Analysis of Income Diversification among Rural Households depending on Oil Palm-related Enterprises in South-South, Nigeria.

[1]MAFIMISEBI, T.E., [2]ERUMWENBIBI, B.O. and [1]OGUNWANDE, I.O.
[1]Department of Agricultural and Resource Economics, School of Agriculture and Agricultural Technology, Federal University of Technology, Akure, Nigeria
[2]Agricultural Economics Division, Nigerian Institute for Oil Palm Research (NIFOR), Benin City, Edo State, Nigeria
e–mail: brighterumwenbibi@gmail.com

Abstract
The need to mitigate risk and enhance the livelihood of the rural household through income diversification is of paramount importance. Therefore, this study analyzed income diversification among rural households depending on oil palm-related enterprises. This research focuses on the following specific objectives; estimating the income shares from each of the income generating strategies, describing the intensity of income diversification and concentration of income across different income generating strategies, examining the factors influencing income diversification among the rural households in the study area. The study adopted a multi-stage sampling procedure in combination with purposive, proportionate and simple random sampling technique in selecting the 342 respondents. The data for the study were analyzed using the Mean of Income shares technique, descriptive statistics, Herfindahl-Hirschman Index (HHI), and Ordered Probit model. According to the result, the share of total income that came from on-farm operations was 49.99% in Delta State and 59.73% in Edo State. The overall income shares from non-farm and off-farm earning activities were 40.85% and 40.22% for Delta and Edo States respectively. The study also reveals diverse levels of engagement in several livelihood strategies, with the respondents with four different income-generating strategies having the highest intensity of income diversification (0.4). Edo State rural households' income was slightly more concentrated across various income sources with HHI value of 0.68, while Delta State was less concentrated with HHI value of 0.67. Based on ordered probit model result, education, primary occupation, access to electricity affected it at $p < 0.01\%$ probability level, environmental concern affected it at $p < 0.05\%$ probability level significantly affected income diversification index. Therefore, it is recommended that, individuals, government and non-governmental organizations should implement programs and policies that can enhance infrastructure and human capital development in order to raise the productivity and living standards of the rural households in the study area,

Keywords: Herfindahl-Hirschman Index (HHI), Ordered Probit model, income generating strategy, income share.

Introduction

Income diversification is a crucial strategy used by rural households to increase their resilience to shocks and uncertainty in the economy (Ellis, 2000). In order to protect themselves against the dangers of agriculture and seasonal swings in rural areas, households frequently rely on numerous sources of income (Reardon & Barrett, 2000). This concept is beneficial to financial planning for both individual households and organizations because it allows rural households to increase their economic activity by dividing their productive assets among different income-generating firms (Alobo & Bignebat, 2017). In order to reduce their reliance on the ups and downs of any one source of income and to diversify their sources in the face of economic uncertainty, households participate in on-farm, non-farm, and off-farm activities. For rural households, income diversification has many advantages, such as improved access to social services, less susceptibility to shocks, and increased income stability (Ellis, 1998; Dercon & Krishnan, 2000). According to Barrett *et al.* (2001), households can mitigate agricultural risks such as crop failures and price volatility by spreading their risks across several sources through diversified income portfolios. Additionally, it can lessen poverty by fostering chances for asset accumulation and human capital investment (Reardon & Barrett, 2000).

The ever-changing socioeconomic, political, environmental, and climatic conditions have made life worse for the majority of rural households as Nigeria has the most impoverished, hungry and malnourished population in the world. However, the economic instability and vulnerability associated with dependence on a single income source raises concerns about the sustainability and welfare of the rural households and therefore the need for income diversification. In order to develop policies and interventions targeted at improving rural lives, it becomes imperative to understand the elements that influence income diversification. However, in spite of the significance of this research, there are still gaps in knowledge and a need to explore the factors influencing households' decisions to diversify their income streams. This research focuses on the following specific objectives; estimating the income shares from each of the income generating strategies, describing the intensity of income diversification and concentration of income across different income generating strategies, examining the factors influencing income diversification in the study area.

