogenous variables that shift the production function.

The Lagrangian of the utility-maximizing problem of the household, given consideration to the constraints as in equation 2,3 and 4, is expressed as:

$$\emptyset = U(F.L_l.K) + \delta\{P_Q Q(E.L_f.D) - P_E E + W_{of} L_{of} + M - P_c F\} + \mu\{L - L_f - L_{of} - L_l\} \quad 5)$$

where δ and μ represent the multipliers related to the income and time constraints, respectively. The optimization problem of the household is to maximize $U(F.L_l.K)$ subject to the time, budget and technology constraints. These are the first-order conditions for the maximization of the Lagrange function over $\{F.L_f.L_{of}.L_l\}$ and minimization of it over $\{\delta.\mu\}$. The conditions for farmer's farm work and off-farm work adoption are, respectively, a subset of the Kuhn-Tucker conditions:

$$\frac{\partial\emptyset}{\partial L_f} = \frac{\delta P_Q \partial Q}{\partial L_f} - \mu = 0 \quad (6)$$

$$\frac{\partial\emptyset}{\partial L_{of}} = \delta W_{of} - \mu \leq 0 \quad (7)$$

Return to labour from farm and off-farm work can be gotten from the rearrangement of equations 6 and 7 as follows:

$$W_{of} \leq \frac{\mu}{\delta} = \frac{P_Q \partial Q}{\partial L_f} \quad (8)$$

where $\mu = \frac{\partial U}{\partial L_l}$ and $\delta = \frac{\partial U}{\partial F}$, $\frac{\mu}{\delta}$ denotes the marginal rate of substitution between leisure and consumption of commodities, $\frac{P_Q \partial Q}{\partial L_f}$ stands for the value of the marginal product of farm labour for the farmer. Looking at equation 7, $W_{of} < \frac{\mu}{\delta} = \frac{P_Q \partial Q}{\partial L_f}$ (strict inequality) indicates that the marginal value of an individual farmer's farm work or leisure is more than the possible wage rate from off-farm work. This is a case of having farmers' total time endowment allocated between work and leisure when there is no optimal time being given to off-farm activities (Huffman, 1991). On the other hand, the marginal product value of farm labour is equal to the wage rate of off-farm when $W_{of} = \frac{\mu}{\delta} = \frac{P_Q \partial Q}{\partial L_f}$ (interior solution) and there may be positive optimal time for off-farm work.

The return to labour from farm and off-farm work can be attained by rearranging the first-order condition for the farm-work and off-farm work adoption.

$$W_{of} = \frac{P_Q \partial Q}{\partial L_f} \quad (9)$$

where $\frac{P_Q \partial Q}{\partial L_f}$ stands for the marginal product value of farm labour for the farmer.

Going by duality theory, the potential effects of off-farm work adoption decision on the intensity of agricultural inputs can be explored. According to Kousar and Abdulai (2015), the production problem of the farming household is expressed as the outcome of a profit-maximizing problem at the optimal solution by Lagrangian duality and it is given as:

$$\pi = Max\left(P_Q Q - P_E E + W_{of} L_{of} + M\right). \text{ subject to } Q = Q\left(E.L_f.D\right). \quad (10)$$

The maximized profit can be expressed as a function of input and output prices, off-farm work wages, farm and household level characteristics as follow:

$$\pi = \pi(P_Q.P_E.W_{of};K) \quad (11)$$

Applying Hotelling's lemma to Equation 10 gives the reduced-form expression for input demand and output supply functions:

$$\frac{d\pi}{dP_E} = -E = E(P_Q . P_E . W_{of} ; K) \quad (12a)$$

$$\frac{d\pi}{dP_Q} = Q = Q(P_Q . P_E . W_{of} ; K). \quad (12b)$$

The expressions as shown in Equation 12a and 12b indicate that the demand for inputs (fertilizer and herbicide for instance) and the supply of output from farm are affected by input and output prices, off-farm work wage together with farm and household level characteristics. Just like it was stated earlier in line with the income effect, farmers can take care of the credit and market constraints and buy productivity-enhancing inputs such as fertilizer and herbicide through revenue from off-farm work. Conversely, there will be lost-labour effect as a result of competition for available labour and capital meant for production between off-farm work and farm work.

2.3 Empirical specification

Following Ma et al., (2017), a reduced-form expression derived from the input demand function in equation 12a was used in determining the impact of off-farm work adoption on the application of fertilizer and herbicide. Due to non-availability of information on wages from off-farm, off-farm labour supply was used in this study. Considering the input demand function in Equation 12a, the regression for productivity-enhancing inputs' (fertilizer and herbicide) expenditures was specified as a function of off-farm work adoption as well as a vector of household and farm level characteristics. The expression is given as follows:

$$D_i = \tau A_i + \omega Y_i + \gamma F_i + \aleph R_i + \varepsilon_i \quad (13)$$