Literature Review

For rural households, diversifying their sources of income is crucial to their livelihood strategy (Ellis, 2000). According to Ellis (1998), diversification is an essential coping mechanism for rural households facing a variety of

socioeconomic difficulties. However, the factors affecting the patterns of income diversification of rural households remain complex and situational (Barrett *et al.*, 2001). Alobo-Loison & Bignebat (2017) looked into the trends and variables affecting the income diversification of households in rural Senegal and Kenya using the Tobit Regression Model and the Hefindahl-Hirshman Index. The findings showed a strong correlation between income diversification and views of food security, migration opportunities, rural town accessibility, household asset endowments, and demographic traits. Tran & Nguyen (2014) looked at the variables that determine income diversification and how rural households' income is impacted by it. The household degree of income diversity was demonstrated using the Herfindahl-Hirschman index (HHI). The results showed that human capital, both in terms of quantity and quality, has a major role in encouraging rural households to diversify their sources of income. Furthermore, rural households with higher educational attainment and greater capacity for diversification tend to have more revenue streams available to them. The results of the study provide more credence to the theory that improvements in rural areas are fueled by economic diversification. The following studies examined the determinants of income diversification among rural households, providing insights into factors that influence livelihood strategies: Lim *et al*. (2019); Sarker *et al*. (2019); Birhanu & Ambelu (2018); Zakaria & Aziz (2018); Asumadu-Sarkodie *et al*. (2017); Nwoye & Odoemenam (2016); Ali & Ahmad (2015); Sodjinou & Ayalew (2014); Thongrak *et al*. (2013); Kassie & Teklewold (2012); Damnyag & Hajjar (2011); Tsiboe & Norton (2005). The significance of income diversification was highlighted by Adesina & Djato's (1997) analysis of the proportionate contributions of various income streams to capital accumulation among farming households in Nigeria. To fill the gap in literature, the present study employed the Mean of Income shares approach, Herfindahl-Hirschman Index (HHI) and Ordered Probit model in analyzing the income shares, the concentration of income among different income sources and examining the factors that influences income diversification. This study is hereby meant to contribute to literature by studying income diversification among oil palm-related rural households.

Research Methodology

Study Area

The study was carried out in the South-South region of Nigeria. The region is made up of six out of the 36 States of the Federal Republic of Nigeria. The six states are Akwa Ibom, Bayelsa, Cross River, Edo, Delta and Rivers States. The area has a total population of 21,034,081 people (NPC, 2006). The South-South is the core oil producing area providing the economic mainstay of the country (oil and gas). It has an average annual rainfall of 1,200 to 2,500mm (NiMET, 2013).

Edo State has a land mass of 17,802km^2 (6.873sq miles) and it lies between longitude $06^0\ 04^1$E and latitude $05^0\ 44^1$ and $07^0\ 34^1$E. It lies at elevations between 500feet (150m) in the south and more than 1,800feet (550m) in the north. Edo State has borders with Kogi State to the north, Delta State to the south and Ondo State to the west (Bondarenko and Roese, 1999). The state is inhabited largely by the Edos (Benins), Afemai, Esan, Owans people who are linked to the historic Benin Kingdom. Agriculture is the mainstay of the economy of the state. According to (NPC, 2006), Edo State has a population of 3,497,502 people in the eighteen (18) Local Government Areas (LGA).

Delta State lies between longitudes 5^0 and $6^0\ 45^1$E and latitude 5^0 and $6^0\ 30^1$N. It has a total land area of 16,842sq.km. The state presently covers a land mass of about 18,050km^2 of which more than 60% is land. It has a wide coastal belt inter-lace with rivulets and streams which form part of the Niger-Delta. It is bounded by Edo state to the north, Anambra state to the east, Rivers state to the southeast and Bayelsa state to the south, the Bight of Benin of the Atlantic Ocean to the west, and Ondo state to the northwest. The average rainfall is about 266.5mm in the coastal areas and 190.5mm in the extreme north. The main ethnic groups in the state are Urhobo, Itesekiri, Ijaw (Izon), Isoko and Anioma. Delta State has a population of 4,098,391 people within twenty-five (25) LGAs (NPC, 2006).

Source of Data

Primary data was used for this study. Data was obtained from randomly selected oil palm-related rural households with the aid of a well-structured questionnaire. The questionnaire for the study was designed in line with the specific objectives of the study.

Sampling Procedure and Sample Size

The study adopted a multi-stage sampling procedure in selecting the respondents for the study.

- First stage was a purposive sampling of Edo and Delta States from the six states in South-South region of Nigeria based on the concentration of oil palm-related rural households.
- The second stage involved a proportionate sampling of 25% of the total Local Government Areas (LGA) from each state giving five (5) for Edo and six (6) for Delta states based on the predominance of oil palm-related rural households.
- The third stage was a purposive sampling of five (5) oil palm producing communities from each LGA.
- The final stage involved a random sampling of 50% of oil palm-related rural households from each community from the list of oil palm producers obtained from Oil Palm Growers Association of Nigeria (OPGAN) which served as the sampling frame (1095 and 1255 oil palm farmers for Edo and Delta states respectively). From the sample size of 342 oil palm-related rural households, only 326 was valid for the analysis of the study. The sample size determination formula as stated by Krejcie & Morgan (1970) was used to calculate the sample size since the population size was known. Below is the mathematical illustration for the Krejcie &

Morgan Formula used in calculating the sample size:

$$n = \frac{N}{1 + N(e^2)}$$

Where,
n = sample size
N = population size
e = is the level of precision or margin of error, expressed as a proportion (0.05 for a 5% margin of error).

Analytical Technique

The data collected for the study were analyzed using, Mean of Income Shares Approach, Descriptive Statistics, Herfindahl-Hirschman Index (HHI) and Ordered Probit Model.

Mean of Income Shares Approach

The Mean of Income Shares approach was used for objective one to estimate the income shares obtained by the respondents in the study area. This approach estimates the shares of incomes at the individual household level (Davis *et al*., 2007) by finding the share of each income source in total household income (THI) for each household. The share for each income source for all households was then realized. The share of Income Sources formula was given as

% share of income sources was given as:

$SIs = \frac{\sum_{h=1}^{n} \frac{y_{ih}}{THI}}{n} x \frac{100}{1}$

Adopted by (Davis *et al*., 2007)

Where:
SIs = Share of income sources
y = Income from a particular livelihood strategy
THI = income coming from all sources (total household income)
i = The income source
h = The individual household
n = The number of households

The sum of Total Household Income (THI) was given as:

$$THI = \sum_{j=i}^{n} Y_j$$

Where:
THI = Total Household Income,
Y = income coming from all sources,
j = income sources.

Descriptive Statistics

Descriptive statistics such as frequencies and percentages were used for objective two to describe the intensity of diversification of livelihood strategies of the respondents. The intensity and percentage of intensity among oil palm-related rural households in the study area was calculated using the formula below.

Intensity of livelihood strategies formula was given as:

$$\text{Intensity} = \frac{\text{number of livelihood strategies per household}}{\text{total number of strategies}}$$

$$\% \text{ of Intensity} = \frac{\text{number of livelihood strategies per household}}{\text{total number of strategies}} \text{ x } \frac{100}{1}$$

Measure of Concentration of Income Source

The HHI was used to measure the concentration of income across different income sources or activities. It focuses on the degree of income concentration, indicating whether income is concentrated in a few sources or evenly distributed among various sources (Chamberlin *et al.,* 2014; Rahman *et al*., 2020). The formula for calculating the HHI is as follows:

$$HHI = \sum_{i=1}^{n} P_i^2$$

Where: P_i = the proportion of income source (i) in total income, n = the total number of income sources. Household incomes was from 16 income sources as observed in the study.

The HHI model was expressed in this study as

$HHI = Cfi^2 + Isi^2 + Tdi^2 + Arti^2 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots Dri^2$.

Where;
cfi = crop farming income, lsi = livestock income, tdi = trading income, arti = artisan income, empi = employment income, peni = pension income, remi = remittance income, cmi = commercial milling income, illhi = income from leasing of land/house, dri = driving income.

Ordered Probit Regression Model

The ordered probit model used the dependent variable (Simpson's diversification index) to assume values that were ordinal in nature. Oparinde *et al*., (2016) and Okoye *et al*. (2010), further stated that the ordered probit model is an extensively used approach in estimating models with ordered types that almost engage the probit relationship function. The latent continuous metric is fundamental to the ordinal responses being observed by the expert.

Y*, which is the latent continuous variable, is a linear function of some variables, X, and a normally distributed disturbance term.