where D represents fertilizer expenditure or herbicide expenditure for farm household i, A stands for a dichotomous variable off-farm adoption status, Y represents a vector of exogenous variables (such as age, education and years of experience), F represents a dichotomous variable credit constraint status, R is the credit constraint residual, τ , ω , γ and $\aleph$ are parameters to be estimated, and ε_i is a random error term. It is worthy of note that credit access helps farmers to invest in productivity-enhancing inputs such as fertilizer and herbicide. On the other hand, increase in investment in the productivity-enhancing inputs may lead to credit constraints. Therefore, this may force farmers to look for additional credit from any available source(s). Credit constraint becomes a potential endogenous variable in Equation 13 as a result of interdependence between investment in productivity-enhancing inputs and credit access. In order to address the potential endogeneity issue, a two-stage control function approach as proposed by Wooldridge (2015) was used since credit constraint variable is dichotomous in nature. The first stage involved the specification of credit constraint variable that is endogenous as a function of exogenous variables together with one instrumental variable. The instrumental variable used is credit source distance which affects credit constraint but does not directly affect the outcome variable fertilizer expenditure and herbicide expenditure. The second stage involved incorporation of observed credit constraint Fi and the corresponding credit constraint residual Ri gotten in the first stage in productivity-enhancing inputs models (that is fertilizer expenditure and herbicide expenditure models).

The assumption is that off-farm work variable is exogenous as specified in Equation 13. It is worthy of note that there may be a problem of self-selection since it is the decision of households to either adopt off-farm work or not on the basis of both observed and unobserved characteristics of the households. Also, the possible endogeneity issue of the off-farm work variable in Equation 13 may cause sample selection problem. According to Gedikoglu et al. (2011), revenue from off-farm work can be used to address the issue of insufficient cash by making cash available for the purchase of productivity-enhancing inputs (for instance, fertilizer and pesticide). On the other hand, there may be a lost-labor effect as a result of labor movement from agricultural production because of off-farm work adoption (Shi et al., 2011). The off-farm work variable in Equation13 is potentially endogenous as suggested by the lost-labour and income effects of off-farm work on production input. Therefore, endogeneity issue of the off-farm work variable should be taken into consideration while estimating the off-farm work impact on fertilizer and herbicide expenditures.

According to Owusu et al. (2011), it is assumed that the reservation wage (W_i^{res}) and the possible market wage (W_i^{pm}) from off-farm work adoption are compared with each other by the farmer. The marginal value of the farmer's time as all the time is allotted to farm and leisure is referred to as reservation wage for off-farm work. Therefore, a farmer decides to adopt off-farm work if W_i^{pm} is higher than the W_i^{res}, that is, $A_i^* = W_i^{pm} - W_i^{res} > 0$. However, it has to be known that wage difference A_i^* is not directly observed, while the only thing that is observed is the decision to adopt or not to adopt off-farm work. The latent variable function can be stated as:

$$A_i^* = \beta T_i + \varphi F_i + \pi R_i + \epsilon_i, with\ A_i = 1\ if\ A_i^* > 0 \quad (14)$$

where A_i is a dichotomous variable that takes the value of 1 for adopters of off-farm work and 0 for non-adopters of off-farm work, T_i represents a vector of farmer and household characteristics that may affect farmers' decision to adopt off-farm work, β. φ and π are parameters to be estimated, and ϵ represents error term, F_i represents a dichotomous variable credit constraint status, which is also possibly endogenous because of its joint determination with the choice of working outside the farm. For instance, off-farm activities are invested in by the farmers because of adequate credit, while revenue from off-farm work assists in solving the problem of credit constraints facing farmers and still provides credit for investment in off-farm work. Based on the two-stage strategy earlier discussed in relation to the credit constraint variable in Equation 13, credit constraint Fi and the corresponding credit constraint residual Ri gotten in the first stage are included in Equation 14 for addressing the endogeneity issue in credit constraint variable.

The treatment effects model is used to determine the impact of off-farm work adoption on the fertilizer and herbicide expenditures with the consideration given to the sample selection bias issue by accounting for observable and unobservable factors. The maximum likelihood approach of the treatment effects model is employed in simultaneously estimating the off-farm work Equation 14 and farm productivity-enhancing expenditure in Equation 13. In treatment effects model, it is assumed that the error term ϵ_i in Equation 14 and ε_i in Equation 13 have a bivariate normal distribution with zero mean and covariance matrix:

$$\begin{bmatrix} \sigma_{\epsilon\varepsilon} & \rho_{\epsilon\varepsilon} \\ \rho_{\varepsilon\epsilon} & 1 \end{bmatrix}$$

where $\sigma_{\epsilon\varepsilon}$ stands for the covariance of ϵ_i and ε_i while $\rho_{\varepsilon\epsilon}$ stands for the correlation coefficient between ε_i and ϵ_i. There exists a sample selection problem coming from unobservable factors if $\rho_{\epsilon\varepsilon}$ is statistically significant (Cong and Drukker, 2000). Having a positive $\rho_{\epsilon\varepsilon}$ implies the existence of positive bias, which means that farmers who have higher mean farm expenditures have higher likelihood of adopting off-farm work. On the other hand, having a negative $\rho_{\epsilon\varepsilon}$ implies the existence of negative bias. The instrument used in the estimation of off-farm work adoption specification in the treatment effects model is perception of the farmer about getting off farm work (that is, whether it is easy or not easy to get off farm work). This is necessary for identification purpose in the off-farm work adoption specification. Perception variable is used because it is expected to influence farmers' off-farm work adoption decisions and should not directly affect fertilizer and herbicide expenditures. The test of the validity of the instrument revealed that it influenced the adoption of off-farm work but did not directly influence the outcome variables. For brevity, the test result is not presented in this report.