$Y_i * = X_i \beta + \varepsilon$

The latent variable Yi* displays itself in ordinal categories, which could be coded as 0, 1, 2, 3., m. The response of category m is thus observed when the underlying continuous response falls in the m-th interval, as follows:

$Y* = 0$ if $Y* \leq \delta_0$ $Y* = 1$ if $\delta_0 < Y* \leq \delta_1$ $Y* = 2$ if $\delta_1 < Y* \leq \delta_2$ $Y* = 3$ if $\delta_2 < Y* \leq \delta 3$

Where δ_1 (i = 0, 1, 2, 3) are the unobservable threshold parameters that will be estimated together with other parameters in the model. δ_0 is normalized to a zero value when an intercept coefficient is included in the model (Greene, 2000), and therefore only m-1 additional parameters are estimated with β_s. Similar to the models for binary data, the probabilities for each of the observed ordinal responses, which in this study had three responses (0, 1, and 2), will be given as follows:

prob (Y = 0) = $P(Y* \leq 0) = P(\beta'X + \varepsilon i \leq 0) = ø(-\beta'X)$

prob (Y = 1) = $ø(\delta 1 - \beta'X) - ø(-\beta'X)$ prob (Y = 2) = $1 - ø(\delta 1 - \beta'X)$

where $0 < \delta 0 < \delta 1 < ... < \delta m-1 \ldots. n$ is the cumulative normal distribution function such that the sum total of the above probabilities is equal to one. The marginal effects of the regressors X on the probabilities are not equal to the coefficients. Therefore, the marginal probabilities could be calculated from the Probit model as follows:

$$\frac{dprob[Y_m]}{dX_m} = \left[\phi(\delta_{m-1} - \beta' X_m) - \phi(\delta_m - \beta' X_m)\right]\beta$$

Where $\phi(.)$ is the normal density function, δ_m is the threshold parameter, and X_m is the k-th explanatory variable.

- The empirical model

The ordered probit model for this study is specified as follows:

$Y\ i = 0,1,2,...j = b_0 + b_1 X_1 + b_2 X_2 + b_3 X_3 + b_4 X_4 + b_5 X_5 + b_6 X_6 + b_7 X_7 + b_8 X_8 + b_9 X_9 + b_{10} X_{10} + b_{11} X_{11}$

Y = Herfindahl-Hirschman Index (HHI) (0 = low HHI, 1 = medium HHI, and 2 = high HHI).

The independent variables are as follows:

X_1: Age in years
X_2: Household size
X_3: Education in years
X_4: Access to Extension (1=Yes, 0=No)
X_5: Market distance in kilometers
X_6: farming experience in years
X_7: Primary occupation (1 = yes, 0 = No)
X_8: Access to electricity (1 = yes, 0 = No)
X_9: Access to school (1 = yes, 0 = No)
X_{10}: Farm size (hectares)
X_{11}: Environmental Concern (1 = Yes, 0 = No)

Results and Discussion

Estimated Income Shares from the Livelihood Strategies of the respondents.

The Table 1 shows the contribution of each income source to the total income in percentage. The income from on-farm activities was ₦1,885,736.14, contributing 49.99% to the total income of rural households in Delta state and ₦2,347,922.53, which accounts for 59.73% of the total income in Edo State. This implies that On-farm activities were a significant source of income for rural households in both states, but it was relatively higher in Edo State, where they contributed more of the total household income. This suggests a higher dependency on agriculture in the two states with Edo State having a higher level compared to Delta State. Rural households earn ₦1,609,532.59 per annum from non-farm activities, which makes up 42.66% of the total income in Delta State, while Edo State was ₦1,134,845.05 per annum, contributing 28.87% to the total income. This indicates that Non-farm activities play a crucial role in Delta State's rural economy, where they accounted for a substantial portion of the total income. In Edo State, although still important, non-farm activities contribute less significantly, indicating a relatively lower diversification of income sources beyond agriculture. Income from off-farm activities is the smallest among the three categories as ₦277,304.33 per annum, contributing 7.35% to the total income in Delta State. Edo State has a higher income (₦447,866.18 per annum) from off-farm activities, which makes up 11.40% of the total income. This also implies that Off-farm activities are less but still notable income source for rural households in both states. Edo State sees a higher contribution from off-farm activities, suggesting some level of engagement in supplementary economic activities outside direct farming and non-farming work. Furthermore, Edo State had a marginally higher total income compared to Delta State. However, the distribution of income sources varies, with Edo State relying more heavily on on-farm activities and Delta State showing a more balanced distribution between on-farm and non-farm activities. This agrees with the findings of Nazir *et al.,* 2018 and Rizwan, *et al.,* 2017b, that farming household's earnings comes from different sources such as on-farm, non-farm and off-farm sources crops.

Intensity of Diversification among Respondents.