3. Results and Discussion

3.1 Mean differences in socioeconomic characteristics

Variables description and mean differences in variables between off-farm work adopters and non-adopters are presented in Table 1. It is shown that off-farm work adopters tend to have larger farm size and higher number of years spent in school and were more likely to be males. Also, more of off-farm work adopters tend to borrow land from friends or relations for farming activities than their non-adopters' counterparts and off-farm work adopters were more likely to be members of cooperative societies than non-adopters of off-farm work. As shown in Table 1, adopters of off-farm work had higher mean fertilizer and herbicide expenditure than non-adopters of off-farm work in the study area. The difference in mean fertilizer expenditure between non-adopters and adopters of non-farm work was significant while that of herbicide expenditure was not significant. Following the arguments of Owusu et al. (2011); Ma et al. (2017); Oparinde and Olutumise (2022) that comparing the mean value of a variable (for instance, quantity of fertilizer) between two groups to check impact may be incorrect and misleading. This is due to the fact that comparison of mean values does not consider confounding factors (observable and unobservable) that can make the impact to be bias. It is against this background that this study used econometric methods such as the treatment effects model for the purpose of addressing sample selection bias resulting from possible systematic difference between adopters and non-adopters of off-farm work. This is done to in order to have thorough estimates of the impact of off-farm work adoption on fertilizer and herbicide expenditures.

3.2 Determinants of off-farm work adoption and its impact on fertilizer and herbicide expenditures

Maximum likelihood estimates of treatment effects model for off-farm work adoption and its impact on fertilizer expenditure are presented in Table 2, while Maximum likelihood estimates of treatment effects model for off-farm work adoption and its impact on herbicide expenditure are presented in Table 3. The Wald tests for $\rho_{\epsilon\varepsilon}$= 0 in Table 2 and 3 are statistically significant, signifying that the null hypothesis that the off-farm adoption variable is exogenous in equation 13 can be rejected.

Table 1. Variable description and mean differences in variables between off-farm work adopters and non-adopters

Variables	Definition	Adopters (N = 109)	Non-adopters (N = 117)	Difference
Age	Age of farmer in years	43.99	41.50	2.5
Gender	1 if farmer is male, 0 otherwise	0.76	0.62	0.14**
Farm size	Size of the farm in Ha	2.03	1.15	0.87***
Household size	Number of people living in household	5.00	6.00	-1
Years of education	Number of years spent in school	12.60	10.72	1.88***
Farming experience	Years of farm experience	17.61	16.43	1.19
Land ownership				
Personal	1 if personal, 0 otherwise	0.36	0.42	-0.06
Inherited	1 if inherited, 0 otherwise	0.24	0.29	-0.05
Borrowed	1 if borrowed, 0 otherwise	0.25	0.13	0.12**
Rented	1 if rented, 0 otherwise	0.16	0.16	0.00
Cooperative society Membership	1 if farmer is a member, 0 otherwise	0.59	0.37	0.22***
Extension visit	1 if visited, 0 otherwise	0.50	0.42	0.08
Car ownership	1 if farmer owns a car, 0 otherwise	0.22	0.21	0.01
Perception	1 if farmer perceives that off-farm work is easy to get, 0 otherwise	0.83	0.76	0.07
Fertilizer expenditure	Total fertilizer expenditure (Naira/1,000/ hectare)	16.59	7.75	8.84**
Herbicide expenditure	Total herbicide expenditure (Naira/1,000/ hectare)	8.64	6.88	1.76
Credit constraint	1 if credit constrained, 0 otherwise	0.52	0.50	0.02
Ondo State	1 if farmer is located in Ondo state, 0 otherwise (Oyo state)	0.65	0.48	0.17**

Note: **5% and ***1% significance levels.

This shows that arable crop farmers are cooperatively making decisions to adopt off-farm activities and finance productivity-enhancing inputs (fertilizer and herbicide) in agricultural production process. According to Cong and Drukker (2000), there exists a selection bias emanating from unobservable factors when the correlation coefficient between error term in the selection equation and the error term in the outcome equation is statistically significant. Therefore, since the correlation coefficients ($\rho_{\epsilon\varepsilon}$) between off-farm work adoption equation and productivity-enhancing inputs (fertilizer and herbicide) equations are significantly different from zero, there is an occurrence of selection bias emanating from unobservable variables. Biased results are inevitable if endogeneity of the off-farm work adoption variable is not addressed. As shown in Table 2 and 3, the negative signs associated with $\rho_{\epsilon\varepsilon}$ indicate negative selection bias, signifying that arable crop farmers who have fertilizer and herbicide expenditure below average have higher likelihood of adopting off-farm work. This corroborates Ma et al., (2017) where it was reported that off-farm work adoption is expected to lessen farmers' capital constraints and improve investment in productivity-enhancing inputs. It has, therefore, been established from the findings above that the use of treatment effects model is suitable in addressing the problem of selection bias and obtaining unbiased estimates of the impact of off-farm work adoption on fertilizer and herbicide expenditures. The fact that the credit constraint residual estimates in all specifications in Table 2 and 3 are not statistically significant shows that the coefficients of credit constraint variable have been estimated consistently (Wooldridge, 2015).

It should be noted that the estimates in the selection equations in Table 2 and 3 are similar in signs and significance. The sample selection issue that is capable of making the impact of off-farm work adoption on fertilizer and herbicide expenditures to be biased is primarily addressed in the estimation of the selection equation with a probit model. Thus, the determinants of off-farm work adoption are discussed as shown in column 2 of Tables 2 and 3 before discussing the estimates from fertilizer and herbicide expenditures specifications.

Table 2. Maximum likelihood estimates of treatment effects model for off-farm work adoption and its impact on fertilizer expenditure

	Off-farm work adoption	Fertilizer expenditure
Off-farm work adoption		6.1300*** (8.96)
Age	-0.0085 (0.92)	0.0842 (0.32)
Gender	0.3857** (1.93)	4.2085 (0.73)
Household size	0.0379 (1.46)	-0.5841 (1.06)
Years of formal education	0.0399** (2.13)	1.4732*** (2.76)
Farming experience	0.0149 (1.46)	0.0966 (0.34)
Farm size	-0.1709*** (2.46)	0.1800*** (3.49)
Inherited land	0.2915 (1.26)	6.5042 (1.00)
Borrowed land	-0.0477 (0.19)	3.627* (1.87)
Rented land	-0.0254 (0.10	-0.5178 (0.07)
Cooperative membership	0.3711** (2.06)	2.7043 (0.52)
Extension visits	-0.1360 (0.72)	0.2418*** (3.05)
Car ownership	-0.0567 (0.26)	-5.9823 (0.96)
Ondo State	0.3144 (1.71)	3.3425*** (2.56)
Credit constraint	-0.0178 (1.03)	3.6932 (0.22)
Credit residual	0.1076 (0.39)	2.1502 (0.31)
Perception	-0.5429*** (3.50)	
Constant	-0.6059 (1.42)	-0.6682 (0.05)
$\rho_{\epsilon\varepsilon}$	-0.9495*** (51.35)	
ath ($\rho_{\epsilon\varepsilon}$)	-1.8270*** (9.72)	
Ln($\sigma_{\epsilon\varepsilon}$)	3.565*** (60.56)	
Wald test ($\rho_{\epsilon\varepsilon} = 0$)	χ^2 (1) =94.50 Prob > χ^2 =0.000	
Observations	226	

Note: *10%, **5%, and ***1% significance levels.

In the column 2 of Table 2 and 3, the coefficient of gender is positive and statistically significant, indicating that male arable crop farmers were more likely to adopt off-farm work. This could be attributed to the availability of resources to men than women. According to Beyene (2008), the probability of male-headed households participating in off-farm activities is expected to be positive since the female-headed households have lesser access to prospects than female-headed households. The coefficient of household size is positive and significant, indicating that farmers with larger household size had higher likelihood of adopting off-farm work. Samuel et al., (2020); Ogah et al., (2020) reported that farmers with larger family size had more needs to engage in off-farm work so as to take care of the family welfare. Years of formal education increases the likelihood of adopting off-farm work, indicating that more years of formal education would bring about higher probability of adopting off-farm work. This result affirms the findings of Anang (2019), where it was reported that farmers with more number of years spent in school had higher probability of off-farm employment participation relative to farmers with reduced number of years spent in school. A negative relationship exists between farm size and adoption of off-farm work indicating that having larger farm size decreases the chance of adopting off-farm work. This supports Benjamin and Kimhi (2006) who reported an inverse association between farm size and off-farm activities. This can be attributed to the fact that more labour supply will be required as farm size increases, which may not allow the farmers to adopt off farm income (Willmore et al., 2012; Atamanov and Van den Berg, 2012).

Membership of cooperative society brings about increase in the likelihood of adopting off-farm work. According to Yue and Sonoda (2012), being a member of cooperative society helps in having access to opportunities and ideas that can aid diversification of means of livelihood into off-farm activities through exchange of information. Anang and Apedo (2023) also reported that membership of farmers' group enhances farmers' participation in off-farm activities. Ondo State dummy variable is positive and significant, indicating that farmers who are located in Ondo State were more likely to adopt off-farm work. The instrument used in the model is farmers' perception about how easy off-farm work is easy to get and its coefficient is positive and significant. This indicates that farmers who perceived getting off-farm work to be easy are more likely to adopt off-farm work. This result confirms the finding of Ma et al., (2017) where it was reported that farmers who perceived the easy access to local off-farm activities had higher likelihood of partaking in off-farm activities.