The distribution of the respondents according to the intensity of income diversification among rural households in the study area presented on Table 2. This result reveals varying degrees of engagement in multiple livelihood strategies. Majority of the respondents, (60.74%), were engaged in two other different income-generating activities outside their oil palm-related enterprise. Additionally, 22.7% of respondents engaged in one strategy, while 14.11% and 1.84% were into three and four strategies respectively. This finding indicates a substantial level of income diversification outside their oil palm-related enterprise carried out by the respondents. This is in consonant with the findings of Alobo & Bignebat, (2017); Davis *et al.,* (2017) that majority of the households engage in more than one income-generating activities to secure their livelihood.

The highest intensity of income diversification was among the respondents with four different income-generating strategies (0.4), followed by three different income-generating strategies (0.3) and two different income-generating strategies (0.2). This means that a significant portion of their income was derived from each of the strategy they engage in and this could help mitigate risks associated with fluctuations in any particular strategy. On the other hand, the lowest intensity of income diversification was found among those with one income-generating strategy (0.1) and this indicates that their entire income comes from a single strategy. This situation can make the households more vulnerable to adverse events or changes in that specific source of income.

Concentration of income among respondents across different Income Sources.

The distribution of respondents according to the concentration of income across different income sources was presented in Table 3. The index range of the respondents shows that between 0.5 - 0.69, 0.7 – 0.89, 0.9 – 1.09 had percentages of 50.7, 15.5 and 23.9 for Edo state, while Delta state percentages were 50.0, 18.5 and 19.5 respectively.

Majority of the respondents were between 0.5 – 0.69 index range for Edo and Delta States respectively.

The HHI value of 0.68 and 0.67 was computed for Edo and Delta States respectively. The HHI value of 0.68 for Edo State suggests that income among rural households is highly concentrated among a few income sources among respondents. This implies that rural households in Edo State rely heavily on a limited number of income sources, potentially indicating a fewer range of activities. The high income concentration may provide some stability, it also suggests a degree of economic vulnerability, as households may be more susceptible to disruptions or fluctuations in those sources. In contrast, the HHI value of 0.67 indicates that income among rural households in Delta State is slightly concentrated than Edo State, reflecting a heavy dependence on a limited income sources. This suggests that rural households in Delta State have to a certain extent more diversified income distribution. They derive their income from a broader range of sources compared to Edo State. The high level of income concentration suggests greater resilience among rural households in Delta State to economic shocks and fluctuations, as income is spread across multiple sources. However, both States have relatively high HHI values, indicating that income is highly concentrated in a few sources for the majority of respondents. The slightly lower HHI value in Delta compared to Edo States suggests marginally better diversification in Delta State.

Factors Influencing Rural Households' Income Diversification

The ordered probit model was utilized to identify the household characteristics that influence the income diversification index of rural households as shown in Table 4. According to Oparinde, (2016) and Isik (2009), the coefficient estimated in ordered probit model do not have direct interpretation but can be used to calculate probabilities of the dependent variable with different levels of the corresponding marginal probabilities. The result shows that education has a significant and negative association ($p<0.001$) with income diversification index. However, the result of the marginal effect also shows that a unit increment in education of rural households yields a statistically significant 0.1% and 2.1% increase in low and medium income diversification index category respectively. This agrees with the findings of Yishak (2017); Ahmed (2016), that as the level of education of the household increases, the level of income diversification index increases. It contradicts the findings of Oluwatayo (2009); Demissie & Legesse (2013), that educated persons specialized in one activity rather than diversification. It will also reduce the probability of being in the high income diversification index category by 2.2%. Primary occupation with a positive coefficient of 0.073 suggests that that having a primary occupation decreases the likelihood of being in the Low income diversification index category by 0.1% and the Medium category by 2.4% and has a positive effect on the High category by 2.5%. The p-value of 0.000 indicates that this relationship is significant at 1%. This implies that certain primary occupations, particularly with higher wages or stable employment, are associated with higher household income levels. Access to electricity had a negative coefficient of -0.692 with a p-value of 0.000 showing 1% level of significant. This implies that access to electricity significantly increases the likelihood of being in the Low income diversification index category by 1.2% and 22.7% in the medium category. It will decrease the probability of being in the High income diversification category by 23.9%. The implication is that access to electricity is a crucial factor for economic development could enable more efficient household operations and support small businesses. This is in consonant with the findings of Adem & Tesafa, (2020), that the positive influence of electricity implies that electric power supply access has effect on increasing income sources of the households. The positive coefficient of 0.180 with a p-value of 0.027 was significant at 5% level. This indicates that higher environmental concern decreases the probability of being in the Low income diversification index category by 0.3% and 5.9% in the medium category. It has a positive effect on the high category by 6.2%. This implies that households with higher environmental concern might prioritize sustainability as well as economic benefits. Chi-square value of 48.631 with a p-value of 0.000 indicates that the null hypothesis can be rejected, meaning that the model as a whole is statistically significant. This implies that the chi-square statistic confirms that the variables included in the model collectively have a significant effect on the dependent variable. The log-likelihood value of -207.92443 indicates a better model fit as the explanatory variables used in the ordered probit model were appropriate.

Conclusion

The study focused on analysis of income diversification among rural households depending on oil palm-related enterprises in south-south, Nigeria. The result showed that on-farm activities were their major income source as it contributed 49.99% in Delta State, while Edo state contributed 59.73% of the total income. The income shares from non-farm income sources was higher than the off-farm in both States. Agricultural-based (on-farm) activities had a larger share of their income earned from activities in this sector thereby emphasizing the significant economic contribution of the livelihood strategies to rural households in the study area. The study further reveals varying degrees of engagement in multiple livelihood strategies as the highest intensity of income diversification were among the respondent with four different income-generating strategies (0.4), followed by three different income-generating strategies (0.3) and two different income generating strategies (0.2), implying that a significant portion of their income was derived from each of the strategy they engage in and this could help mitigate risks associated with fluctuations in any particular strategy. The income among rural households was slightly more concentrated across different income sources in Edo State while that of Delta State was less concentrated across different income sources, implying that the later derives their income from a broader range of sources and the former a fewer range of activities. The study revealed the education, access to electricity, primary occupation and environmental concerns significantly influenced income diversification index of the respondents. It is recommended that, individuals, government and non-governmental organization should put in place programmes and policies that are capable of improving infrastructure and human capital development in order to improve productivity and standards of living of the rural households in the study area.

Table 1: Income Share Estimates of the Rural Households from different income sources.

S/N	Income sources	Delta State (₦)	Income share to total income in Delta in %	Edo State (₦)	Income share to total income in Edo in %
1	Income from on-farm activities	1,885,736.14	49.99	2,347,922.53	59.73
2	Income from non-farm activities	1,609,532.59	42.66	1,134,845.05	28.87
3	Income from off-farm activities	277,304.33	7.35	447,866.18	11.40
4	Total income from all the activities	3,772,573.06	100	3,930,633.76	100

Source: Computed from Field Survey Data; 2023**.**

Table 2: Distribution of respondents according to intensity of income diversification

Number of strategy	Frequency of the number of strategy	Percentage of the number of strategy	Intensity of income diversification	% Intensity of income diversification
0 (no other n strategy/activities outside oil palm)	2	0.61		
1	74	22.70	0.1	10.0
2	198	60.74	0.2	20.0
3	46	14.11	0.3	30.0
4	6	1.84	0.4	40.0
Total	**326**	**100.0**		

Source: Computed from Field Survey Data, 2023.

Table 3: Distribution of respondents according to Concentration of Income across different Income Sources

	Edo State		Delta State	
Index range	Frequency	%	Frequency	%
0	2	1.4	0	0.0
0.10-0.29	0	0.0	0	0.0
0.30-0.49	12	8.5	22	12.0
0.50-0.69	72	50.7	92	50.0
0.70-0.89	22	15.5	34	18.5
0.90-1.09	34	23.9	36	19.5
HHI mean	0.68		0.67	
N	142		184	
Range	0 – 1.0		0.35 – 1.0	

Source: Computed from Field Survey Data; 2023

Table 4: Results of the Ordered Probit Model

Variable	Coefficient	Standard error	P-value	Marginal effects		
				Low HHI	Medium HHI	High HHI
Age	-0.013	0.009	0.144	0.000	0.004	-0.005
Education	-0.063	0.023	0.006***	0.001	0.021	-0.022
Household size	-0.006	0.029	0.827	0.000	0.002	-0.002
Primary occupation	0.073	0.02	0.000***	-0.001	-0.024	0.025
Access to extension	0.155	0.181	0.394	-0.003	-0.051	0.054
Access to electricity	-0.692	0.181	0.000***	0.012	0.227	-0.239
Farm size	0.05	0.05	0.318	-0.001	-0.016	0.017
Environmental concern	0.180	0.082	0.027**	-0.003	-0.059	0.062
Farming experience	-0.006	0.015	0.675	0.000	0.002	-0.002
Market distance	0.005	0.013	0.689	-0.000	-0.002	0.002
Access to school	0.191	0.883	0.829	-0.003	-0.063	0.066
Pseudo r-squared	0.105					
Chi-square	48.631					
Prob > chi2	0.000					
Log likelihood	-207.92443					
Number of observations	326					