The estimates from fertilizer expenditure specification and herbicide expenditure specification are presented in column 3 of Table 2 and 3, respectively. It is worthy of note that the sample mean values for fertilizer and herbicide expenditures in Naira per 1,000 per hectare are 12.0128 and 7.7292, respectively. It is shown that off-farm work adoption directly and significantly influenced both fertilizer and herbicide expenditures with the marginal effects of 6.1300 and 3.1023, respectively. This implies that there were increase in fertilizer and herbicide expenditures by 51.03% and 40.14%, respectively, using the sample mean values for fertilizer and herbicide expenditures. The conspicuous difference couldn't have been observed in the descriptive statistics as it does not consider endogenous selection bias as well as the observable and unobservable factors between the adopters and non-adopters of non-farm work. The marginal effect of off -farm work adoption in the two specifications is in line with Pfeiffer et al., (2009); Babatunde (2015); Ma et al., (2017) where it was reported that off-farm employment had direct impact on investment on inputs.

Table 3. Maximum likelihood estimates of treatment effects model for off-farm work adoption and its impact on herbicide expenditure

Variables	Off-farm work adoption	Herbicide expenditure
Off-farm work adoption		3.1023*** (3.33)
Age	-0.0167 (1.68)	0.0321 (0.47)
Gender	0.3956* (1.79)	-0.4561 (0.30)
Household size	0.1025*** (3.82)	-0.0453** (1.89)
Years of formal education	0.0417** (2.09)	-0.0223 (0.16)
Farming experience	0.0098 (0.88)	0.0122 (0.16)
Farm size	-0.2629*** (3.45)	1.2824*** (2.30)
Inherited land	0.2067 (0.87)	-0.1245 (0.08)
Borrowed land	-0.3129 (1.12)	3.5708* (1.85)
Rented land	-0.0727 (0.27)	-0.5590 (0.29)
Cooperative membership	0.4091*** (2.18)	2.0992 (1.51)
Extension visits	-0.0163 (0.08)	1.2469 (0.90)
Car ownership	-0.3082 (1.31)	-3.5725 (0.16)
Ondo State	0.3911** (2.01)	3.1435*** (2.27)
Credit constraint	-0.4535 (1.50)	1.0013 (0.23)
Credit residual	0.2247 (0.60)	0.5668 (0.31)
Perception	-0.5974*** (3.07)	
Constant	-1.3976 (2.88)	10.6749 (3.33)
$\rho_{\epsilon\varepsilon}$	-0.8413*** (11.32)	
ath ($\rho_{\epsilon\varepsilon}$)	-1.2258*** (4.82)	
Ln($\sigma_{\epsilon\varepsilon}$)	2.2267*** (26.74)	
Wald test ($\rho_{\epsilon\varepsilon} = 0$)	χ^2 (1) =23.22 Prob > χ^2 =0.000	
Observations	226	

Note: *10%, **5%, and ***1% significance levels.

Other variables that had significant influence on fertilizer and herbicide expenditures are household size, years of formal education, farm size, borrowed land, extension visits and location base variable Ondo State. Household size had inverse and significant impact on herbicide expenditure, but it did not have significant impact on fertilizer expenditure, indicating that increase in household size decreased expenditure on herbicide. This could be credited to the fact that farmers with large household size may have access to family labour that can carry out weeding on the farm, which would bring about fall in the herbicide expenditure. This confirms the findings of Ma et al. (2017) where household size was reported to have a reducing impact on productivity-enhancing input such as pesticide. Years of formal education positively influenced fertilizer expenditure, indicating that number of years spent in school increases the expenditure on fertilizer. Also, farm size increased fertilizer and herbicide expenditures, which implies that increase in farm size increases investment in productivity-enhancing inputs (that is, fertilizer and herbicide). These results are consistent with Babatunde (2015) where it was reported that farm size and years of schooling increased inputs expenditure. In the case of borrowed land as a means of land acquisition, farmers with borrowed land tend to invest more in productivity-enhancing inputs such as fertilizer and herbicide in order to maximum output.

The positive and significant coefficient of number of extension visits in the fertilizer expenditure specification indicates that the level of fertilizer expenditure is increased as the number of extension visits increased. Emmanuel et al. (2016) noted that farmers with extension services access tend to have higher likelihood of using chemical fertilizer.

This is reaffirming the importance of extension services in promoting the use of productivity-enhancing inputs as noted by Abdulai and Huffman (2014). The Ondo State dummy variable was positive and significant in both fertilizer expenditure and herbicide expenditure specifications, showing that farmers who are located in Ondo State were investing more in productivity-enhancing inputs (fertilizer and herbicide) than their counterparts in Oyo State. This confirms the differences in type of forest, rainfall pattern and soil quality between the two States.

The impact of off-farm work adoption on productivity-enhancing inputs (fertilizer and herbicide) expenditures was estimated using Endogenous Switching Regression (ESR) Model for the purpose of carrying out a robustness check. The ESR model addresses the issue of selection bias considering observed and unobserved factors just like Treatment Effects Model (TEM) does. In order to be brief, only the estimates of Average Treatment effects on the Treated (ATT) is presented in Table 4. The results revealed that impact of off-farm work adoption on fertilizer and herbicide expenditures is positive and significant. The causal effect of off-farm work adoption increased fertilizer and pesticide expenditure by 22.2% and 20.0%, respectively. This results further confirmed the increasing impact of off-farm work adoption on productivity-enhancing inputs investment as noted by Pfeiffer et al. (2009); Babatunde (2015) and Ma et al. (2017).