**** p<.01, ** p<.05, * p<.* Source: Computed from Field Survey Data, 2023.

Reference

Adem, M. & Tesafa, F. (2020). Intensity of income diversification among small-holder farmers in Asayita Woreda, Afar Region, Ethiopia, *Cogent Economics & Finance*, **8**(1): 1-15.

Adesina, A. A., & Djato, K. K. (1997). Relative contributions of income sources to farm households' capital accumulation: Evidence from rural Nigeria. *World Development*, **25**(2): 321-331.

Agyeman, B. A. S., Asuming-Brempong, S., & Onumah, E, E (2014). Determinants of income diversification of farm households in the western region of Ghana. *Quarterly Journal of International Agriculture,* **53**(1): 55-72.

Ahmad, A. L., Yasin, N. H. M., & Derek, C. J. C. (2016). Recent advances in new generation biodiesel production: a review. *Journal of Cleaner Production*, **145**, 44-59.

Ali, M., & Ahmad, N. (2015). Factors affecting income diversification among smallholder oil palm farmers in Indonesia. *Journal of International Studies*, **8**(2): 40-54.

Alobo Loison, S. H. & Bignebat, C. (2017). Patterns and determinants of household income diversification in rural Senegal and Kenya. *Journal of Poverty Alleviation and International Development* **8**(1): 93-126.

Barrett, C. B., Reardon, T., & Webb, P. (2001). Nonfarm income diversification and household livelihood strategies in rural Africa: concepts, dynamics, and policy implications. *Food Policy*, **26**(4), 315-331.

Birhanu, M., & Ambelu, W. (2018). Determinants of income diversification among rural farm households in Ethiopia: The case of Fogera District, South Gondar. *Cogent Economics & Finance,* **6**(1), 1449430

Bondarenko, Dmitri M. & Roese, Peter M. (1999). "Benin Prehistory: The Origin and Settling down of the Edo". *Anthropos*. **94** (4/6): 542–552.

Chamberlin, J., Jayne, T. S., & Headey, D. D. (2014). Scarcity amid abundance? Reassessing the potential for cropland expansion in Africa. *Food Policy*, **(48):** 51-65.

Cutler, D. R., et al. (2001). Random forests for classification in ecology. *Ecology*, **88**(11): 2783-2792.

Damnyag, L. & Hajjar, R. (2011). Determinants of income diversification among rural households in Southern Laos. *Canadian Journal of Development Studies*, **32**(1): 89-102.

Davis, B., Di Giuseppe, S. and Zezza, A. (2017). Are African households (not) leaving agriculture? Patterns of households' income sources in rural Sub-Saharan Africa. *Food Policy* **67**: 153-174.

Davis, B., Winters, P., Carletto, G., Covarrubias, K., Quinones, E., Zezza, A., Stamoulis, K., Bonomi, G. and Diguiseppe, S. (2007). Rural Income Generating Activities: A Cross Country Comparison. *World Development* 2010 38 91 (1): 48-63.

Demissie, A., & Legesse, B. (2013). Determinants of income diversification among rural households: The case of smallholder farmers in Fedis district. *Eastern Hararghe Zone, Ethiopia*, **5**(3), 120–128.

Dercon, S., & Krishnan, P. (2000). In sickness and in health: Risk sharing within households in rural Ethiopia. *Journal of Political Economy*, **108**(4), 688-727.

Ellis, F., (1998). Household strategies and rural livelihood diversification. *The Journal of Development Studies*, **35**(1):1-38.

Ellis, F. (2000). Rural Household and Diversify in Developing Countries; Oxford University Press: Oxford, UK, 1–15.

Greene, W.H. (2000). Econometric Analysis. International Edition (4 Ed). New York University. Prentice Hall International, Inc.

Isik, H.B., Aksoy, A. & Yavuz, F. (2009). Factors Affecting Dairy Farmers' Utilization of Agricultural supports in Erzurum, Turkey. *Scientific Research and Easy*. **4**(11):1236-1242.