Table 4. Endogenous Switching Regression model estimation of Impact of off-farm work adoption on fertilizer and herbicide expenditure

Productivity-enhancing inputs expenditure	Mean outcome				
	Adopters	Non-adopters	ATT	t-value	Change (%)
Fertilizer expenditure	22	18	4***	16.87	22.22
Herbicide expenditure	18	15	3***	12.72	20.00

Note: ATT is average treatment effects on the treated. ***1% significance levels.

4. Conclusion and Recommendation

In this paper, the impact of off-farm work adoption on productivity-enhancing inputs was examined. Treatment effects model which addresses issue of selection bias accounting for observed and unobserved factors and estimates the marginal effect of the dependent variable in the selection equation on the outcome variables was used in the analysis of the data. The empirical findings from the study showed that off-farm work adopters tend to have larger farm size and higher number of years spent in school and were more likely to be males than nonadopters. Occurrence of negative selection bias in the study indicates that arable crop farmers who have fertilizer and herbicide expenditure below average have higher likelihood of adopting off-farm work. Also, the study revealed that years of formal education and membership of cooperative society increase the likelihood of adopting off-farm work. The study confirmed the positive role of extension services in investing in productivity-enhancing inputs as number of extension visits increased level of fertilizer expenditure in the study area. Finally, the study clearly showed that off-farm work adoption had direct and significant impact on both fertilizer and herbicide expenditures with the marginal effects of 6.1300 and 3.1023, respectively, which answers the question - Is off-farm work impacting productivity-enhancing inputs?

Having empirically demonstrated that off-farm work adoption plays vital role in increasing investments in productivity-enhancing inputs – fertilizer and herbicide, policies that promote off-farm work adoption should be put in place by all the concerned authorities. The study demonstrated that education plays a vital role in the adoption of off-farm work. Therefore, each farming household should make it a policy to increase investment in education. Giving opportunities to female farmers to have access to productive resources is one of the policy options that can be adopted towards enhancing off-farm work adoption since male farmers tend to have higher probability of adopting off-farm work in the study area. Since membership of cooperative society increased the likelihood of adopting off-farm work, arable crop farmers should be encouraged to be members of cooperative societies where they can access opportunities and ideas that can aid diversification of means of livelihood into off-farm activities through exchange of information.

The number of extension visits was seen to have positive and significant effect on fertilizer expenditure. In view of this, policy makers should give all the necessary attentions to agricultural extension delivery system in the study area in order to have enhanced investments in soil improving measures such as fertilizer. However, there should be more campaign in favour of organic fertilizer than synthetic fertilizer because of its possible negative impact on the environment. One major limitation of this study is in the area of covering only one region of the country without considering the remaining regions. Going by the fascinating results coming from this study, further studies that cover more regions of the country will provide better understanding of impact of off-farm work adoption on productivity-enhancing inputs in Nigeria.

References:

1. Abdulai, A. and Huffman, W. (2014). The adoption and impact of soil and water conservation technology: an endogenous switching regression application. Land Econ., 90(1), 26–43. DOI: 10.3368/le.90.1.26.

2. Atamanov, A. and Van den Berg, M. (2012). Participation and returns in rural nonfarm activities: Evidence from the Kyrgyz Republic. Agricultural Economics, 43(4), 459–471. DOI: 10.1111/j.1574-0862.2012.00596.x.

3. Alasia, A., Weersink, A., Bollman, R.D. and Cranfield, J. (2009). Off-farm labour decision of Canadian farm operators: urbanization effects and rural labour market linkages. J Rural Stud, 25(1),12–24.

4. Anang, B.T. (2019). Effect of off-farm work on agricultural productivity: empirical evidence from northern Ghana. Agricultural Science and Technology, 11(1), 49–58. DOI: 10.15547/ast.2019.01.008.

5. Anang, B.T. and Apedo, C.K. (2023). The influence of off- farm work on farm income among smallholder farm households in northern Ghana, Cogent Economics & Finance, 11:1, 2196861, DOI: 10.1080/23322039.2023.2196861.

6. Anríquez, G. and Daidone, S. (2010). Linkages between the farm and nonfarm sectors at the household level in rural Ghana: A consistent stochastic distance function approach. Agric Econ., 41(1), 51–66. https://doi.org/10.1111/j.1574-0862.2009.00425.x.

7. Babatunde, R.O. and Qaim, M. (2010). Impact of off-farm income on food security and nutrition in Nigeria. Food Policy, 35(4), 303–311. doi:10.1016/j.foodpol.2010.01.006.

8. Babatunde, R.O. (2015). On-Farm and Off-Farm Works: Complement or Substitute? Evidence from Nigeria. Maastricht School of Management Working Paper No. 2015/02.

9. Benjamin, C. and Kimhi, A. (2006). Farm work, off-farm work, and the hired labour: estimating a discrete choice model of French farm couples' labour decisions. European Review of Agricultural Economics, 33, 149-171. https://doi.org/10.1093/erae/jbl002.