Kassie, M., & Teklewold, H. (2012). Determinants of income diversification among rural households: Evidence from rural Ethiopia. *Food Policy*, **37**(3), 264-276.

Krejcie, R. V., & Morgan, D. W. (1970). Table for determining sample size from a given population. *Educational and Psychological Measurement*, **30**(3), 607-610.

Lim, Y. C., Lee, H. L. & Saban, G. (2019). Factors influencing income diversification among small-scale oil palm farmers in Sabah, Malaysia. *International Journal of Business and Society*, **20**(S1), 68-86.

Market Development in the Niger Delta (MADE), (2019). Mapping of Oil Palm Clusters in Niger Delta States of Nigeria. Monograph Series, **22**:20

National Population Commission. NPC (2006). National Population Census, Federal Republic of Nigeria official gazette, Lagos, Nigeria. Retrieved from www.population.gov.ng/

Nazir, A., Li1, G., Inayat, S., Iqbal, M. A., Humayoon, A. & Akhtar, S. (2018). Determinants for Income Diversification by Farm Households In Pakistan. *Journal of Animal and Plant* 28(4): 1163 – 1173.

Nigerian Meteorogical Agency (NiMet) (2013). NigeriaClimate Review Bulletin, Abuja, Nigeria. Retrieved from http://www.nimet.gov.ng

Nwoye, U. U., & Odoemenam, V. U. (2016). Determinants of income diversification among oil palm farming households in Southeast Nigeria. *Journal of Agricultural Extension and Rural Development*, **8**(7), 169-179.

Oluwatayo, I.B. (2009). Poverty and Income Diversification among Households in Rural Nigeria: A Gender Analysis of Livelihood Patterns. A paper presented at the 2nd Instituto de Estudos Sociais e Económicos (IESE) *Conference on 'Dynamics of Poverty and Patterns of Economic Accumulation* in Mozambique', 22-23 April, 2009. 1-21.

Okoye,B.C., Onyenweaku, C.E. & Ukoha, O.O. (2010). An Ordered Probit Model Analysis of Transaction costs and Market participation by Smallholders Cassava Farmers in South Eastern Nigeria. MPRA Paper No 26114.

Oparinde, L.O., Fatuase, A.I. & Daramola, A.G. (2016). Risk Attitudes and Poverty Status Nexus: A study of Fish Farmers in Ondo State, Nigeria. *Asian Journal of*

Agricultural Extension, Economics & Sociology. **13***(3):1-12*.

Rahman, S., Mia, M. I., & Bhuiyan, M. S. (2020). Income Diversification and Livelihood Resilience of Smallholders in Developing Countries: Evidence from Bangladesh. *World Development, 131*, 104955.

Rizwan, M., Deyi, Z., Nazir, A., Osti, R., Traore, L. & Sargani, G.R. (2017b). Determinants and Choices of Off-Farm work among Rice Farmers in a Developing Country. *The J. Anim. Plant Sci.*, **27**(6), 1993-2002.

MAFIMISEBI et al.

Reardon, T., & Barrett, C. B. (2000). Agro-industrialization, globalization, and international development: An overview of issues, patterns, and determinants. *Agricultural Economics*, **23**(3); 195-205.

Sarker, A., Rahman, S., & Alam, M. J. (2019). Determinants of income diversification of oil palm farmers in Bangladesh: An empirical analysis. *South Asia Economic Journal*, **20**(2): 231-248

Sodjinou, E. & Ayalew, H. (2014). Determinants of income diversification among rural households in Southern Benin. *African Development Review*, **26**(2), 294-306.

Thongrak, S., Waibel, H., & Buchenrieder, G. (2013). Determinants of income diversification among rural households in Thailand. *Journal of Rural Studies*, **32**: 96-107.

Tran, T. K. & Nguyen, N. D. (2014). Determinants of Income Diversification and its Effect on Household Income in Rural Vietnam. https://www.researchgate.net/publication/319125781

Tsiboe, F., & Norton, G. W. (2005). Determinants of income diversification among rural households: Evidence from Ghana. *Food Policy*, **30**(4): 421-435.

Yishak, G. (2017). Rural farm households' income diversification: the case of wolaita zone, southern ethiopia.social. **2**: 45-56. doi:10.11648/j. ss.20170602.1

Zakaria, Z. & Aziz, N. A. (2018). Determinants of income diversification among small-scale oil palm farmers in Malaysia. *International Journal of Academic Research in Business and Social Sciences*, **8**(7): 326-336.