10. Beyene, D. (2008). Determinants of off-farm participation decision of farm households in Ethiopia. Agrekon: Agricultural Economics Research, Policy and Practice in Southern Africa, 47(1):140-161. DOI:10.1080/03031853.2008.9523794.

11. Chang, H. H. and Mishra, A. K. (2012). Chemical usage in production agriculture: Do crop insurance and off-farm work play a part? Journal of Environmental Management, 105, 76–82. DOI: 10.1016/j.jenvman.2012.03.038.

12. Cong, R. and Drukker, D. M. (2000). sg141-Treatment effects model. Stata Technical Bulletin, 55(1), 25–33.

13. Davis, B., Winters, P., Reardon, T. and Stamoulis, K. (2009). Rural nonfarm employment and farming: Household-level linkages. Agricultural Economics, 40, 119-23. https://doi.org/10.1111/j.1574-0862.2009.00374.x.

14. de Brauw, A. (2010). Seasonal migration and agricultural production in Vietnam. Journal of Development Studies, 46(1), 114–139. https://doi.org/10.1080/00220380903197986.

15. Ellis, F. and Freeman, H.A. (2004). Rural livelihoods and poverty reduction strategies in four African countries. Journal of Development Studies, 40, 1-30. https://doi.org/10.1080/00220380410001673175.

16. El-Osta, H. S., Mishra, A. K. and Morehart, M. J. (2008). Off-farm labor participation decisions of married farm couples and the role of government payments. Review of Agricultural Economics, 30(2), 311–332. https://www.jstor.org/stable/30225872.

17. Emmanuel, D., Owusu-Sekyere, E., Owusu, V. and Jordaan, H. (2016). Impact of agricultural extension service on adoption of chemical fertilizer: Implications for rice productivity and development in Ghana. NJAS - Wageningen Journal of Life Sciences, 79, 41–49. https://doi.org/10.1016/j.njas.2016.10.002.

18. Feng, S.N., Heerink, N., Ruben, R. and Qu, F. (2010). Land rental market, off-farm employment and agricultural production in Southeast China: A plot-level case study. China Economic Review, 21(4), 598–606. DOI: 10.1016/j.chieco.2010.06.002.

19. Gedikoglu, H., McCann, L. M.J. and Artz, G.M. (2011). Off-farm employment effects on adoption of nutrient management practices. Agricultural and Resource Economics Review, 40(2), 293–306. https://doi.org/10.1017/S1068280500008078.

20. Haggblade, S., Hazell, P. and Reardon, T. (2010). The Rural Non-farm Economy: Prospects for Growth and Poverty Reduction. World Development, 38(10), 1429–1441. https://doi.org/10.1016/j.worlddev.2009.06.008.

21. Hoang, T.X., Pham, C.S. and Ulubaşoğlu, M.A. (2014). Non-farm activity, household expenditure, and poverty reduction in rural Vietnam: 2002–2008. World Development, 64, 554–568. https://doi.org/10.1016/j.worlddev.2014.06.027.

22. Hou, Y., Ji, X., Chen, J. and Zhang, H. (2023). The Impact of Off-Farm Employment on Farmland Production Efficiency: An Empirical Study Based in Jiangsu Province, China. Processes, 11(219),1-14. https://doi.org/10.3390/pr11010219

23. Huffman, W. E. (1991). Agricultural household models: Survey and critique. In M. C. Hallberg, J. L. Findeis, and D. A. Lass (Eds.), Multiple job-holding among farm families, Ames, IA. Iowa State University Press. (pp79–111)

24. Jaraite, J. and Kazukauskas, A. (2012). The effect of mandatory agro-environmental policy on farm fertilizer and pesticide expenditure. Journal of Agricultural Economics, 63(3), 656–676. DOI: 10.1111/j.1477-9552.2012.00346.x.

25. Key, N. (2020). Off-farm Income, Credit Constraints, and Farm Investment. Journal of Agricultural and Applied Economics, 52, 642–663. doi:10.1017/aae.2020.25.

26. Kousar, R. and Abdulai, A. (2015). Off-farm work, land tenancy contracts and investment in soil conservation measures in rural Pakistan. Australian Journal of Agricultural and Resource Economics, 59(1), 1–19. https://doi.org/10.1111/1467-8489.12125.

27. Ma, W., Abdulai, A. and Ma, C. (2017). The effects of off-farm work on fertilizer and pesticide expenditures in China. Review of Development Economics Review, 22(2), 1-19. https://doi.org/10.1111/rode.12354.

28. Mathenge, M.K., Smale, M. and Tschirley, D. (2015). Off-farm employment and input intensification among smallholder maize farmers in Kenya. Journal of Agricultural Economics, 66(2), 519–536. DOI: 10.1111/1477-9552.12093.

29. Mishra, A. K., Mottaleb, K. A. and Mohanty, S. (2015). Impact of off-farm income on food expenditures in rural Bangladesh: An unconditional quantile regression approach. Agricultural Economics, 46(2), 139–148. DOI: 10.1111/agec.12146.

30. Mitiku, A., Fufa, B. and Tadese, B. (2012). Analysis of Factors Determining Households Food Security in Pastoral Area Oromia Region, Moyale District, In Ethiopia. International Journal of Agricultural Science, Research and Technology in Extension and Education Systems (IJASRT in EESs), 2(3),105-110.

31. Ogah, O.M., Ogebe, F.O. and Shehu, M.A. (2020). Analysis of Income Determinants among Farm Households in Kaduna State, Nigeria. International Journal of Agricultural Science, Research and Technology in Extension and Education Systems (IJASRT in EESs), 10(1), 29-34.

32. Ogbanje, E.C., Chidebelu, S.A.N.D. and Nweze, N.J. (2015). An evaluation of off-farm work and household income among small-scale farmers in North Central Nigeria. Journal of Agriculture and Sustainability, 7(2), 227–244.

33. Oparinde, L. O. (2019). Fish Output and Food Security under Risk Management Strategies among Women Aquaculture Farmers in Ondo State, Nigeria. AGRIS on-line Papers in Economics and Informatics, 11(1), 93-105. DOI 10.7160/aol.2019.110110.

34. Oparinde, L. O. and Olutumise, A. I. (2022). Impact of credit constraints on aquaculture production and risk exposure in Ondo State, Nigeria. Journal of Applied Aquaculture, 1-18. DOI: 10.1080/10454438.2020.1815629.

35. Oseni, G. and Winters, P. (2009). Rural nonfarm activities and agricultural crop production in Nigeria", Agricultural Economics, 40, 198-201. https://doi.org/10.1111/j.1574-0862.2009.00369.x.

36. Owusu, V., Abdulai, A. and Abdul-Rahman, S. (2011). Non-farm work and food security among farm households in Northern Ghana. Food Policy, 36(2), 108–118. DOI: 10.1016/j.foodpol.2010.09.002.

37. Pfeiffer, L., López-Feldman, A. and Taylor, J.E. (2009). Is Off-farm Income Reforming the Farm? Evidence from Mexico. Agricultural Economics, 40(2), 125-138. https://doi.org/10.1111/j.1574-0862.2009.00365.x.

38. Phimister, E. and Roberts, D. (2006). The effect of off-farm work on the intensity of agricultural production", Environmental and Resource Economics, 34(4), 493–515. https://doi.org/10.1007/s10640-006-0012-1.

39. Samuel, O.U., Smiles, I.U. and Justin, N. (2020). Socio-economic Determinants of Farmers' Participation in Off-Farm Income Employment in Ezza South Local Government Area of Ebonyi State, Nigeria. Sustainability Agri, Food and Environmental Research, 8(X), 212-228. http://dx.doi.org/10.7770/safer-V0N0-art1957.

40. Seng, K. (2015). The effects of nonfarm activities of farm households' food consumption in rural Cambodia. Development Studies Research 2, 77-89. https://doi.org/10.1080/21665095.2015.1098554.

41. Shi, X., Heerink, N. and Qu, F. (2011). Does off-farm employment contribute to agriculture-based environmental pollution? New insights from a village-level analysis in Jiangxi Province, China. China Economic Review, 22(4), 524–533. DOI: 10.1016/j.chieco.2010.08.003.

42. Shittu, A.M. (2011). Off-farm Labour Drift in the Sub-Saharan Africa: Patterns, Determinants and Production Efficiency Outcomes in Southwest. LAP Lambert Academic Publishing, Germany, Nigeria.

43. Shittu, A.M. (2014). Off-farm labour supply and production efficiency of farm household in rural Southwest Nigeria. Agricultural and Food Economics, 2(8), 1-21. https://doi.org/10.1186/s40100-014-0008-z.

44. Su, W., Eriksson, T., Zhang, L. and Bai, Y. (2016). Off-farm employment and time allocation in on-farm work in rural China from gender perspective. China Economic Review, 41, 34–45. https://doi.org/10.1016/j.chieco.2016.08.006.

45. Ullah, R. and Shivakoti, G.P. (2014). Adoption of on-farm and off-farm diversification to manage agricultural risks: Are these decisions correlated? Outlook on Agriculture, 43(4), 265-271. DOI 10.5367/OA.2014.0188.

46. Wang, X., Han, L., Huang, J., Zhang, L. and Rozelle, S. (2016). Gender and off-farm employment: Evidence from rural China. China and World Economy, 24(3), 18–36. https://doi.org/10.1111/cwe.12156.

47. Willmore, L., Cao, G.Y. and Xin, L. J. (2012). Determinants of off-farm work and temporary migration in China. Population and Environment, 33(2–3), 161–185. DOI: 10.1007/s11111-011-0135-3.

48. Wooldridge, J. M. (2015). Control function methods in applied econometrics. The Journal of Human Resources, 50(2), 420–445. doi: 10.3368/jhr.50.2.420.

49. Yue, B. and Sonoda, D. (2012). The effect of off-farm work on farm technical efficiency in China. Working paper, Nagoya University. Furi-cho, Chikusa-ku, Nagoya, Japan.

50. Zhu, N. and Luo, X. (2010). The impact of migration on rural poverty and inequality: A case study in China. Agricultural Economics, 41(2), 191–204. https://doi.org/10.1111/j.1574-0862.2009.00434.x.